Carbonate system data from the US GEOTRACES GP17-ANT cruise in the Amundsen Sea on RVIB Nathaniel B. Palmer (NBP2401) from November 2023 to January 2024

Website: https://www.bco-dmo.org/dataset/1002581
Data Type: Cruise Results
Version: 1
Version Date: 2026-09-16

Project
» US GEOTRACES GP17-OCE and GP17-ANT: Inorganic Carbon Cycling in the South Pacific and Southern Oceans by Direct Measurement (GP17-OCE and GP17-ANT Inorganic Carbon)
» US GEOTRACES GP17 Section: Amundsen Sea Sector of the Antarctic Continental Margin (GP17-ANT) (GP17-ANT)

Program
» U.S. GEOTRACES (U.S. GEOTRACES)

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Abstract
This dataset includes total alkalinity (TA), dissolved inorganic carbon (DIC), and pH on the total scale at 20 degrees Celsius collected on the GEOTRACES GP17-ANT cruise onboard the R/V Nathaniel B. Palmer in the Amundsen Sea between November 29, 2023 and January 28, 2024. All three were collected from the ODF rosette. pH on the total scale was measured at 20 degrees Celsius onboard, while the TA and DIC were collected into borosilicate glass bottles and returned to the laboratory for analysis. These data provide the first high-resolution full water depth column inorganic carbon system measurements of the Amundsen Sea. It provides an understanding of the processes that alter the carbon system as water (specifically circumpolar deep water, CDW) flows through the sea and interacts with sea ice and the ice shelf. Additionally it provides important baseline conditions for the evaluation of future data collected in the sea.

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Coverage

Location: Amundsen Sea
Spatial Extent: **N**:-65.2341 **E**:-78.85842 **S**:-74.38078 **W**:-133.02988
Temporal Extent: 2023-12-05 - 2024-01-13

Methods & Sampling

All samples were collected and analyzed following best practices guidelines (Dickson et al. 2007). Dissolved inorganic carbon (DIC) was collected in 250-milliliter (mL) borosilicate glass reagent bottles and sealed using Apiezon L grease and a rubber band held in place with a plastic hose clamp. The total alkalinity (TA) and pH_T were collected in 150 mL borosilicate glass serum bottles and sealed with a butyl-rubber cap and aluminum seal. All bottles were filled in the same manner. A silicone tube was attached to the Niskin valve. A small amount of water was added to the bottle, and the bottle was swirled to cover all surfaces and dumped out. This rinse was repeated a total of three times. Then the tube was placed near the bottom of the bottle and filled. The tube was tapped against the bottom to dislodge any bubbles, and care was taken to overflow any bubbles. Once full, the water was allowed to overflow for at least half the volume of the bottle (as estimated by time to fill the bottle) and all visible bubbles were gone. Overflow water was used to rinse the caps. With the water still flowing, the tube was gently, but quickly, removed leaving the bottle full to the brim. A pipette was then used to remove a precise amount of water, leaving ~1% headspace once the bottle was capped. After removing the water for headspace, a saturated mercuric chloride solution was added to a total volume of 0.04% of the sample. The DIC was then capped with a glass stopper with Apiezon L grease, twisting the cap to ensure even distribution of grease, creating an airtight seal. A rubber band and hose clamp were then placed on the cap to keep it in place. For TA and pH_T, the rubber stopper was inserted and an aluminum seal was crimped on top. Once sealed, all bottles were gently inverted several times in order to mix the mercuric chloride. The entire collection process was completed as quickly as possible, but with care, to minimize any gas exchange. After collection, DIC/TA bottles were placed in plastic crates with protective foam and stored in a refrigerated shipping van until arrival in port. The samples were shipped back to the laboratory without temperature control and stored in the laboratory at room temperature until analysis. The pH_T samples were immediately placed in a 20-degree Celsius (°C) water bath to equilibrate the temperature before analysis.

