**GEOTRACES SCIENTIFIC STEERING COMMITTEE**
**ANNUAL REPORT TO SCOR 2024/2025**

May 1st, 2024 to April 30th, 2025

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## 1. SCOR Scientific Steering Committee (SSC) for GEOTRACES

*Co-Chairs*
Karen Casciotti, USA
Alessandro Tagliabue, UK
Jun Nishioka, Japan

***Members***
Erin Bertrand, Canada
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Walter Geibert, Germany
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Yu-Te Alan Hsieh, China-Taipei
Yoshiko Kondo, Japan
Taryn Noble, Australia
Hélène Planquette, France
Thomas Ryan-Keogh, South Africa
Juan Santos-Echeandía, Spain
Dalin Shi, China-Beijing
Caroline Slomp, Netherlands
Dina Starodymova, Russia
Adi Torfstein, Israel
Rodrigo Torres, Chile

The SSC membership (listed above) contains representatives of 15 different countries, with diverse expertise, including marine biogeochemistry of carbon and nutrients; trace elements and isotopes as proxies for past climate conditions; land-sea fluxes of trace elements/sediment-water interactions; trace element effects on organisms; internal cycles of the elements in the oceans; hydrothermal fluxes of trace elements; tracers of ocean circulation; tracers of contaminant transport; and ocean modelling.

## 2. Progress on implementation of the project

With 160 cruises completed, three Intermediate Data Products successfully released (the next planned for November 2025), over 2,680 peer-reviewed publications, 41 scientific and training workshops held, and 166 sessions organized at international conferences, GEOTRACES continues to demonstrate steady and effective implementation.

### 2.1 Status of GEOTRACES field programme

The GEOTRACES field programme continues to progress successfully with **160 cruises completed**, corresponding to 41 GEOTRACES sections (with 54 cruises), 47 process studies (with 76 cruises), 19 compliant datasets, as well as, 11 cruises completed as a GEOTRACES contribution to the International Polar Year (IPY).

During the past year (May 1st, 2023 to April 30th, 2024), 2 new section cruises from Germany (marked in orange in the Figure 1) and 5 process studies (2 from Germany, 2 from Australia and 1 from Canada) have been undertaken - see Data Management section below for further details).

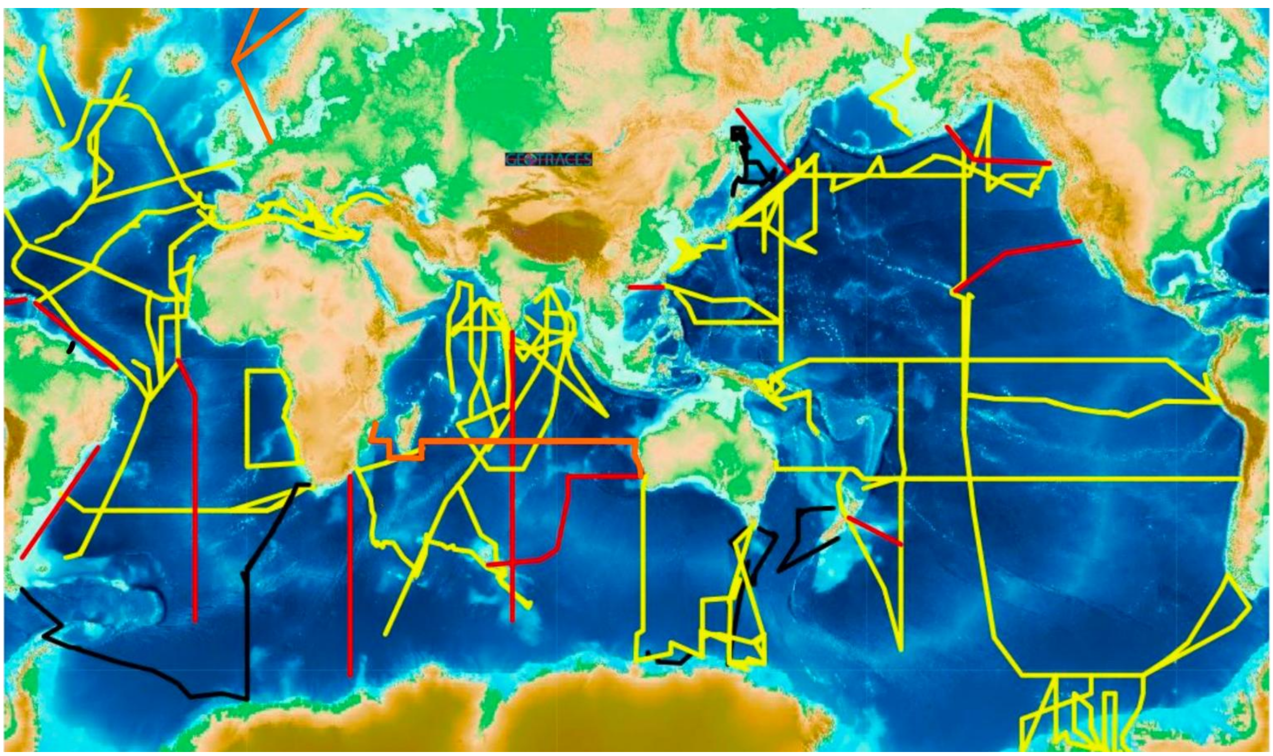


*Figure 1. Status of GEOTRACES global survey of trace elements and their isotopes. In black: Sections completed as the GEOTRACES contribution to the International Polar Year. In yellow: Sections completed as part of the primary GEOTRACES global survey. In orange: Sections completed during the past year. In red: Planned Sections. An interactive cruise map is available at the following website:* [*https://www.bodc.ac.uk/geotraces/cruises/section_maps/interactive_map/*](https://www.bodc.ac.uk/geotraces/cruises/section_maps/interactive_map/)

## 2.2 Forthcoming GEOTRACES Intermediate Data Product

GEOTRACES is currently undertaking intensive efforts to prepare its upcoming Intermediate Data Product 2025 (IDP2025), scheduled for release in November 2025. To date, over 1,100 datasets have been reviewed and approved for inclusion by the GEOTRACES Standards and Intercalibration Committee, reflecting a significant expansion in data coverage and quality.

As with the previous edition of the IDP, the release event will be online, allowing broad participation from the international scientific community. Final decisions regarding the release strategy and associated dissemination plans will be made during the upcoming meetings of the Data Management Committee (DMC) and the Scientific Steering Committee (SSC), which will take place in Goa, India, in October 2025.

## 2.3 GEOTRACES publications

During the reporting period, **155 new peer-reviewed papers** have been published (**2,682 publications in total)**. This includes the following special issue (one more in preparation):

- Special (virtual) Issue of the U.S. GEOTRACES Pacific Meridional Transect (GEOTRACES Section GP15) in Global Biogeochemical Cycles with 20 papers already published: <https://agupubs.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)1944-9224.GP15>.

In addition, 15 papers from GEOTRACES researchers have been included in the third edition of the *Treatise on Geochemistry*: <https://www.sciencedirect.com/referencework/9780323997638/treatise-on-geochemistry>.

For complete information about GEOTRACES publications please check the following web pages:

- GEOTRACES peer-reviewed papers database: https://www.geotraces.org/geotraces-publications-database/
- GEOTRACES special issues: https://www.geotraces.org/category/scientific-publications/geotraces-special-issues/
- List of GEOTRACES promotional articles: https://www.geotraces.org/category/library/publicity/

## 2.4 GEOTRACES science highlights

The GEOTRACES International Project Office regularly generates science highlights of notable published articles, which are posted on the GEOTRACES website (https://www.geotraces.org/category/science/newsflash/). So far, **373 highlights** have been published. Among the numerous highlights published since last year's report, we selected the following five:

### Paradoxical Influence of hydrothermal methylmercury on local ecosystems

Torres Rodríguez and her colleagues (2025, see reference below) investigate hydrothermal mercury inputs at the Tonga volcanic arc and their impact on local surface ocean ecosystems. Although they identified high mercury fluxes (4,763 pmol $m^{-2}$ $day^{-1}$) reaching productive surface waters, they found that mercury concentrations in phytoplankton remain unexpectedly low. In fact, natural iron fertilisation from hydrothermal sources stimulates intense phytoplankton blooms, which dilute mercury at the cellular level and reduce the impact of hydrothermal mercury. The authors also provide a revised global estimate of hydrothermal mercury inputs, with a maximum of 120 t $yr^{-1}$—considerably lower than anthropogenic emissions.

