US GEOTRACES Guidelines for participating in the Peru-Tahiti section
28 November 2011

PURPOSE

This document was prepared by the US GEOTRACES Scientific Steering Committee (SSC) to serve as a resource for members of the chemical oceanography (marine geochemistry) community when developing research plans for participation in the US GEOTRACES section between Peru and Tahiti, tentatively scheduled for late 2013. These guidelines also offer information that will aid in the preparation of individual research proposals, which should be submitted to the NSF Chemical Oceanography program by the 15 February 2012 deadline. Participation is open to anyone eligible to submit proposals to the US NSF.

RESEARCH THEMES AND OBJECTIVES

A section between Peru and Tahiti was selected by the SSC as a high priority for US GEOTRACES because three distinct situations thought to influence the supply, removal and internal cycling of trace elements and their isotopes can be studied within a single section. These specific conditions include:

1) A large gradient in biological productivity and export production, ranging from the productive eastern boundary current upwelling system off the coast of Peru to very oligotrophic waters near Tahiti;

2) An intense and expanding oxygen minimum zone (oxygen deficient zone); and

3) The hydrothermal plume emanating from the southern East Pacific Rise near 15°S, the largest known such plume in the ocean.

These features offer excellent opportunities to examine the distribution and speciation of trace elements and isotopes their interaction with marine organisms as well as their overall supply, removal and internal cycling. Individual proposals will benefit by demonstrating that the proposed research supports goals related to one or more of these themes. Furthermore, as the goal of the cruise is to integrate research across all three themes, individual proposals will benefit if they are integrative as well.

In addition to these themes, the SSC encourages investigators to submit proposals bringing new ideas to the program, provided that they are justified in terms of objectives that support the mission and goals of GEOTRACES, as defined in the Science Plan.

ADDITIONAL INFORMATION AND RESOURCES

Several documents that can be helpful in planning for the Peru-Tahiti section are available via the internet:

1) The GEOTRACES Science Plan defines the overall mission and goals of the program. The Peru-Tahiti section will support that mission. The document is available at: < http://www.obs-vlfr.fr/GEOTRACES/libraries/documents/Science_plan.pdf>.

2) An international GEOTRACES workshop in 2007 provided a context for research throughout the Pacific Ocean, including the Peru-Tahiti section. The report of this workshop is available at: < http://www.obs-vlfr.fr/GEOTRACES/libraries/documents/Pacific_Report.pdf>.

3) A US GEOTRACES implementation workshop in 2008 refined the scientific goals of the Peru-Tahiti section. The report from that workshop, which served as the basis for

planning the Peru-Tahiti section, is available at:
<http://www.usgeotraces.org/documents/pacificDOC/Pacific_Report_Jun09_000.pdf>

4) A cruise planning workshop for the Peru-Tahiti section was held 12-14 September 2011. Plenary presentations from the workshop are posted at:
<http://www.usgeotraces.org/documents/pacificDOC/WSPac2011/PlenaryOverviewTalks.html>

5) Cruise logistics will be supported via a management proposal, which has already been funded. The Project Description of the proposal is posted at:
<http://www.usgeotraces.org/documents/pacificDOC/ProposalPrep folder/ETSP Management.pdf>

Investigators planning to submit an individual research proposal should pay particular attention to the management proposal, as it provides for the collection of water samples, as well as for hydrography and nutrient measurements. Collection of other types of samples (e.g., aerosols, *in situ* filtration) must be covered by individual proposals, so it is vital that anyone interested in these types of samples coordinate the development and submission of their proposals (see next section).

RESEARCH COORDINATION/LETTERS OF INTENT

Investigators who need water samples for their research should be cognizant of sample size limitations. Following the precedent of the US GEOTRACES Atlantic section, it is anticipated that the following will be collected at each sample depth at each regular full-depth station:

• 22 liters of filtered seawater collected using the trace metal-clean rosette

• One sample of suspended particulate material collected from one 12-liter GO-Flo bottle for trace metal analysis

• 30 liters of water collected using a standard Niskin bottle that will be divided as needed between unfiltered samples and water that is filtered through a 0.45-micron pore diameter Acropak capsule.

