

# Carbonate chemistry and CTD data collected along a North Pacific transect between Hawaii and Alaska on R/V Kilo Moana cruise KM1712 in August 2017

**Website:** <https://www.bco-dmo.org/dataset/836954>

**Data Type:** Cruise Results

**Version:** 2

**Version Date:** 2022-01-31

## Project

» [Collaborative Research: CaCO<sub>3</sub> Dissolution in the North Pacific Ocean: Comparison of Lab and Field Rates with Biogenic and Abiogenic Carbonates](#) (CDISK\_4)

» [Ocean Acidification - Collaborative Research: Measuring the kinetics of CaCO<sub>3</sub> dissolution in seawater using novel isotope labeling, laboratory experiments, and in situ experiments](#) (CaCO<sub>3</sub> dissolution)

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## Abstract

This dataset includes carbonate chemistry and general measurements from CTD casts at 6 stations between Hawaii and Alaska. Data were collected in August 2017 onboard R/V Kilo Moana.

## Table of Contents

- [Coverage](#)
- [Dataset Description](#)
  - [Methods & Sampling](#)
  - [Data Processing Description](#)
- [Data Files](#)
- [Related Publications](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

## Coverage

**Spatial Extent:** N:59.99433 E:-148.2917 S:22.74635 W:-157.97658

**Temporal Extent:** 2017-08 - 2017-08

## Methods & Sampling

Water samples were collected at 24 different depths during each CTD cast. Temperature, salinity, [O<sub>2</sub>], density and fluorescence were measured in situ both downcast and upcast. After CTD recovery, water samples were

collected and DIC, pH, d13C of DIC were measured onboard. Other parameters in the carbonate system were calculated using CO2SYS.

DIC and d13C were measured using a Picarro Cavity Ring-Down Spectroscopy (G2131-i). pH was measured using a Varian Cary 400 spectrophotometer. The CTD included a rosette of 24 10L bottles.

Data columns d13C\_DIC\_PDB\_USC1 and d13C\_DIC\_PDB\_USC2 were measured by the USC and Caltech groups. All other data columns to the right (d13C\_DIC\_PDB\_USF1 and d13C\_DIC\_PDB\_USF2, Alk, DIC, pH, OmegaCa, and OmegaAr) were measured by the USF group.

## Data Processing Description

### BCO-DMO Processing:

Version 1:

- renamed fields;
- converted latitude and longitude to decimal degrees.

Version 2:

- renamed fields;
- converted latitude and longitude to decimal degrees.

### Version History:

Version 1 of this dataset was replaced by version 2 on 2022-01-31. Version 2 contains additional measurements (water column densities, nutrients, and AOU) and has the CTD downcast columns removed. In version 2, only the mean values for duplicate measurements in the carbonate system parameters are reported.

[ [table of contents](#) | [back to top](#) ]

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## Data Files

File
<b>CTD.csv</b> (Comma Separated Values (.csv), 57.25 KB) MD5:0e9b9946e08dc21cdf9d72859cfcbccb Primary data file for dataset ID 836954

[ [table of contents](#) | [back to top](#) ]

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## Related Publications

Dong, S., Berelson, W. M., Rollins, N. E., Subhas, A. V., Naviaux, J. D., Celestian, A. J., Liu, X., Turaga, N., Kemnitz, N. J., Byrne, R. H., & Adkins, J. F. (2019). Aragonite dissolution kinetics and calcite/aragonite ratios in sinking and suspended particles in the North Pacific. *Earth and Planetary Science Letters*, 515, 1–12.

<https://doi.org/10.1016/j.epsl.2019.03.016>

*Methods*

Naviaux, J. D., Subhas, A. V., Dong, S., Rollins, N. E., Liu, X., Byrne, R. H., ... Adkins, J. F. (2019). Calcite dissolution rates in seawater: Lab vs. in-situ measurements and inhibition by organic matter. *Marine Chemistry*, 215, 103684. doi:[10.1016/j.marchem.2019.103684](https://doi.org/10.1016/j.marchem.2019.103684)

*Methods*

[ [table of contents](#) | [back to top](#) ]

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## Parameters

Parameter	Description	Units

Station	station number	unitless
CastNo	cast number	unitless
Latitude	latitude	decimal degrees North
Longitude	longitude	decimal degrees East
Bottle	bottle number	unitless
Depth	ctd depth	meters
Pressure	water pressure at depth	decibars (dbar)
Temp	Water temperature	degrees Celsius
Sal	salinity	psu
O2	oxygen concentration	micromoles per kilogram
Density	seawater density	kilogram per cubic meter
Fluorescence	fluorescence concentration	milligrams per cubic meter
Theta	Potential temperature	degrees Celsius
Density_anomaly	Density anomaly from 1000 kg/m3	kilograms per cubic meter
Sigma0	Sigma-theta referenced to surface pressure	kilograms per cubic meter
Sigma4	Density anomaly referenced to 4 km	kilograms per cubic meter
Phosphate	phosphate concentration	micromoles per kilogram
Nitrate	nitrate concentration	micromoles per kilogram
Silicate	silicate concentration	micromoles per kilogram