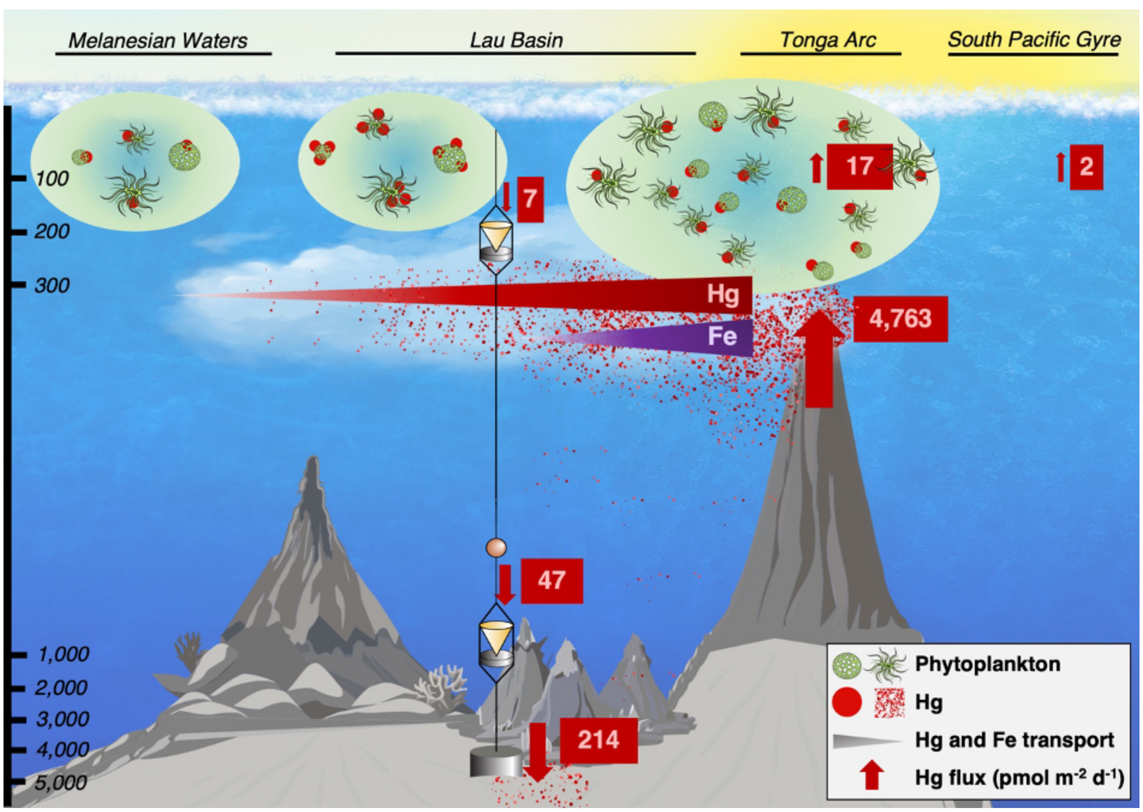


*Figure 2: The authors use a combination of water column, phytoplankton, sediment trap, and sediment core observations of Hg species and stable isotopes to investigate the fate of mercury inputs released from the Tonga Arc (fluxes in pmol m-2 d-1).*

Reference:

Torres-Rodriguez, N., Yuan, J., Dufour, A., Živković, I., Point, D., Boulart, C., Knoery, J., Horvat, M., Amouroux, D., Bonnet, S., Guieu, C., Sun, R., & Heimbürger-Boavida, L.-E. (2025). Natural Iron Fertilization Moderates Hydrothermal Mercury Inputs from Arc Volcanoes. *Environmental Science &Amp; Technology*, *59*, 11039–11050. Access the paper:10.1021/acs.est.5c01767

## Intrigued by Rare Earth Elements and neodymium isotopes? A review for the curious

Vanessa Hatje and a group of Rare Earth Element (REE) specialists (2024, see reference below) propose an exhaustive review on the behaviour of REE, not forgetting the informative neodymium (Nd) isotopes, in the aquatic environment. The sources, sinks and transformations of these elements along the land-sea continuum are reviewed. The effects of increased use of REE in industry and medicine are also discussed, as are their bioavailability, bioaccumulation and transfer along trophic chains. Finally, the potential effects of climate change on the cycling, mobility and bioavailability of these elements are discussed. In other words, this paper is a comprehensive review of REE behavior in the environment, from their properties and roles to their distribution and anthropogenic impacts, offering valuable insights and pinpointing key knowledge gaps.

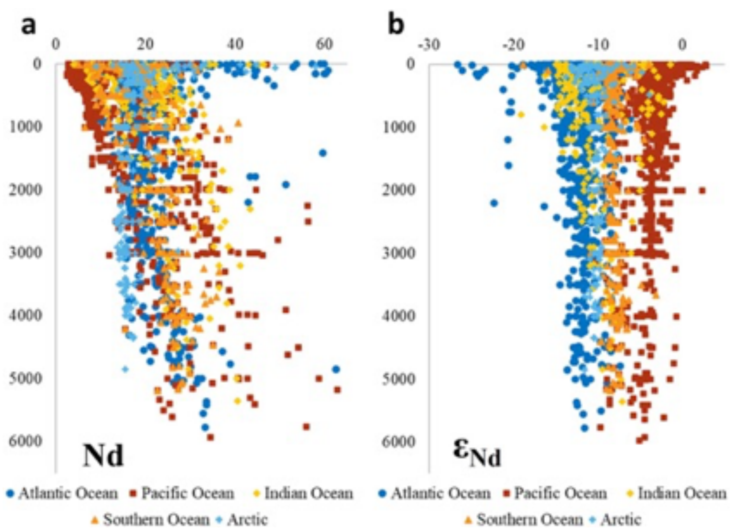


*Figure 3:* *Global ocean compilation of (a) dissolved Nd concentrations and (b) corresponding Nd isotopic composition (εNd). Data extracted from van de Flierdt et al. (2016), Filippova et al. (2017), Crocket et al. (2018), Paffrath et al. (2021) and Pham et al. (2022).*

References:

Hatje, V., Schijf, J., Johannesson, K. H., Andrade, R., Caetano, M., Brito, P., Haley, B. A., Lagarde, M., & Jeandel, C. (2024). The Global Biogeochemical Cycle of the Rare Earth Elements. Global Biogeochemical Cycles, 38. Access the paper: 10.1029/2024gb008125 van de Flierdt, T., Grifths, A. M., Lambelet, M., Little, S. H., Stichel, T., & Wilson, D. J. (2016). Neodymium in the oceans: A global database, a regional comparison and implications for palaeoceanographic research. Philosophical Transactions of the Royal Society A: Mathematical, Physical & Engineering Sciences, 374(2081), 20150293. Access the paper: 10.1098/rsta.2015.0293

Filippova, A., Frank, M., Kienast, M., Rickli, J., Hathorne, E., Yashayaev, I. M., & Pahnke, K. (2017). Water mass circulation and weathering inputs in the Labrador Sea based on coupled Hf–Nd isotope compositions and rare earth element distributions. Geochimica et Cosmochimica Acta, 199, 164–184. Access the paper: 10.1016/j.gca.2016.11.024

Crocket, K. C., Hill, E., Abell, R. E., Johnson, C., Gary, S. F., Brand, T., & Hathorne, E. C. (2018). Rare earth element distribution in the NE Atlantic: Evidence for benthic sources, longevity of the seawater signal, and biogeochemical cycling. Frontiers in Marine Science, 5, 147. Access the paper: 10.3389/fmars.2018.00147

Paffrath, R., Pahnke, K., Böning, P., Rutgers van der Loeff, M., Valk, O., Gdaniec, S., & Planquette, H. (2021). Seawater-Particle Interactions of Rare Earth Elements and Neodymium Isotopes in the Deep Central Arctic Ocean. Journal of Geophysical Research: Oceans, 126(8), e2021JC017423. Access the paper: 10.1029/2021JC017423

Pham, V. Q., Jeandel, C., Grenier, M., Cravatte, S., Eldin, G., Belhadj, M., et al. (2022). Neodymium Isotopic Composition and Rare Earth Element Concentration Variations in the Coral and Solomon Seas. Frontiers in Environmentl Chemistry, 3. Access the paper: 10.3389/fenvc.2022.803944

## Iron limitation also affects the twilight zone

Iron limitation is known to affect the phytoplankton growth in the oceanic surface waters. Less know (but also less studied!) is its role in shaping microbial production in the mesopelagic layer, also called the twilight zone (200-500m below the surface). Siderophores are bacterial metabolites that convert iron bound to proteins or water-soluble compounds into a form accessible to microorganisms. Consequently, siderophores are biomarkers for microbial iron deficiency: the less iron is available, the more efficient the uptake must be.

Li and co-workers (2024, see reference below) established the distribution and uptake of siderophores along the GEOTRACES cruise GP15 (Pacific Meridional Transect). They reveal that concentrations are high not only in iron-limited surface waters but also in the twilight zone underlying the North and South Pacific subtropical gyres. They propose that such bacterial Fe deficiency owing to low iron availability also occurs in twilight zones of other large ocean basins, greatly expanding the region of the marine water column in which nutrients limit microbial metabolism.

