

Measured and calculated geochemistry values and uncertainty for water samples taken from the water column of Celestun Lagoon, Yucatan, Mexico in May of 2015

Website: <https://www.bco-dmo.org/dataset/941377>

Data Type: Other Field Results

Version: 1

Version Date: 2024-10-25

Project

» [Calcification in low saturation seawater: What can we learn from organisms in the proximity of low pH; undersaturated submarine springs](#) (CalcificationLowSatSeawater)

Program

» [Science, Engineering and Education for Sustainability NSF-Wide Investment \(SEES\): Ocean Acidification \(formerly CRI-OA\)](#) (SEES-OA)

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Abstract

Measured and calculated geochemistry values and uncertainty for water samples taken from the water column of Celestun Lagoon, Yucatan, Mexico in May of 2015. This dataset was collected in coordination with the following study (See "Related Datasets" section): Isotopes ($\delta^{11}\text{B}$, $87\text{Sr}/86\text{Sr}$, $\delta^{18}\text{O}$, $\delta^{13}\text{C}$), elemental concentrations (B, Mg, Ca), and carbon content were collected from the foraminifera *Ammonia parkinsoniana* and sediments in Celestun Lagoon, Yucatan, Mexico in June 2009 and May 2015. Sediment cores were taken with push corers and piston corers. Sampling sites were distributed unevenly along a transect along the lagoon. These data were collected to investigate the influence of low-pH groundwater-seawater mixing on the boron isotope pH proxy.

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Coverage

Location: Celestún Biosphere Reserve, Yucatan, Mexico. 20.88 N 90.36 E depth 0.5 m.

Spatial Extent: N:20.95318 E:-90.32955 S:20.77012 W:-90.41782

Temporal Extent: 2015-05-25 - 2015-05-26

Methods & Sampling

Location: Celestún Biosphere Reserve, Yucatan, Mexico. 20.88 N 90.36 E depth 0.5 m.

Collection: Data collected from dinghy. No vessel name. June 2009 and May 2015.

Water samples from 2015 were filtered (0.45 μ m) and analyzed for salinity, pH, and elemental concentrations. Analytical methods involved MC-ICPMS for boron and strontium isotopes, with careful sample preparation, including microsublimation for $\delta^{11}\text{B}$, Sr-spec resin for $^{87}\text{Sr}/^{86}\text{Sr}$, and isotope ratio mass spectrometry for $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$. Elemental concentrations (B, Mg, Ca) were analyzed using ICPMS. Reproducibility was verified using established standards.

Additional methods citations:

Boron isotope method: Wang et al. (2020).

Strontium isotope method: Liu et al. (2012).

pH and borate equations: Foster et al. (2016).

Related dataset descriptions (See section "Related Datasets" for data citations):

The water sample data in this dataset were collected concurrently with the May 2015 sampling event in BCO-DMO dataset <https://www.bco-dmo.org/dataset/941327> which contains isotope data, elemental concentrations, and carbon content collected from the foraminifera *Ammonia parkinsoniana* and sediments in Celestun Lagoon, Yucatan, Mexico in June 2009 and May 2015.

This study and Paytan (2021, BCO-DMO dataset <https://www.bco-dmo.org/dataset/564766>) both derive groundwater from the same regional aquifer in Yucatan, Mexico, and both studies review the effects of low-pH springs on saturation and calcification of organisms. They are different sample material.

The sediment cores and assemblages in Hardage et al. (2021, doi:10.25921/qkc1-yw35) at NOAA provide the sample material for the geochemistry reported in this study (foraminifera, bulk sediment, physical observations). The Hardage et al. (2021) dataset also contains additional lithology and geochemistry that can be paired with these new data for interested parties.

Instrument and equipment list:

LDPE bottles: water samples were collected in acid-washed LDPE bottles for trace metals.

rubber septum glass vials: water samples were collected in ashed glass bottles for nutrients.

0.5 mL micro-centrifuge tubes: used to store crushed foraminifera for cleaning.

Yellow Springs Instrument Model 63 handheld sonde and pH probe.

Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICPMS).

Lachat QuikChem 8000.

UIC Carbon Coulometer Analyzer (CM150).

Orion 950 Titrator.

Thermo Scientific Element XR ICPMS.

ThermoFinnigan Delta Plus XP isotope ratio mass spectrometer.

Data Processing Description

Element data were corrected for blank, drift, mass bias, and calcium matrix effects.

