

An International Study of the Marine Biogeochemical Cycles of Trace Elements and their Isotopes



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Document prepared by: GEOTRACES IPO

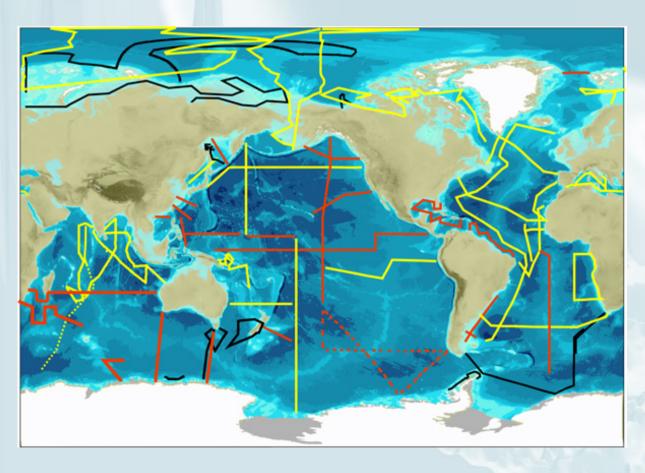
1. GEOTRACES International Programme

- Co-chairs: Reiner Schlitzer (AWI, Germany)
 Ed Boyle (Massachusetts Institute of Technology, USA)
- **GEOTRACES** is an international programme which aims to improve the understanding of **biogeochemical cycles** and **large-scale distribution** of **trace elements and their isotopes** in the marine environment
- Scientists from approximately 35 nations have been involved in the programme, which is designed to study all major ocean basins over the next decade
- GEOTRACES Science Plan (2006)
- First Intermediate Data Product (IDP2014) released in February 2014 (Ocean Sciences Meeting, Honolulu, Hawaii)



2. Status of GEOTRACES Field Programme

84 cruises (31 GEOTRACES Section cruises) completed



GEOTRACESSections

In red:
Planned Sections

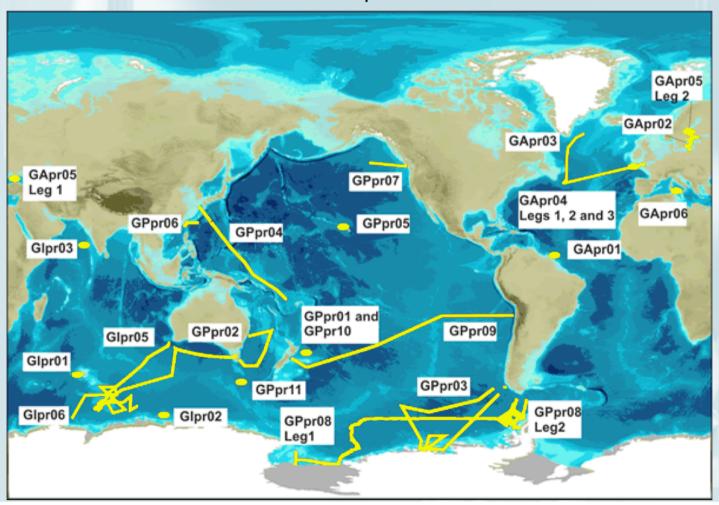
In yellow: Completed Sections

In black:
Sections completed as
GEOTRACES
contribution to the IPY



2... GEOTRACES Process Studies (Completed)

They investigate a particular process relevant to the cycling of trace metal and isotopes.





2... International Arctic GEOTRACES Programme

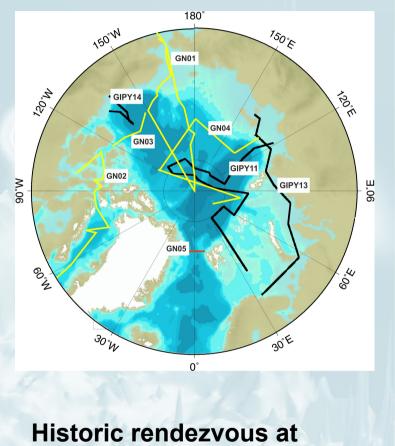
Very close to be completed!

