16S rRNA gene and particulate monooxygenase diversity from R/V Atlantis AT15-68, AT18-10, AT15-44, AT15-59 off Costa Rica and USA, Pacific Ocean, 2009-2011 (Authigenic Carbonate Ecosystems project)

Website: https://www.bco-dmo.org/dataset/489401
Version: 2014-01-31

Project
» Structure, Function and Evolution of Authigenic, Methane-Derived Carbonate Ecosystems (Authigenic Carbonate Ecosystems)

Programs
» Integrated Marine Biogeochemistry and Ecosystem Research -US (IMBER-US)
» U.S. GLOBal ocean ECosystems dynamics (U.S. GLOBEC)
» United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

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Dataset Description

PCR amplicon data pertaining to this project has been submitted to Genbank at the National Center for Biotechnology Information (NCBI)- www.ncbi.nlm.nih.gov referenced by the following accession numbers:

Three Datasets:

1) Archaeal and Bacterial 16S rRNA gene sequences from carbonate rocks and sediment near the methane seeps of Hydrate Ridge, OR. In preparation, released by NCBI March 2014. NCBI accession numbers KF616507-KF616827.

http://www.ncbi.nlm.nih.gov/nuccore/?term=KF616507%3AKF616827+[ACCN]

2) Particulate methane monooxygenase gene and 16S rRNA gene sequences of methanotrophs – water column Costa Rica Margin. Tavormina et al. 2013, Environmental Microbiology Reports (2013) 5(3), 414–423 doi:10.1111/1758-2229.12025. NCBI accession numbers JX569083-JX569145.

http://www.ncbi.nlm.nih.gov/nuccore/?term=JX569083%3AJX569145+[ACCN]

3) Particulate methane monooxygenase and 16S rRNA genes sequences of bacteria from overlying water, sediment and carbonates near methane seeps Santa Monica Basin and Eel River Basin, CA. Tavormina et al. 2008, Appl. Environ. Microbiol. 2008, 74(13):3985. DOI: 10.1128/AEM.00069-08. NCBI accession numbers EU444837-EU444876.

http://www.ncbi.nlm.nih.gov/nuccore/?term=EU444837%3AEU444876+[ACCN]

Methods & Sampling

Sample locations: Hydrate Ridge, Oregon Coast, USA; Eel River Basin and Santa Monica Basin, California Coast, USA; Costa Rica Margins.

Data Processing Description

Sequenced using Sanger method by Laragen, http://www.laragen.com/.

Edited in software programs Sequencher, Mothur and ARB.

Relevant References:

Patricia L. Tavormina, William Ussler III, Joshua A. Steele, Stephanie A. Connon, Martin G. Klotz and Victoria J. Orphan. Abundance and distribution of diverse membrane-bound monooxygenase (Cu-MMO) genes within the Costa Rica oxygen minimum zone. Environmental Microbiology Reports. 2013, 5(3), 414-423. doi:10.1111/1758-2229.12025.

Patricia L. Tavormina, William Ussler III and Victoria J.Orphan. Planktonic and Sediment-Associated Aerobic Methanotrophs in Two Seep Systems along the North American Margin. Appl. Environ. Microbiol. 2008, 74(13):3985. doi:10.1128/AEM.00069-08.

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Data Files

File
accession_numbers.csv (Comma Separated Values (.csv), 74.77 KB) MD5:2e591f03581300955fdfda9c254dddf9 Primary data file for dataset ID 489401

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Parameters

Parameter	Description	Units
organism	source organism of genetic sequence	unitless
gene	gene types	unitless
sample_descrip	type of material from which sequences were obtained	unitless
location	location of source material	unitless
accession_number	NCBI accession number	unitless

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Instruments

Dataset-specific Instrument Name	Automated Sequencer
Generic Instrument Name	Automated DNA Sequencer
Generic Instrument Description	A DNA sequencer is an instrument that determines the order of deoxynucleotides in deoxyribonucleic acid sequences.

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Deployments

AT15-68

Website	https://www.bco-dmo.org/deployment/58870
Platform	R/V Atlantis
Start Date	2010-07-31
End Date	2010-08-12
Description	Cruise information and original data are available from the NSF R2R data catalog.

AT18-10

Website	https://www.bco-dmo.org/deployment/58871
Platform	R/V Atlantis
Start Date	2011-08-31
End Date	2011-09-08
Description	Cruise information and original data are available from the NSF R2R data catalog.

