GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2021/2022

May 1st, 2021 to April 30th, 2022

Table of contents

1. SCOR Scientific Steering Committee (SSC) for GEOTRACES

Co-Chairs
Karen Casciotti, USA
Maeve Lohan, UK

Members
Jay T. Cullen, Canada
Susanne Fietz, South Africa
Jessica Fitzsimmons, USA
Walter Geibert, Germany
Vineet Goswami, India
Yoshiko Kondo, Japan
Marina Kravishina, Russia
Rob Middag, Netherlands
Taryn Noble, Australia
Haojia (Abby) Ren, China-Taipei
Yeala Shaked, Israel
Dalin Shi, China-Beijing
Kazuyo Tachikawa, France
Alessandro Tagliabue, UK
Rodrigo Torres, Chile
Antonio Tovar-Sanchez, Spain

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; controls on distribution and speciation of trace elements; and ocean modelling.

2. Progress on implementation of the project

The GEOTRACES programme is enjoying a very successful implementation, with new field programmes and its third Intermediate Data Product released in November 2021.

2.1 Status of GEOTRACES field programme

Despite the COVID-19 pandemic GEOTRACES field programme has continued to progress successfully. During the past year (May 1st, 2021 to April 30th, 2022), 4 cruises have been completed. This includes 2 new section cruises from Germany and India (sections in orange in the Figure 1) and 2 process studies from Australia and The Netherlands (see Data Management section below for further details).

In addition, 3 new compliant data sets have been endorsed. Overall, 132 cruises have been completed, corresponding to 34 GEOTRACES sections (with 45 cruises), 40 process studies (with 63 cruises) and 13 compliant data sets, as well as, 11 cruises completed as a GEOTRACES contribution to the International Polar Year (IPY).

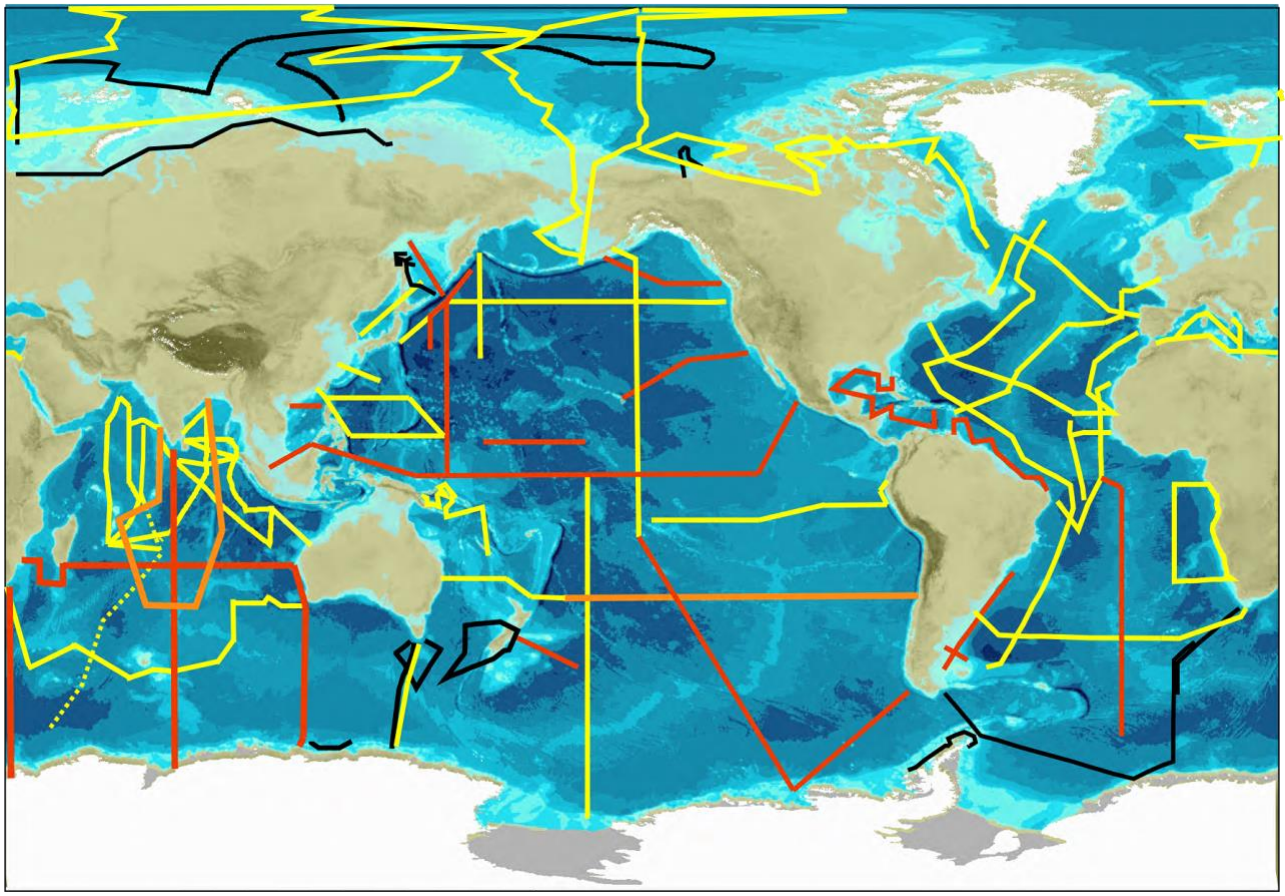


Figure 1. *Status of GEOTRACES global survey of trace elements and their isotopes. In black: Sections completed as the GEOTRACES contribution to the International Polar Year. In yellow: Sections completed as part of the primary GEOTRACES global survey. In orange: Sections completed during the past year. In red: Planned Sections.*

2.2 GEOTRACES Intermediate Data Product

Intermediate Data Product 2021 released!

The GEOTRACES Intermediate Data Product 2021 (IDP2021; https://www.geotraces.org/geotraces-intermediate-data-product-2021/) was successfully released on 17 November 2021. More than 390 people registered for the launch webinar events held on two different day/times to facilitate attendance across different time zones. These events were recorded and posted on the GEOTRACES website and YouTube channel; the links to the programme and recordings are provided below:

You can view the recording of the **entire event** here or view each individual talk by clicking on the links below:

- **Introduction**
  Alessandro Tagliabue (University of Liverpool, UK) / Bill Landing (Florida State University, US)
- **Video introducing the GEOTRACES international programme** Watch the video
- **What does the Intermediate Data Product 2021 include and how can it be accessed?**
  Reiner Schlitzer (Alfred Wegener Institute, AWI, Germany) Watch the video
- **Intermediate Data Product 2021 panel**
  Reiner Schlitzer (AWI, Germany), Maite Maldonado (University of British Columbia, Canada), Rob Middag (NIOZ, The Netherlands) / Jun Nishioka (Hokkaido University, Japan), Adrian Burd (University of Georgia, US)

  Chaired by: Alessandro Tagliabue (University of Liverpool, UK) / Bill Landing (Florida State University, US)
- **Science highlights**
  - **International synthesis in the Arctic:** Laramie Jensen (University of Washington, US) Watch the video
  - **New insights from the Indian Ocean:** Sunil Kumar Singh (National Institute of Oceanography, India) Watch the video
  - **Constraining elemental cycling using data and models:** Tom Weber (University of Rochester, US) Watch the video

The IDP2021 represents a significant expansion in data available compared to the previous version released in 2017. The product contains now hydrographic and marine geochemical data from 77 cruises and 3191 stations. It consists of two parts:

(1) a **digital data package** (https://dx.doi.org/10/g55p for bulk download AND https://geotraces.webodv.awi.de/ to download subsets of data) and,

(2) an **eGEOTRACES Atlas** (https://www.egeotraces.org/) that allows visualisation though section plots and animated 3D scenes of many of the parameters.