The pH_T at 20°C was analyzed within 6 hours of collection. The samples were allowed a minimum of 2 hours for temperature equilibration before analysis was started. The pH_T was then measured spectrophotometrically with purified metacresol purple (mCP) dye (Woosley lab batch 4) obtained from the laboratory of Robert H. Byrne (University of South Florida), using a custom-designed automated system similar to that of Carter et al. (2013). The instrument uses a 10 mL Kloehn syringe pump to draw the sample from the bottle, rinse the flow-through 10-centimeter (cm) quartz micro-volume spectrophotometric cell (Starna, Inc.), add and mix the mCP indicator, and finally rinse the cell after analysis. An Agilent 8454 UV/VIS spectrophotometer was used to take the blank, and full spectra with mCP. The absorbances at 434, 578, 730, and 488 nanometers (nm) were used for calculations. The equations of Liu et al. (2011) were used to calculate pH_T, and the isobestic absorbance at 488 nm was used to determine the indicator perturbation adjustment following the method described in Carter et al. (2013). The dye perturbation slope and intercept were -0.0649 and 0.0781, respectively. Duplicate samples, Certified reference material provided by the laboratory of Andrew G. Dickson (University of California, San Diego), and TRIS buffers prepared according to Paulsen and Dickson (2020) were used to check precision and "accuracy". The mean absolute difference between duplicate samples was 0.0013 ± 0.0008 (N=27). The mean and standard deviation of CRM (Batch 199) were 7.9115 ± 0.0013 (N =15), and for TRIS (Woosley Lab Batch 5) 8.21514 ± 0.0016 (N = 17).

The DIC/TA samples were stored in a refrigerated van on deck after collection, and shipped (without temperature control) to the land-based laboratory at MIT (via USAP in Port Hueneme, California), and then stored at room temperature in a closet until analysis. Analyses were performed between 8 and 20 months after the end of the cruise. All TA samples were analyzed first. Then DIC was analyzed with several analyses of TA being performed immediately afterwards from the DIC bottle as a check on the sample collected for TA.

DIC was analyzed using a custom-designed DIC extractor (DICE) built by NOAA PMEL (Pacific Marine Environmental Laboratory). It is a modern version of the original SOMMA system (Johnson 1992) and follows the methods described in Dickson et al. (2007) in SOP 2. Analysis is performed at 20°C. The instrument uses a calibrated pipette to precisely dispense the volume of sample into a stripper chamber where 8.5% phosphoric acid had been added. The acid converted all the DIC to CO_2 gas. A pure N_2 carrier gas then carried the evolved CO_2 through a condensor to remove water vapor followed by a silica gel (Orbo Tube, Millipore-Sigma, Inc.) to remove any organic acids and finally into the coulometer (UIC, Inc.) for detection. The instrument was calibrated at the start of each coulometer cell (1 per day) with a blank, 2 pure (99.999% CO_2) gas loops, each run at least twice, and certified reference material (CRM) provided by the laboratory of Andrew G. Dickson (University of California, San Diego). Sample values were adjusted to the CRM value for that day using a constant offset from the certified value. Two duplicates per station were analyzed to assess precision. The mean and standard deviation of the absolute difference between duplicates was 1.6 ± 1.1 (N = 29). CRM Batch 216 was used, the overall mean difference from the certified (measured - certified) value was -2.55 ± 1.47 (N = 51).

TA was analyzed using an instrument custom-designed and built by the laboratory of Andrew G. Dickson (UCSD)