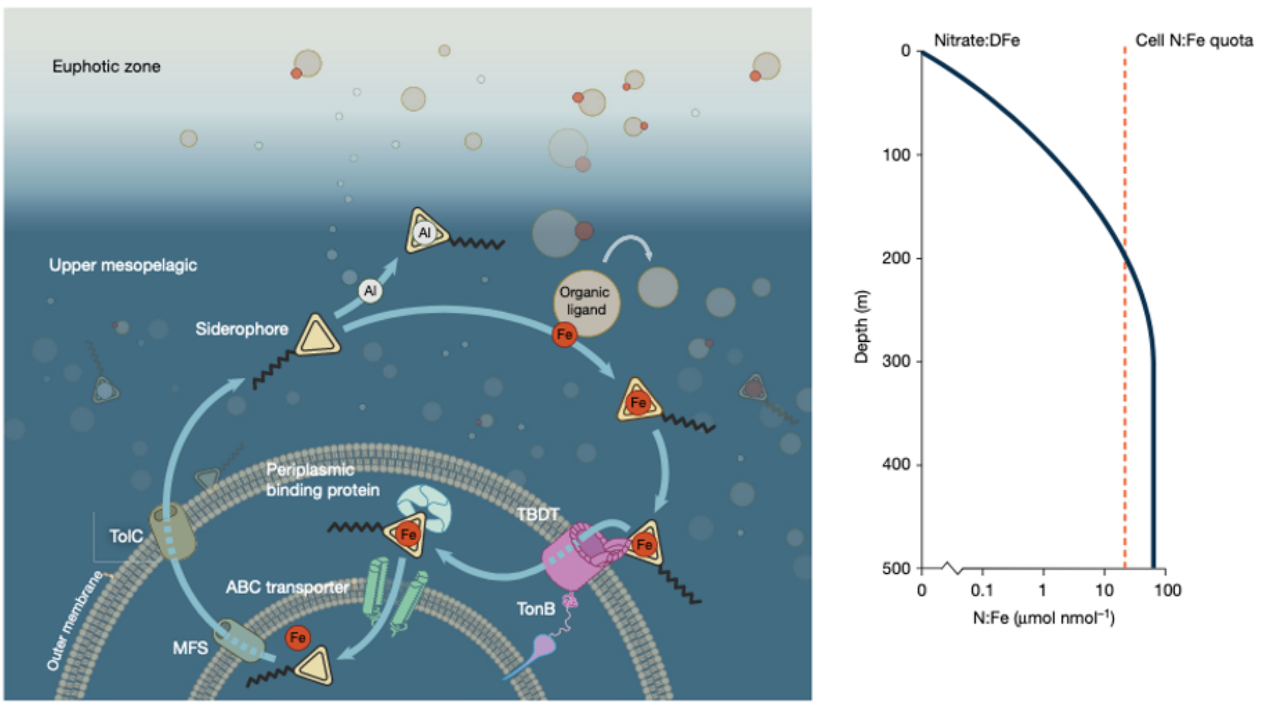


*Figure 4: Iron–siderophore cycling in the mesopelagic ocean. Marine bacteria acquire iron (Fe) and cycle siderophores between the cell and the environment through several different species-dependent pathways. In the generalised scheme shown here, metal-free siderophores bind Fe from weaker organic ligands dissolved in seawater and the Fe–siderophore complex is then transported through the outer membrane of gram-negative bacteria by means of specialised TonB-dependent transporters (TBDT). After passing through the outer membrane, the Fe–siderophore complex binds to a periplasmic binding protein for transport into the cytoplasm, where Fe is recovered. Siderophores in the cytoplasm are exported back into the environment through major facilitator subtype (MFS) and TolC protein complexes. Siderophore-mediated Fe acquisition is active in the mesopelagic at depths at which the nitrate:DFe ratio (right) exceeds the maximum N:Fe quota of heterotrophic bacteria and at which there is sufficient labile carbon substrate to fuel Fe demand. As shown here, siderophores can also bind aluminium, thereby decreasing the efficiency of the siderophore Fe acquisition pathway.*

Reference:

Li, J., Babcock-Adams, L., Boiteau, R. M., McIlvin, M. R., Manck, L. E., Sieber, M., Lanning, N. T., Bundy, R. M., Bian, X., Ștreangă, I.-M., Granzow, B. N., Church, M. J., Fitzsimmons, J. N., John, S. G., Conway, T. M., & Repeta, D. J. (2024). Microbial iron limitation in the ocean's twilight zone. Nature, 633, 823–827. Access the paper: 10.1038/s41586-024-07905-z

## Trace metal effluxes from Peruvian shelf sediments

Shelf sediments are a major reservoir of labile trace metals. For dissolved redox sensitive elements such as iron (Fe), shelf sediments underneath oxygen minimum zones are typically a major source to the water column. However, quantifying the associated dissolved fluxes is methodologically challenging. Liu and colleagues (2025, see reference below), compare four different methods for estimating the Fe flux from Peruvian shelf sediments and show that the results are quite variable. Estimates of benthic Fe release suggest Fe residence times in the water column from 5 days to 7 years for the Peruvian shelf depending on exactly what spatial scale the benthic efflux is constrained over. This largely reflects the strong attenuation of dissolved Fe efflux from shelf sediments on spatial scales of 0.1-10 m from the seafloor.

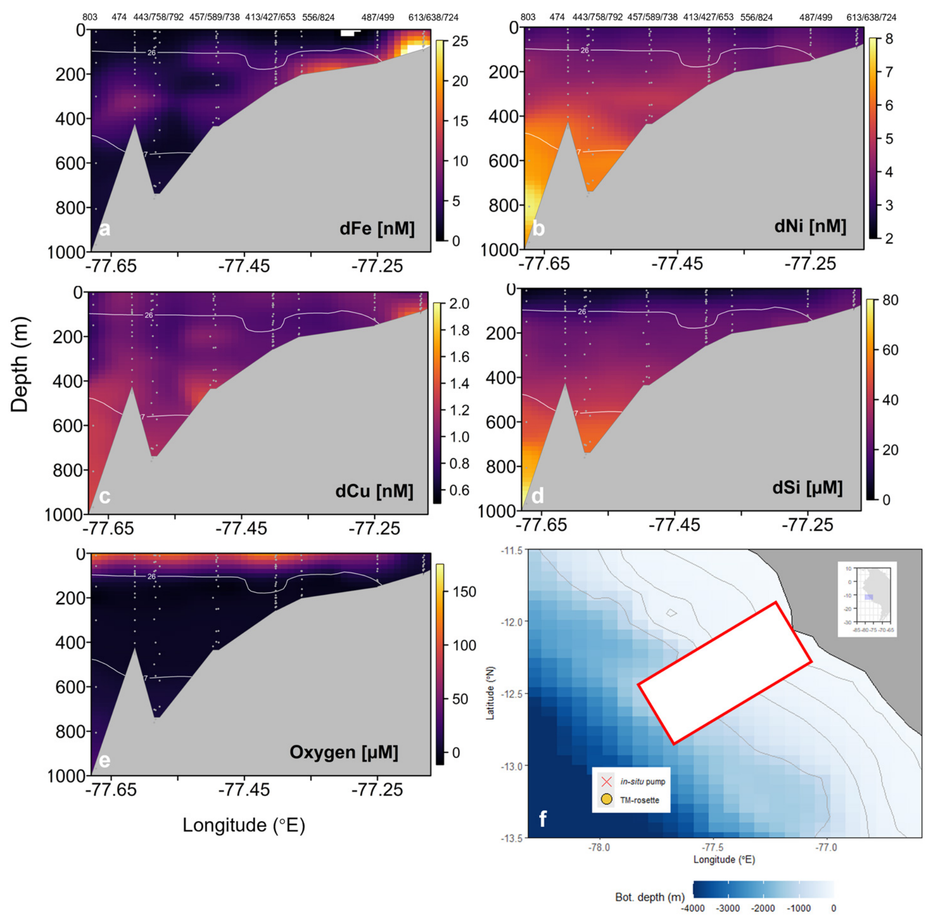


*Figure 5: Dissolved iron, nickel, copper, silicon, and oxygen along a transect across the Peruvian shelf at 12°S. The data were collected using the TM-rosette system during two research cruises, M136 and M137.*

Reference:


Mete, Liu, T., Plass, A., Gledhill, M., Scholz, F., Achterberg, E. P., & Hopwood, M. J. (2025). Trace Metal Effluxes From Peruvian Shelf Sediments Constrained in Parallel by Benthic Lander Mounted Pumps and Pelagic Rosette Sampling. Journal of Geophysical Research: Biogeosciences, 130. Access the paper: 10.1029/2024jg008583

## Coupling copper and neodymium data highlights the importance of the margin sources for the copper oceanic cycle

Among the bioactive metals, copper's marine cycle (Cu) is far from being understood yet. Lemaitre and co-workers (2025, see reference below) analysed the dissolved (dCu) concentrations and isotopes along the GEOVIDE (GA01) section. Their data reveal that i) in the surface waters, microorganisms take up dCu along with carbon, leaving "heavy" dCu in the surrounding waters and ii) at depth, particle remineralization and (reversible) scavenging onto particles, are also influencing dCu distributions.

