

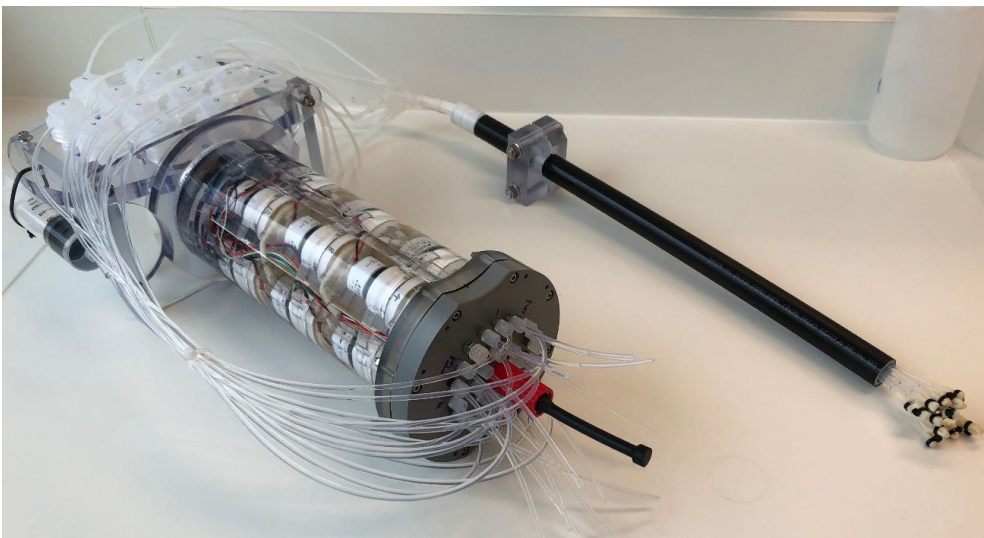
## ANNUAL REPORT ON GEOTRACES ACTIVITIES IN AUSTRALIA

May 1st, 2017 to March 30th, 2018

### ***New scientific results***

Pier Van Der Merwe, Andy Bowie and colleagues have developed a trace metal clean seawater sampler suitable for 1 year deployments on oceanographic moorings. Twelve samples per unit can be programmed to collect 65 ml of seawater at any time interval. The sample path is made entirely out of Savillex Teflon and 1m intake tubes allow uncontaminated sampling in upstream water. Samples are drawn into the sampling containers via micro-peristaltic pumps. The unit itself is non-contaminating, being made of polycarbonate, Teflon and titanium. The system is pressure compensated and has successfully been tested to 100 m. Blank testing of the system deployed in the Southern Ocean during Geotraces voyage GA01 in January 2018 revealed no significant difference between an industry standard trace metal rosette in the 100 pM range, proving its capability at collecting uncontaminated samples in the oligotrophic open ocean.

A spin off project saw the “TM sampler” partially redesigned for rapid turnaround deployments on the Australian Maritime College autonomous underwater vehicle, ‘*nupiri muka*’ with funding made available through the Antarctic Gateway Project and the Antarctic Climate and Ecosystems CRC, University of Tasmania. During testing, the TM sampler was mounted within the AUV, with its intake tubes extending outside of the turbulent flow around the AUV’s hull (see image) to avoid contamination. Samples were successfully collected during a test deployment in an estuary. Testing will continue through 2018 with the ultimate goal of deployment under the Sordsal Glacier in Antarctica during the 2018-2019 field season. If successful, this collaboration will shed light on the fertilisation potential of ice shelf water as well as quantify sub-glacial, melt water trace metal concentrations. As our climate warms and our ice shelves lose mass, this fertilisation pathway may dramatically change into the future. Therefore, observations of this process will enable prediction of Southern Ocean productivity with flow on impacts on global climate.





### ***Cruises***

- Completion of the Australian SR3-GEOTRACES section voyage in the Southern Ocean. GEOTRACES section GS01 was completed along the SR3 line (approximately 140°E) from Hobart (Tasmania, Australia) to the Antarctic ice-edge. Scientists measured TEIs, nutrients, the carbon system and ocean physics along the SR3 section over 6 weeks in January/February 2018. Measurements of trace metals and isotopes (TEIs) are scarce in the Southern Ocean, particularly on repeat sections and in deeper waters. TEI distributions on the SR3 line will be compared to expeditions in spring 2001 and late autumn 2008 to assess seasonal and longer-term changes. The section also sampled for TEIs in marine particles, and stable, radioactive and radiogenic isotopes that have not been measured before in this sector of the Southern Ocean, as well as sampling for TEIs in aerosol particles. Metagenomic analyses will be used to characterise the structure and function of the microbial community as a function of latitude and depth along the repeat transects. Steve Rintoul (CSIRO/ACE CCRC) was the Chief Scientist and Andrew Bowie (IMAS-UTAS/ACE CRC) was the GEOTRACES PI.
- Two transit voyages completed around Australia under the project “Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine Biogeochemistry” (PI Bowie) provided GEOTRACES compliant aerosol data.
- Completion of SOTS time series “Subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site”. GEOTRACES PIs: Boyd, Ellwood, Bowie. This voyage took place in March 2018 in the Subantarctic Southern Ocean south of Tasmania and follows up a similar voyage in March 2016. A number of overseas scientists participated in this GEOTRACES process study (GprI08), including Ben Twining (Bigelow Marine Labs) and members of the Barbeau (SIO) and Wilhelm (UT) labs. The focus was on particle dynamics and TEI biogeochemistry.