4 cruises completed in 2015 (in yellow) from: USA (1), Canada (2) and Germany (1)

1 cruise currently at sea (in red):

GN05 – Germany (GRIFF, PS100) 19 July 2016 – 9 Sept. 2016





Historic rendezvous at the North Pole!



2... Advancing Field Programme: International Workshops

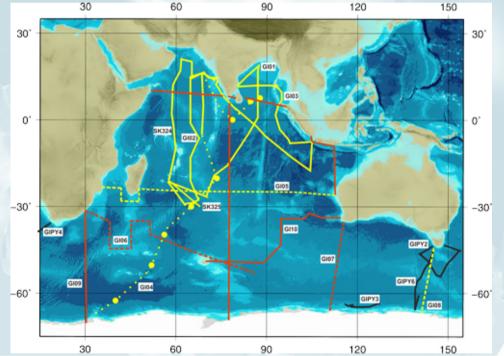
- Biogeochemical studies in the Siberian Shelf Seas, 27–28 January, Kiel, Germany (also supported by IASC, TRANSDRIFT)
 - Possibilities emerged for cooperation with Russia in the field of tracer studies in the Barents, Kara and Laptev Seas

• **GEOTRACES Indian Ocean Planning Workshop**, 29 June 2016, Yokohama,

Japan

>> 2 up-coming cruises from Germany and Australia (dashed yellow) and several being planned

Map pending of approval ->





3. Next GEOTRACES Intermediate Data Product

Next Intermediate Data Product planned for

2017

(Goldschmidt 2017, 13-18 August, Paris, France)





3. ...GEOTRACES Intermediate Data Product 2014



DOI: Mawji, E., et al., The GEOTRACES Intermediate Data Product 2014, Mar. Chem. (2015), http://dx.doi.org/10.1016/j.marchem.2015.04.005

Version 3 now available

Total number of downloads = 879



3... GEOTRACES Intermediate Data Product 2014

It includes **hydrographic and marine geochemical data** acquired during the **first 3 years** of the programme

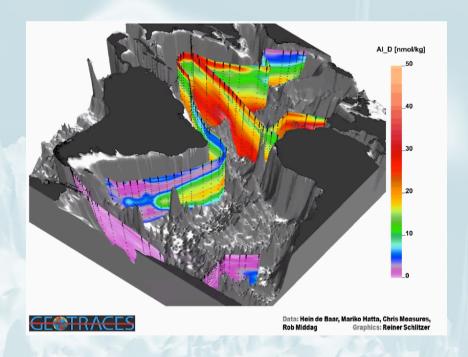
2 parts:

Digital Data Package

(available at www.bodc.ac.uk/geotraces/data/idp2014/)

eGEOTRACES Electronic Atlas

(available at www.egeotraces.org)





3... GEOTRACES Intermediate Data Product 2014

Publicising IDP2014, promoting the use of data and intensifying collaboration with the broader community... *Examples of actions at international conferences*:

SCOR Booth at OSM2016:



GEOTRACES is very grateful to SCOR for this opportunity

Town Hall « Strengthen your science using GEOTRACES data » **OSM2016**



Workshop « Exploring GEOTRACES data with ODV » Goldschmidt 2016





4. GEOTRACES Publications to date

703 Papers

database available on-line:

http://www.geotraces.org/library-88/scientific-publications/peer-reviewed-papers

8 special issues published and 3 more in preparation:

list of special issues available here:

http://www.geotraces.org/library-88/scientific-publications/geotraces-special-issues

Several publicity articles, for example:

Turner, D., & Urban, E. (2016). GEOTRACES: High-Quality Marine Analytical Chemistry on a Global Scale. Chemistry International, 38(1), 16–17. doi:10.1515/ci-2016-0108 (Open Access)

Compilation of publicity articles (not completed yet) available here:

http://www.geotraces.org/outreach/publicity-documents



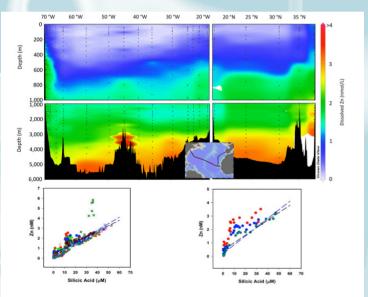
4. GEOTRACES Science Highlights: Examples

