

# pH model for Calcifying Fluid study of Sapodilla Caye, Belize at UNC, Ries laboratory, starting 2010 (OA - Ocean Acidification and Warming Impact on Calcification project)

**Website:** <https://www.bco-dmo.org/dataset/3543>

**Version:** 20 September 2011

**Version Date:** 2011-09-20

## Project

» [Investigation of the Effects of CaCO<sub>3</sub> Saturation State and Temperature on the Calcification Rate and Skeletal Properties of Benthic Marine Calcifiers](#) (OA - Ocean Acidification and Warming Impact on Calcification)

## Program

» [Ocean Carbon and Biogeochemistry](#) (OCB)

Contributors	Affiliation	Role
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## Dataset Description

Carbonate system constraints and energetic requirements of the two end-member calcifying fluid models  
Original contributed as Table 1 in a .doc document

## Methods & Sampling

(tbd)

## Data Processing Description

### BCO-DMO Processing Notes

-Generated from original .doc file "Data\_Ries\_OCE1031995\_5Jul2011\_Calcifying\_fluid\_pH\_model.doc"

contributed by Justin Ries

- Original table in .doc document converted to text and uploaded to Excel

- Parameter names extensively edited to conform to BCO-DMO naming convention found at [Choosing Parameter Name](#)

- Columns added for Seawater type and Fluid type

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## Data Files

File
<b>Calcfluid_pH_model.csv</b> (Comma Separated Values (.csv), 2.64 KB) MD5:f1f94b749182155d674ae9b3efa317e8 Primary data file for dataset ID 3543

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## Parameters

Parameter	Description	Units
Model	Model Type	text
Fluid	Fluid Type	text
pCO2	pCO <sub>2</sub> = CO <sub>2</sub> partial pressure of air in equilibrium with external seawater	ppm
Hplus_minus_removed	[H <sup>+</sup> ]-removed = [H <sup>+</sup> ]-removed from calcifying fluid by proton pump	micromol/kg-SW
Hplus_E_to_Hplus_I	[H <sup>+</sup> <sub>E</sub> ]/[H <sup>+</sup> <sub>I</sub> ] = ratio of external seawater [H <sup>+</sup> ] to calcifying fluid [H <sup>+</sup> ]	ratio
Delta_Energy	δ-Energy = change in energy required to maintain given level of proton regulation relative to 400 ppm pCO <sub>2</sub> scenario	assuming that energy required varies linearly with [H <sup>+</sup> ]-removed or [H <sup>+</sup> ] <sub>E</sub> /[H <sup>+</sup> ] <sub>I</sub>
TA	TA = total alkalinity of fluid	calculated as external seawater TA plus [H <sup>+</sup> ]-removed from calcifying fluid (assuming that seawater is the ultimate source of calcifying fluid)
DIC	DIC = dissolved inorganic carbon of fluid; calcifying fluid DIC is treated as equivalent to seawater DIC (assuming that seawater is the ultimate source of calcifying fluid)	micromol/kg-SW
pH	pH	sea water scale
HCO3_minus	[HCO <sub>3</sub> <sup>-</sup> ] = bicarbonate ion concentration of fluid	micromol/kg-SW
CO3_2_minus	[CO <sub>2</sub> ] <sub>aq</sub> = CO <sub>2</sub> concentration of fluid	micromol/kg-SW
Omega_A	Ω <sub>A</sub> = saturation state of fluid with respect to aragonite	(tbd)

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## Deployments

### lab\_Ries\_Sapodilla\_Caye

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58722">https://www.bco-dmo.org/deployment/58722</a>
<b>Platform</b>	Ries
<b>Report</b>	<a href="http://www.unc.edu/~jries/field_sites.html">http://www.unc.edu/~jries/field_sites.html</a>
<b>Start Date</b>	2010-09-01
<b>End Date</b>	2099-01-01
<b>Description</b>	The Ries Lab - Sapodilla Caye, Belize

#### lab\_Ries\_UNC\_Chapel\_Hill

<b>Website</b>	<a href="https://www.bco-dmo.org/deployment/58723">https://www.bco-dmo.org/deployment/58723</a>
<b>Platform</b>	Ries
<b>Report</b>	<a href="http://www.unc.edu/~jries/index.html">http://www.unc.edu/~jries/index.html</a>
<b>Start Date</b>	2010-09-01
<b>End Date</b>	2099-01-01
<b>Description</b>	The Ries Lab

