

## ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED KINGDOM

May 1st, 2016 to April 30th, 2017

### *New scientific results*

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

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

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

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

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

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

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

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

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

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

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

- What constraints the hydrothermal dissolved iron isotopic signature?

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

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

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

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

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

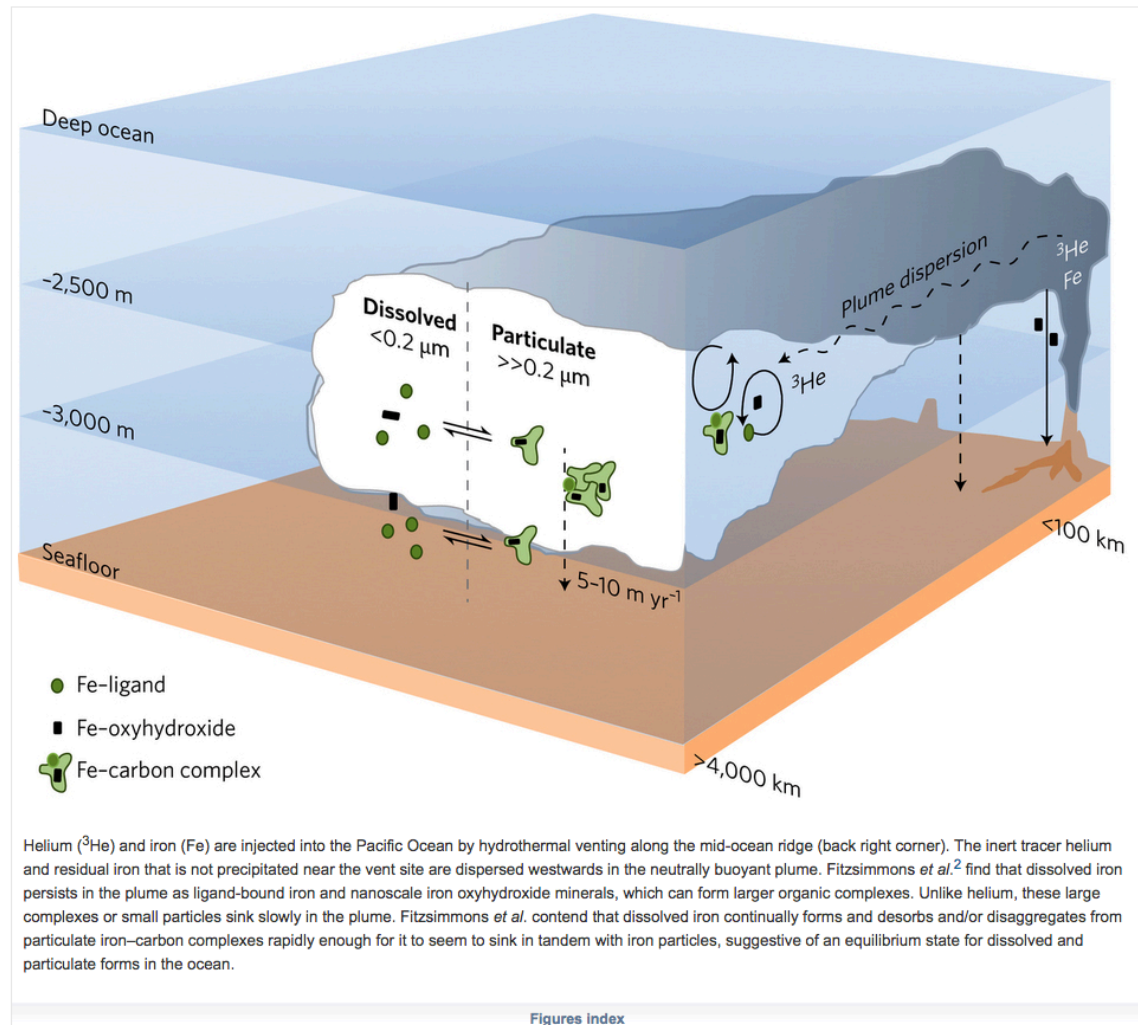
From

**Biogeochemistry: Deep ocean iron balance**

**William B. Homoky**

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

### ***New publications (published or in press)***

- Baker, A.R. & Jickells, T.D. (2016). Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). *Progress in Oceanography*, doi:10.106/j.pocean.2016.10.002.
- Baker, A.R., Landing, W.M., Bucciarelli, E., Cheize, M., Fietz, S., Hayes, C.T., Kadko, D., Morton, P.L., Rogan, N., Sarthou, G., Shelley, R.U., Shi, Z., Shiller, A. & van Hulten, M.M.P. (2016). Trace element and isotope deposition across the air-sea interface: progress and research needs. *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.2016.0190.
- Boyd, P.W., Ellwood, M., Tagliabue, A. & Twining, B.S. (2017). Biotic and abiotic retention, recycling, and remineralisation of metals in the ocean. *Nature Geoscience*, doi:10.1038/ngeo2876.
- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M.C., Baker, A.R., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., Rijkenberg, M.J.A., Gerringa, L.J.A. & de Baar, H.J.W. (2016). Return of naturally sourced Pb to Atlantic surface waters. *Nature Communications*, 7, doi:10.1038/ncomms12921.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Murphy, K., Khondoker, R., Baker, A.R., Chance, R. & Achterberg, E.P. (2017). The Cd isotope composition of atmospheric aerosols from the Tropical Atlantic Ocean. *Geophysical Research Letters*, 44, doi:10.1002/2017GL0272748.
- Casacuberta, N., Masqué, P., Henderson, G., Rutgers van der Loeff, M., Bauch, D., Vockenhuber, C., Daraoui, A., Walther, C., Synal, H.A. & Christl, M. (2016). First <sup>236</sup>U data from the Arctic Ocean and use of <sup>236</sup>U/<sup>238</sup>U and <sup>129</sup>I/<sup>236</sup>U as a new dual tracer. *Earth and Planetary Science Letters*, 440, doi:10.1016/j.epsl.2016.02.020.
- Charette, M.A., Lam, P.J., Lohan, M.C., Kwon, E.Y., Hatje, V., Jeandel, C., Shiller, A.M., Cutter, G.A., Thomas, A., Boyd, P.W., Homoky, W.B., Milne, A., Andersson, P.S., Porcelli, D., Geibert, W. & Orellana, J.G. (2016). Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learnt from GEOTRACES. *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.20160076.
- German, C.R., Casciotti, K.A., Dutay, J.-C., Heimbürger, L.E., Jenkins, W.J., Measures, C.I., Mills, R.A., Obata, H., Schlitzer, R., Tagliabue, A., Turner, D.R., Whitby, H. (2016). Hydrothermal impacts on trace element and isotope ocean biogeochemistry. *Phil. Trans. R. Soc. A*, 374, (2081), doi:10.1098/rsta.2016.0035.
- Henderson, G.M. (2016). Ocean Trace Element Cycles. *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.2015.0300.
- Homoky, W.B. (2017). Biogeochemistry: Deep ocean iron balance. *Nature Geoscience*, 10, 162-163, doi:10.1038/ngeo2908.
