

Note from Ed Urban: Organizers of GEOTRACES are involved with the SCOR/IGBP Ocean Biogeochemistry and Ecosystems Analysis project in discussions about the role of portions of GEOTRACES as components of the new project. Nonetheless, SCOR desires input on this proposal from its National Committees and others. Such input will be important to both GEOTRACES and the new project. There are obvious potential relations of GEOTRACES with other SCOR, IGBP, and WCRP projects.

Proposal to establish a SCOR Working Group to plan and implement GEOTRACES...

...a collaborative multi-national program to investigate the global marine biogeochemical cycles of trace elements and their isotopes

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On behalf of the GEOTRACES Planning Group

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Abstract

A SCOR Working Group is proposed to provide a platform to plan and implement an international research program to study the global marine biogeochemical cycles of trace elements and their isotopes. Although the primary objective of the proposed program is an improved understanding of the marine biogeochemistry of trace elements, benefits of the program will extend into multiple sub-disciplines of oceanography, as described in the main body of this proposal. The proposed program will be global in its scope and international in the composition of its participants. Furthermore, the program will involve close linkages with several other major international oceanographic research programs. Consequently, the planning and implementation of this program are well suited to take place under the auspices of SCOR.

Activities of the Working Group will include: (1) Organizing national and international planning workshops; (2) Preparing Science and Implementation Plans; (3) Initiating efforts for intercalibration of analytical methods, and for the development of standard reference materials; (4) Defining a policy for data management and sample archival; and (5) Forging scientific linkages with other research programs holding overlapping interests. A working group of 10 members is envisioned initially, but it is anticipated that the size of the group will increase as funds from other sources become available to support the planning and implementation of the program.

Rationale

Trace elements and isotopic tracers play an important role in oceanography; for example, as: (1) limiting micronutrients that regulate ecosystem structure and the efficiency of the ocean's biological pump; (2) tools with which to evaluate export production as well as the rates of other processes involved in the ocean carbon cycle; (3) tracers of ocean circulation; (4) proxies used in paleoceanography; and (5) tracers of the transport and fate of pollutants. Much has been learned in recent years about the biogeochemical cycling of trace elements and isotopic tracers, but progress has been limited by the lack of any large-scale coordinated research effort in this area since the GEOSECS program in the early 1970's.

Great advances in the analytical capabilities to measure trace elements and isotopes in the ocean have been made in the quarter century since the completion of GEOSECS, but much remains to be learned about the sources, transport, chemical speciation, biological availability, internal cycling and fate of the broad spectrum of trace elements and isotopes of interest to marine biogeochemists. Advances in chemical sensors, analytical instrumentation, and modeling make possible now research that could not have been envisioned even a decade ago. With the definition of a number of high priority research questions, and the availability of analytical techniques that permit sampling at high spatial and temporal density, the community of marine biogeochemists believes that the time is right to mount a major international research program to study the global marine biogeochemical cycles of trace elements and their isotopes.

A global study of the marine biogeochemical cycles of trace elements will, simply by its scope, require the resources of many nations in order to achieve its objectives. Coordination and collaboration among international partners would benefit immensely from the status and the connections offered by a SCOR affiliation. In addition, the proposed program will share scientific interests with a number of other research programs. A SCOR affiliation would facilitate the development of scientific linkages with these programs.

Historical Background

Beginning in the late 1990's, informal discussions at international meetings revealed a widespread interest in mounting a coordinated research program to study the marine biogeochemical cycles of a broad array of trace elements and isotopes. To provide a venue for presenting current research interests, as well as to identify important outstanding research questions, a special session on "Trace Elements and Isotopes in Oceanography" was held at the Fall 2001 meeting of the American Geophysical Union (10-14 December, 2001). The session drew a total of 58 titles, illustrating the widespread interest in this topic.

An open forum held during the same AGU meeting was attended by more than 70 scientists, representing at least eight nations, who were uniformly enthusiastic about the timeliness of, and potential benefits from, a coordinated field program dedicated to the study of the marine biogeochemical cycles of trace elements and isotopes. There was a strong consensus among participants that recent advances in analytical instrumentation and seagoing technology, as well as new insights gained from small-scale and individual research projects, have placed the field in a position that is well poised to make major advances in our understanding of trace element biogeochemistry.

