C14 and N15 isotopes in rocks and animals from methane seep hard substrate ecosystems from R/V Atlantis AT15-44 in the Pacific, off Costa Rica from 2009-2009 (Seep Carbonate Ecology CROCKS II project)

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Project
» Short-term colonization processes at Costa Rica methane seeps (Seep Carbonate Ecology CROCKS II)

Contributors	Affiliation	Role
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Dataset Description

Average stable isotopic signatures (d15N and d13C) for carbonate rocks and animals collected during AT 15-44 at various methane seep sites on the Costa Rica margin. The values are averages, not actual measurements. Researchers needing the raw data should seek them from llevin@ucsd.edu.

Animal tissues were sorted, processed and analysed according to methods in Levin & Mendoza.

Levin, L. A. & Mendoza, G. (2007) "Community structure and nutrition of deep methane seep macroinfauna from the Aleutian Margin and Florida Escarpment, Gulf of Mexico." Mar. Ecol. 28, 131-151. (doi:10.1111/j.1439-0485.2006.00131.x)

For further information, see:

Lisa A. Levin, Victoria J. Orphan, Greg W. Rouse, Anthony E. Rathburn, William Ussler III, Geoffrey S. Cook, Shana K. Goffredi, Elena M. Perez, Anders Waren, Benjamin M. Grupe, Grayson Chadwick and Bruce Strickrott.(2012) "A hydrothermal seep on the Costa Rica margin: middle ground in a continuum of reducing ecosystems" Proc. R. Soc. B published online 7 March 2012. doi: 10.1098/rspb.2012.0205

From Final Report:

At Costa Rica, carbonate organic matter content was high (0.5 to 3.5%). Organic matter in the carbonates had d 13C signatures of -65o/oo to -23o/oo indicating a varied methane contribution to the C pool. Faunal isotopic signatures ranged broadly, from -101o/oo to -10o/oo for d13C and -12 to +18 for d 15N. They revealed strong trophic resource partitioning among mollusk and polychaete species. A broad range of d 13C signatures reflect use of a variety of microbial food resources, often within a single rock. Very light d 13C signatures (mean -92o/oo, n=18) in an abundant dorvilleid polychaete (Dorvillea sp.) in the most sulfidic carbonates provides evidence of a carbonate endolithofauna that may rely primarily on archaeal carbon. Intense grazing of rocks by lepetopsid limpets many with isotopic evidence for methane-derived C, apparently

exerts strong top-down control on the distribution of protists and smaller invertebrates.

At Hydrate Ridge, inorganic d13C values of carbonates ranged from -26o/oo to -54o/oo, whereas the rock organic d13C spanned a much broader range (from -19o/oo to -71o/oo.). Within a rock the two values were not correlated and there were no significant isotopic differences on average between active and inactive carbonates, although inactive values were less variable. Natural abundance animal carbon isotope signatures ranged from -17o/oo to -88o/oo, with average values of animals (per rock) showing no significant difference between active and inactive sites (P-0.232). However, carbonate d13C org (P=0.002) and d15N (animal P=0.005) were isotopically lighter on rocks designated as active, relative to those designated as inactive.

Data Processing Description

Samples were kept cold (5o C), sieved through a 0.3 mm mesh, and sorted live at sea to collect macrofauna for stable isotopic analyses. Living specimens were identified, allowed to clear guts overnight in filtered seawater, washed in milli Q water and placed in preweighed tin boats or combusted vials (500o C overnight) and frozen at 70o C. In the laboratory, specimens were oven dried (60o C), weighed and acidified with 1% PtCl2 to remove inorganic C. Stable isotope measurements (d13C, d15N) were made on single individuals, parts of individuals or several small specimens of a single species combined. Analyses were conducted on a Finnigan Conflow 2 continuous flow system and a Fisons NA 1500 elemental analyzer coupled to a Finnegan Delta S isotope ratio mass spectrometer at Boston University and on a continuous flow PDZ Europa 20/20 isotope ratio mass spectrometer at UC Davis. Isotope ratios are expressed as d13C or d15N in units of per mil (o/oo). Standards were Pee Dee Belemnite Belemnite and nitrogen gas (atmospheric). Estimates of the percentage of methane-derived carbon in the macrofaunal carbon pool of each region and habitat were generated using a two-source, single isotope mixing model as in Fry & Sherr (1984). The formula is:
Fm = (di - dPOC)/(dm - dPOC)
where di, dPOC, and dm refer to the d13C signatures of infauna, particulate organic carbon (POC), and methane, respectively. The POC value was taken to be the average d13C signature of non-seep fauna sampled by this study in each region. No trophic shift was included as this is negligible (<1o/oo per trophic level) for d13C.

