ANNUAL REPORT ON GEOTRACES ACTIVITIES IN FRANCE

May 1st, 2021 to April 30th, 2022

New GEOTRACES or GEOTRACES relevant scientific results

- The residence time of Amazon waters on the Brazilian continental shelf based on radium

Radium isotopes are used as a tracer of the Amazon plume that enters into the Atlantic Ocean. We combined data collected in the framework of three large projects: i) AmasSeds (1991), ii) AMANDES/ GEOTRACES process study GApr01 (2007–2008) and iii) M147 (2018). The result revels that it takes between 9 and 14 days for the waters of the Amazon to reach the northwestern limit of the Brazilian continental shelf (off French Guiana) and between 12 and 21 days to reach the northwestern limit, east of the Brazilian continental. The average transport velocity towards the northwest along the Brazilian coast is thus estimated at 30 cm/s. Residence times obtained from radium isotopes agree with those estimated from high-resolution numerical simulations based on the NEMO model (Léon et al., 2022).

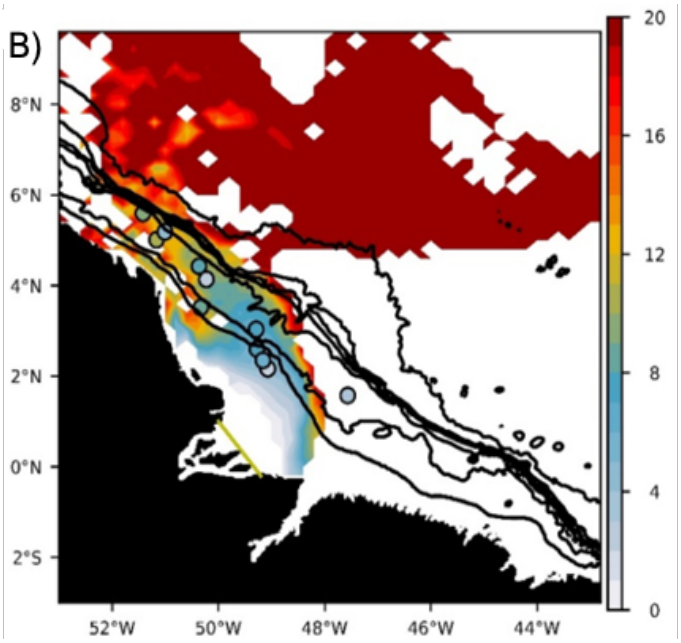

Fig. 1: Age (in days) of the Amazon plume determined using NEMO model for AMANDES 4 (July 2008). The water parcels are released in the model along the green line. The colored circles show the radium apparent ages (in days). From Léon et al. (2022).

- Early winter barium excess in the Southern Indian Ocean as an annual remineralisation proxy (GEOTRACES GIPr07 cruise)

The Southern Ocean (SO) is of global importance to the carbon cycle, and processes such as mesopelagic remineralisation that impact the efficiency of the biological carbon pump in this region need to be better constrained. During the study by van Horsten et al (2022), early austral winter barium excess (Baxs) concentrations were measured for the first time, along 30°E in the Southern Indian Ocean. Winter Baxs concentrations of 59 to 684 pmol L^{-1} were comparable to those observed throughout other seasons. The expected decline of the mesopelagic Baxs signal to background values during winter was not observed, supporting the hypothesis that this remineralisation proxy likely has a longer timescale than previously reported. A compilation of available SO mesopelagic Baxs data, including data from this study, shows an accumulation rate of ~ 0.9 µmol m^{-2} d^{-1} from September to July that correlates with temporally integrated remotely sensed primary productivity (PP), throughout the SO from data spanning ~ 20 years, advocating for a possible annual timescale of this proxy. The percentage of mesopelagic POC remineralisation as calculated from estimated POC remineralisation fluxes over integrated remotely sensed PP was approximately 2-fold higher south of the polar front (19±15 %, n=39) than north of the polar front (10±10 %,

n=29), revealing the higher surface carbon export efficiency further south. By linking integrated remotely sensed PP to mesopelagic Baxs stock we could obtain better estimates of carbon export and remineralisation signals within the SO on annual and basin scales.