The authors also established the relative importance of the external dCu sources to the North Atlantic (atmospheric, hydrothermal, benthic…). A fruitful strategy was to compare the dCu data to neodymium concentration (Lagarde et al., 2024) allowing them to highlight the Iberian margin as a source of Cu to the ocean. Overall, the margin inputs could contribute significantly to the missing source of Cu in the ocean.

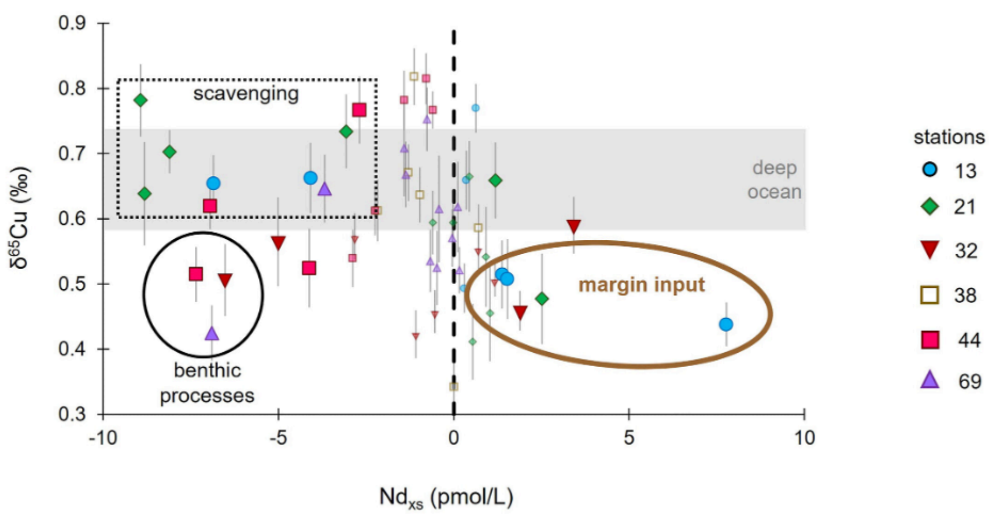


***Figure 6:*** *Copper isotope compositions ($\delta^{65}$Cu) are compared to non-conservative neodymium concentrations (Ndxs; data from Lagarde et al., 2024). High $\delta^{65}$Cu values are co-located with Ndxs < 0, suggesting a removal of both elements by scavenging (as shown by the black dotted rectangle). Conversely, significant Nd inputs (Ndxs > 0) coincide with low $\delta^{65}$Cu values (as shown by the brown oval). Neodymium being a lithogenic tracer, this comparison highlights the importance of lithogenic particle dissolution as a source of light Cu. This lithogenic input originates from the Iberian Margin.*


Reference:

Lemaitre, N., Lagarde, M., & Vance, D. (2025). Controls on Dissolved Cu Concentrations and Isotopes in the North Atlantic: The Importance of Continental Margins. Global Biogeochemical Cycles, 39. Access the paper: 10.1029/2024gb008453

Lagarde, M., Pham, V. Q., Lherminier, P., Belhadj, M., & Jeandel, C. (2024). Rare Earth elements in the North Atlantic, part I: Non-conservative behavior reveals margin inputs and deep waters scavenging. Chemical Geology, 664, 122230. Access the paper: 10.1016/j.chemgeo.2024.122230

## 3. Activities

### 3.1 GEOTRACES intercalibration activities

#### S&I Committee composition:

| Member | Institution | Preliminary Assignments |
|---|---|---|
| Ana Aguilar-Islas (Co-Chair) | University of Alaska Fairbanks (U.S.) | Polar parameters, aerosols |
| Hélène Planquette (Co-Chair) | LEMAR Laboratory, CNRS (France) | Particulate TEs |
| Luke Bridgestock | University of Cambridge (U.K.) | Other stable of isotopes of TEs, Pb isotopes, Ba isotopes, REES and some radiogenic isotopes (Hf, Nd, Os, Sr) |
| Tim Conway | University of South Florida (U.K.) | Water column dissolved TEs + Fe, Zn, Cu isotopes |
| Julie Granger | University of Connecticut (U.S.) | Isotopes of N and C, pH, DIC, TALK, macronutrients |
| Christopher Hayes | University of Southern Mississippi (U.S.) | Natural and artificial radiogenic isotopes |
| Lars-Eric Heimbürger-Boavida | Mediterranean Institute of Oceanography (France) | Mercury species |
| Randelle Bundy | University of Washington (USA) | Dissolved ligands and inorganic elements, dissolved oxygen peroxide |
| Yeala Shaked | Institute of Marine Science, Eilat (Israel) | Biogeotraces related parameters |

***Table 1:*** *Updated Standard and Intercalibration Committee Members between May1st, 2024- April 30th, 2025*

Co-chairs Planquette participated virtually and Aguilar-Islas in person in the 2024 DMC and International SSC meetings and reported on S&I activities

**Cookbook update:** The S&I committee reviewed the cookbook, involving for each chapter the relevant scientific community. All sections have been updated and new chapters have been added (e.g. DOoR, data management). The updated version was released in September 2024. Polar will be added & Hg will be edited at a later date.

**Reviewing reports for the next IDP:** The S&I meeting met virtually a couple of times (August $20^{th}$, 2024; September $10^{th}$, 2024; November $12^{th}$, 2024; January 7, 2025) before having a 5-day meeting in person in Alaska (March $3^{rd}$ – $7^{th}$, 2025) organized by co-chair Aguilar-Islas. ECS member Laramie Jensen was invited to witness the work performed by the S&I. Luke Bridgestock and Lars-Eric Heimbürger attended virtually.

During the in-person meeting, priority was given to Section and Process Study reports, followed by reports concerning Compliant Data. On the final day, efforts focused on identifying data submissions lacking reports. The committee contacted the corresponding PIs to request submission of S&I report prior to July 2025 to ensure these reports were reviewed for potential incorporation into IDP2025. Additional virtual meetings were held on April, May and June 2025 to go through the remaining reports. One more meeting is scheduled for June16th and early July 2025 to finalize the reports and intercalibration process. In total, ca. 110 reports have been reviewed, corresponding to ca. 1100 parameters. With the combination of in-person and virtual meetings, the S&I committee managed to review all submitted reports.


***Figure 7****: (top) in-person meeting in Alaska. From left to right: Hélène Planquette, Julie Granger, Tim Conway, Christopher Hayes, Ana Aguilar-Islas, Laramie Jensen, Yeala Shaked, Randie Bundy. (right): S&I committee reviewing reports during the in-person meeting.*

**Updating naming conventions for ligands:** During the course of these meetings, the S&I Committee decided it would be best to develop a standardized naming convention for metal-binding ligands in seawater, as there was no consensus standard for naming the various methods by which ligands are determined. We know from several lab intercomparisons exercises that analytical methods span a range of analytical windows (achieved using different competitive ligands, or different concentrations of the same competitive ligand). What was found was that the different analytical windows measured different concentrations and binding strengths of ligands.

Lower analytical windows targeted the measurement of the weaker ligands, while higher analytical windows targeted the measurement of stronger ligands. Measurements done at similar analytical windows were very comparable. So, in order to have directly comparable ligand measurements, it is crucial to define the analytical window (in the case of voltammetry, the added ligand and its concentration) in the parameter name. In this light, we proposed to amend Token 1 of the parameter names (e.g. L1Cu) with an addition of a short name that describes the method. The new names that are proposed are shown in Table 2.