In addition, the **webODV tool** allows analysis, exploration and visualisation of these data (https://explore.webodv.awi.de/).

The IDP2021 was also presented during a Town Hall at the virtual Ocean Sciences Meeting 2022 on 25 February 2022. The Town Hall programme along with the presentations and videos recorded are available using the links below:

- **Introduction to GEOTRACES and the GEOTRACES Intermediate Data Product 2021**
  Catherine Jeandel (LEGOS, Université de Toulouse, CNES/CNRS/IRD/UT3, Toulouse, France)
  Download this document as pdf or ppt or watch the video

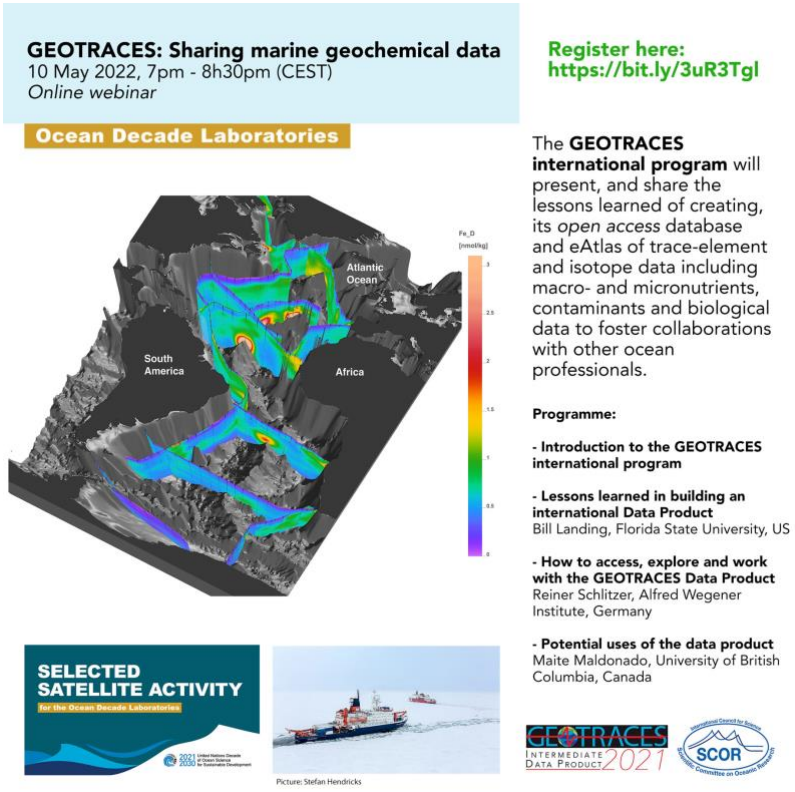
- **Accessing the IDP2021**
  Reiner Schlitzer (Alfred Wegener Institute, Bremerhaven, Germany)
  Download this document as pdf or ppt or watch the video

- **Education: Working with IDP2021 and webODV Explore tool**
  Phoebe Lam (University of California, Santa Cruz, USA)
  Download this document as pdf or ppt or watch the video

- **Exploration: Linking trace metal and isotope (TEI) and genomics data within IDP2021**
  Maite Maldonado (University of British Columbia, Vancouver, Canada)
  Download this document as pdf or ppt or watch the video

- **Using the DOoR Portal to register data for next IDP**
  Bill Landing (Florida State University, USA)
  Download this document as pdf or ppt or watch the video

In addition, a webinar introducing the IDP2021 was also organised on 10 May 2022 as a satellite activity of the UN Ocean Decade Laboratory on "An Accessible Ocean".



This webinar opened the series of satellite events for UN Ocean Decade laboratory. About 150 individuals coming from different audiences were registered and the live event counted with the participation 60 individuals.

The recording of the webinar and the presentations files are available here.

2.3 GEOTRACES publications

During the reporting period, 534 new peer-reviewed papers have been published. This includes the publication of one special issue:

Atmospheric deposition in the low-nutrient-low-chlorophyll (LNLC) ocean: effects on marine life today and in the future
Biogeosciences and Atmospheric Chemistry and Physics

Edited by Christine Klaas, Cecile Guieu, Karine Desboeufs, Jan-Berend Stuut, Mark Moore, Paraskevi Pitta, Silvia Becagli, and Chiara Santinelli.
https://bg.copernicus.org/articles/special_issue1040.html

The issue presents the results obtained during the PEACETIME (ProcEss studies at the Air-sEa Interface after dust deposition in the MEditerranean sea) cruise conducted in 2017 in the Mediterranean Sea.

It is worthwhile to mention that a paper introducing and synthesising the outcomes of the research completed during two Japanese GEOTRACES cruises along the GP02 section in the subarctic Pacific was published in the May 2022 issue of the *Limnology and Oceanography Bulletin*. An article introducing the volume is available at:

"Subarctic Pacific Intermediate Water: An Oceanic Highway for the Transport of Trace Metals in the North Pacific".

The cover of the issue features a picture from the GP02 cruise with Dr. Yoshiko Kondo from Nagasaki University. The complete volume is available here: Limnology and Oceanography Bulletin Volume 31 Number 2 May 2022

In total, the GEOTRACES peer-reviewed paper database includes 2,006 publications.

Publicity documents: In addition to the peer-reviewed publications, publicity articles to promote GEOTRACES are continuously published nationally and internationally. These publications are not included in the GEOTRACES publication database, but have a dedicated web page on the GEOTRACES site. This year we would like to highlight the following paper published in a special issue devoted to the United Nations Decade of Ocean Science for Sustainable Development in the *Marine Technology Society Journal:*

Masferrer Dodas, E., Anderson, R. F., & Jeandel, C. (2022). GEOTRACES International Program: Open Access Database of Seawater Trace Metal and Isotope Data Available. Marine Technology Society Journal, 56(3), 130–131. doi: https://dx.doi.org/10.4031/mtsj.56.3.23

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, about 281 highlights have been published. Among the numerous highlights published since last year's report, we selected the following five:

A new proxy for ocean iron bioavailability

In many oceanic regions, iron exerts strong control on phytoplankton growth, ecosystem structure and carbon cycling. Yet, iron bioavailability and uptake rates by phytoplankton in the ocean are poorly constrained.

Recently, Shaked et al. (2020) (see the science highlight about this paper), established a new approach for quantifying the availability of dissolved Fe (dFe) in natural seawater based on its uptake kinetics by Fe-limited cultured phytoplankton. In a follow up study published in 2021 in *GBC*, this approach was extended to *in situ* phytoplankton, establishing a standardized proxy for dFe bioavailability in low-Fe ocean regions.

Yeala Shaked, Ben Twining, and their colleagues have analyzed large datasets collected during 10 research cruises (including 3 GEOTRACES section and process cruises) in multiple ocean regions. Dissolved Fe bioavailability was estimated through single cell Fe uptake rates, calculated by combining measured Fe contents of individual phytoplankton cells collected with concurrently-measured dFe concentrations, as well as modeled growth rates (Figure 2). Then the authors applied this proxy for: a) comparing dFe bioavailability among organisms and regions; b) calculating dFe uptake rates and residence times in low-Fe oceanic regions; and c) constraining Fe uptake parameters of earth system models to better predict ocean productivity in response to climate-change.

The data suggest that dFe species are highly available in low-Fe settings, likely due to photochemical reactions in sunlit waters.

