

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2019 to March 30th, 2020

New GEOTRACES or GEOTRACES relevant scientific results

Fe delivery by the Congo River

Vieira et al (2020) have been able to show that the River Congo is an important source of iron to the southeast Atlantic. As they write in the international journal Nature Communications, this is in contrast to other large rivers like the Amazon.

In terms of discharge, the Congo is the second largest river on earth. It transports large quantities of freshwater and sediments from the interior of Africa to the southeast Atlantic. Its remote location and the geopolitical tensions in southwest Africa have long prevented detailed studies on the effects of the Congo River on the ocean. During an expedition with the German research vessel METEOR in 2015, which was carried out as part of the international GEOTRACES programme, an international team of researchers led by the GEOMAR Helmholtz Centre for Ocean Research Kiel conducted the first comprehensive study on this issue. The work showed that the Congo supplies the Atlantic Ocean with significantly more iron than other large rivers.

Vieira, L. H., S. Krisch, M. J. Hopwood, A. J. Beck, J. Scholten, V. Liebetrau and E. P. Achterberg, 2020: Unprecedented Fe delivery from the Congo River margin to the South Atlantic Gyre. Nat. Commun., 11, 556, <https://doi.org/10.1038/s41467-019-14255-2>



This Landsat 8 image of the Congo river and its coastal plume was collected on March 2, 2015 © NASA/USGS, NASA's Goddard Space Flight Center

Tracing water mass mixing in the Cape Basin and the restricted Angola Basin with radiogenic Nd isotopes

In the frame of GEOTRACES cruise GA08, Rahlf et al. (2020) determined seawater profiles of dissolved radiogenic neodymium isotope signatures (ϵ_{Nd}) and neodymium concentrations across the restricted western Angola Basin and along the northern Cape Basin to investigate mixing and provenance of water masses. Nd isotope compositions of deep water masses in both basins primarily reflect conservative water mass mixing, except the central Angola Basin, which is significantly overprinted by terrestrial inputs. Bottom waters of the Cape Basin show some excess Nd concentrations released from detrital sediments, however, without significantly changing their Nd isotopic compositions ranging between ϵ_{Nd} -9.6 and 10.5. Highly unradiogenic ϵ_{Nd} signatures of up to -17.6 in the upper water column originate from a west African coastal plume in the Angola Basin and from Mozambique Channel surface waters advected into the Cape Basin.

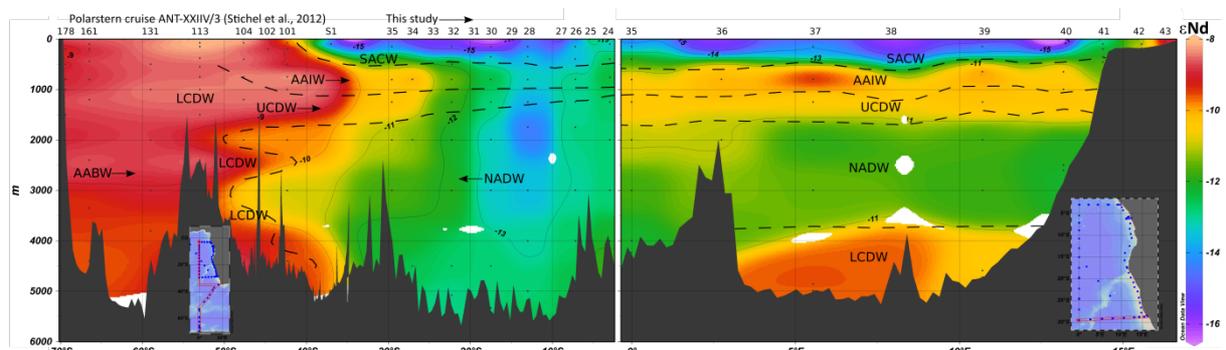


Figure: Nd isotope distributions in the western Angola Basin (left section) and the northern Cape Basin (right section) along the cruise track of GA08, combined with isotope data obtained further south from cruise ANT-XXIV/3 (Stichel et al., 2012). Dashed lines indicate approximate boundaries of the prevailing water masses. The figure is adopted from Rahlf et al. (2020).

References:

- Rahlf, P., Hathorne, Ed., Laukert, G., Gutjahr, M., Weldeab, S., Frank, M. (2020). Tracing water mass mixing and continental inputs in the southeastern Atlantic Ocean with dissolved neodymium isotopes. *Earth Planet. Sci. Lett.*, in press, DOI: 10.1016/j.epsl.2019.115944.
- Stichel, T., Frank, M., Rickli, J., Haley, B.A. (2012). The hafnium and neodymium isotope composition of seawater in the Atlantic sector of the Southern Ocean. *Earth Planet. Sci. Lett.* 317–318, 282–294.