and described in Dickson et al. (2003, 2007). Analysis was performed at 20°C. A sample of approximately 100 to 130 grams (g) is weighed and added to a clean, dry water-jacketed beaker with a stir bar, and a cap with an Ecotrode electrode (Metrohm, AG), thermometer, acid line, and air line is placed on top. A computer-controlled dosimat then adds enough acid to reach a pH of ~3.5. The sample is then stirred (450 rpm) and bubbled with lab air for 300 seconds to drive off evolved CO_2. Then 15-20 fine additions of 50 microliters (µL) of acid are added and voltages and temperatures recorded. Once complete, a non-linear least squares fitting method is used to calculate the TA as well as calibrate the E^0 of the electrode. The fitting method is described in Dickson et al. (2003). A CRM was analyzed at the beginning and end of each day. Sample values were NOT adjusted to the certified value. Two duplicates per station were analyzed to assess precision. In addition, several bottles collected for DIC were also analyzed for TA as a check and to provide additional duplicate measurements. These samples were analyzed immediately after analyzing DIC (generally within 15-20 minutes). The acid was ~0.1 N HCl prepared in ~0.6 M NaCl to match the approximate ionic strength of seawater. The exact concentration was calibrated by borax titration following the method of Kolthoff (1926). The mean and standard deviation of the absolute difference between duplicates was 2.43 ± 1.65 (N = 153). The mean and standard deviation of the CRM Batch 216 difference from the certified value (measured - certified) was -0.10 ± 2.09 (N = 116).

Data Processing Description

For pH_T, the raw absorbance values were used to calculate pH_T on the total scale using the absorbance ratio and equations of Liu et al. (2011). The indicator perturbation adjustment was applied following the method of Carter et al. (2013).

For DIC, the raw coulometer counts were converted to DIC following the equations in Dickson et al. (2007), with the blank and gas calibration factor determined for each coulometer cell. Values were corrected to the CRM using a constant offset from the CRM measured on the same cell as the sample.

For TA, the titration data were fit using the non-linear least squares fit method described in Dickson et al. (2003, 2007). No adjustment was made to the CRM.

For all parameters, values were checked for outliers by comparing nearby profiles, comparisons to nutrients, and oxygen, and internal consistency calculations. If a cause for an outlier was found (e.g. analysis issue), the value was flagged as bad; if no clear cause was found, the value was flagged as questionable.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Imported the original file "NBP2401_Carbon Data Submit BCODMO.xlsx" (sheet 1) into the BCO-DMO processing system, treating "-999", "-999.0000", and "-999.0" as missing data values (missing values are empty/blank in the final CSV file).
- Deleted the empty "Column title" column.
- Renamed columns to comply with BCO-DMO parameter naming conventions.
- Deleted empty End_Date_UTC, End_Time_UTC, End_Latitude, End_Longitude columns.
- Combined Start_Date_UTC and Start_Time_UTC (both UTC) into new ISO_DateTime_UTC column formatted as %Y-%m-%dT%H:%MZ.
- Reformatted Start_Date_UTC to date type with output format %Y-%m-%d.
- Reformatted Start_Time_UTC to time type with output format %H:%M.
- Renamed ISO_DateTime_UTC column to Start_ISO_DateTime_UTC.
- Saved the final primary data file as "1002581_v1_gp17-ant_carbonate_system_data.csv".

- Imported the original file "NBP2401_RawAbsorbances_pHt.xlsx" into the BCO-DMO system, treating "-999" as a missing value (missing values are empty/blank in the final CSV file).
- Renamed column "GEOTRACES#" to "GEOTRACES_Sample_Num" and "pH TMP" to "pH_TMP".
- Saved the final supplemental file as "1002581_v1_raw_absorbance_values.csv".

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed. See: https://www.bco-

dmo.org/how-to/standard-curation-edits

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

Problem Description

No significant issues occurred for pH_T or DIC. There was a period when the TA electrodes were sometimes not stable and switching to a new electrode did not always improve the stability. In such cases, no samples were analyzed and the instrument was shut down for the day. Later testing indicated the diaphragm of the electrodes were likely clogged, and the electrodes could be revived using the Metrohm electrode cleaning solution. Analysis was always halted when issues arose (typically at the start of the day before any samples had been run) and is unlikely to have impacted the results. Any samples which may have been impacted are flagged questionable or bad. Since there was enough volume in the DIC bottle to also analyze TA, several bottles collected for DIC were also used analyzed for TA. This was performed after the electrode issue was fully resolved and demonstrated that the problem did not significantly impact the results.

