Synchrotron micro-probe X-ray diffraction data from seafloor sulfide deposits collected during cruise AT42-09 on the East Pacific Rise (EPR) in April 2019

Website: https://www.bco-dmo.org/dataset/937020
Data Type: Other Field Results
Version: 2
Version Date: 2025-11-25

Project
» Collaborative Research: From hot to cold in the dark - shifts in seafloor massive sulfide microbial communities as physical and geochemical conditions change after venting ceases (Hot2cold Vents)

Contributors	Affiliation	Role
Toner, Brandy Marie	University of Minnesota Twin Cities (UMTC)	Co-Principal Investigator
Jones, Rose	University of Minnesota Twin Cities (UMTC)	Scientist, Contact
Mickle, Audrey	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Synchrotron micro-probe X-ray diffraction data were collected for seafloor sulfide deposits. Seafloor sulfide mineral samples were collected from hydrothermally active chimneys and inactive off-axis massive sulfide deposits at East Pacific Rise (EPR) 9.50°N in 2019-2021 on cruise AT42-09. Samples were collected using the HOV Alvin. Samples were placed in a positive-pressure glove bag flushed with N_2 (g), sparged with N_2, heat-sealed into mylar bags containing Anaeropaks, and stored at -20°C. Epoxy embedded petrographic thin sections were created using these samples. Subsamples were dried for 24 hours under N_2 (g), vacuum embedded in epoxy resin (Struers EpoFix Resin, 1L kit: Part #40200030) following manufacturer's guidelines, and cured under N_2 (g) for 24 hours. Each epoxy-embedded sample was pre-cut using a wafering saw then sent to Spectrum Petrographics, Inc. (Washington, USA) for preparation as 30 micron thick, double-polished thin sections mounted on quartz slides using methods to limit sample exposure to water and ambient air. When not in use, thin-sections were stored under N_2 (g) to limit oxidation. Thin sections were analyzed for X-ray diffraction at the X-ray Fluorescence Microprobe beamline "XFM", National Synchrotron Light Source II (NSLS II), Brookhaven National Laboratory, NY.

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Coverage

Location: East Pacific Rise (EPR) 9.50°N
Spatial Extent: **N**:9.84686048 **E**:-104.17492161 **S**:9.50320309 **W**:-104.29357589
Temporal Extent: 2019-04-04 - 2019-04-10

Dataset Description

File naming:

Sample name (e.g. ALV5015_01_R01b)/sample name noted at time of data collection if incorrectly noted at that time (e.g. 5015_01_R01b)_sub-map name where there is one (A, a, b, B etc.)_where p occurs, refers to point collected within a sample_KeV, where it occurs is beam energy information_other annotations e.g. full_real come from beamline scientists, left in the file name to keep file name as original as possible_number generated by beamline software at time of collection

Methods & Sampling

Synchrotron micro-probe X-ray diffraction data were collected for seafloor sulfide deposits. Seafloor sulfide mineral samples were collected from hydrothermally active chimneys and inactive off-axis massive sulfide deposits at East Pacific Rise (EPR) 9.50°N in 2019-2021 on cruises AT42-09. Samples were collected using the HOV Alvin.

Samples were placed in a positive-pressure glove bag flushed with N2 (g), sparged with N2, heat-sealed into mylar bags containing Anaeropaks, and stored at -20°C. Epoxy embedded petrographic thin sections were created using these samples. Subsamples were dried for 24 hours under N2 (g), vacuum embedded in epoxy resin (Struers EpoFix Resin, 1L kit: Part #40200030) following manufacturer's guidelines, and cured under N2 (g) for 24 hours. Each epoxy-embedded sample was pre-cut using a wafering saw then sent to Spectrum Petrographics, Inc. (Washington, USA) for preparation as 30 micron thick, double-polished thin sections mounted on quartz slides using methods to limit sample exposure to water and ambient air. When not in use, thin-sections were stored under N2 (g) to limit oxidation.

Thin sections were analyzed for X-ray diffraction at the X-ray Fluorescence Microprobe beamline "XFM", National Synchrotron Light Source II (NSLS II), Brookhaven National Laboratory, NY. X-ray diffraction patterns were collected from thin sections at XFM in transmission mode using a Perkin Elmer 1621 detector at 18 KeV (λ = 0.688801 Å) incident energy with a 60 s exposure time and 5 x 5µm spot size.

