

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NETHERLANDS

June 1st, 2015 to April 30th, 2016

Transect GA02: western Atlantic Ocean: The Dutch GEOTRACES cruises between 2010-2012 aimed to map the distribution of important trace elements and isotopes (PI: Hein de Baar) and to investigate the deep-sea microbiology (PI: Gerhard Herndl) in the West Atlantic Ocean. Gerhard Herndl is also involved in bioGEOTRACES together with Penny Chisholm (MIT) and Julie LaRoche (Dalhousie University). In 2015-2016 we focused with our west Atlantic work on the ongoing compilation and analysis of the data collected in the western Atlantic Ocean in 2010 – 2012. An estimated 22 articles have appeared.

Transect GA04N: Mediterranean Sea and the Black Sea: In 2012/2013 funding was granted by the Dutch Organization for Scientific Research (NWO) for GEOTRACES cruises in the Mediterranean Sea and the Black Sea (PI: Hein de Baar). The Dutch GEOTRACES cruises in the Mediterranean Sea (GA04N) was organized in concert with a cruise of the Spanish Mediterranean GEOTRACES program (GA04S). In 2015/16 our work in the Mediterranean and Black Seas focused on preparing the data for the IDP2017 and the presentation and writing up of the data. An estimated 3 articles have appeared and another 4 have been submitted.

Transect GN04: Arctic Ocean: In August-October 2015, a Dutch team (NIOZ and RUG) participated in the German organized GEOTRACES cruise (TransARC-II, PS94) on the RV Polarstern to the Arctic Ocean. On board we have measured DFe, Fe-binding ligands, CDOM, humics, bacteria, viruses, DIC, alkalinity, oxygen and the macronutrients nitrate, nitrite, phosphate, silicate and CTD data. Furthermore we took samples to measure a range of bio-essential and toxic metals.

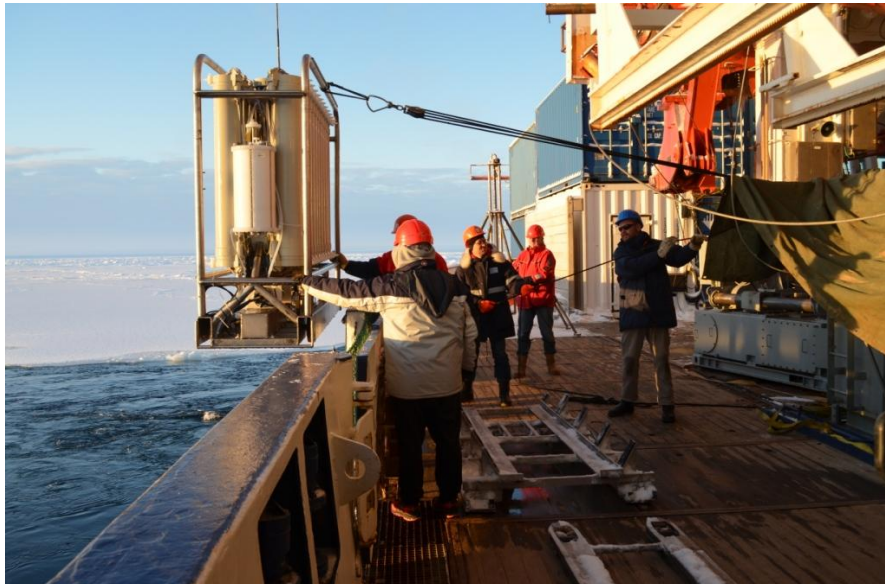


Figure. Return of the NIOZ ultraclean titanium CTD with PRISTINE samplers in on board RV Polarstern during cruise PS94 in the Arctic, 2015.

Transect GN05: Fram Strait / Arctic Ocean: In July-September 2016, a Dutch team (NIOZ/RUG) will participate in the German organized GEOTRACES cruise (GRIFF 2016, PS100) on the RV Polarstern to Fram Strait. On board measurement of DIC, Alkalinity and Oxygen will be performed and samples for DFe and Fe-binding ligands will be taken.

Process study: Response of the Iron Biogeochemical Cycle on Continental Shelves to Seawater Deoxygenation. In 2014, funding was granted by the Dutch Organization for Scientific Research (NWO) for GEOTRACES cruises in the Black Sea (September 2015) and Baltic Sea (planned for June 2016) (PI: Caroline Slomp). The research during both cruises will focus on quantifying the release of Fe and Mn and other metals from shelf sediments, elucidating the relevant mechanisms and assessing the transport pathways of the metals in the water column over the shelf and its transfer to the deep basin. Techniques include: lander deployments for in-situ determinations of sediment-water exchange fluxes, porewater analyses and the collection and analyses of dissolved and particulate constituents in the water column (with in-situ pumping and on deck filtration).