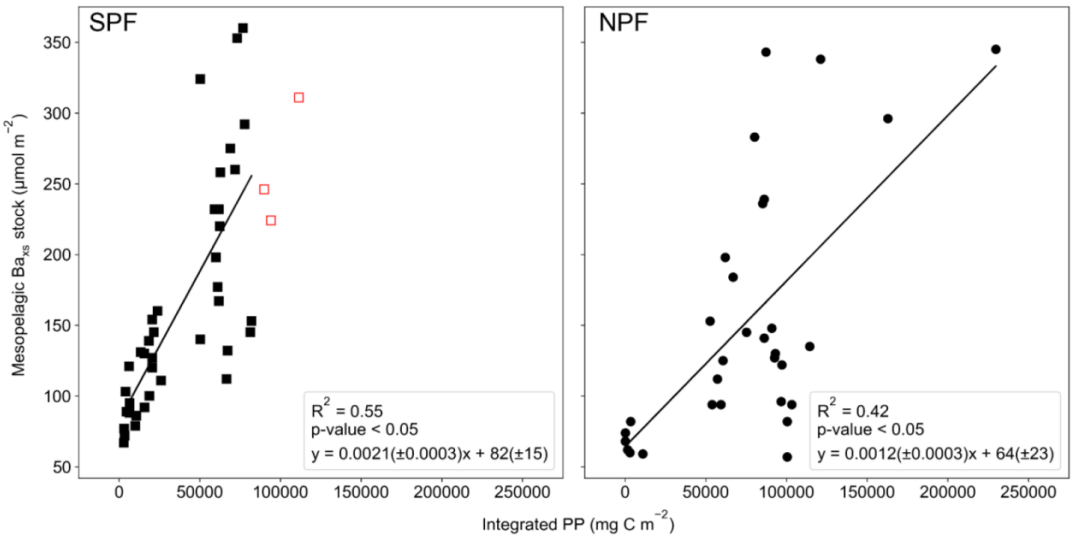

Fig. 2. Integrated mesopelagic Baxs stock plotted against integrated remotely sensed PP from the preceding September up to one month prior to sampling, all available literature data and winter data from this study, (a) South of the PF (SPF, black squares) and (b) North of the PF (NPF, black circles). Red open squares are data points from our winter dataset where there was not sufficient remote sensing PP data to integrate up to 1 month prior to sampling and available data up to 3 months prior to sampling was plotted but not included in the statistical analysis (van Horsten et al., 2022).

- Influence of metamorphic rocks and ice cover in the rivers' watersheds on river-borne neodymium isotope signatures and REE concentrations: in the case of the Canadian Arctic Archipelago (GN02 cruise)

Dissolved REEs and Nd isotopes were measured in thirteen rivers draining in the Canadian Arctic Archipelago (CAA) (GN02 cruise, August 2015). Results show that dissolved REE concentrations increase with increasing fractions of metamorphic rocks and ice cover in the rivers' watersheds, while ε_{Nd} and PAAS-normalized REE patterns are inherited from the watershed's bedrock lithology (Fig. 3). The CAA river Nd flow is equivalent to the Nd marine input from the Canada Basin. Depending on the percentage of Nd removal during mixing with seawater, the impact of river water on the ε_{Nd} of seawater exiting the CAA could potentially impart a climate-sensitive ε_{Nd} signature to the seawater reaching Baffin Bay, with possible implications for the use of ε_{Nd} in paleoceanographic reconstructions of water mass distribution.

