Compiled global dataset of PIC/POC and bSi concentrations measured by in situ pumps on multiple research cruises conducted from between 1973 and 2013

Website: https://www.bco-dmo.org/dataset/883965
Data Type: Cruise Results
Version: 1
Version Date: 2022-11-18

Project
» Biogenic Calcium Carbonate Solubilities and Reaction Rates by Lab and Field Saturometry (Calcite Saturometer)

Contributors	Affiliation	Role
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Abstract
This dataset is a compiled global dataset of inorganic and organic carbon and biogenic silica concentrations measured by in situ pumps. We merged the Multiple Unit Large Volume in-situ Filtration System (MULVFS, Bishop et al. 1985) LVP PIC, POC, and bSi dataset published partially in Lam et al. 2011 with new data collected using McLane in-situ pumps equipped with two size-fractionating filters during the GEOTRACES program. The filter sizes generally consist of a 51 micrometer (µm) or 53µm pre-filter that collects large particles, followed by a 0.8µm or 1µm filter that collects smaller particles. We annotate large size fraction particles (>53µm or >51µm) as "LSF", and small size fraction particles (1-53µm or 0.8-51µm) denoted "SSF" (small size fraction).

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Coverage

Spatial Extent: **N**:50 **E**:-9.66 **S**:-66.4 **W**:-172
Temporal Extent: 1973-12 - 2013-12

Methods & Sampling

The data in this compilation come from three existing datasets already on BCO-DMO:
(1) The Compilation of MULVFS size-fractionated POC, PIC, and bSi data (https://www.bco-dmo.org/dataset/884057; DOI: 10.26008/1912/bco-dmo.884057.1),
(2) GEOTRACES GP16 Particle Composition (https://www.bco-dmo.org/dataset/668083; DOI:

10.1575/1912/bco-dmo.668083.1), and
(3) GEOTRACES GA03 Particulate Composition (https://www.bco-dmo.org/dataset/3871; DOI: 10.1575/1912/bco-dmo.3871.5.1).

The collection and measurement methodologies for each of these datasets are described in detail on their respective BCO-DMO dataset landing pages.

For this dataset, we merged the Multiple Unit Large Volume in-situ Filtration System (MULVFS, Bishop et al. 1985) LVP PIC, POC, and bSi dataset published partially in Lam et al. 2011 with new data collected using McLane in-situ pumps equipped with two size-fractionating filters during the GEOTRACES program. The filter sizes generally consist of a 51 micrometer (µm) or 53µm pre-filter that collects large particles, followed by a 0.8µm or 1µm filter that collects smaller particles. We annotate large size fraction particles (>53µm or >51µm) as "LSF", and small size fraction particles (1-53µm or 0.8-51µm) denoted "SSF" (small size fraction).

Data Processing Description

Data quality flags were assigned to values as follows:
0 = good quality - passed lab QC;
1 = unknown quality - oceanographically consistent, but no intercalibration possible;
4 = questionable quality - below detection limit or anomalously high or low;
8 = bad quality - failed lab QC, or known issue with sample.

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Data Files

File	
compiled_pic_poc_bsi.csv	(Comma Separated Values (.csv), 177.31 KB) MD5:1e56c7ff88cf5aaa4bd5ee82506ee57e
Primary data file for dataset ID 883965	

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Related Publications

Bishop, J. K. B., Schupack, D., Sherrell, R. M., & Conte, M. (1985). A Multiple-Unit Large-Volume In Situ Filtration System for Sampling Oceanic Particulate Matter in Mesoscale Environments. In Mapping Strategies in Chemical Oceanography (pp. 155–175). American Chemical Society. https://doi.org/10.1021/ba-1985-0209.ch009
Methods

Lam, P. J., Doney, S. C., & Bishop, J. K. B. (2011). The dynamic ocean biological pump: Insights from a global compilation of particulate organic carbon, CaCO3, and opal concentration profiles from the mesopelagic. Global Biogeochemical Cycles, 25(3), GB3009. doi:10.1029/2010gb003868
Methods

