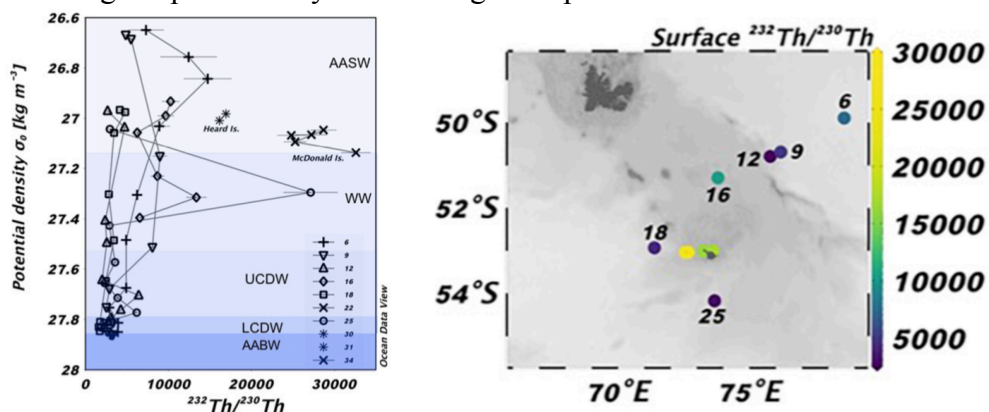


ANNUAL REPORT ON GEOTRACES ACTIVITIES IN AUSTRALIA

April 1st, 2019 to March 31st, 2020

New GEOTRACES or GEOTRACES relevant scientific results

- New research by Perez-Tribouillier et al. highlights results from GEOTRACES process study (GIpr05) around Heard and McDonald Islands on the Kerguelen Plateau in the Southern Indian Ocean. This work quantified the input of lithogenic iron to this region using long lived thorium isotopes. High concentrations of lithogenically-derived ^{232}Th were observed close to Heard and McDonald Islands, and in subsurface waters influenced by transport from the plateau (see below). By combining thorium residence times estimated from ^{230}Th measurements with measurements of ^{232}Th , the authors calculated the input of lithogenic material, and of lithogenically-derived dissolved iron. The calculated fluxes of dissolved support previous assessments, based on independent methods, which suggested dissolution of lithogenic iron represents a missing component in the iron budget for this region and an important source of soluble iron to support biological productivity on the Kerguelen plateau.



Citation: Pérez-Tribouillier, H., Noble, T.L., Townsend, A.T., Bowie, A.R., Chase, Z., 2020. Quantifying Lithogenic Inputs to the Southern Ocean Using Long-Lived Thorium Isotopes. *Front. Mar. Sci.* 7, 7. doi:10.3389/fmars.2020.00207

GEOTRACES or GEOTRACES relevant cruises

The Southern Ocean Time Series (SOTS; GIpr08) 2020 voyage was postponed due to the COVID-19 pandemic. A shorter SOTS voyage is planned for July 2020 to recover and turn around the moorings.

New projects and/or funding

- Australian Antarctic Program Partnership is funded for 10 years by the Australian Government's Department of Industry, Innovation and Science, through the Antarctic Science Collaboration Initiative program. Includes GEOTRACES-relevant work in Biogeochemistry and ecosystems, with GEOTRACES CIs (all from UTAS) Lannuzel, Boyd, Bowie and Strzepek.
- Australian Research Council funded Australian Centre for Excellence in Antarctic Science: A partnership between many Australian and international Universities and

institutions including The University of Tasmania (GEOTRACES CIs Bowie, Chase, Lannuzel and Boyd) and The Australian National University (GEOTRACES CI Ellwood). Expected to start in January 2021 and run for 3 years. Multidisciplinary centre that includes GEOTRACES-relevant work on Antarctic and Southern Ocean biogeochemistry.

- Delphine Lannuzel (University of Tasmania) was awarded an Australian Research Council Future Fellowship for the project “Ocean fertilisation: a positive effect from Antarctica’s great thaw?”