AT15-44

Website	https://www.bco-dmo.org/deployment/58869
Platform	R/V Atlantis
Start Date	2009-02-21
End Date	2009-03-08
Description	Cruise Objective: We will conduct research in exposed carbonate ecosystems on the Costa Rica margin (700-1,400 m), to test hypotheses about the influence of active seepage on carbonate rock animal communities and their successional phases, on microbial activity including anerobic methane oxidation and sulfide oxidation, on carbon isotopic composition of shelled organisms, and on phylogenetic affinities of animals. To test hypotheses we will sample existing authigenic carbonates from 3 levels of seepage activity: highly active, weak and inactive. Activity level will be defined by presence of /or proximity to bubbles/shimmering water, microbial mat development and megafauna, as well as previous fluid flow and composition measurements made at the Costa Rica study sites. We will sample 5 to 8 locations with each activity level in each study region, controlling for rock size and carbonate configuration when possible. ALVIN: During 3 dives at each of 4 study sites we will conduct bottom surveys and video transects, measure S, T, O2, select 4 to 8 highly active, weakly active and inactive sites, photograph organisms and classify rocks in situ, collect rocks of varying sizes with organisms, and sample nearby sediments and biotic substrata (mussels, tube worms) for taxonomic comparisons. The remaining 2 dives at Costa Rica seeps will be used to conduct follow-up survey and sampling of the most promising locations, based on shipboard sample observations. Nighttime operations will consist of CTD casts (a minimum of one each at Mound 11, Mound 13, Jaco Scarp and Mound Quepos), multicoring (adjacent to mounds and at 400 m and 600 m sites in the OMZ), and pre-dive seabeam surveys. Cruise information and original data are available from the NSF R2R data catalog.

AT15-59

Website	https://www.bco-dmo.org/deployment/58765
Platform	R/V Atlantis
Start Date	2010-01-06
End Date	2010-01-13
Description	Costa Rica seafloor methane seeps 8 deg 55 N 84 depth 990m. Included Alvin dives 4586-4591. The primary goal of the cruise was to recover biological experiments deployed at active and inactive seep areas during Feb./March 2009. We successfully recovered 23/24 experimental units deployed on Mound 12, Costa Rica. One was simply missing on the sea floor. By using a gear elevator each day to maximize sample collection (and reserve ALVIN basket space for experiments) we were able to recover our experiments rapidly. This left us time for exploration of unusual biological communities at Jaco Scar. Cruise information and original data are available from the NSF R2R data catalog. Cruise dates changed Feb 2015 to match WHOI ship schedule and R2R.

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Project Information

Structure, Function and Evolution of Authigenic, Methane-Derived Carbonate Ecosystems (Authigenic Carbonate Ecosystems)

Coverage: Hydrate Ridge, Oregon, USA; Costa Rica Margins; off the coast of California [Costa Rica seafloor methane seeps 8 deg 55 N 84 deg 18 W depth 990m]

Authigenic carbonate precipitation associated with methane seepage is typically mediated by anaerobic

oxidation of methane (AOM). This microbial process produces massive amounts of carbonate rock, introducing habitat heterogeneity to continental margins and providing a major repository for methane-derived carbon released from the sea floor. This study will investigate the extent to which these carbonate substrates form a distinct ecosystem within the seep environment by characterizing associated microbial, foraminiferal, macrofaunal and megafaunal communities in a successional context. Surveys and sampling of carbonate will take place at 4 bathyal locations on the Costa Rica margin (730-1300 m) and at Hydrate Ridge North on the Oregon margin (590 m).

Location differences and associated water depth, oxygenation, seep megafauna and carbonate formation variation are expected to influence community composition. This study will characterize assemblages inhabiting carbonates subject to active, weak and no methane seepage, and conduct rock colonization and transplant experiments to address the following main hypotheses:(1) Under conditions of active seepage at the seafloor-water interface, authigenic carbonate functions as a distinct ecosystem fueled by AOM, with its own sources of (chemosynthetic) primary and secondary production; (2) Seep carbonate faunal communities undergo succession driven by methane supply and microbial activity; (3) Sessile seep carbonate assemblages include mainly microbial, protozoan and metazoan species that are taxonomically and evolutionarily distinct from the biota of surrounding seep sediments, but ecologically and evolutionarily related to deep-sea, hard-substrate and reducing faunas, including those from seeps, vents, coral mounds and whale bones.

