U.S. GEOTRACES North Atlantic Section

Responsibilities of the Management and Logistics Team

Summary- Funding has been requested within the Management and Logistics Proposal to support a number of project- and cruise-related activities. We summarize these here not only to make it clear what the Management and Logistics Team's responsibilities are, but also so that participants can budget and plan accordingly. Succinctly put, the Team will be responsible for the basic logistics of the cruise, including interaction with UNOLS, ship operators, agents, and State Department clearances. The Team will coordinate a pre-cruise organizational meeting and communicate with cruise participants regarding ship-board requirements and operation. We will provide "water catching" support as outlined in the U.S. Atlantic Section Implementation Plan, including acquisition, quality control and archival of the appropriate operational metadata (navigation, event logs, etc) as well as hydrographic data. Water sampling will be done using both the GEOTRACES trace metal-clean 24 x 12L GO-Flo carousel and Kevlar cable winch developed and used during the GEOTRACES Intercalibration Exercise (see detail discussion below) along with a clean-lab van, and also using a "traditional" 12 x 30L Niskin rosette on the standard hydro winch. The Team will take responsibility for coordination of on-board water sampling activity and to ensure smooth and efficient operation of station-related procedures. They will enforce appropriate GEOTRACES sampling protocols (developed as part of the Intercalibration Program), and those established during the pre-cruise planning meeting (e.g., the correct order of bottle sampling and recording), as well as maintaining the cruise event log.

By hydrographic data we mean CTD and related sensor data (fluorometer, transmissometer, oxygen electrodes), discrete water sample measurements (micromolar inorganic nutrients, dissolved oxygen, salinity), and nanomolar nutrients. The Team, along with ODF technicians, will be responsible for establishing and monitoring GO-Flo and Niskin integrity using the discrete hydrographic measurements. They will also be responsible for quality control and archival of the ship-board measurement data, as well as making it available to on-board participants during and after the cruise.

Cruise participants are required to provide their own suitably cleaned and prepared sample containers for shore-based TEI analysis, and will be responsible for transporting these containers to the ship at its departure port (tentatively Woods Hole). The Team will provide shipping and logistics support for the return of their samples Lisbon, the likely terminus of the cruise, to Norfolk VA. Investigators should budget for shipping their samples from Norfolk to their labs. Furthermore, international shipment of samples requiring special conditions (e.g., refrigeration) will be the responsibility of those participants requiring it. On the ship, we will provide a dispensing system for and coordinate testing of a trace metal clean automated acid dispensing system for sample preservation. The Team will also perform on-board Zn measurements on bottle samples to establish GEOTRACES Go-Flo and carousel sample integrity and will continue to monitor for contamination throughout the cruise (see later section).

Finally, the Team will be responsible for quality control and submission of the ship-board acquired data and metadata to the appropriate GEOTRACES agency (BCO-DMO) and will make the data available to the cruise participants on a web page. The Team will be responsible for creating a final cruise report

based on this data and a preliminary description of the ship-board data and hydrography that may be useful for the interpretation of TEI data obtained from shore-based analysis. The Team will also host a post-cruise "synthesis meeting" to promote collaboration and discussion among the participants.

Trace Element Sampling- Depth profiles for dissolved and suspended particulate TEIs will be obtained using the GEOTRACES carousel sampling system operated by Cutter's group in combination with those from a conventional rosette. The GEOTRACES carousel is a Seabird aluminum frame with polyurethane powder coating that holds twentyfour, 12 L GO-Flo bottles capable of firing up to 3 at once. The bottles are mounted onto pivoting polyethylene blocks with titanium pins to facilitate easy removal. The carousel has a Seabird 9+ CTD with dual temperature and conductivity sensors, SBE 43 oxygen sensor, a Seapoint fluorometer, and a Wet Labs transmissometer; all of the pressure housings and pylon are titanium, eliminating the need for zinc anodes and resulting contamination. The carousel itself is attached to a 14 mm OD, 7800 m long Kevlar conducting cable spooled onto a Dynacon traction winch with slip rings. The bottles are fired (up to 3) on the upcast while moving into clean water at ca. 3 m/min in order to minimize contamination from the frame and sensors. After recovery the bottles are transferred into the HEPA-filtered, positive pressure clean lab van where they are sub-sampled for dissolved and particulate TEIs (the GO-Flos are also stored in the clean van). Specifically, one GO-Flo is pressurized (<8 psi) with filtered, compressed air (can be nitrogen for suboxic or anoxic waters) and the water directly passed through a capsule filter (e.g., 0.45 μm Osmonics) and into sample bottles (low density polyethylene, Teflon, etc depending on the analyte) for contamination-prone elements (e.g., Fe, Zn). In addition, if a TEI cannot be filtered due to contamination (e.g, perhaps Pb isotopes), unfiltered samples can be taken from this GO-Flo. Another GO-Flo is devoted to particulate samples where the entire volume (ca. 11.5 L) is passed directly through a membrane filter (to be determined after Intercalibration Cruise 2, but likely a 0.45 μm polysulfone Supor filter, or 0.45 μm cellulose acetate Millipore membrane) under <8 psi pressure (not vacuum). The filtrate from this membrane filter is then used for TEIs that are not as prone to contamination (e.g., Al, Cu, Mn), and the filter used for total metals determinations via acid digestion and ICP-MS analysis. All water samples from the carousel system are completely processed in the Class 100 clean van, including acidification under a HEPA hood. During the first Intercalibration Cruise (June-July 2008) both ship-board and stored sample analyses showed no contamination for any of the key dissolved or particulate TEIs with this system (Dec. 2008 Intercalibration Workshop). Examining the tentative water budget given in the Implementation Plan, it is possible to cover all of the key TEIs with two GO-Flos (for contamination-prone elements) and water from the conventional CTD/rosette for TEIs not prone to contamination (e.g., Nd and Th isotopes). However, an additional GO-Flo can be fired if the water budget for contamination-prone elements is too large (> 22 L). Finally, to assess the integrity and representativeness of the TEI samples, salinity and nutrient samples, and aliquots for shipboard determinations of dissolved Zn, are taken from each GO-Flo. Comparisons of salinity and nutrients concentrations with those from the conventional rosette (with bottles that are not prone to leaking) allow leaking or misfiring to be easily identified (e.g., Cutter and Measures, 1999). To evaluate potential TEI contamination, shipboard determinations of dissolved Zn are utilized since this metal is amongst the most contamination prone due to galvanization on most of the ship's exposed steel and the use of zinc sacrificial anodes. For underway surface samples, we will use a trace metal-clean "fish" (e.g., De Jong et al., 1998; Vink et al., 2000) that is deployed ca. 8-10 m from the ship's quarter using an Al boom, and to