Analyses that require a substantial fraction of the available water cannot be accommodated at regular full depth stations. A small number of "super" stations (ca. 6) will provide additional casts to collect water for analyses that require larger volumes. Sample volumes of up to 20-liters are being collected using the standard Niskin rosette at super stations occupied during the Atlantic section. This may serve as the upper limit for water sample sizes during the Pacific section.

Other samples will be available in limited quantity as well. For example, as noted above, a single sample of total suspended matter will be collected at each depth from one GO-Flo bottle on the trace metal clean rosette. It is anticipated that these filters will be used primarily to determine concentrations of particulate trace elements. Proposals that apply non-destructive analytical methods to the filters prior to digestion for trace element analysis are welcome provided that the methods can be demonstrated to avoid contaminating the filters and that the non-destructive analyses are coordinated with the primary trace element measurements.

It is anticipated that larger samples of suspended particulate material will be collected by *in situ* filtration. The collection of particles by *in situ* filtration depends on the submission of an individual proposal to collect these samples that passes review successfully. Investigators planning to submit a proposal for *in situ* filtration should incorporate a plan for sharing aliquots of the filters with other investigators. Other investigators proposing analyses that require material collected by *in situ* filtration are encouraged to coordinate their sampling and sample needs in advance of preparing their proposals. Letters of intent will be solicited and posted (see below) to facilitate coordination of research plans.

A similar situation exists for the collection and analysis of aerosols. The collection of aerosol samples depends on the submission of an individual proposal to collect these samples that passes review successfully. Investigators planning to submit a proposal for collection of aerosol samples should incorporate a plan for sharing aliquots of the filters with other investigators. Other investigators proposing analyses of aerosols are encouraged to coordinate their sampling and sample needs in advance of preparing their proposals. Letters of intent will be solicited and posted (see below) to facilitate coordination of research plans.

Following the precedent of the Atlantic section, proposals may be submitted to collect samples from underway pumping systems as well as from over-the-side pumping systems while on station.

Investigators who are contemplating the submission of a proposal to participate in the Peru-Tahiti section are encouraged to submit a letter of intent to the US GEOTRACES Project Office <geotraces@ldeo.columbia.edu> describing their plans. A one-page document covering items listed below is sufficient. Letters of intent will be posted on the US GEOTRACES web site to facilitate coordination of research activities. Letters are voluntary, but past experience has shown that everyone benefits by sharing information about proposal plans well in advance of the proposal deadline to facilitate collaboration and coordination of logistics.

Topics to cover in a letter of intent include:
1) Research goals and relevance to the overall objectives of the section,
2) Sample requirements,
3) Berth requirements*, and
4) Anticipated collaboration and synergies.

*As was the case in the Atlantic section, it is anticipated that berths will be at a premium during the Peru-Tahiti cruise. Due to the large number of sampling activities during the cruise, each person at sea will be expected to contribute to the collection of samples for a number of groups. If a dedicated berth is required, for example to perform analyses at sea, then this should be noted in the letter of intent and justified in the proposal.

STRAGTEGIES TO REDUCE COSTS

The SSC has the sense that the cumulative awards for the Atlantic were more costly than necessary, partly because of duplication of effort and partly because the inability to coordinate proposals led to more people funded to go to sea than the number of berths available on the ship. The SSC identified the following recommendations to minimize unnecessary costs for the Peru-Tahiti expedition:

1) Proposals that cover multiple parameters are encouraged.

2) Collaborative proposals that cover that cover measurements to be made along the entire section are encouraged. Splitting the cruise track between separate proposals creates a liability that one proposal will be funded and the other declined.

3) Investigators involved in collaborative proposals are urged to eliminate unnecessary redundancies. It will be helpful to identify a lead PI for each collaborative proposal who will make the effort a major part of their research program in 2013 and 2014, thereby taking on most of the responsibilities and associated expenses. Collaborating PIs are encouraged to take a supporting role, thereby keeping their budgets as low as possible.

4) Junior scientists are encouraged to participate either with their own stand-alone proposal or, if they prefer, as part of a collaborative proposal under the mentorship of a more established PI. Again, early submission of letters of intent will help facilitate the latter.