The new names have been confirmed for 40 out of the 51 datasets in the current IDP, and all PIs have been contacted, following DMC agreement.

| Token 1 additions | Method |
|---|---|
| CSV10TAC | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (10 μM TAC) |
| CSV25SA | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (25 μM SA) |
| CSV10SA | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (10 μM SA) |
| CSV5SA | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (5 μM SA) |
| CSV2.5SA | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (2.5 μM SA) |
| CSV2SA | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (2 μM SA) |
| CSV500DMG | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (500 μM DMG) |
| CSV200DMG | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (200 μM DMG) |
| CSV50DMG | Cathodic stripping voltammetry of Fe-binding ligands using a competitive ligand (50 μM DMG) |
| IMAC | Pre-concentration of Cu-binding ligands onto an IMAC column followed by analysis using UV-vis or mass spectrometry |
| SPEENV | Pre-concentration of ligands onto an ENV column followed by analysis using mass spectrometry |
| SE500OX | Inert Cu measurement using oxine (500 μM) |

***Table 2:*** *Updated ligand parameter names*

<u>Updating parameter naming convention for dissolved Copper:</u> We have recently learned that oxidation (UV or otherwise) of acidified seawater samples is necessary to release 100% of the dissolved Cu. Acidification by itself is not sufficient in many cases, as seen clearly with the Cu isotope data. We thus proposed to make the following changes:

- change the description of Cu_D to "concentration of dissolved Cu (after H202 or UV oxidation)" for all sampling systems
- change the description of Cu_65_63_D_DELTA to "Atom ratio of dissolved Cu isotopes expressed in conventional DELTA notation referenced to {NIST976} (after H202 or UV oxidation)" for all sampling systems.
- Cu_DL parameter exists already for BOTTLE but will be added for all other clean sampling systems. This should be defined as "concentration of dissolved Cu (without H202 or UV oxidation)". This would include all of the existing Cu_D data that didn't use oxidation in addition to other methods (like electrochemical) that have been used to measure the "labile" fraction of dissolved Cu. The particular method would be included in the metadata for each dataset.

- Create Cu_65_63_DL_DELTA and define as "Atom ratio of dissolved Cu isotopes expressed in conventional DELTA notation referenced to {NIST976} without H202 or UV oxidation" for all sampling systems. The particular method would be included in the metadata for each dataset.

Tokens Cu_T, Cu_TD could stay as they are defined for now, and there currently are no datasets in the IDP anyway.

As these changes affect some of the existing Cu_D data in IDP2021v2, volunteers have been helping going through the methods information for all the Cu_D data and the Cu_65_63_D_DELTA data to see whether oxidation was used in addition to acidification and change the parameter name accordingly. Data generators/submitters/PIs have been notified of this change and graphical examples demonstrating the need for the change have been added to the communication with them.

<u>Member rotation:</u> Co-chair Planquette and Aguilar-Islas will step down after the release of IDP 2025. Current S&I members Conway and Granger have already agreed to step up as future co-chairs. Co-chairs Planquette and Aguilar-Islas will remain as long as necessary to ensure a smooth transition.
The S&I committee will also have to find members with similar expertise (particulate trace metals ; aerosols ; dissolved trace metals) as well as Hg species, as Lars-Eric Heimbürger will also step down.

<u>Participation in management meetings:</u> Co-chairs Planquette (virtually) and Aguilar-Islas (in-person) participated in the annual International SSC and DMC meeting in September 2024. They also participated in ad-hoc virtual meetings with DMC members to address issues that concerned both committees.

## 3.2 Data management for GEOTRACES

The British Oceanography Data Centre (BODC), at the National Oceanography Centre (UK), hosts the GEOTRACES Data Assembly Centre (GDAC, https://www.bodc.ac.uk/geotraces/). Donna Cockwell is the lead GEOTRACES Data Manager, working in collaboration with Samantha Blakeman and Francesca Paros. The GDAC benefits from additional BODC expertise, when required.

The GDAC is responsible for the entirety of the GEOTRACES data activities. This involves the following components:

- Interaction between principal investigators (PIs) and national data centres in order to encourage regular and timely data/ metadata submissions;

- Maintaining and modifying GDAC web pages to include updated ocean basin maps (http://www.bodc.ac.uk/geotraces/cruises/section_maps/) and upcoming cruises on the programme page (http://www.bodc.ac.uk/geotraces/cruises/programme/);
- Liaising with the Data Management Committee and the Standards and Intercalibration Committee to answer issues/questions relating to GEOTRACES;
- Input of metadata and data into the BODC databases and compilation of documentation, including the originator's methodology;
- Collation of data and metadata for future IDPs;
- Ensuring availability of the IDP through DOI generation and delivery of IDP data package
- Answering requests from the GEOTRACES community and assisting on IDP downloads.

The main GDAC tasks over the last year were:

IDP2025 data reception and archiving: For the last year the focus has been preparation for IDP2025. 30 submissions were received for the May 2025 deadline with the remaining submissions received in December. In August work was completed on adapting the new BODC samples processing system to work with the specific requirements for the GEOTRACES IDP processing. This enables the use of a more standardised, efficient system for processing. Submissions systems with BCO-DMO were also improved to enable stronger flow of data from BCO-DMO to GDAC.

Development and implementation of standardised hydrography profile workflow: Work has continued on standardising the hydrography profile data with progress made on 23 cruises with 9 complete.

Cruises: The summary of GEOTRACES cruises, which have taken place in the period May 2024-May 2025 is shown in Table 3.

| Cruise | GEOTRACES Cruises | Chief Scientist(s) | GEOTRACES scientist(s) | Type | Period | Location |
|---|---|---|---|---|---|---|
| IN2025_V02 | GIpr08 | Elizabeth Shadwick | Zanna Chase | Process Study | 2025-03-26 — 2025-04-16 | Southern Ocean |
| V3/2025 | GPpr17 | Delphine Lannuzel | Michael Ellwood | Process Study | 2025-02-20 — 2025-05-02 | Southern Ocean |
| SANAE64 | GApr23 | Ole Valk | Ole Valk | Process Study | 2024-12-03 — 2025-02-15 | Southern Ocean |

| | | | | | | |
|---|---|---|---|---|---|---|
| M206 | GApr21 | Andrea Koschinksy | Martin Frank | Process Study | 2024-12-01 — 2024-12-30 | Atlantic Ocean |
| SO308 | GI07 | Eric Achterberg | Eric Achterberg | Section Cruise | 2024-10-31 — 2024-12-22 | Indian Ocean |
| PS144 | GN06 | Benjamin Rabe | Walter Geibert | Section Cruise | 2024-08-09 — 2024-10-13 | Central Arctic Ocean |
| Refuge-Arctic | GApr24 | Mathieu Ardyna | Catherine Jeandel | Process Study | 08/08/2024 – 03/10/2024 | Arctic Ocean |

***Table 3.*** *Cruises completed during the reporting period.*

<u>In summary:</u> The past year has been focused on final preparations to the systems ahead of the IDP submission deadlines and then the receiving of submissions and processing of data received.

## <u>3.3 GEOTRACES International Project Office</u>

The GEOTRACES International Project Office (IPO) is based at the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) in Toulouse, France. The IPO is staffed by Elena Masferrer Dodas, the IPO Executive Officer. She works in collaboration with the senior scientist Catherine Jeandel (CNRS, LEGOS, France).

The IPO is responsible for:

- assisting the Scientific Steering Committee (SSC) in implementing the GEOTRACES Science Plan and implementation plans of the programme;
- organising and staffing meetings of the SSC, working groups and task teams;
- liaising with the sponsors and other relevant organisations;
- seeking and managing programme finances;
- representing the project at international meetings;
- maintaining the project website and Facebook, Twitter, YouTube, BlueSky and LinkedIn pages;
- maintaining the project mailing lists;
- preparing GEOTRACES science highlights and the bimonthly GEOTRACES eNewsletter;
- maintaining the GEOTRACES publications database and the GEOTRACES Scientists Analytical Expertise Database;
- ensuring the development and maintenance of the DOoR portal;
- assisting the GDAC in securing information about upcoming cruises; and

- interacting with GEOTRACES national committees and groups, as well as other international projects.

This year, we want to highlight the following activities:

Maintenance of the GEOTRACES DOoR portal: The IPO has continued to manage the development and maintenance of the GEOTRACES Data for Oceanic Research (DOoR, https://geotraces-portal.sedoo.fr/pi/) on-line portal that has proved to be an excellent tool which enormously facilitated the building of the IDP2021. The technical work is assured by Aurélien Sánchez from the Data Centre of the Observatoire Midi-Pyrenées (SEDOO, https://www.sedoo.fr/) in Toulouse, France.

Main developments:

- Development of a more enhanced administration portal to make it easier for the administrator (IPO) to modify a dataset in the database when required (e.g., correct user errors).
- Response to requests from GDAC, the S&I committee, the Parameter Definition Committee (PDC) and users as needed.

IDP2025: The IPO has been providing support in the building of the IDP2025:

- Ensuring communication of IDP2025 deadlines to the GEOTRACES community.
- Organising virtual meetings with GDAC, DMC and S&I co-chairs to advance IDP2025.
- Registering or managing the necessary changes in the DOoR datasets and providing assistance and guidance as needed to PI.

Early Career Committee: The IPO has supported the ECS members in launching the new call for recruiting new members to the Early Career Committee, including the preparation and collection the applications forms and assistance in the review process.