Boron isotopes were corrected using the standard-sample-standard bracket technique to correct drift and bias across each individual sample.

pKB* and $\delta^{11}\text{B}$ borate were calculated using Branson (2024) CBSYST with implementation of Hain et al. (2015) speciation of Ca and Mg.

The MarChemSpec (Clegg & Turner, 2023) model uses measured inputs of salinity, temperature, DIC, TA, [B], [Mg], [Ca], $[\text{NO}_3^-]$, $[\text{PO}_4^-]$, and $[\text{SiO}_4^{4-}]$. Other major ion concentrations were estimated by applying LOESS smoothing regression (R Software version 4.3.1) to salinity versus $[\text{Cl}^-]$, $[\text{SO}_4^{2-}]$, and $[\text{Sr}^{2+}]$ data from a lagoon transect in Young et al., (2008) to account for minor non-linear variations at lower salinity. [Na] and [K] concentrations were estimated from the LOESS-derived $[\text{Cl}^-]$ using $[X] = [\text{Cl}]_{\text{estimated}}/[\text{Cl}]_{\text{Millero}} * [X]_{\text{Millero}}$, where $[\text{Cl}]_{\text{Millero}} = 536$ mM and X is typical seawater [Na] = 456 mM or [K] = 10.2 mM (Millero et al., 2008). These estimates apply for mixed lagoon waters only. For endmember waters (well water, seawater, large spring), values from were taken directly from Young et al. (2008) and assumed to reflect expected concentrations in the identical sampling locations in this study. Charge imbalances from MarChemSpec calculations were corrected by adjusting [Na], chosen because it was not measured and because its seawater concentration dominates charge balance adjustments relative to [K]. [Na] absolute adjustment ranged from about -22 to +19 mM (< 10 % of [Na]). MarChemSpec calculated pH on the total scale using Pitzer constants.

Software:

MarChemSpec software (<https://marchemspec.org/wp/software/>) has been archived at Zenodo (Clegg & Turner, 2023, doi: 10.5281/ZENODO.8373046).

CBSYST software (<https://github.com/oscarbranson/cbsyst>) Version 0.4.9 has been archived at Zenodo (Branson et al., 2024, doi: 10.5281/ZENODO.14185784).

See the "Parameters" section for more details applicable to each data column in this dataset including how MarChemSpec and CBSYST software was used.

Note about aggregated data (means, standard deviations):

The averages are from the instruments themselves, not from true replicates. They typically take 4 to 10 readings and average the result, depending on the instrument. Since these are mass spectrometers counting individual ions, this averaging is necessary to reduce noise. For parameters calculated using CBSYST, mean and standard deviation are derived from 10,000 Monte Carlo realizations.

BCO-DMO Processing Description

* Data table from submitted file "Hardage_boron_water_parameter_values.csv" (file supplied by email on 2024-12-06) was imported into the BCO-DMO data system for this dataset. Values "-999" imported as missing data values.

** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Datetime with timezone (UTC) added as column from local dates and times provided in GMT-6 (Central Standard Time in Yucatan, Mexico).

* Table row order sorted by DateTime.

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Data Files

File**941377_v1_water-samples.csv**(Comma Separated Values (.csv), 6.71 KB)

MD5:c35891b6af6afdb0bbaf4aa0754a91bb

Primary data file for dataset ID 941377, version 1

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Related Publications

Branson, O., Whiteford, R., Fernandes, F., Coenen, D. & Gaskell, D. (2024). oscarbranson/cbsyst: 0.4.9 - Kgen update to 0.3.0 (Version 0.4.9) [Computer software]. Zenodo. <https://doi.org/10.5281/ZENODO.14185784>

<https://doi.org/10.5281/zenodo.14185784>

Software

Clegg, S. L., & Turner, D. R. (2023). MarChemSpec (Marine Chemical Speciation Model) (Version 1.01)

[Computer software]. Zenodo. <https://doi.org/10.5281/ZENODO.8373046>

<https://doi.org/10.5281/zenodo.8373046>

Software

Foster, G. L., & Rae, J. W. B. (2016). Reconstructing Ocean pH with Boron Isotopes in Foraminifera. Annual Review of Earth and Planetary Sciences, 44(1), 207–237. <https://doi.org/10.1146/annurev-earth-060115-012226>

[012226](https://doi.org/10.1146/annurev-earth-060115-012226)