<u>Decoupling between dissolved zinc and silicon in the North</u> <u>Atlantic Ocean driven by mixing of end-members</u>

Correlation between dissolved zinc (Zn) and silicon (Si) is relatively weak in the North Atlantic Ocean (GA03 US section). Surprisingly, they present evidence that remineralization might have an insignificant effect on the zinc distribution in

this region

>> Dissolved zinc in the North Atlantic Ocean is mainly controlled by water mass mixing, although some water mass end-members exhibit deviations in the Zn-Si correlation as, for example, the Mediterranean Outflow Waters.



Roshan, S., & Wu, J. (2015). Water mass mixing: The dominant control on the zinc distribution in the North Atlantic Ocean. Global Biogeochemical Cycles, 29(7), 1060–1074. doi: 10.1002/2014GB005026



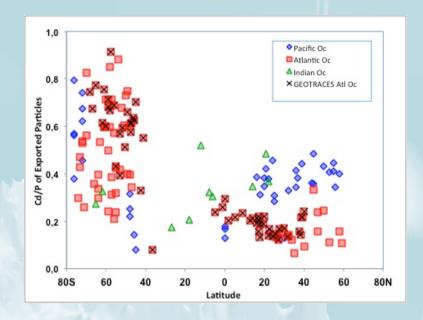
4... GEOTRACES Science Highlights: Examples

Changing the cadmium: phosphorus paradigm?

Cd/P of particles exported from the surface ocean doubles in high-nutrient low chlorophyll (HNLC) regions

Cd/PO₄ variations in the surface ocean and deep sea depend on Cd/P of degraded particles

Using a box model, authors present evidence that past changes in HNLC conditions would change the Cd-PO₄ relationship in deep sea... which has to be considered in paleoreconstructions!



Quay, P., Cullen, J., Landing, W., & Morton, P. (2015). Processes controlling the distributions of Cd and PO_4 in the ocean. Global Biogeochemical Cycles, 29(6), 830–841. doi:10.1002/2014GB004998



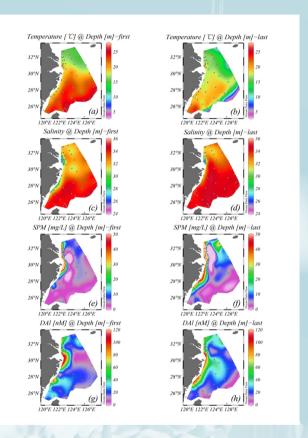
4... GEOTRACES Science Highlights: Examples

Large fluxes of dissolved aluminium exported from the coast to the ocean

In the Eastern China Sea, the continental shelf serves as an important source of dissolved aluminium (DAI) for the overlaying waters via resuspension of sediments and benthic fluxes

More than half of this AI is transported northward within the region enclosed by the 100 m and 200 m isobaths to the Japan Sea/East Sea. The remaining flux is transported out of the shelf across the 200 m isobath

This highlights the importance of coastal processes and subsurface cross-shelf transport as a source of dissolved trace elements to the open ocean



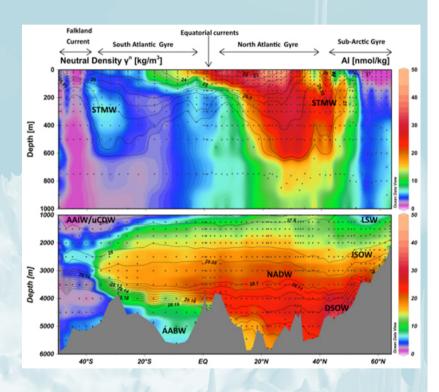
Ren, J.-L., Xuan, J.-L., Wang, Z.-W., Huang, D., & Zhang, J. (2015). Cross-shelf transport of terrestrial AI enhanced by the transition of northeasterly to southwesterly monsoon wind over the East China Sea. Journal of Geophysical Research: Oceans, 120(7), 5054–5073. doi: 10.1002/2014JC010655



4... GEOTRACES Science Highlights: Examples

Multiple controls on the dissolved aluminium fate in the western Atlantic Ocean

- atmospheric inputs are affecting only the surface and subsurface waters;
- there is an elusive but obvious coupling between Si-containing biogenic particles and Al;
- scavenging is occurring faster than the horizontal advective transports, preventing the use of Al as quantitative water mass tracer; and
- not observed at a basin-wide scale before, suspended sediments are a significant source for dissolved Al in the deep waters.



