

# 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:** 1

**Version Date:** 2021-01-20

## 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.

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## Coverage

**Spatial Extent:** N:59.99433 E:-148.2917 S:22.74635 W:-157.9765833

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

## Acquisition Description

Water samples were collected at 24 different depths during each CTD cast. Temperature, salinity, [O2], 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.

## Processing Description

BCO-DMO Processing:

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

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## Related Publications

Dong, S., Berelson, W. M., Rollins, N. E., Subhas, A. V., Naviaux, J. D., Celestian, A. J., ... 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. doi:[10.1016/j.epsl.2019.03.016](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*

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## Parameters

Parameter	Description	Units
Latitude	latitude	degrees North
Longitude	longitude	degrees East
Bottle	bottle number	unitless
Depth	ctd depth	meters
Pressure	water pressure at depth	decibars (dbar)
Temp_downcast	downcast water temperature	degrees Celsius
Sal_downcast	downcast salinity	psu
O2_downcast	downcast oxygen concentration	micromoles per kilogram (umol/kg)
Density_downcast	downcast seawater density	kilogram per cubic meter (kg/m3)

Fluorescence_downcast	downcast fluorescence concentration	milligram per cubic meter (mg/m <sup>3</sup> )
Temp_upcast	upcast water temperature	degrees Celsius
Sal_upcast	upcast salinity	psu
O2_upcast	upcast oxygen concentration	micromoles per kilogram (umol/kg)
Density_upcast	upcast seawater density	kilogram per cubic meter (kg/m <sup>3</sup> )
Fluorescence_upcast	upcast fluorescence concentration	milligram per cubic meter (mg/m <sup>3</sup> )
d13C_DIC_PDB_USC1	isotopic composition of DIC; measurements made by USC and Caltech groups	per mil
d13C_DIC_PDB_USC2	isotopic composition of DIC; measurements made by USC and Caltech groups	per mil
d13C_DIC_PDB_USF1	isotopic composition of DIC; measurements made by USF group	per mil
d13C_DIC_PDB_USF2	isotopic composition of DIC; measurements made by USF group	per mil
Alk1	total alkalinity	micromoles per kilogram (umol/kg)
Alk2	total alkalinity	micromoles per kilogram (umol/kg)
DIC1	dissolved inorganic carbon	micromoles per kilogram (umol/kg)
DIC2	dissolved inorganic carbon	micromoles per kilogram (umol/kg)
pH1	pH	unitless
pH2	pH	unitless
pH_corr	corrected pH	unitless
pH_in_situ	in situ pH	unitless
OmegaCa_Alk_DIC_P_T_S	calcite omega calculated with Alk-DIC pair	unitless
OmegaCa_Alk_pH_corr_P_T_S	calcite omega calculated with Alk-pH pair	unitless
OmegaCa_pH_corr_DIC_P_T_S	calcite omega calculated with pH-DIC pair	unitless
OmegaAr_Alk_DIC_P_T_S	aragonite omega calculated with Alk-DIC pair	unitless
OmegaAr_Alk_pH_in_corr_P_T_S	aragonite omega calculated with Alk-pH pair	unitless
OmegaAr_pH_corr_DIC_P_T_S	aragonite omega calculated with pH-DIC pair	unitless

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## Instruments

<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 and permits scientists observe the physical properties in real time via a conducting cable connecting the CTD to a deck unit and computer on the 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 instrument designation is used when specific make and model are not known.

<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.

<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).

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## 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>

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## 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 (CaCO<sub>3</sub>) 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 (CaCO<sub>3</sub>) 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 <sup>13</sup>C from labeled solids to seawater. Using this method has led to breakthroughs in understanding the controls of CaCO<sub>3</sub> 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 CaCO<sub>3</sub> 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 CaCO<sub>3</sub> dissolution in**

## **seawater using novel isotope labeling, laboratory experiments, and in situ experiments (CaCO<sub>3</sub> dissolution)**

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

### *NSF Award Abstract:*

Ocean acidification by anthropogenic carbon dioxide (CO<sub>2</sub>) 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 CO<sub>2</sub> 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 (<sup>13</sup>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 <sup>13</sup>C label. With enrichments of around 30,000‰ in the calcium carbonate (CaCO<sub>3</sub>), 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 <sup>13</sup>C labeled inorganic CaCO<sub>3</sub> 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 <sup>13</sup>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 CO<sub>2</sub> 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.

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## **Funding**

<b>Funding Source</b>	<b>Award</b>
<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>

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