GEOTRACES or GEOTRACES relevant cruises

- Application for Arctic cruise TransArc3/ArcWatch1 in 2022 (re-occupying previous GEOTRACES transects to capture temporal variability) by PIs Rabe & Geibert had to be resubmitted in March; If approved, GEOTRACES section status for the cruise will be sought from the SSC.

New projects and/or funding

- The successor cruise of M147 (GApr11, AMAZON-GEOTRACES) that took place in spring 2018 in the high-discharge period in the Amazon estuary and plume to study trace-

metal DOM processes and fluxes was approved and is planned for the end of 2022 in the dry, low-discharge period, but is not yet scheduled. Cruise applicants are Andrea Koschinsky, Thorsten Dittmar, Martin Frank and Martha Gledhill. This second cruise will also be applied for as a GEOTRACES process study.

- Acquisition of a trace-metal clean CTD system for Polarstern is anticipated for the near future

GEOTRACES workshops and meetings organised

- Cruise planning meeting for S Indian Ocean GEOTRACES Section cruise SO276. November 22, 2019.
- Reiner Schlitzer organized and carried out a two-day hands-on Ocean Data View workshop Exploring GEOTRACES and other environmental data at the University of Tasmania, Hobart (4th - 5th September 2019, 52 participants).

Outreach activities conducted (please list any outreach/educational material available that could be shared through the GEOTRACES web site)

- Press release for Congo Fe outflow paper. <https://www.uni-kiel.de/en/research/details/news/047-congo-river#>

Other GEOTRACES activities

- Reiner Schlitzer participated in the GEOTRACES DMC and SSC meetings in Hobart (7th to 11th September 2019). He was teacher at the 2nd GEOTRACES International Summer School in Cadiz, Spain (23rd to 28th September 2019) and he participated in the IDP2021 Production meeting in Toulouse, France (13th to 14th January 2020).
- A Reiner Schlitzer participated in the GEOTRACES DMC and SSC meetings in Hobart (7th to 11th September 2019). He was teacher at the 2nd GEOTRACES International Summer School in Cadiz, Spain (23rd to 28th September 2019) and he participated in the IDP2021 Production meeting in Toulouse, France (13th to 14th January 2020).
- Eric Achterberg participated in the GEOTRACES SSC meetings in Hobart (7th to 11th September 2019). He was teacher at the 2nd GEOTRACES International Summer School in Cadiz, Spain (23rd to 28th September 2019).

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

- Andrade, R.L.B., Hatje, V., Pedreira, R.M.A., Böning, P., Pahnke, K., 2020. REE fractionation and human Gd footprint along the continuum between Paraguaçu River to coastal South Atlantic Waters. *Chem. Geol.* 532, 1-11. doi: 10.1016/j.chemgeo.2019.119303.
- Charette, M.A., Kipp, L., Jensen, L.T., Dabrowski, J.S., Whitmore, L.M., Fitzsimmons Jessica, N., Williford, T., Ulfsbo, A., Jones, E., Bundy, R.M., Vivancos, S., Pahnke, K., John, S.G., Xiang, Y., Hatta, M., Petrova, M.V., Heimbürger, L.E., Bauch, D., Newton, R., Pasqualini, A., Agather, A.M., Amon, R.M.W., Anderson, R.F., Andersson, P., Benner, R., Bowman, K.P., Edwards, L., Gdaniec, S., Gerringa, L., González, A.G., Granskog, M., Haley, B.A., Hammerschmidt, C.R., Hansell, D.A., Henderson, P.B., Kadko, D., Kaiser,