Joint Science Highlight with US Ocean Carbon and Biogeochemistry (OCB).

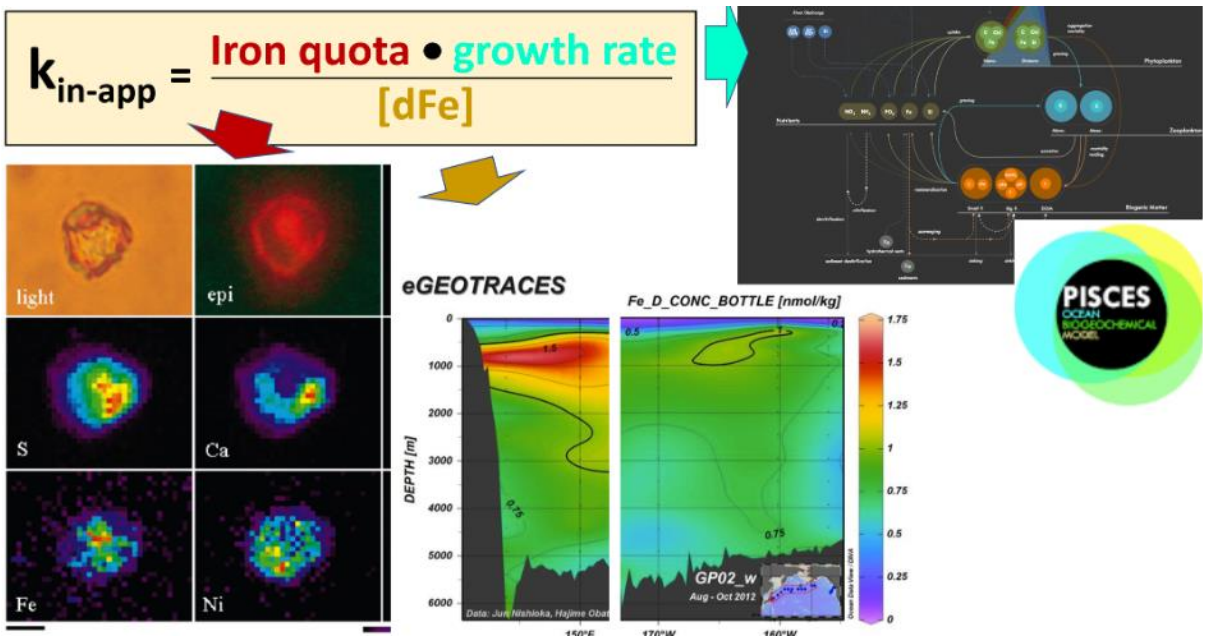


Figure 2. *The new bioavailability proxy (an uptake rate constant-kin-app) was calculated for ~1000 single cells from multiple ocean regions. For each cell, the iron quota was measured with synchrotron x-ray fluorescence (left panel), a growth rate was estimated from the PISCES model for the corresponding phytoplankton group (right panel), and the dissolved Fe concentration was measured concurrently (middle panel).*

References:

Shaked, Y., Twining, B. S., Tagliabue, A., & Maldonado, M. T. (2021). Probing the bioavailability of dissolved iron to marine eukaryotic phytoplankton using in situ single cell iron quotas. Global Biogeochemical Cycles, e2021GB006979. Access the paper: https://doi.org/10.1029/2021GB006979

Shaked, Y., Buck, K. N., Mellett, T., & Maldonado, M. T. (2020). Insights into the bioavailability of oceanic dissolved Fe from phytoplankton uptake kinetics. The ISME Journal, 1–12. Access the paper: https://doi.org/10.1038/s41396-020-0597-3

Measuring actinium-227 by mass spectrometry is feasible, sensitive and reliable!

Actinium-227 (^{227}Ac) is a radioelement (half-life = 22 y) produced in marine sediments by the decay of protactinium-231. ^{227}Ac remobilization in the sediment is the main source of actinium to seawater. It makes ^{227}Ac a good tracer of the process of remobilization from sediments and of the deep vertical mixing on decadal time scales. However, ^{227}Ac was difficult to study until now because of its very low concentration in the environment, from 0 to 35 ag/kg (1ag = 10^{-18}g) in seawater. Levier and co-authors (2021, see reference below) have developed a new protocol measurement of the dissolved actinium in seawater. This new measurement is by isotope dilution, chromatographic purification, and Multi-Collection Induced Coupled Plasma Mass Spectrometry (ICPMS). The detection limit achieved with this method is around 1 ag/kg measured on samples of 10L of seawater. This new protocol was applied to archived samples from the Bonus GoodHope cruise (GIPY04) collected in 2008 in the Weddell Gyre. The resulting profile (see Figure 3) is consistent with previous data from the Weddell Gyre obtained by alpha spectrometry on 20-300 L seawater samples (Geibert and Vöge, 2008).

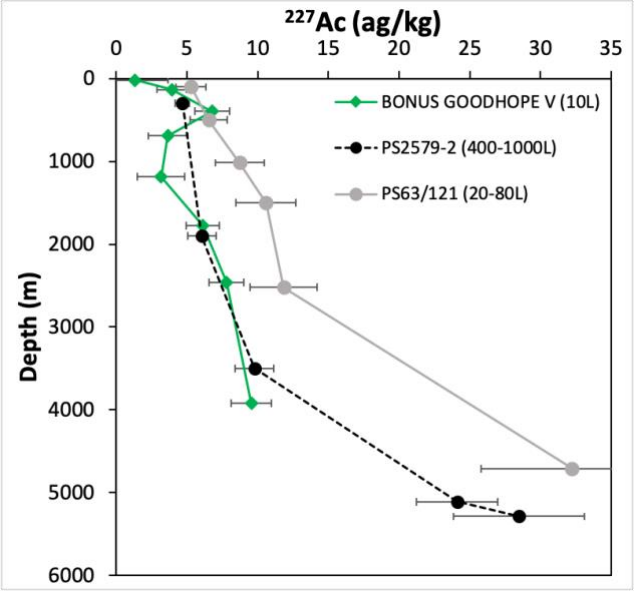


Figure 3. *Seawater ^{227}Ac profiles in Weddell Gyre, at station Super V from the Bonus GoodHope cruise, measured by mass spectrometry (green diamonds) which is in good agreement with ^{227}Ac profiles at station PS2579–2 (Geibert et al., 2002) (black dot) and PS63–121 measured by alpha-spectrometry (Geibert and Vöge, 2008) (grey dots). All uncertainties are expressed at 2σ.*

References:

Geibert, W., Vöge, I., 2008. Progress in the determination of 227Ac in sea water. Mar. Chem. 109, 238–249. https://doi.org/10.1016/j.marchem.2007.07.012

Levier, M., Roy-Barman, M., Colin, C., Dapoigny, A., 2021. Determination of low level of actinium 227 in seawater and freshwater by isotope dilution and mass spectrometry. Mar. Chem. 233, 103986. https://doi.org/10.1016/j.marchem.2021.103986

Retreat of large marine-terminating glaciers may increase iron supply to surface waters

The availability of the micronutrient iron (Fe) limits primary production in large parts of the high latitude oceans. There, glacial discharge enriched in dissolved Fe may stimulate phytoplankton growth and carbon sequestration. Previous research conducted in pro-glacial environments with samples collected on land suggested that glacial dissolved Fe supply to shelf waters may scale with freshwater discharge volume. Yet, data to support this conclusion is lacking for marine-terminating glaciers where glacial freshwater is injected subsurface into subglacial cavity waters residing beneath floating ice-tongues. GEOTRACES expedition GN05 on *RV Polarstern* sampled immediately adjacent to Greenland's largest floating ice-tongue. Results reveal that subglacial dissolved Fe discharge from glacier Nioghalvfjerdsbrae at 79°N is decoupled from freshwater Fe inputs, but has important benthic dissolved Fe sources. Krisch et al (2021, see reference below) show that the long residence time of waters inside the subglacial cavity results in equilibration between dissolved Fe, and sedimentary and freshwater Fe sources. As a consequence, dissolved Fe fluxes to the shelf are currently unaffected by increasing freshwater discharge, and may instead scale with the seawater circulation beneath the large floating ice-tongue. The findings demonstrate that glacial retreat and loss of ice-shelves may potentially result in

increases in dissolved Fe supply to surface waters downstream of large marine terminating glaciers in future.

