Radiocarbon DelC14 from the 2013 Eastern Pacific Zonal Transect cruise on R/V Thomas G. Thompson (TN303) (US GEOTRACES EPZT project)

Website: https://www.bco-dmo.org/dataset/664845
Data Type: Cruise Results
Version: 15 Nov 2016
Version Date: 2016-11-15

Project
» U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)
» Measurement of Helium Isotopes, Tritium, Noble Gases, and Radiocarbon (EPZT Noble Gases He Tritium)

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

Contributors	Affiliation	Role
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Dataset Description

Radiocarbon DelC14 from GEOTRACES 2013 Eastern Pacific Zonal Transect cruise (TN303).

Methods & Sampling

Radiocarbon measurements were performed on gas splits from gas extracted for d13C measurements by the University of Washington group (headed by Dr. Paul Quay). The measurements were done by AMS by NOSAMS (http://www.whoi.edu/nosams/home).

Radiocarbon Measurement Methodology:
Samples were drawn from 30 liter Niskin bottles to 500 ml gas tight bottles and treated with mercuric chloride. The CO2 was stripped from the water using acidification in high vacuum line, a small split was taken for 13C analysis by another laboratory, and the remainder flame sealed in a glass ampoule.

The gas samples were submitted for analysis to the U.S. National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) Facility in Woods Hole, MA, USA (http:// http://www.whoi.edu/nosams/home). The CO2 was processed by iron-catalyzed hydrogen reduction to filamentous graphite. The graphite was packed into ~1 mg aluminum targets and analyzed by Cs-sputter accelerator mass spectrometry. Either or both of the following AMS systems were used for measurement (it is NOSAMS policy not to divulge which instrument is used for a particular analysis):

(1) A custom-built compact 500 KV National Electrostatics Corporation (NEC), Middleton, WI model 15SDH-1 accelerator with a 134 position NEC MC-SNICS source.
(2) A 2.5 MV US-AMS tandetron accelerator with a modified bouncer-injector and 40 position NEC MC-SNICS source.

In both instances, primary standardization of the AMS was done use NBS oxalic acid (OX-I) and blanks were assessed using IAEA C-1 standard material.

Radiocarbon data calculations are further described on the NOSAMS website: http://www.whoi.edu/nosams/radiocarbon-data-calculations

Data Processing Description

Additional column (pressure) provided in original data is included for reference only. All quality flags follow CCHDO/WOCE conventions.

BCO-DMO Processing Note: modified parameter names to conform with BCO-DMO and GEOTRACES naming conventions.

Additional GEOTRACES Processing:
As was done for the GEOTRACES-NAT data, BCO-DMO added standard US GEOTRACES information, such as the US GEOTRACES event number, to each submitted dataset lacking this information. To accomplish this, BCO-DMO compiled a 'master' dataset composed of the following parameters: cruise_id, EXPOCODE,SECT_ID, STNNBR, CASTNO, GEOTRC_EVENTNO, GEOTRC_SAMPNO, GEOTRC_INSTR, SAMPNO, GF_NO, BTLNBR, BTLNBR_FLAG_W, DATE_START_EVENT, TIME_START_EVENT, ISO_DATETIME_UTC_START_EVENT, EVENT_LAT, EVENT_LON, DEPTH_MIN, DEPTH_MAX, BTL_DATE, BTL_TIME, BTL_ISO_DATETIME_UTC, BTL_LAT, BTL_LON, ODF_CTDPRS, SMDEPTH, FMDEPTH, BTMDEPTH, CTDPRS, CTDDEPTH.

This added information will facilitate subsequent analysis and inter comparison of the datasets.

Bottle parameters in the master file were taken from the GT-C_Bottle and ODF_Bottle datasets. Non-bottle parameters, including those from GeoFish tows, Aerosol sampling, and McLane Pumps, were taken from the TN303 Event Log (version 30 Oct 2014). Where applicable, pump information was taken from the PUMP_Nuts_Sals dataset.

A standardized BCO-DMO method (called "join") was then used to merge the missing parameters to each US GEOTRACES dataset, most often by matching on sample_GEOTRC or on some unique combination of other parameters.

If the master parameters were included in the original data file and the values did not differ from the master file, the original data columns were retained and the names of the parameters were changed from the PI-submitted names to the standardized master names. If there were differences between the PI-supplied parameter values and those in the master file, both columns were retained. If the original data submission included all of the master parameters, no additional columns were added, but parameter names were modified to match the naming conventions of the master file.

See the dataset parameters documentation for a description of which parameters were supplied by the PI and which were added via the join method.