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Data Files

File
seep_isotopes.csv (Comma Separated Values (.csv), 2.73 KB) MD5:d6098f2bb8a44d90497a7d9b6aba92f2 Primary data file for dataset ID 3761

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Parameters

Parameter	Description	Units
activity	methane seep activity at station	text
station	station identification	text
lat	latitude; North is positive	decimal degrees
lon	longitude; East is positive	decimal degrees
dive_id	Alvin dive identification number	integer
sample	rock identifier	text
depth_w	depth of water	meters
region	region of sampling	text
delC13_rock	mean ratio of stable isotopes 13C:12C in carbonate rock sample as compared with the PDB standard.	parts per thousand (o/oo)
delC13_animal	mean ratio of stable isotopes 13C:12C in animal tissue sample as compared with the PDB standard.	parts per thousand (o/oo)
delC13_animal_err	standard error of delta-13C in animal tissue vs. the PDB standard	parts per thousand (o/oo)
delN15_rock	mean ratio of stable isotopes 15N:14N in carbonate rock sample.	parts per thousand (o/oo)
delN15_animal	mean ratio of stable isotopes 15N:14N in animal tissue sample as compared with the air standard.	parts per thousand (o/oo)
delN15_animal_err	standard error of delta-15N in animal tissue vs. air standard	parts per thousand (o/oo)

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Instruments

Dataset-specific Instrument Name	Alvin tube core
Generic Instrument Name	Alvin tube core
Generic Instrument Description	A plastic tube, about 40 cm (16 inches) long, is pushed into the sediment by Alvin's manipulator arm to collect a sediment core.

Dataset-specific Instrument Name	Multi Corer
Generic Instrument Name	Multi Corer
Dataset-specific Description	Ocean Instruments MultiCorer
Generic Instrument Description	The Multi Corer is a benthic coring device used to collect multiple, simultaneous, undisturbed sediment/water samples from the seafloor. Multiple coring tubes with varying sampling capacity depending on tube dimensions are mounted in a frame designed to sample the deep ocean seafloor. For more information, see Barnett et al. (1984) in Oceanologica Acta, 7, pp. 399-408.

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Deployments

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.

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Project Information

Short-term colonization processes at Costa Rica methane seeps (Seep Carbonate Ecology CROCKS II)

Coverage: Costa Rica seafloor methane seeps 8 deg 55 N 84 deg 18 W depth 990m

This RAPID project will conduct 5 submersible or ROV dives to collect a series of colonization experiments deployed in March 2009 on Mound 12 off Costa Rica (997 m). These experiments were deployed opportunistically, and to optimize the information that could be obtained, the PIs needed to recover them within a 12 month time frame. Early colonization of rock, wood, shell and tube substrates will be studied. The microbes, foraminiferans and metazoans present after 6-12 mo will be compared to those colonizing similar experiments to be deployed at Hydrate Ridge, where seeps occur within an oxygen minimum zone. The overall project goal is to integrate physical, geological, chemical and biological data to develop a holistic view of the influence of seep-generated carbonate hard-ground ecosystems on margins.

The objectives of the research are to (a) Compare colonizers at seeps off Costa Rica and Hydrate Ridge to assess the importance of different oxygen regimes in the development of anaerobic methane oxidation, sulfide oxiders and other microbial metabolisms on hard substrates, and to evaluate their roles in driving protozoan and metazoan succession at methane seeps. (b) Deploy a suite of biotic and abiotic substrates to distinguish the specific roles of carbonate substrate from those of other hard substrates (wood, clam and mussel shells, worm tubes) available. (c) Explore the similarity of vent and seep colonization processes by comparing colonization at the Costa Rica seeps, where vent species are common, to the Hydrate Ridge seeps, where they are not. (d) Determine whether there are diagnosable biogeographic isotope or other biomarker signatures from newly recruited Costa Rica microbial, foraminiferal and animal populations at active vs. inactive seeps, and whether these differ from those at Hydrate Ridge.

This research will involve international participation from Costa Rican scientists at the Univ. of Costa Rica.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0825791
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NSF Division of Ocean Sciences (NSF OCE)	OCE-0939232
NSF Division of Ocean Sciences (NSF OCE)	OCE-0939557

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