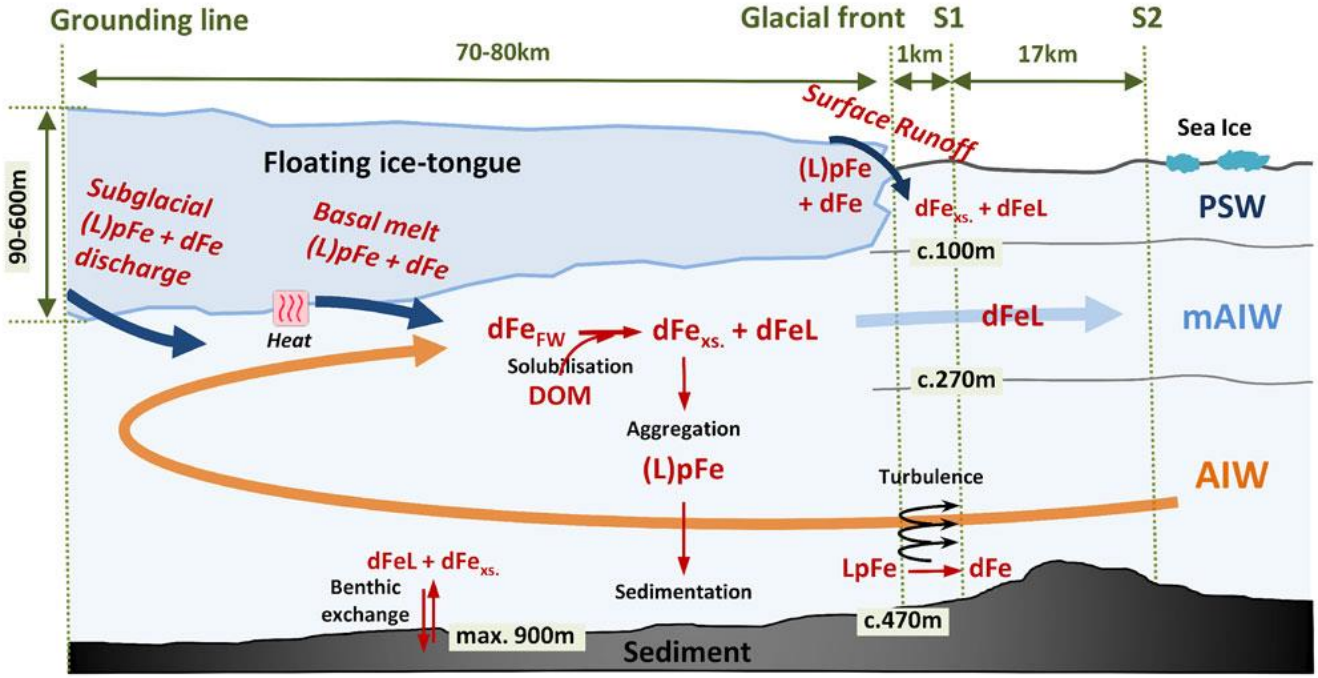


Figure 4. *Iron cycling in subglacial cavity underneath the 79°N floating ice tongue. Sediment supply, particle-dissolved Fe exchange and Fe ligand binding in combination with a prolonged water residence in the cavity (~162 days) resulted in enhanced dissolved Fe concentrations in the waters exiting the cavity.*

Reference:

Krisch, S., Hopwood, M. J., Schaffer, J., Al-Hashem, A., Höfer, J., Rutgers van der Loeff, M. M., Conway, T. M., Summers, B. A., Lodeiro, P., Ardiningsih, I., Steffens, T., Achterberg, E. P. (2021). The 79°N Glacier cavity modulates subglacial iron export to the NE Greenland Shelf. *Nature Communications*, *12*(1), 3030. Access the paper: https://doi.org/10.1038/s41467-021-23093-0

Pros and cons of nine bioactive trace elements as tracers of modern and paleo-productivity

Horner and co-authors (2021, see reference below) assess whether nine bioactive trace metals – iron (Fe), zinc (Zn), copper (Cu), cadmium (Cd), molybdenum (Mo), barium (Ba), nickel (Ni), chromium (Cr), and silver (Ag) – and their isotopes can be used as paleo-productivity proxies. Drawing on GEOTRACES datasets, their goal is to contribute to develop a comprehensive understanding of the marine behavior of these elements, including: mapping their distribution; elucidating the drivers of these distributions; characterising sources, sinks, and transformations associated with biological, physical and chemical (notably redox) reactions; and, eventually recognising if (and how) a given element is incorporated and preserved in marine sediments.

They find that cadmium, barium, nickel, and chromium isotopes (δ^{114}Cd, δ^{138}Ba, δ^{60}Ni, and δ^{53}Cr) show the most promise as productivity tracers; however, their distributions are not controlled locally by dissolved–particulate transformations, but instead offer a regionally integrated history of vertical cycling and mixing that is imparted over the scale of an ocean basin. Indeed, the major features of the low latitude distributions of these four elements are set in the Southern Ocean. In addition to these common features, the study identifies several aspects of the biogeochemical cycle of each element that are often unique.

Combining these unique behaviors could be an opportunity, leading to a more complete picture of marine paleoproductivity, biogeochemical cycles, and Earth's climate history.

