

## ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED KINGDOM

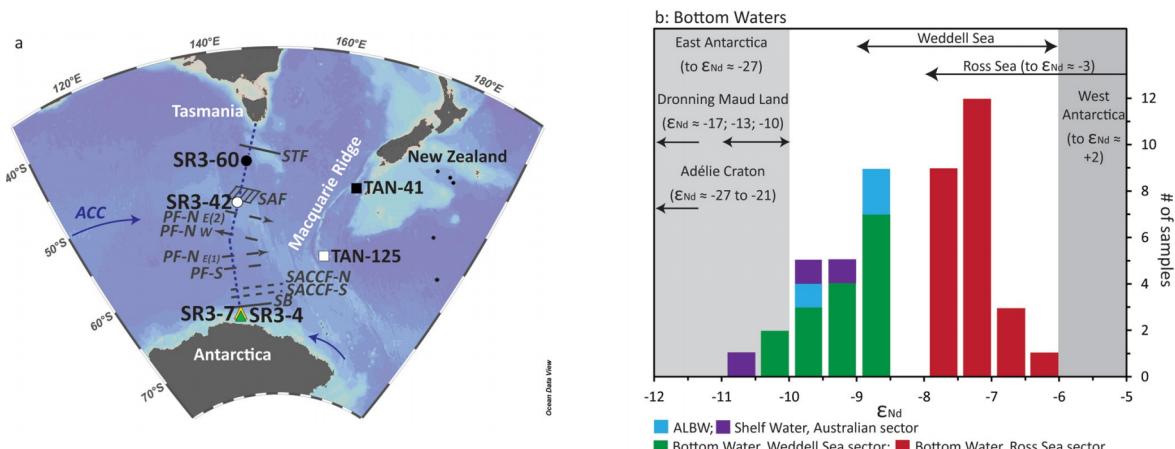
April 1st, 2018 to March 31th, 2019

### **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  $\epsilon_{\text{Nd}}$  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.

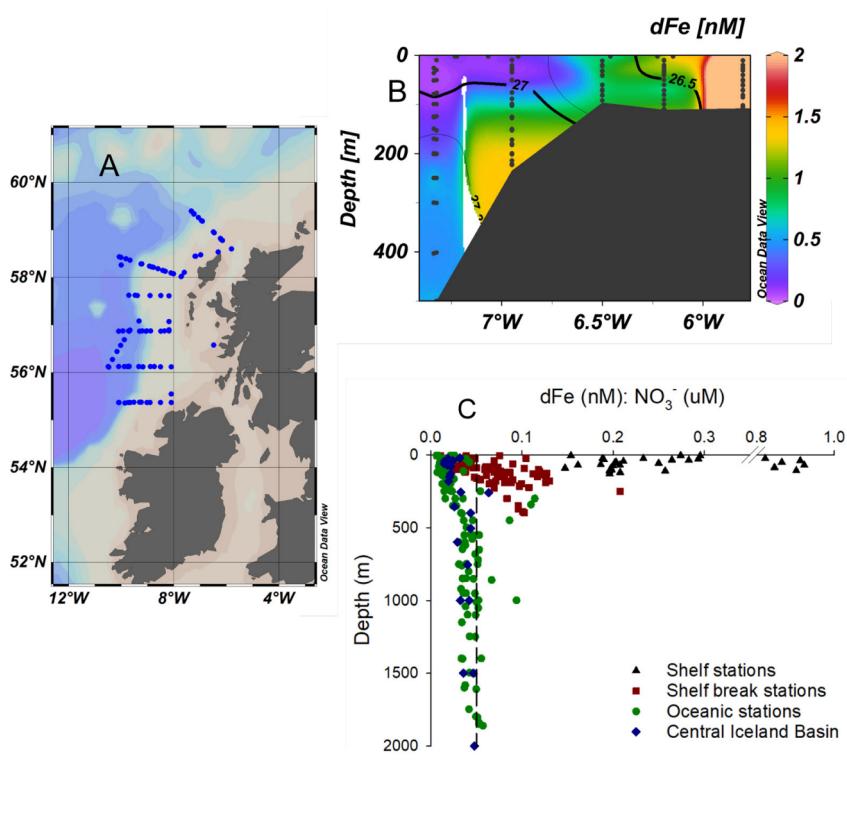
<http://www.geotraces.org/science/science-highlight/1627-local-geologies-imprint>