Methods

Hain, M. P., Sigman, D. M., Higgins, J. A., & Haug, G. H. (2015). The effects of secular calcium and magnesium concentration changes on the thermodynamics of seawater acid/base chemistry: Implications for Eocene and Cretaceous ocean carbon chemistry and buffering. Global Biogeochemical Cycles, 29(5), 517–533. Portico. <https://doi.org/10.1002/2014gb004986> <https://doi.org/10.1002/2014GB004986>

<https://doi.org/10.1002/2014gb004986> <https://doi.org/10.1002/2014GB004986>

Methods

Hardage, K. H., Wang, T.-H., Liu, H.-C., You, C.-F., Herrera-Silveira, J. A., Steet, J. H., and Paytan, A. (in review). $\delta^{11}\text{B}$ variability in *Ammonia parkinsoniana* and implications for paleo-pH in coastal margins. Paleoceanography and Paleoclimatology.

Results

Liu, H.-C., You, C.-F., Huang, K.-F., & Chung, C.-H. (2012). Precise determination of triple Sr isotopes (^{87}Sr and ^{88}Sr) using MC-ICP-MS. Talanta, 88, 338–344. <https://doi.org/10.1016/j.talanta.2011.10.050>

<https://doi.org/10.1016/j.talanta.2011.10.050>

Methods

Millero, F. J., Feistel, R., Wright, D. G., & McDougall, T. J. (2008). The composition of Standard Seawater and the definition of the Reference-Composition Salinity Scale. Deep Sea Research Part I: Oceanographic Research Papers, 55(1), 50–72. <https://doi.org/10.1016/j.dsr.2007.10.001>

<https://doi.org/10.1016/j.dsr.2007.10.001>

Methods

RCore Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria (<http://www.R-project.org/>)

Software

Wang, B.-S., You, C.-F., Huang, K.-F., Wu, S.-F., Aggarwal, S. K., Chung, C.-H., & Lin, P.-Y. (2010). Direct separation of boron from Na- and Ca-rich matrices by sublimation for stable isotope measurement by MC-ICP-MS. Talanta, 82(4), 1378–1384. doi:[10.1016/j.talanta.2010.07.010](https://doi.org/10.1016/j.talanta.2010.07.010)

[10.1016/j.talanta.2010.07.010](https://doi.org/10.1016/j.talanta.2010.07.010)

Methods

Young, M. B., Gonnee, M. E., Fong, D. A., Moore, W. S., Herrera-Silveira, J., & Paytan, A. (2008). Characterizing sources of groundwater to a tropical coastal lagoon in a karstic area using radium isotopes and water chemistry. Marine Chemistry, 109(3-4), 377–394. doi:[10.1016/j.marchem.2007.07.010](https://doi.org/10.1016/j.marchem.2007.07.010)

[10.1016/j.marchem.2007.07.010](https://doi.org/10.1016/j.marchem.2007.07.010)

Methods

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Related Datasets

IsRelatedTo

Hardage, K. H., Wang, T. D., Liu, H. A., You, C., Herrera-Silveira, J. A., Paytan, A. (2024) **Isotopes (d11B, 87Sr/86Sr, d18O, d13C), elemental concentrations (B, Mg, Ca), and carbon content collected from the foraminifera Ammonia parkinsoniana and sediments in Celestun Lagoon, Yucatan, Mexico in June 2009 and May 2015**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-10-25 doi:10.26008/1912/bco-dmo.941327.1 [[view at BCO-DMO](#)] *Relationship Description: Datasets collected as part of the same study. Both contain data from samples collected from Celestun Lagoon, Yucatan, Mexico in May of 2015.*

Hardage, K., Street, J., Herrera-Silveira, J. A., Oberle, F. K. J., & Paytan, A. (2021). *NOAA/WDS Paleoclimatology - Celestun Lagoon, Yucatan 5300 Year Foraminifera Census and Geochemistry* [Data set]. NOAA National Centers for Environmental Information. <https://doi.org/10.25921/QKC1-YW35> <https://doi.org/10.25921/qkc1-yw35>

Paytan, A. (2021) **Results of an experiment on recruitment and succession on a tropical benthic reef community in response to in-situ ocean acidification in Puerto Morelos, Quintana Roo, Mexico from 2010-2011 (CalcificationLowSatSeawater project)**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2015-09-09 doi:10.26008/1912/bco-dmo.564766.1 [[view at BCO-DMO](#)] *Relationship Description: Low-pH spring studies on the eastern coast of the Yucatan Peninsula. Both derive groundwater from the same regional aquifer in Yucatan, Mexico, and both studies review the effects of low-pH springs on saturation and calcification of organisms. They used different sample material.*