Data Processing Description

All data processing was done in software Dioptas (Prescher and Prakapenka 2015). The central beam stop was masked and substrate background subtracted. Diffraction patterns were radially integrated to obtain profiles of intensity verses 2θ.

BCO-DMO Processing Description

Version 1

* Adjusted title, abstract and methods to reflect and describe the submitted data specifically, accepted by submitter.
* Added cruise id to dataset itself.

Version 2

* Updated submitter file "Toner_Jones_XRD_summary V3.xlsx" in data pipeline workflow
* Changes made to some sample metadata (location, time, heading, and depth), based on manual review of video of sample collection while creating sample metadata for IGSN submissions

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Data Files

File	
937020_v2_xraydiffraction.csv	(Comma Separated Values (.csv), 63.21 KB) MD5:a5cd0a0a4f5fc21468b088862612a189
Primary data file for dataset ID 937020, version 2	

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Supplemental Files

File	
AT42-09.zip	(ZIP Archive (ZIP), 9.94 MB) MD5:0c5d68fc65a53be0c89137cf4d0ee146
X-ray diffraction data for cruise AT42-09: profiles of intensity verses 2θ. File namining Sample name (e.g. ALV5015_01_R01b)/sample name noted at time of data collection if incorrectly noted at that time (e.g. 5015_01_R01b)_sub-map name where there is one (A, a, b, B etc.)_where p occurs, refers to point collected within a sample_KeV, where it occurs is beam energy information_other annotations e.g. full_real come from beamline scientists, left in the file name to keep file name as original as possible_number generated by beamline software at time of collection	

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Related Publications

Prescher, C., & Prakapenka, V. B. (2015). DIOPTAS: a program for reduction of two-dimensional X-ray diffraction data and data exploration. High Pressure Research, 35(3), 223–230. https://doi.org/10.1080/08957959.2015.1059835
Software

Putz H, Brandenburg K Match! In: Match! - Phase Analysis using Powder Diffraction, Version 3.10.2, Crystal Impact. GbR, Kreuzherrenstr. 102, 53227 Bonn, Germany,. https://www.crystalimpact.de/match/. Accessed 7 Apr 2022
Software

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Parameters

Parameter	Description	Units
Cruise	Cruise ID (AT42-09)	unitless
File_name	file name	unitless
Sample_name	Sample name	unitless
Time	T0	unitless
Hydrotherml_vent_category	Type 1, 3 or 4	unitless
Location	Mosh Pit, M Vent area, Bio9	unitless
Lat_dd	Sampling latitude	decimal degrees
Lon_dd	Sampling longitude	decimal degrees
Depth_mbs	Sample depth below seafloor	meter below seafloor (mbs)
Hdg	Heading of vehicle at time of collection	degrees
Date_collected	Collection date in ISO format	unitless
Time_collected	Collection time in ISO format	unitless
ISO_DateTime_UTC	Collection DateTime in ISO format (UTC timezone)	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	HOV Alvin
Generic Instrument Description	Human Occupied Vehicle (HOV) Alvin is part of the National Deep Submergence Facility (NDSF). Alvin enables in-situ data collection and observation by two scientists to depths reaching 6,500 meters, during dives lasting up to ten hours. Commissioned in 1964 as one of the world's first deep-ocean submersibles, Alvin has remained state-of-the-art as a result of numerous overhauls and upgrades made over its lifetime. The most recent upgrades, begun in 2011 and completed in 2021, saw the installation of a new, larger personnel sphere with a more ergonomic interior; improved visibility and overlapping fields of view; longer bottoms times; new lighting and high-definition imaging systems; improved sensors, data acquisition and download speed. It also doubled the science basket payload, and improved the command-and-control system allowing greater speed, range and maneuverability. With seven reversible thrusters, it can hover in the water, maneuver over rugged topography, or rest on the sea floor. It can collect data throughout the water column, produce a variety of maps and perform photographic surveys. Alvin also has two robotic arms that can manipulate instruments, obtain samples, and its basket can be reconfigured daily based on the needs of the upcoming dive. Alvin's depth rating of 6,500m gives researchers in-person access to 99% of the ocean floor. Alvin is a proven and reliable platform capable of diving for up to 30 days in a row before requiring a single scheduled maintenance day. Recent collaborations with autonomous vehicles such as Sentry have proven extremely beneficial, allowing PIs to visit promising sites to collect samples and data in person within hours of their being discovered, and UNOLs driven technological advances have improved the ability for scientific outreach and collaboration via telepresence Alvin is named for Allyn Vine, a WHOI engineer and geophysicist who helped pioneer deep submergence research and technology. (from https://www.whoi.edu/what-we-do/explore/underwater-vehicles/hov-alvin/, accessed 2022-09-09)

