Total Th data from samples collected on 5 cruises at Station ALOHA off Hawaii and Station M off California from 2019 to 2020

Website: https://www.bco-dmo.org/dataset/923028
Data Type: Cruise Results
Version: 1
Version Date: 2024-03-20

Project
» Collaborative Research: Assessing the relative importance of small vs large particles as sources of nutrition to abyssal communities (Abyssal food web)

Contributors	Affiliation	Role
Drazen, Jeffrey C.	University of Hawaii at Manoa (SOEST)	Principal Investigator
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Abstract
The abyssal plains of the oceans cover roughly half of the earth's surface, host enormous reservoirs of biodiversity and mineral resources, and play important roles in nutrient regeneration and carbon sequestration. The most important process controlling the structure and function of these ecosystems is the quantity and quality of food (mostly sinking organic particles) that reaches the deep-sea floor. The goals of this research were to evaluate the relative importance of small and large particles that sink to the deep-sea using the naturally occurring short-lived radionuclide, 234Th. Particulate and dissolved samples were collected throughout the water column (12-17 depths) during 5 cruises in the productive waters off of California (Station M, May and October 2019) within the nutrient-poor central Pacific, north of Hawaii (Station ALOHA, July 2019 and January and July 2020). Total water column (2 L) and particulate 234Th activities collected using in situ pumps (53 um, 1 um, and 0.3 um) have been measured in all of the samples collected from the 5 cruises: April 2019, July 2019, October 2019, January 2020, and July 2020. This dataset includes the Total Th measurements. Particulate Th is available in a separate, related dataset.

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Coverage

Spatial Extent: **N**:35.14 **E**:-123 **S**:22.65 **W**:-157.9
Temporal Extent: 2019-04 - 2020-08

Methods & Sampling

Total 234-Thorium (Th) sampling and analyses are similar to those described in Buesseler et al. (2020). Briefly, 2 liters (L) of seawater was collected from 5 - 2500 meters (m) depth. Samples were acidified to pH ~1 and a 230Th yield tracer added. After samples were allowed to equilibrate for 6-8 hours, the pH was adjusted to ~8-9, and reagents were added to form a Mn-oxide precipitate that scavenges Th. Samples were allowed to stand for ~8 hours; after which the precipitate was filtered onto a 25-millimeter (mm) quartz microfiber filter (QMA) and dried at 60 degrees Celsius (˚C) before counting on a low level RISO beta counter using a helium/1%butane gas mixture. Samples were recounted after six months to account for any residual background activity stemming from other naturally occurring radionuclides that co-precipitate with the Mn-oxide. 230Th sample recoveries were measured using ICP-MS after acid digestion and spiking with 229Th according to the methods described in Pike et al. (2005) and Umhau et al. (2019) to account for any loss of sample material during processing.

Data Processing Description

All data are decay corrected to the mid-point of sample collection. Calibration was confirmed using deep waters (> 1000 m) with overall efficiencies determined via minimizing the difference between 238U (determined from salinity) and 234Th at depth. U-238 (not reported) was calculated using the equation described in Owens et al. (2011): U-238 (dpm/L) = (Salinity * 0.0786) – 0.315

BCO-DMO Processing Description

- Imported original file "Total Th Data BCO-DMO.csv" into the BCO-DMO system.
- Converted the "Date" column to YYYY-MM format.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved the final file as "923028_v1_total_th.csv"

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Data Files

File	
923028_v1_total_th.csv	(Comma Separated Values (.csv), 5.13 KB) MD5:cbd33e3bf6d05f4f14e2019f267b77f8
Primary data file for dataset ID 923028, version 1	

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Related Publications

Buesseler, K. O., Benitez-Nelson, C. R., Roca-Martí, M., Wyatt, A. M., Resplandy, L., Clevenger, S. J., Drysdale, J. A., Estapa, M. L., Pike, S., & Umhau, B. P. (2020). High-resolution spatial and temporal measurements of particulate organic carbon flux using thorium-234 in the northeast Pacific Ocean during the EXport Processes in the Ocean from RemoTe Sensing field campaign. Elementa: Science of the Anthropocene, 8(1). https://doi.org/10.1525/elementa.2020.030 https://doi.org/10.1525/elementa.030
Methods

Owens, S. A., Buesseler, K. O., & Sims, K. W. W. (2011). Re-evaluating the 238U-salinity relationship in seawater: Implications for the 238U–234Th disequilibrium method. Marine Chemistry, 127(1-4), 31–39. doi:10.1016/j.marchem.2011.07.005
Methods

Pike, S. M., Buesseler, K. O., Andrews, J., & Savoye, N. (2005). Quantification of 234Th recovery in small volume sea water samples by inductively coupled plasma-mass spectrometry. Journal of Radioanalytical and Nuclear Chemistry, 263(2), 355–360. doi:10.1007/s10967-005-0062-9 https://doi.org/10.1007/s10967-005-0594-z
Methods

