Trace metal ratios from four coral skeletons from three coral species (Diploria labyrinthiformis, Pseudodiploria strigosa, Orbicella franksi) extracted from Hog Reef in Bermuda, collected in August of 2016.

Website: https://www.bco-dmo.org/dataset/963175
Data Type: Other Field Results
Version: 1
Version Date: 2025-05-30

Project
» Drivers of coral and reef-scale calcification in the North Atlantic (Coral Calc)

Contributors	Affiliation	Role
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Abstract
These data include trace metal ratios from four coral skeletons from three coral species (Diploria labyrinthiformis, Pseudodiploria strigosa, Orbicella franksi) extracted from Hog Reef in Bermuda. The cores were collected in August of 2016 using small boats from the Bermuda Institute of Ocean Sciences (BIOS). Trace metal ratios were measured at intervals of 200 micrometer in each coral core ranging from the top to a core depth of 36305 to 79625 micrometer using LA-ICP-MS. Understanding seasonal, interannual, and long-term variations in trace metal ratios incorporated into coral skeletons has the potential to refine our understanding of environmental drivers of coral calcification. These data were collected by Dr. Andreas Andersson, Scripps Institution of Oceanography, University of California San Diego, and Dr. Travis Courtney, University of Puerto Rico, Mayagüez Campus.

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Coverage

Location: Hog Reef, Bermuda (variable name: hogreef = lat: 32.4505 lon: -64.8363)
Spatial Extent: **Lat**:32.4505 **Lon**:-64.8363
Temporal Extent: 2016-08-17 - 2016-08-18

Methods & Sampling

Day-trips aboard BIOS small boat on various days between 1 August 2016 to 31 August 2016.

Coral cores were collected in August 2016 using a 2-inch diameter wet concrete diamond drill bit powered by an underwater pneumatic drill. The colonies were sealed with a cement plug and underwater epoxy to promote recovery of the coral following core extraction. All cores were scanned via a GE Lightspeed VCT at San Diego Imagery to determine annual linear extension, density, and calcification rate. A subset of cores from Hog Reef was used for skeletal trace metal analysis. Cores were cut using a double-bladed lapidary saw to produce an 8 mm thick cross section from the center of each core. To accommodate trace metal analysis using LA-ICP-MS, this section was reduced to 1.5 mm thick slabs separated into pieces on average 20-25 mm wide and 30-40 mm long. Each piece was polished, ultrasonicated in DI water for approximately 15 minutes, and image-mapped before analysis. All trace element abundance analyses were done at the Scripps Isotope Geochemistry Laboratory (SIGL), at the University of California, San Diego. Analyses were performed with laser ablation inductively coupled mass spectrometry (LA-ICP-MS) using a Thermo Scientific iCAP Q ICP-MS and a New Wave Research UP213 deep UV-YAG 213 µm laser. The LA-ICP-MS sessions consisted of a combination of sample spots bookended by standard reference materials (NIST-610, NIST-612, BHVO-2G, BCR-2G, MACS-3), with additional NIST-610 reference materials run every 5 samples. The spot size was 100 µm, with a common laser fluency of 2.7-3.7 J/cm^2, ~20 seconds of background followed by ~40 seconds of sample measurement, and a 2-minute wash out after each spot flushing the ablation cell.

All cores were collected under the Government of Bermuda Department of Environment and Natural Resources license number 2015–05–26–46.

Data Processing Description

The data were normalized to Ca and assessed for potential outliers. Measurements were rejected and reported as zero for a given analyte if any of the following rejection criteria were met:

1) If the laser ablation integration window average counts per second (cps) was less than the wash integration window average cps.

2) If the laser ablation integration window average cps was less than 3 times the standard deviation (STD) of the wash integration window cps.

3) If the STD of the laser integration window cps was greater than 2 times its average cps.

Both the wash and laser integration window times were corrected as needed. Most data points flagged as potential outliers by SIGL's in-house program (those with counts greater than 6 times the STD of their respective ranges) were rejected for spots ablating standard reference materials. However, for the sample spots only the most pronounced potential outliers, generally those close to a magnitude or more greater than the average, were rejected.

BCO-DMO Processing Description

* Adjusted parameter names to comply with database requirements

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Data Files

File	
963175_v1_trace.csv	(Comma Separated Values (.csv), 176.63 KB) MD5:0cef59fb3b6b4608bd34774b27b5efa4
Primary data file for dataset ID 963175, version 1	

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Related Datasets

IsRelatedTo

Courtney, T., Andersson, A. (2020) **Annual linear extension, skeletal density, and calcification rate data from coral cores collected across Bermuda in 2016.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2020-08-24 doi:10.26008/1912/bco-dmo.821212.1 [view at BCO-DMO]
Relationship Description: This dataset includes annual extension, density, and calcification rates for the same cores analyzed for trace metal ratios. This includes cores: DLAB7, DLAB9, OFRA6, PSTR5.

