ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2023 to April 30th, 2024

New GEOTRACES or GEOTRACES relevant scientific results

- https://www.geotraces.org/overlooked-riverine-contributions-of-dissolved-neodymium-and-hafnium-to-the-amazon-estuary-and-oceans/
- https://www.geotraces.org/decoupling-of-barium-and-silicon-transport/

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.
- EMS FORE cruise on Meteor (M187) 'Impact of climate on ecosystem functioning and carbon export in Eastern Mediterranean' sailed from Limassol (Cyprus) to Catania (Italy) between January 3 and February 6 2024. PIs Tom Browning, Eric Achterberg, Zvi Steiner.

New projects and/or funding

- INSPIRES-PhD studentship Alexandra Bettinelli (Trimborn/Geibert, AWI) for PS144: Impact of Ice Drift on Nutrient and Trace-Metal Distribution, Ocean Productivity, and Carbon Export
- Research cruise M206 (RV Meteor) as a follow-up study of cruise M147 (GApr11) for studying trace metal and DOM input from the Amazon estuary into the Atlantic funded and scheduled for Dec. 2024; will be applied for as a GEOTRACES process study again.

Outreach activities conducted

- 22.03.2024 Web release: Annette-Barthelt-Preis würdigt herausragende Abschlussarbeiten, https://idw-online.de/de/news830805.
- 28.09.2023 Web release: 'How trace elements affect marine CO_2 sinks', https://www.awi.de/ueber-uns/service/presse/presse-detailansicht/wie-spurenelemente - die-co2-speicherung-im-ozean-veraendern.html.
- 06.06.2023 Web release: https://www.simona.de/en/company/news/detail/ ?tx_news_pi1%5Bnews%5D=534&cHash=28ce6f380118ea9bad7153d4b7db4651
- Educational videos from GEOTRACES Summer School in Bremerhaven 2022 on video platforms:
    1. ICP-MS and ICP-OES for analysing marine samples 1/3
    2. Calibrating and validating analyses of marine samples 2/3
    3. Trace metal clean preparation of marine samples 3/3

Other GEOTRACES activities

- Preparation and release of IDP2021v2 (R. Schlitzer, July 2023)

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

- Arnone, V., Santana-Casiano, J. M., González-Dávila, M., Sarthou, G., Krisch, S. , Lodeiro, P., Achterberg, E. P. and González, A. G. 2024. Distribution of copper-binding ligands in Fram Strait and influences from the Greenland Shelf (GEOTRACES GN05). Open Access Science of the Total Environment, 909. DOI 10.1016/j.scitotenv.2023.168162.
- Balaguer, J., Koch, F., Flintrop, C., Völkner, C., Iversen, M., Trimborn, S. 2023 Iron and manganese availability drive primary production and carbon export in the Weddell Sea. Current Biology, doi:10.2139/ssrn.4342993.
- Balaguer, J., Thoms, S., Trimborn, S. 2023 The physiological response of an Antarctic key phytoplankton species to low iron and manganese concentrations. Limnol Oceanogr 68:2153-2166, doi:10.1002/lno.12412.
- Böckmann, S., Trimborn, S., Schubert, H., Koch, F. 2024 Grazing by nano- and microzooplankton on heterotrophic picoplankton dominates the biological carbon cycling around the Western Antarctic Peninsula. Polar Biology 47:279-294, doi:10.1007/s00300-024-03231-2.
- Browning, T. J. , Al-Hashem, A. A., Achterberg, E. P. , Carvalho, P. C., Catry, P., Matthiopoulos, J., Miller, J. A. O. and Wakefield, E. D. 2023. The role of seabird guano in maintaining North Atlantic summertime productivity. Science of The Total Environment, 897 . Art.Nr. 165309. DOI 10.1016/j.scitotenv.2023.165309.
- Browning, T. J. , Saito, M. A., Garaba, S. P., Wang, X., Achterberg, E. P. , Moore, C. M., Engel, A. , Mcllvin, M. R., Moran, D., Voss, D., Zielinski, O. and Tagliabue, A. 2023. Persistent equatorial Pacific iron limitation under ENSO forcing. Open Access Nature . DOI 10.1038/s41586-023-06439-0.
- Camoying, M., Koch, F., Stimpfle, J., Hassler, C., Trimborn, S Distinct responses of diatom- and flagellate-dominated Antarctic phytoplankton communities to altered iron and light supply. In revision for Front Mar Sci on 30.5.24, minor
- Camoying, M., Trimborn, S. 2023 Physiological response of an Antarctic cryptophyte to increasing temperature, CO2 and irradiance. Limnol Oceanogr 68:1880-1894, doi:10.1002/lno.12392.
- Chen, X. G., Milne, A., Klar, J. K., Gledhill, M. , Lohan, M. C., Hsieh, Y. T., Henderson, G. M., Woodward, E. M. S. and Achterberg, E. P. 2024. Controls on distributions of aluminium, manganese and cobalt in the South Atlantic Ocean along GEOTRACES transect GA10. Open Access Geochimica et Cosmochimica Acta, 373. pp. 177-196. DOI 10.1016/j.gca.2024.03.019.
- Chen, X. G., Gledhill, M. , Lohan, M. C., Milne, A. and Achterberg, E. P. 2024. Surface ocean biogeochemistry and deep ocean circulation control relationships between nutrient-type trace metals (Cd, Ni, Cu, and Zn) and nutrients in the South Atlantic Ocean near the subtropical front. Open Access Geochimica et Cosmochimica Acta, 370 . pp. 144-160. DOI 10.1016/j.gca.2024.01.001.