Umhau, B. P., Benitez-Nelson, C. R., Close, H. G., Hannides, C. C. S., Motta, L., Popp, B. N., ... Drazen, J. C. (2019). Seasonal and spatial changes in carbon and nitrogen fluxes estimated using 234Th:238U disequilibria in the North Pacific tropical and subtropical gyre. Marine Chemistry, 217, 103705. doi:10.1016/j.marchem.2019.103705
Methods

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Related Datasets

IsRelatedTo

Drazen, J. C., Benitez-Nelson, C. R. (2024) **Particulate Th data from samples collected on 5 cruises at Station ALOHA off Hawaii and Station M off California from 2019 to 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-03-20 doi:10.26008/1912/bco-dmo.922922.1 [view at BCO-DMO]

Drazen, J. C., Popp, B. N., Romero, S. (2021) **Amino acid compound specific isotope analyses of abyssal deposit feeders, gut contents, and surrounding surface sediments collected on R/V Atlantis cruise AT42-10 and R/V Western Flyer Pulse 72 in the eastern North Pacific in 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-03-30 doi:10.26008/1912/bco-dmo.840749.1 [view at BCO-DMO]

Drazen, J. C., Popp, B. N., Smith, C. R. (2022) **Bulk isotopic composition (d15N and d13C) of abyssal megafauna and macrofauna from Stations M and Aloha.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-01-12 doi:10.26008/1912/bco-dmo.866774.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Cruise_ID	Station ID number	unitless
Station	Station M or ALOHA	unitless
lat	Station latitude, south is negative	decimal degrees
lon	Station longitude, west is negative	decimal degrees
Date	Year and month	unitless
Depth	Depth in water column	meters (m)
Th234	Total 234Th	disintegrations per minute per liter (dpm/L)
Th234_err	+/- error based on counting statistics and efficiency correction	disintegrations per minute per liter (dpm/L)

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Instruments

Dataset-specific Instrument Name	Standard CTD Rosette
Generic Instrument Name	CTD - profiler
Generic Instrument Description	The Conductivity, Temperature, Depth (CTD) unit is an integrated instrument package designed to measure the conductivity, temperature, and pressure (depth) of the water column. The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real-time via a conducting cable, which is typically connected to a CTD to a deck unit and computer on a ship. The CTD is often configured with additional optional sensors including fluorometers, transmissometers and/or radiometers. It is often combined with a Rosette of water sampling bottles (e.g. Niskin, GO-FLO) for collecting discrete water samples during the cast. This term applies to profiling CTDs. For fixed CTDs, see https://www.bco-dmo.org/instrument/869934.

Dataset-specific Instrument Name	ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	McLane WTS-LV Pump
Generic Instrument Name	McLane Large Volume Pumping System WTS-LV
Dataset-specific Description	McLane WTS-LV Pump fitted with three stage mini-MLVFS filter holders and bubbler to remove air pockets
Generic Instrument Description	The WTS-LV is a Water Transfer System (WTS) Large Volume (LV) pumping instrument designed and manufactured by McLane Research Labs (Falmouth, MA, USA). It is a large-volume, single-event sampler that collects suspended and dissolved particulate samples in situ. Ambient water is drawn through a modular filter holder onto a 142-millimeter (mm) membrane without passing through the pump. The standard two-tier filter holder provides prefiltering and size fractioning. Collection targets include chlorophyll maximum, particulate trace metals, and phytoplankton. It features different flow rates and filter porosity to support a range of specimen collection. Sampling can be programmed to start at a scheduled time or begin with a countdown delay. It also features a dynamic pump speed algorithm that adjusts flow to protect the sample as material accumulates on the filter. Several pump options range from 0.5 to 30 liters per minute, with a max volume of 2,500 to 36,000 liters depending on the pump and battery pack used. The standard model is depth rated to 5,500 meters, with a deeper 7,000-meter option available. The operating temperature is -4 to 35 degrees Celsius. The WTS-LV is available in four different configurations: Standard, Upright, Bore Hole, and Dual Filter Sampler. The high-capacity upright WTS-LV model provides three times the battery life of the standard model. The Bore-Hole WTS-LV is designed to fit through a narrow opening such as a 30-centimeter borehole. The dual filter WTS-LV features two vertical intake 142 mm filter holders to allow simultaneous filtering using two different porosities.

Dataset-specific Instrument Name	low level RISO Beta Counter
Generic Instrument Name	Riso Laboratory Anti-coincidence Beta Counters
Generic Instrument Description	Low-level beta detectors manufactured by Riso (now Nutech) in Denmark. These instruments accept samples that can be mounted on a 25mm filter holder. These detectors have very low backgrounds, 0.17 counts per minute, and can have counting efficiencies as high as 55%.