Single rocks will be split and sectioned for carbonate mineralogy and isotopic analysis, FISH-SIMS analyses of endogeneous microorganisms and their respective delta 13C signatures, faunal (protozoan and metazoan) taxonomic, lifestyle and position studies. Stable isotopic and lipid analyses of foraminifera and metazoan protoplasm, delta 18O and delta 13C signatures of foraminiferan tests and mollusk shells will be linked to microbial and carbonate signatures to assess trophic pathways and paleo proxies for methane release. Archaea and AOM are hypothesized as key to both. Defaunated carbonate substrates will be deployed at active and inactive sites for 1 year to examine early faunal succession and the role of external seepage. Rocks transplanted between inactive and active sites, with appropriate manipulation controls, will provide additional information about faunal reliance on seepage and persistence of AOM in the absence of seepage. Community comparisons will be drawn with seep sediments, other biotic substrates (mussels, clams, tubeworms) and with other deep-sea reducing and hardground systems (vents, whales, deep-water corals). Macrofaunal assemblages will be DNA and selected annelid and foraminiferan taxa will be targeted for phylogenetic analyses to assess evolutionary affinities with fauna from other hardground-reducing ecosystems (vents).

Broader Impacts: Benefits of this research to society include: (1) an understanding of seep carbonate ecosystems for improved marine resource management and more comprehensive assessments of seafloor biodiversity, carbon cycling, and adaptations to extreme environments; and (2) a model for successional changes in carbonate ecosystems and the use of their faunas as proxies to more accurately assess past methane release and paleoclimate change. Education and outreach will include local school presentations; web site development and interdisciplinary, hands-on, at-sea training of future scientists at undergraduate, graduate, and post-doc levels, including under-represented groups (women; first-generation university students from rural communities) recruited through SURF, STARS and REU programs. Research results will be incorporated into lectures, exercises and field trips for deep-sea biology, microbiology, geology, paleontology, oceanography and benthic ecology courses, and onto websites and databases managed by the Census of Marine Life and the SIO Benthic Invertebrate Collection.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Thurber, A, L.A Levin, V.J. Orphan, J. Marlow. "Archaea in metazoan diets: implications for food webs and biogeochemical cycling," ISME J, v.6, 2012, p. 1602â??16.

Tavormina, P. L., W. Ussler III, S.M. Joye and V. J. Orphan. "Distributions of putative aerobic methanotrophs in diverse pelagic marine environments," ISME J, v.4, 2010, p. 700.

Levin, LA, VJ Orphan, GW Rouse, AE Rathburn, W Ussler III, GS Cook, SK Goffredi, EM Perez, A Waren, B Grupe, G. Chadwick, and B. Strickrott. "Hybridization of vent and seep ecosystems in the deep sea," Proceedings Royal Society of London, 2011.

Bailey, J. V, V. Salman, G.W. Rouse, H.N. Schulz-Vogt, L.A. Levin and V.J. Orphan. "Dimorphism in methane seep-dwelling ecotypes of the largest known bacteria," ISME J, 2011.

BOOKS/ONE TIME PROCEEDING

Harrison, B; O. Mason, V. Orphan. "MICROBIAL COMMUNITY SIGNATURES ASSOCIATED WITH DISCRETE PHASES OF CARBONATE MINERALIZATION IN METHANE SEEP ENVIRONMENTS", 10/01/2009-09/30/2010,

2010, "17th annual International Society of Microbial Ecology symposium. Seattle, WA".

Bailey, J; Salman, V; Rouse, G; Orphan, V; Schulz-Vogt, H; Levin,L.. "DIMORPHISM IN METHANE SEEP INHABITING THIOMARGARITA", 10/01/2009-09/30/2010, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

Dekas, A; Hansman, R; Sessions, A; Lee, R; Bowles, M; Joye, S; Orphan, V. "INVESTIGATING BENTHIC NITROGEN FIXATION AT SITES OF NATURAL CARBON LOADING ALONG THE EAST PACIFIC MARGIN", 10/01/2009-09/30/2010, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

Tavormina, P; Ussler, W; Orphan, V. "ABUNDANCE AND DISTRIBUTIONS OF PELAGIC METHANOTROPHS ALONG THE EASTERN PACIFIC CONTINENTAL MARGIN", 10/01/2009-09/30/2010, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

Harrison, B; O. Mason, V. Orphan. "MICROBIAL COMMUNITY SIGNATURES ASSOCIATED WITH DISCRETE PHASES OF CARBONATE MINERALIZATION IN METHANE SEEP ENVIRONMENTS", 10/01/2010-09/30/2011, 2010, "17th annual International Society of Microbial Ecology symposium. Seattle, WA".