The WOCE quality flag scheme was used:
2 = good
3 = questionable
4 = bad
5 = sample lost
6 = average of two duplicates
9 = not sampled

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Data Files

File	
1002581_v1_gp17-ant_carbonate_system_data.csv	(Comma Separated Values (.csv), 48.75 KB) MD5:71b934a85954138d37a8475317752cfa
Primary data file for dataset ID 1002581, version 1	

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Supplemental Files

File	
1002581_v1_raw_absorbance_values.csv	(Comma Separated Values (.csv), 31.42 KB) MD5:bd8f515a1139e85152228f3fa503adfb

Supplemental file for dataset ID 1002581, version 1. Contains the raw absorbance values of the spectrophotometric pHT measurements. These data can be used to recalculate pHT in the event that an improved calibration is developed.

Column descriptions:
column name,description,units

GEOTRACES#,GEOTRACES sample number,unitless
Station,station number,unitless
Cast,cast number,unitless
Niskin,Niskin bottle number,unitless
A434,Absorbance at 434 nm,Absorbance units (AU)
A578,Absorbance at 578 nm,Absorbance Units (AU)
A730,Absorbance at 730 nm,Absorbance Units (AU)
A488,Absorbance at 488 nm,Absorbance Units (AU)
R,Absorbance Ratio,unitless
pH_TOT,pH on the total scale,unitless
pH TMP,Temperature of pH measurement,Degrees Celsius
Flag,WOCE Quality Flag,unitless

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Related Publications

Carter, B. R., Radich, J. A., Doyle, H. L., & Dickson, A. G. (2013). An automated system for spectrophotometric seawater pH measurements. Limnology and Oceanography: Methods, 11(1), 16–27. doi:10.4319/lom.2013.11.16
Methods

Dickson, A. G., Afghan, J. D., & Anderson, G. C. (2003). Reference materials for oceanic CO2 analysis: a method for the certification of total alkalinity. Marine Chemistry, 80(2), 185–197. https://doi.org/10.1016/S0304-4203(02)00133-0
Methods

Dickson, A.G.; Sabine, C.L. and Christian, J.R. (eds) (2007) Guide to best practices for ocean CO2 measurement. Sidney, British Columbia, North Pacific Marine Science Organization, 191pp. (PICES Special Publication 3; IOCCP Report 8). DOI: https://doi.org/10.25607/OBP-1342
Methods

Johnson, K. M. (1992). Single-operator multiparameter metabolic analyzer (SOMMA) for total carbon dioxide (C{sub T}) with coulometric detection. Operator`s manual. Office of Scientific and Technical Information (OSTI). https://doi.org/10.2172/10194787
Methods

Kolthoff, I. M. (1926). THE STANDARDIZATION OF HYDROCHLORIC ACID WITH POTASSIUM IODATE AS COMPARED WITH BORAX AND SODIUM CARBONATE AS STANDARD SUBSTANCES. Journal of the American Chemical Society, 48(6), 1447–1454. https://doi.org/10.1021/ja01417a001
Methods

Liu, X., Patsavas, M. C., & Byrne, R. H. (2011). Purification and Characterization of meta-Cresol Purple for Spectrophotometric Seawater pH Measurements. Environmental Science & Technology, 45(11), 4862–4868. doi:10.1021/es200665d
Methods

Paulsen, M., & Dickson, A. G. (2020). Preparation of 2-amino-2-hydroxymethyl-1,3-propanediol (TRIS) pHT buffers in synthetic seawater. Limnology and Oceanography: Methods, 18(9), 504–515. Portico. https://doi.org/10.1002/lom3.10383
Methods

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Parameters

Parameter	Description	Units
Station_ID	Station number	unitless
Event_ID	Cruise event number	unitless
Gear_ID	Sampling instrument (ODF rosette bottle ID)	unitless
Start_Date_UTC	Date (UTC) at start of event	unitless
Start_Time_UTC	Time (UTC) at start of event	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) at start of event in ISO 8601 format	unitless