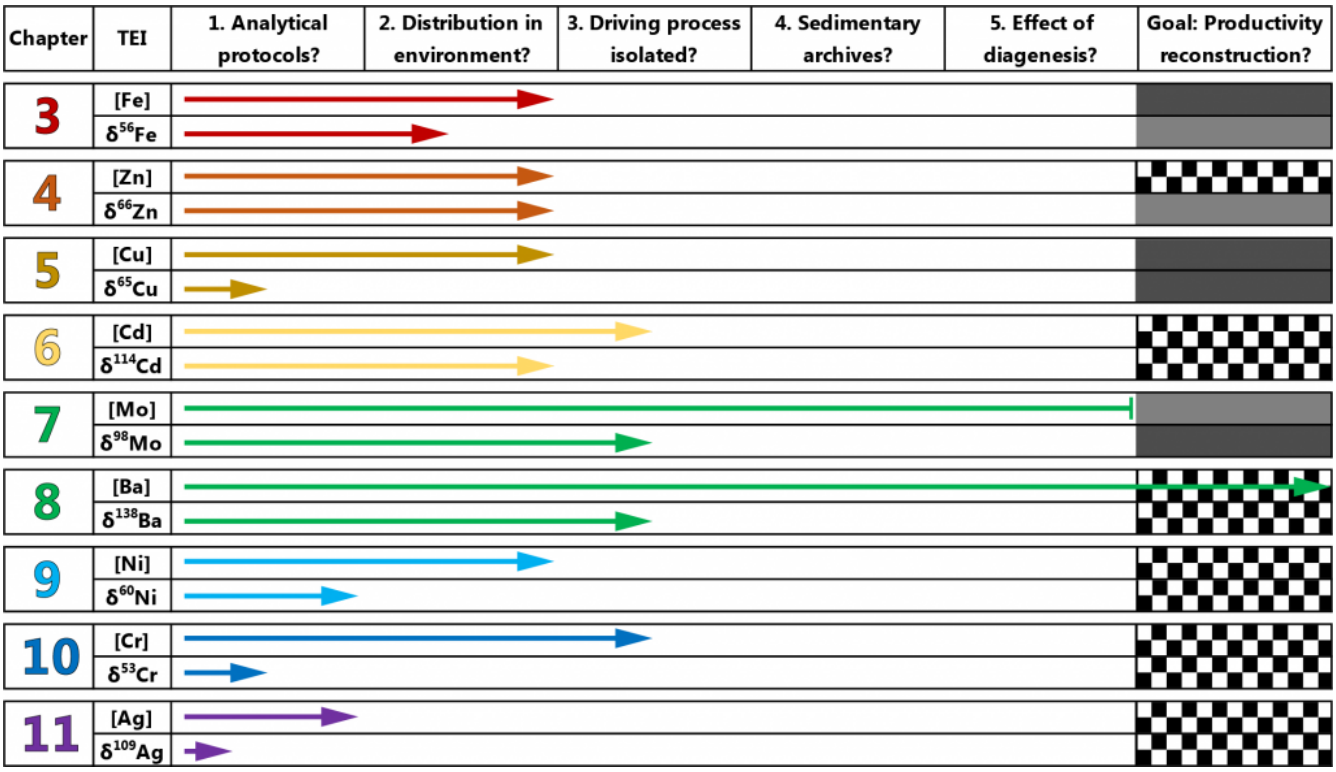


Figure 5. *How far along are the proxies? Horner and co-authors describe five steps to developing a trace element isotope (TEI) system into reliable proxy of biological productivity. These steps range from being able to make measurements of that TEI in the environment through to understanding how that TEI is preserved in the geological record. The authors assess the development of each TEI using GEOTRACES data and conclude that cadmium (Cd), barium (Ba), nickel (Ni), and chromium (Cr) isotopes show the most promise for tracing past productivity, whereas iron (Fe), zinc (Zn), copper (Cu), and molybdenum (Mo) isotopes do not. It is too early to say for silver (Ag).*

This synthesis paper results from the joint GEOTRACES-PAGES workshop (Aix en Provence, France, December 2018).

Reference:

Horner, T. J., Little, S. H., Conway, T. M., Farmer, J. R., Hertzberg, J. E., Janssen, D. J., Lough, A.J.M., McKay, J., Tessin, A., Galer, S.J.G., Jaccard, S.L., Lacan, F., Paytan, A., Wuttig, K. GEOTRACES–PAGES Biological Productivity Working Group Members (2021). Bioactive trace metals and their isotopes as paleoproductivity proxies: An assessment using GEOTRACES-era data. Global Biogeochemical Cycles, e2020GB006814. https://doi.org/10.1029/2020GB006814

Pros and cons of carbon, nitrogen and silicon as tracers of modern and paleo-productivity

Farmer and co-authors (2021, see reference below) review the geochemical proxies based upon sedimentary isotope ratios of three abundant biologically mediated elements: carbon (C), nitrogen (N), and silicon (Si), commonly used as productivity tracers. Their paleo-applications are informed by recent improvements to the understanding of ocean element and isotopic distributions thanks to the GEOTRACES and other hydrographic data. The pros and cons of the 3 elements as productivity tracers are discussed by the authors. They underline that, for instance:

- carbon isotopes will not only change with the surface biological productivity but also circulation, air-sea gas exchange, upwelling, and mixing of water masses with different signatures (non-productivity processes);
- regarding nitrate, using isotopic ($\delta^{15}N$) measurements in sedimentary archives to reconstruct past nitrate utilization requires that changes in the subsurface and any other source nitrate isotopes (δ15N) are quantified or assumed constant, and that the supply of nitrate to the surface layer has also not changed over time (non-productivity processes again);
- silicon isotope ratios ($\delta^{30}Si$) will reflect the productivity of silicifiers but not necessarily total productivity, as these two processes could be decoupled.

The authors then discuss the carbon, nitrogen and silicon isotope ($\delta^{13}C$, $\delta^{15}N$, and $\delta^{30}Si$) proxy applications linking ocean nutrient and carbon cycling with atmospheric dioxide carbon partial pressure (pCO_2) over the last glacial-interglacial climates as well as the whole Cenozoic. Authors underline that:

- multiproxy applications minimize the potential bias of the non-productivity processes, and provide novel insights gained by concurrent inferences on the uptake of carbon and major nutrients;
- the expansion of C, N and Si isotope proxies to the Cenozoic should greatly improve understanding of long-term C, N, and Si cycles and their coupling to Earth's climate.

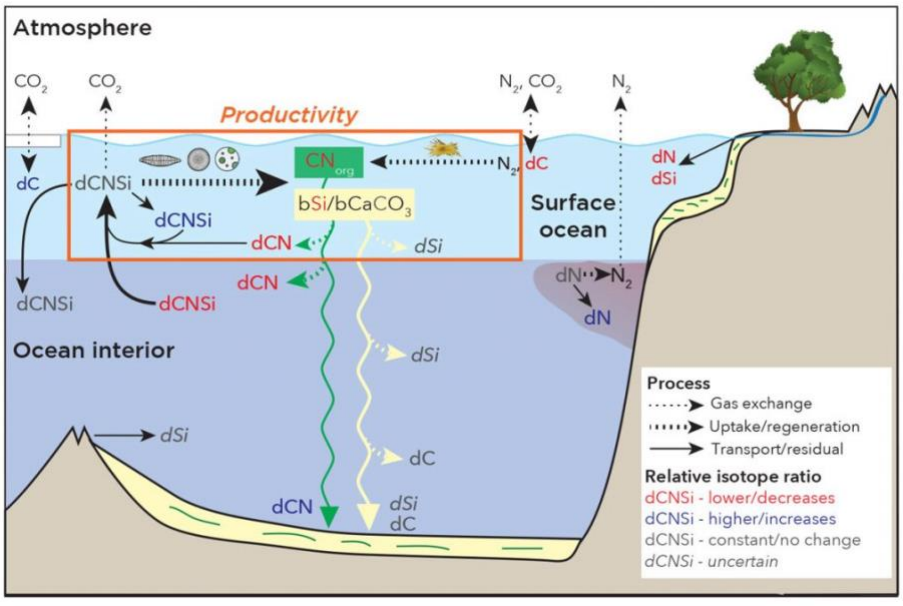


Figure 6. *Schematic of processes affecting carbon, nitrogen, and silicon isotopic compositions in seawater. Processes related to ocean biological productivity occur within the orange box. While productivity processes are*

central to C, N, and Si cycling, each element possesses non-productivity sources, sinks, and internal cycling that contribute to their isotopic variations in marine sediments.

This synthesis paper results from the joint GEOTRACES-PAGES workshop (Aix en Provence, France, December 2018).

Reference:

Farmer, J. R., Hertzberg, J. E., Cardinal, D., Fietz, S., Hendry, K., Jaccard, S. L., Paytan, A., Rafter, P. A., Ren, H., Somes, C. J., Sutton, J. N. (2021). Assessment of C, N and Si isotopes as tracers of past ocean nutrient and carbon cycling. Global Biogeochemical Cycles, e2020GB006775. https://doi.org/10.1029/2020GB006775

3. Activities

3.1 GEOTRACES intercalibration activities

The Standards and Intercalibration Committee (S&I) underwent a large change in membership during this time period.