Bailey, J; Salman, V; Rouse, G; Orphan, V; Schulz-Vogt, H; Levin,L.. "DIMORPHISM IN METHANE SEEP INHABITING THIOMARGARITA", 10/01/2010-09/30/2011, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

Dekas, A; Hansman, R; Sessions, A; Lee, R; Bowles, M; Joye, S; Orphan, V. "INVESTIGATING BENTHIC NITROGEN FIXATION AT SITES OF NATURAL CARBON LOADING ALONG THE EAST PACIFIC MARGIN", 10/01/2010-09/30/2011, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

Tavormina, P; Ussler, W; Orphan, V. "ABUNDANCE AND DISTRIBUTIONS OF PELAGIC METHANOTROPHS ALONG THE EASTERN PACIFIC CONTINENTAL MARGIN", 10/01/2010-09/30/2011, 2010, "17th annual International Society of Microbial Ecology symposium Seattle, WA".

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Program Information

Integrated Marine Biogeochemistry and Ecosystem Research -US (IMBER-US)

Website: http://www.imber.info/

Coverage: global

The BCO-DMO database includes data from IMBER endorsed projects lead by US funded investigators. There is no dedicated US IMBER project or data management office. Those functions are provided by US-OCB and BCO-DMO respectively.

The information in this program description pertains to the Internationally coordinated IMBER research program. The projects contributing data to the BCO-DMO database are those funded by US NSF only. The full IMBER data catalog is hosted at the Global Change Master Directory (GCMD).

IMBER Data Portal: The IMBER project has chosen to create a metadata portal hosted by the NASA's Global Change Master Directory (GCMD). The GCMD IMBER data catalog provides an overview of all IMBER endorsed and related projects and links to datasets, and can be found at URL http://gcmd.nasa.gov/portals/imber/.

IMBER research will seek to identify the mechanisms by which marine life influences marine biogeochemical cycles, and how these, in turn, influence marine ecosystems. Central to the IMBER goal is the development of a predictive understanding of how marine biogeochemical cycles and ecosystems respond to complex forcings, such as large-scale climatic variations, changing physical dynamics, carbon cycle chemistry and nutrient fluxes, and the impacts of marine harvesting. Changes in marine biogeochemical cycles and ecosystems due to global change will also have consequences for the broader Earth System. An even greater challenge will be drawing

together the natural and social science communities to study some of the key impacts and feedbacks between the marine and human systems.

To address the IMBER goal, four scientific themes, each including several issues, have been identified for the IMBER project: Theme 1 - Interactions between Biogeochemical Cycles and Marine Food Webs; Theme 2 - Sensitivity to Global Change: How will key marine biogeochemical cycles, ecosystems and their interactions, respond to global change?; Theme 3 - Feedback to the Earth System: What are the roles of the ocean biogeochemistry and ecosystems in regulating climate?; and Theme 4 - Responses of Society: What are the relationships between marine biogeochemical cycles, ecosystems, and the human system?

U.S. GLOBal ocean ECosystems dynamics (U.S. GLOBEC)

Website: http://www.usglobec.org/

Coverage: Global

U.S. GLOBEC (GLOBal ocean ECosystems dynamics) is a research program organized by oceanographers and fisheries scientists to address the question of how global climate change may affect the abundance and production of animals in the sea.

The U.S. GLOBEC Program currently had major research efforts underway in the Georges Bank / Northwest Atlantic Region, and the Northeast Pacific (with components in the California Current and in the Coastal Gulf of Alaska). U.S. GLOBEC was a major contributor to International GLOBEC efforts in the Southern Ocean and Western Antarctic Peninsula (WAP).

United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Website: http://www.us-solas.org/

Coverage: Global

The Surface Ocean Lower Atmosphere Study (SOLAS) program is designed to enable researchers from different disciplines to interact and investigate the multitude of processes and interactions between the coupled ocean and atmosphere.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds, and also weather and hazards that are affected by processes at the surface ocean.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds.

Physical, chemical, and biological research near the ocean-atmosphere interface must be performed in synergy to extend our current knowledge to adequately understand and forecast changes on short and long time frames and over local and global spatial scales.

The findings obtained from SOLAS are used to improve knowledge at process scale that will lead to better quantification of fluxes of climate relevant compounds such as CO2, sulfur and nitrogen compounds, hydrocarbons and halocarbons, as well as dust, energy and momentum. This activity facilitates a fundamental understanding to assist the societal needs for climate change, environmental health, weather prediction, and national security.

The US SOLAS program is a component of the International SOLAS program where collaborations are forged with investigators around the world to examine SOLAS issues ubiquitous to the world's oceans and atmosphere.

Â» International SOLAS Web site

Science Implementation Strategy Reports

US-SOLAS (4 MB PDF file)
Other SOLAS reports are available for download from the US SOLAS Web site

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0825791
NSF Division of Ocean Sciences (NSF OCE)	OCE-0826254
NSF Division of Ocean Sciences (NSF OCE)	OCE-0825436

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