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Data Files

File
delC14_joined.csv (Comma Separated Values (.csv), 46.86 KB) MD5:9427418a8e32f5b65504e58504e41039 Primary data file for dataset ID 664845

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Parameters

Parameter	Description	Units
cruise_id	Cruise identification	unitless
STNNBR	Station number	unitless
CTDPRS	CTD pressure	decibars
CTDDEPTH	CTD bottle firing depth; joined from BCO-DMO GEOTRACES master file	meters
GEOTRC_EVENTNO	GEOTRACES event number; joined from BCO-DMO GEOTRACES master file	unitless
CASTNO	Cast number	unitless
SAMPNO	Sequential sample number within the cast (usually corresponds to bottle number).	unitless
GEOTRC_SAMPNO	Unique GEOTRACES sample number	unitless
C_14_DELTA	Radiocarbon \ Delta^{14}C in per mil. d14C is the per mil deviation of 14C/12C ratio relative to a standard, normalized to a d13C of -25 per mil. For more details on radiocarbon calculation, see: http://www.whoi.edu/nosams/radiocarbon-data-calculations	per mil
C_14_DELTA_ERR	Uncertainty in radiocarbon \ Delta^{14}C in per mil	per mil
C_14_DELTA_FLAG_W	Quality flag for radiocarbon \ Delta^{14}C	unitless
GEOTRC_INSTR	Sampling instrument; joined from BCO-DMO GEOTRACES master file	unitless
BTLNBR	Bottle number; typically 1-24; joined from BCO-DMO GEOTRACES master file	unitless
BTLNBR_FLAG_W	Bottle number quality flag; follows WOCE conventions. 2 = good; 3 = questionable; 4 = bad; 9 = missing data; joined from BCO-DMO GEOTRACES master file	unitless
BTL_ISO_DATETIME_UTC	Date and time, formatted to the ISO 8601 standard, at the time of bottle firing; joined from BCO-DMO GEOTRACES master file	YYYY-MM-DDTHH:MM:SS[.xx]Z
BTL_LAT	Latitude of bottle firing; north is positive; joined from BCO-DMO GEOTRACES master file	decimal degrees
BTL_LON	Lonitude of bottle firing; east is positive; joined from BCO-DMO GEOTRACES master file	decimal degrees
BTMDEPTH	Bottom depth; joined from BCO-DMO GEOTRACES master file	meters

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Instruments

Dataset-specific Instrument Name	Cs-sputter accelerator mass spectrometry
Generic Instrument Name	Accelerator Mass Spectrometer
Dataset-specific Description	The CO2 was processed by iron-catalyzed hydrogen reduction to filamentous graphite. The graphite was packed into ~1 mg aluminum targets and analyzed by Cs-sputter accelerator mass spectrometry. Either or both of the following AMS systems were used for measurement: (1) A custom-built compact 500 KV National Electrostatics Corporation (NEC), Middleton, WI model 15SDH-1 accelerator with a 134 position NEC MC-SNICS source. (2) A 2.5 MV US-AMS tandetron accelerator with a modified bouncer-injector and 40 position NEC MC-SNICS source.
Generic Instrument Description	An AMS measures "long-lived radionuclides that occur naturally in our environment. AMS uses a particle accelerator in conjunction with ion sources, large magnets, and detectors to separate out interferences and count single atoms in the presence of 1x1015 (a thousand million million) stable atoms, measuring the mass-to-charge ratio of the products of sample molecule disassociation, atom ionization and ion acceleration." AMS permits ultra low-level measurement of compound concentrations and isotope ratios that traditional alpha-spectrometry cannot provide. More from Purdue University: http://www.physics.purdue.edu/primelab/introduction/ams.html

Dataset-specific Instrument Name	
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.

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Deployments

TN303

Website	https://www.bco-dmo.org/deployment/499719
Platform	R/V Thomas G. Thompson
Report	http://dmoserv3.whoi.edu/data_docs/GEOTRACES/EPZT/GT13_EPZT_ODFReport_All.pdf
Start Date	2013-10-25
End Date	2013-12-20
Description	A zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition. Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version] Additional cruise information is available from the Rolling Deck to Repository (R2R): http://www.rvdata.us/catalog/TN303

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Project Information

U.S. GEOTRACES East Pacific Zonal Transect (GP16) (U.S. GEOTRACES EPZT)