- Homoky, W.B., Weber, T., Berelson, W.M., Conway, T.M., Henderson, G.M., van Hulten, M., Jeandel, C., Severmann, S. & Tagliabue, A. (2016). Quantifying Trace Element and Isotope Fluxes at the Ocean-sediment Boundary: A Review. *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.2016.0246.
- Jickells, T.D., Buitenhuis, E.T., Altieri, K., Baker, A.R., Capone, D., Duce, R.A., Dentener, F., Fennel, K., Kanakidou, M., LaRoche, J., Lee, K., Liss, P.S., Middelburg, J.J., Moore, J.K., Okin, G., Oschlies, A., Sarin, M., Seitzinger, S., Sharples, J., Singh, A.,

- Suntharalingam, P., Uematsu, M. & Zamora, L.M. (2017). A re-evaluation of the magnitude and impacts of anthropogenic atmospheric nitrogen inputs on the ocean. *Global Biogeochemical Cycles*, 31, doi:10.1002/2016GB005586.
- Klar, J.K., Homoky, W.B., Statham, P.J., Birchill, A.J., Harris, E.L., Woodward, E.M.S., Silburn, B., Cooper, M.J., James, R.H., Connelly, D.P., Chever, F., Lichtschlag, A. & Graves, C. (2017). Stability of dissolved and soluble Fe(II) in shelf sediment pore waters and release to an oxic water column. *Biogeochemistry*, 1-19, doi:10.1007/s10533-017-0309-x.
  - Lough, A.J.M., Klar, J.K., Homoky, W.B., Comer-Warner, S.A., Milton, J.A., Connelly, D.P., James, R.H. & Mills, R.A. (2017). Opposing authigenic controls on the isotopic signature of dissolved iron in hydrothermal plumes. *Geochimica et Cosmochimica Acta*, 202, 1-20, doi:10.1016/j.gca.2016.12.022.
  - Milne, A.M., Schlosser, C., Wake, B., Achterberg, E.P., Chance, R., Baker, A., Forryan, A. & Lohan, M.C. (2017). Particulate phases are key in controlling dissolved iron concentrations in the (sub)tropical North Atlantic. *Geophysical Research Letters*, 44, doi:10.1002/2016GL072314.
  - Moore, C.M. (2016). Diagnosing oceanic nutrient deficiency. *Phil. Trans. R. Soc. A*, 374 (2081), doi:1098/rsta.2015.0290.
  - Myriokefalitakis, S., Nenes, A., Baker, A.R., Mihalopoulos, N. & Kanakidou, M. (2016). Bioavailable atmospheric phosphorous supply to the global ocean: a 3-D global modelling study. *Biogeosciences*, 13, 6519-6543, doi:10.5194/bg-13-6519-2016.
  - Osborne A.H., Hathorne, E.C., Schijf, J., Plancherel, Y., Boening, P. & Frank M. (2017). The potential of sedimentary foraminiferal rare earth element patterns to trace water masses in the past. *Geochemistry, Geophysics, Geosystems*, doi:10.1002/2016GC006782.
  - Shelley, R.U., Wyatt, N.J., Tarran, G.A., Rees, A.P., Worsfold, P.J. & Lohan, M.C. (2016). A tale of two gyres: Contrasting distributions of dissolved cobalt and iron in the Atlantic Ocean. *Progress in Oceanography*, doi:10.1016/j.pcean.2016.10.013.
  - Tachikawa K., Arsouze, T., Bayon, G., Bory, A., Colin, C., Dutay, J.-C., Frank, N., Giraud, X., Gurlan, T., Jeandel, C., Lacan, F., Meynardier, L., Montagna, P., Piotrowski, A., Plancherel, Y., Puceat, E., Roy-Barman, M. & Waelbroeck, C. (2017). The large-scale evolution of neodymium isotopic composition in the global modern and Holocene ocean revealed from seawater and archive data. *Chemical Geology*, doi:10.1016/j.chemgeo.2017.03.018.
  - Tagliabue, A. & Resing, J. (2016). Impact of hydrothermalism on the ocean iron cycle. *Phil. Trans. R. Soc. A*, 374 (2081), doi:1098/rsta.2015.0291.
  - Tagliabue, A., Bowie, A.R., Boyd, P.W., Buck, K.N., Johnson, K.S. & Saito, M.A. (2017). The integral role of iron in ocean biogeochemistry, *Nature*, doi:10.1038/nature21058.
  - Vance, D., Little, S.H., Archer, C., Cameron, V., Andersen, M.B., Rijkenberg, M.J. & Lyons, T.W. (2017). The oceanic budgets of nickel and zinc isotopes: the importance of sulfidic environments as illustrated by the Black Sea. *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.20150294.
  - Vance, D., Little, S.H., de Souza, G.F., Khatiwala, S.P., Lohan, M.C. & Middag, R. (2017). Coupling the oceanic biogeochemical cycles of silicon and zinc through the southern ocean. *Nature Geoscience*, 10(3), 202-206, doi:10.1038/NGEO2890.

