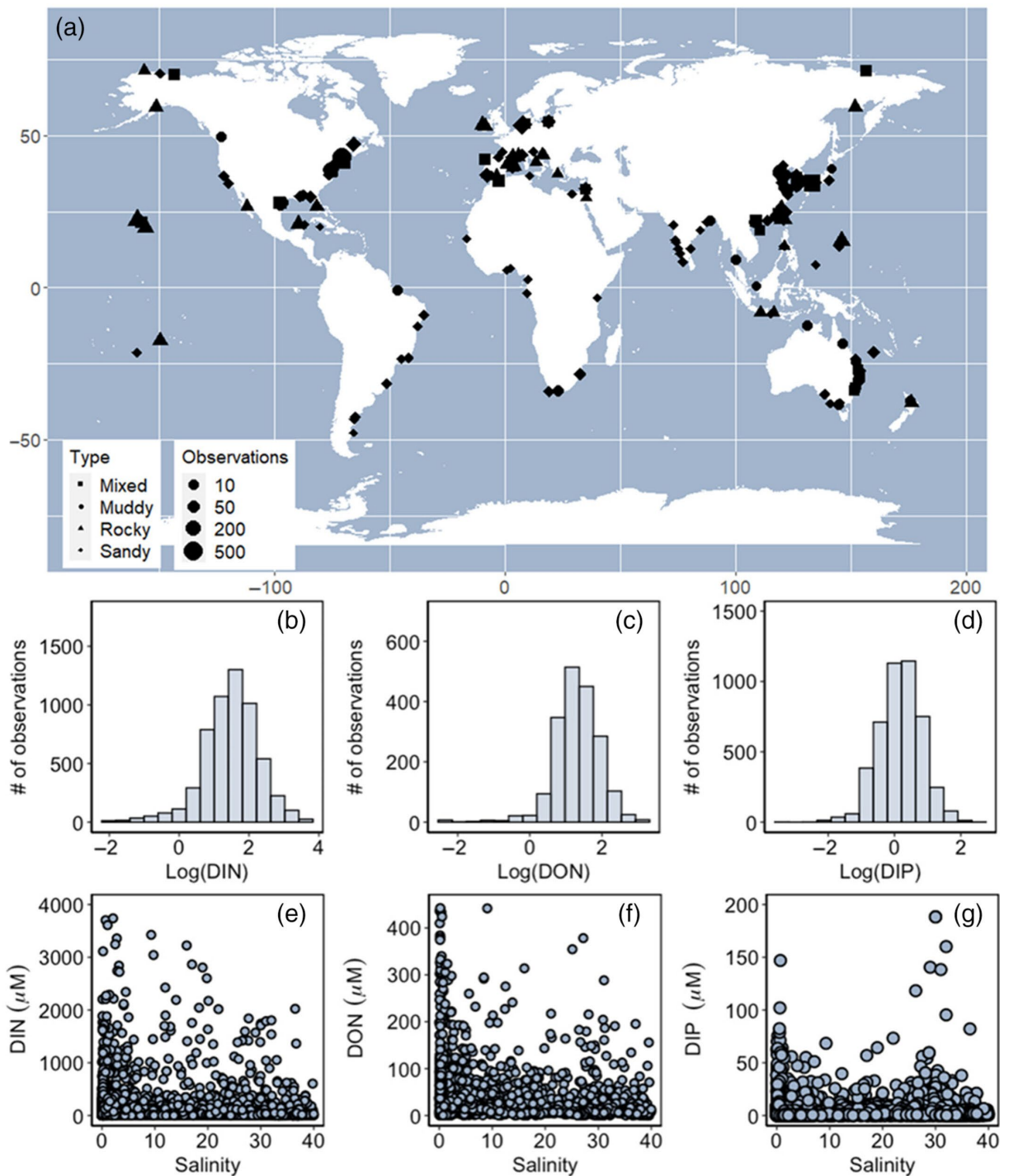


ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ...

May 1st, 2023 to April 30th, 2024

New GEOTRACES or GEOTRACES relevant scientific results

- **Wilson et al. (2024). Global subterranean estuaries modify groundwater nutrient loading to the ocean**



- (a) Global map of meta-dataset site locations (n = 216), including local-scale groundwater sample size (count) indicated by point size and lithology indicated by shape. Histograms of

log-transformed groundwater (all samples) nutrient concentrations (μM) including (b) DIN ($n = 5660$), (c) DON ($n = 1890$), and (d) DIP ($n = 4569$). Scatter plots of groundwater (e) DIN, (f) DON, and (g) DIP concentrations (μM) vs. groundwater sample salinity (note the different Y-axes). Interactive sample map available at: https://marineresearch.shinyapps.io/Gobal_STE_Nutrients/.

