454 pyrotag sequencing of 16S rRNA genes from R/V Atlantis cruise AT15-35 in the Cascadia Basin and Juan de Fuca Ridge in 2008

Website: https://www.bco-dmo.org/dataset/636894
Data Type: experimental, Other Field Results
Version: 28 Jan 2016
Version Date: 2016-01-28

Project
» Genetic diversity and distribution of microbes colonizing igneous minerals and glasses incubated in IODP Hole 1301A on the eastern flank of the Juan de Fuca Ridge (Microbe Diversity & Distribution JdFR)

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

Contributors	Affiliation	Role
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Dataset Description

Status Note (28 January 2016): Microbial sequences will be submitted to GenBank, but are not available.

454 pyrotag sequencing of 16S rRNA genes from the Juan de Fuca Ridge. Samples collected on 2008 R/V Atlantis cruise AT15-35.

Methods & Sampling

Twelve igneous minerals and glasses were incubated in 3.5 my old basaltic crust in three flow cells (Smith et al., 2011). Each flow cell was connected to an osmotic pump that ensured continuous fluid flow (~ 30 mL per year) for the duration of the experiment (4 years total). Each flow cell contained four mineral chambers arranged in sequence through which fluid flowed. Each chamber contained only one mineral. In the first flow cell, fluid flowed through chambers containing forsterite, Fo90 olivine, fayalite, and then hornblende. The sequence of minerals in the second flow cell was basalt glass, obsidian, augite, and then diopside. In the third flow cell, fluid flowed from anorthite to bytownite, orthoclase, then apatite (Smith et al., 2011).

Each flow cell-pump assembly was placed into IODP Hole 1301A (47 45.210'N, 127 45.833'W) between 275 and 287 meters below sea floor (Smith et al., 2011). Hole 1301A was emplaced in oceanic crust at 2667 meters below sea level and has a CORK (Fisher et al., 2005) designed to seal the observatory system at the

seafloor and allow the aquifer to return to native conditions after drilling and CORK insertion. During the first three years of the incubation, bottom seawater leaked into the observatory and mixed with aquifer fluids, providing a cooler, more oxidant-rich environment for aquifer communities (Wheat et al., 2010). In the fourth year of incubation, seawater entrainment became undetectable and the mineral samples were exposed to fluids characteristic of the natural basement aquifer (Wheat et al., 2010). Minerals were retrieved in August 2008 and frozen at – 40 degrees C until extraction with a FastDNA Spin Kit for Soil.

References:
Smith A, Popa R, Fisk M, Nielsen M, Wheat CG, Jannasch HW, *et al.* 2011. In situ enrichment of ocean crust microbes on igneous minerals and glasses using an osmotic flow-through device. *Geochemistry Geophys Geosystems* 12:1–19. doi:10.1029/2010GC003424

Fisher AT, Wheat CG, Becker K, Davis EE, Jannasch H, Schroeder D, *et al.* 2005. Scientific and technical design and deployment of long-term subseafloor observatories for hydrogeologic and related experiments , IODP Expedition 301 , eastern flank of Juan de Fuca Ridge 1 and general design. *Proc Integr Ocean Drill Progr* 301. doi:10.2204/iodp.proc.301.103.2005

Wheat CG, Jannasch HW, Fisher AT, Becker K, Sharkey J, Hulme S. 2010. Subseafloor seawater-basalt-microbe reactions: Continuous sampling of borehole fluids in a ridge flank environment. *Geochemistry Geophys Geosystems* 11:1–18. doi:10.1029/2010GC003057

Data Processing Description

V4 region 16S rRNA gene amplicons were produced using universal primers for bacteria and archaea and sequenced using 454 FLX pyrosequencing technologies.

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Parameters

Parameters for this dataset have not yet been identified

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Deployments

AT15-35

Website	https://www.bco-dmo.org/deployment/637087
Platform	R/V Atlantis
Start Date	2008-07-28
End Date	2008-08-13
Description	Science activities (according to WHOI's cruise synopsis): 1) Service instrumentation at up to seven subseafloor “CORK” hydrological observatories installed by ODP in 1996 and IODP in 2004; 2) make in situ, shipboard and shore-based measurements to characterize the microbial geochemistry of the subseafloor basement (basaltic crust) utilizing subset of above 7 CORK observatories; and 3) test underwater optical communication device associated with a temperature probe deployed within a thermal vent.

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Project Information

Genetic diversity and distribution of microbes colonizing igneous minerals and glasses incubated in IODP Hole 1301A on the eastern flank of the Juan de Fuca Ridge (Microbe Diversity &

Distribution JdFR)

Coverage: Juan de Fuca Ridge flank

Project description from C-DEBI:
The Integrated Ocean Drilling Program (IODP) Hole 1301A on the eastern flank of Juan de Fuca Ridge (JFR) was used as a long term sub-seafloor microbial observatory to determine microbial colonization preferences for twelve silicate minerals and glasses common in igneous rocks. Previous work revealed significant differences in total cell densities, with iron-bearing olivine minerals maintaining the highest densities of total cells, culturable organotrophic mesophiles, and the only culturable organotrophic thermophiles. Since 90% of identified culturable strains were able to oxidize iron in the laboratory, we hypothesized that iron-bearing minerals would support distinct communities from iron-poor minerals. Since most organisms are unculturable, inferences about differences in complexity between microbial communities colonizing minerals could best be made using high-throughput sequencing. We proposed to use 454 pyrosequencing and sequence analysis of the hypervariable V4 region of the SSU rRNA gene for bacteria and archaea using genomic DNA extracted from our mineral samples to test our hypothesis.

Through this work, we found that mineralogy of the crust governed attached community assemblages, diversity, and distribution in deep ocean crust. We discovered that the olivine group of minerals had communities that were unique among igneous minerals and that they were the most diverse. Communities from iron-bearing minerals were more similar to each other than communities from iron-poor minerals, indicating there is an iron-related compositional influence on community development. We compared mineral communities to surrounding aquifer fluid and bottom seawater and found that attached communities differed considerably from their free-living counterparts. Our hypothesis was validated through this work, and the results have significantly increased our understanding of how mineralogy controls micro-scale diversity within igneous rocks. This work has allowed us a glimpse into ecosystem function in the largest habitat on Earth, and will allow us to better model reactive transport, weathering, and biogeochemical cycling in the ocean crust.

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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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