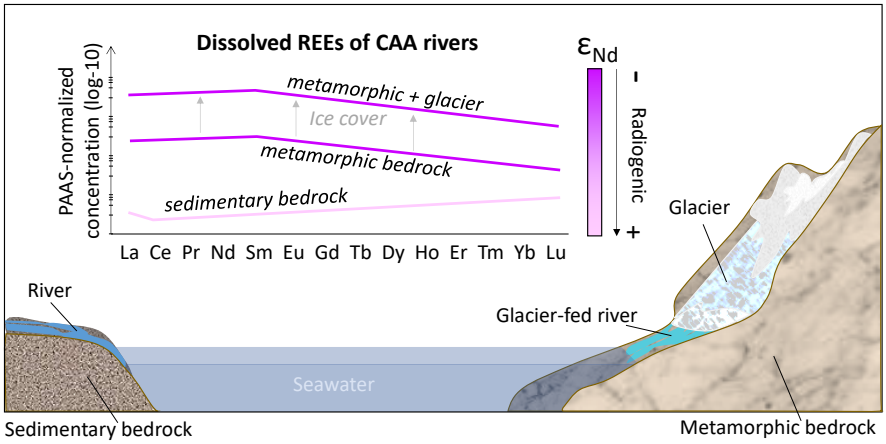

Fig. 3. Schematics of the dissolved REE and Nd isotope characteristics determined in the CAA rivers. From Grenier et al. (2022).

- Analytical development. Interferences and matrix effects on iron isotopic composition measurements by MC-ICPMS: influence of Calcium and Aluminium Interferences

This work presents for the first time a study of the impact of Cr, Ni, Ca, Si, and Al interferences and Na, Mg, Ca, K, and Mo matrix effects on Fe isotope measurements using Neptune and Neptune Plus MC-ICPMS with desolvation and a ^{57}Fe-^{58}Fe double-spike. These results document thresholds below which reliable measurements could be obtained, and point toward elements, which require particular attention. They should provide a useful framework for future Fe isotope analyses. The figure illustrates the case of Ca perturbations.

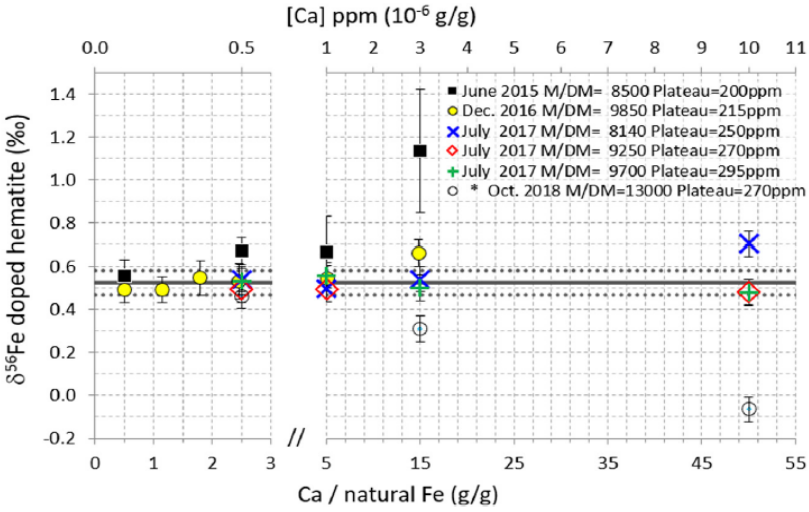

Fig. 4. The influence of Ca on d54Fe measurements by MC-ICP-MS. From Lacan et al. (2021)

• Phytoplanktonic response to simulated volcanic and desert dust deposition events in the South Indian and Southern Oceans

Contrasting concentrations of macronutrients and micronutrients induce different nutrient limitations of the oceanic productivity and shape the composition of the phytoplankton communities of the South Indian Ocean and Indian sector of the Southern Ocean. To assess the phytoplankton response to nutrient release by desert dust and volcanic ash aerosols in these distinct biogeochemical regions, we conducted a process study with microcosm incubation experiments. A dry or wet deposition of either dust from Patagonia or ash from the Icelandic volcano Eyjafjallajökull or dissolved nutrients (Si, Fe, N and/or P) were added to trace metal clean incubations of surface seawater collected from five stations. These deposition experiments enabled the measurement of the biological response along with solubility calculations of nutrients. Both types of aerosols alleviated the iron deficiency occurring in the Southern Ocean during austral summer and resulted in a 24–110% enhancement of the primary production, depending on the station. The release of dissolved silicon may also have contributed to this response, although to a lesser extent, whereas neither the dust nor the ash relieved the nitrogen limitation in the low-nutrient and low-chlorophyll area. Diatom growth was responsible for 40% to 100% of the algal biomass increase within the responding stations, depending on the region and aerosol type. The high particle concentrations that are characteristic of ash deposition following volcanic eruptions may be of equal or higher importance to phytoplankton compared to desert dust, despite ashes' lower nutrient solubility to the ocean (Geisen et al. 2022).

