

Effects of temperature on biomass and sulfide production in *Desulfovibrio hydrothermals* (INSPIRE_Pyrite project)

Website: <https://www.bco-dmo.org/dataset/638091>

Data Type: experimental

Version: working

Version Date: 2016-02-09

Project

» [INSPIRE Track 1: Microbial Sulfur Metabolism and its Potential for Transforming the Growth of Epitaxial Solar Cell Absorbers](#) (INSPIRE_Pyrite)

Contributors	Affiliation	Role
Girguis, Peter	Harvard University	Principal Investigator
Clarke, David	Harvard University	Co-Principal Investigator
Allison, Dicky	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

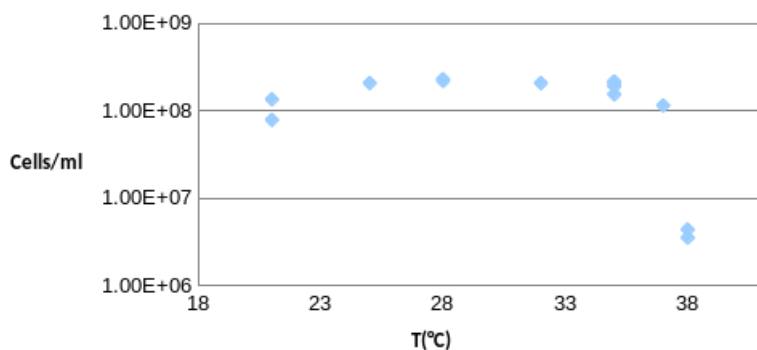
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [Data Processing Description](#)
- [Data Files](#)
- [Parameters](#)
- [Instruments](#)
- [Project Information](#)
- [Funding](#)

Dataset Description

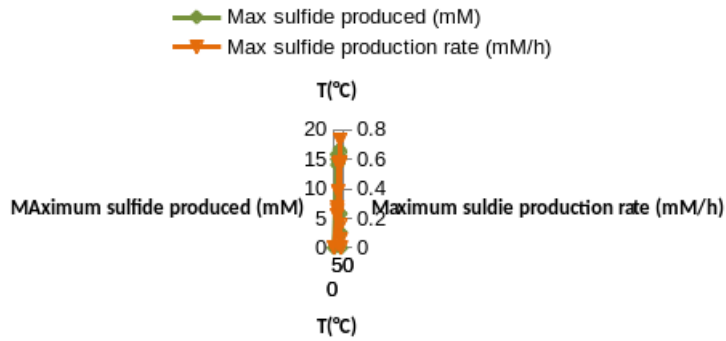
Effects of temperature on biomass and sulfide production in *Desulfovibrio hydrothermalis* strain AM13 across a range of biologically relevant temperatures. Measured biomass production (cell concentration in stationary phase) and maximum sulfide concentration produced and maximum sulfide production rate in the exponential phase.

Figures included with the data:

Cell concentration in stationary phase



Sulfide production



Methods & Sampling

Inoculum: 200 µl stock culture (stationary phase) into 50 ml medium (expected at t0: 8.0 E+5 cells/ml).

"The time between t0 and tend is variable. We wait to reach the stationary phase. The rate is the maximum rate (exponential phase of sulfide production)." A. Picard, personal communication.

Data Processing Description

Method for cell counting: Cell cultures were fixed with 3.7% formaldehyde for cell counts. Between 100 and 1,000 microliters of fixed sample were filtered onto a 0.2 µm GTBP polycarbonate filter (Millipore), stained with DAPI (4',6'-diamidino-2-phenylindole; Sigma), and counted via epifluorescent microscopy, using a Zeiss Axiophot scope equipped with objectives capable of 20x, 60x and 100x magnification.

Method for sulfide concentration: Spectrophotometric quantification using standard curve after [Cline, 1969](#).

adapted to the range of concentrations in the cultures.