Start_Latitude	Latitude at start of event	decimal degrees
Start_Longitude	Longitude at start of event	decimal degrees
Rosette_Position	Rosette position	unitless
Sample_ID	GEOTRACES sample ID number	unitless
Sample_Depth	Sample depth	meters
PH_TMP_BOTTLE_ivhgkg	Temperature at which pH was determined	degrees Celsius
SD1_PH_TMP_BOTTLE_ivhgkg	standard deviation of PH_TMP_BOTTLE_ivhgkg	degrees Celsius
Flag_PH_TMP_BOTTLE_ivhgkg	Quality Flag for PH_TMP_BOTTLE_ivhgkg	unitless
DIC_D_CONC_BOTTLE_2nk2fs	Concentration of dissolved inorganic carbon	micromoles per kilogram of seawater (umol/kg)
SD1_DIC_D_CONC_BOTTLE_2nk2fs	standard deviation of DIC_D_CONC_BOTTLE_2nk2fs	micromoles per kilogram of seawater (umol/kg)
Flag_DIC_D_CONC_BOTTLE_2nk2fs	Quality Flag for DIC_D_CONC_BOTTLE_2nk2fs	unitless
TALK_D_CONC_BOTTLE_bjyhik	Concentration of total alkalinity	micromoles per kilogram seawater (umol/kg)
SD1_TALK_D_CONC_BOTTLE_bjyhik	standard deviation of TALK_D_CONC_BOTTLE_bjyhik	micromoles per kilogram seawater (umol/kg)
Flag_TALK_D_CONC_BOTTLE_bjyhik	Quality flag for TALK_D_CONC_BOTTLE_bjyhik	unitless
PH_TOT_BOTTLE_5rqziy	pH, referred to total scale	unitless
SD1_PH_TOT_BOTTLE_5rqziy	standard deviation of PH_TOT_BOTTLE_5rqziy	unitless
Flag_PH_TOT_BOTTLE_5rqziy	Quality Flag for PH_TOT_BOTTLE_5rqziy	unitless

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Instruments

Dataset-specific Instrument Name	custom-designed DIC extractor (DICE)
Generic Instrument Name	CO2 Coulometer
Dataset-specific Description	DIC was analyzed using a custom designed DIC extractor (DICE) built by NOAA PMEL (Pacific Marine Environmental Laboratory). It is a modern version of the original SOMMA system (Johnson 1992) and follows the methods described in Dickson et al. (2007)
Generic Instrument Description	A CO2 coulometer semi-automatically controls the sample handling and extraction of CO2 from seawater samples. Samples are acidified and the CO2 gas is bubbled into a titration cell where CO2 is converted to hydroxyethylcarbonic acid which is then automatically titrated with a coulometrically-generated base to a colorimetric endpoint.

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Agilent 8454 UV/VIS spectrophotometer
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	custom-built open-cell potentiometric titrator
Generic Instrument Name	Titrator
Dataset-specific Description	Custom-built open-cell potentiometric titrator (Dickson lab, UCSD) using a Metrohm Ecotrode electrode and automated dosimat for total alkalinity determination via non-linear least squares fitting.
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Deployments

NBP2401

Website	https://www.bco-dmo.org/deployment/969543
Platform	RVIB Nathaniel B. Palmer
Report	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/reports/nathanielbpalmer_nbp2401.pdf
Start Date	2023-11-29
End Date	2024-01-28
Description	See more information at: R2R https://www.rvdata.us/search/cruise/NBP2401 BODC https://www.bodc.ac.uk/resources/inventories/cruise_inventory/report/18091/ US GEOTRACES https://usgeotraces.ldeo.columbia.edu/content/gp17-ant Description: The U.S. GEOTRACES GP17-ANT expedition departed Punta Arenas, Chile on November 29th, 2023 and arrived in Lyttelton, New Zealand on January 28th, 2024. The cruise took place in the Amundsen Sea aboard the R/V Nathaniel B. Palmer with a team of 35 scientists led by Peter Sedwick (Old Dominion University), Phoebe Lam (University of California, Santa Cruz), and Robert Sherrell (Rutgers University). GP17 was planned as a two-leg expedition, with its first leg (GP17-OCE) as a southward extension of the 2018 GP15 Alaska-Tahiti expedition and this second leg (GP17-ANT) into coastal and shelf waters of Antarctica's Amundsen Sea.