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- Geilert, S., Grasse, P., Doering, K., Wallmann, K., Ehlert, C., Scholz, F., Frank, M., Schmidt, M., Hensen, C., 2020. Impact of ambient conditions on the Si isotope fractionation in marine pore fluids during early diagenesis. *Biogeosciences Discussions* 2020, 1-39. doi: 10.5194/bg-2019-481.
 - Liguori, B.T.P., Ehlert, C., Pahnke, K., 2020. The Influence of Water Mass Mixing and Particle Dissolution on the Silicon Cycle in the Central Arctic Ocean. *Front. Mar. Sci.* 7. doi: 10.3389/fmars.2020.00202.
 - Paffrath, R., Pahnke, K., Behrens, M.K., Reckhardt, A., Ehlert, C., Schnetger, B., Brumsack, H.J., accepted. Rare earth element behavior in a sandy subterranean estuary of the southern North Sea. *Front. Mar. Sci.*
 - Valk, O., Rutgers van der Loeff, M.M., Geibert, W., Gdaniec, S., Moran, S.B., Lepore, K., Edwards, R.L., Lu, Y., Puigcorbé, V., Casacuberta, N., Paffrath, R., Smethie, W., Roy-Barman, M., 2020. Decrease in ²³⁰Th in the Amundsen Basin since 2007: far-field effect of increased scavenging on the shelf? *Ocean Science* 16, 221-234. doi: 10.5194/os-16-221-2020.
 - Waska, H., Greskowiak, J., Ahrens, J., Beck, M., Ahmerkamp, S., Böning, P., Brumsack, H.J., Degenhardt, J., Ehlert, C., Engelen, B., Grünenbaum, N., Holtappels, M., Pahnke, K., Marchant, H.K., Massmann, G., Meier, D., Schnetger, B., Schwalfenberg, K., Simon, H., Vandieken, V., Zielinski, O., Dittmar, T., 2019. Spatial and Temporal Patterns of Pore Water Chemistry in the Inter-Tidal Zone of a High Energy Beach. *Front. Mar. Sci.* 6. doi: 10.3389/fmars.2019.00154.
 - Ardiningsih, I, Krisch, S., Lodeiro, P., Reichart, G., Achterberg, E.P., Gledhill, M., Middag, R., Gerringa, L.J.A. (2020). Natural Fe-binding organic ligands in Fram Strait and over the Northeast Greenland shelf. *Marine Chemistry*, doi.org/10.1016/j.marchem.2020.103815
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- Rapp, I., Schlosser, C., Browning, T.J., Wolf, F., Le Moigne, F.A.C, Gledhill, M. and Achterberg, E.P. (2020). El Niño-driven oxygenation impacts Peruvian shelf iron supply to the South Pacific Ocean. *Geophysical Research Letters*, e2019GL086631.
- Guinoiseau, D., Galer, S. J. G., Abouchami, W., Frank, M. , Achterberg, E. P. und Haug, G. H. (2019) Importance of cadmium sulfides for biogeochemical cycling of Cd and its isotopes in Oxygen Deficient Zones – a case study of the Angola Basin. *Global Biogeochemical Cycles*. DOI 10.1029/2019GB006323.
- Rapp, I., Schlosser, C. , Menzel Barraqueta, J. L. , Wenzel, B., Lüdke, J. , Scholten, J., Gasser, B., Reichert, P., Gledhill, M. , Dengler, M. und Achterberg, E. P. (2019) Controls on redox-sensitive trace metals in the Mauritanian oxygen minimum zone. *Biogeosciences (BG)*, 16 (21). pp. 4157-4182. DOI 10.5194/bg-16-4157-2019.
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Completed GEOTRACES PhD or Master theses

- Bianca Torres Liguori Pires: The Biogeochemical Silicon Cycle in the Arctic Ocean: Insights from Silicon Stable Isotopes, PhD thesis, pp.167, University of Oldenburg, Germany, 2019
- Lucia Vieira: Use of radium isotopes as tracers for the cycling of dissolved trace elements in the Atlantic and Arctic Ocean, PhD Thesis, University of Kiel, Germany, 2019.

GEOTRACES presentations in international conferences

- Paffrath, R., Bauch, D., Rutgers van der Loeff, M., Laukert, G., Pahnke, K., 2019, Water Mass Contributions to the Central Arctic – New Insights from Rare Earth Elements and Nd Isotopes, International Goldschmidt Conference, Barcelona, Spain.
- Liguori, B. T. P., Ehlert, C., Pahnke, K., 2019, Silicon Cycling and Shelf Input in the Central Arctic Ocean: Insights from Stable Silicon Isotopes, International Goldschmidt Conference, Barcelona, Spain.
- The distribution of dissolved molybdenum, vanadium and uranium in the Atlantic Ocean. Imelda Velasquez, Sandra Poehle, Andrea Koschinsky. Oral presentation. <https://agu.confex.com/agu/osm20/meetingapp.cgi/Paper/649948>
- Trace metal behaviour and size fractionation along the river water- seawater mixing gradient in the Amazon River estuary and plume. Andrea Koschinsky, Leandro de Carvalho, Martha Gledhill, Adrienne Hollister, Cristian H. Krause, Alexandre B. Schneider and Imelda Velasquez. Oral presentation. <https://agu.confex.com/agu/osm20/meetingapp.cgi/Paper/650839>
- Dissolved Concentrations and Organic Speciation of Cu in the Amazon River Estuary and Mixing Plume. Adrienne Hollister, Martha Gledhill and Andrea Koschinsky. Oral Presentation. <https://agu.confex.com/agu/osm20/meetingapp.cgi/Paper/643404>
- Importance of the colloidal pool for trace metal cycling in deep-sea sediments. Sophie Paul, Katja Schmidt and Andrea Koschinsky. Oral presentation. <https://agu.confex.com/agu/osm20/meetingapp.cgi/Paper/651172>
- Co-Chair of session at OSM2020. Controls on trace metal biogeochemistry and physicochemical speciation in seawater. Hannah Whitby, Randelle M. Bundy, Jessica N. Fitzsimmons, Andrea Koschinsky. <https://agu.confex.com/agu/osm20/meetingapp.cgi/Session/92980>
- N and Fe as Factors Controlling Phytoplankton Limitation in Fram Strait at 79° N, Arctic Ocean S Krisch, T Browning, P Lodeiro, MJ Hopwood, M Graeve, E Achterberg. Ocean Sciences Meeting 2020
- Nutrient limitation of cyanobacteria in the Tropical Pacific, T Browning, MA Saito, X Wang, A Tagliabue, A Engel, EP Achterberg. Ocean Sciences Meeting 2020.