AOU	aparent oxygen utilization	micromoles per kilogram
Alk	total alkalinity	micromoles per kilogram
DIC	dissolved inorganic carbon	micromoles per kilogram
d13C_DIC	isotopic cmposition of DIC	per mil (‰)
pHTpTS	pH at in situ temperature and pressure conditions	unitless
pHTp0T25S	pH at 25 °C and surface pressure	unitless
OmegaCa_Alk_DIC_PTS	calcite saturation state	unitless
OmegaCa_Alk_pH_corr_PTS	calcite saturation state	unitless
OmegaCa_pH_corr_DIC_PTS	calcite saturation state	unitless
OmegaAr_Alk_DIC_PTS	aragonite saturation state	unitless
OmegaAr_Alk_pH_incorr_PTS	aragonite saturation state	unitless
OmegaAr_pH_corr_DIC_PTS	aragonite saturation state	unitless

[ [table of contents](#) | [back to top](#) ]

## Instruments

<b>Dataset-specific Instrument Name</b>	Picarro Cavity Ring-Down Spectroscopy (G2131-i)
<b>Generic Instrument Name</b>	Cavity enhanced absorption spectrometers
<b>Generic Instrument Description</b>	Instruments that illuminate a sample inside an optical cavity, typically using laser light, and measure the concentration or amount of a species in gas phase by absorption spectroscopy. Techniques include cavity ring-down spectroscopy (CRDS) and integrated cavity output spectroscopy (ICOS).

<b>Dataset-specific Instrument Name</b>	CTD with 24 bottle rosette
<b>Generic Instrument Name</b>	CTD - profiler
<b>Generic Instrument Description</b>	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 <a href="https://www.bco-dmo.org/instrument/869934">https://www.bco-dmo.org/instrument/869934</a> .

<b>Dataset-specific Instrument Name</b>	Varian Cary 400 spectrophotometer
<b>Generic Instrument Name</b>	Spectrophotometer
<b>Generic Instrument Description</b>	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.

[ [table of contents](#) | [back to top](#) ]

## Deployments

### KM1712

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/837321">https://www.bco-dmo.org/deployment/837321</a>
<b>Platform</b>	R/V Kilo Moana
<b>Start Date</b>	2017-08-01
<b>End Date</b>	2017-09-01
<b>Description</b>	Additional cruise information is available from the Rolling Deck to Repository (R2R): <a href="https://www.rvdata.us/search/cruise/KM1712">https://www.rvdata.us/search/cruise/KM1712</a>

[ [table of contents](#) | [back to top](#) ]

## Project Information

### Collaborative Research: CaCO<sub>3</sub> Dissolution in the North Pacific Ocean: Comparison of Lab and Field Rates with Biogenic and Abiogenic Carbonates (CDISK\_4)

**Coverage:** NE Pacific transect (22.75 N to 60 N, 150-160 W)

#### NSF Award Abstract:

Ocean acidification (OA) is the decrease in seawater pH due to increased oceanic uptake of anthropogenic carbon dioxide (CO<sub>2</sub>) from the atmosphere. The impact of this uptake in the marine environment is lessened

by the dissolution of calcium carbonate ( $\text{CaCO}_3$ ) to calcium and carbonate ions, allowing carbonate ions to bind free hydrogen ions that cause the decrease in pH. Researchers from the University of Southern California and California Institute of Technology have developed a new method for determining carbonate dissolution rates that work in both laboratory and field settings. Preliminary data using this technique has revealed a distinct difference in measured rates between those obtained in the laboratory and those in the field. It is crucial that laboratory and field measurements be standardized to be able to accurately study and compare dissolution rate studies. As such, the researchers will perform extensive fieldwork and laboratory to bridge the gap between these dissolution rate measurements. Results will be widely useful to the ocean chemistry community, especially modelers, wishing to study any aspect of ocean carbonate chemistry, as well as paleoceanographers using carbonate material to study past ocean conditions. Graduate students will be co-mentored by the researchers, and the University of Southern California's (USC) Young Researcher Program will allow the researchers to involve local high school students. USC International Relations students will be involved in the project, not only gaining scientific experience, but also will learn the policy aspect of the science.

