Siderophore-enhanced olivine dissolution experiments from the University of Southern California (Microbial Olivine Dissolution project)

Website: https://www.bco-dmo.org/dataset/713673
Data Type: experimental
Version: 2017-08-17

Project
» Identifying the Mechanisms and Limits of the Microbial Enhancement of Olivine Dissolution (Microbial Olivine Dissolution)

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

Contributors	Affiliation	Role
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Dataset Description

The dataset contains time-series measurements of the masses of Magnesium, Iron, and Silicon released into solution per gram of olivine in experiments with varying initial concentration of the purified siderophore Deferoxamine B (DFOB) .

Methods & Sampling

Experiments were conducted by adding a known mass of olivine to a TRIS/HCl buffered solution (10 mM; pH approximately 7.5) in a plastic bottle. Deferoxamine B purchased from Sigma Aldrich was added to experiments after being dissolved in de-ionized water. The bottles were placed into a heated shaking table (200 rpm) and incubated at 30 degrees celsius. Periodically, solution samples were removed by pipette and preserved by acidification with one uL of concentrated HCl per mL of sample solution. Solutions were analyzed for Mg, Si, and Fe concentrations.

Data Processing Description

Linear calibration against synthetic, matrix-matched standards

BCO-DMO Processing Notes:
- modified parameter names to conform with BCO-DMO naming conventions.

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Data Files

File
Microb_olivine_diss.csv (Comma Separated Values (.csv), 1.09 KB) MD5:33d812f24c212f62fe84bd113c9fdce1 Primary data file for dataset ID 713673

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Parameters

Parameter	Description	Units
elapsed_time	time elapsed of experiment	hours
initial_DFOB_concentration	Deferoxamine B initial concentration	micromoles (umole)
Si_released	concentration of Si released	micromole per liter (umole/liter)
Fe_released	concentration of Fe released	micromole per liter (umole/liter)
Mg_released	concentration of Mg released	micromole per liter (umole/liter)

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Instruments

Dataset-specific Instrument Name	Agilent 4100 MP-AES
Generic Instrument Name	Spectrometer
Dataset-specific Description	Solutions were analyzed for Mg, Si, and Fe concentrations using Agilent 4100 Microwave Plasma Atomic Emission Spectrometer (MP-AES).
Generic Instrument Description	A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

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Project Information

Identifying the Mechanisms and Limits of the Microbial Enhancement of Olivine Dissolution (Microbial Olivine Dissolution)

Project abstract from C-DEBI:

Project abstract from C-DEBI.
The project focused on the efficacy by which microorganisms can obtain nutrient Fe from silicate minerals. Silicate minerals are a particularly abundant mineral phase in the oceanic crust and thus the bio-availability of silicate-bound nutrients has important implications for microbial activity in the deep subseafloor (C-DEBI theme 1) and the limits to microbial life (C-DEBI theme 3). The specific goal of this project was to quantitatively determine how metal-binding organic compounds (siderophores) produced by microorganisms under Fe-limited conditions affect the rate of Fe-silicate mineral dissolution using laboratory experiments. The exact effect of microbial activity on Fe-silicate mineral dissolution has previously been hard to discern due to the complicating effects of feedbacks associated with microbial growth, siderophore production, and mineral dissolution rates. To limit the effects of these feedbacks, my experimental design used purified microbial siderophores and a silicate mineral (olivine) that dissolves at a rate that is relatively insensitive to the accumulation of its constituent ions in solution. My results showed that sub-millimolar siderophore concentrations lead to an order of magnitude increase in olivine dissolution rates. The accelerating effect of siderophores was linked to the removal of an inhibiting surface Fe-oxide coating that forms during the reaction of olivine at circum-neutral pH in the presence of O2. By combining the experimental results with a numerical model of the relevant biological feedbacks, this work further constrained the maximum extent to which microbial activity may affect silicate mineral dissolution rates under conditions of Fe-limitation. The results of this study are presently under review for publication in *Geobiology*.

This work was supported through a C-DEBI graduate fellowship.

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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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