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Project Information

US GEOTRACES GP17-OCE and GP17-ANT: Inorganic Carbon Cycling in the South Pacific and Southern Oceans by Direct Measurement (GP17-OCE and GP17-ANT Inorganic Carbon)

Coverage: South Pacific and Amundsen Sea

NSF Award Abstract
The oceans help to slow climate change by absorbing about a quarter of the carbon dioxide (CO2) produced by burning of fossil fuels and other human activities. The Pacific and Southern Oceans are known to take up and store significant amounts of anthropogenic CO2, but many questions regarding the amount, variability, and biogeochemical and ecological impacts remain unanswered. This research will focus on answering some of those questions in two areas of the Pacific by analyzing samples for total CO2, total alkalinity, and pH on two GEOTRACES cruises, GP17-OCE and GP17-ANT. The project will support several undergraduate student researchers and create educational modules on ocean acidification for general public and K-12 students.

On the GP17-OCE expedition in the south Pacific, sub-decadal scale variability in the uptake of CO2 and resulting decrease in pH (termed ocean acidification) will be examined by comparing data collected on this expedition with data from prior occupations of the line in 1991, 2005 and 2014. An extended multilinear regression technique will be used to separate natural variability from human induced changes. The second expedition, GP17-ANT, covers the Amundsen Sea, an area with few prior carbon measurements. This sea is perennially ice-covered with several seasonal polynyas (areas of open water surrounded by sea ice) and exhibits complex water circulation making the contribution to the global carbon cycle uncertain. The data collected from this expedition will examine several hypotheses regarding how carbon is taken up, mixed, and recirculated in the region, how glacial ice melt, sea ice, and biological productivity influence the carbon cycle, and provide baseline measurements against future data to determine changes in the carbon cycle of the region over time. Both expeditions will leverage the myriad of other parameters being measured, particularly trace metals such as iron and zinc, to examine how cycling of carbon and trace metals are interlinked through pH.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

US GEOTRACES GP17 Section: Amundsen Sea Sector of the Antarctic Continental Margin (GP17-ANT) (GP17-ANT)

Website: https://www.geotraces.org/

Coverage: Amundsen Sea Sector of the Antarctic Continental Margin

U.S. GEOTRACES extended its meridional transect, initiated on the 2018 GP15 Alaska-Tahiti expedition, south to the Antarctic ice edge and then east to Chile with GP17-OCE (December 2022 - January 2023). Because of the potentially important trace elements and isotopes (TEIs) inputs and transformations occurring in Antarctic waters and shelves, GP17 also had a second leg, GP17-ANT (November 29, 2023 - January 30, 2024) into coastal and shelf waters of Antarctica's Amundsen Sea. Further information is available on the US GEOTRACES website.

NSF Project Title: Collaborative Research: Management and Implementation of US GEOTRACES GP17 Section: Amundsen Sea Sector of the Antarctic Continental Margin (GP17-ANT)

