

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED KINGDOM

May 1st, 2022 to April 30th, 2023

New GEOTRACES or GEOTRACES relevant scientific results

Olivelli and co-authors (2023, see reference below) present total dissolvable lead (Pb) concentrations and isotope compositions for 23 surface waters collected in 2011 along a latitudinal transect offshore of the South American coast from Punta Arenas to the Equator (Leg 3 of the Dutch GEOTRACES GA02 section). They reveal that the mean Pb concentrations in the surface waters of the western South Atlantic Ocean decreased by 34 % between the 1990s and 2011. Pb isotope compositions also show a shift towards a more natural Pb isotope signal: 2011-samples show that natural Pb sources contributed 36 ± 6 % of the Pb present in western South Atlantic surface waters, while it was 24 ± 4 % in 1996.

As for the preceding work of the same team in the North Atlantic (Bridgestock and al, 2016 - read the science highlight here: <https://www.geotraces.org/testament-of-environmental-policies/>) these results evidence the positive effect of environmental and health policies that banned the use of leaded gasoline in South America since the 1990s.

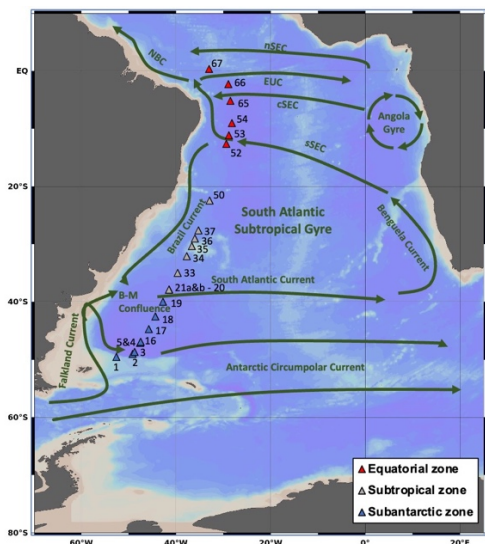
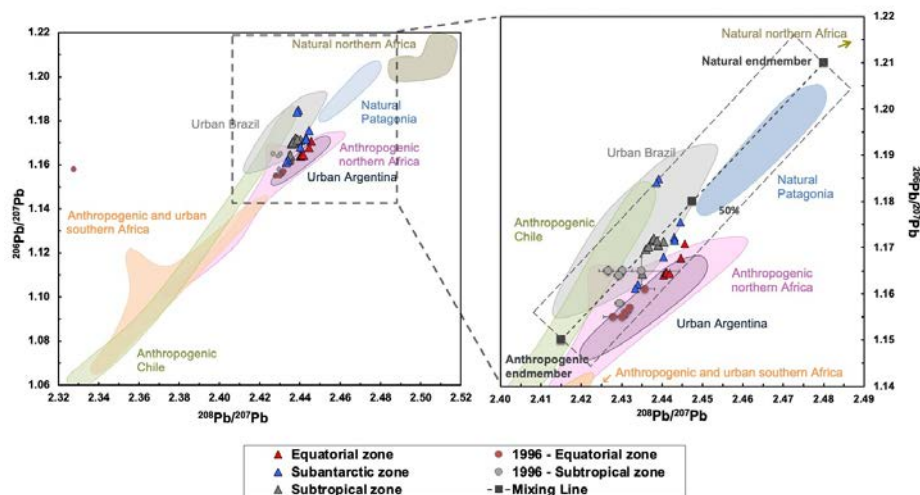


Figure UK-1: Top panel: Map of sampling locations (triangles) along GEOTRACES GA02 Leg 3, and surface currents (green arrows) in South Atlantic Ocean. Bottom panel: three-isotope plot showing the Pb isotope composition of the samples analysed in this study (triangles), historical samples (circles) and potential sources of Pb from Africa and South America (coloured fields). The mixing envelope between the inferred anthropogenic and natural endmembers shows that anthropogenic Pb is still predominant, but there is relatively more natural Pb in the 2011-samples than in those from 1996.



Olivelli, A., Murphy, K., Bridgestock, L., Wilson, D. J., Rijkenberg, M., Middag, R., Weiss, D. J., van de Flierdt, T., & Rehkämper, M. (2023). Decline of anthropogenic lead in South Atlantic Ocean surface waters from 1990 to 2011: New constraints from concentration and isotope data. *Marine Pollution Bulletin*, 189, 114798. doi:10.1016/j.marpolbul.2023.114798

Tagliabue and co-authors (reference below) bring together new year-round observations and modelling of the ocean iron cycle as part of the GEOTRACES process study GApr13 to assess the prevailing conceptual understanding of how ocean dissolved iron is regulated. They find that the changes in dissolved iron observed over the year are not consistent with prevailing control by ocean iron binding ligands. Instead, a new model is advanced that emphasises the cycling of colloidal iron phases, out of equilibrium with iron binding ligands that fuel a hitherto not well acknowledged authigenic particulate iron phase.