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Parameters

Parameter	Description	Units
site	Site code for water sample.	unitless
lat	Site latitude in WGS84; north is positive.	decimal degrees
long	Site longitude in WGS84; east is negative.	decimal degrees
distance	Distance along the central lagoon axis from the northern fringe mangrove to the southern lagoon opening to the ocean.	kilometers (km)
region	Biogeographic region of the lagoon identified by Hardage et al. (2022). J. Paleolim. 10.8 km is the dividing point.	unitless
date	Date of sample collection in ISO 8601 yyyy-mm-dd format. Time Zone GMT-6 (Central Standard Time in Yucatan, Mexico)	unitless
time	Time of sample collection in ISO 8601 format HH:MM.	unitless
ISO_DateTime_UTC	DateTime with time zone of sample collection in ISO 8601 format (UTC).	unitless
tide	Tide position based on the nearest tide gauge in Progreso, Yucatan, Mexico.	unitless

sample	Water sample type. Valid values are Lagoon Water, Seawater, Spring Water, Well Water.	unitless
temperature	Water column temperature measured in situ.	degrees Celsius
salinity	Water column salinity measured with a salinometer against KCl.	practical salinity units (PSU)
pH	Water column pH, measured in situ using standards on the National Bureau of Standards scale and converted to total scale using $\text{pH} = \text{value} - 0.14$.	total scale
DIC	Water column dissolved inorganic carbon.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
DIC_2sd	Water column dissolved inorganic carbon 2 standard deviations of replicate measurements.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
TA	Water column total alkalinity. Uncertainty determined as 45 based on the Dickson Standard Batch 121.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
NO3	Water column dissolved nitrate as N.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
NO3_2sd	Water column dissolved nitrate as N 2 standard deviations of replicate measurements.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
PO4	Water column dissolved phosphate. Uncertainty determined as ± 0.02 based on lab standards.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
SiO4	Water column dissolved silica.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
SiO4_2sd	Water column dissolved silica 2 standard deviations of replicate measurements.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
Ca_conc	Water column dissolved calcium concentration. Uncertainty determined as ± 0.2 from 2SD of lab standard gravimetric solutions.	millimolar (mM)
Mg_conc	Water column dissolved magnesium concentration. Uncertainty determined as ± 0.12 from 2SD of lab standard gravimetric solutions.	millimolar (mM)
B_conc	Water column dissolved boron concentration. Uncertainty determined as ± 31.6 from 2SD of lab standard gravimetric solutions.	micromolar (μM)

Sr8786	Water column radiogenic strontium ratio $87\text{Sr}/86\text{Sr}$.	unitless
Sr8786_2sd	Water column radiogenic strontium ratio $87\text{Sr}/86\text{Sr}$ 2 standard deviations of replicate measurements.	unitless
d18O	Water column oxygen-18.	per mil (0/00)
d18O_2sd	Water column oxygen-18, 2 standard deviations based on replicate standards.	per mil (0/00)
d11B	Water column bulk boron-11.	per mil (0/00)
d11B_2sd	Water column bulk boron-11 2 standard deviations of replicate standards.	per mil (0/00)
pCO2_mean	Water column partial pressure of carbon dioxide calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	microatmospheres (uatm)
pCO2_2sd	Water column partial pressure of carbon dioxide uncertainty, calculated as $2 * \text{standard deviation}$ of 10,000 Monte Carlo simulations of CBSYST Version 0.4.9 (Branson et al., 2024).	microatmospheres (uatm)
CO2_mean	Water column dissolved carbon dioxide concentration calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
CO2_sd	Water column dissolved carbon dioxide concentration uncertainty, calculated as $2 * \text{standard deviation}$ of 10,000 Monte Carlo simulations of CBSYST Version 0.4.9 (Branson et al., 2024).	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
CO3_mean	Water column dissolved carbonate ion concentration calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
CO3_2sd	Water column dissolved carbonate ion concentration uncertainty, calculated as $2 * \text{standard deviation}$ of 10,000 Monte Carlo simulations of CBSYST.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)
HCO3_mean	Water column dissolved bicarbonate ion concentration calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	micromoles per kilogram ($\mu\text{mol}/\text{kg}$)

