Criteria for Establishing GEOTRACES Process Studies
Revised by the Scientific Steering Committee (SSC) in December 2019

The following information is provided to guide scientists who wish to develop a research programme to be designated as a GEOTRACES process study. General characteristics of GEOTRACES process studies are described in Section 8.1.3 of the Science Plan (available on the web at www.geotraces.org), the text of which is reproduced below.

It is preferable that project leaders obtain GEOTRACES Scientific Steering Committee (SSC) approval *before* submitting a proposal to a funding agency for a cruise that is called a GEOTRACES process study in the proposal. In such cases the SSC co-chairs will provide letters of support for use in funding applications. However, it is also possible to seek endorsement once the funding has been secured. In any case the process study application must occur prior to the fieldwork taking place. Requests require a minimum of one month to process, although a longer lead time is appreciated.

The GEOTRACES SSC has established seven criteria that must be met in order to gain endorsement by the SSC as a process study:

1. It must study one or more processes that contribute to the scientific goals of GEOTRACES.

2. The intent of the project leaders to follow the GEOTRACES process study criteria must be indicated in the proposal requesting resources to support the study.

3. It must provide measurements of at least one of the key trace element and isotope (TEI) parameters of GEOTRACES (listed in Table 2 of the Science Plan, reproduced below).

4. It will collect sufficient ancillary data to allow interpretation of the TEI data. These include at least temperature and salinity, and, preferably, nutrients and oxygen. Collection of CTD and other data that aid in interpreting TEI data should follow GO-SHIP guidelines on how to produce good quality hydrographic data, at: http://www.go-ship.org/HydroMan.html

5. It will follow GEOTRACES Intercalibration procedures to allow comparison with data collected elsewhere. These procedures will be updated periodically on the GEOTRACES web site:
http://www.geotraces.org/library-88/geotraces-policies/946-intercalibration-procedures-2
More detailed information is available in the GEOTRACES cookbook:
http://www.geotraces.org/libraries/documents/Intercalibration/Cookbook.pdf
For the TEIs to be measured, the request for a process study must provide information to explain how the intercalibration protocols will be met (e.g., analyzing consensus reference samples, collecting duplicate samples to be analyzed at a collaborating intercalibrated lab). Results from the analysis of reference samples must be reported together with the main cruise data.

6. It will follow GEOTRACES Data Management protocols, including:
a) Once the cruise is funded the chief scientist or the lead GEOTRACES scientist must inform the GEOTRACES Data Assembly Centre (GDAC, geotraces.dac@bodc.ac.uk)

and the International Project Office (IPO, ipo@geotraces.org) that the cruise has been funded.

b) Submission of post-cruise metadata form and cruise report, ensuring that the waypoints of the cruise track are included in the cruise report. Guidelines for preparing the cruise report and a metadata template form are available at: http://www.bodc.ac.uk/geotraces/cruises/documentation/.

c) Submission of data and metadata for all datasets, including ancillary data, to the PI's national data centre (for American, French, Dutch and Chinese researchers) or to GDAC in a timely manner, and no more than two years after the analysis of samples.

d) Permit public access to the data beginning two years after the collection of the data. This policy recognizes that some analyses are labour intensive and post-cruise sample analyses may require a substantial amount of time.

7. It will commit in advance to acknowledging GEOTRACES in products of the project.

Recommendations

I. Ideally, the study would include multiple trace elements and isotopes (TEIs); programmes are encouraged to take account of the principle that additional information is gained from measurement of multiple TEIs. If requested, the SSC could assist investigators planning process studies in locating scientists who can help expand the number of TEIs to be measured by participating in the programme. Also, a GEOTRACES Researchers Analytical Expertise database is available on the GEOTRACES web site to help search for particular TEI expertise: http://www.geotraces.org/science/geotraces-researchers-analytical-expertise-database

II. Cruise leaders are requested to contact the GEOTRACES International Project Office (IPO, ipo@geotraces.org) to inquire about investigators studying new tracers who are searching for cruises to provide sampling opportunities.

III. When possible, chief scientists shall include a funding contribution to GDAC in their proposals to help provide financial support for data management.

IV. GEOTRACES encourages cruise leaders to welcome scientists from developing countries to be trained on board GEOTRACES cruises. Limited funding to cover the airfare of the trainee is available through SCOR.