When represented in a global model, this new understanding permits a better reproduction of observed dissolved and particulate iron data, as well as the seasonal dynamics across dissolved, particulate and ligand bound iron phases. This introduces the production of dissolution of authigenic mineral iron as a critical determinant of the ocean inventory of iron in the ocean.

Tagliabue, A., Kristen Buck, Laura Sofen, Benjamin Twining, Olivier Aumont, Philip Boyd, Salvatore Caprara, William Homoky, Daniela König, Rod Johnson, Daniel Ohnemus, Bettina Sohst, Peter Sedwick. *Authigenic mineral phases as a driver of the upper ocean iron cycle. Nature (Accepted, In press).*

GEOTRACES or GEOTRACES relevant cruises

- PS132, September 2022, Bremerhaven – Cape Town, Aerosol chemistry and surface waters Th isotopes
- DY157 (AMT30), Feb – Mar 2023, Falkland Islands – Southampton, ditto (both as part of the NERC-funded ThorMap project)
- Forthcoming PICCOLO project to seek GEOTRACES process study

New projects and/or funding

- NERC funding project: Silicon Cycling in Glaciated Environments (SiCLING). This will start in Feb 2024, with fieldwork in Svalbard and West Antarctic Peninsula.

GEOTRACES workshops and meetings organized

- UK GEOTRACES Townhall strategy meeting conducted June 28th
- Arianna Olivelli*, Rhiannon Jones*, Amber Annett, Oscar Branson, Suzanne Robinson*, and Hana Jurikova convened Session T3: “Chemistry of nutrients, trace elements and their isotopes in the Ancient, Modern and Future Oceans” at the Challenger 150 Conference (London, September 2022).

Outreach activities conducted

- Olivelli, A. Lead in the ocean: pollution, policies and dynamics. Invited talk at the Environmental Network of the UK Department for Transport.

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

- Tagliabue, A., Kristen Buck , Laura Sofen , Benjamin Twining , Olivier Aumont , Philip Boyd , Salvatore Caprara , William Homoky , Daniela König, Rod Johnson , Daniel Ohnemus , Bettina Sohst , Peter Sedwick. Authigenic mineral phases as a driver of the upper ocean iron cycle. *Nature* (Accepted, In press).
- Moore, O.W., Lisa Curti , Clare Woulds , James Bradley , Peyman Babakhani , Benjamin Mills , William Homoky , Ke-Qing Xiao , Andrew Bray , Ben Fisher , Majid Kazemian , Burkhard Kaulich , Andy Dale , Caroline Peacock Long-term organic carbon preservation enhanced by iron and manganese. *Nature* (Accepted, In press).
- Lough, A. J. M., Tagliabue, Alessandro, et al, Tracing differences in iron supply to the Mid-Atlantic Ridge valley between hydrothermal vent sites: implications for the addition of iron to the deep ocean. *Biogeosciences*, 20(2), 405-420. 2023
- Gonzalez-Santana, D., A. J. M. Lough, H. Planquette, G. Sarthou, Alessandro Tagliabue, and M. C. Lohan, The unaccounted dissolved iron (II) sink: Insights from dFe(II) concentrations in the deep Atlantic Ocean, *Sci Total Environ*, 161179, doi:10.1016/j.scitotenv.2022.161179. 2022
- Tagliabue, Alessandro, A. J. M. Lough, C. Vic, V. Roussenov, J. Gula, M. C. Lohan, J. A. Resing, and R. G. Williams, Mechanisms driving the dispersal of hydrothermal iron from the northern Mid Atlantic Ridge, *Geophysical Research Letters*, 49(22), doi:10.1029/2022gl100615. 2022
- Pham, A. L. D., O. Aumont, L. Ratnarajah, and Alessandro Tagliabue, Examining the Interaction Between Free-Living Bacteria and Iron in the Global Ocean, *Global Biogeochemical Cycles*, 36(5), doi:10.1029/2021gb007194. 2022
- Huang, Y., Tagliabue, Alessandro, & Cassar, N. Data-driven modeling of dissolved iron in the global ocean. *Frontiers in Marine Science*. doi:10.3389/fmars.2022.837183. 2022
- Tagliabue, Alessandro, A. R. Bowie, T. Holmes, P. Latour, P. van der Merwe, M. Gault-Ringold, K. Wuttig, and J. A. Resing, Constraining the Contribution of Hydrothermal Iron to Southern Ocean Export Production Using Deep Ocean Iron Observations, *Frontiers in Marine Science*, doi:10.3389/fmars.2022.754517. 2022
- Chmiel, R., et al. (incl. Alessandro Tagliabue), Major processes of the dissolved cobalt cycle in the North and equatorial Pacific Ocean, *Biogeosciences*, 19(9), 2365-2395, doi:10.5194/bg-19-2365-2022. 2022
- Hawco, N. J., Alessandro Tagliabue, and B. S. Twining, Manganese Limitation of Phytoplankton Physiology and Productivity in the Southern Ocean, *Global Biogeochemical Cycles*, 36(11), doi:10.1029/2022gb007382. 2022
- König, D., T. M. Conway, D. S. Hamilton, and Alessandro Tagliabue, Surface Ocean Biogeochemistry Regulates the Impact of Anthropogenic Aerosol Fe Deposition on the Cycling of Iron and Iron Isotopes in the North Pacific, *Geophysical Research Letters*, 49(13), doi:10.1029/2022gl1098016. 2022
- Neil Wyatt, Antony Birchill, Simon Ussher, Angela Milne, Heather Bouman, Elizabeth Shoenfelt Troein, Katsiaryna Pabortsava, Alan Wright, Oliver Flanagan, Thomas S. Bibby, Adrian P Martin, C. Mark Moore Phytoplankton responses to dust addition in the FeMn co-limited eastern Pacific sub-Antarctic differ by source region, *PNAS*.
- Zhao, M., Mills, B.J., Homoky, W.B., and Peacock, C.L. Oxygenation of the Earth aided by mineral-organic carbon preservation. *Nature Geoscience* 16 (3), 262-267 (2023).