- The main nutrient sources to the ocean include atmospheric deposition, rivers, and groundwater. Of these sources, groundwater-borne nutrients transported to the ocean via submarine groundwater discharge have remained the most uncertain at the global scale. We quantified global nutrient loading via groundwater by compiling the largest meta-dataset of coastal groundwater nutrient concentrations available. Dissolved organic nitrogen was identified as a key component of the groundwater nutrient pool and salinity and land cover were important drivers of nutrient concentrations. We provide evidence that nutrients behave non-conservatively in subterranean estuaries resulting in increases in groundwater inorganic nitrogen and phosphorus but decreases in organic nitrogen. Lastly, estimates of groundwater nutrient loading suggest submarine groundwater discharge deliver a similar amount of nutrients to the global ocean as rivers and nitrogen fixation. Our findings indicate that submarine groundwater discharge is an important source of nitrogen and phosphorus to the ocean that should be accounted for in nutrient budgets.

GEOTRACES or GEOTRACES relevant cruises

- iCRAG (Irish Centre for Research in Applied Geoscience) researchers participated in an international research expedition CE23011 SiTrAc (Signal Tracking to unveil Arctic Climate variability to the Arctic) onboard the Celtic Explorer. Chief Scientist, Dr Audrey Morley (iCRAG@UG), this was a follow up expedition to the 2020 expedition CIAAN (Constraining the Impact of Arctic Amplification in the Nordic Sea: A biogeochemical approach).

New projects and/or funding

- There were no new projects or funding initiated during the reporting period. A pre-proposal had been submitted (Dec 2023) to SFI for a new SFI centre focused on the Marine Environment (FORCE – Future Ocean Research Centre), in June 2024, SFI announced that they were delaying making a decision on this until later in 2024. Currently iCRAG is funded until the end of 2026.

GEOTRACES workshops and meetings organized

- There were no GEOTRACES specific workshops run in Ireland during the reporting period. On January 19, 2024, an IMBER workshop, as part of an EPA/Marine Institute funded project ‘NUTS & BOLTS’ was held at the University of Galway on the topic of ‘The sustainability of Irish marine transitional zones’ This workshop which included a presentation on new trace metal data from Irish estuaries and coastal waters which were collected and analyzed following the GEOTRACES cookbook.

Outreach activities conducted (please list any outreach/educational material available that could be shared through the GEOTRACES web site) (We are particularly interested in recordings from webinars from GEOTRACES research)

- There were no specific GEOTRACES outreach activities conducted during the reporting period.

Other GEOTRACES activities

- Prof. Croot is a member of the Chemical Speciation Group – Joint Committee on the Properties of Seawater (2023-present).
- Prof. Croot is an associate member of SCOR Working Group 167 - Reducing Uncertainty in Soluble aerosol Trace Element Deposition (RUSTED) (2022 – present).
- Prof. Croot attended the annual SCOR meeting, held in Guayaquil, Ecuador in October 2023, in his role as Secretary of the SCOR Executive Committee.

New GEOTRACES or GEOTRACES-relevant publications (published or in press) (If possible, please identify those publications acknowledging SCOR funding)