UN Ocean Decade: The GEOTRACES IPO and the DMC co-chairs met with the new team of the Decade Coordination Office (DCO) for Ocean Data Sharing on 28 February 2025. As in previous year, GEOTRACES requested help in providing more visibility to the GEOTRACES data within Ocean Decade. The following actions followed:

- Webinar "Boosting Data Sharing in the Decade" webinar with GEOTRACES – 7 May 2025 at 16:00 CEST, see it here: https://youtu.be/FQzM2aaZFYY
- Social Media Campaign promoting GEOTRACES through Ocean Decade social networks.

In addition, GEOTRACES was present with a poster at the One Ocean Science Congress, 3-6 June 2025, Nice, France.

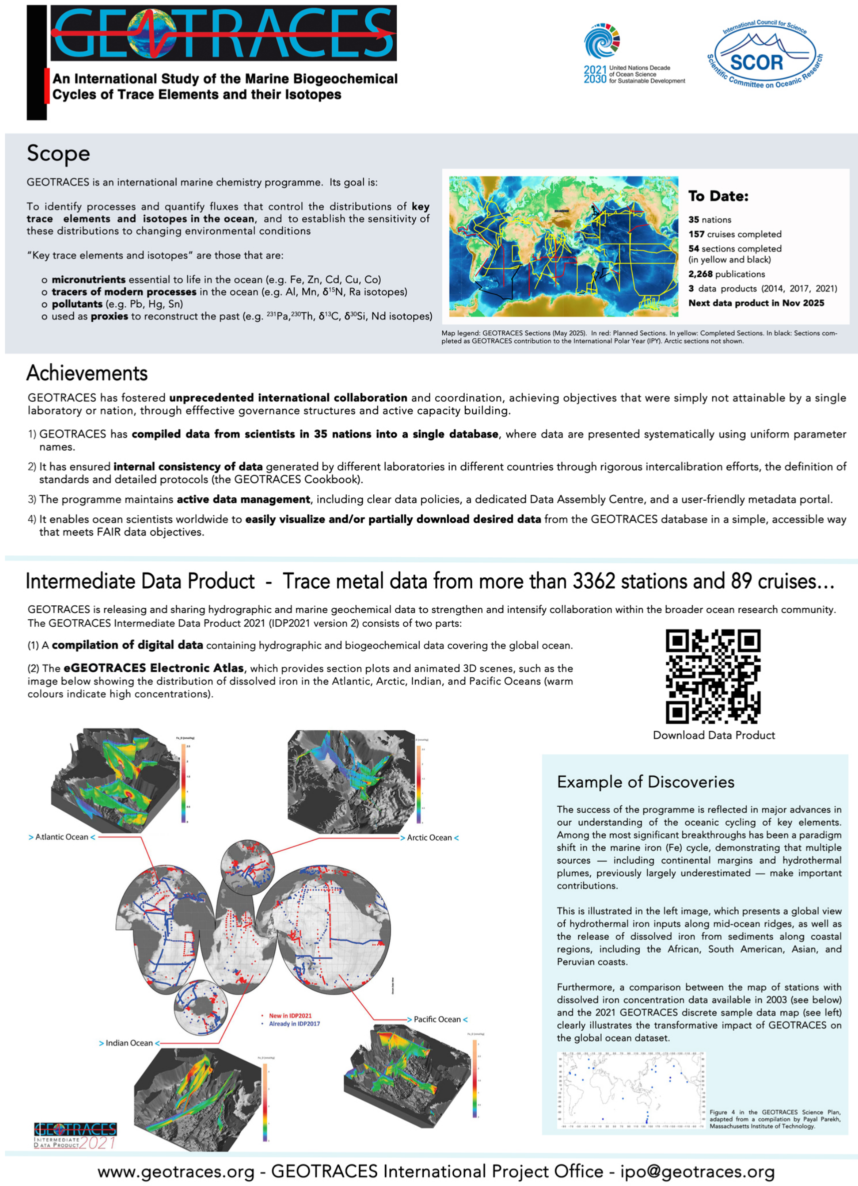


***Figure 8:*** *GEOTRACES poster at the One Ocean Science Congress, 3-6 June 2025, Nice, France.*

<u>Some statistics for the period May 1st, 2024 to April 30th, 2025</u>

- 29 new highlights published (373 in total)
- 6 eNewsletters published, including one special issue (bimonthly 70 in total)
- 155 new peer-reviewed papers included in the GEOTRACES Publication Database (2,680 in total)
- 102 new articles published on the GEOTRACES website
- 1k followers in Facebook, 2,5k followers in Twitter, 501 in LinkedIn. BlueSky recently created with 209 followers.

## 3.4 GEOTRACES Early Career Scientist Committee

**Co-Chairs (2024-present):** Laramie Jensen (University of Washington, USA) and Jianghui Du (University of Beijing, China)

**Regular members (2024-present):**
Lise Artigue (France)
Tal Benaltabet (ETH Zurich, Switzerland)
Ryan Cloete (LEMAR, France)
Layla Creac'h (Heidelberg University, Germany)
David González-Santana (Universidad de Las Palmas de Gran Canaria, Spain)
Thomas Holmes (University of Tasmania, Australia)
Rhiannon Jones (British Antarctic Survey, UK)
Nolwenn Lemaitre (Observatoire Midi Pyrénées – LEGOS, France)
Wen-Hsuan Liao (National Cheng Kung University, Taiwan)
Anh Le-Duy Pham (University of California, Los Angeles, USA)
Shotaro Takano (Kyoto University, Japan)
Yang Xiang (University of Washington, USA)
Zhouling Zhang (GEOMAR Helmholtz Center for Ocean Research Kiel, Germany)

The GEOTRACES Early Career Scientist (ECS) Committee was established in the summer of 2024. The committee comprises 15 members representing 10 different countries, highlighting the international scope and collaborative nature of this initiative. Since its formation, the ECS Committee has been meeting approximately every two months, beginning in August 2024.

The committee's major goals include defining its Terms of Reference, creating and leading activities tailored for the early career community, building connections with other oceanographic ECS groups, representing early career perspectives within the GEOTRACES Scientific Steering Committee (SSC) and its subcommittees, and contributing suggestions for the future direction of GEOTRACES.

To date, the committee has made several important contributions. It has successfully defined its Terms of Reference and established a mandate for future ECS committee members. Co-chair Jianghui Du participated in the 2024 SSC meeting as an ECS representative, while co-chair Laramie Jensen attended the Standards and Intercalibration Committee meeting in the same capacity. Additionally, ECS members have played an active role in the planning of the 2025 GEOTRACES Summer School and will help select participants for the summer school alongside the Summer School organizational committee. Members involved in the organizational committee include Ryan Cloete*, Laramie Jensen*, Lise Artigue*, Rhiannon Jones, Zhouling Zhang*, David Gonzalez-Santana*, Thomas Holmes, Layla Creac'h, and Yang Xiang (* indicates ECS members who will also serve as lecturers or lead practical sessions at the Summer School).

ECS members have also contributed to organising the GEOTRACES Synthesis Preparation Workshop held in Delmenhorst, Germany, with Lise Artigue, Jianghui Du and David González Santana) serving on the planning committee. A dedicated listserv has been launched to connect early career scientists affiliated with or interested in GEOTRACES, further enhancing communication within this community.

The ECS Committee has also defined the selection criteria for the next cohort of members, aiming to welcome at least five new members while retaining about half of the current committee. Applications have already been received and will be reviewed by the current committee.

Looking ahead, the committee plans to review and select new members, determine which current members (including one co-chair) will rotate off, and formalize and publish its Terms of Reference. There are also plans to host an informal gathering for GEOTRACES ECS members at Goldschmidt 2025, led by Rhiannon Jones (with help from Zhouling Zhang, Layla Creac'h, Anh Le-Duy Pham, David González-Santana, and Tal Benaltabet)—pending the availability of funding. Additionally, the committee will continue discussions around subcommittee representation for current and future ECS members.

***Figure 9:*** *First meeting of the inaugural GEOTRACES ECS Committee. Held over zoom across 7 time zones.*

***Figure 10:*** *The geographic locations of the committee members.*

## 3.5 GEOTRACES Synthesis Preparation Workshop

A GEOTRACES Synthesis Preparation Hybrid Workshop will be held on 3–4 July at the Hanse-Wissenschaftskolleg – Institute for Advanced Study (HWK), Delmenhorst, Germany, and online. The event is being organised by Walter Geibert and Elena Masferrer-Dodas (Alfred Wegener Institute, Bremerhaven, Germany / GEOTRACES IPO, Toulouse).

The objective of the workshop is to initiate and strengthen collaboration on synthesising existing GEOTRACES results, explore future opportunities for the programme, and develop actionable steps for synthesis.