The enthusiastic response of participants in that open forum led to an effort to hold an international planning workshop. That growing effort eventually obtained support from the US NSF Chemical Oceanography Program and the French Centre National de la Recherche Scientifique, as well as from the Observatoire Midi-Pyrénées and the Université Paul Sabatier in Toulouse, France. A planning workshop was held in Toulouse on 13-16 April, 2003, and was attended by approximately 85 participants representing 15 nations. Objectives of the workshop were to:

- 1) Define the principal questions and hypotheses to be addressed in future research on the marine biogeochemistry of trace elements and their isotopes;
- 2) Identify and develop common interests and synergies that would benefit from a coordinated study of the marine biogeochemistry of trace elements;
- 3) Identify beneficial linkages between such a coordinated study and planned activities of other oceanographic research programs (e.g., CLIVAR, SOLAS, OCEANS, LOICZ, PAGES, RIDGE, MARGINS, etc.).

Deliberations during the workshop identified a number of research objectives for the program, and determined that an optimum strategy to achieve those objectives would involve a global study consisting of a number of ocean sections anchored by regional process studies tied to specific sections. Process studies would focus on open questions pertaining to the sources, sinks and internal cycling of trace elements, such as the importance of riverine particles as sources, the mobilization and recycling of trace elements by redox processes in ocean-margin sediments, the removal of trace elements by scavenging in hydrothermal plumes emanating from mid-ocean ridges.

It was the consensus recommendation of workshop participants that the continued development and planning of a research program on marine biogeochemical cycles of trace elements and their isotopes should take place under the auspices of SCOR. That recommendation led to this proposal.

Workshop participants further approved by majority vote that the name of the program should be GEOTRACES. The name is not an acronym but, rather, reflects the intent to study the global marine biogeochemical cycles of trace elements and their isotopes.

Program Objectives

The broadly-defined goal of GEOTRACES is to generate a greatly-improved understanding of the marine biogeochemical cycles of selected trace elements as well as of stable and radioactive isotopes. In many cases these species serve as tracers of oceanic processes or they function as essential elements in biological processes. A coupled effort linking field studies, laboratory experiments and modeling to more fully elucidate the processes influencing the transport and cycling as well as biological impact of these tracers is envisioned. That information, in turn, would be exported to, and exploited by, other research programs, such as those mentioned in the next section.

More specific goals of GEOTRACES include the following:

- 1) To determine the global distributions of selected trace elements and their isotopes, and to generate a sufficient understanding of their biogeochemical cycles (sources, sinks, transport, transformations, chemical speciation, biological availability, fates, etc.) to apply that knowledge reliably to interdisciplinary problems.
- 2) To build and maintain a core community of marine scientists who understand the physical and chemical properties of trace elements and their isotopes, as well as their biological impacts, well enough to exploit them reliably in future interdisciplinary studies.

Beneficiaries and Linkages to Other Programs

Successful completion of the GEOTRACES program will lead to the following benefits:

1) An improved understanding of the global biogeochemical cycles of essential micronutrients that are believed to regulate the structure of marine ecosystems and the efficiency of the ocean's biological pump;

2) Improved techniques that use natural radionuclides to evaluate the flux of carbon exported from the surface ocean, as well as the dynamics of sinking particulate carbon and other parameters that influence the ocean carbon cycle;

3) New tracers of ocean circulation that may result from an improved understanding of the processes by which ocean water masses become labeled with distinct isotopic signatures from selected trace elements;

4) The development and calibration of paleoceanographic proxies that are used to assess past changes in ocean circulation, ecosystem structure, biological productivity and carbon fluxes, chemical composition of seawater, continental weathering, and more; and

5) Insights into the transport and fate of contaminants for which natural trace elements and isotopes serve as chemical analogs.

The objectives of the GEOTRACES program, together with the anticipated benefits to be derived by fulfilling those objectives, lead to clear linkages to other oceanographic research programs. A non-exhaustive list includes several IGBP programs (OCEANS, SOLAS, LOICZ), as well as PAGES/IMAGES, CLIVAR, RIDGE and MARGINS. Developing the GEOTRACES program under the auspices of SCOR will facilitate the formation of linkages with these programs, and will further ensure that cross-fertilization between programs will lead to maximum mutual benefit through shared information. Furthermore, developing GEOTRACES under SCOR will facilitate the design and implementation of coordinated research activities in which GEOTRACES investigators collaborate with scientists from other programs in joint research initiatives.