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Deployments

AT42-09

Website	https://www.bco-dmo.org/deployment/937024
Platform	R/V Atlantis
Start Date	2019-03-25
End Date	2019-04-23

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Project Information

Collaborative Research: From hot to cold in the dark - shifts in seafloor massive sulfide microbial communities as physical and geochemical conditions change after venting ceases (Hot2cold Vents)

Coverage: East Pacific Rise

NSF Award Abstract:
Hydrothermal vents, which deposit seafloor massive sulfides (SMS), occur along the 89,000 km of mid-ocean

ridges, submarine volcanoes, and backarc basins that occur at tectonic plate boundaries in the ocean. Active hydrothermal vent sulfide chimneys are hotspots of biodiversity and productivity in the deep ocean, as well as potential resources for metals. While significant effort has focused on understanding the diversity of biological communities and geochemistry associated with actively venting SMS, relatively little is known about the biological communities associated with SMS once venting ceases. Furthermore, little is known about the microbiological and geochemical changes that occur during the transition period from active to inactive, during which an important succession occurs in the microbial community and geochemistry of fluids within the chimney. This interdisciplinary project will create and sample this transition period by collecting multiple active SMS samples from individual vents at 9 degrees N East Pacific Rise and allowing them to transition to inactive on the seafloor, mimicking the end of venting while allowing for the exact time when venting ceased to be known, something not possible when sampling naturally formed inactive SMS. Microbial community diversity and metabolism will be analyzed in parallel with bulk and fine-scale geological measurements for active, transitioning, and inactive sulfides. This seafloor experimental and analytical approach will provide knowledge of how microbial communities, rates of biogeochemical transformations, and geological conditions change as SMS transition from hot and actively venting to cold and inactive. Students in grades 6-8 will be entrained into the project through research cruise "ship-to-shore" interactions and communications, post-cruise workshops for educators working with students typically underrepresented in STEM fields, and a collaboration with the Science, Engineering, Art and Design Gallery (SEAD), a community and economic development project in Bryan, TX.

Hydrothermal vents are quantitatively important to the biology and chemistry of the deep ocean, but the vast majority of current knowledge focuses on actively venting deposits. However, after venting ceases, sulfides can persist on the seafloor for tens of thousands of years, making them long-lived, globally-abundant microbial substrates. In recent years, studies of inactive SMS found drastically different microbial communities than those on active deposits, indicating a succession of the microbial community, and thus a potentially different impact on deep ocean biodiversity and biogeochemistry than actively venting deposits. However, ages of the inactive structures are often not known, so it is impossible to estimate how quickly these changes occur, and how quickly co-occurring changes in sulfide mineralogy and microbiological communities occur. This project will provide the first insight into what happens at the microbial and mineralogical level as SMS initially transition from active to inactive. Active SMS will be sampled and analyzed for microbial community composition, functional capacity, gene expression and metabolic rates. Co-located subsamples will be analyzed for porosity and bulk and fine-scale mineralogy. Subsamples of those active SMS samples will be left on the seafloor to incubate and be collected weeks and a year or more later, with the same analyses conducted upon collection. This will allow for determination of microbiological and mineralogical changes that occur during that initial transition and for comparison with older inactive SMS from the same vent fields. Together, the data collected will be integrated to generate a conceptual model of succession of biology, mineralogy, porosity and pore distribution as vent deposits transition from active to inactive. This project will fill a knowledge gap about hydrothermal ecosystems and has the potential to transform the current understanding of diversity and rates of change in these important seafloor biomes.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756339
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756558
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756419

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