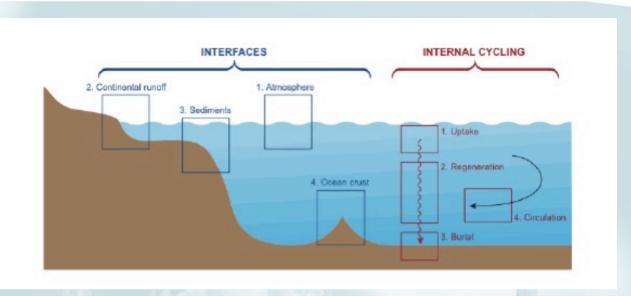
Middag, R., van Hulten, M. M. P., Van Aken, H. M., Rijkenberg, M. J. A., Gerringa, L. J. A., Laan, P., & de Baar, H. J. W. (2015). Dissolved aluminium in the ocean conveyor of the West Atlantic Ocean: Effects of the biological cycle, scavenging, sediment resuspension and hydrography. Marine Chemistry. doi: 10.1016/j.marchem.2015.02.015



5. GEOTRACES Synthesis Strategy

3-pronged synthesis

covering main scientific goals of GEOTRACES

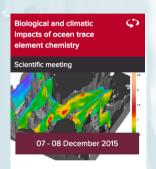


1- Supply and removal of TEI at ocean interfaces	2- Internal cycling of TEIs within the ocean	3- Geochemical tracers as paleoceanographic proxies
2 Royal Society Scientific Meetings7-10 December 2015	Joint GEOTRACES Ocean Carbon and Biogeochemistry (OCB) programme Workshop 1-4 August 2016	Exploring partnership with the Past Global Changes project (PAGES) for a joint workshop in 2018



5... GEOTRACES Synthesis Workshops

Royal Society scientific meetings, December 7-10, 2015:



Biological and climatic impacts of ocean trace element chemistry" December 7-8, 2015, London, UK https://royalsociety.org/events/2015/12/ocean-chemistry/

About 180 participants



"Quantifying fluxes and processes in trace-metal cycling at ocean boundaries", December 9-10, Chicheley Hall, Buckinghamshire

https://royalsociety.org/events/2015/12/trace-metal-cycling/

80 participants (participation limited)

Forthcoming special issue at *Philosphical Transactions A (*Oct. 2016, on-line)

Including 18 articles



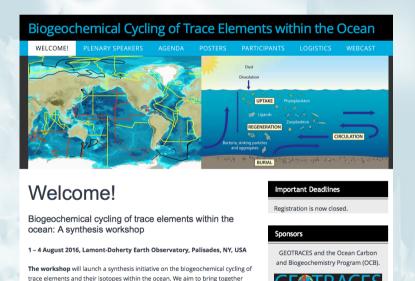
5... GEOTRACES Synthesis Workshops

Joint OCB/GEOTRACES Workshop

« Biogeochemical cycling of trace elements within the ocean: A synthesis workshop » August 1-4, 2016, Lamont-Doherty Earth Observatory, Palisades, NY, USA

Website: http://web.whoi.edu/geotraces-synthesis/

- >> More than 100 participants from 12 nations
- >> Plenary sessions have been recorded and they will be available on-line soon on the above workshop website!
- >> Several papers in progress!



expertise from GEOTRACES, OCB, and the broader oceanographic community of observationalists and modelers to explore the biological-chemical-physical underpinnings of trace element cycling, including (but not limited to) bioavailability, uptake, scavenging, and regeneration. The workshop will identify a small number of high-priority synthesis objectives that can be achieved over the next decade, exploiting the rapidly expanding set of data from GEOTRACES and