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Deployments

AT42-10

Website	https://www.bco-dmo.org/deployment/840850
Platform	R/V Atlantis
Start Date	2019-04-28
End Date	2019-05-09
Description	Collaborative Research: Assessing the relative importance of small vs large particles as sources of nutrition to abyssal communities AT42-10; Alvin Dive numbers: D5027-D5030

Pulse 72

Website	https://www.bco-dmo.org/deployment/840845
Platform	R/V Western Flyer
Start Date	2019-10-16
End Date	2019-10-25
Description	Collaborative Research: Assessing the relative importance of small vs large particles as sources of nutrition to abyssal communities Dive numbers: D1196, D1197, D1201

KM1914

Website	https://www.bco-dmo.org/deployment/866828
Platform	R/V Kilo Moana
Start Date	2019-07-18
End Date	2019-07-28
Description	See additional cruise information from Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KM1914

KM2002

Website	https://www.bco-dmo.org/deployment/866784
Platform	R/V Kilo Moana
Start Date	2020-01-17
End Date	2020-01-26
Description	See additional cruise information from Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KM2002

KM2008

Website	https://www.bco-dmo.org/deployment/866879
Platform	R/V Kilo Moana
Start Date	2020-07-24
End Date	2020-08-03
Description	See additional cruise information from Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/KM2008

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Project Information

Collaborative Research: Assessing the relative importance of small vs large particles as sources of nutrition to abyssal communities (Abyssal food web)

Coverage: California current, Station M (34º 50' N, 123º W) and North Pacific Subtropical Gyre, Station Aloha (22º 45' N, 158º W)

NSF Award Abstract:
The abyssal plains of the oceans cover roughly half of the earth's surface, host enormous reservoirs of biodiversity and mineral resources, and play important roles in nutrient recycling and carbon sequestration. The most important process controlling the structure and function of these ecosystems is the quantity and quality of food (mostly sinking organic particles) that reaches the deep-sea floor. However, we do not fully understand the processes provisioning this vast ecosystem. We propose to evaluate the relative importance of small and larger "marine snow" particles that sink to deep-sea benthic communities by using the stable isotope signature of amino acids within various food sources and trace their consumption by fauna on the seafloor. This project compares ecosystems from the productive waters off California with the nutrient poor central Pacific, north of Hawaii. This project provides novel insights into how surface ocean processes are coupled to food-webs at the deep ocean seafloor and how changes in food sources potentially impact deep-sea communities. This project also provides excellent training opportunities for graduate students, a postdoctoral researcher, and undergraduates at UH and USC, particularly underrepresented minorities who pursue majors in the geosciences. The project will sponsor an annual G6-12 teacher workshop to inform Hawaii educators about the deep sea and broadly disseminate knowledge to the community. All results are communicated broadly to inform the public as concerns regarding abyssal ecosystems are rising due to interests in deep-sea mining.

The most important process controlling the structure and function of abyssal ecosystems is the quantity and quality of organic material that ultimately reaches the deep-sea floor. Despite the strong relationship between euphotic zone export flux and benthic ecology, studies of abyssal ecosystems have observed a deficit between food supply and benthic community demand. Additional work is therefore needed, particularly with regards to understanding the sources of nutrition to the deep-sea benthos. Recent evidence suggests that small particles may be significant contributors to carbon export, increasing in relative importance with depth in the mesopelagic and reaching the abyssal seafloor. This project is to evaluate the relative importance of small and larger "marine snow" particles to deep-sea benthic communities using a combination of particle flux measurements and state of the art compound specific stable isotope analysis of amino acids (AA-CSIA) at two

abyssal locations that contrast in overlying productivity, seasonality, and export magnitude. Time series measurements at these locations (Sta. M off California and Sta. Aloha off Hawaii) provide a rich context for the work. In the mesopelagic central North Pacific larger particles (>53 um) can be resolved from microbially reworked, smaller (0.7-53 um) particles using AA-CSIA. This project is characterizing the isotopic compositions of key individual compounds in a continuum of particle sizes (< 1.0 um suspended particles to large sinking particles >53 um) collected using in situ filtration near the seafloor and bottom-moored sediment traps, thereby defining source-specific isotopic signatures that can be traced into benthic fauna and sediments (that are collected by ROVs and epibenthic sleds). This research to understand pelagic-benthic coupling from particles to megafauna using isotopic measurements at the compound-level will yield novel insights into the importance of small microbially reworked particles to deep-sea benthic food webs. This will more precisely couple surface ocean processes to food-webs at the deep ocean seafloor with implications for understanding climate change effects and the efficiency of energy transfer to higher trophic levels. Furthermore, isotopic measurements can also be used to further parameterize ecosystem models by quantifying trophic position across size classes and thus estimate predator-prey mass ratios in relation to variation in body size spectra, functional type, and ultimately to carbon flux and remineralization. Finally, the results will help refine interpretations of deep-sea paleorecords of past nitrogen dynamics by calibrating potential changes in organic matter isotope values between the surface and seafloor archives.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829519

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