NSF Award Abstract:
This project will support the management and implementation of a 60-day research cruise to the Amundsen Sea sector of the Antarctic continental margin to collect samples for measurements of a broad suite of trace elements and isotopes ('TEIs'), as part of the U.S. GEOTRACES program. GEOTRACES is a global effort in the field of Chemical Oceanography, the goal of which is to understand the distributions of trace elements and their isotopes in the ocean. Determining the distributions of these elements and isotopes will increase the understanding of processes that shape their distributions and also the processes that depend on these elements. Key TEIs include essential micronutrients such as iron and zinc; 'tracers' such as aluminum, manganese, and isotopes of nitrogen, thorium and neodymium that can be used to investigate modern and ancient ocean processes; and elements such as lead that are indicative of human activities. In the Southern Ocean, the Antarctic continental margins are important as sources of micronutrient trace elements such as iron, which is required to support biological production and carbon export over the Antarctic shelf and in offshore waters of the Antarctic Circumpolar Current. Moreover, these regions are experiencing rapid environmental changes that are expected to impact oceanic circulation and biogeochemical cycles, for which TEIs provide crucial data needed to test and refine numerical models of the Earth system. The Amundsen Sea sector holds particular interest because of the pronounced, decadal-scale increases in the melting rates of glacial ice shelves that border the region, driven by intrusions of warm Circumpolar Deep Water onto the continental shelf. This melting has potentially major impacts on global sea level, on the formation of Antarctic Bottom Water in the Ross Sea, and on the regional ecosystem.

The cruise will comprise essential sampling operations (collection and shipboard processing) and ancillary measurements (hydrography, nutrients, algal pigments) in support of multiple, individual science projects, following the successful model of previous U.S. GEOTRACES cruises in the Atlantic, Pacific and Arctic ocean basins. The cruise will sample the ocean region between 100°W and 135°W, with stations ranging from 67°S in the Antarctic Circumpolar Current southward to the Amundsen Sea continental shelf, including stations adjacent to several rapidly melting ice shelves and in highly-productive shelf polynyas. Water column samples will be collected using conventional and trace-metal clean CTD-rosette systems, in-situ high-volume pumps, and a towed fish sampler or small boat, using established methods. Sampling time will also be provided for collection of sea ice, floating glacial ice, and seafloor sediments. To facilitate coordination with a complementary open-ocean cruise and ensure access to the study region to document the impact of biological processes, the cruise is planned for late austral summer (late January-late March). Beyond the disciplinary contributions, the proposed research will contribute knowledge concerning the cryosphere and its impacts on global sea level and ocean circulation, regional ecosystems and biological processes, ocean-atmosphere interactions, and past and future environmental change. The project will contribute to STEM education and outreach through the participation of an NSF-funded PolarTREC education professional, and a K-12 STEM program for students from underserved and underrepresented schools run by Rutgers University education specialists. To foster public engagement, the investigators will partner with the UCSC Science Communication Program to engage freelance science journalists to profile research in this spectacular and harsh Antarctic environment.

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Program Information

U.S. GEOTRACES (U.S. GEOTRACES)

Website: http://www.geotraces.org/

Coverage: Global

GEOTRACES is a SCOR sponsored program; and funding for program infrastructure development is provided by

the U.S. National Science Foundation.

GEOTRACES gained momentum following a special symposium, S02: Biogeochemical cycling of trace elements and isotopes in the ocean and applications to constrain contemporary marine processes (GEOSECS II), at a 2003 Goldschmidt meeting convened in Japan. The GEOSECS II acronym referred to the Geochemical Ocean Section Studies To determine full water column distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, along a sufficient number of sections in each ocean basin to establish the principal relationships between these distributions and with more traditional hydrographic parameters;

* To evaluate the sources, sinks, and internal cycling of these species and thereby characterize more completely the physical, chemical and biological processes regulating their distributions, and the sensitivity of these processes to global change; and

* To understand the processes that control the concentrations of geochemical species used for proxies of the past environment, both in the water column and in the substrates that reflect the water column.

GEOTRACES will be global in scope, consisting of ocean sections complemented by regional process studies. Sections and process studies will combine fieldwork, laboratory experiments and modelling. Beyond realizing the scientific objectives identified above, a natural outcome of this work will be to build a community of marine scientists who understand the processes regulating trace element cycles sufficiently well to exploit this knowledge reliably in future interdisciplinary studies.

Expand "Projects" below for information about and data resulting from individual US GEOTRACES research projects.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2148468

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