ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BRAZIL

April 1st, 2018 to March 31st, 2019

New Scientific Results

- Rare Earth Elements are less and less natural tracers in the ocean

This verdict is well illustrated by the recent study of Rodrigo Pedreira (2018, see reference below) off the North East Brazilian coast. His Rare Earth Elements (REE) data reveal marked positive Gadolinium (Gd) anomaly which reflects the release of Gd in hospital and domestic effluents. Indeed, this element is used as contrasting agent in magnetic resonance imaging (MRI) to enhance clarity of diagnosis. The authors estimated that between 700 and 2000 g Gd d^{-1} are discharged into Tropical and South Atlantic waters due to submarine outfalls. While the Gd complex behaves conservatively and can be used as a new tracer for sewage discharges from submarine outfalls in ocean waters, it is also clear that high technology wastes are distorting the use of REE as "natural" tracers.

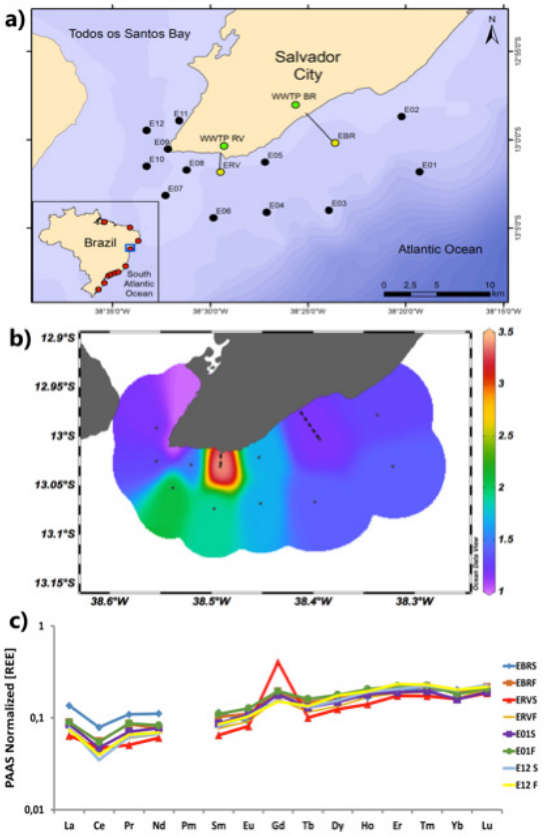

***Figure** 1: Sampling took place (a) off the northeastern coast of Brazil, whereas discharges of submarine outfalls located along the coast of Brazil (a insert) were used to estimate order-of-magnitude emissions of anthropogenic Gd to the Atlantic Ocean. A plume of Gd anomalies (Gdsn/Gdsn*) can be clearly identified for surface waters (b). Positive Gd anthropogenic anomalies are observed in shale (PAAS)-normalized REE patterns (c) for surface waters (S) in most stations in the proximity of submarine outfalls (ERVS and EBVS). (http://www.geotraces.org/science/science-highlight/1574-rare-earth-elements)*

Reference: Pedreira, R. M. A., Pahnke, K., Böning, P., & Hatje, V. (2018). Tracking hospital effluent-derived gadolinium in Atlantic coastal waters off Brazil. Water Research, 145, 62–72.

Cruises

- The PIRATA-BR XVIII cruise was performed in two legs between September and December 2018 on board the R/V Vital de Oliveira. During the first lag, surficial samples were collected using a new fishing system for speciation of dissolved metals (Cu and Fe) and particulate Al. Full depth profiles were also performed to collect waters for the analysis of nutrients, biogenic silica, and particulate carbon and nitrogen (Figure 2). Dr. Mônica Wallner-Kersanach was the researcher responsible for sample collection and analysis at Federal University of Rio Grande.
- For the leg two, water samples were collected from 8 full depth profiles along a transect from the coast of Maceio to open waters at 5°S (Figure 3). It was also planned to collect samples from a transect at 11°S. However, the very strong winds and high seas precluded us to perform this transect. The ship does not have a trace metal sampling rosette, hence water samples were collected only for the determination of REE and Nd isotopes. GEOTRACES Scientist Vanessa Hatje.