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

- Rintoul SR, Bowie AR, Tilbrook BD, Bodrossy L, Detecting Southern Ocean change from repeat hydrography, deep Argo and trace element biogeochemistry, CSIRO Marine National Facility, \$5625k (in kind)
- Boyd PW, Ellwood M, Bowie AR, Surface and subsurface subantarctic biogeochemistry of carbon and iron, Southern Ocean Time Series site, CSIRO Marine National Facility \$1125k (in kind)
- Ellwood M, Boyd PW, Bowie AR, Chase Z, Abbot A, Constraining external iron inputs and cycling in the southern extension of the East Australian Current, Southern Ocean Time Series site, CSIRO Marine National Facility, \$2875k (in kind)

- van der Merwe, Bowie Trull, Integration and testing of clean water sampler on ARC Antarctic Gateway Partnership Autonomous Underwater Vehicle (AUV) 'nupiri muka' (\$8256 cash)
- Chase, Meissner, Bostock, Ren and Sikes. The Southern Ocean's response to abrupt climate change, Australian Research Council \$385,650

### ***GEOTRACES workshops and meetings***

- Christina Schallenberg, Sophie Bestley, Diana Davies, Ruth Eriksen, Melanie Gault-Ringold, Andreas Klocker, Michael Sumner, Ashley Townsend, Thomas W. Trull, Pier van der Merwe, Karen Westwood, Kathrin Wuttig, Andrew Bowie. Sustained upwelling of subsurface iron supplies the phytoplankton blooms around the southern Kerguelen plateau. Symposium on Kerguelen Plateau Marine Ecosystem and Fisheries. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- Wuttig et al., 2017. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- van der Merwe, Wuttig, Holmes, Chase, Trull, Bowie, 2017. Trace metal bioavailability is greater of particles sourced from glacial erosion than hydrothermalism in the Southern Ocean. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- Coffin, Arculus, Bowie, Chase, Robertson, Trull, In2016\_V01 Science Party, 2017. Volcanism, Iron, and Phytoplankton on the Kerguelen Plateau. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania

### ***Outreach activities***

- Iron and anemia in the Southern Ocean, Poster presentations at the Festival of Bright Ideas, Hobart (Tasmania), August 2017
- Royal Society of Tasmania Winter Series public lecture by Philip Boyd, Geoengineering the Planet: Can we, should we try to offset global climate change

### ***Other activities***

- Al Tagliabue visited the Institute for Marine and Antarctic Science (IMAS) for six weeks as a University of Tasmania visiting scientist. He worked with worked with Boyd and Bowie on merging results in the Pacific basin from GEOTRACES survey and process stations. The results were presented at the Ocean Sciences Meeting in Portland.

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

- Archer, C., Andersen, M.B., Cloquet, C., Conway, T.M., Dong, S., Ellwood, M., Moore, R., Nelson, J., Rehkämper, M., Rouxel, O. and Samanta, M., 2017. Inter-calibration of a proposed new primary reference standard AA-ETH Zn for zinc isotopic analysis. *Journal of Analytical Atomic Spectrometry*, 32(2), pp.415-419.

