Table 1: Experimental conditions and fluid carbonate chemistry for RPI-3 run where only aragonite precipitated

Website: https://www.bco-dmo.org/dataset/806920
Data Type: experimental
Version: 1
Version Date: 2020-03-25

Project
» Biologically induced methane oxidation and precipitation of carbonate minerals: An experimental study (Deep Sea Geochem CaCO3)

Program
» Center for Dark Energy Biosphere Investigations (C-DEBI)

Contributors	Affiliation	Role
Gabitov, Rinat	Mississippi State University (MSU)	Principal Investigator
Borrelli, Chiara	University of Rochester	Co-Principal Investigator
Rogers, Karyn	Rensselaer Polytechnic Institute (RPI)	Co-Principal Investigator
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Abstract
Table 1: Experimental conditions and fluid carbonate chemistry for RPI-3 run where only aragonite precipitated.

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Coverage

Temporal Extent: 2014 - 2014

Dataset Description

Table 1: Experimental conditions and fluid carbonate chemistry for RPI-3 run where only aragonite precipitated

Methods & Sampling

Crystallization experiment
In order to simulate the high-pressure conditions at the seafloor, three laboratory experiments involving aragonite precipitation were conducted. Two experiments were conducted using a high-pressure apparatus (Figure 1). The control experiment was performed at atmospheric pressure and 8°C in a container immersed in a constant temperature bath. The experimental fluid (growth medium) was prepared by mixing artificial

seawater (ASW) and small aliquots of Na2CO3. The addition of Na2CO3 allowed the saturation state of the fluid with respect to aragonite to be increased, in order to promote nucleation and crystallization on carbonate minerals. Artificial seawater was prepared by dissolving 32 g of Instant Ocean salt (Instant Ocean Spectrum Brands) mix in 1 kg of distilled water and filtering it through a 0.2 µm Nalgene filter. A small amount of 0.1M Na2CO3 was then introduced into the continuously stirred artificial seawater using a syringe pump set at a rate of ~1 ml/min, to reach a final volume ratio of Na2CO3 to artificial seawater of ~1:13. During the addition of Na2CO3, the solution was in contact with the atmosphere. This procedure homogenized the fluid and also precluded aragonite nucleation prior to the beginning of the experiment. The absence of crystal nucleation was confirmed visually by monitoring the solution pH, which remained stable for the 1-2 hours needed for the experiment setup. The observation that aragonite crystallization did not start prior to the beginning of the experiment is consistent with previously published data, which show that 6 hours elapsed before onset of crystallization in the solution similar to the one we used (7.4 mmol of Na2CO3 :1 liter of seawater) (Pytkowicz, 1965).

Petrographic glass slides frosted with silicon carbide (SiC) abrasive paper were used to promote aragonite crystallization along scratches. For each experiment, one slide was placed into the high-pressure vessel prior to the transfer of the experimental fluid. The experimental fluid was then placed into the vessel after it was precooled to 8°C. After that, the air space above the solution (<200 cm3) was purged with nitrogen three times before the pressure was increased to a desired value (110 or 345 bars). The experimental fluid was sampled daily using a valve on the pressure vessel (Figure 1) and pH was measured to estimate time of nucleation and crystallization of CaCO3. For pH measurements, electrode calibration and measurements were conducted at temperatures similar to those of the experiment. NBS buffer solutions with pH of 4, 7, and 10 were used for electrode calibration. The pH initially decreased due to carbonate precipitation and reached near-constant values less than 170 hrs from the beginning of the experiments, suggesting that most of the CaCO3 precipitated in the first few days of each experiment. At the end of each run, the experimental products were extracted from the pressure vessel. Crystals (<10 µm in size) were rinsed with distilled water and dried, whereas the experimental fluid was filtered and refrigerated for subsequent elemental analyses. The alkalinity of the final fluid was measured the day after the end of each experiment. Experimental parameters are presented in Table -1.