- 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 (GAp04). 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<sub>3</sub><sup>-</sup>, 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<sub>3</sub><sup>-</sup> (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 <sup>231</sup>Pa and <sup>230</sup>Th in freshly ventilated waters with CFC ages enables testing of the <sup>231</sup>Pa/<sup>230</sup>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 Taipei 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), Geotrace 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 activity 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  $^{231}\text{Pa}$  and  $^{230}\text{Th}$  in Overflow Waters of the North Atlantic, *Biogeosciences* 15, 7299-7313, doi:10.5194/bg-15-7299-2018.
- de Souza G.F., Khatriwala S.P., Hain M.P., Little S.H., Vance D. (2018), On the origin of the marine zinc-silicon correlation, *Earth and Planetary Science Letters*, 492, 22-34, doi: 10.1016/j.epsl.2018.03.050.
- Grand, M. M., et al. (incl. Tagliabue, A.) (2019), Developing Autonomous Observing Systems for Micronutrient Trace Metals, *Frontiers in Marine Science*, 6, doi:10.3389/fmars.2019.00035.
- Hayes C., Anderson R.F., Cheng H., Conway T.M., Edwards R., Fleisher M.Q., Huang K-F., John S.G., Landing W.M., Little S.H., Lu Y., Morton P.L., Moran S.B., Robinson L.F., Shelley R.U., Shiller A.M., Zheng X-Y (2018), Oceanic residence times of a spectrum of elements based on thorium supply, *Global Biogeochemical Cycles*, 32 (9), doi:10.1029/2017GB005839.
- Hawco, N. Lam, P.J., Lee, J-M., Ohnemus, D.C., Noble, A.E., Wyatt, N.J., Lohan, M.C., Saito, M.A. (2018), Cobalt scavenging in the mesopelagic ocean and its influence on global mass balance: Synthesizing water column and sedimentary fluxes, *Marine Chemistry*, 201, 151-166, doi:10.1016/j.marchem.2017.09.001.

- Khondoker, R., Weiss, D., van de Flierdt, T., Rehkämper, M., Kreissig, K., Coles, B.J., Strekopytov, S., Humphries-Williams, E., Dong, S., Bory, A., Bout-Roumazeilles, V., Smichowski, P., Cid-Agüero, P., Babinski, M., Losno, R., Monna, F. (2018), New constraints on elemental and Pb and Nd isotope compositions of South American and Southern African aerosol sources to the South Atlantic Ocean, *Chemie der Erde*, 78, 372-384, doi:10.1016/j.chemer.2018.05.001.
- 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, *Geophysical Research Letters*, 45(20), 11247-11256, doi:10.1029/2018GL080074.
- Lohan, M.C. and Tagliabue, A. (2018), Oceanic Micronutrients: Trace Metals that are Essential for Marine Life, *Elements*, 14(6), 385-390, doi:10.2138/gselements.14.6.385.
- Lough, A.J.M., Homoky, W.B., Connelly, D.P., Comer-Warner, S.A., Nakamura, K., Abyaneh, M.K., Kaulich, B., Mills, R.A. (in press), Soluble iron conservation and colloidal iron dynamics in a hydrothermal plume, *Chemical Geology*, doi: 10.1016/j.chemgeo.2019.01.001.
- Mahowald, N.M., Hamilton, D.S., Mackey, K.R.M., Moore, J.K., Baker, A.R., Scanza, R.A., Zhang, Y. (2018), Aerosol trace metal leaching and impacts on marine microorganisms, *Nature Communications*, 9, 2614, doi: 10.1038/s41467-018-04970-7.
- Ducklow, H.W., Stukel, M.R., Eveleth, R., Doney, S.C., Jickells, T., Schofield, O., Baker, A.R., Brindle, J., Chance, R., Cassar, N. (2018), Spring-summer net community production, new production, particle export and related water column biogeochemical processes in the marginal sea ice zone of the Western Antarctic Peninsula 2012-2014, *Philosophical Transactions of the Royal Society A*, 376, 20170177, doi:10.1098/rsta.2017.0177.
- Little S.H., Archer C., Milne A., Schlosser C., Achterberg E., Vance D. (2018), Paired dissolved and particulate phase Cu isotope distributions in the South Atlantic, *Chemical Geology*, 502, 29-43, doi:10.1016/j.chemgeo.2018.07.022.
- 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.U., Bowie, A., Perron, M.M.G., Duce, R.A. (2018), The GESAMP atmospheric iron deposition model intercomparison study, *Biogeosciences*, 15, 6659-6684, doi: 10.5194/bg-15-6659-2018.
- Ng, H.C., Robinson, L.F., McManus, J.F., Mohamed, K.J., Jacobel, A.W., Ivanovic, R.F., Gregoire, L.J., Chen, T. (2018), Coherent deglacial changes in western Atlantic Ocean circulation, *Nature Communications*, 9 (1), 2947, doi:10.1038/s41467-018-05312-3.
- Rusieka, D., Gledhill, M., Milne, A., Achterberg, E.P., Annet, A.L. Atkinson, S., Birchill, A., Kartensen, J., Lohan, M.C., Mariez, C., Middag, R., Rolison, J.M., Tanhua, T., Ussher, S., Connelly, D. (2018), Long range transport and sediment release of Pb in the North East Atlantic. *Geophysical Research Letters*, 45, 2734-2743, doi:10.1002/2017GL076825.
- Scanza, R.A., Hamilton, D.S., Perez Garcia-Pando, C., Buck, C., Baker, A., Mahowald, N.M. (2018). Atmospheric processing of iron in mineral and combustion aerosols, *Atmospheric Chemistry and Physics*, 18 (19), 14175-14196, doi: 10.5194/acp-18-14175-2018.