• A silicon isotopic perspective on the contribution of diagenesis to the sedimentary silicon budget in the Southern Ocean

Diatoms are known to fractionate silicon isotopes during the formation of their frustules causing the silicon isotopic composition of biogenic silica to track the degree of silicic acid consumption in surface waters. Despite a growing body of work that uses this proxy to reconstruct past changes in silicic acid utilization, the understanding of the benthic silicon cycle, particularly the identification and quantification of the processes that potentially alter the silicon isotopic composition of biogenic silica during early diagenesis is still lacking. We investigated these processes by comparing the silicon isotopic composition of pore water silicic acid, biogenic silica and, for the first time, lithogenic silica from five sediment cores collected in the deep basin of the Southern Ocean representing a diversity of sedimentation regimes. Silicic acid concentrations and the isotopic composition of Southern Ocean pore waters were the result of a dynamic balance between the dissolution of biogenic silica, reactive lithogenic silica phases and Si re-precipitation with the relative importance of each processes differing significantly between regions. The results are consistent with the formation of authigenic alumino-silicates derived from dissolved biogenic silica in the Sub-Antarctic Zone and in the Antarctic Zone (on average 12 ± 5% and 17 ± 13%, respectively). Since this latter process can fractionate silicon isotopes, this implies that, even if the silicon isotopic composition of diatoms preserved in the sediments is a reliable proxy for silicic acid utilization in the past ocean, care must be taken to extract a clean biogenic silica phase free of authigenic clays and lithogenic phases from sediments to eliminate this potential bias when interpreting isotopic records (Closset et al. 2022).

Special issue in the framework of PEACETIME

In the frame of the PEACETIME project, a special issue BIOGEOSCIENCES and ATMOSPHERIC CHEMISTRY and PHYSICS was completed in 2022 (see here: https://bg.copernicus.org/articles/special_issue1040.html). 21 papers were published following the PEACETIME cruise, a process-study endorsed by GEOTRACES (GAPR09 PROCESS STUDY – CRUISE PEACETIME; MEDITERRANEAN SEA. The most relevant new papers to GEOTRACES are marked with # in the publication list.

GEOTRACES or GEOTRACES relevant cruises

- Resilience cruise (Marion Dufresne), 19/04/2022- 23/05/2022: surface samples collected with the towed fish for dissolved, soluble and particulate trace metals and iron isotopes in the Mozambique Channel. This cruise might seek for GEOTRACES compliant data endorsement.

GEOTRACES workshops and meetings organized

- SWINGS post-cruise meeting (May 9-12, 2022, 36 attendees) was organized by C. Jeandel and H. Planquette in Auxerre (France)

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

- Many post cruise interviews and conferences about SWINGS. A list of SWINGS outreach activities is available here: https://www.geotraces.org/geotraces-french-swings-gs02-cruise-press-review/

- As GEOTRACES IPO, C. Jeandel realized with Elena Masferrer and Adrian Artis of 3 videos describing: 1) The GEOTRACES Programme (https://youtu.be/IGUt4OZL2Z8); 2) The Pb scientific challenges and results; (3) The Isotopes.
- Rencontre EchoScientifique: Le Réveilleur & Cécile Guieu and Sophie Bonnet: https://www.youtube.com/watch?v=9HGYQQAWuXY (interview in French about the TONGA project)
- Le Réveilleur: Why does life struggle in the ocean? Scientific reflections on what limits life in the ocean, particularly in the region covered by the TONGA project and campaign. https://www.youtube.com/watch?v=3105ScO53fo (in French)