- Boyd, P.W., Ellwood, M.J., Tagliabue, A. and Twining, B.S., 2017. Biotic and abiotic retention, recycling and remineralization of metals in the ocean. *Nature Geoscience*, 10(3), p.167.
- Buchanan, P J, R. J. Matear, Z. Chase, S J Phipps, and N.L. Bindoff. "Dynamic Biological Functioning Important for Simulating and Stabilizing Ocean Biogeochemistry." *Global Biogeochemical Cycles* 42, no. 9 (2018): 1675. doi:10.1002/2017gb005753.
- Durand, A., Z. Chase, T. Noble, H. Bostock, S. L. Jaccard, P. Kitchener, A. T. Townsend, et al. "Export Production in the New-Zealand Region Since the Last Glacial Maximum." *Earth and Planetary Science Letters* 469 (2017): 110–22. doi:10.1016/j.epsl.2017.03.035.
- Durand, A., Z. Chase, T. Noble, H. Bostock, S. L. Jaccard, A. T. Townsend, N. L. Bindoff, H. Neil, and G. Jacobsen. "Reduced Oxygenation at Intermediate Depths of the Southwest Pacific During the Last Glacial Maximum." *Earth and Planetary Science Letters* 491 (June 1, 2018): 48–57. doi:10.1016/j.epsl.2018.03.036.
- 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*, 32, doi.org/10.1002/2017GB005736. FT130100037 (2014–18)
- Genovese C, Grotti M, Pittaluga J, Ardini F, Janssens J, Wuttig K, Moreau S and Lannuzel D, 2018. Influence of the organic complexation on dissolved iron distribution in East Antarctic pack ice, *Marine Chemistry*, in press (<https://doi.org/10.1016/j.marchem.2018.04.005>).
- Hassler, C.S., van den Berg, C.M. and Boyd, P.W., 2017. Toward a regional classification to provide a more inclusive examination of the ocean biogeochemistry of iron-binding ligands. *Frontiers in Marine Science*, 4, p.19.
- Holmes, T.M., Chase Z., van Der Merwe P., Townsend A.T., Bowie A.R., 2017. Detection, dispersal and biogeochemical contribution of hydrothermal iron in the ocean, *Marine and Freshwater Research*, 68, 2184-2204, doi:10.1071/mf16335. DP150100345 (2015-17)
- Meyerink, S.W., Ellwood, M.J., Maher, W.A., Dean Price, G. and Strzepek, R.F., 2017. Effects of iron limitation on silicon uptake kinetics and elemental stoichiometry in two Southern Ocean diatoms, *Eucampia antarctica* and *Proboscia inermis*, and the temperate diatom *Thalassiosira pseudonana*. *Limnology and Oceanography*, 62(6), pp.2445-2462.
- Meyerink, S., Ellwood, M.J., Maher, W.A. and Strzepek, R., 2017. Iron Availability Influences Silicon Isotope Fractionation in Two Southern Ocean Diatoms (*Proboscia inermis* and *Eucampia antarctica*) and a Coastal Diatom (*Thalassiosira pseudonana*). *Frontiers in Marine Science*, 4, p.217.
- Ratnarajah L., Lannuzel D., Townsend A.T., Meiners K.M., Nicol S., Friedlaender A.S., Bowie A.R., 2017. Physical speciation and solubility of iron from baleen whale faecal material. *Marine Chemistry*, 294, 79-88, doi.org/10.1016/j.marchem.2017.05.004
- Ratnarajah L., Nicol S., Bowie A.R., Pelagic iron recycling in the Southern Ocean: Exploring the contribution of marine animals. *Frontiers in Marine Science* Horizon Scan 2018: Emerging Issues in Marine Science, <https://doi.org/10.3389/fmars.2018.00109>
- Samanta, M., Ellwood, M.J. and Strzepek, R.F., 2018. Zinc isotope fractionation by *Emiliania huxleyi* cultured across a range of free zinc ion concentrations. *Limnology and Oceanography*, 63(2), pp.660-671.
- Samanta, M., Ellwood, M.J., Sinoir, M. and Hassler, C.S., 2017. Dissolved zinc isotope cycling in

the Tasman Sea, SW Pacific Ocean. *Marine Chemistry*, 192, pp.1-12.

- Sutton, J.N., André, L., Cardinal, D., Conley, D.J., de Souza, G., Dean, J., Dodd, J., Ehlert, C., Ellwood, M.J., Frings, P.J. and Grasse, P., 2017. A review of the stable isotope bio-geochemistry of the global silicon cycle and its associated trace elements. *Frontiers in Earth Science*, 5, p.112.
- 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* 543, 51–59, doi:10.1038/nature21058. FT130100037 (2014-18)

***Presentations in international conferences (not a comprehensive list)***

- Wuttig K., Schallenberg C., van der Merwe P., Chase Z., Gault-Ringold M., Holmes T., Tonnard M., Townsend A., Trull T.W., Bowie A.R., 2018. From bio-essential to toxic: Trace elements around Heard and McDonald Islands and the Kerguelen Axis in the Indian Sector of the Southern Ocean. AGU/ASLO/TOS Ocean Sciences Meeting, Abstract ID: CT34A-1334, Portland (USA), 11-16 February
- Tonnard M., Gonzalez A., Whitby H., Bowie A.R., van der Merwe P., Planquette H., Boutorh J., Cheize M., Menzel J.-L., Pereira Contreira L., Shelley R., Sarthou G., 2017. Iron organic speciation in the North Atlantic Ocean and Labrador Sea along the GEOVIDE section (GEOTRACES GA01). Goldschmidt 2017, Paris (France), 13-18 August
- Chase, Z., Durand, A., Bostock, B., Jaccard, S., Neil, H., Noble, T., Townsend, A. 2017. SW Pacific export production since the Last Glacial Maximum: No evidence for iron fertilization. Goldschmidt 2017, Paris (France), 13-18 August
- Boyd co-chaired the session Abiotic and Biotic Retention, Recycling, and Remineralization of Metals in the Ocean at the AGU/ASLO/TOS Ocean Sciences Meeting in Portland, 11 – 16 February.

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