Data Processing Description

BCO-DMO Data Manager Processing Notes:
- added a conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- blank values in this dataset are displayed as "nd" for "no data." nd is the default missing data identifier in the BCO-DMO system.
- reformatted table so each column is unique

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Data Files

File
Table1.csv (Comma Separated Values (.csv), 291 bytes) MD5:692ace7b6dfc1f698ed55c7ed63a7a87 Primary data file for dataset ID 806920

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Supplemental Files

File
Fig.1: high-pressure apparatus filename: Fig1_high_pressure_apparatus.png (Portable Network Graphics (.png), 649.50 KB) MD5:5dc7a60afcec97a3e67c39c317c489f3 Fig.1: high-pressure apparatus
POSTER: Fall AGU Meeting 2017 (EP13A-1595): Characterization of Carbonate Crust from Deep-sea Methane Seeps on the Northern US Atlantic Margin filename: Gabitov_poster_AGU_2017.pdf (Portable Document Format (.pdf), 759.62 KB) MD5:18eb6d411ab9da21cf19f18e8d655422 POSTER: Fall AGU Meeting 2017 (EP13A-1595): Characterization of Carbonate Crust from Deep-sea Methane Seeps on the Northern US Atlantic Margin

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Related Publications

Doerner, H. A., & Hoskins, W. M. (1925). Co-Precipitation of radium and barium sulfates1. Journal of the American Chemical Society, 47(3), 662-675. https://pubs.acs.org/doi/pdf/10.1021/ja01680a010
Methods

Gabitov, R., Borrelli, C., Buettner, J., Kirkland, B., Skarke, A., Trail, D., … Zverkova, I. (2019). Characterization of Carbonate Crust from a Recently Discovered Methane Seep on the North Atlantic Continental Margin of the USA. Minerals, 9(3), 138. doi:10.3390/min9030138
Results

Lewis, E., Wallace, D., & Allison, L. J. (1998). Program developed for CO2 system calculations (No. ORNL/CDIAC-105). Brookhaven National Lab., Dept. of Applied Science, Upton, NY (United States); Oak Ridge National Lab., Carbon Dioxide Information Analysis Center, TN (United States). doi: 10.2172/639712
Methods

Pytkowicz, R. M. (1965). Rates of Inorganic Calcium Carbonate Nucleation. The Journal of Geology, 73(1), 196–199. doi:10.1086/627056
Methods

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Parameters

Parameter	Description	Units
fluid	exprimental fluid (growth medium): ASW= artificial seawater; initial= artificial seawater doped with aliquot 0.1M Na2CO3 in the proportion of ~1:13 to ASW; final= fluid at end of experiment	unitless
temp	temperature	degrees Celsius
press	pressure	bars
S	salinity	salinity units
TA	total alkalinity	micromole per kg of water
pH_meas	pH measured	pH units
pH_calc	pH calculated	pH units
CO3	carbonate ion	micromole per kg of water
Ca	calcium ion	milligram per kg of water
OM_ar	saturation state of the fluid with respect to aragonite	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Benchtop pH Meter
Dataset-specific Description	Used to measure pH.
Generic Instrument Description	An instrument consisting of an electronic voltmeter and pH-responsive electrode that gives a direct conversion of voltage differences to differences of pH at the measurement temperature. (McGraw-Hill Dictionary of Scientific and Technical Terms) This instrument does not map to the NERC instrument vocabulary term for 'pH Sensor' which measures values in the water column. Benchtop models are typically employed for stationary lab applications.

Dataset-specific Instrument Name	
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Used to measure concentrations of ions.
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	high-pressure apparatus
Generic Instrument Name	no_bcodmo_term
Dataset-specific Description	Custom designed pressure chamber used to simulate the high-pressure conditions at the seafloor for this set of experiments.(designed at Rensselaer Polytech Institute, Department of Earth and Environmental Sciences)
Generic Instrument Description	No relevant match in BCO-DMO instrument vocabulary.