The S&I Committee membership from May 1st to September 29th, 2021, is shown in Table 1.

Table 1. Standard and Intercalibration Committee Members

Maeve Lohan (Co-Chair)	University of Southampton (U.K.)
Walter Geibert (Co-Chair)	Alfred Wegner Institute (Germany)
Ana Aguilar-Islas	University of Alaska Fairbanks (U.S.)
Karen Casciotti	Stanford University (U.S.)
Tina van de Flierdt	Imperial College London (U.K.)
Lars-Eric Heimbürger-Boavida	Mediterranean Institute of Oceanography (France)
Hélène Planquette	LEMAR Laboratory, CNRS (France)
Yoshiko Kondo	Nagasaki University (Japan)
Peter Sedwick	Old Dominion University (U.S.)
Alyson Santoro	University of California Santa Barbara (U.S.)

The S&I committee continued their work on intercalibrating datasets for the Intermediate Data Product (IDP) released on the 17th of November 2021. Due to COVID-19 all meetings were held virtually, with a peak working load of meeting typically twice a week for 1.5-2 h per week in the period leading up to the IDP2021, with the last IDP virtual meeting on the 20th of May 2021 to approve the last remaining datasets for the IDP. After this last flurry, a few outstanding approvals were carried out by e-mail. Due to the frequent meetings and the general workload for intercalibrating, combined with the useful documentation features by the GEOTRACES Data for Oceanic Research (DOoR), no official written meeting minutes were prepared.

Overall data from 77 cruises were intercalibrated, these included TEIs from seawater discrete data (570 TEIs), aerosol data (167 TEIs), precipitation data (75 TEIs) and cryosphere data (10 TEIs).

The co-chairs, Maeve Lohan and Walter Geibert participated in 2 virtual Data Management meetings on the 7th of May and on the 8th of September to report on S&I activities. The co-chairs also participated in an Executive meeting on the 20th of May. The co-chairs also reported on S&I activities at the GEOTARCES SSC meeting (29th-1st October 2021).

New Committee:

Some members of the S&I committee wished to rotate off after the IDP. The following members rotated off (Maeve Lohan, Walter Geibert, Karen Casciotti and Tina van de Flierdt Alyson Santoro. We thank all these members for all the hard work ensuring the IDP could be delivered, under very challenging COVID conditions. Meeting monthly and biweekly in many cases over 1.5 yrs was very difficult due to the demand on committee member's time and the odd meeting time hours for those in Japan, Alaska and the West Coast of the US.

Ana Aguilar Islas and Helene Planquette stepped up to be the new co-chairs of the S&I committee and we thank them for taking on this task.

The rotations were reported to the SSC on the 1st of October. A handover meeting between the past co-chairs Walter Geibert and Maeve Lohan and the new co-chairs Ana Aguilar Islas and Helene Planquette took place on the 20th of October.

On the 8th of February 2022, the remaining S&I committee members and past co-chairs met to discuss new members and identify experts who could evaluate the success of the data intercalibration previously assigned old S&I members and identify potential new data sets and experts who can report on this. The new co-chairs contacted new members by email and clarified the role of individual members who requested it at two occasions: on February 22nd with Yeala Shaked and with Luke Bridgestock on March 11th, both by video conference. The SSC held a remote poll to confirm the new members, which was closed on 24 March 2022 with the confirmation of the new S&I committee. We are pleased to report the new S&I Committee members below in Table 2 and thank them for stepping up to this role.

Table 2. Standard and Intercalibration Committee Members' preliminary assignments

Member	**Institution**	**Preliminary Assignments**
Ana Aguilar-Islas (Co- Chair)	University of Alaska Fairbanks (U.S.)	Polar parameters
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
Yoshiko Kondo	Nagasaki University (Japan)	Dissolved ligands and inorganic elements, dissolved oxygen peroxide
Peter Sedwick	Old Dominion University (U.S.)	Aerosols, water column dissolved TEs
Yeala Shaked	Institute of Marine Science, Eilat (Israel)	Biogeotraces related parameters

Then, the co-chairs met virtually on April 6th to change the name of experts for each and everyone of eac of the 8,090 parameters registered in the DOoR portal and liaised with Elena Masferrer so that the intercalibration process can continue. The S&I committee will thus continue to evaluate new data as it is registered on DOoR.

The next S&I meeting will be hosted by Co-Chair Planquette and will take place in person in Brest, France on the 8 & 9th of September prior to the next SSC meeting.

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/). Dr Mohamed Adjou is the lead GEOTRACES Data Manager. He works in active collaboration with Donna Cockwell. GDAC benefits from additional BODC expertise when work cases require it.

GDAC is responsible for the entirety of the GEOTRACES data activities. This takes into account the following components:

- Interaction between 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 and upcoming cruises on the programme page (http://www.bodc.ac.uk/geotraces/cruises/programme/);
- Liaising with the Data Management Committee and Standards and Intercalibration Committee to answer issues/questions relating to GEOTRACES;
- Input of metadata and data into the BODC database and compilation of documentation to include originator's methodology
- Collation of data and metadata for the future IDP;
- Answering requests from GEOTRACES community and assisting on IDP download.

The main GDAC tasks over the past year were:

IDP2021 data, archiving and processing: over a major part of the last year, the main working focus of GDAC was the collation of data and metadata from different individual data submitters (i.e. GEOTRACES PIs or data contributors) or directly from national marine data centres (i.e. BCO-DMO, CYBER-LEFE, JAMSTEC, NIOZ and SKLMES). Data and metadata review was performed

systematically before the data processing and requests were sent to the data PIs for complementary information when required.
In total, between May 1st 2021 and November 1st 2021, over ~700 new datasets were archived and processed at GDAC for potential inclusion in IDP2021.

DMC meeting series: Over the last year, a series of virtual DMC meetings were scheduled to follow the progress of the GEOTRACES IDP preparation under pandemic conditions. GDAC participation was key to providing an update on IDP2021 data processing progress and contributing actively to discussions on increasing data quality checks.

Providing proof-check files of processed data to PIs via DOOR portal: The DOoR portal has proven to be a platform where essential metadata converge, by providing dataset registration to PIs among other services. In order to improve the data quality in the GEOTRACES IDP, a new service of *proof-check*, proposed by GDAC, was offered to PIs via DOoR by providing to PIs the final format of each dataset months before the release of the IDP.

Delivering GEOTRACES IDP2021 (meta-)data: The GEOTRACES (meta-)data processed at GDAC are gathered by Prof. Reiner Schlitzer before creating GEOTRACES IDP and the eGEOTRACES electronic Atlas. Tests were performed and specifications of the technical delivery of the (meta-)data were defined with Prof. Reiner Schlitzer, using relational tables. The new (meta-)data delivery path improved the GEOTRACES (meta-)data extraction from GDAC database, and the IDP creation.

Minting the GEOTRACES IDP2021 DOI: The GEOTRACES IDP2021, released on 17 November 2021, is the first offered to users as an open access data release of the GEOTRACES IDP, with a DOI released by NERC EDS British Oceanographic Data Centre NOC.

Releasing a new GEOTRACES interactive cruise map: The increase in GEOTRACES cruises numbers made the representation of the whole cruise programme on a static map difficult to maintain, in particular with overlapping information and transects. GDAC identified the creation of a proper GEOTRACES interactive map as a priority after the IDP2021 release. The new GEOTRACES interactive cruise map was released in May 2022 (https://www.bodc.ac.uk/geotraces/cruises/section_maps/interactive_map/).