Subhas, A. V., Pavia, F. J., Dong, S., & Lam, P. J. (2023). Global Trends in the Distribution of Biogenic Minerals in the Ocean. Journal of Geophysical Research: Oceans, 128(2). Portico. https://doi.org/10.1029/2022jc019470 https://doi.org/10.1029/2022JC019470
Results

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Related Datasets

IsDerivedFrom

Bishop, J. K., Lam, P. J. (2022) **Compilation of MULVFS size-fractionated POC, PIC, and bSi data from 17 cruises conducted between 1973 and 2005.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-11-21 doi:10.26008/1912/bco-dmo.884057.1 [view at BCO-DMO]
Relationship Description: Dataset 883965, "Compiled Global Dataset of PIC/POC and bSi Concentrations Measured by In Situ Pumps" (contributed by Sijia Dong & Adam Subhas), includes some data from 884057, "Compilation of MULVFS size-fractionated POC, PIC, and bSi data" (contributed by Phoebe Lam).

Lam, P. (2017) **Size-fractionated major and minor particle composition and concentration collected from RV Thompson (TN303) along the US GEOTRACES EPZT transect in the Eastern Tropical Pacific during 2013 (US GEOTRACES EPZT project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2017-01-03 doi:10.1575/1912/bco-dmo.668083.1 [view at BCO-DMO]
Relationship Description: Dataset 883965, "Compiled Global Dataset of PIC/POC and bSi Concentrations Measured by In Situ Pumps" (contributed by Sijia Dong & Adam Subhas), includes some data from 668083, "GP16 Particle Composition" (contributed by Phoebe Lam).

Lam, P. (2018) **Size-fractionated major and minor particle composition and concentration from R/V Knorr KN199-04, KN204-01 in the subtropical North Atlantic Ocean from 2010-2011 (U.S. GEOTRACES NAT project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 5.1) Version Date 2018-08-06 doi:10.1575/1912/bco-dmo.3871.5.1 [view at BCO-DMO]
Relationship Description: Dataset 883965, "Compiled Global Dataset of PIC/POC and bSi Concentrations Measured by In Situ Pumps" (contributed by Sijia Dong & Adam Subhas), includes some data from 3871, "GT10-11 - Particulate composition" (contributed by Phoebe Lam).

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Parameters

Parameter	Description	Units
cruise_id	Cruise ID number if available; if not, a unique numeric cruiseID was created based on year and month of cruise. These correspond to the "cruiseID" column of related dataset 884057.	unitless
station_GEOTRC	GEOTRACES Station Number	unitless
Lon	longitude (negative values = West)	degrees East
Lat	latitude (negative values = South)	degrees North
depth_n	depth	meters
month	month	unitless
year	year	unitless
PICPOC_ssf	particulate inorganic carbon to particulate organic carbon in small size fraction	unitless
PICPOC_lsf	particulate inorganic carbon to particulate organic carbon in large size fraction	unitless
PICPOC_lsf_ssf	particulate inorganic carbon to particulate organic carbon, large size fraction over small size fraction	unitless
POC_ssf	small size particulate organic carbon concentration	micromoles per liter
POC_ssf_flag	small size particulate organic carbon quality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless
POC_lsf	large size particulate organic carbon flux	micromoles per liter

POC_lsf_flag	large size particulate organic carbon quality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless
PIC_ssf	small size particulate inorganic carbon concentration	micromoles per liter
PIC_ssf_flag	small size particulate inorganic carbon quality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless
PIC_lsf	large size particulate inorganic carbon flux	micromoles per liter
PIC_lsf_flag	large size particulate inorganic carbon quality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless
bSi_ssf	small size biogenic silica concentration	micromoles per liter
bSi_ssf_flag	small size biogenic silica fquality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless
bSi_lsf	large size biogenic silica flux	micromoles per liter
bSi_lsf_flag	large size biogenic silica quality control flags, defined as: 0 = good quality - passed lab QC; 1 = unknown quality - oceanographically consistent, but no intercalibration possible; 4 = questionable quality - below detection limit or anomalously high or low; 8 = bad quality - failed lab QC, or known issue with sample.	unitless