GEOTRACES workshops and meetings organised

- Andrew Bowie and Reiner Schlitzer organised a workshop entitled “Ocean Data View Workshop: Exploring GEOTRACES and other environmental data” held at Institute for Marine and Antarctic Studies at the University of Tasmania, 4 – 5 September 2019
- The Institute for Marine and Antarctic Studies at the University of Tasmania (Zanna Chase and Andrew Bowie) hosted the 2019 meetings of the GEOTRACES Data Management Committee (7 – 8 September) and Scientific Steering Committees (9 – 11 September)
- Zanna Chase, Andrew Bowie and Philip Boyd organised a GEOTRACES workshop entitled “Southern Ocean Biogeochemistry” held at the Institute for Marine and Antarctic Studies at the University of Tasmania on September 12 & 13

Outreach activities conducted

- Habacuc Pérez-Tribouillier gave a public lecture hosted by The Royal Society of Tasmania entitled “It’s not only bad news: how radioactivity is used to study the ocean” on 5 November 2019
- Andrew Bowie, GEOTRACES and Southern Ocean iron biogeochemistry – where have we come? Ocean University of China, College of Ocean and Atmospheric Sciences, 23 May 2019

New GEOTRACES or GEOTRACES-relevant publications (published or in press)

- Cabanes, D.J.E., L. Norman, A. R. Bowie, S. Strmecki, C.S. Hassler, 2019. Electrochemical evaluation of iron-binding ligands along the Australian GEOTRACES southwestern Pacific section (GP13). (2020). *Marine Chemistry* Volume 219.
- Ellwood, M.J., Strzepak, R.F., Strutton, P.G., Trull, T.W., Fourquez, M., Boyd, P.W. (2020). Distinct iron cycling in a Southern Ocean eddy. *Nat. Commun.* 11, 1-8.
- Ellwood, M.J., Strzepak, R., Chen, X., Trull, T.W., Boyd, P.W. (2020). Some observations on the biogeochemical cycling of zinc in the Australian sector of the Southern Ocean: a dedication to Keith Hunter. *Marine and Freshwater Research* 71, 355-373.
- 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, MM., Laes-Huon, A., Fietz, S., Resing, JA., Obata, H., Luther III, GW., Tagliabue, A., Achterberg, EP., Middag, R., Tovar-Sanchez, A., and Bowie, AR, (2019).

Developing autonomous observing systems for micronutrient trace metals, *Frontiers in Marine Science*, 6 Article 35.

- Ito, A., Myriokefalitakis, S., Kanakidou, M., Mahowald, N.M., Scanza, R.A., Hamilton, D.S., Baker, A.R., Jickells, T., Sarin, M., Bikkina, S., Gao, Y., Shelley, R.U., Buck, C.S., Landing, W.M., and Bowie, A.R., Perron, M.M.G., Gulieu, C., Meskhidze, N., Johnson, M.S., and Feng, Y., Kok, J.F., Nenes, A., Duce, R.A., (2019), Pyrogenic iron: the missing link to high iron solubility in aerosols, *Science Advances*, 5 (5) Article eaau7671.
- Louropoulou, E., Gledhill, M., Browning, T.J., Desai, D.K., Menzel Barraqueta, J-L., Tonnard, M., Sarthou, G., Planquette, H., Bowie, A.R., Schmitz, R.A., LaRouche, J., and Achterberg, E.P., (2019), Regulation of the phytoplankton heme b iron pool during the North Atlantic spring bloom, *Frontiers in Microbiology*, 10 (JULY) Article 1566.
- Meyerink, S.W., Boyd, P.W., Maher, W.A., Milne, A., Strzepek, R., Ellwood, M.J. (2019). Putting the silicon cycle in a bag: Field and mesocosm observations of silicon isotope fractionation in subtropical waters east of New Zealand. *Mar. Chem.* 213, 1-12.
- Pérez-Tribouillier, H., Noble, T.L., Townsend, A.T., Bowie, A.R., Chase, Z., 2020. Quantifying Lithogenic Inputs to the Southern Ocean Using Long-Lived Thorium Isotopes. *Front. Mar. Sci.* 7, 7. doi:10.3389/fmars.2020.00207
- Perron, M.M.G., Strzelec, M., Gault-Ringold, M., Proemse, B.C., Boyd, P.W., and Bowie, A.R., (2020), Assessment of leaching protocols to determine the solubility of trace metals in aerosols, *Talanta*, 208 Article 120377. ISSN 0039-9140 (2020)
- Perron, M.M.G., Proemse, B.C., Strzelec, M., Gault-Ringold, M., Boyd, P.W., Sanz Rodriguez, E., Paull, B., Bowie, A.R., (2020). Origin, transport and deposition of aerosol iron to Australian coastal waters. *Atmospheric Environment*, Volume 228, 1 May 2020, 117432
- Sanz Rodriguez, E., Perron, M.M.G., Strzelec, M., Proemse, B.C., Bowie, A.R., and Paull, B., (2019), Analysis of levoglucosan and its isomers in atmospheric samples by ion chromatography with electrospray lithium cationisation - triple quadrupole tandem mass spectrometry, *Journal of Chromatography A*, 1610 Article 460557.
- Sedwick, P.N., Bowie, A.R., Church, T.M., Cullen, J.T., Johnson, R.J., Lohan, M.C., Marsay, C.M., McGullicuddy Jr, D.J., Sohst, B.M., Tabliabue, A., and Ussher, S.J., (2019), Dissolved iron in the Bermuda region of the subtropical North Atlantic Ocean: seasonal dynamics, mesoscale variability, and physicochemical speciation, *Marine Chemistry*, 219 Article 103748.
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- Strzelec, M.; Proemse, B.C.; Barmuta, L.A.; Gault-Ringold, M.; Desservettaz, M.; Boyd, P.W.; Perron, M.M.G.; Schofield, R.; Bowie, A.R. (2020), Atmospheric Trace Metal Deposition from Natural and Anthropogenic Sources in Western Australia. *Atmosphere*, 11, 474.
- Tagliabue, A., Bowie, A.R., DeVries, T., Ellwood, M.J., Landing, W.M., Milne, A., Ohnemus, D.C., Twining, B.S., Boyd, P.W. (2019). The interplay between regeneration and scavenging fluxes drives ocean iron cycling. *Nat. Commun.* 10, 4960.
- Tonnard, M., Planquette, H., Bowie, A.R., van der Merwe, P., Gallinari, M., de Gesincourt, F.D., Germain, Y., Gourain, A., Benetti, M., Reverdin, G., Treguer, P.,