Terms of Reference

The SCOR Working Group will serve as the initial core of a planning group who will lead the design and implementation of the GEOTRACES program. Tasks to be performed by that body include:

1) Organizing national and international planning workshops as well as special sessions at international conferences;

2) Preparing Science and Implementation Plans;

3) Initiating and overseeing efforts for intercalibration of analytical methods, and for the development of standard reference materials;

4) Defining a policy for data management and sample archival; and

5) Forging scientific linkages with other research programs holding overlapping interests to create synergies where possible and avoid duplication of efforts.

Meetings

Planning to date for the GEOTRACES program has successfully exploited major international conferences as venues for planning activities. This started with the Fall 2001 AGU meeting in San Francisco, and continued with a special session held at the EGS-EUG-AGU meeting in Nice, France, immediately before the planning workshop in Toulouse. The next event in this sequence will be a special session at the Goldschmidt Conference, to be held in Kurashiki, Japan, in September, 2003. It is anticipated that special sessions will continue to be held at international conferences, and that these will serve as opportunities to schedule planning meetings of the SCOR Working Group.

National and regional planning workshops are being scheduled as well. The first will take place in London (UK) on 29th and 30th September 2003. A US planning workshop is scheduled for the first half of January, 2004, and an organizational meeting in Germany is planned for mid-summer 2003, although the venue is not yet established for either workshop. Organizing efforts for additional workshops is underway. In many nations, a SCOR affiliation would greatly facilitate the acquisition of local resources to hold these meetings.

Working Group Membership

Planning to date, including the organization of special sessions as well as the workshop in Toulouse, has been managed by the following group of marine scientists:

Robert Anderson – Lamont-Doherty Earth Observatory <boba@ldeo.columbia.edu>

Roger Francois – Woods Hole Oceanographic Institution <rfrancois@whoi.edu>

Martin Frank - ETH Zürich <frank@erdw.ethz.ch>

Gideon Henderson – Oxford University <Gideon.Henderson@earth.ox.ac.uk>

Catherine Jeandel - LEGOS (CNRS/CNES/UPS) <Catherine.Jeandel@cnes.fr>

Mukul Sharma – Dartmouth College <Mukul.Sharma@dartmouth.edu>

It is anticipated that each of these individuals will continue to devote a substantial level of time and effort to planning activities, regardless of their designation as full or associate members of the Working Group.

During the program-building phase of GEOTRACES, an evolving membership is envisioned. Initially, full members will be selected to help build national and regional

GEOTRACES programs. Associate members will bring expertise in particular processes, and will provide linkages to affiliated research programs. As funds become available to support national and regional planning activities, full members will exchange places with associate members as appropriate to make the most effective use of funds available to support travel to planning meetings. This strategy is intended to maximize the effectiveness of the planning group.

Members:

Robert Anderson (US; Chair) – radionuclide tracers; biogenic particle fluxes
Gideon Henderson (UK; co-chair) – tracers of scavenging and ocean circulation
Bill Jenkins (US) – tracers of ocean circulation (CLIVAR link)
Tim Jickells (UK) – atmospheric sources (SOLAS link)
Martin Frank (Switzerland) – ocean circulation; particle fluxes; paleo proxies
Catherine Jeandel (France) – margin exchange; circulation tracers
Anton Eisenhauer (Germany) – isotope tracers; paleo proxies
Toshitaka Gamo (Japan) – trace element biogeochemical cycles
S. Krishnaswami (India) – margin sources; radionuclide tracers
Denis Mackey (Australia) – margin sources; bioactive trace elements

Associate Members

Roger Francois (US) – radionuclide tracers; ocean circulation
Mukul Sharma (US) – cosmogenic isotopes; hydrothermal fluxes
Chris German (UK) – hydrothermal fluxes
Per Andersson (Sweden) – riverine fluxes
Chris Measures (US) – atmospheric fluxes
Reiner Schlitzer (Germany) – inverse modeling

Each of the proposed members and associate members identified above participated in the GEOTRACES planning workshop in Toulouse, at which time the consensus recommendation was to propose that a SCOR working group take the lead on future planning activities. However, because of the short time since returning from the Toulouse workshop (less than 2 weeks at the time of this writing) it has not been possible to contact each of the individuals listed above to ascertain their willingness to serve as a working group member, or associate member. Furthermore, it is anticipated that the list of Associate Members will be expanded. Consequently, there may be changes in the proposed membership before the final proposal is presented to the SCOR Executive Committee.