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Project Information

Biologically induced methane oxidation and precipitation of carbonate minerals: An experimental study (Deep Sea Geochem CaCO3)

Website: https://www.darkenergybiosphere.org/award/biologically-induced-methane-oxidation-and-precipitation-of-carbonate-minerals-an-experimental-study/

Biologically-mediated CaCO3 precipitation widely occurs in aquatic systems and is often directly linked to the metabolic activity of microorganisms, which could significantly affect the local environment. An example is oxidation of methane and reduction of sulfate mediated by a consortium of Bacteria and Archaea. In order to investigate geochemistry of CaCO3precipitated abiotically and under microbial activity experimental work was initiated. The abiotic experiments were performed at different temperatures and pressures (nitrogen and nitrogen-methane mixture). Further geochemical analyses will allow evaluating of the effect of total pressure and methane partial pressure on the geochemistry of CaCO3. Sulfate reducing bacterial (*Desulfovibrio salexigens*) was successfully cultured and precipitation experiments on microbially mediated CaCO3 are in progress. This work is relevant to C-DEBI Research Theme I (Activity in the Deep Subseafloor Biosphere: function & rates of global biogeochemical processes) because carbonate growth rate is linked to microbial activity and the rate of methane oxidation.

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Program Information

Center for Dark Energy Biosphere Investigations (C-DEBI)

Website: http://www.darkenergybiosphere.org

Coverage: Global

The mission of the Center for Dark Energy Biosphere Investigations (C-DEBI) is to explore life beneath the seafloor and make transformative discoveries that advance science, benefit society, and inspire people of all ages and origins.

C-DEBI provides a framework for a large, multi-disciplinary group of scientists to pursue fundamental questions about life deep in the sub-surface environment of Earth. The fundamental science questions of C-DEBI involve exploration and discovery, uncovering the processes that constrain the sub-surface biosphere below the oceans, and implications to the Earth system. What type of life exists in this deep biosphere, how much, and how is it distributed and dispersed? What are the physical-chemical conditions that promote or limit life? What are the important oxidation-reduction processes and are they unique or important to humankind? How does this biosphere influence global energy and material cycles, particularly the carbon cycle? Finally, can we discern how such life evolved in geological settings beneath the ocean floor, and how this might relate to ideas about the origin of life on our planet?

C-DEBI's scientific goals are pursued with a combination of approaches:
(1) coordinate, integrate, support, and extend the research associated with four major programs—Juan de Fuca Ridge flank (JdF), South Pacific Gyre (SPG), North Pond (NP), and Dorado Outcrop (DO)—and other field sites;
(2) make substantial investments of resources to support field, laboratory, analytical, and modeling studies of the deep subseafloor ecosystems;
(3) facilitate and encourage synthesis and thematic understanding of submarine microbiological processes, through funding of scientific and technical activities, coordination and hosting of meetings and workshops, and support of (mostly junior) researchers and graduate students; and
(4) entrain, educate, inspire, and mentor an interdisciplinary community of researchers and educators, with an emphasis on undergraduate and graduate students and early-career scientists.

Note: Katrina Edwards was a former PI of C-DEBI; James Cowen is a former co-PI.

Data Management:
C-DEBI is committed to ensuring all the data generated are publically available and deposited in a data repository for long-term storage as stated in their Data Management Plan (PDF) and in compliance with the NSF Ocean Sciences Sample and Data Policy. The data types and products resulting from C-DEBI-supported research include a wide variety of geophysical, geological, geochemical, and biological information, in addition to education and outreach materials, technical documents, and samples. All data and information generated by C-DEBI-supported research projects are required to be made publically available either following publication of research results or within two (2) years of data generation.

To ensure preservation and dissemination of the diverse data-types generated, C-DEBI researchers are working with BCO-DMO Data Managers make data publicly available online. The partnership with BCO-DMO helps ensure that the C-DEBI data are discoverable and available for reuse. Some C-DEBI data is better served by specialized repositories (NCBI's GenBank for sequence data, for example) and, in those cases, BCO-DMO provides dataset documentation (metadata) that includes links to those external repositories.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0939564

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