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- Urban, E.R., Bowie, A.R., Boyd, P.W., Buck, K.N., Lohan, M.C., Sander, S.G., Schlitzer, R., Tagliabue, A., Turner, D., (2020) The importance of bottom-up approaches to international cooperation in ocean science: the iron story, *Oceanography*, 33 (1) pp. 11-15.
- van der Merwe, P., Trull, T.W., Goodwin, T., Jansen, P., and Bowie, A (2019), The autonomous clean environmental (ACE) sampler: a trace-metal-clean seawater sampler suitable for open-ocean time-series applications, *Limnology and Oceanography: Methods*, 17 (9) pp. 490-504.
- Whitby, H., Bressac, M., Sarthou, G., Ellwood, M.J., Guieu, C., Boyd, P.W. (2020). Contribution of Electroactive Humic Substances to the Iron-Binding Ligands Released During Microbial Remineralization of Sinking Particles. *Geophys. Res. Lett.* 47, e2019GL086685.

The data from these publications have been submitted to the GEOTRACES database.

- Janssen, D.J., Sieber, M., Ellwood, M.J., Conway, T.M., Barrett, P.M., Chen, X., de Souza, G.F., Hassler, C.S., Jaccard, S.L. (2020). Trace metal and nutrient dynamics across broad biogeochemical gradients in the Indian and Pacific sectors of the Southern Ocean. *Mar. Chem.*, 103773.
- Sieber, M., Conway, T.M., de Souza, G.F., Hassler, C.S., Ellwood, M.J., Vance, D. (2020). Cycling of zinc and its isotopes across multiple zones of the Southern Ocean: Insights from the Antarctic Circumnavigation Expedition. *Geochim. Cosmochim. Acta* 268, 310–324.
- Sieber, M., Conway, T.M., de Souza, G.F., Hassler, C.S., Ellwood, M.J., Vance, D. (2019). High-resolution Cd isotope systematics in multiple zones of the Southern Ocean from the Antarctic Circumnavigation Expedition. *Earth and Planetary Science Letters* 527, 115799.
- Rickli, J., Janssen, D., Hassler, C., Ellwood, M., Jaccard, S. (2019). Chromium biogeochemistry and stable isotope distribution in the Southern Ocean. *Geochim. Cosmochim. Acta* 262, 188-206.