- Schlitzer, R. and ~300 co-authors (2018), The GEOTRACES Intermediate Data Product 2017, *Chemical Geology*, 493, 210-223, doi: 10.1016/j.chemgeo.2018.05.040.
- Schlosser, C., Schmidt, K., Aquilina, A., Homoky, W.B., Castrillejo, M., Mills, R., Patey, M., Fielding, S., Atkinson, A., Achterberg, E.P. (2018), Mechanisms of dissolved and labile particulate iron supply to shelf waters and phytoplankton blooms off South Georgia, Southern Ocean, *Biogeosciences*, 15(16), 4973-4993, doi:10.5194/bg-2017-299.
- Shi, J., Wang, N., Gao, H., Baker, A.R., Yao, X., Zhang, D. (2019), Phosphorus solubility in aerosol particles related to particle sources and atmospheric acidification in Asian continental outflow, *Atmospheric Chemistry and Physics*, 19 (2), 847-860, doi:10.5194/acp-19-847-2019.
- Vincent, A. G., Pascal, R.W., Beaton, A.D., Walk, J., Hopkins, J.E., Woodward, E.M.A., Mowlem, M., Lohan, M.C. (2018), Nitrate drawdown during a shelf sea spring bloom revealed using a novel microfluidic in situ chemical sensor deployed within an autonomous underwater glider, *Marine Chemistry*, 205, 29-36, doi:10.1016/j.marchem.2018.07.005.
- Weber, T., John, S., Tagliabue, A., DeVries, T. (2018), Biological uptake and reversible scavenging of zinc in the global ocean, *Science*, 361, 6397, 72-76, doi: 10.1126/science.aap8532.
- Worsfold, P.J., Achterberg, E.A., Birchill, A.J., Clough, R., Leito, I., Lohan, M.C., Milne, A., Ussher, S.J. (2019), Estimating uncertainties in oceanographic methods. *Frontiers in Marine Science*, 5, 515, doi:10.3389/fmars.2018.00515.
- Xie, R.C., Rehkämper, M., Grasse, P., van de Flierdt, T., Frank, M. (2019), Isotopic evidence for complex biogeochemical cycling of Cd in the eastern tropical South Pacific, *Earth and Planetary Science Letters*, 512, 134-146, doi:10.1016/j.epsl.2019.02.001.
- Yodle, C. and Baker, A.R. (2019), Influence of collection substrate and extraction method on the speciation of soluble iodine in atmospheric aerosols, *Atmospheric Environment*, X 1, 100009, doi:10.1016/j.aeaoa.2019.100009.

### ***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, ‘Silicon isotopes in Patagonian Rivers: Investigating how variable glacial cover affects the biogeochemical cycling of silicon.’
- 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 from 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. Tarhan, 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  $^{231}\text{Pa}/^{230}\text{Th}$  ratio record information about rates of ocean circulation?’
- K. Hendry, ‘Probing the silicon cycle with novel isotope systems.’

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