Cruises: The summary of GEOTRACES cruises, which have taken place in the period May 2021-April 2022 is shown in Table 4.

Table 4. Cruises completed during the reporting period

Cruise	Chief scientist(s)	GEOTRACES scientist(s)	Type	Period	Location
SSD-079 (GI09)	Damare Samir	Kumar Singh Sunil, Goswami Vineet	Section Cruise	2021-03-01 — 2021-06-30	Bay of Bengal (Indian Ocean)
IN2022_V03 (GIpr08)	Shadwick Elizabeth	Chase Zanna, Bowie Andrew	Process Study	2022-05-03 — 2022-05-15	Southern Ocean (East Indian sector)
SO289 (GP21)	Achterberg Eric	Achterberg Eric, Frank Martin,	Section Cruise	2022-02-18 — 2022-04-08	Section along South Pacific at 32.5°S

		Koschinsky Andrea			
PE474 (GApr16)	Middag Rob	Middag Rob	Process Study	2021-07-17 — 2021-08-17	North Atlantic (Around Iceland)

In summary: The past year was marked by the release of the GEOTRACES IDP2021, a crowning achievement of the hard work of the whole GEOTRACES community. GDAC work was central in preparing and processing all the GEOTRACES (meta-)data, and closely collaborating with all the acting parties. Beyond the GEOTRACES data work, GDAC released a GEOTRACES interactive cruise map to provide a better representation of the GEOTRACES cruise programme.

3.3 GEOTRACES International Project Office

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 under the scientific supervision of Catherine Jeandel (CNRS, LEGOS, France). On March 2022, Emilie Le Roy has joined as part-time project officer supporting Elena Masferrer mainly in web mastering tasks.

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 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 and building the IDP2021

  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 has enormously facilitated the building of the IDP2021. The technical work was

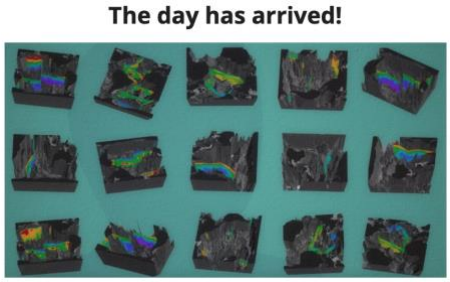
assured by François André from the Data Centre of the Observatoire Midi-Pyrenées (SEDOO, https://www.sedoo.fr/) in Toulouse, France. The team has been meeting weekly or bi-weekly during the reporting period.

The main developments completed during the reporting period include:

- Improve the GDAC Interface to allow upload of proof check files for each PI to check their data before they are being included in the IDP;
- Development of a new interface to manage the IDP GEOTRACES reference system and GEOTRACES publication database available on the GEOTRACES website.
- Improve IDP2017 metadata by linking the names of the associated researchers to each IDP2017 data set.
- Preparing the DOoR portal to accept data for the next IDP, including a major overhaul of it.
- Update the S&I reviewers from all the 8,090 parameters available in DOoR.

In addition, the IPO and the SEDOO have assisted GDAC, the S&I committee and the Parameter Definition Committee (PDC) in improving their interfaces to facilitate their job, reviewing registered datasets and creating new parameters when needed.

- Intermediate Data Product 2021 release and promotion events



The IPO has assisted in the organization of the IDP2021 webinar release events (two events organized on 17 and 18 November 2022 as well as the virtual Town Hall organized at the Ocean Science Meeting on 25 February 2022).

In addition, the IPO has prepared all the promotional materials, including several eNewsletters and an IDP brochure available here: https://www.geotraces.org/wp-content/uploads/2021/11/IDP2021_Brochure_v2.pdf

- GEOTRACES endorsed as Ocean Decade Action

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

The IPO has participated in several Ocean Decade coordination and communication meetings. In addition, it has prepared and submitted a proposal for a satellite event of the UN Ocean Decade Laboratory on "An Accessible Ocean". The webinar "GEOTRACES: sharing marine geochemical data" that introduced the GEOTRACES programme along with the IDP2021 was held on 10 May 2022 as reported on page 4 of the report.

The IPO has also participated in a special issue of the devoted to the United Nations Decade of Ocean Science for Sustainable Development, published in the *Marine Technology Society Journal*. The publication is available here: https://doi.org/10.4031/MTSJ.56.3.23

- Outreach

The IPO has collaborated with Chris Parsons (US NSF Ocean science communication & policy specialist) in preparing promotional materials. Four main products have been released:

- Video: GEOTRACES: Examining our Oceans! https://youtu.be/NwvMnma0Cxw
- Two articles:
  - Article introducing the GEOTRACES Programme in NSF Science Matter Blog (Thanks to Laura Whitmore, University of Fairbanks, Alaska and Wen-Hsuan Liao, LEMAR, Brest, France): https://beta.nsf.gov/science-matters/geotraces-research-voyages-studying-rare-substances-oceans
  - Article in ECO Magazine on GEOTRACES Hg research (thanks to Lars-Eric Heimburger (University of Aix-Marseille, France; Carl Lamborg University of California, Santa Cruz; and Katlin Bowman, San José State University): http://digital.ecomagazine.com/publication/?i=724539&ver=html5&p=94
- Webinar for the general public – Ocean Decade satellite event – on NSF supported programmes that featured Phoebe Lam (University of California, Santa Cruz) who presented GEOTRACES: https://www.nsf.gov/geo/oce/ocean-obs/ocean-observing-webinar-video.mp4

Another outreach project is also on-going with Adrian Artis (graphical designer) to prepare a suite of short videos presenting the science of GEOTRACES for the general audience. The first of these videos, introducing the GEOTRACES programme was presented during the launch of the IDP2021: https://youtu.be/IGUt4OZL2Z8

- Some statistics for the period May 1st, 2021 to April 30th, 2022

35 new highlights published (281 in total)
6 eNewsletters published, including one special issue (bimonthly 45 in total)
534 new peer-reviewed papers included in the GEOTRACES Publication Database (2,006 in total)
191 new articles published on the GEOTRACES website
2,302 followers in Twitter and 772 followers in Facebook

3.4 GEOTRACES summer school

The *International GEOTRACES Summer School: Introducing Polar Parameters* will take place from 10th to 15th July 2022 at the Helmholtz-Centre Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. Organised by Walter Geibert and Claudia Hanfland.

It will offer training possibilities for 50 students, with a combination of lectures and hands-on training in marine geochemistry of trace elements and their isotopes, including:

- Polar parameters: sea ice, snow, meltponds
- Pre-campaign planning and preparation
- Sampling at sea
- Sample processing and analysis
- Data processing and visualization
- Modeling

The Summer School will also include a full day of shipboard sampling of marine trace elements onboard *RV Heincke* and 1:1 science discussions with renowned experts in the field.

The summer school has received 110 applications from students coming from 32 different countries.

The event is supported by VolkswagenStiftung and SCOR through the SCOR travel grants. GEOTRACES thanks SCOR for the financial support received.

For further information: https://geotraces2022.sciencesconf.org/

3.5 Special sessions at international conferences featuring GEOTRACES findings

Several GEOTRACES special sessions were held or are planned in major international conferences including:

Virtual 2021 ASLO meeting, 22-26 June 2021
For further information: https://www.aslo.org/2021-virtual-meeting/

Plenary Talk:

*Trace metals as agents and tracers in the ocean and climate system
Plenary speaker: Katharina Pahnke

GEOTRACES sessions:

*SS63: Towards a mechanistic understanding of metal-microbe interactions in the Oceans
Co-conveners: Martha Gledhill, Yeala Shaked, Ingrid Obernosterer.