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Parameters

Parameter	Description	Units
core_ID	Core ID label	unitless
species	Species of coral	unitless
site	Site of core extraction	unitless
core_collection_date	Date of core extraction	unitless
latitude	Latitude	decimal degrees
longitude	longitude	decimal degrees
dist	Distance from top of the core	micrometer
Li_Ca	Elemental ratio	micromol/mol
B_Ca	Elemental ratio	micromol/mol
Mg_Ca	Elemental ratio	micromol/mol
Fe_Ca	Elemental ratio	micromol/mol
Sr_Ca	Elemental ratio	micromol/mol
Ba_Ca	Elemental ratio	micromol/mol
Pb_Ca	Elemental ratio	micromol/mol
Th_Ca	Elemental ratio	micromol/mol
U_Ca	Elemental ratio	micromol/mol

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Instruments

Dataset-specific Instrument Name	Thermo Scientific iCAP Q ICP-MS
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	The core samples were analyzed via the laser ablation system coupled to the ICP-MS at SIGL (Scripps Isotope Geochemistry Laboratory) at the University of California, San Diego. The ICP-MS used Thermo Scientific's Qtegra software suite to collect data and export it into CSV files. These data were then reduced into Excel spreadsheets using an in-house software, readying them for subsequent analysis. Thermo Scientific iCAP Q ICP-MS RF Power: 1550 W Ar (carrier) gas: ~1 L/min Ar coolant gas flow: 14 L/min Ar auxiliary gas flow: 1 L/min Isotopes: 7Li, 10B, 11B, 24Mg, 25Mg, 31P, 42Ca, 44Ca, 57Fe, 88Sr, 111Cd, 114Cd, 137Ba, 208Pb, 232Th, 238U Dwell time per mass: ~40 s New Wave Research UP213 (213 µm) laser He gas flow see Ar (carrier) gas ThO/Th: ~0.5% Uo/U: ~0.4% Laser pulse rate: 5 Hz Energy: 2.7-3.7 J/cm2 (full range; avg 2.9-3.3 J/cm2) Spot size: 100 µm Avg dwell time: 40 sec Avg wash time: 2 min after each spot
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	New Wave Research UP213 deep UV-YAG Laser Ablation System
Generic Instrument Name	Laser
Dataset-specific Description	An instrument that performs laser ablation with a 213 µm laser upon samples and transports the ablated material via a carrier gas to a connected ICP-MS system.
Generic Instrument Description	A device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules.

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Project Information

Drivers of coral and reef-scale calcification in the North Atlantic (Coral Calc)

Coverage: Bermuda

NSF Award Abstract:
Millions of people around the world are dependent on the ecosystem services provided by coral reefs, which include the provision of nutrition, fishing, tourism, and protection from storms and waves. The foundation for these services is based on the basic principle that coral reefs maintain positive calcium carbonate accretion, which is facilitated by the production of calcium carbonate by corals and other marine calcifiers. For the past several decades, coral reef calcium carbonate production has declined in many reef systems throughout the world primarily due to coral bleaching, coral disease, and poor water quality. Current projections suggest that this production will continue to decline in response to future ocean warming and acidification. However, our knowledge of how environmental parameters control coral and reef-scale calcification rates in situ is not complete and limits our understanding of the underlying mechanisms for past and future changes in coral and reef-scale calcium carbonate production. Thus, the research proposed here seeks to quantify how coral calcification rates determined from image analysis of coral cores collected in Bermuda have varied as a function of environmental parameters across space and time. This analysis is made possible by the existence of time-series datasets of physical and chemical parameters offshore in the Sargasso Sea and inshore where

the coral cores were collected. The combination of data will offer new insights to the environmental controls of coral and reef-scale calcification. Furthermore, we will engage in educational field and classroom activities with Ocean Discovery Institute (ODI) in San Diego. ODI's mission is to engage, educate, and inspire youth from diverse backgrounds through scientific explorations of the ocean and nature, and specifically work with students from underserved communities.

The research to be conducted here seeks to understand the relative importance of different environmental drivers of coral and reef-scale calcification on seasonal to interannual timescales. To accomplish this, we will characterize the skeletal density, extension, and calcification rates of 42 coral cores extracted from three different species (*Diploria labyrinthiformis*, *Pseudodiploria strigosa* and *Orbicella franksi*) at five different sites from the Bermuda coral reef platform using computed tomography (CT) scanning techniques. Seasonal measurements of coral skeletal parameters will be analyzed in conjunction with a unique decadal time series of monthly resolved *in situ* seawater physical-biogeochemical parameters. We will also conduct stable isotope and trace metal geochemical analyses (18O, 13C, Sr/Ca, Cd/Ca) of the coral skeleton to evaluate and construct additional proxy records of environmental conditions for the duration of the coral cores. This combination of coral growth, environmental, and geochemical datasets provides an unprecedented opportunity to evaluate the relative importance of different environmental drivers on coral and reef-scale calcification rates between three dominant coral species along inshore-offshore gradients and over seasonal and interannual timescales. To our knowledge, no such other datasets currently exist and the proposed research has strong potential to contribute to scientific advancement in several areas. The coral calcification record coupled with the geochemical proxies and the monthly *in situ* seawater biogeochemistry data will help to elucidate causal links between coral calcification and its environmental drivers, including interannual variability linked to the North Atlantic Oscillation. In addition, evaluation and validation of the trace metals and isotopic proxies in the context of the well-constrained environmental data have the potential to greatly assist the coral paleoceanography community in generating more robust reconstructions of past environmental conditions.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829778

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