5... Joint OCB/GEOTRACES Workshop

Recommendations and anticipated products:

- Explore Redfieldian concepts of elemental stoichiometry using GEOTRACES TEI data
- Estimate Bioavailability of Fe with oceanographic data using "bioavailability envelope" concept of Lis et al., ISME Journal, 2015
- New hypothesis for light and Fe co-limitation in deep chlorophyll maxima
- A Synthesis Paper on "Paradigms of ligand composition and cycling and the degree of confidence in them" will be produced
- Compare radionuclide-based methods (²³⁴Th/²³⁸U; ²²⁸Th/²²⁸Ra; ²³⁰Th/²³⁴U; ²¹⁰Po/²¹⁰Pb; Pu/Np) to estimate the downward flux of particulate C, N, P, ²³²Th, Al, Cd, Fe, Co, Cu, and Mn
- Combine measured TEI distributions with calculated AOU and preformed TEI concentrations to discriminate among effects of abiotic scavenging, biotic uptake and regeneration, and physical transport



6. GEOTRACES Meetings in 2016

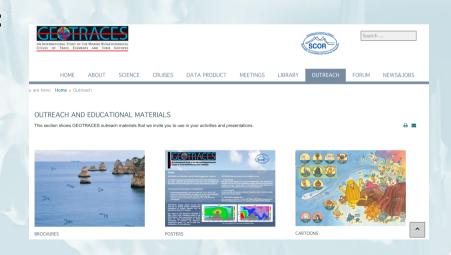
Events for		
	2016	
January 2016	Tuesday 12 January 2016 GEOTRACES Standards and Intercalibration Committee Meeting: GEOTRACES Meetings Wednesday 27 January 2016 - Thursday 28 January 2016 Biogeochemical studies in the Siberian Shelf Seas: GEOTRACES Scientific Workshops	
April 2016	Wednesday 27 April 2016 - Friday 29 April 2016 GEOTRACES Standards and Intercalibration Committee Meeting: GEOTRACES Meetings	
May 2016	Thursday 26 May 2016 - Friday 27 May 2016 GEOVIDE (GA01) post cruise meeting : GEOTRACES Cruise Workshops	
June 2016	Sunday 26 June 2016 Exploring GEOTRACES data with Ocean Data View : GEOTRACES Scientific Workshops Wednesday 29 June 2016 18:00 GEOTRACES Indian Ocean Planning Workshop : GEOTRACES Cruise Workshops	
August 2016	Monday 01 August 2016 - Thursday 04 August 2016 Biogeochemical cycling of trace elements within the ocean: A synthesis workshop: GEOTRACES Scientific Workshops	
September 2016	Monday 12 September 2016 - Tuesday 13 September 2016 2016 GEOTRACES Data Management Committee Meeting : GEOTRACES Meetings Wednesday 14 September 2016 - Friday 16 September 2016 2016 GEOTRACES Scientific Steering Committee Meeting : GEOTRACES Meetings	
October 2016	Wednesday 05 October 2016 - Friday 07 October 2016 US GEOTRACES Alaska-Tahiti Planning Workshop : GEOTRACES Cruise Workshops	



7. Outreach and educational Resources

- GEOTRACES eNewsletter Special Issue devoted to GEOTRACES
 Outreach activities
- Remarkable effort invested in outreach for the GEOTRACES International Arctic Programme (58 videos, 17 cruise blogs, PolarTREC teacher on board, etc.)
- Video display documenting scientific activities of several SCORsponsored projects
- Set of 4 postcards showing 4 different eGEOTRACES Atlas 3D scenes
- And more! Discover all them on:

Outreach webpage
http://www.geotraces.org/
outreach





Thank you very much!

International Coordination:

GEOTRACES International Project Office

(LEGOS-OMP, Toulouse, France)

Catherine Jeandel (Scientific Director)
Elena Masferrer Dodas (Executive Officer)

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Abby Bull (GEOTRACES Data Manager)

www.geotraces.org