- 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.
- Conway, T.M., R. Middag, and R. Schlitzer. 2024. GEOTRACES: Ironing out the details of the oceanic iron sources? Oceanography 37(2):35–45, https://doi.org/10.5670/oceanog.2024.416.
- Fourquez, M., Cabanes, D., Janssen, D., Conway, T., Jaccard, S., Sieber, M., Ellwood, M., Trimborn, S., Hassler, C. 2023 Chasing iron bioavailability in the Southern Ocean: Insights from Phaeocystis antarctica and iron speciation. Science Advances 9(26), eadf9696, doi: 10.1126/sciadv.adf9696.
- Gosnell, K. J., Heimbürger-Boavida, L. E., Beck, A. J. , Ukotije-Ikwut, P. R. and Achterberg, E. P. 2023. World war munitions as a source of mercury in the southwest Baltic Sea. Chemosphere, 345 . Art.Nr. 140522. DOI 10.1016/j.chemosphere.2023.140522.
- Gu, Y., James Hopwood, M., Gledhill, M. , Rapp, I., Wuttig, K. and Achterberg, E. 2024. Spatial and temporal variations in the micronutrient Fe across the Peruvian shelf from 1984-2017. Progress in Oceanography, 221 . Art.Nr. 103208. DOI 10.1016/j.pocean.2024.103208.
- Krause, J., Carroll, D., Höfer, J., Donaire, J., Achterberg, E. P. , Alarcón, E., Liu, T., Meire, L., Zhu, K. and Hopwood, M. J. 2024. The macronutrient and micronutrient (iron and manganese) signature of icebergs. DOI 10.5194/egusphere-2023-2991.
- Krause, J., Zhu, X., Höfer, J., Achterberg, E. P. , Engel, A. , Meire, L., Stuart-Lee, A. E. and Hopwood, M. J. 2023. Glacier-Derived Particles as a Regional Control on Marine Dissolved Pb Concentrations. Journal of Geophysical Research: Biogeosciences, 128 (10). Art.Nr. e2023JG007514. DOI 10.1029/2023JG007514.
- Kurahashi, E., Poehle, S. and Koschinsky, A., 2024. Determination of vanadium redox species V (IV) and V (V) in seawater using chelating resin and inductively coupled plasma mass spectrometry. Deep Sea Research Part I: Oceanographic Research Papers, p.104261. https://doi.org/10.1016/j.dsr.2024.104261
- Liu, T., Hopwood, M. J. , Krisch, S. , Vieira, L. H. and Achterberg, E. P. 2023. Trace metal fluxes of Cd, Cu, Pb and Zn from the Congo River into the South Atlantic Ocean are supplemented by atmospheric inputs. Open Access Geophysical Research Letters, 50 (24). e2023GL107150. DOI 10.1029/2023GL107150.
- Massmann, G., Abarike, G., Amoako, K., Auer, F., Badewien, T.H., Berkenbrink, C., Böttcher, M.E., Brick, S., Cordova, I.V.M., Cueto, J., Dittmar, T., Engelen, B., Freund, H., Greskowiak, J., Günther, T., Herbst, G., Holtappels, M., Marchant, H.K., Meyer, R., Müller-Petke, M., Niggemann, J., Pahnke, K., Pommerin, D., Post, V., Reckhardt, A., Roberts, M., Schwalfenberg, K., Seibert, S.L., Siebert, C., Skibbe, N., Waska, H., Winter, C., Zielinski, O. (2023). The DynaDeep observatory – a unique approach to study high-energy subterranean estuaries. Frontiers in Marine Science 10. doi:10.3389/fmars.2023.1189281.

