Geotraces

Trace Elements and Isotopes in our Oceans

by Angie Souren

If you attended the recent Goldschmidt meeting in Japan, you probably noticed special symposium S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II).

GEOSECS II - dubbed that way after the successful Geochemical Ocean Section Studies program of the 1970s - has meanwhile officially been named Geotraces. Recent advances in seagoing technologies and analytical capabilities as well as new insights have created a need for a new coordinated research program. A number of meetings at which scientists from various countries and disciplines exchanged ideas led to a workshop exclusively dedicated to this issue. It took place in Toulouse, France in April of this year and was supported by the NSF's Chemical Oceanography Program, the CNRS, the Observatoire Midi-Pyrenees and the Universite Paul Sabatier. A proposal to form a SCOR working group was submitted two weeks later (http://www.jhu.edu/scor/GEOTRACES.PDF) and when you read this, has been evaluated at the annual SCOR meeting in Moscow (September 16-19). SCOR, by the way, stands for Scientific Committee on Oceanic Research.

Geotraces will take shape as a global study of several ocean sections complemented with regional process studies along those sections. Ultimate goals are to achieve a more complete view of the global biogeochemical cycles of trace elements and isotopes that play a role in the oceans and to build a strong group of marine scientists with a profound understanding of the aspects involved. Geotraces will probably be one of the core projects of the IGBP program IMBER (Integrated Marine Biogeochemistry and Ecosystem Research; see http://www.igbp.kva.se/obe/recentupdates.html). Geotraces will also seek interaction with other ongoing programs, such as MARGINS, RIDGE and SOLAS.

Iron

One of the trace elements Geotraces will be targeting is iron, which has been gaining more and more attention among marine biogeochemists. SCOR working group 109 finalized its activities with the production of the book "The Biogeochemistry of Iron in Seawater" (John Wiley and Sons: New York 2001, IUPAC Series on Analytical and Physical Chemistry of Environmental Systems, Vol. 7). Another outcome of this working group is the drive toward producing a certified standard of ultralow dissolved iron in seawater. After two SCOR-sponsored planning workshops (Amsterdam in November 1998 and San Antonio in February 2000), the first international exercise was started during the IRONAGES-1 cruise in the Eastern Atlantic in October 2000 on-board RV Polarstern, which was funded by the European Union. In the oligotrophic ocean toward the southern section of this cruise, the four parallel shipboard iron analysis teams found subnanomolar dissolved iron in the surface waters (Bowie et al., 2003). This seawater was collected and filtered into a large tank and fixed at ~pH 2 by using ultrapure hydrochloric acid. This sample water was subsequently distributed into several hundred bottles, which were sent out to over 25 laboratories worldwide for analysis. The results were collated by an independent data manager and discussed in a workshop in San Francisco in December 2002, leading to a joint article (Bowie et al., Marine Chemistry, in preparation). Andrew Bowie of the University of Tasmania in Australia, who is currently synthesizing the data, comments: "The results are fascinating. Although progress still needs to be made, this study represents a significant improvement over earlier intercalibration exercises for trace elements where iron was measured. We are now aiming to harmonize sampling and analytical methods used for the routine determination of iron in seawater."

Deployment of Niskin-X samplers specially modified for trace metal clean research onboard R/V Weatherbird II in the North Atlantic. Photograph: Andrew Bowie, University of Tasmania, Antarctic Climate and Ecosystems CRC

The final cruise of the IRONAGES program took place in October of 2002. Hein de Baar of the Royal NIOZ in The Netherlands adds: "We will soon have new standard equipment for sampling iron. We have successfully tested the new system during the October 2002 IRONAGES-3 cruise near Madeira. We now have a special winch, which allows us to implement the new method routinely. We are talking about a 16-mm Kevlar cable, the core of which contains the signal wires for the CTD frame, so with 7 kilometers of wire on it the winch is quite large. We will now need only 4 to 5 hours of sampling in order to complete the 4 to 5 km deep water column, as compared to one day of ship time when using individual Go-Flo bottles. Thus we can now run real sections of a suite of deep stations for trace elements at feasible economics of low overall ship time. This helps us to accomplish substantial savings, as ship time usually is the largest expense of an ocean research project. All this was tested successfully

in the October 2002 cruise. At that time, we still had a prototype ultraclean sampling/CTD frame, but we are now looking into building a superclean titanium frame."

There will be a second iron certification exercise in 2004. "The NSF recently awarded funds for the SAFE (Sampling and Analysis of Fe) project to our colleagues Boyle, Bruland, Coale, Johnson, Measures and Moffett in the U.S." explains Eric Achterberg of the University of Plymouth, another researcher with a strong interest in iron and whose group participated in IRONAGES and the SOIREE project, the first iron enrichment experiment in the Southern Ocean. The core of SAFE will be a cruise on RV Thompson (July 2-20, 2004; Hawaii to Astoria, Oregon), focused primarily on the low-iron region of the North Pacific." This area has been sampled three times (VERTEX and SOLAS programs 1984, 1986 and 2001) with similar results each time." says Eric. "Dissolved iron concentrations in surface waters were 0.05 to 0.1 nM and ~0.8 nM at 1000 m depth." RV Thompson will occupy a station at 30ºN, 140ºW for 10 days to conduct intercomparison measurements (collection, filtration and analysis of iron) among an international group of expert analysts from the U.S., Europe, Japan and other countries. Moreover, a large number of surface and 1000 m depth samples for analysis ashore will be collected as well as a subset for analysis at sea. RV Thompson will also occupy a coastal station with higher iron concentrations for 5 days. In addition, the cruise will contain a series of experiments at both stations to compare dissolved iron measurements by various techniques that are used in the field, such as flow injection-chemiluminescence, flow injection-colorimetry and cathodic stripping voltammetry with various ligands (SA, DHN, TAC). The range of sampling and filtration methods that are in general use to collect uncontaminated samples will be examined. The samples will be filtered through a 0.2 mm cartridge, acidified to ~pH 1.8, and sent out for land-based analyses (including graphite furnace atomic absorption spectroscopy and inductively coupled plasma-mass spectrometry with isotope dilution). A much smaller set of samples will be frozen without acidification for iron speciation measurements.

Deployment of trace metal clean samplers from RRS Discovery. Photograph: Eric Achterberg, University of Plymouth, School of Earth, Ocean and Environmental Sciences.

Deployment of trace metal clean samplers from RRS Discovery.

These are only a few examples of what is happening in marine iron research, but they make abundantly clear that anyone working on the marine biogeochemistry of iron will certainly welcome a new framework like Geotraces. And as iron is only one of those intriguing trace elements and isotopes (TEIs) out there about which we still have many questions, the need for a program like Geotraces is evident.

Angelina Souren
Associate Editor for The Geochemical News
Angie@smarterscience.com

For more information, see:

Andrew R. Bowie, Eric P. Achterberg, St phane Blain, Marie Boye, Peter L. Croot, Hein J.W. de Baar, Patrick Laan, G raldine Sarthou, Paul J. Worsfold (2003). Shipboard analytical intercomparison of dissolved iron in surface waters along a north–south transect of the Atlantic Ocean, Marine Chemistry, in press.

Andrew R. Bowie et al. A community-wide intercalibration exercise for the determination of iron in seawater, Marine Chemistry, in preparation.