The programme will begin with a session titled "Taking Stock: What kind of synthesis efforts are already going on?", during which various components of GEOTRACES will be reviewed to assess what has been achieved, what synthesis activities are already in progress, and how these efforts are being carried out. The next session, "Aims and Strategies," will focus on different approaches to synthesis. The final session, "Networking and Funding," will offer participants an opportunity to reflect on the types of networks they would like to see in the future, explore funding possibilities to support synthesis activities, and identify current barriers to progress.

A full report of the workshop will be submitted to the Scientific Steering Committee in October.

The workshop is supported by Hanse-Wissenschaftskolleg (HWK) and SCOR to whom we extend our thanks.


*Figure 11: GEOTRACES Synthesis Preparation Workshop banner.*

## 3.6 Special sessions at international conferences featuring GEOTRACES findings

Since 2010, GEOTRACES has organized 166 sessions in international conferences. Below there is the list of GEOTRACES or GEOTRACES-related special sessions held during the reporting period and those that are planned in major international conferences.

AGU 2024, 9-13 December 2024
For further information: https://www.agu.org/annual-meeting

> *OS013 - Disentangling Hydrothermal Impacts on Ocean Biogeochemistry
> https://agu.confex.com/agu/agu24/prelim.cgi/Session/230146
> Co-conveners: Christopher R German, Randelle M Bundy and Alessandro Tagliabue.
> Student/Early Career Convener: Alexandria Aspin.

> *OS038 - Trace Element Distributions and Cycling Across Ocean Basins
> https://agu.confex.com/agu/agu24/prelim.cgi/Session/228153
> Co-conveners: Benjamin S Twining, Jessica N Fitzsimmons and Gregory A Cutter.

EGU General Assembly 2025, 27 April – 2 May 2025
For further information: https://www.egu25.eu/

> *Chemical Processes in Coastal Oceans: Natural and Anthropogenic impacts on the biogeochemical processes
> https://meetingorganizer.copernicus.org/EGU25/session/52604
> Co-conveners: Aridane González González l Co-conveners: David González-Santana, J. Magdalena Santana-Casiano, Melchor Gonzalez-Davila

*Forthcoming:*

Goldschmidt 2025, 6 – 11 July 2025
For further information:
https://conf.goldschmidt.info/goldschmidt/2025/goldschmidt/2025/meetingapp.cgi

*12a – Elemental Enigmas: Cracking the Code of Trace Metals in Polar Oceans
https://conf.goldschmidt.info/goldschmidt/2025/meetingapp.cgi/Session/8207
Co-conveners: Rhiannon Jones, Sasa Marcinek, Hung-An Tian.

*12e – Tracing marine trace element dynamics: impact of external sources and oceanic cycling
https://conf.goldschmidt.info/goldschmidt/2025/goldschmidt/2025/meetingapp.cgi/Symposium/714
Co-conveners: Kai Deng, Vineet Goswami, Zhouling Zhang and Antao Xu.

*12g – Seafloor hydrothermal processes and their impacts on the modern and ancient Earth
https://conf.goldschmidt.info/goldschmidt/2025/goldschmidt/2025/meetingapp.cgi/Session/8223
Co-conveners: Thomas M Belgrano, Benjamin M. Tutolo, Drew Syverson, William P Gilhooly

*13f – Geochemical proxy development for paleoceanographic and paleoclimatic research
https://conf.goldschmidt.info/goldschmidt/2025/goldschmidt/2025/meetingapp.cgi/Session/8234
Co-conveners: Jun Shen and Sylvie Bruggman

Ocean Sciences Meeting 2026, 22-27 February 2026
For further information: https://www.agu.org/Ocean-Sciences-Meeting

*OB020 – Multi-tracer approaches to understanding and quantifying marine biogeochemical processes
https://agu.confex.com/agu/osm26/prelim.cgi/Session/256137
Co-conveners: William M Landing, Hélène Planquette and Anne Leal

*CB002 – Coastal, Shelf, and Island Mass Effects on Trace Element Biogeochemistry in the Ocean
https://agu.confex.com/agu/osm26/prelim.cgi/Session/254981
Co-conveners: David González-Santana, Aridane G. González, Emilie Le Roy and Gabriel Dulaquais.

*OB026 – Revising Ocean Silicon Cycle: Pathways, Stoichiometry and Climate-Carbon Feedback in the Anthropocene
https://agu.confex.com/agu/osm26/prelim.cgi/Session/257658
Co-conveners: Diksha Sharma, Haimanti Biswas and Shaily Rahman

*HE004 – Mercury in Polar Waters: Sources, Transformations, and Bioaccumulation in Food Webs
https://agu.confex.com/agu/osm26/prelim.cgi/Session/254233
Co-conveners: Emily Seelen, Marissa Despins, Stephen Kohler, Marissa Despins

## 3.7 Capacity building

### Fourth GEOTRACES Summer School


The fourth GEOTRACES summer school will take place from 21st to 27th November in Cape Town, South Africa organised by Hélène Planquette, Thomas Ryan-Keogh and Susanne Fietz.

It will provide training in marine biogeochemistry of trace elements and their isotopes for 36 students. The training will include a combination of lectures, practicals, and field work, all led by 15 international GEOTRACES experts.

80 applications were received by the 30 June deadline.

The summer school is supported by the French National Centre for Scientific Research (CNRS) and SCOR to whom we express our thanks.

For further information please see the Summer School website: https://geotraces-2025.sciencesconf.org/

***Figure 12**: 2025 GEOTRACES Summer School flyer.*

## Sampling Systems

It is a goal of GEOTRACES that every nation carrying out oceanographic research should have access to a trace metal-clean sampling system. GEOTRACES offers guidance based on past experience in the design and construction of sampling systems, as well as advice in operating these systems as shared facilities. In this sense, a document including "Recommendations for nations developing a trace metal-clean sampling system" prepared by Greg Cutter (Old Dominion University, past S&I co-chair) is available on the GEOTRACES website. This document summarises the lessons learned during past guidance experiences and it will be of great resource for other countries wishing to develop trace metal-clean sampling. This document along with other materials is available on the GEOTRACES Capacity Building web page https://www.geotraces.org/geotraces-capacity-building-activities/

An updated status of trace metal-clean sampling systems to support GEOTRACES research is provided in the Table 4 below (in blue new additions since last reporting period). Scientists interested in developing one of these systems for their own use are encouraged to contact the GEOTRACES IPO, who will arrange for contact with an appropriate person to provide technical information about the design, construction and cost of a system.

| Nation | Status | System/ Carousel | Bottles | Depth |
|---|---|---|---|---|
| Australia (Australia National University) | Complete | Powder coated aluminium, autonomous 1018 intelligent rosette system (General Oceanics) | 12 x 10-L Teflon-lined Niskin-1010X (General Oceanics) | 6000 m; 6 mm Dynex rope |
| Australia (Marine National Facility) | Complete | Polyurethane powder-coated aluminium autonomous Seabird rosette with CTD and other sensors, auto-fire module, and all titanium housings and fittings | 12 x 12-L Teflon-lined OTE external-spring Niskin-style bottles | 1750 m 9mm Dyneema rope or 200 m 6 mm Dyneema rope wth coupling to 6000 m CTD wire |
| Australia (Marine National Facility) | Complete (backup system) | Polyurethane powder-coated aluminium autonomous Seabird rosette with CTD and other sensors, auto-fire module, and all titanium housings and fittings | 12 x 12-L Teflon-lined OTE external-spring Niskin-style bottles | 1750 m 9mm Dyneema rope or 200 m 6 mm Dyneema rope wth coupling to 6000 m CTD wire |
| Brazil | Complete | GEOTRACES WATER SAMPLER - 24-bottle sampler for use with modem equipped 911plus CTD | 24 X 12-L GO-Flo | 3000 m; Kevlar cable |
| Canada | Complete | Seabird GEOTRACES Powder-coated aluminum with titanium | 24 X 12-L GO-Flo | 5000 m conducting |