- Paul, S. A. L., Schmidt, K., Achterberg, E. P. and Koschinsky, A. 2024. The importance of the soluble and colloidal pools for trace metal cycling in deep-sea pore waters. Open Access Frontiers in Marine Science, 11 . Art.Nr. 1339772. DOI 10.3389/fmars.2024.1339772.
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- Smith, W. O. Jr., Trimborn, S. 2024 Phaeocystis: A global enigma. Annual Reviews of Marine Science 16:12.1-12.25, doi:10.1146/annurev-marine-022223-025031.
- Steiner, Z. , Antler, G., Berelson, W. M., Crockford, P. W., Dunlea, A. G., Hou, Y., Adkins, J. F., Turchyn, A. V. and Achterberg, E. P. 2023. Trace Element Geochemistry in North Pacific Red Clay Sediment Porewaters and Implications for Water-Column Studies. Open Access Global Biogeochemical Cycles, 37 (11). e2023GB007844. DOI 10.1029/2023GB007844.
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- Waltemathe, H., Struve, T., Rehbein, M., Pahnke, K. (accepted). Influence of water mass mixing and hydrothermal processes on the distribution of dissolved Nd isotopes and concentrations in the South Pacific. Earth and Planetary Science Letters.
- Xu, A., Hathorne, E., Laukert G. and Frank, M. (2023): Overlooked riverine contributions of dissolved neodymium and hafnium to the Amazon estuary and oceans.- Nature Communications 14, 4156, https://doi.org/10.1038/s41467-023-39922-3.
- Zhang, Z., Yu, Y., Hathorne, E.C., Vieira, L.H., Grasse, P., Siebert, C., Rahlf, P. and Frank, M. (2023): Decoupling of barium and silicon at the Congo River-dominated Southeast Atlantic margin: Insights from combined barium and silicon isotopes.- Global Biogeochemical Cycles 37, e2022GB007610, https://doi.org/10.1029/2022GB007610.
- Zhang, Z., Zhou, L., Chen, X. G., Achterberg, E. P. , Yu, Y., Hathorne, E. , Steiner, Z. , Siebert, C. and Frank, M. 2024. Introduction of isotopically light barium from the Rainbow hydrothermal system into the deep Atlantic Ocean. Open Access Earth and Planetary Science Letters, 625 . Art.Nr. 118476. DOI 10.1016/j.epsl.2023.118476.
- Zhou, L., Liu, F., Achterberg, E. P. , Engel, A. , Campbell, P. G. C., Fortin, C., Huang, L. and Tan, Y. 2024. Promoting effects of aluminum addition on chlorophyll biosynthesis and growth of two cultured iron-limited marine diatoms. Open Access Limnology and Oceanography . DOI 10.1002/lno.12558.
- 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. Open Access Global Biogeochemical Cycles, 37 (5). e2022GB007617. DOI 10.1029/2022GB007617.

Completed GEOTRACES PhD or Master theses

- Al-Hashem, A. (2023) The Biogeochemical Cycling of Particulate Trace Metals off the Southwest African and Peruvian Shelves. (PhD/ Doctoral thesis), Christian-Albrechts-Universität zu Kiel, Kiel, Germany.
- Liu, T. (2023) Trace Metal Biogeochemical Cycling and Fluxes in the eastern South Atlantic. (PhD/ Doctoral thesis), Christian-Albrechts-Universität zu Kiel, Kiel, Germany, IX, 175 pp
- Antao Xu (PhD thesis): Neodymium and Hafnium Isotope and Rare Earth Element Geochemical Cycling and Fluxes from the Amazon to the tropical western Atlantic, defended in Feb. 2024

GEOTRACES presentations in international conferences

- Balaguer, J., Koch, F., Trimborn, S. 2024 The combined effect of light, iron and manganese availability on Southern Ocean phytoplankton growth and productivity. Ocean Science Meeting, 17-23 February New Orleans, USA.
- Fourquez, M., Cabanes, D., Janssen, D., Conway, T., Cabanes, D., Ellwood, M., Sieber, M., Trimborn, S., Hassler, C. 2023. Extreme variability of iron bioavailability in the Southern Ocean. Goldschmidt Conference, 9-14 July, Lyon, France.
- Liu, T., Hopwood, M. J. , Krisch, S. , Vieira, L. H. and Achterberg, E. P. 2023. Trace metal fluxes from the Congo River into the South Atlantic Ocean are supplemented by atmospheric inputs from gas flaring. [Talk] In: Goldschmidt Conference 2023, 9.-14.07.2023, Lyon, France
- Pedre, I., Fröhberg, N., Waska, H., Koschinsky, A., Pahnke, K. (2023). Simple and portable devices for measuring manganese in pore- and coastal water samples, Goldschmidt Conference, Lyon, France. doi:10.7185/gold2023.17048.
- Stimpfle, J., Koch, F., Ebner, B., Zitoun, R., Henkel, S., Trimborn, S. 2024 Quantifying the bioavailability of nearshore iron sources from South Georgia to natural phytoplankton communities. Ocean Science Meeting, 17-23 February New Orleans, USA.
- Vieira, L. H. , Steiner, Z. , Scholten, J., Beck, A. J. and Achterberg, E. P. (2023) Is the Rainbow ultramafic hydrothermal system a poor source of radium isotopes to the Atlantic Ocean?. Open Access [Poster] In: Goldschmidt Conference 2023. , 9.-14.07.2023, Lyon, France .
- Zander, M., Struve, T., Lamy, F., Pahnke, K. (2024). Influence of water mass mixing and non-conservative modifications on dissolved neodymium isotopes in the eastern Tasman Sea. Ocean Sciences Meeting, New Orleans, USA.
- Poster: Ebner, B., Henkel, S., Köster, M., Trimborn, S., Koch, F., Stimpfle, J., Staubwasser, M., Laufer-Meiser, K., Kattein, L., Geibert, W., Müller, D., Kasten, S. 2023. Iron transport and reaction pathways traced by sedimentary stable iron isotopes from South Georgia into the adjacent Southern Ocean. Ocean Science Meeting, 17-23 February New Orleans, USA.

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