

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2022 to April 30th, 2023

GEOTRACES or GEOTRACES relevant cruises

- GP11 section cruise ‘Cycling of trace elements and their isotopes in the Equatorial Pacific Ocean and consequences for ocean productivity’ on *FS Sonne* (SO298) in the Equatorial Pacific Ocean (Guayaquil_Ecuador – Townsville_Australia) has been sailed in the period April 14 – June 2 2023 PIs Achterberg, Frank, Koschinsky, and important involvement by Scholten, Walter Geibert, S Galer, W Abouchami.
- *R/V Sonne* cruise SO290, Nouméa-Nouméa, took place in April/May 2022 (chief scientist Katharina Pahnke, co-chief scientist Frank Lamy). The water column in the southern Tasman Sea was sampled for dissolved Nd isotopes and REE, nutrients and dissolved stable O, C, H and Si isotopes. Surface sediment and long sediment cores were collected from intermediate to deep depths for paleoceanographic reconstructions.
- GEOTRACES Process study GApr17 ‘Island Impact’ *RV Polarstern* cruises PS133/1 and PS133/2 South Georgia and the adjoining Antarctic Circumpolar Current, took place from Oct 1 to Dec 19, 2022
- Heincke training cruise HE603 scheduled for 12 July-15 July 2022 (GEOTRACES Summer School, Geibert/Benthien/Cutter/Middag) started but was aborted after one day due to pandemic

Upcoming:

- Arcwatch-2 (=Transarc3) FS *Polarstern* expedition PS143 to the Central Arctic Ocean August-September 2024, main applicant Geibert, Chief Scientist Rabe
- GI07 section cruise on FS *Sonne* (SO308) in the South Indian Ocean is scheduled for the period November- December 2024. PIs Achterberg, Frank, Koschinsky, and important involvement by Walter Geibert, S Galer, W Abouchami.

New projects and/or funding

- European Research Council Starting Grant funding for Dr Tom Browning for project Oceanglow
- Funding of one Postdoc for 26 months within project ‘Cycling of trace elements and their isotopes in the Equatorial Pacific Ocean and consequences for ocean productivity’, related to research cruise SO298

GEOTRACES workshops and meetings organised

- GEOTRACES Summer School at AWI Bremerhaven, led by W. Geibert, C. Hanfland, E. Le Roy. 10-15 July 2022, funded by Volkswagen Stiftung with additional travel support by US GEOTRACES and SCOR. 50 participants, 14 lecturers.
- GApr11: research cruise M147 (2018) related workshop. M147 Amazon-GEOTRACES workshop held as a hybrid-meeting at Constructor University (formerly known as Jacobs University), 27 participants of Germany, Brazil, England, France, and Switzerland

Outreach activities conducted

- Press release for Equatorial Pacific GEOTRACES cruise GP11. <https://www.geomar.de/en/news/article/measuring-plankton-growth-across-the-pacific-ocean>
- The alumni of a German pupil/student award for artificial intelligence (“Bundeswettbewerb KI”) were invited to the Alfred Wegener Institute on 20 and 21st of April 2023 and introduced to marine sciences and GEOTRACES data resources by Walter Geibert and Sebastian Mieruch-Schnülle: <https://www.instagram.com/p/CrQyZ9fgdbU/?hl=en>
- Training videos (Cleanroom and ICP-MS), developed in conjunction with the GEOTRACES summer school at AWI Bremerhaven, funded by Volkswagen Stiftung, were continued and are in the final cutting stage.

