Calculated power from the oxidation of necromass that is produced in marine sediment on a global scale.

Website: https://www.bco-dmo.org/dataset/784480
Data Type: Other Field Results
Version: 1
Version Date: 2019-12-20

Project
» Develop a 1D biogeochemical-evolutionary model for deep sediments (BIO-SED)

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

Contributors	Affiliation	Role
Bradley, James	University of Southern California (USC)	Principal Investigator
LaRowe, Doug	University of Southern California (USC)	Co-Principal Investigator
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Abstract
Calculated power from the oxidation of necromass that is produced in marine sediment on a global scale.

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Coverage

Spatial Extent: **Lat**:-41.85 **Lon**:-153.1

Dataset Description

This sheet contains data on calculated power from the oxidation of necromass that is produced in marine sediment on a global scale.

This project quantifies the role of microbial necromass and organic carbon as a power source to living microorganisms in marine sediments. The project utilizes a physiochemical model of marine sediment bioenergetics using data available in the literature and well-established modeling constructs. Data sources and model formulation are described in Bradley et al. 2018 (DOI: 10.1002/2017JG004186). For modelling South Pacific Gyre sediments, cell abundance and particulate organic carbon concentrations were determined for site U1370 (IODP Expedition 329) based on published analysis of extracted drill cores: D'Hondt et al. 2015 (DOI: 10.1038/ngeo2387); D'Hondt et al. 2011 (DOI: 10.2204/iodp.proc.329.2011). For modelling global cell abundance, we use the formulation described in Parkes et al. 2014 (DOI: 10.1016/j.margeo.2014.02.009).

Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- added latitude and longitude coordinates for site U1370

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Related Publications

(2011). Proceedings of the IODP. doi:10.2204/iodp.proc.329.2011

Bradley, J. A., Amend, J. P., & LaRowe, D. E. (2018). Necromass as a Limited Source of Energy for Microorganisms in Marine Sediments. Journal of Geophysical Research: Biogeosciences, 123(2), 577–590. doi:10.1002/2017JG004186

D'Hondt, S., Inagaki, F., Zarikian, C. A., Abrams, L. J., Dubois, N., Engelhardt, T., … Ziebis, W. (2015). Presence of oxygen and aerobic communities from sea floor to basement in deep-sea sediments. Nature Geoscience, 8(4), 299–304. doi:10.1038/ngeo2387

Parkes, R. J., Cragg, B., Roussel, E., Webster, G., Weightman, A., & Sass, H. (2014). A review of prokaryotic populations and processes in sub-seafloor sediments, including biosphere:geosphere interactions. Marine Geology, 352, 409–425. doi:10.1016/j.margeo.2014.02.009

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Parameters

Parameter	Description	Units
Depth_below_SWI	depth below sea water interface	meters (m)
Sediment_Age	sediment age	years
Power_law_cells	power law cells	cells per centimeter cubed (cells/cm3)
Necromas	Necromass	cells per centimeter cubed per year (cells/cm3/yr)
Death_rate	death rate	per year (yr-1)
Power_cell_size_small	Power available from necromass oxidation. Temp: 21.1 C; Electron acceptor: oxygen; Power cell size small	nanoJoules per year (nJ/yr)
Power_cell_size_medium	Power available from necromass oxidation. Temp: 21.1 C; Electron acceptor: oxygen; Power cell size medium	nanoJoules per year (nJ/yr)
Power_cell_size_large	Power available from necromass oxidation. Temp: 21.1 C; Electron acceptor: oxygen; Power cell size large	nanoJoules per year (nJ/yr)
lat	latitude with negative values indicating South	decimal degrees
lon	longitude with negative values indicating West	decimal degrees

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Project Information

Develop a 1D biogeochemical-evolutionary model for deep sediments (BIO-SED)

Website: https://www.darkenergybiosphere.org/award/develop-a-1d-biogeochemical-evolutionary-model-for-deep-sediments/

Abstract (from C-DEBI, www.darkenergybiosphere.org) Microorganisms buried in marine sediments endure prolonged energy-limitation over geological timescales. My research within C-DEBI is motivated by the quest to determine and understand activity levels among microbial communities in the marine subsurface in relation to their geochemical and physical environment. To this end, in collaboration with Doug LaRowe and Jan Amend (USC), I developed novel modelling frameworks based on thermodynamic and microbial-modelling principles to explore and quantify: The energy sources to deeply buried microorganisms and their demand for energy. The activity of microorganisms and the factors that determine physiological transitions between active and dormant states. The varying energy requirements of active and dormant microbes and the allocation of energy between maintenance and growth. The cell-specific energy utilization (i.e. power) of subsurface life on a global scale. I led the development of a new freely-available and open-source platform MicroLow 1.0 – a process-based microbial model that explicitly considers physiological state transitions and energy for maintenance and growth. Using this model, I showed that energetic efficiency provides a selective advantage for long-term microbial survival in oligotrophic marine sediments. Numerous additional opportunities have arisen thanks to the C-DEBI program and community, including participation in two collaborative workshops (organic carbon preservation, impacts of deep sea mining), numerous valuable interactions, ongoing collaborations and spin-off projects, presentations at international conferences, professional development opportunities, media exposure, complementary funding including a Deep Carbon Observatory DLMV Fellowship, significant widening of my professional network, fieldwork opportunities, and career progression.

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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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