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

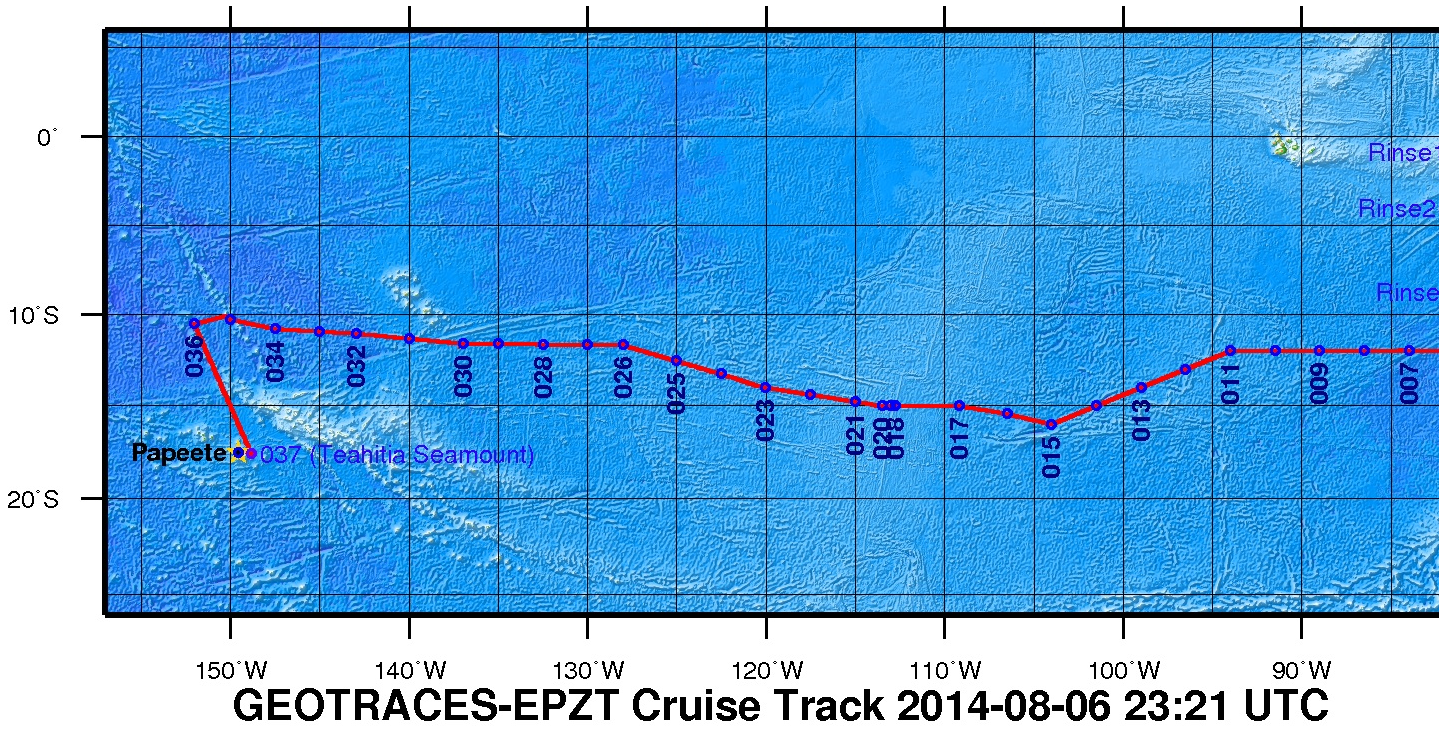
Coverage: Eastern Tropical Pacific - Transect from Peru to Tahiti (GP16)

From the NSF Award Abstract
The mission of the International GEOTRACES Program (https://www.geotraces.org/), of which the U.S. chemical oceanography research community is a founding member, is "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions" (GEOTRACES Science Plan, 2006). In the United States, ocean chemists are currently in the process of organizing a zonal transect in the eastern tropical South Pacific (ETSP) from Peru to Tahiti as the second cruise of the U.S.GEOTRACES Program. This Pacific section includes a large area characterized by high rates of primary production and particle export in the eastern boundary associated with the Peru Upwelling, a large oxygen minimum zone that is a major global sink for fixed nitrogen, and a large hydrothermal plume arising from the East Pacific Rise. This particular section was selected as a result of open planning workshops in 2007 and 2008, with a final recommendation made by the U.S.GEOTRACES Steering Committee in 2009. It is the first part of a two-stage plan that will include a meridional section of the Pacific from Tahiti to Alaska as a subsequent expedition.