- Longman, J., Ann G Dunlea, Philipp Böning, Martin R Palmer, Thomas M Gernon, James McManus, Hayley R Manners, William B Homoky, Katharina Pahnke (2023) Release of tephra-hosted iron during early diagenesis fingerprinted by iron isotopes. *Earth and Planetary Science Letters*, 605, 118006 (2022)
- Longman, J., Faust, J., Bryce, C., Homoky, W.B., and März, C. (2022) Organic carbon burial with reactive iron across global environments. *Global Biogeochemical Cycles*, e2022GB007447
- Olivelli, A., Murphy, K., Bridgestock, L., Wilson, D. J., Rijkenberg, M., Middag, R., Weiss, D. J., van de Flierdt, T., & Rehkämper, M. (2023). Decline of anthropogenic lead in South Atlantic Ocean surface waters from 1990 to 2011: New constraints from concentration and isotope data. *Marine Pollution Bulletin*, 189, 114798. doi:10.1016/j.marpolbul.2023.114798
- C.V. Guerreiro, A. Ferreira, L. Cros, J.B. Stuut, A.R. Baker, A. Tracana, C. Pinto, V. Veloso, A.P. Rees, M.A.P. Cachao, T. Nunes, V. Brotas. (2023). Response of coccolithophore communities to oceanographic and atmospheric processes across the North-and Equatorial Atlantic, *Frontiers in Marine Science*, 10, 1119488.
- H. Packman, S.H. Little, A.R. Baker, L. Bridgestock, R.J. Chance, B.J. Coles, K. Kreissig, M. Rehkämper, T. van de Flierdt. (2022). Tracing natural and anthropogenic sources of aerosols to the Atlantic Ocean using Zn and Cu isotopes, *Chemical Geology*, 610, 121091.
- Francis, A., Ganeshram, R. S., Tuerena, R. E., Spencer, R. G. M., Holmes, R. M., Rogers, J. A., and Mahaffey, C.: Permafrost degradation and nitrogen cycling in Arctic rivers: insights from stable nitrogen isotope studies, *Biogeosciences*, 20, 365–382, <https://doi.org/10.5194/bg-20-365-2023>, 2023.
- Santos-Garcia, M., Ganeshram, R. S., Tuerena, R. E., Debyser, M. C. F., Husum, K., Assmy, P., and Hop, H.: Nitrate isotope investigations reveal future impacts of climate change on nitrogen inputs and cycling in Arctic fjords: Kongsfjorden and Rijpfjorden (Svalbard), *Biogeosciences*, 19, 5973–6002, <https://doi.org/10.5194/bg-19-5973-2022>, 2022.
- Debyser, M. C. F., Pichevin, L., Tuerena, R. E., Dodd, P. A., Doncila, A., and Ganeshram, R. S.: Tracing the role of Arctic shelf processes in Si and N cycling and export through the Fram Strait: insights from combined silicon and nitrate isotopes, *Biogeosciences*, 19, 5499–5520, <https://doi.org/10.5194/bg-19-5499-2022>, 2022.
- Hatton, J. E., Ng, H. C., Meire, L., Woodward, E. M. S., Leng, M. J., Coath, C. D., ... & Hendry, K. R. (2023). Silicon isotopes highlight the role of glaciated fjords in modifying coastal waters. *Journal of Geophysical Research: Biogeosciences*, e2022JG007242.

Completed GEOTRACES PhD or Master theses

- Margot Debyser 2023 (University of Edinburgh): <https://era.ed.ac.uk/handle/1842/39796>
- Daniela Koenig 2023 (University of Liverpool):

GEOTRACES presentations in international conferences

- Olivelli, A., Murphy, K., Rehkämper, M., van de Flierdt, T., Weiss, D. (2022). *Lead concentrations and isotope compositions of surface waters from the western South Atlantic Ocean*. Challenger 150 Conference
- Invited Keynote W. Homoky: “The unreconciled significance of terrigenous iron supply for the ocean carbon cycle” at 2022 Goldschmidt Conference: Session 12a: *The interplay*

between terrigenous fluxes and the biological pump as reflected by trace elements and their isotopes in the oceans, Hawaii, USA.

Submitted by Alessandro Tagliabue (a.tagliabue@liverpool.ac.uk).