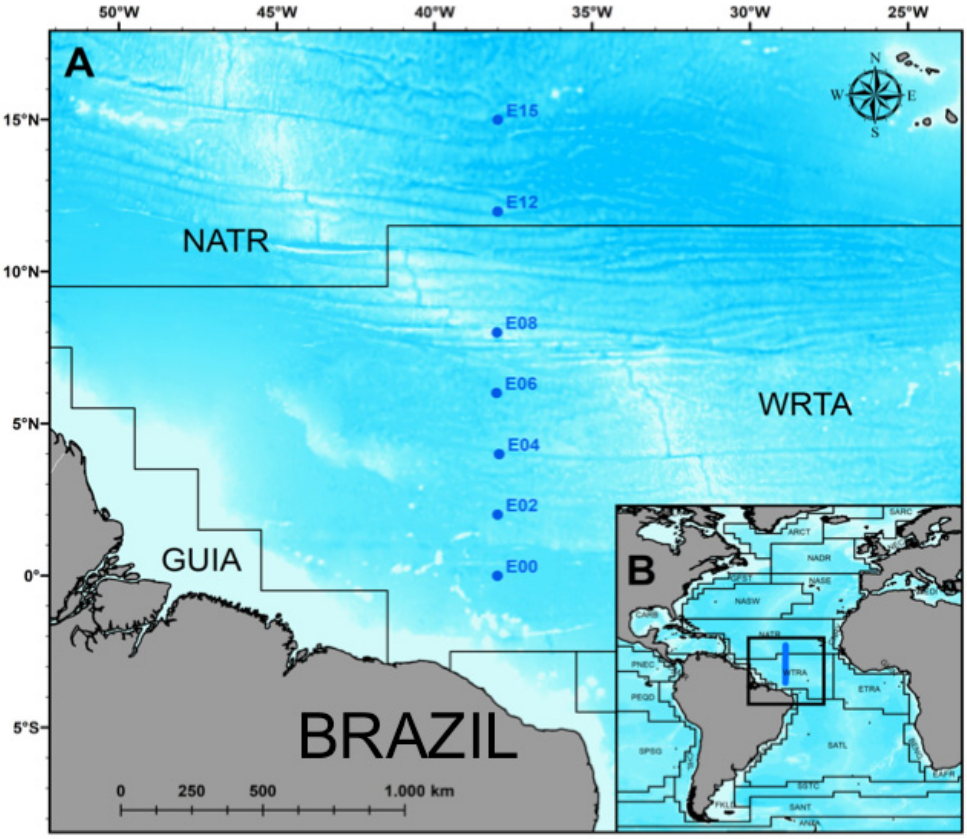

Figure 2. *Sampling stations between 0° to 15°N for the PIRATA-BR XVIII cruise (A) and the different biogeochemical provinces (B).*