Other GEOTRACES activities

- As IPO senior scientist, C. Jeandel is preparing all the highlights posted on the GEOTRACES website: https://www.geotraces.org/category/science/newsflash/
  and also assist Elena Masferrer to miscellaneous tasks, on request.
- Co-organization of a session in AGU 2021 fall meeting. PP024. Refinement of paleo-proxies in the GEOTRACES era (Co-conveners: Christopher Hayes, Kazuyo Tachikawa, Kassandra Costa and Jesse R Farmer)

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

- Artigue L., Wyatt N.J., Lacan F., Mahaffey C., Lohan M.C. 2021. The importance of water mass transport and dissolved-particle interactions on the dissolved aluminum cycle in the subtropical North Atlantic. Global Biogeochemical Cycles. doi.org/10.1029/2020GB006569
- #Bressac, M., Wagener, T., Leblond, N., Tovar-Sánchez, A., Ridame, C., Taillandier, V., Albani, S., Guasco, S., Dufour, A., Jacquet, S. H. M., Dulac, F., Desboeufs, K., and Guieu, C., 2021. Subsurface iron accumulation and rapid aluminum removal in the Mediterranean following African dust deposition, Biogeosciences, 18, 6435-6453, https://doi.org/10.5194/bg-18-6435-2021.
- Cloete, R., Loock, J.C., van Horsten, N.R., Menzel Barraqueta J.-L., Fietz, S., Mtshali, T.N., Planquette, H., García-Ibáñez, M.I., Roychoudhury, A.N., 2021. Winter dissolved and particulate zinc in the Indian Sector of the Southern Ocean: Distribution and relation to major nutrients (GEOTRACES GIpr07 transect). Marine Chemistry, 236, 104031. https://doi.org/10.1016/j.marchem.2021.104031.
- Cloete, R., Loock, J. C., van Horsten, N. R., Fietz, S., Mtshali, T. N., Planquette, H., and Roychoudhury, A. N., 2021. Winter Biogeochemical Cycling of Dissolved and Particulate Cadmium in the Indian Sector of the Southern Ocean (GEOTRACES GIpr07 Transect). Frontiers in Marine Science 8, https://www.frontiersin.org/article/10.3389/fmars.2021.656321.
- Closset**, I., Brzezinski, M. A., Cardinal, D., Dapoigny, A., Jones, J. L., & Robinson, R. S., 2022. A silicon isotopic perspective on the contribution of diagenesis to the sedimentary silicon budget in the Southern Ocean. Geochimica et Cosmochimica Acta, 327, 298–313. https://doi.org/10.1016/J.GCA.2022.04.010 (1 post-doc **)
- #Desboeufs, K., Fu, F., Bressac, M., Tovar-Sánchez, A., Triquet, S., Doussin, J.-F., Giorio, C., Chazette, P., Disnaquet, J., Feron, A., Formenti, P., Maisonneuve, F., Rodríguez-

Romero, A., Zapf, P., Dulac, F., and Guieu, C., 2022: Wet deposition in the remote western and central Mediterranean as a source of trace metals to surface seawater, Atmos. Chem. Phys., 22, 2309-2332, https://doi.org/10.5194/acp-22-2309-2022.