*SS03: Distribution and impacts of ocean nutrient limitation
Co-conveners: Thomas Browning, Mark Moore, Erin Bertrand and Alessandro Tagliabue

Virtual Goldschmidt 2021, 4-9 July 2021
For further information: https://2021.goldschmidt.info/

GEOTRACES session:

*13a. Marine biogeochemistry: Particle fluxes and dissolved trace element cycling from source to sink
Co-conveners:
Adi Torfstein, Phoebe Lam, William B Homoky, Erin Black, Amber Annett, Christopher T Hayes

Keynote speaker:
Claudia Benitez-Nelson, University of South Carolina

Hybrid AGU Fall Meeting 2021, 13-17 December 2021, New Orleans, LA, and on-line.
For further information: https://www.agu.org/Fall-Meeting

GEOTRACES session:

*PP024. Refinement of paleo-proxies in the GEOTRACES era
Co-conveners: Christopher Hayes, Kazuyo Tachikawa, Kassandra Costa and Jesse R Farmer

Virtual Ocean Sciences Meeting 2022, 24 February – 4 March 2022, on-line.
For further information: https://www.aslo.org/osm2022/

GEOTRACES Town Hall:

*TH33 Accessing and utilizing the GEOTRACES 2021 Intermediate Data Product (IDP2021)

GEOTRACES and GEOTRACES-related sessions:

*CT01 Temporal Variability of Bioactive Trace Elements in the Ocean: Towards Constraining Drivers, Mechanisms and Timescales
Organizers: Peter Sedwick, Erin Black, Alessandro Tagliabue and Simon Ussher.

*CT03 Advances in understanding of the biogeochemical processes shaping the basin-scale distributions of trace elements and their isotopes
Organizers: Tim Conway, Lauren Kipp, Jessica Fitzsimmons and Greg Cutter.

*CT10 Sources, sinks, and cycling of trace elements in coastal and near-shore systems
Organizers: David Janssen, Veronique Oldham and Emily Estes.

*CT11 Mercury transformations in marine ecosystems
Organizers: Eric Capo, Amina Schartup, Heyu Lin and Lars-Eric Heimbürger.

*OB20 Towards BioGeoSCAPES: Linking cellular metabolism with ocean biogeochemistry
Organizers: Adrian Marchetti, Yoshiko Kondo, Naomi Levine and Dalin Shi.

*HL11 Arctic Ocean processes, progress, and potential explored through synthesis supported research
Organizers: Laura Whitmore, Laramie Jensen and Ryan McCabe.

Forthcoming:

Hybrid Virtual Goldschmidt 2022, 10-15 July 2022
For further information: https://2022.goldschmidt.info

GEOTRACES sessions:

*12a – The interplay between terrigenous fluxes and the biological pump as reflected by trace elements and their isotopes in the oceans
Conveners: Adi Torfstein and Zanna Chase

*12d – The Role of Trace Metal Speciation (Physical And Chemical) At Marine Geochemical Interfaces
Conveners: Catherine Jeandel, Rebecca Zitoun, Hélène Planquette, Sylvia Sander, William M. Landing and Andrea Koschinsky

*14b – Transport of particle-reactive elements from estuaries to open ocean: role of boundary exchange and oceanic internal cycling
Convenors: Kai Deng, Milena Horvat, Jianghui (JD) Du, Igor Živković, Jožef Stefan Institute and Jennifer L Middleton

The Challenger Society Conference 2022, 6-8 September 2022
For further information: https://www.nhm.ac.uk/our-science/science-events/the-challenger-society-conference-2022-in-london.html

GEOTRACES session:

*T3 – Chemistry of nutrients, trace elements and their isotopes in the Ancient, Modern and Future Oceans
Convenors: Rhiannon Jones, Arianna Olivelli, Suzanne Robinson, Dr Amber Annett, Dr Oscar Branson, Dr Hana Jurikova

3.6 Capacity building

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 web site. 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 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 or any member of the SSC, 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	Powder coated aluminium with titanium CTD housing, Seabird Rosette	24 X 12-L GO-Flo	5000 m conducting 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
France	Complete	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 but awaiting test	Titanium frame with 911 plus CTD; all sensors with titanium housing	24 x 12-L OTE GO-Flo	8000 m; conducting Vectran cable
India	Complete	Powder coated aluminum with titanium pressure housings and fittings	24 X 12-L Niskin-X	8000 m; conducting Kevlar
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
Italy	Complete	Go-Flo bottles on Kevlar line	5 x 20-L Go-Flo	Kevlar
Italy - National Research Council of Italy, CNR	In progress	Seabird GEOTRACES Powder-coated aluminium with titanium pressure housings and fittings	24 X 12-L C-Free bottles	6000 m, steel conducting cable
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	Titanium frame	24 X 24-liter ultraclean polypropylene	10000 m; conducting Kevlar* **There is only one cable for the two systems*
Netherlands	Complete	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 development	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	Titanium frame PRISTINE	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
Russia	In development (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	Powder coated aluminium, titanium housing/fittings	24 X 12-liter GO-Flo	6500 m; Kevlar cable
South Korea	Complete	Titanium frame	24 × 12L PVDF	10,000 m; conducting Kevlar
UK	Complete	2 x Titanium frame, Ti pressure housings	24 10-L OTE 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 aluminium with titanium pressure housings and fittings	24 X 12-L GO-FLO	7000 m conducting Vectran cable
USA-University of Alaska Fairbanks	Complete	Sea-Bird GEOTRACES Powder-coated aluminium with Ti parts and pressure housing.	12 X 5-L Teflon-lined Niskin-X	No Kevlar line available yet.

		Fires at pre-programmable depths		
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- 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 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 12 X 5-L Niskin-X	2000 m Amsteel cable and 2000 m Space-Lay coated metal cable
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

4. Plans for the coming year

GEOTRACES field work programme

In the coming year, GEOTRACES will continue to advance the implementation of the field work programme with section cruises already planned by Japan, US and Germany supplemented by process studies (at least Canada and Australia have already cruises scheduled) that will investigate particular physical, chemical, and biological processes regulating the distributions of these TEIs. These new data will enrich future intermediate data products.

Towards a new Intermediate Data Product

Thanks to the DOoR portal the submission and review of data can now be done on a continuous basis. Indeed, PIs are encouraged to provide data as soon as available so that the S&I Committee and GDAC can review and process them as soon as possible to facilitate the integration of these data in the next IDP.

Nevertheless, during the next meetings of the Data Management and Scientific Steering Committees meeting, a new calendar for the preparation and release of the next IDP will be established.

Scientific workshops

GEOTRACES is planning to undertake the synthesis workshop on "Changing marine elemental cycles" which was initially planned for 2021 but that had to be postponed due to the COVID-19 pandemic. This workshop will be driven by Walter Geibert and will continue GEOTRACES synthesis efforts initiated by the suite of three synthesis workshops (in 2015, 2016 and 2018, http://www.geotraces.org/science/synthesis-of-results). It should also continue the efforts in bringing together the observational and modelling communities fostered by the three Data-Model Synergy Workshops that GEOTRACES organised in 2007, 2009 and 2011. In any case, the synthesis will continue to respond to the expectation that GEOTRACES results benefit other oceanographic disciplines.

BioGeoSCAPES effort

GEOTRACES investigators continue to provide advice and recommendations, as appropriate, to help launch this new programme.

Acknowledgements

We wish to express our gratitude to SCOR, and to Patricia Miloslavich on her role of Executive Director, for providing support and valuable advice for the successful implementation of the GEOTRACES programme. A complete report on the activities completed by the BioGeoSCAPES is available in the annex of this report.

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