Meetings

- GEOTRACES SSC meeting: Micha Rijkenberg attended the GEOTRACES Scientific Steering Committee meeting on 15-17 July 2015 in Vancouver, Canada
- Workshop HYDROTHERMAL input during GN04 (cruise PS94, 2015) in the Arctic: Loes Gerringa and Micha Rijkenberg attended the workshop on 4-5 April 2016 in Bremerhaven, Germany

Cruises

- Transect GN04: was sailed from half August to half October 2015 on board of the *RV Polarstern*.
- Black Sea, Istanbul-Varna was sailed in September 2015 on board Pelagia.
- Baltic Sea, will be sailed in June 2016 on board Pelagia.
- Transect GN05 to FRAM Strait will be sailed in July-September 2016 on board of *RV Polarstern*.

New results

- Investigators are making good progress in the sample analysis and subsequent interpretation of the data collected in the western Atlantic Ocean. Many results of the western Atlantic transect have been presented at international conferences and appeared in journal publications.
- The first presentations and publications resulting from the MedBlack GEOTRACES cruises appeared.
- The Arctic dissolved Fe data measured during PS94 (transect GN04) show Fe limitation in the Nansen Basin.

Presentations

- Boye, M., Dulaquais, G., Planquette, H., Rijkenberg, M.J.A., 2016. Assessing the marine geological cycle of cobalt from its interactions with particles in the Black Sea Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Bridgestock, L., Van de flierdt, T., Rehkämper, M., Baker, A., Achterberg, E., Rijkenberg, M., Lohan, M., de Baar, H., 2015. Detection of Pb from natural sources in the Tropical Atlantic, Goldschmidt. Prague, Czech Republic, 16-21 August
- Dijkstra, N., Kraal, P., Rijkenberg, M.J.A., Slomp, C.P., 2015. Coupled dynamics of iron, manganese and phosphorus in the water column of the Black Sea and implications for phosphorus burial Nutrient Cycling on the Modern and Ancient Earth conference. Leeds, School of Earth & Environment, University of Leeds, UK, 6-7 July
- Heimbürger, L.-E., Cossa, D., Rijkenberg, M.J.A., Sarthou, G., Rutgers van der Loeff, M., Sunderland, E.M., Sonke, J., 2016. Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Margolin, A.R., Gerringa, L.J.A., Hansell, D.A., Rijkenberg, M.J.A., 2015. Net removal of dissolved organic carbon in the subsurface Black Sea, AGU Fall Meeting. San Francisco, 14-18 Dec. 2015.
- Middag, R., Rolison, J.M., Stirling, C.H., van Hulten, M.M.P., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Dissolved aluminium in the West-Atlantic Ocean and Mediterranean Sea, Goldschmidt Conference. Prague, Czech Republic, 16-21 August
- Rijkenberg, M.J.A., et al. 2016. Trace metals in the Atlantic and Arctic Oceans, Workshop: Biogeochemical studies in the Siberian Shelf Seas. Kiel, Germany, 27-28 Jan.
- Rijkenberg, M.J.A., Gerringa, L.J.A., Slagter, H.A., van Ooijen, J., Ober, S., Rutgers v.d. Loeff, M., 2015. Fe limitation in the Arctic Ocean, Symposium Polar Tipping Points. Den Haag, The Netherlands, 5 November
- Rolison, J.M., Stirling, C.H., George, E., Middag, R., Gault-Ringold, M., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Biogeochemical cycling of the uranium, iron and cadmium isotope systems during oceanic anoxia: A case study of the Black Sea, Goldschmidt Conference. Prague, Czech Republic, 16-21 August
- Rolison, J.M., Stirling, C.H., Middag, R., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Uranium Isotope Fractionation Factor During U(VI)-U(IV) Reduction In The Black Sea, AGU Fall Meeting. San Francisco, US, 14-18 Dec. 2015.
- Rosati, G., Heimbürger, L.E., Sonke, J.E., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., 2015. Developing a methylmercury dynamic model for the Black Sea, 12th International Conference on Mercury as a Global Pollutant. Jeju, South Korea, 14-19 June
- Séguret, M.J.M., Dijkstra, N., Andersen, A., Severmann, S., Rijkenberg, M., Laan, P., Slomp, C.P., 2016. Water column iron dynamics along a shelf-to-basin transect in the Black Sea, Nederlands Aardwetenschappelijk Congres. Veldhoven, NWO & KNGMG, 7-8 April, poster
- Tagliabue, A., Boyd, P., Rijkenberg, M.J.A., Williams, R.G., 2016. How do local and remote processes affect the distribution of iron in the Atlantic Ocean?, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016

- van den Berg, C.M.G., Abualhaja, M.M., Rijkenberg, M.J.A., 2016. Iron binding ligands in the ocean are similar to humic substances, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Wu, Y., Goldstein, S.L., Pena, L., Hartman, A.E., Rijkenberg, M.J.A., de Baar, H.J.W., 2016. Potential Sources Affecting Seawater Nd Isotopes in the Southwest Atlantic Ocean, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016

Publications

Published:

- Gerringa, L. J. A., Laan, P., van Dijken, G. L., van Haren, H., de Baar, H. J. W., Arrigo, K. R., Alderkamp, A.-C. (2015) Sources of iron in the Ross Sea polynya in early summer, *Marine Chemistry*, 177, 447–459
- Gerringa, L.J.A., Rijkenberg, M.J.A., Schoemann, V., Laan, P., de Baar, H.J.W. (2015) Organic speciation of dissolved iron in the West Atlantic Ocean. *Mar. Chem.*, 177, 434–446.
- Lambelet, M., van de Flierdt, T., Crocket, K., Rehkämper, M., Kreissig, K., Coles, B., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., Steinfeldt, R. (2015) Neodymium isotopic composition and concentration in western North Atlantic seawater: results from the GEOTRACES GA02 section. *Geoch. Cosmochim. Acta.*, 177, 1-29
- Middag, R., van Hulst, M.M.P., van Aken, H.M., Rijkenberg, M.J.A., Gerringa, L.J.A., Laan, P., de Baar, H.J.W. (2015) Dissolved aluminium in the ocean conveyor of the West Atlantic Ocean: Effects of the biological cycle, scavenging, sediment resuspension and hydrography. *Mar. Chem.*, 177, 69-86
- Middag, R., Séférian, R., Conway, T. M., John, S. G., Bruland, K.W., de Baar, H.J.W (2015) Intercomparison of Dissolved Trace Elements at the Bermuda Atlantic Time Series Station, *Marine Chemistry*, 177, 476-489
- Rijkenberg, M.J.A., de Baar, H.J.W., Bakker, K., Gerringa, L.J.A., Keijzer, E., Laan, M., Laan, P., Middag, R., Ober, S., van Ooijen, J., Ossebaar, S., van Weerlee, E.M., Smit, M.G. (2015) “PRISTINE”, a new high volume sampler for ultraclean sampling of trace metals and isotopes. *Mar. Chem.*, 177, 501–509
- Rolison, J.M., Middag, R., Stirling, C.H., Rijkenberg, M.J.A., de Baar, H.J.W. (2015) Zonal distribution of dissolved aluminium in the Mediterranean Sea. *Mar. Chem.*, 177, 87-100.
- Sintès, E., De Corte, D., Haberleitner, E., Herndl, G.J., 2016. Geographic distribution of archaeal ammonia oxidizing ecotypes in the Atlantic Ocean. *Frontiers in Microbiology* 7, 10.3389/fmicb.2016.00077
- van de Poll, W.H., Boute, P.G., Rozema, P.D., Buma, A.G.J., Kulk, G., Rijkenberg, M.J.A. (2015) Sea surface temperature control of taxon specific phytoplankton production along an oligotrophic gradient in the Mediterranean Sea. *Mar. Chem.*, 177, 536-544.
- Xie, R.C., Galer, S.J.G., Abouchami, W., Rijkenberg, M.J.A., de Jong, J., de Baar, H.J.W., Andreae, M.O. (2015) The cadmium-phosphate relationship in the western South Atlantic

– the importance of mode and intermediate waters on the global systematics. *Mar. Chem.*, 177, 110-123

Submitted:

- Abualhaija, M.M., van den Berg, C.M.G., Rijkenberg, M.J.A., submitted. Probable identity of the main iron-binding substances in the Atlantic ocean. *Mar. Chem.*
- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M., Baker, A., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., Bruland, K., submitted. Return of naturally sourced Pb to Atlantic surface waters. *Nature Communications*.
- Ditt, R.F., Rijkenberg, M.J.A., Lindsay, R., Orellana, M.V., submitted. RuBisCO: a specific tracer for organic matter dynamics in the deep South Atlantic. *Limnol. Oceanog.*
- Gabriel Dulaquais, Hélène Planquette, Stephane l'helguen, Micha J. A. Rijkenberg and Marie Boye, submitted. Biogeochemical cycle of cobalt in the Mediterranean Sea: behind its scavenged profile. *Biogeosciences*
- Gerringa, L.J.A., Rijkenberg, M.J.A., Bown, J., Margolin, A.R., Laan, P., de Baar, H.J.W., submitted. Fe-binding dissolved organic ligands in the oxic and suboxic waters of the Black Sea. *Frontiers*.
- Margolin, A.R., Gerringa, L.J.A., Hansell, D.A., Rijkenberg, M.J.A., submitted. Net removal of dissolved organic carbon in the subsurface Black Sea. *Mar. Chem.*
- Rolison, J.R., Stirling, C.H., Middag, R., Rijkenberg, M.J.A., submitted. Uranium stable isotope fractionation in the Black Sea: Modern calibration of the $^{238}\text{U}/^{235}\text{U}$ paleo-redox proxy. *Geoch. Cosmochim. Acta*.
- Vance, D., Little, S.H., Archer, C., Cameron, V., Andersen, M., Rijkenberg, M.J.A., Lyons, T.W., submitted. The oceanic budgets of nickel and zinc isotopes: the importance of sulphidic environments as illustrated by the Black Sea. *Philosophical Transactions of the Royal Society A*.

Submitted by Micha Rijkenberg (micha.rijkenberg@nioz.nl).