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## Project Information

### Investigation of the Effects of CaCO<sub>3</sub> Saturation State and Temperature on the Calcification Rate and Skeletal Properties of Benthic Marine Calcifiers (OA - Ocean Acidification and Warming Impact on Calcification)

**Website:** <http://www.unc.edu/~jries/index.html>

**Coverage:** Chapel Hill, North Carolina (lab) and Mesoamerican Barrier Reef System - Sapodilla Caye, Belize (16.2 N 88.5 W)

#### *Description from NSF award abstract:*

Anthropogenic elevation of atmospheric pCO<sub>2</sub> is increasing the acidity of the oceans, thereby reducing the saturation state of seawater with respect to calcium carbonate (CaCO<sub>3</sub>). Of mounting concern is the potential impact of these changes on the ability of calcifying organisms to form their shells and skeletons. Recent studies, including pilot work conducted by investigator Ries and his colleagues on a suite of benthic marine calcifiers spanning broad taxonomic, mineralogical, and ecological ranges, have revealed that marine organisms exhibit a wide range of calcification responses to CO<sub>2</sub>-induced ocean acidification, including positive, negative, parabolic, threshold, and neutral responses. Marine calcifiers build their shells and skeletons from various forms (polymorphs) of CaCO<sub>3</sub>, most commonly aragonite, high-Mg calcite, and low-Mg calcite. These polymorphs differ greatly in their solubility in seawater and, therefore, in their potential response to CO<sub>2</sub>-induced ocean acidification. X-ray diffraction analysis of shells secreted by the organisms investigated in the pilot study reveals that the proportion of calcite (the less soluble form of CaCO<sub>3</sub>) to aragonite (the more soluble form) within their shells increases under elevated pCO<sub>2</sub>, while the Mg:Ca ratio of their calcite declines. These observations suggested that some marine calcifiers may partially adapt to a declining CaCO<sub>3</sub> saturation state by accreting a greater proportion of the less-soluble form of CaCO<sub>3</sub> (low-Mg calcite) at the expense of the more soluble forms (aragonite, high-Mg calcite). However, it is likely that such mineralogical and compositional changes in the shells and skeletons of marine organisms would alter their structural and biomechanical properties.

The project seeks to build upon the results of a pilot study by rearing a suite of benthic marine calcifiers under past (280 ppm), present (385 ppm), and predicted future (540, 840 ppm) pCO<sub>2</sub> and under three distinct temperatures to investigate changes in: (1) their rates of calcification and linear extension; (2) the relative

abundance and micron-scale distribution of the various CaCO<sub>3</sub> polymorphs within their shells/skeletons; (3) the ultrastructure and crystal morphology of their shells/skeletons; and (4) their biomechanical properties. The research also builds upon the pilot experiments by utilizing a more thoroughly replicated study design, by more precisely constraining the chemical parameters of the experimental seawater treatments, by investigating calcification responses under 3 different temperature regimes, and by employing a "pre-industrial" pCO<sub>2</sub> level (280 ppm). The results of the proposed research should advance our understanding of how benthic marine calcifiers shall respond to future CO<sub>2</sub>-induced changes in seawater temperature and CaCO<sub>3</sub> saturation state. By investigating the response of organisms over the range of atmospheric pCO<sub>2</sub> that has occurred since late Paleozoic time, this research should inform our understanding of the putative links between atmospheric pCO<sub>2</sub>, mass extinction events, and secular variation in the polymorph mineralogy of marine calcifiers throughout geologic time. Finally, comparison of the observed biological responses to variable pCO<sub>2</sub>-T scenarios with that already established for abiogenic carbonates will advance our understanding of the very mechanisms by which marine calcifiers build their shells and skeletons.

Results of this research project will inform the decisions of policy makers and legislators working to mitigate the impacts of CO<sub>2</sub>-induced warming and ocean acidification by establishing pCO<sub>2</sub>-T tolerances for a range of marine calcifiers.

**Note (02 Oct 2014):** Funding for this project has transferred from award OCE-1031995 to OCE-1357665, coincident with Principal Investigator's affiliation change from University of North Carolina at Chapel Hill to Northeastern University.

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## Program Information

### Ocean Carbon and Biogeochemistry (OCB)

**Website:** <http://us-ocb.org/>

**Coverage:** Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF.

The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems.

The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO<sub>2</sub> and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two.

The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

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## Funding

Funding Source	Award
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1031995</a>
<a href="#">NSF Division of Ocean Sciences (NSF OCE)</a>	<a href="#">OCE-1357665</a>

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