- Daly, E., Nolan, G., Berry, A., Büscher, J.V., Cave, R.R., Caesar, L., Cronin, M., Fennell, S., Lyons, K., McAleer, A., McCarthy, G.D., McGovern, E., McGovern, J.V., McGrath, T., O'Donnell, G., Pereiro, D., Thomas, R., Vaughan, L., White, M., Cusack, C. Diurnal to interannual variability in the Northeast Atlantic from hydrographic transects and fixed time-series across the Rockall Trough. *Deep Sea Research Part I: Oceanographic Research Papers* **204**, 104233, doi:<https://doi.org/10.1016/j.dsr.2024.104233> (2024).
- Grégoire, M., Oschlies, A., Canfield, D., Castro, C., Ciglenc̆ki, I., Croot, P., Salin, K., Schneider, B., Serret, P., Slomp, C.P., Tesi, T., Yücel, M., 2023. Ocean Oxygen: the role of the Ocean in the oxygen we breathe and the threat of deoxygenation., in: Rodriguez Perez, A., Kellett, P., Alexander, B., Muñiz Piniella, Á., Van Elslander, J., Heymans, J.J. (Eds.), Future Science Brief No. 10 of the European Marine Board. European Marine Board, Ostend, Belgium. https://www.marineboard.eu/sites/marineboard.eu/files/public/EMB_FSB10_Ocean_oxygen_Web-150DPI_V7.pdf
- Gregory, C., Cave, R.R., Raine, R., McDermott, G. Phytoplankton abundance and biodiversity in adjacent estuaries: the importance of submarine groundwater discharge. *Hydrobiologia*, doi:10.1007/s10750-024-05497-3 (2024).
- Jiang, S., Jin, J., Wei, Y., Wu, Y., Zhang, Y., Rocha, C., Ibánhez, J.S.P., Zhang, G., Zhang, J., 2023. Sandy seepage faces as bioactive nitrate reactors: Biogeochemistry, microbial ecology and metagenomics. *Geoscience Frontiers* **14**, 101529, doi:<https://doi.org/10.1016/j.gsf.2022.101529> (2023).
- Savatier, M., Morrissey, P., Gill, L., Rocha, C., 2023. Intercomparison of marine tracer and catchment-based submarine groundwater discharge estimates for a karst aquifer. *Journal of Hydrology* **627**, 130358, doi:<https://doi.org/10.1016/j.jhydrol.2023.130358> (2023).
- Turner, D.R., Croot, P.L., Dickson, A.G., Gledhill, M., 2024. Physicochemical controls on seawater, Reference Module in Earth Systems and Environmental Sciences. Elsevier. <https://doi.org/10.1016/B978-0-323-99762-1.00035-8>
- Wilson, S.J., Moody, A., McKenzie, T., Cardenas, M.B., Luijendijk, E., Sawyer, A.H., Wilson, A., Michael, H.A., Xu, B., Knee, K.L., Cho, H.-M., Weinstein, Y., Paytan, A., Moosdorf, N., Chen, C.-T.A., Beck, M., Lopez, C., Murgulet, D., Kim, G., Charette, M.A., Waska, H., Ibánhez, J.S.P., Chaillou, G., Oehler, T., Onodera, S.-i., Saito, M., Rodellas, V., Dimova, N., Montiel, D., Dulai, H., Richardson, C., Du, J., Petermann, E., Chen, X., Davis, K.L., Lamontagne, S., Sugimoto, R., Wang, G., Li, H., Torres,

A.I., Demir, C., Bristol, E., Connolly, C.T., McClelland, J.W., Silva, B.J., Tait, D., Kumar, B., Viswanadham, R., Sarma, V., Silva-Filho, E., Shiller, A., Lecher, A., Tamborski, J., Bokuniewicz, H., Rocha, C., Reckhardt, A., Böttcher, M.E., Jiang, S., Stieglitz, T., Gbewezoun, H.G.V., Charbonnier, C., Anschutz, P., Hernández-Terrones, L.M., Babu, S., Szymczycha, B., Sadat-Noori, M., Niencheski, F., Null, K., Tobias, C., Song, B., Anderson, I.C., Santos, I.R. Global subterranean estuaries modify groundwater nutrient loading to the ocean. *Limnology and Oceanography Letters* **n/a**, doi:<https://doi.org/10.1002/lol2.10390> (2024).

- Xu, H., Wang, H., Singh, B.P., Croot, P., Zhang, C., 2023. Identification of possible sources for potentially toxic elements and polycyclic aromatic hydrocarbons and their spatially varying relationships in urban soils of Dublin, Ireland. *Environmental Pollution* **333**, 122034, doi:<https://doi.org/10.1016/j.envpol.2023.122034> (2023).

• ***Please indicate if there is any forthcoming or planned GEOTRACES special issue publication***

- There are no forthcoming or planned GEOTRACES special issue publications.

Completed GEOTRACES PhD or Master theses (please include the URL link to the pdf file of the thesis, if available)

- No GEOTRACES related PhD or Master theses were completed during the reporting period.

GEOTRACES presentations in international conferences

- There were no specific GEOTRACES presentations at international conferences during the reporting period.

Submitted by Prof. Peter Croot (peter.croot@universityofgalway.ie)