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| | | CTD housing, Seabird Rosette | | Vectran |
| China - Beijing | Complete | Seabird Rosette. Powder coated aluminium with titanium pressure housings and fittings | 24 x 12-L OTE GO-Flo; 24 X 12-L Teflon-lined Niskin-X | 8000 m; conducting Kevlar |
| China - Taipei | Complete | Teflon coated rosette | Multi- size GO-Flo | 3000 m; Kevlar line |
| China - Xiamen | Complete | Seabird GEOTRACES powder-coated aluminium with titanium pressure housings and fittings | 24 x 12L OTE GoFlo, Titanium CTD housings | 7000 m conducting Vectran cable |
| Taiwan - National Taiwan University | Complete | Seabird GEOTRACES powder-coated aluminium with titanium pressure housings and fittings | 28 x 12-L OTE external-spring Niskin-style bottles | 8000 m; conducting Vectran cable |
| France | Complete | Seabird GEOTRACES Powder coated aluminium with titanium pressure housing for CTD | 24 X 12-L GO-Flo | 8000 m; conducting Kevlar |
| Germany (GEOMAR) | Complete | Two titanium rosette frames (built by KUM, Kiel) with titanium pressure housings and fittings | 27 x 12-L OTE GO-Flo and 27 x 12-L OTE Niskin | 8000 m; conducting Kevlar |
| Germany (Polarstern) | Complete | Titanium frame with 911 plus CTD; all sensors with titanium housing; clean container, winch container and CTD storage container associated | 24 x 12-L OTE GO-Flo | 8000 m; conducting Vectran cable |
| Germany (MARUM / CU) | Complete* (* to be upgraded to 12x Model 114 bottles and CTD sensor package) | Titanium rosette frame (built by KUM, Kiel) with G.O. 1018 autonomous control unit | 12x 5L bottles* (* currently 5x O.T.E. Model 114 teflon-lined "Go-Flos" & 7x Model 110 teflon-lined "Niskins") | 4000 m; Aramide rope* (* using existing winches on research vessels) |
| India | Complete | Seabird GEOTRACES Powder-coated aluminum with titanium pressure housings and fittings | 24 X 12-L Niskin-X | 8000 m; conducting Vectran |
| Israel | Complete | Powder coated aluminium, SeaBird Rosette | 12 X 12-L Niskin; 8 X 12-L GO-Flo (Teflon coated) | 2000 m, steel conducting cable |

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|---|---|---|---|---|
| Italy | Complete | Go-Flo bottles on Kevlar line | 5 x 20-L Go-Flo | Kevlar |
| Italy - National Research Council of Italy, CNR | Complete | SBE9plus and SBE32 SeaBird GEOTRACES carousel (Powder-coated aluminium with titanium pressure housings and fittings) | 24 X 12-L C-Free bottles | 6000 m, hydrographic fibre cable with a polyurethane coating |
| Japan | Complete | Powder coated aluminium | 12-L Niskin-X | 7000 m; Vectran conducting Cable |
| Japan | Complete | Powder coated aluminium | 12-L Niskin-X | 10000 m; Aramid yarn conducting cable |
| Netherlands | Complete | TITAN Titanium frame | 24 X 24-liter ultraclean polypropylene | 10000 m; conducting Kevlar* **There is only one cable for the two systems* |
| Netherlands | Complete | TITAN Titanium frame | 24 X 24-liter ultraclean PVDF | 10000 m; conducting Kevlar* **There is only one cable for the two systems* |
| New Zealand | Complete | Powder coated aluminium | 13 X 5-L Teflon-lined Niskin-X; 13 X 5GO-Flo | 4000 m; 8 mm Kevlar line |
| Norway | In developme nt | Standard 12 positions CTD Rosette GO | 5-L Niskin-X | |
| Poland | Complete* (although the steel cable) | Powder coated aluminum, SeaBird Rosette | 8x 10L GoFlo | 3000m, steel conducting cable |
| Poland | Complete | Single bottle | 10l G-FLO X Teflon coated | 300m Kevlar |
| Republic of Korea | Complete | TITAN Titanium frame PRISTINE bottles | 24 × 12L PVDF | 10,000 m; conducting Kevlar |
| Russia | Complete* (although the steel cable) | Powder coated aluminium, SeaBird Rosette SBE9p occupied CTD SBE 9+ | 24 × 12-L Niskin bottles | 4000 m, steel conducting cable |

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|---|---|---|---|---|
| Russia | In developme nt (by 2022–2024) | Powder coated aluminium, SeaBird Rosette and all titanium housings and fittings | GO-FLO, Niskin-X, 24 × 12-L | 10000 m, conducting Kevlar |
| South Africa | Complete | Seabird GEOTRACES Powder-coated aluminium, titanium housing/fittings | 24 X 12-liter GO-Flo | 6500 m; Kevlar cable |
| South Korea | Complete | TITAN Titanium frame + PRISTINE bottles | 24 × 12L PVDF | 10,000 m; conducting Kevlar |
| UK | Complete | 2 x Titanium frame, Ti pressure housings | 24 10-L OTE<br>24 10-L OTE | 2 x 8000m conducting Kevlar |
| USA - CLIVAR | Complete | Sea-Bird GEOTRACES Powder-coated aluminium | 12 X 12-L GO-FLO | 1500 m; conducting Vectran cable |
| USA - GEOTRACES | Complete | Seabird GEOTRACES Powder-coated aluminum with titanium pressure housings and fittings | 24 X 12-L GO-FLO | 7000 m conducting Vectran cable |
| USA-<br>University of Alaska Fairbanks | Complete | Sea-Bird GEOTRACES Powder-coated aluminium with Ti parts and pressure housing. Fires at pre-programmable depths | 12 X 5-L Teflon-lined Niskin-X | No Kevlar line available yet. |
| USA – University of South Florida | Complete | Sea-Bird GEOTRACES Powder-coated aluminium with Ti parts and pressure housing. Fires at pre-programmable depths | 12 X 12-L OTE Niskin-X | 3000 m 0.25” Amsteel wire |
| USA-<br>Old Dominion University | Complete | Sea-Bird GEOTRACES Rosette. SBE-19plusV2 CTD unit. Powder coated aluminium with Ti parts and pressure housing. Fires at pre-programmable depths | 12 X 5-L Teflon-lined Niskin-X | 2000 m 0.5-inch Kevlar wire |
| USA – Polar Programs | Complete | Sea-Bird GEOTRACES Powder-coated aluminium with titanium pressure housings and fittings | 12 X 12-L<br>Niskin-X | 3500 m; conducting Vectran cable |
| USA – Scripps Institution of Oceanography | Complete | Sea-Bird painted aluminium with stainless pressure housing (standard system). Fires at pre-programmable depths | 12 X 10-L Niskin-X<br>12 X 5-L Niskin-X | 2000 m Amsteel cable and 2000 m Space-Lay coated metal cable |

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|---|---|---|---|---|
| USA – Woods Hole Oceanographic Institution | Complete | Sea-Bird painted aluminium with stainless pressure housing (standard system). Fires at pre-programmable depths | 12 X 8-L Niskin-X | 4000 m Amsteel cable |

*Table 4. Trace metal-clean sampling systems to support GEOTRACES research.*

## 4. Plans for the coming year

GEOTRACES will continue refining its completion strategy to ensure the accomplishment of its scientific objectives by the end of the programme. As part of this ongoing effort, it will also support early-career researchers in launching new initiatives that can carry forward the legacy of GEOTRACES and ensure long-term use of its data.

***GEOTRACES field work programme:*** With 3 process studies already planned from Japan in the Pacific Ocean, GEOTRACES will continue to advance the implementation of the field work programme. These cruises will be supplemented by compliant data to enrich future intermediate data products.

***GEOTRACES Intermediate Data Product 2025:*** As mentioned in section 2.2. above, GEOTRACES is currently intensively working in preparing the new Intermediate Data Product which will be released in November 2025. The GEOTRACES SSC will decide the launch strategy at its next SSC meeting in October 2025.

***GEOTRACES State Estimates:*** GEOTRACES is advancing its initiative to develop global State Estimates (GSE) product for trace element and isotope (TEI) concentrations, launched in September 2023 and overseen by the Data Management Committee (DMC). Extensive discussions at the DMC and SSC meetings in 2023 and 2024 have shaped the vision. A workshop to further refine this vision will be held in October 2025 in Goa, immediately before the 2025 GEOTRACES DMC and SSC meetings. The GSE is envisioned as an atlas of global TEI distributions to be released alongside the GEOTRACES Final Data Product. It will support a wide array of data users, ranging from those who seek model initialisation fields, large scale data analysis, surrogates for TEI data alongside e.g., biological data, upper trophic level ecosystem science, paleoceanography and pollutant assessments.

**GEOTRACES Synthesis workshops:** As mentioned in section 3.5 above, GEOTRACES plans to undertake a Synthesis Preparation Workshop on 3-4 July 2025 that would both continue and complement the GEOTRACES synthesis efforts inspired initiated by the first suite of three synthesis workshops (in 2015, 2016 and 2018, http://www.geotraces.org/science/synthesis-of-results).

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Written and compiled by:

Elena Masferrer Dodas (GEOTRACES IPO Executive Officer)
Catherine Jeandel (GEOTRACES IPO Science Director)
Ana Aguilar-Islas and Hélène Planquette (Co-chairs of the GEOTRACES S&I Committee)
Bill Landing and Maite Maldonado (Co-Chairs of the GEOTRACES DMC Committee)
Donna Cockwell (GEOTRACES Data Manager)
Bob Anderson (Past SSC co-chair)


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