- Fourrier*, P., G. Dulaquais, C. Guigue, P. Giamarchi, G. Sarthou, H. Whitby & R. Riso, 2022. Characterization of the vertical size distribution, composition and chemical properties of dissolved organic matter in the (ultra)oligotrophic Pacific Ocean through a multi-detection approach, Mar. Chem, https://doiorg.inee.bib.cnrs.fr/10.1016/j.marchem.2021.104068 . (1 Ph. D. student *)
- Garcia-Orellana J., Rodellas V., Tamborski J., Diego-Feliu M., van Beek P., Weinstein Y., Charette M., Alorda-Kleinglass A., Michael H.A., Stieglitz T., Scholten J., 2021. Radium isotopes as submarine 1 groundwater discharge (SGD) tracers: review and recommendations. Earth Science Reviews, https://doi.org/10.1016/j.earscirev.2021.103681
- Geisen*, C., Ridame, C., Journet, E., Delmelle, P., Marie, D., Lo Monaco, C., … Cardinal, D., 2022. Phytoplanktonic response to simulated volcanic and desert dust deposition events in the South Indian and Southern Oceans. Limnology and Oceanography, 9999, 1–17. https://doi.org/10.1002/LNO.12100 (1 Ph. D. student *)
- González**, A.G., Bianco A., Boutorh J., Cheize M., Mailhot G., Delort A.-M., Planquette H., Chaumerliac, N., Deguillaume L., Sarthou G, 2022. Influence of strong iron-binding ligands on cloud water oxidant capacity, STOTEN, https://doi.org/10.1016/j.scitotenv.2022.154642. (1 post-doc **)
- Grenier**, M., Brown, K. A., Colombo, M., Belhadj, M., Baconnais, I., Pham, V., Soon, M., Myers, P. G., Jeandel, C., and François, R., 2022. Controlling factors and impacts of river-borne neodymium isotope signatures and rare earth element concentrations supplied to the Canadian Arctic Archipelago. Earth and Planetary Science Letters 578, 117341, https://doi.org/10.1016/j.epsl.2021.117341. (1 post-doc **)
- Hamilton, D. S., Perron, M. M., Bond, T. C., Bowie, A. R., Buchholz, R. R., Guieu, C., ... & Mahowald, N. M., 2022. Earth, wind, fire, and pollution: aerosol nutrient sources and impacts on ocean biogeochemistry. Annual review of marine science, 14, 303-330.
- Hodel F., R. Grespan, M. De Rafélis, G. Dera, C. Lézin, E. Nardin, D. Rouby, M. Aretz, M. Steinnman, M. Buatier, F. Lacan, C. Jeandel et V. Chavagnac., 2021. Drake Passage Gateway opening and Antarctic Circumpolar Current onset 31 Ma ago: the message of foraminifera and reconsideration of the Neodymium isotope record – Chemical Geology, Volume 570. https://doi.org/10.1016/j.chemgeo.2021.120171 ⟨hal-03358760⟩
- Horner T., S. Little, T. Conway, J. Farmer, J. Hertzberg, et al., 2021. Bioactive trace metals and their isotopes as paleoproductivity proxies: An assessment using GEOTRACES-era data. Global Biogeochemical Cycles, 35, e2020GB006814. ⟨10.1029/2020GB006814⟩.
- Lacan F., Artigue L., Klar J.K., Pradoux C., Chmeleff J., Freydier R. 2021. Interferences and matrix effects on iron isotopic composition measurements by 57Fe-58Fe double-spike multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS); the importance of calcium and aluminium interferences. Frontiers in Environmental Chemistry. doi:10.3389/fenvc.2021.692025
- Léon M., van Beek P., Scholten J., Moore W., Souhaut M., DeOliveira J., Jeandel C., Seyler P., Jouanno J., 2022. Use of ^{223}Ra and ^{224}Ra as chronometers to estimate the residence time of Amazon waters on the Brazilian continental shelf, Limnology & Oceanography 00, 1-15, doi: 10.1002/lno.12010