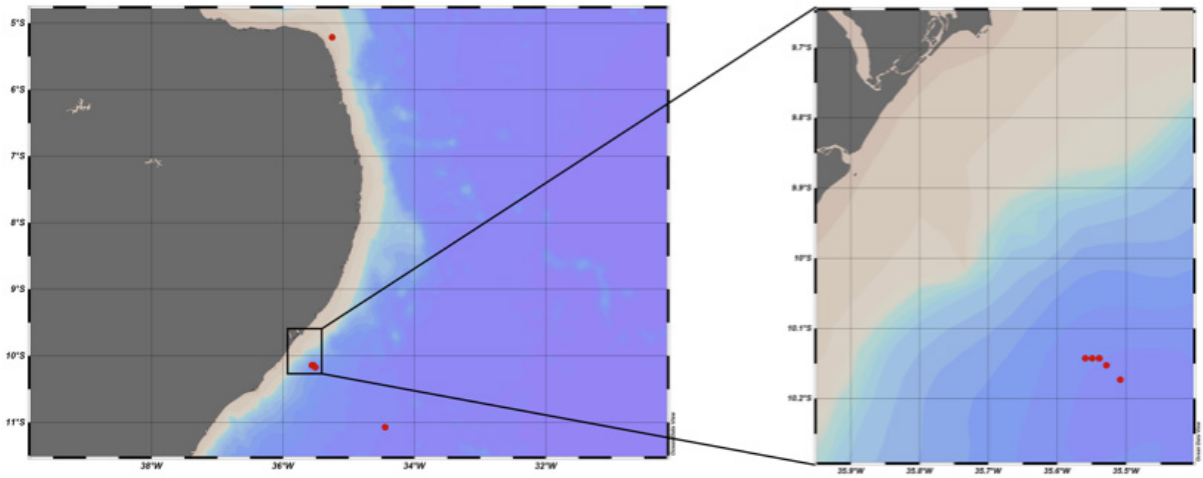

Figure 3. *Location of the full depth profiles performed during the PIRATA-Br XVIII.*

- Interactions of trace metals, DOM, and particles in the Amazon estuary and associated plume as key processes for trace metal and DOM fluxes into the Atlantic. Meteor Cruise 147 (Figure 4). Las Palmas (Gran Canaria) – Belém (Brazil). Chief scientist Andrea Koschinsky, the Brazilian scientist Carlos Eduardo Rezende was responsible for DOM and Hg measurements.

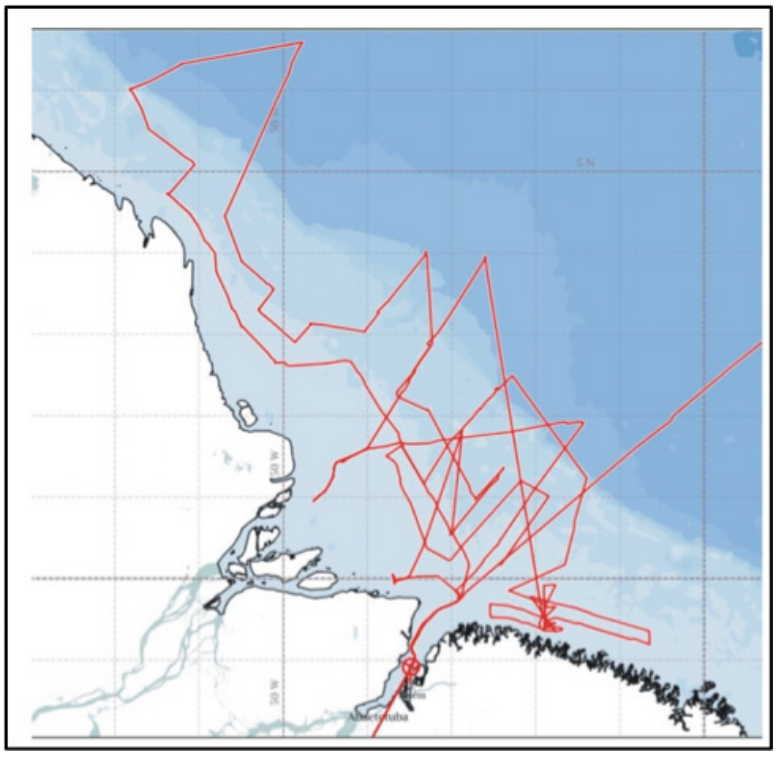

Figure 4. *Cruise track of R/V Meteor cruise 147, along which water and sediment stations and continuous monitoring of S and CO2 were carried out.*

New projects and/or funding

- Project Sources, sinks and control processes of the distribution of rare earth elements (REE) and εNd in the Tropical Atlantic (15ºN-21ºS) (PI: Vanessa Hatje) (Funding CNPq)

  This project has the following objectives: 1) Determination of REE in the western Atlantic waters between the latitudes 21ºS and 15ºN obtained in the oceanographic cruise PIRATA XVII / GEOTRACES Apr 10 ; 2) Evaluate "Boundary Exchange" processes along transects at 5ºS and 11ºS on the continental shelf during the cruise to PIRATA XVIII / GEOTRACES performed between September and October 2018 and at 34.5ºS during the SAMBAR cruise schedule for May 2019; 3) To train the members of the research group in the preparation of ocean water samples for the determination of Nd and Ba isotopes.