- van de Flierdt, T., Griffiths, A.M., Lambelet, M., Little, S.H., Stichel, T., & Wilson, D.J. (2016). Neodymium in the oceans: a global database, a regional comparison and implications for palaeoceanographic research *Phil. Trans. R. Soc. A*, 374 (2081), doi:10.1098/rsta.20150293.
- van Hulst, M., Middag, R., Dutay, J.-C., de Baar, H., Roy-Barman, M., Gehlen, M., Tagliabue, A. & Sterl, A. (2017). Manganese in the west Atlantic Ocean in the context of the first global ocean circulation model of manganese, *Biogeosciences*, 14, 1123-1152, doi:10.5194/bg-14-1123-2017.
- Zheng, X.Y., Plancherel, Y., Saito, M.A., Scott, P.M. & Henderson, G.M. (2016). Rare Earth Elements (REEs) in the tropical South Atlantic and quantitative deconvolution of their non-conservative behavior. *Geochimica et Cosmochimica Acta*, 177, doi:10.1016/j.gca.2016.01.018.

### ***Cruises***

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

### ***New projects and/or funding***

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

### ***PhD theses***

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

## *Meetings*

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

- W.B. Homoky et al. (NERC SSB: WP3 and collaborators). ‘Sediments as a source of iron to the water-column’.
- Aquatic Sciences meeting, Honolulu, February/March 2017
  - W.B. Homoky, T.M. Conway, S.G. John, E.M.S. Woodward & R.A. Mills. ‘Model evaluations of pore water iron isotope signatures in the South Atlantic Ocean - implications of benthic exchange’.
- Geochemistry in Progress Meeting (GGRiP), Bristol, April 2017
  - Presentations by A. Griffiths, M. Lambelet and S. Little (Imperial College London)

### ***Outreach activities***

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

Homoky, W.B. (2016). Elements for life: efforts to measure iron release from the seafloor. *Ocean Challenge* 21(2), 20-27.
- Blog piece covering conference/field-trip designed to ‘hook’ new audiences to GEOTRACES activities:
 

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

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

### ***Other activities***

- Tina van de Flierdt hosted the annual Standards and Intercalibration (S&I) committee meeting in January 2017 in London, and Maeve Lohan co-chaired the meeting. Both attended/co-chaired an additional five virtual S&I meetings in the reporting period in order to get ready for the release of IDP2017. Maeve Lohan attended additional meetings with the Data Management Committee (DMC), co-chaired by Alessandro Tagliabue. Both attended the annual DMC and Science Steering Committee (SSC) meeting in Toulouse.
- Together with other international GEOTRACES scientists, Gideon Henderson and Maeve Lohan co-edited a volume of the *Philosophical Transactions of the Royal Society A*. The volume contains results from the Royal Society discussion meeting on ‘Biological and climatic impacts of ocean trace element chemistry’ held in December 2015 in London (see list of publications).

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