- Levier*, M., Roy-Barman, M., Colin, C., and Dapoigny, A., 2021. Determination of low level of actinium 227 in seawater and freshwater by isotope dilution and mass spectrometry. *Marine Chemistry*, *233*, 103986. (1 Ph. D. student *)
- Lory, C., Van Wambeke, F., Fourquez, M., Barani, A., Guieu, C., Tilliette, C., ... & Bonnet, S., 2022. Assessing the contribution of diazotrophs to microbial Fe uptake using a group specific approach in the Western Tropical South Pacific Ocean. ISME Communications, 2(1), 1-11.
- Michael S., Resing J., Lacan F., Buck N., Pradoux C., Jeandel C. 2021. Constraining the Solomon Sea as a source of Al and Mn to the Equatorial Undercurrent. Deep Sea Research Part I: Oceanographic Research Papers, Elsevier, 174, pp.103559. ⟨10.1016/j.dsr.2021.103559⟩. ⟨hal-03358780⟩
- #Pulido-Villena, E., Desboeufs, K., Djaoudi, K., Van Wambeke, F., Barrillon, S., Doglioli, A., Petrenko, A., Taillandier, V., Fu, F., Gaillard, T., Guasco, S., Nunige, S., Triquet, S., and Guieu, C., 2021. Phosphorus cycling in the upper waters of the Mediterranean Sea (PEACETIME cruise): relative contribution of external and internal sources, Biogeosciences, 18, 5871-5889, https://doi.org/10.5194/bg-18-5871-2021.
- Rodellas V., Stieglitz T., Tamborski J., van Beek P., Andrisoa A., Cook P., 2021. Conceptual uncertainties in groundwater and porewater fluxes estimated by radon and radium mass balances, Limnology & Oceanography 9999, 1–19, doi: 10.1002/lno.11678
- Silori*, S., Sharma*, D., Chowdhury, M., Biswas, H., Cardinal, D., & Mandeng-Yogo, M., 2021. Particulate organic matter dynamics and its isotopic signatures (δ13CPOC and δ15NPN) in relation to physical forcing in the central Arabian Sea during SW monsoon (2017–2018). Science of The Total Environment, 785, 147326. https://doi.org/10.1016/j.scitotenv.2021.147326 (2 Ph. D Students *)
- Silori*, S., Sharma*, D., Chowdhury, M., Biswas, H., Bandyopadhyay, D., Shaik, A. U. R., Cardinal, D., Mandeng-Yogo, M., & Narvekar, J., 2021. Contrasting phytoplankton and biogeochemical functioning in the eastern Arabian Sea shelf waters recorded by carbon isotopes. Marine Chemistry, 232, 103962. https://doi.org/10.1016/j.marchem.2021.103962 (2 Ph. D. students*)
- Thibon F., Weppe L., Montanes M., Telouk P., Vigier N., 2021. Lithium isotopic composition of the organic-rich reference materials TORT-2, DORM-2, TORT-3, DORM-4, SRM-1400 and ERM-CE278k, J. Anal. At. Spectrom. 36, 1381-1388 doi: 10.1039/D1JA00045D.
- Thibon F., Metian M., Oberhaensli F., Montanes M., Vasileva E., Orani A-M,Telouk P., Swarzenski P. and Vigier N., 2021. Bioaccumulation of lithium isotopes in mussels and implications for coastal environments, ACS Earth and Space Chemistry, doi: 10.1021/acsearthspacechem.1c00045
- Van Horsten*, N, Planquette, H., Sarthou, G., Mtshali, T. N, Roychoudhury, A., Bucciarelli. E., 2022. Early winter barium excess in the Southern Indian Ocean as an annual remineralisation proxy (GEOTRACES GIPr07 cruise). Biogeosciences, https://doi.org/10.5194/bg-2021-42. (1 Ph. D. student *)
- #Van Wambeke, F., Taillandier, V., Desboeufs, K., Pulido-Villena, E., Dinasquet, J., Engel, A., Marañón, E., Ridame, C., and Guieu, C., 2021. Influence of atmospheric deposition on biogeochemical cycles in an oligotrophic ocean system, Biogeosciences, 18, 5699-5717, https://doi.org/10.5194/bg-18-5699-2021.

- Yeghicheyan, D., Grinberg, P., Alleman, L., Belhadj, M., Causse, L., Chmeleff, J., Cordier, L., Djouraev, I., Dumoulin, D., Dumont, J., Freydier, R., Mariot, H., Cloquet, C., Kumkrong, P., Malet, B., Jeandel, C., Marquet, A., Riotte, J., Tharaud, M., and Mester, Z., 2021. Collaborative determination of trace element mass fractions and isotope ratios in AQUA-1 drinking water certified reference material. Anal. Bioanal. Chem. 413 10.1007/s00216-021-03456-8.