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

- Al-Hashem, A.A., Beck, A.J., Krisch, S., Menzel Barraqueta, J.L., Steffens, T., Achterberg, E.P. (2022). Particulate Trace Metal Sources, Cycling and Distributions on the Southwest African Shelf. *Global Biogeochemical Cycles*, 36 (11). e2022GB007453. DOI 10.1029/2022GB007453.
- Browning, T.J., Liu, X., Zhang, R., Wen, Z., Liu, J., Zhou, Y., Xu, F., Cai, Y., Zhou, K., Cao, Z., Zhu, Y., Shi, D., Achterberg, E.P. and Dai, M. (2022), Nutrient co-limitation in the subtropical Northwest Pacific. *Limnol Oceanogr*, 7: 52-61. <https://doi.org/10.1002/lol2.10205>
- Camoying, M., Thoms, S., Geuer, J. K., Koch, B. P., Bischof, K., Trimbom, S. 2022 In contrast to diatoms, cryptophytes are susceptible to iron limitation, but not to ocean acidification. *Physiol Plant* 174(1), e13614, doi:10.1111/ppl.1361.
- Chen, X. G., Rusiecka, D., Gledhill, M. , Milne, A., Annett, A. L., Birchill, A. J., Lohan, M. C., Ussher, S., Woodward, E. M. S. and Achterberg, E. P. (2023) Ocean circulation and biological processes drive seasonal variations of dissolved Al, Cd, Ni, Cu, and Zn on the Northeast Atlantic continental margin. *Marine Chemistry* . Art.Nr. 104246. DOI 10.1016/j.marchem.2023.104246.
- Chen, X. G., Rusiecka, D., Gledhill, M. , Milne, A., Annett, A. L., Beck, A. J. , Birchill, A. J., Lohan, M. C., Ussher, S. and Achterberg, E. P. (2023) Physical and biogeochemical controls on seasonal iron, manganese, and cobalt distributions in Northeast Atlantic shelf seas. *Geochimica et Cosmochimica Acta*, 348 . pp. 278-295. DOI 10.1016/j.gca.2023.03.023.
- Chen, X. G., Krisch, S. , Al-Hashem, A., Hopwood, M. J. , Rutgers van der Loeff, M. M., Huhn, O., Lodeiro, P. , Steffens, T. and Achterberg, E. P. (2022) Dissolved, labile and total particulate trace metal dynamics on the northeast Greenland Shelf. *Global Biogeochemical Cycles*, 36 (11). e2022GB007528. DOI 10.1029/2022GB007528.
- Fourquez, M., Cabanes, D., Janssen, D., Conway, T., Jaccard, S., Sieber, M., Ellwood, M., Trimbom, S., Hassler, C. Chasing iron bioavailability in the Southern Ocean: Insights from *Phaeocystis antarctica* and iron speciation. *Science Advances*, in press
- Gledhill, M., Zhu, K., Rusiecka, D., Achterberg, E.P. (2022). Competitive Interactions Between Microbial Siderophores and Humic like Binding Sites in European Shelf Sea Waters. *Frontiers in Marine Science*, section Marine Biogeochemistry, 9, 855009.

- Gledhill, M. , Hollister, A., Seidel, M., Zhu, K., Achterberg, E. P. , Dittmar, T. and Koschinsky, A. (2022) Trace metal stoichiometry of dissolved organic matter in the Amazon plume. *Science Advances*, 8 (31). Art.Nr. eabm2249. DOI 10.1126/sciadv.abm2249.
- Gosnell, K.J., Beck, A.J., Müller, P., Keßler, A. and Achterberg, E.P. (2022). Effects of salinity and temperature on seawater dissolution rate of initial detonation agent mercury fulminate. *Marine Pollution Bulletin*, 185(Pt A), pp.114311-114311.
- Hunt, H. R., Summers, B. A., Sieber, M., Krisch, S. , Al-Hashem, A., Hopwood, M., Achterberg, E. P. and Conway, T. M. (2022) Distinguishing the influence of sediments, the Congo River, and water-mass mixing on the distribution of iron and its isotopes in the Southeast Atlantic Ocean. *Marine Chemistry*, 247 . Art.Nr. 104181. DOI 10.1016/j.marchem.2022.104181.
- Janssen, D.J., Gilliard, D., Rickli, J., Nasemann, P., Koschinsky, A., Hassler, C.S, Bowie, A.R., Ellwood, M.J., Kleint, C., Jaccard, S.L. (2023) Chromium stable isotope distributions in the southwest Pacific Ocean and constraints on hydrothermal input from the Kermadec Arc. *Geochimica et Cosmochimica Acta* 342, 31-44. <https://doi.org/10.1016/j.gca.2022.12.010>.
- Krisch, S. , Huhn, O., Al-Hashem, A., Hopwood, M. J. , Lodeiro, P. and Achterberg, E. P. (2022) Quantifying Ice-Sheet Derived Lead (Pb) Fluxes to the Ocean; A Case Study at Nioghalvfjærdsbræ. *Open Access Geophysical Research Letters*, 49 (21). e2022GL100296. DOI 10.1029/2022GL100296.
- Krisch, S., Hopwood, M. J., Roig, S., Gerringa, L. J., Middag, R., Rutgers van der Loeff, M. M., et al. (2022). Arctic – Atlantic exchange of the dissolved micronutrients Iron, Manganese, Cobalt, Nickel, Copper and Zinc with a focus on Fram Strait. *Global Biogeochemical Cycles*, 36, e2021GB007191. <https://doi.org/10.1029/2021GB007191>
- Liu, T, Krisch, S., Xie, R.C., Hopwood, M.J., Dengler, M. and Achterberg, E.P. (2022). Sediment release in the Benguela Upwelling System dominates trace metal input to shelf and eastern South Atlantic Ocean. *Global Biogeochemical Cycles*, e2022GB007466.
- Liu, F., Gledhill, M. , Tan, Q. G., Zhu, K., Zhang, Q., Salaün, P., Tagliabue, A., Zhang, Y., Weiss, D., Achterberg, E. P. and Korchev, Y. (2022) Phycosphere pH of unicellular nano- and micro- phytoplankton cells and consequences for iron speciation. *The ISME Journal*, 16 . pp. 2329-2336. DOI 10.1038/s41396-022-01280-1.
- Pausch, F., Koch, F., Hassler, C., Bracher, A., Bischof, K., Trimborn, S. 2022 Responses of a natural phytoplankton community from the Drake Passage to two predicted climate change scenarios. *Front Mar Sci Glob Change* 9: 759501. doi:10.3389/fmars.2022.759501.
- Schmidt, K., Paul, S. A., Achterberg, E. P. (2022). Assessing the availability of trace metals and rare earth elements in deep ocean waters of the Clarion-Clipperton Zone, NE Pacific: Application of an in situ DGT passive sampling method. *TrAC Trends in Analytical Chemistry*, 116657.
- Schneider, A.B., Velasquez, I., Paul, S.A.L., Krause, C.H., Koschinsky, A. (2022). Mixing and partially non-conservative behavior of molybdenum, uranium and vanadium along the salinity gradients of the Amazon and Pará estuaries and associated plume. *Marine Chemistry* 247, 104182. <https://doi.org/10.1016/j.marchem.2022.104182>.
- Steiner, Z. , Rae, J. W. B., Berelson, W. M., Adkins, J. F., Hou, Y., Dong, S., Lampronti, G. I., Liu, X., Achterberg, E. P. , Subhas, A. V. and Turchyn, A. V. (2022) Authigenic formation