Calcium carbonate ( $\text{CaCO}_3$ ) dissolution helps to mitigate the effects of ocean acidification (OA) and is a key factor in the ocean's alkalinity balance. The researchers have recently developed a novel tracer methodology which can monitor carbonate dissolution rates in both the lab and field. This method traces the transfer of  $^{13}\text{C}$  from labeled solids to seawater. Using this method has led to breakthroughs in understanding the controls of  $\text{CaCO}_3$  dissolution kinetics, but it has also revealed that the measurements made in a lab and in the field are not entirely in line. It is crucial to be able to correlate these two measurements to be able to fully study and understand the dynamics of  $\text{CaCO}_3$  dissolution. Therefore, the researchers will extend their previous work to standardize the results of measurements in the lab with those in the ocean. The North Pacific Ocean with a gradient in carbonate saturation states will be used for the field study, and lab-based experiments will allow the researchers to constrain variables such as pressure, the dissolved inorganic carbon/alkalinity ratio, and concentrations of phosphate. This research will further understanding of OA, the mechanisms controlling carbonate dissolution, and how the ocean modulates its alkalinity budget.

### **Ocean Acidification - Collaborative Research: Measuring the kinetics of $\text{CaCO}_3$ dissolution in seawater using novel isotope labeling, laboratory experiments, and in situ experiments ( $\text{CaCO}_3$ dissolution)**

**Coverage:** North Pacific, 150 W, 20 to 60 N, all depths

#### *NSF Award Abstract:*

Ocean acidification by anthropogenic carbon dioxide ( $\text{CO}_2$ ) emissions to the atmosphere will ultimately be balanced by sedimentary carbonate dissolution. The time constant for this reaction, however, is ca. 6,000 years. So, in the coming decades, the ocean's response to  $\text{CO}_2$  uptake will be based on the kinetics of supply and removal, not on the thermodynamics of the system. Unfortunately our understanding of the basic rate law for carbonate dissolution in the ocean is lacking. The order of the rate law is still argued to be anywhere from 1 to 4.5; this range represents a major difference in the sensitivity of the system to small changes in saturation state. The relative importance of aragonite vs. calcite dissolution, the influence of magnesium content in the minerals, and the sign of the role of organic matter are all still unknowns in the modern ocean. Of course, a truly useful rate law would be able to combine the relative importance of all of these factors into a predictive rule for how dissolution will respond to ocean acidification.

In this study, researchers at the California Institute of Technology and the University of Southern California will address this problem with a novel set of laboratory and in situ experiments that use carbon-13 ( $^{13}\text{C}$ ) tracer labeled biogenic carbonates to measure the dissolution rate under a wide range of saturation states. They will assemble a set of rules that will govern carbonate dissolution in sinking particles and in marine sediments. This will require two sub-projects. First, they will culture several different species of biogenic carbonate producers in the lab under the influence of a strong  $^{13}\text{C}$  label. With enrichments of around 30,000‰ in the calcium carbonate ( $\text{CaCO}_3$ ), they will measure the change in dissolved inorganic carbon-13 at several time points over 1-2 weeks in specially built high-pressure reaction chambers. The construction of a prototype chamber is completed and it provides the means, for the first time, to control carbonate saturation state by changing seawater chemistry, pressure, and temperature independently. Experiments with pure  $^{13}\text{C}$  labeled inorganic  $\text{CaCO}_3$  will provide the inorganic reference frame for the biogenic carbonate results. Secondly, to check the lab-based rate data, they will also use labeled biogenic particles in a simple Niskin bottle based reactor that will be deployable on regular hydrowire. The accumulation of  $^{13}\text{C}$  in the Niskin dissolved inorganic carbon over 1-2 days will provide an initial rate that is directly comparable to the more extensive laboratory study on the same

sorts of materials. Using the San Pedro Basin as a test bed for these in situ experiments will sample a range of saturation states in a series of 3-day cruises. This high-sensitivity approach should allow the team to unpack the various components of carbonate dissolution in seawater under rising CO2 concentrations.

Broader Impacts. Producing a better rate law for carbonate dissolution will have broad implications for the fields of marine chemistry, marine biology, paleoceanography, and for potential societal response to ocean acidification. This rate law sits at the heart of the marine carbonate cycle. In addition, this work will benefit at least two graduate students and promote US-Israel collaborations via the inclusion of Jonathan Erez and his students. The specific involvement of underrepresented high school students in scientific/oceanographic research is built into the efforts of this project as well as ongoing efforts by both PIs to communicate their science to a broad array of non-scientific audiences.

[ [table of contents](#) | [back to top](#) ]

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1559004</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1220600</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1220302</a>

[ [table of contents](#) | [back to top](#) ]