5) It is essential that PIs share sampling responsibilities at sea. This will be dictated in any case by berth limitation. NSF review of proposals will be aided if PIs indicate in their proposals where resources (e.g., sampling equipment, seagoing personnel) will be shared. A sound plan for sharing resources at sea will also be viewed favorably during proposal review.

6) PIs are advised to submit proposals that cover the full cost of their research while also indicating where costs can be cut if other specific proposals are funded that allow resources to be shared.

PRIORITY GUIDELINES

At the request of the NSF Chemical Oceanography program, the SSC has developed a set of priorities, appended to this document, to facilitate the writing and reviewing of individual proposals. Priorities are organized by sampling activity and according to variables to be determined.

See the Appendix for additional information about the priority guidelines.

Appendix - Pacific Parameter Priority

The US GEOTRACES Scientific Steering Committee has developed this description of priorities for the US GEOTRACES section between Peru and Tahiti to provide a framework for proposing research as a contribution to the section. This document is also intended to facilitate review of the proposals by NSF. Parameters (variables) to be studied along the section are divided into three categories: "key", "essential" and "of interest".

Key parameters are designated in Table 2 of the GEOTRACES Science Plan as those that must be measured on every GEOTRACES section. Selection of key parameters was guided by the following considerations: 1) their anticipated contribution to the fulfillment of the GEOTRACES mission and 2) the readiness of the international community of ocean chemists to undertake a global survey of the parameter.

Essential parameters are those considered to be necessary specifically for the Peru-Tahiti section, either to provide an overall oceanographic context for the cruise or to interpret the distribution, supply or removal of other trace elements and isotopes.

Parameters of interest incorporate most parameters, including most trace elements and isotopes. The rationale for designating most parameters in this manner is to allocate as much of the available funding as possible to the most scientifically compelling proposals.

Listed below are the parameters included in each category, with annotations where explanations may be helpful. The "of interest" list is not meant to be exclusive. Compelling proposals on any topic relevant to the marine biogeochemical cycling of trace elements and their isotopes along the Peru-Tahiti section are welcome.

Key Parameters (from Table 2 of the GEOTRACES Science Plan)

Dissolved and particulate trace element concentrations: Fe, Al, Zn, Mn, Cd, Cu

Dissolved stable isotopes: $\delta^{15}N$ of nitrate and $\delta^{13}C$ of dissolved inorganic carbon

Dissolved and particulate radioisotope concentrations: ^{230}Th, ^{231}Pa.

Radiogenic isotope ratios: Dissolved and particulate Nd isotope ratios; Dissolved Pb isotope ratios as well as measurements of dissolved Pb concentrations.

Solid phases: Particles in the water column and aerosols. GEOTRACES considers that particles and aerosols must be collected on each section, but that the specific parameters to be measured in the solid phases may vary from one section to another depending on the scientific questions and processes of interest that are specific to each section.

NOTE:
Other parameters are organized below according to the three topics listed above to help facilitate searches for additional information. This organizational scheme is not meant to prescribe or to proscribe the use of any parameter.

A. Trace metal cycling in the OMZ

Essential Parameters

a) Shipboard Fe & Zn measured (to identify contamination of the clean sampling system and to guide on-site adjustment of the sampling scheme),
b) Fe(II) - (to define the sensitivity of Fe cycling in the OMZ to redox conditions, and to complement studies of other elements for which the redox cycle of Fe may play a role as a source or as a sink),
c) Fe-ligands (to fully characterize Fe speciation and behavior),
d) Co - dissolved and particulate (to characterize its relationship as a limiting micronutrient to offshore gradients in biological productivity),
e) Hg - monomethyl, dimethyl, total, elemental (contaminant of concern related to local fisheries as well as to local mining and smelting),
f) Dissolved and particulate rare earth elements (to interpret Nd isotopes and to constrain supply and removal from margin sediments and from hydrothermal plumes),