This award provides funding for management of the U.S.GEOTRACES Pacific campaign to a team of scientists from the University of Southern California, Old Dominion University, and the Woods Hole Oceanographic Institution. The three co-leaders will provide mission leadership, essential support services, and management structure for acquiring the trace elements and isotopes samples listed as core parameters in the International GEOTRACES Science Plan, plus hydrographic and nutrient data needed by participating investigators. With this support from NSF, the management team will (1) plan and coordinate the 52-day Pacific research cruise described above; (2) obtain representative samples for a wide variety of trace metals of interest using conventional CTD/rosette and GEOTRACES Sampling Systems; (3) acquire conventional JGOFS/WOCE-quality hydrographic data (CTD, transmissometer, fluorometer, oxygen sensor, etc) along with discrete samples for salinity, dissolved oxygen (to 1 uM detection limits), plant pigments, redox tracers such as ammonium and nitrite, and dissolved nutrients at micro- and nanomolar levels; (4) ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES Intercalibration protocols; (5) prepare and deliver all hydrographic-type data to the GEOTRACES Data Center (and US data centers); and (6) coordinate cruise communications between all participating investigators, including preparation of a hydrographic report/publication.

Broader Impacts: The project is part of an international collaborative program that has forged strong partnerships in the intercalibration and implementation phases that are unprecedented in chemical oceanography. The science product of these collective missions will enhance our ability to understand how to interpret the chemical composition of the ocean, and interpret how climate change will affect ocean chemistry. Partnerships include contributions to the infrastructure of developing nations with overlapping interests in the study area, in this case Peru. There is a strong educational component to the program, with many Ph.D. students carrying out thesis research within the program.

Figure 1. The 2013 GEOTRACES EPZT Cruise Track. [click on the image to view a larger version]



Measurement of Helium Isotopes, Tritium, Noble Gases, and Radiocarbon (EPZT Noble Gases He Tritium)

Coverage: Oxygen minium zone; East Pacific Rise

The biogeochemical cycling of trace elements and isotopes (TEIs) in the marine environment is an important research area within the context of global change that motivates the International GEOTRACES program. Some trace elements are known to play potentially important roles as micronutrients in biological cycling, particularly in regard to enzymatic and catalytic processes in the marine environment. Radioisotopes, transient tracers, and noble gases are valuable tracers of these and related processes, and of the ocean?s interaction with the atmosphere and the solid earth, which in turn play a role in shaping many trace element distributions within the ocean.

According to the GEOTRACES Science Plan, the guiding mission of the GEOTRACES program is "to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean". The key observational strategy for GEOTRACES is an internationally-coordinated global-scale ocean survey of key TEIs. The second US GEOTRACES section, set for the Eastern South Pacific in 2013, is aimed at the characterization of key processes in an oxygen minimum zone (OMZ), as well as a major abyssal hydrothermal plume extending westward from the East Pacific Rise.

To help achieve these goals, with support from this grant, a research team at the Woods Hole Oceanographic Institution will collaborate with other GEOTRACES investigators on the Eastern South Pacific expedition to measure a suite of tracers useful for interpreting the rest of the synoptic TEI data. Specifically, the team will make measurements of the noble gases, helium isotopes, tritium, and radiocarbon include in order to: (1) quantify ventilation, circulation, and diapycnal mixing in the OMZ to enable estimation of fluxes and transformation rates of key TEIs; (2) determine upwelling rates in the oxygen minimum zone (OMZ) over a range of timescales to constrain the fluxes of biogeochemically important properties; (3) estimate hydrothermal fluxes of key TEIs using 3He as a flux gauge, and also use 3He as a measure of downstream dilution in the hydrothermal plume; (4) use radiocarbon to estimate abyssal remineralization rates for key TEIs; and (5) probe for evidence of off-axis contribution of hydrothermal processes to TEI distribution. The collective effort will allow marine geochemists to understand mechanistically and quantitatively how a variety of physical, chemical, and biological processes join to determine the distribtuion of TEIs in the ocean.

It has been argued that anthropogenic influence on the global cycles of many elements is emerging as significant. As outlined in the International GEOTRACES Science Plan, the broader impacts of this activity include both an important "baseline snapshot" of the biogeochemical state of the oceanic environment, and a quantitative improvement in the characterization and understanding of important processes in the marine environment. Both of these build a foundation for improved models and quantitative predictions of the oceanic response and role in global change and climate, particularly with anthropogenic forcing. For example, recent evidence of "ocean deoxygenation" has profound implications for marine biologic response. In particular, the evolving state of marine OMZs represents an important biogeochemical "climate canary". A key benefit of diagnosing trace metal dynamics and response to changing redox conditions is the improvement in prognostic capabilities of coupled ocean-atmosphere biogeochemical models for global change.

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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-1232991

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