- Project PROVOCCAR - Processos de Ventilação Oceânica e Ciclo do Carbono no Norte da Península Antártica (Oceanic Ventilation and Carbon Cycle Processes in Northern Antarctic Peninsula) (PI: Mauricio Mata, Co-PI: Rodrigo Kerr) (Funding CNPq).

  The Project PROVOCCAR is conducted by the researchers of the Brazilian High Latitude Oceanography Group (GOAL) and was approved by the Brazilian Antarctic Program (PROANTAR) in 2018 to execute, at least, three Antarctic summer cruises between 2019-2022. The activities are planned to occur around the Northern Antarctic Peninsula, where the group will investigate the processes related with hydrographic and biogeochemical properties changes and ocean ventilation, mainly those associated with heat and carbon uptake and storage at deep and dense ocean layers.

- Project SAMBAR – Interannual variability of the meridional transports across the SAMOC basin wide array (Funding FAPESP 2017/09659-6).

  The project aims to better understand the interannual variability of heat content and the southern transport across 34.5°S, a zonal region referred to as SAMBA (the South Atlantic Meridional Overturning Circulation (SAMOC) Basin-wide Array). It will investigate the impacts of global ocean shifts and feedback on changes in the South Atlantic Circulation in the Regional Climate and in the stability of the Southern Circulation (MOC).

Outreach activities

- "Hora do Brasil" interview with Vanessa Hatje about GEOTRACES activities during the cruise PIRATA-BR XVIII.

Other GEOTRACES Activities

- V. Hatje is a Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC).
- V. Hatje is serving as a member of the IAEA Standing Advisory Group on Nuclear Applications (SAGNA).
- The Universidade Federal da Bahia and the Scientific Committee on Oceanic Research (SCOR) sponsored a visit by the PhD candidate Raiza Andrade to visit Catherine Jeandel at Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) at the Université Toulouse III. The student stayed in Toulouse for three weeks during November 2018 learning the water sample preparation procedures to perform Nd isotopes chemistry. The student is now preparing Atlantic Ocean samples and is applying for a scholarship to

spend 1 year at LEGOS to finish the sample preparation steps and perform the determination of the isotopes.

- Rodrigo Aguiar participate on the training course on Metal Speciation and Isotopes in the Ocean for GEOTRACES and Beyond, China, May 2018.