Parameters of interest

a) Particulate Fe(II)/Fe(III) fractionation (synchrotron),
b) Dissolved and particulate Fe isotope ratios,
c) Biological availability of Fe, both dissolved and colloidal
d) Shipboard dissolved Mn concentration
e) Acid-leachable particulate Mn concentration
f) Cu-binding ligands
g) Acid-leachable particulate Cu concentration
h) Shipboard dissolved Al concentration
i) Acid-leachable particulate Zn concentration
j) Labile Co concentration
k) Acid-leachable Co
l) Ni: dissolved and particulate concentration (total and acid leachable particulate fraction)
m) Ti: dissolved and particulate concentration (total and acid leachable particulate fraction)
n) Ba: dissolved and particulate concentration (total and acid leachable particulate fraction)
o) I: dissolved, redox speciation
p) Dissolved Cu, Cd, Zn isotopes
q) Zn binding ligands
r) Concentrations of labile Ni and of Ni-binding ligands

s) Ag: dissolved and particulate concentration (total and acid leachable particulate fraction)
t) As: dissolved, speciation
u) Se: dissolved, speciation
v) Mo: particulate Mo concentrations and stable isotope ratios
w) V: dissolved and particulate concentration, speciation of dissolved V
x) Cr: dissolved and particulate concentration, speciation of dissolved Cr

B. Cycling of non-metals in the OMZ

Essential Parameters

a) N_2O concentrations (empirically linked to cycling of Cu and, possibly, other trace metals within the OMZ)
b) Sulfide concentration, ideally at nanomolar detection (as a regulator of metal speciation)
c) Oxygen concentration, ideally at nanomolar detection (in anticipation of very low dissolved oxygen concentrations and as a measure of redox conditions)

Parameters of interest

a) $\delta^{15}N$ of Nitrite,
b) $\delta^{15}N$ of N_2O,
c) N_2/Ar concentration ratio
d) $\delta^{15}N$ of N_2

C. Internal Cycling and removal

Essential Parameters

a) Dissolved and particulate concentrations of ^{234}Th (export fluxes from the surface ocean)
b) Particulate concentrations of POC, opal and $CaCO_3$ determined with samples collected by *in situ* filtration (to infer the influence of particle composition on the sorption and removal of other trace elements and isotopes)
c) Particulate concentrations of lithogenic trace elements with samples collected by *in situ* filtration (to characterize the source of lithogenic phases)
d) Particulate concentrations of authigenic trace elements with samples collected by *in situ* filtration (to characterize the removal of reactive elements)

Parameters of interest

a) Dissolved and particulate concentrations of ^{228}Th,
b) Dissolved and particulate concentrations of ^{210}Pb and ^{210}Po,
c) ^{210}Pb and ^{210}Po in aerosols
d) Anthropogenic radionuclides
e) Isotope ratios of particulate authigenic trace elements

D. Boundary sources

Essential Parameters

a) Dissolved and particulate concentrations of rare earth elements (REE patterns are diagnostic of trace element sources)

Parameters of interest

a) Dissolved and particulate concentrations of ^{232}Th,
b) Concentrations of total and soluble ^{232}Th in aerosols,
c) Concentrations of total and soluble rare earth elements in aerosols,
d) Concentrations of dissolved ^{7}Be
e) Concentrations of ^{7}Be in aerosols
f) Dissolved, particulate and aerosol Sr isotope ratios
g) Hf isotopes

E. Circulation tracers & other parameters

Essential Parameters

a) ^{3}He (tracer of dispersion and dilution of hydrothermal plume)
b) CFC-SF_6 (ventilation ages of OMZ)
c) DIC/ALK (provides a measure of *in situ* pH that is insensitive to changes in T and P)
d) DOC concentration (to constrain processes of trace element removal in hydrothermal plume).

Parameters of interest

a) ^{3}H - ^{3}He,
b) Shipboard ADCP,
c) LADCP
d) ^{14}C of DIC
e) pH
f) Dissolved ^{7}Be

g) Quartet of short-lived radium isotopes
h) Dissolved ^{227}Ac
i) Dissolved Si isotopes
j) Particulate Si isotopes (may be measurable only near the continental margin)
k) $\delta^{18}O$ of H_2O
l) Trace metal distribution within individual cells
m) Remote sensing (wind, color, SST, altimetry)