[[table of contents](#) | [back to top](#)]

Data Files

File
DhydroBioProd.csv (Comma Separated Values (.csv), 1.26 KB) MD5:6025ae334770865c9c6c7b2e019b4960
Primary data file for dataset ID 638091

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
phase	growth phase - exponential or stationary	text
temp	temperature	degrees Celsius
numb_cells_t0	number of cells at time = 0 (beginning)	cells per milliliter
numb_cells_tend	number of cells at time = end (of experiment)	cells per milliliter
max_sulfide_prod	maximum sulfide concentration produced	milliMoles
std_error_prod	standard error of maximum sulfide concentration	milliMoles
max_sulfide_prod_rate	maximum sulfide production rate	milliMoles per hour
std_error_rate	standard error of maximum sulfide production rate	milliMoles per hour

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	Epifluorescence Microscope - Zeiss Axiophot
Generic Instrument Name	Fluorescence Microscope
Dataset-specific Description	Light microscope equipped for bright field (both transmitted and reflected), phase contrast, transmitted and reflected polarization and Nomarski differential interference contrast microscopy, as well as epifluorescence.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of fluorescence and phosphorescence instead of, or in addition to, reflection and absorption of visible light. Includes conventional and inverted instruments.

Dataset-specific Instrument Name	spectrophotometer
Generic Instrument Name	Spectrophotometer
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

[[table of contents](#) | [back to top](#)]

Project Information

INSPIRE Track 1: Microbial Sulfur Metabolism and its Potential for Transforming the Growth of Epitaxial Solar Cell Absorbers (INSPIRE_Pyrite)

This INSPIRE award is partially funded by Biological Oceanography Program in Division of Ocean Sciences, in the Directorate of Geosciences; the Electronic and Photonic Materials Program in the Division of Materials Research, Directorate of Mathematical and Physical Sciences.

A simple idea motivates this project: By characterizing the mechanisms underlying pyrite film deposition by

subsurface microbes living at hydrothermal vents, can approaches be developed to controllably grow high-purity pyrite films that could be used to produce low-cost photovoltaic solar cells? Recent in situ studies at hydrothermal vents have found "subsurface" microbes associated with the deposition of large crystalline metal sulfides (up to 1.1 millimeters), including iron pyrite. In laboratory incubations, vent microbes specifically deposited pyrite (FeS₂), devoid of Zn, Cu and other metals that were abundant in the liquid media. Abiotic incubations did not exhibit this specificity. The investigators hypothesize that, in situ, microbes deposit pyrite via a number of potential processes, including a physiological process called extracellular electron transfer (EET), wherein microbes shuttle electrons to/from minerals. In situ, EET-enabled microbes may use conductive minerals to electrically access oxidants, and deposit pyrite on these surfaces. Vents are thus natural bioelectrochemical cells, which grow metal sulfides via microbial and abiotic electrochemical processes, though the details and mechanisms remain to be determined. This project is aimed at elucidating the mechanisms underlying microbial FeS₂ pyrite bio-deposition, and assessing how microbes might be used to deposit epitaxial films for solar cells absorbers. FeS₂ pyrite has been identified as prospective low cost solar absorbers because of their abundance, suitable band-gap (~0.95 eV) and high optical absorbance. Microbial pyrite film deposition at lower temperatures (<100 C) might offer a radically new, low cost approach to creating large area PV solar cells. Nothing is currently known about the mechanisms underlying microbial pyrite growth, though the large crystal sizes suggest epitaxial deposition is favored over re-nucleation implying that, once nucleated, epitaxial growth can occur. A series of experiments using natural vent microbial communities and isolates will be conducted to determine: A) environmental factors that influence bio-deposition; B) potential molecular mechanisms; C) the microstructural and electrical properties of these films; and D) whether bio-deposition by single species or consortia yields films of highest purity, size and homogeneity.

The project is both highly-integrated and transformative. It is relevant to our understanding of microbial sulfur cycling, as little is known about how microbes mediate crystalline pyrite formation and the degree to which this influences sulfur isotope geochemistry. Molecular studies will be used to interrogate relevant microbial metabolic processes and constrain the possible mechanisms of pyrite film growth, which is critical to advancing our ability to grow FeS₂ films for device applications. Understanding the effects of substrate crystallography and electrical conductivity on the growth morphology will further inform our knowledge of microbial pyrite deposition. Notably, this research differ from existing biomimetic approaches. The studies are not focused on crystal growth via tethered peptides or synthetic extracellular matrices. Rather, they aim to advance our understanding of natural biodeposition, use the insights gained to grow pyrite materials and devices.

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1344241

[[table of contents](#) | [back to top](#)]