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Instruments

Dataset-specific Instrument Name	Multiple Unit Large Volume in-situ Filtration System
Generic Instrument Name	Multiple Unit Large Volume Filtration System
Generic Instrument Description	The Multiple Unit Large Volume Filtration System (MULVFS) was first described in Bishop et al., 1985 (doi: 10.1021/ba-1985-0209.ch009). The MULVFS consists of multiple (commonly 12) specialized particulate matter pumps, mounted in a frame and tethered to the ship by a cable (Bishop et al., 1985; Bishop and Wood, 2008). The MULVFS filters particulates from large volumes of seawater, although the exact protocols followed will vary for each project.

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Project Information

Biogenic Calcium Carbonate Solubilities and Reaction Rates by Lab and Field Saturometry (Calcite Saturometer)

NSF Award Abstract:
The ocean actively exchanges carbon dioxide with the atmosphere and is currently absorbing about a third of the carbon dioxide humans emit through fossil fuel burning. Because carbon dioxide is acidic, ocean pH drops as it takes up carbon dioxide, a process known as "ocean acidification". Ocean acidification negatively affects the health of marine ecosystems by making it harder for organisms to grow their calcium carbonate shells. Yet, the dissolution of these calcium carbonate shells in the deep ocean helps neutralize the carbon dioxide we emit as humans. The extent to which this process takes place is a function of the solubility of marine calcium carbonate. This project will evaluate the temperature and pressure effects on the stability of biologically produced calcium carbonate minerals. The results from this study will allow us to better predict where, how much, and how fast, carbon dioxide will be neutralized and stored in the world's ocean. We will also investigate the ways in which small changes in the chemical composition of calcium carbonate shells - such as the incorporation of magnesium - influence their stability. This project will also conduct micro-computed tomography scans of microorganisms' shells to better visualize them in 3-dimensional detail. We will print these 3-dimensional scans for use as educational tools in the classroom and in the Woods Hole Visitor Center. In addition, professional development workshops for high school teacher on ocean acidification and the importance of marine calcification will be held yearly.

The ocean is the ultimate repository for most of anthropogenic carbon dioxide emissions, which in turn is making ocean chemistry less favorable for biogenic carbonate precipitation through the process of ocean acidification. Ocean acidification decreases seawater pH but dissolution of primarily biogenic carbonate minerals has the capacity to buffer this acidification and over thousands of years push whole-ocean pH and atmospheric carbon dioxide to their preindustrial values. Unfortunately, the relationship between seawater chemistry, carbonate mineral solubility, and the kinetics that govern carbonate dissolution and precipitation are not fully understood. Currently, it is clear that relationships based solely on inorganic calcite are insufficient to describe the cycling of biogenic calcites in the ocean. This project will conduct a systematic determination of the solubilities and reaction kinetics of the three most common biogenic carbonates (coccoliths, foraminifera, and pteropods), both in the laboratory and in the field, using spectrophotometric pH saturometry. The saturometer incubates calcium carbonate with seawater in a closed system. During each run, the change in pH within the saturometer traces the progression of calcium carbonate dissolution/precipitation as the system approaches equilibrium. The saturometer therefore has the potential to link mechanistic interpretations of mineral dissolution/precipitation kinetics to measurements of solubility in a single experiment. The spectrophotometric pH method uses well-calibrated indicator dyes, allows solubility and data to be tied to modern pH calibrations and reference materials, and can be used in the laboratory or deployed on a hydrowire at sea. Field experiments will be conducted at multiple depths, elucidating in-situ controls on solubility and kinetics, as well as the sensitivity of biogenic calcite solubility to temperature and pressure. Experiments will be conducted from both sides of equilibrium, allowing for robust determinations of inorganic and biogenic solubilities.

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-1923998

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