Magnesium isotopic compositions of seawater, extrapallial fluid, and Crassostrea virginica shell material from ocean acidification experiments

Website: https://www.bco-dmo.org/dataset/955164
Data Type: experimental
Version: 1
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Project
» Collaborative Research: Does ocean acidification induce a methylation response that affects the fitness of the next generation in oysters? (Epigenetics to Ocean)

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Abstract
The geochemistry of biogenic carbonates is an established proxy to record changing seawater parameters. However, the effect of ocean acidification on seawater chemistry and organism physiology may impact isotopic signatures and how elements are incorporated into carbonate shells. In this study, we investigated the geochemistry of three reservoirs important for biomineralization--seawater, the extrapallial fluid (EPF), and the shell. Ocean acidification laboratory experiments were conducted at [____place___] during [____time range___] to examine the effects of ambient, moderate, and high ocean acidification conditions on the geochemistry of the biomineralization reservoirs. Here we present magnesium isotope data for seawater, EPF, and Crassostrea virginica shells.

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Dataset Description

This dataset of magnesium isotopic compositions of seawater, extrapallial fluid, and Crassostrea virginica shell material is part of a larger ocean acidification study examining the geochemistry of carbonates with changing environmental conditions.

Methods & Sampling

Ocean acidification laboratory experiments were conducted at [____place___] during [____time range___] to examine the effects of ambient (500 ppm CO2), moderate (900 ppm CO2), and high (2800 ppm CO2) ocean acidification conditions on the geochemistry of seawater, extrapallial fluid (EPF) and shells of the Eastern oyster, *Crassostrea virginica*.

[More details are needed here on experimental design, set-up, instruments, etc.]

Here we present magnesium isotope data for three biomineralization reservoirs--seawater, EPF, and Crassostrea virginica shells.

[More details are needed]

Measured on an isotope ratio mass spectrometer [***provide make, model, and lab]***

Data Processing Description

The averages and average standard deviations were found by taking the square root of the squared magnesium isotope values:

SQRT ((CV3 delta-26Mg)^2 + CV6 delta-26Mg)^2 + CV7 delta-26Mg)^2 + CV8 delta-26Mg)^2)

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Related Publications

Alvarez Caraveo, B., Guillermic, M., Downey-Wall, A., Cameron, L. P., Sutton, J. N., Higgins, J. A., Ries, J. B., Lotterhos, K., & Eagle, R. A. (2024). Magnesium (Mg/Ca, δ26Mg), boron (B/Ca, δ11B), and calcium ([Ca2+]) geochemistry of Arctica islandica and Crassostrea virginica extrapallial fluid and shell under ocean acidification. https://doi.org/10.5194/egusphere-2024-1957
Results

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Parameters

Parameter	Description	Units
Sample _Label	Sample identification	unitless
pCO2	Partial pressure of carbon dioxide simulating ocean acidification conditions	parts per million (ppm)
Sample_type	Identifies which biomineralization reservoir the sample represents	unitless
N	number???, of what??	unitless
delta_26Mg	Magnesium isotope ratio	per mil
SD	Standard deviation of delta 26Mg isotope measurement	per mil

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Instruments

Dataset-specific Instrument Name	????
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Need details from submitter
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).

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Project Information

Collaborative Research: Does ocean acidification induce a methylation response that affects the fitness of the next generation in oysters? (Epigenetics to Ocean)

Coverage: Coastal Massachusetts near Nahant: 42°25'06"N 70°54'14"W

NSF Award Abstract:
Marine ecosystems worldwide are threatened by ocean acidification, a process caused by the unprecedented rate at which carbon dioxide is increasing in the atmosphere. Since ocean change is predicted to be rapid, extreme, and widespread, marine species may face an "adapt-or-die" scenario. However, modifications to the DNA sequence may be induced in response to a stress like ocean acidification and then inherited. Such "epigenetic" modifications may hold the key to population viability under global climate change, but they have been understudied. The aim of this research is to characterize the role of DNA methylation, a heritable epigenetic system, in the response of Eastern oysters (Crassostrea virginica) to ocean acidification. The intellectual merit lies in the integrative approach, which will characterize the role of DNA methylation in the intergenerational response of oysters to ocean acidification. These interdisciplinary data, spanning from molecular to organismal levels, will provide insight into mechanisms that underlie the capacity of marine invertebrates to respond to ocean acidification and lay the foundation for future transgenerational studies. Ocean acidification currently threatens marine species worldwide and has already caused significant losses in aquaculture, especially in Crassostrea species. This research has broader impacts for breeding, aquaculture, and the economy. Under the investigators' "Epigenetics to Ocean" (E2O) training program, the investigators will build STEM talent in bioinformatics and biogeochemistry, expose girls in low-income school districts to careers in genomics, and advance the field through open science and reproducibility.

This research will specifically test if intermittent exposure to low pH induces a methylation response with downstream beneficial effects for biomineralization. These methylation states could be inherited and confer a fitness advantage to larvae that possess them. Phase 1 of the project will use an exposure experiment to determine the degree to which DNA methylation is altered and regulates the response to OA. Data from this experiment will be used to test the hypotheses that (i) DNA methylation, induced in the tissue of shell formation (i.e., mantle tissue), is correlated with changes in transcription and regulation of pallial fluid pH (calcifying fluid pH, measured by microelectrode), and (ii) that methylation changes induced in the mantle tissue are also induced in the germline --indicating that such changes are potentially heritable. Phase 2 of the project will use a pair-mated cross experiment to test the hypothesis that parental exposure to OA alters larval traits (calcification rate, shell structure, and polymorph mineralogy). Larvae will be generated from parents exposed

to OA or control seawater, and then raised under control or OA conditions. Results will be used to (i) characterize inheritance of induced methylation states, (ii) estimate the variance in larval traits explained by genotype, non-genetic maternal/paternal effects, adult OA exposure, larval OA exposure, and parental methylome, and (iii) test the hypothesis that adult exposure alters the heritability (a quantity that predicts evolutionary response) of larval traits. Since the effects of epigenetic phenomena on estimates of heritability are highly debated, the results would advance understanding of this important issue. Because the investigators could discover that DNA methylation is a mechanism for heritable plastic responses to OA, knowledge of this mechanism would significantly improve and potentially transform predictive models for how organisms respond to global change.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635423

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