Completed GEOTRACES PhD or Master theses

- Pérez-Tribouillier, H.U. 2020. PhD Thesis, The University of Tasmania. Dissolved thorium, rare earth elements and neodymium isotopic composition in the Kerguelen Plateau: method development and application to quantify and trace lithogenic inputs. Supervisors: Zanna Chase, Andrew Bowie, Taryn Noble and Ashely Townsend
- Perron, M. 2020. PhD Thesis, The University of Tasmania. Natural iron fertilization of oceans around Australia: linking terrestrial aerosols to ocean biogeochemistry. Supervisors: Andrew Bowie, Philip Boyd, Bernadette Proemse and Melanie East

GEOTRACES presentations in international conferences

- Morgane M.G. Perron, Melanie Gault-Ringold, Bernadette Proemse, Philip W. Boyd, Andrew R. Bowie. 2019. Aerosol Iron transport and deposition to the ocean around Australia. SOLAS Open Science Conference, Sapporo, Japan, 21-25 April 2019
- Aflenzer H., Wuttig K., van der Merwe P., Boyd P.W., Bowie A.R., 2019. Fe(II) availability for phytoplankton in a future Southern Ocean, EGU General Assembly 2019.
- Llorc, J., Matear, R., Strutton, P., and Chase, Z., 2019. Decadal changes in phytoplankton induced by drought -enhanced dust storms, IUGG General Assembly, Montreal, July 8 – 18 2019

Goldschmidt

- Pauline Latour, Kathrin Wuttig, Pier Van der Merwe, Robert Strzepek and Andrew Bowie, Manganese: A Key Trace Metal in the Southern Ocean? Goldschmidt 2019, Barcelona August 2019.
- M. Strzelec, B.C. Proemse, M. Gault-Ringold, P.W. Boyd, M.M.G. Perron, A.R. Bowie, 2019. Quantifying anthropogenic and natural iron deposition across Australia. Goldschmidt 2019, Barcelona Spain, August 18-23, 2019
- K. Wuttig, Holmes, T., P. L. Croot, M. Gault-Ringold, Heller, M. I., P. Van Der Merwe, C. Schallenberg, A. T. Townsend And A. Bowie, 2019. Iron-cycling in various environments. Goldschmidt 2019, Barcelona Spain, August 18-23, 2019

The Kerguelen Plateau: Marine Ecosystems and Fisheries. Proceedings of the second symposium.

- Obernosterer, I., S. Blain, P. Debeljak, A. Bowie, P. van der Merwe, T. Holmes and M. Tonnard. 2019. Role of particle-attached bacteria in rendering iron and carbon bioavailable. pp 125.
- Schallenberg, C., S. Bestley, A. Klocker, D. Davies, R. Eriksen, M. Gault-Ringold, M. Sumner, A. Townsend, T.W. Trull, P. van der Merwe, K. Westwood, K. Wuttig and A. Bowie. 2019. Sustained upwelling of subsurface iron supplies seasonally persistent phytoplankton blooms around the southern Kerguelen Plateau, Southern Ocean. pp 129-130
- van der Merwe, P., K. Wuttig, T. Holmes, Z. Chase, T. Trull and A. Bowie. 2019. Trace metal bioavailability is greater of particles sourced from glacial erosion than hydrothermalism in the Southern Ocean. pp 131-132
- Holmes, T., K. Wuttig, Z. Chase, P. van der Merwe, C. Schallenberg, A. Townsend and A. Bowie. 2019. Dissolved iron sources and impact on productivity at Heard Island and McDonald Islands, Kerguelen Plateau. pp 133-134

Ocean Sciences 2020

- Aflenzer H., Boyd P., van der Merwe P., Wuttig K., Bowie A., 2020. Iron(II) concentrations and availability for phytoplankton – Multiple stressor studies of a future Southern Ocean. Ocean Sciences 2020, San Diego, USA, 16-21 February.

- Pauline Latour, Kathrin Wuttig, Robert F Strzeppek, Pier van der Merwe, Andrew R Bowie, 2020. Manganese limitation of phytoplankton in the Southern Ocean. Ocean Sciences 2020, San Diego, USA, 16-21 February.
- Joan Llorc, Richard J. Matear and Pete G. Strutton. Decadal Changes In Phytoplankton Induced By Drought-Enhanced Dust Storms. Ocean Sciences 2020, San Diego, USA, 16-21 February
- Thomas M. Holmes, Kathrin Wuttig, Zanna Chase, Christina Schallenberg, Pier van der Merwe, Ashley T. Townsend, Andrew R. Bowie, 2020. Glacial and hydrothermal sources of dissolved iron(II) in Southern Ocean waters surrounding Heard and McDonald Islands. Ocean Sciences 2020, San Diego, USA, 16-21 February.

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