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

- Carla Geisen (PhD): Macro- and micronutrient dissolution from desert and volcanic aerosols in rain and seawater: impact on phytoplankton in the Southern Indian Ocean, Sorbonne Université, defended on 27 September 2021. Available from 27 September 2022 on www.theses.fr
- Natasha van Horsten (PhD): Insights into early winter Southern Indian Ocean dissolved iron distributions and remineralization using excess barium (GEOTRACES GIPr07 cruise), in Brest in cotutelle with Stellenbosch University (South Africa), defended on 16 November 2021.
- Martin Levier (PhD): Development and use of Actinium 227 as a tracer of deep ocean mixing, Université Paris-Saclay, defended on 21 March 2022.

GEOTRACES presentations in international conferences

Goldschmidt 2021, 4-9 July 2021, virtual

- Iron (II) oxidation kinetics variability in the Atlantic Ocean and development of an improved theoretical equation. *Submitted by D. Gonzalez-Santana, david.gonzalez@fpct.ulpgc.es at the time Postdoc at LEMAR*
- Particulate Trace Metals from Shallow Hydrothermal Vents. *Submitted by M.-E. Vorrath, maria-elena.vorrath@awi.de at the time Postdoc at LEMAR*
- 227 Ac and 231 Pa in the southeast sector of Southern Ocean (Bonus GoodHope–GEOTRACES cruise. Levier, M., Roy-Barman, M., & Dapoigny, A. M. Levier was a PhD student at LSCE at the time

European Aerosol Conference, 30 August – 3 September, 2021:

- Influence of Fe-binding ligands on cloud water oxidant capacity: a study on samples collected at puy de Dôme (France). Bianco, Angelica, Aridane G. González, Julia Boutorh, Marie Cheize, Anne-Marie Delort, Gilles Mailhot, Hélène Planquette, Laurent Deguillaume, Géraldine Sarthou. *Submitted by A. Bianco, A.Bianco@opgc.fr*

AGU 2021, 13-17 December 2021, New Orleans and online everywhere

- Neodymium isotope budget in the Mediterranean Sea inferred from core-top sediments, seawater data synthesis and box model calculation. Submitted by K. Tachikawa, kazuyo@cerege.fr

Ocean Sciences 2022, 24 February- 4 March 2022, Hawaii and online everywhere

- The distribution of size-fractionated particulate cadmium in the North Atlantic Ocean along the GEOVIDE section (GEOTRACES GA01): linking Cd and phytoplankton community structure. *Submitted by H. Planquette, helene.planquette@univ-brest.fr*
- Lost mercury: High mercury release and rapid scavenging from deep hydrothermal vent sites at the Mid-Atlantic Ridge. N. Torres Rodriguez. *Submitted by N Torres Rodriguez, natalia.torres-rodriguez@mio.osupytheas.fr*
- 3D study of the TAG hydrothermal plume: interaction between hydrodynamics and geochemistry. *Submitted by C. Cathalot, Cecile.Cathalot@ifremer.fr*
- dFe pattern impacted by shallow hydrothermal sources along a transect through the Tonga-Kermadec arc, Ocean Science Meeting, Hawaï, 2022. Submitted by C. Tilliette, *chloe.tilliette@imev-mer.fr*
- An oasis in the desert: shallow hydrothermal iron triggers massive diazotroph blooms in the subtropical Pacific Ocean. Bonnet S., Guieu C. and the TONGA team, [sophie.bonnet@mio.osupytheas.fr; cecile.guieu@imev-mer.fr]
- dFe pattern impacted by shallow hydrothermal sources along a transect through the Tonga-Kermadec arc. Tilliette C. et al., [chloe.tilliette@imev-mer.fr]
- Distribution of thiol and humic substances during the 2019 Tonga cruise. Portlock G. et al., [g.portlock@liverpool.ac.uk]
- Lithium concentration and Li isotope composition of plankton from the Tonga volcanic arc: influence of shallow hydrothermal fluids. Vigier N. et al. Submitted by nathalie.vigier@imev-mer.fr

Submitted by Kazuyo Tachikawa (kazuyo@cerege.fr)