GEOTRACES-related articles

- Pedreira, R.M.A.; Pahnke, K.; Böning, P.; Hatje, V. Tracking Hospital Effluent-Derived Gadolinium In Atlantic Coastal Waters Off Brazil. Water Research, V. 145, P. 62-72, 2018.
- Hatje, V.; Lamborg, C.H.; Boyle, E.A. Trace-Metal Contaminants: Human Footprint On The Ocean. Elements, V. 14, P. 403-408, 2018.
- Andrade, R.L.B.; Hatje, V.; Pedreira, R.M.A.; Pahnke, K. (2019, Submitted). Ree Fractionation And Gd Human Footprint Along The Continuum Between Paraguaçu River To Coastal South Atlantic Waters.
- Hatje, V.; Cotrim Da Cunha, L.; Da Costa, M. Global Changes, Anthropogenic Impacts And The Future Of The Oceans. Revista Virtual De Química, V. 10, P. 1947-1967, 2018.
- Egres, A.G.; Hatje, V.; Miranda, D.A.; Gallucci, F.; Barros, F. Functional Response Of Tropical Estuarine Benthic Assemblages To Perturbation By Polycyclic Aromatic Hydrocarbons. -Ecological Indicators, V. 96, P. 229-240, 2019.
- Pedreira, R.M.A.; Barros, F.; Farias, C.; Wagener, A.L.; Hatje, V. A Tropical Bay As A Reference Area Defined By Multiple Lines Of Evidences. Marine Pollution Bulletin, V. 1, P. 1-14, 2017.
- Adlich, H.L.; Venturini, N.; Martins, C.C.; Hatje, V.; Tinelli, P.; Gomes, L.E.O. ; Bernardino, A.F. .Multiple Biogeochemical Indicators Of Environmental Quality In Tropical Estuaries Reveal Contrasting Conservation Opportunities. Ecological Indicators, V. 95, P. 21-31, 2018.
- Fragoso, C.P.; Bernini, E.; Araújo, B.F.; Almeida, M.G. De; Rezende, C. E. De. Mercury In Litterfall And Sediment Using Elemental And Isotopic Composition Of Carbon And Nitrogen In The Mangrove Of Southeastern Brazil. Estuarine Coastal And Shelf Science, V. 202, P. 30-39, 2018.
- Araujo, B. F.; Hintelmann, H.; Dimock, B.; De Lima Sobrinho, R.; Bernardes M.C.; De Almeida, M.G.; Krusche, Alex V.; Rangel, T.P.; Thompson, F.; De Rezende, C.E.. Mercury Speciation And Hg Stable Isotope Ratios In Sediments From Amazon Floodplain Lakes-Brazil. Limnology And Oceanography, V. 63, P. 1134-1145, 2018.
- Kerr, R.; Orselli, I.B.M.; Lencina-Avila, J.M.; Eidt, R.T.; Mendes, C.R.B.; Da Cunha, L. C.; Goyet, C.; Mata, M.M.; Tavano, V. M. Carbonate System Properties In The Gerlache Strait, Northern Antarctic Peninsula (February 2015): I. Sea-Air Co2 Fluxes. Deep-Sea Research Part Ii-Topical Studies In Oceanography, V. 1, P. 1, 2018.
- Kerr, R.; Goyet, C.; Da Cunha, L. C.; Orselli, I.B.M.; Lencina-Avila, J.M.; Borges, M.; Mendes, C.R.B.; Mata, M.M.; Tavano, V. M. Carbonate System Properties In The Gerlache Strait, Northern Antarctic Peninsula (February 2015): Ii. Anthropogenic CO 2 and Seawater Acidification. DEEP-SEA RESEARCH PART II-TOPICAL STUDIES IN OCEANOGRAPHY, v. 1, p. 1, 2018.
- Cotrim da Cunha, L.; Hamacher, C.; Farias, C.O.; Kerr, R.; Mendes, C.R.B.; Mata, M.M. Contrasting end-summer distribution of organic carbon along the Gerlache Strait,

Northern Antarctic Peninsula: Bio-physical interactions. DEEP-SEA RESEARCH PART II-TOPICAL STUDIES IN OCEANOGRAPHY, V. 149, P. 206-217, 2018.

- Santos Neves, J.M.C.O.; MARQUES, E.D.; Kutter, V.T.; LACERDA, L.D.; SANDERS, C.; SELLA, S.M.; Silva-Filho, E.V. Influence of river water diversion on hydrogeochemistry and REE distribution, Rio de Janeiro, Brazil. CARPATHIAN JOURNAL OF EARTH AND ENVIRONMENTAL SCIENCES, V. 13, P. 453-464, 2018.

GEOTRACES presentations in international conferences

- Three GEOTRACES presentations and co-authorships by Brazilian Scientists at the Aquatic Science Meeting (Porto Rico), 2019.
- One GEOTRACES presentation during the "All Atlantic Research Forum/Belem Statement", MCTIC, 2018.
- Plenary talk by Vanessa Hatje: Trace elements in the ocean: critical importance and human footprint/GEOTRACES. Jornadas Nacionales de Ciencias del Mar, Buenos Aires, September, 2018.

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