Process to seek endorsement

-To seek endorsement, project leader(s) should approach their national or regional SSC member with (1) the "Process study request form" (available at: http://www.geotraces.org/cruises/cruise-programme/process-studies) duly filled in and (2) written agreement of the Chief Scientist of the cruise stating their approval for the cruise being endorsed by GEOTRACES (the list of SSC members is available at the following web page: http://www.geotraces.org/about-us/ssc-members/ssc-members-and-officers). This SSC member will provide the project leader(s) with advice during

preparation of the document, and forward the final document to the International Project Office (ipo@geotraces.org). Recommendations will be made by the SSC who will either make decisions during the annual SSC meeting or by email for those proposals arriving out of cycle (i.e., those that require approval prior to the next SSC meeting).

Additional information

REPRODUCED FROM THE GEOTRACES SCIENCE PLAN
8.1.3 Process studies
Although ocean sections will offer insight into many processes of interest to GEOTRACES, in some cases dedicated process studies will be required to fulfil the GEOTRACES mission. Many processes influence the marine biogeochemical cycles of TEIs, far more than can be examined by a single programme. Therefore, while it remains the prerogative of national GEOTRACES programmes and funding agencies to select specific process studies to be carried out (Section 9), some guiding principles will help set priorities in reaching these decisions.

Process studies likely to be of greatest value to GEOTRACES are those that:

- evaluate sources and sinks for TEIs for which large uncertainties currently exist;
- establish the processes that control the recording of geochemical proxies in sedimentary archives;
- establish the sensitivity of critical processes to changing environmental parameters; and
- complement but do not duplicate research conducted by other programmes.

Based on the implementation strategies outlined in Sections 3, 4 and 5 above, four particular process studies are currently identified as meeting these criteria and therefore as being high priority. This is not an exhaustive list of process studies that would help GEOTRACES meet its goals, but it represents those process studies that can already be identified as of particularly high priority:

- ocean–sediment exchange at oxygen minimum zones (see implementation strategy under Sections 3.3, 4.2 and 4.3);
- release of TEIs from particulate material when high-particulate load rivers discharge to the ocean (see Section 3.2);
- the flux of TEIs to the ocean from SGDs (see Section 3.2);
- recording of geochemical proxies in sediments from regions underlying strong ocean gradients (see Sections 5.2 and 5.3).

In each of these cases, additional work will be required to complement that derived from the ocean section approach. This work will involve tasks such as the collection of sediment or of data on repeat sections that are not planned as part of the ocean section campaign.

Other processes, although important to the goals of GEOTRACES, may be investigated by other programmes. Examples include the processes controlling the fractional dissolution of aerosol material (Section 3.1), which may be investigated by SOLAS, or the chemistry of near-vent hydrothermal fluids (Section 3.4), which may be investigated by InterRidge. The GEOTRACES Scientific Steering Committee will ensure close dialogue with such programmes to ensure that, while there is no duplication, suitable

process studies are performed to meet the GEOTRACES goals. Synergies between programmes will also be sought, for instance, by adding new TEI measurements to existing programmes, or by welcoming scientists from other programmes on GEOTRACES cruises.

In general, process studies will run concurrently with ocean section work. However, it is anticipated that the analysis of section results may identify unexpected areas in need of process studies. For example, anomalies in systematic relationships between TEI concentrations and standard hydrographic parameters may indicate the location of previously unknown TEI sources or sinks for which further investigation by process studies is deemed necessary. Therefore, the long-range plan for GEOTRACES should allow for such process studies to occur near the end of the programme.

Table 2. GEOTRACES Key parameters

Key Parameter	Examples of use
Trace Elements	
Fe	Essential micronutrient
Al	Tracer of Fe inputs (from mineral dust and elsewhere)
Zn	Micronutrient; potentially toxic at high concentration
Mn	Tracer of Fe inputs and redox cycling
Cd	Essential micronutrient; palaeoproxy for nutrient content of waters
Cu	Micronutrient; potentially toxic at high concentration
Stable isotopes	
δ15N (nitrate)	Modern and palaeoproxy for nitrate cycling
δ13C	Modern and palaeoproxy for nutrient content and ocean circulation
Radioactive isotopes	
230Th	Constant flux monitor in sediments; tracer of modern ocean circulation and particle scavenging
231Pa	Palaeoproxy for circulation and productivity; tracer of modern particle processes
Radiogenic isotopes	
Pb isotopes	Tracer of natural and contaminant sources to the ocean
Nd isotopes	Tracer of natural sources of TEIs to the ocean
Other parameters	
Stored sample	To allow future work
Particles	Essential transport vector for many TEIs
Aerosols	Essential source of TEIs to the surface ocean