- Predicting Iron (III) Speciation in the Peruvian Upwelling Region. K Zhu, M Gledhill, MJ Hopwood, JE Groenenberg, A Engel, E Achterberg. Ocean Sciences Meeting 2020.
- Role of Colloids in Controlling Mobilization and Transport of Trace Metals during the Formation of Deep Sea Sediment Plumes. K Schmidt, T Brengelmann, S Paul, EP Achterberg. Ocean Sciences Meeting 2020.
- Iron sources and cycling in the Peruvian oxygen minimum zone assessed using iron isotopes., I Rapp, M Sieber, F Scholz, MJ Hopwood, TM Conway, RC Xie, M Frank, E Achterberg. Ocean Sciences Meeting 2020.
- Biogeochemical Dynamics of Particulate Trace Metals in the South-East Atlantic along the GEOTRACES GA08 Section Cruise. A Al-Hashem, AJ Beck, S Krisch, T Steffens, EP Achterberg. Ocean Sciences Meeting 2020.
- Quantifying vertical nutrient fluxes along GEOTRACES sections using helium observations. S Rigby, RG Williams, EP Achterberg, WJ Jenkins, A Tagliabue. Ocean Sciences Meeting 2020
- Anderson, R.F., Francois, R., Frank, M., Henderson, G.M., Jeandel, C., Sharma, M. (2019): GEOTRACES: Inspired by GEOSECS to investigate trace elements and their isotopes in the ocean. Goldschmidt Conference 2019, Barcelona, Spain, Talk, August, 18-23, 2019.
- Border, E.C., Kamm, J., Koschinsky, A., Frank, M., Frank, N. (2019): Uranium Dynamics in Amazon Estuary revealed by Isotopic Analysis. Goldschmidt Conference 2019, Barcelona, Spain, Talk, August, 18-23, 2019.
- Hathorne, E.C., Frank, M. (2020): How important is the suspended particulate pool for controlling seawater rare earth element distributions? Ocean sciences Meeting, San Diego, Talk, February, 16-21, 2020.
- Laukert, G., Grasse, P., Doering, K., Novikhin, A.E., Povazhny, V., Frank, M., Kassens, H. (2019): Spatial and temporal variability in supply, transport and utilization of silicate in the Laptev Sea based on dissolved stable silicon isotopes. Arctic Science Summit Week, Arkhangelsk, Russia, Talk, May, 22-30, 2019.
- Laukert, G., Bauch, D., Frank, M., Hathorne, E.C., Dreyer, J., Meulenbroek, K., Schaffer, J., Rabe, J., Paffrath, R., Pahnke, K., Rutgers van der Loeff, M., Meyer, H., Graeve, M. (2019): Inconsistencies between Fram Strait water mass budget assessments based on radiogenic neodymium isotopes and nutrients. Goldschmidt Conference, Barcelona, Spain, Talk, August, 17-22, 2019.
- Rahlf, P., Laukert, G., Hathorne, E.C., Frank, M. (2020): Congo River Influence on the Atlantic's Rare Earth Element and Nd/Hf Isotope Distributions. Goldschmidt Conference 2020, Online contribution, June, 21-26, 2020.
- Rutgers van der Loeff, M., Stimac, I., Casacuberta, N., Wefing, A.-M., Laukert, G., Bauch, D., Paffrath, R., Provost, C., Karcher, M. (2019): Surface water changes during transit from North Pole to Fram Strait. Goldschmidt Conference, Barcelona, Spain, Talk, August, 17-22, 2019.
- Rutgers van der Loeff et al. 2019: Surface water changes during transit from North Pole to Fram Strait (Goldschmidt conference Barcelona '19)
- Valk et al. 2019: Circulation Changes in the Amundsen Basin from 1991 to 2015 Revealed from Distributions of Dissolved ^{230}Th (Goldschmidt conference Barcelona '19)

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