of clay minerals in the abyssal North Pacific. *Global Biogeochemical Cycles*, 36 (11). e2021GB007270. DOI 10.1029/2021GB007270.

- Sutorius, M., Mori, C., Greskowiak, J., Boettcher, L., Bunse, C., Dittmar, T., Dlugosch, L., Hintz, N.H., Simon, M., Striebel, M., Pahnke, K., 2022. Rare earth element behaviour in seawater under the influence of organic matter cycling during a phytoplankton spring bloom – A mesocosm study. *Front. Mar. Sci.* 9. doi: 10.3389/fmars.2022.895723.
- Ukotije-Ikwut, P. R., Steiner, Z. , Gledhill, M. , Müller, M., Oakes, J. M., Sukri, R. S., Jiang, S. and Achterberg, E. P. (2023) The distribution and behaviour of Fe, Al, Si, Mn, Cu and Ni in ombrotrophic tropical peat draining blackwater estuaries on Borneo Island. *Open Access Frontiers in Marine Science*, 9 . Art.Nr. 1075155. DOI 10.3389/fmars.2022.1075155.
- Zhu, K., Achterberg, E. P. , Bates, N. R., Gerringa, L. J. A., Middag, R., Hopwood, M. J. and Gledhill, M. (2023) Influence of changes in pH and temperature on the distribution of apparent iron solubility in the oceans. *Global Biogeochemical Cycles*, 37 (5). e2022GB007617. DOI 10.1029/2022GB007617.

Completed GEOTRACES PhD or Master theses

- PhD thesis: Trace Metal Biogeochemical Cycling and Fluxes in the eastern South Atlantic (Te Liu, 2023.04; related to cruise GA08)
- Jenna Balaguer (2022): Iron manganese co-limitation – a potential driver of Southern Ocean phytoplankton ecology. University Bremen. <https://doi.org/10.26092/elib/1980>

GEOTRACES presentations in international conferences

- Liu, Te: Shelf sediments in the Benguela Upwelling System as a major source of trace metals to the shelf and eastern South Atlantic Ocean. Sixth Xiamen Symposium on Marine Environmental Sciences (XMAS-VI, January 2023)
- Tessele SR., I., Carvalho, L., Koschinsky, A.: Distribution of chromium and thallium species along the Amazon and Pará estuaries and mixing plume. Goldschmidt conference 2022
- Kurahashi, E., Poehle, S., Koschinsky, A.: Determination of vanadium redox species V(IV) and V(V) in the South-East Atlantic Ocean using chelating resin and Inductively-coupled Plasma Mass Spectrometry. Goldschmidt conference 2022
- Fröhberg, N., Klose, L., Koschinsky, A.: Organic complexation of Ni in the hydrothermal plume of the Rainbow vent field. Goldschmidt conference 2022
- Schneider, A.B., Koschinsky, A., Krause, C.H., Gledhill, M., Carvalho, L.: Distribution of dissolved and soluble Ti along the salinity gradients in the Pará and Amazon estuaries and plume. Goldschmidt conference 2022
- Stichel, T., Freitag, J. Henkel, S. Geibert, W. and Kasten, S.: Marine Ice: A sleeping iron giant in the Southern Ocean? Goldschmidt conference 2022

[the list of conference contributions is not exhaustive]

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