HCO3_2sd	Water column dissolved bicarbonate ion concentration uncertainty, calculated as 2 * standard deviation of 10,000 Monte Carlo simulations of CBSYST.	micromoles per kilogram (umol/kg)
omegaC_mean	Water column calcite saturation state, calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 monte carlo simulations.	unitless
omegaC_2sd	Water column calcite saturation state uncertainty, calculated as 2 * standard deviation of 10,000 Monte Carlo simulations of CBSYST.	unitless
delta_carb	Water column degree of calcite saturation, calculated from CO3_mean - (CO3_mean / omegaC_mean).	micromoles per kilogram (umol/kg)
delta_carb_err	Water column delta_carb propagated error calculated as $\text{delta_carb_err} = \sqrt{\text{CO3_sd}^2 + (\text{CO3_mean}/\text{omegaC_mean} * \text{omegaC_sd})^2}$	micromoles per kilogram (umol/kg)
pKB_mean	Stoichiometric dissociation (equilibrium) constant for the borate-boric acid system. Calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	unitless
pKB_2sd	Stoichiometric dissociation (equilibrium) constant uncertainty for the borate-boric acid system, calculated as 2 * standard deviation of 10,000 Monte Carlo simulations of CBSYST Version 0.4.9 (Branson et al., 2024).	unitless
BOH4_mean	Water column dissolved borate, calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	micromoles per kilogram (umol/kg)
BOH4_2sd	Water column dissolved borate uncertainty, calculated as 2 * standard deviation of 10,000 Monte Carlo simulations of CBSYST Version 0.4.9 (Branson et al., 2024).	micromoles per kilogram (umol/kg)
d11B_BOH4_mean	Water column boron-11 ratio of borate ion, calculated using CBSYST Version 0.4.9 (Branson et al., 2024). Mean of 10,000 Monte Carlo simulations.	per mil (0/00)
d11B_BOH4_2sd	Water column boron-11 ratio of borate ion uncertainty, calculated as 2 * standard deviation of 10,000 Monte Carlo simulations of CBSYST Version 0.4.9 (Branson et al., 2024).	per mil (0/00)
Cl_est	Water column dissolved chloride. Estimated from LOESS smoothing of Cl transect data in Tables 1 and 4 of Young et al. (2008). Marine Chemistry. https://doi.org/10.1016/j.marchem.2007.07.010	millimolar (mM)

SO4_est	Water column dissolved sulfate. Estimated from LOESS smoothing of SO4 transect data in Tables 1 and 4 of Young et al. (2008). Marine Chemistry. https://doi.org/10.1016/j.marchem.2007.07.010	millimolar (mM)
Sr_est	Water column dissolved strontium. Estimated from LOESS smoothing of Sr data in Tables 1 and 4 of Young et al. (2008). Marine Chemistry. https://doi.org/10.1016/j.marchem.2007.07.010	micromolar (uM)
K_est	Water column dissolved potassium. Estimated from Na/Cl ratio of seawater using Cl data herein and seawater [K] from Millero et al. (2008). Deep Sea Research Part 1. https://doi.org/10.1016/j.dsr.2007.10.001	millimolar (mM)
Na_est	Water column dissolved sodium. Estimated from Na/Cl ratio of seawater using Cl data herein and seawater [Na] from Millero et al. (2008). Deep Sea Research Part 1. https://doi.org/10.1016/j.dsr.2007.10.001	millimolar (mM)
adjusted_Na	Water column dissolved sodium, determined by adjusting column (Na) to reduce column (charge_imbalance) value within MarChemSpec (Clegg & Turner, 2023).	millimolar (mM)
charge_imbalance	Solution charge imbalance resulting from MarChemSpec (Clegg & Turner, 2023) calculation of pH using parameters in this file.	moles
pH_MarChemSpec	Water column pH calculated from MarChemSpec (Clegg & Turner, 2023) using Pitzer constants.	total scale

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Bottle
Dataset-specific Description	LDPE bottles: water samples were collected in acid-washed LDPE bottles for trace metals. Rubber septum glass vials: water samples were collected in ashed glass bottles for nutrients.
Generic Instrument Description	A container, typically made of glass or plastic and with a narrow neck, used for storing drinks or other liquids.