which is attached Teflon-lined tubing that leads to a deck-mounted Teflon diaphragm pump. This system provides flow rates of up to 5L/min while steaming at 10+ knots and the water is capsule filtered (as above) or taken unfiltered. In addition to rosette sampling while on station, large volume samples in the upper 50 m can be obtained with this pumping system.

Onboard Contamination Monitoring- The Team will be responsible for identifying and hiring a postdoc who will do shipboard Zn analyses to verify that the Go-Flo rosettes are properly working. On the June 2008 GEOTRACES intercalibration cruise, we learned that this Zn screening was extremely important to establishing proper functioning of Go-Flo bottles; bottles that otherwise appeared to be working would show Zn contamination, and Zn was the most sensitive element to problems (i.e., bottles that showed contamination for other elements almost always showed Zn contamination as well). For example, of 48 Go-Flos taken to sea, almost half of them had some problems (including otherwise obvious problems such as leaking but also more subtle ones such as trace metal contamination that could only be detected by chemical analysis). Although many of these particular problems will be fixed by the time of the zonal section cruise, experienced Go-Flo users say that continued vigilance is required as problems can arise mid-cruise. It will be MIT's responsibility to hire a postdoctoral fellow to fill this role. In the first year, this postdoc will be responsible for equipment, reagent, and bottle preparation; in the second year, the cruise and activities associated with it, and in the final year, shorebased analyses of samples to verify the shipboard Zn data and it's relation to other contamination-prone trace elements.

Shipboard "Hydrography"- Good quality hydrographic measurements are necessary not only for bottle quality control (ensuring that the GO-Flo and Niskin bottles are properly sealing and have tripped at the correct depth) but also for interpretation of the origin and character of the water masses being sampled. Bill Jenkins, Ed Boyle and Greg Cutter will be co-chief scientists on the cruise and thus will assume responsibility for ship board operations. The Team will be responsible for obtaining suitable ship time from UNOLS, overall coordination of cruise activities and ship-board operation of the sampling equipment described in this proposal. Specifically they will be responsible for working with the Ocean Data Facility (ODF) to ensure that high quality hydrographic measurements will be made along with operation of the 12 x 30L "standard" rosette, CTD, transmissometer, and LADCP. Shipboard measurements of micromolar inorganic nutrients (nitrate, silicate, and phosphate), salinity and dissolved oxygen will be made on the standard rosette and the trace-metal clean rosette both for identification of water masses and diagnosis of bottle performance issues. Such measurements will be done to WOCE/CLIVAR standards. These results will be integrated with measurements made by Cutter's lab of nutrients (including ammonia and nitrite) down to nanomolar levels in the upper 200m (see below). Along with ODF, the Team will manage on-going QA/QC of data to identify developing problems during the cruise and will also ensure that the appropriate metadata and shipboard hydrodata will be collected and reported in a timely fashion to the appropriate GEOTRACES data repositories (BCO-DMO and CCHDO) and made available to cruise participants both during the cruise and afterward on a suitable web site. In addition, the Team will collaborate with Jim Swift (at SIO) to produce a "hydrographic synthesis", hopefully of publishable quality, describing the basic hydrographic context (water mass structure, major current flows, etc) that will be made available to cruise participants for use in their interpretation of TEI measurements.

Nanomolar Nutrients- Since the GEOTRACES program requires nutrients to be determined at levels comparable to those for the TEIs (i.e., nanomolar) in order to facilitate full biogeochemical integration of the "macro" nutrients (N, P) with those of the micro nutrients (e.g., Fe, Zn), Cutter's lab will make determinations of ammonium, nitrite, nitrate, and phosphate at nanomolar concentrations for all samples in the upper 200 m (i.e., including underway fish samples). For this, the detection limits on our continuous-flow Astoria Pacific Rapid Flow Analyzer are lowered ca. 100 fold using long path length (2.2 m), liquid core waveguide cells as fully described by Zhang (2000) for nitrite and nitrate, Zhang and Chi (2002) for phosphate, and Li et al. (2005) for ammonium. These methods have been evaluated (e.g., intercalibrating MAGIC with waveguide phosphates) as a part of the GEOTRACES Intercalibration Cruises. The nanomolar nutrient data will be fully available to all cruise participants in addition to the conventional nutrient determinations at micromolar levels by the ODF hydrography group.

References

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