Dataset-specific Instrument Name	UIC Carbon Coulometer Analyzer (CM150, UIC, Inc.)
Generic Instrument Name	CM150 Total Carbon Analyzer
Dataset-specific Description	Instrument housed at UCSC Marine Analytical Lab. CM150 (UIC, Inc.) Carbon Analysis (TC/TIC/TOC) By Combustion, Acidification And Coulometric Detection.
Generic Instrument Description	The CM150 Total Carbon Analyzer, made by UIC, Inc., is a complete analytical system capable of measuring total carbon, total organic carbon and total inorganic carbon in solid and/or liquid samples. (From https://www.uicinc.com/cm150-carbon-analysis/).

Dataset-specific Instrument Name	Carlo Erba elemental analyzer IRMS
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Thermo Scientific Element XR ICPMS
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	ThermoFinnigan Delta Plus XP isotope ratio mass spectrometer.
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	ThermoScientific MAT-253 dual-inlet isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Lachat QuikChem 8000
Generic Instrument Name	Lachat QuikChem 8000 flow injection analyzer and Ion Chromatography (IC) system
Generic Instrument Description	The Lachat QuikChem 8000 can operate flow injection analysis and ion chromatography simultaneously and independently on the same instrument platform. Instrument includes sampler, dilutor, sampling pump, electronics unit, and data station. Analysis takes 20-60 seconds, with a sample throughput of 60-120 samples per hour. Measurements are in the range of parts per trillion to parts per hundred.

Dataset-specific Instrument Name	
Generic Instrument Name	Multi Collector Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICPMS).
Generic Instrument Description	A Multi Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS) is a type of mass spectrometry where the sample is ionized in a plasma (a partially ionized gas, such as Argon, containing free electrons) that has been generated by electromagnetic induction. A series of collectors is used to detect several ion beams simultaneously. A MC-ICPMS is a hybrid mass spectrometer that combines the advantages of an inductively coupled plasma source and the precise measurements of a magnetic sector multicollector mass spectrometer. The primary advantage of the MC-ICPMS is its ability to analyze a broader range of elements, including those with high ionization potential that are difficult to analyze by Thermal Ionization Mass Spectrometry (TIMS). The ICP source also allows flexibility in how samples are introduced to the mass spectrometer and allows the analysis of samples introduced either as an aspirated solution or as an aerosol produced by laser ablation.

Dataset-specific Instrument Name	Yellow Springs Instrument Model 63 handheld sonde and pH probe
Generic Instrument Name	Multi Parameter Portable Meter
Dataset-specific Description	YSI Model 63 Handheld pH, Conductivity, Salinity and Temperature System.
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	
Generic Instrument Name	Piston Corer
Dataset-specific Description	Piston, Bolivia, Livingstone corers: coring devices used to collect sediments.
Generic Instrument Description	The piston corer is a type of bottom sediment sampling device. A long, heavy tube is plunged into the seafloor to extract samples of mud sediment. A piston corer uses a "free fall" of the coring rig to achieve a greater initial force on impact than gravity coring. A sliding piston inside the core barrel reduces inside wall friction with the sediment and helps to evacuate displaced water from the top of the corer. A piston corer is capable of extracting core samples up to 90 feet in length.

Dataset-specific Instrument Name	Orion 950 Titrator
Generic Instrument Name	Titrator
Generic Instrument Description	Titrators are instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

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Project Information

Calcification in low saturation seawater: What can we learn from organisms in the proximity of low pH; undersaturated submarine springs (CalcificationLowSatSeawater)

Coverage: Puerto Morelos, Quintana Roo, Mexico

NSF Abstract:

To date scientists have primarily used short-term single species experiments to study responses of organisms to increased pCO₂. While these experiments are important, they represent an artificial situation, being isolated from many of the biological interactions. Moreover, these experiments do not truly reflect the effects on organisms over longer timescales in actual field situations.

In this study, researchers at the University of California at Santa Cruz will assess the utility of low pH submarine springs as field study sites for investigating calcification at low aragonite saturation. It has been reported that many reef-building corals cease calcification at saturation as high as 2.0; around these springs calcifying corals inhabit waters well below this value. Work will take place at a series of springs in Mexico where

discharging water pH ranges from 8.07 to 7.25 and saturation from less than 0.5 to 5. While these springs are by no means analogs for future ocean calcification they can still provide a natural laboratory to study controls on coral calcification. Field observations are usually confounded by the presence of many potentially important variables in addition to saturation. Moreover, it is not trivial to quantify the natural spatial and temporal variability of the parameters of interest. Thus it is not clear how useful this setting might be for conducting extensive field based calcification research (high risk). Accordingly, the research team will conduct field surveys to map the chemical and physical characteristics of the water around the springs (and corals) and describe population and community patterns along the saturation gradient. They will install probes to capture the temporal and spatial variability. These observations should allow assessment of the site's utility for researching processes that sustain calcification at low saturation and for future manipulative experiments.

Background publications:

Crook ED, Potts D, Rebolledo-Vieyra M, Hernandez L, Paytan A. 2011. Calcifying coral abundance near low pH springs: implications for future ocean acidification. *Coral Reefs*, 31(1): 239-245.

Paytan A, Crook ED, Cohen AL, Martz T, Takeshita Y et al. 2014. Reply to Iglesias-Prieto et al.: Combined field and laboratory approaches for the study of coral calcification. *Proc Natl Acad Sci USA*, 111 (3): E302-E303.

Crook ED, Cohen AL, Rebolledo-Vieyra M, Hernandez L, Paytan A. 2013. Reduced calcification and lack of acclimatization by coral colonies growing in areas of persistent natural acidification. *Proc Natl Acad Sci USA*, 110 (27): 1044-1049.

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Program Information

Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES): Ocean Acidification (formerly CRI-OA) (SEES-OA)

Website: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503477

Coverage: global

NSF Climate Research Investment (CRI) activities that were initiated in 2010 are now included under Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES). SEES is a portfolio of activities that highlights NSF's unique role in helping society address the challenge(s) of achieving sustainability. Detailed information about the SEES program is available from NSF (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504707).

In recognition of the need for basic research concerning the nature, extent and impact of ocean acidification on oceanic environments in the past, present and future, the goal of the SEES: OA program is to understand (a) the chemistry and physical chemistry of ocean acidification; (b) how ocean acidification interacts with processes at the organismal level; and (c) how the earth system history informs our understanding of the effects of ocean acidification on the present day and future ocean.

Solicitations issued under this program:

[NSF 10-530](#), FY 2010-FY2011

[NSF 12-500](#), FY 2012

[NSF 12-600](#), FY 2013

[NSF 13-586](#), FY 2014

NSF 13-586 was the final solicitation that will be released for this program.

PI Meetings:

[1st U.S. Ocean Acidification PI Meeting](#) (March 22-24, 2011, Woods Hole, MA)

[2nd U.S. Ocean Acidification PI Meeting](#) (Sept. 18-20, 2013, Washington, DC)

3rd U.S. Ocean Acidification PI Meeting (June 9-11, 2015, Woods Hole, MA - Tentative)

NSF media releases for the Ocean Acidification Program:

[Press Release 10-186 NSF Awards Grants to Study Effects of Ocean Acidification](#)

[Discovery Blue Mussels "Hang On" Along Rocky Shores: For How Long?](#)

[Discovery nsf.gov - National Science Foundation \(NSF\) Discoveries - Trouble in Paradise: Ocean Acidification This Way Comes - US National Science Foundation \(NSF\)](#)

[Press Release 12-179 nsf.gov - National Science Foundation \(NSF\) News - Ocean Acidification: Finding New Answers Through National Science Foundation Research Grants - US National Science Foundation \(NSF\)](#)

[Press Release 13-102 World Oceans Month Brings Mixed News for Oysters](#)

[Press Release 13-108 nsf.gov - National Science Foundation \(NSF\) News - Natural Underwater Springs Show How Coral Reefs Respond to Ocean Acidification - US National Science Foundation \(NSF\)](#)

[Press Release 13-148 Ocean acidification: Making new discoveries through National Science Foundation research grants](#)

[Press Release 13-148 - Video nsf.gov - News - Video - NSF Ocean Sciences Division Director David Conover answers questions about ocean acidification. - US National Science Foundation \(NSF\)](#)

[Press Release 14-010 nsf.gov - National Science Foundation \(NSF\) News - Palau's coral reefs surprisingly resistant to ocean acidification - US National Science Foundation \(NSF\)](#)

[Press Release 14-116 nsf.gov - National Science Foundation \(NSF\) News - Ocean Acidification: NSF awards \\$11.4 million in new grants to study effects on marine ecosystems - US National Science Foundation \(NSF\)](#)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1040952

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