

Trace metal CTD bottle sensor data from the Hydrothermal Estuaries expedition to the Juan de Fuca hydrothermal plume, Northeast Pacific Ocean, aboard R/V Atlantis (AT50-15) in August and September 2023

Website: <https://www.bco-dmo.org/dataset/1008499>

Data Type: Cruise Results

Version: 1

Version Date: 2026-09-30

Project

» [Collaborative Research: Hydrothermal Estuaries: What Sets the Hydrothermal Flux of Fe and Mn to the Oceans?](#) (Hydrothermal Estuaries)

Contributors	Affiliation	Role
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Abstract

This dataset includes the processed bottle-CTD sensor data collected with depth profiles of a trace metal clean CTD owned by the Fitzsimmons lab and deployed on the Hydrothermal Estuaries cruise to the Endeavour hydrothermal plume, Juan de Fuca Ridge, Northeast Pacific Ocean aboard R/V Atlantis (AT50-15) from August to September 2023. Data are only shown for the depths on which Niskin-X bottles were closed. Bottles were closed on the upcast only, and every depth has duplicate bottles fired to satisfy our water budget requirements. Station locations were selected using modeling estimates and sensor data from the AUV Sentry; a station upstream of the hydrothermal plume was also sampled as a background. Each station (except for the background) targeted the most concentrated plume at sequential distances aimed to represent increasing plume age.

Table of Contents

- [Coverage](#)
- [Dataset Description](#)
 - [Methods & Sampling](#)
 - [Data Processing Description](#)
 - [BCO-DMO Curation Notes](#)
 - [Problem Description](#)
- [Data Files](#)
- [Related Datasets](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

Coverage

Location: Endeavour Segment, Juan de Fuca Ridge, Northeast Pacific Ocean

Spatial Extent: N:48.003363 E:-129.060304 S:47.923545 W:-129.235036

Temporal Extent: 2023-08-28 - 2023-09-15

Methods & Sampling

This dataset includes the processed bottle-CTD sensor data collected with depth profiles of a trace metal clean

CTD owned by the Fitzsimmons lab and deployed on the Hydrothermal Estuaries cruise to the Endeavour hydrothermal plume, Juan de Fuca Ridge, Northeast Pacific Ocean aboard R/V Atlantis (AT50-15) from August-September 2023. Data are only shown for the depths on which Niskin-X bottles were closed. Bottles were closed on the upcast only, and every depth has duplicate bottles fired to satisfy our water budget requirements. Station locations were selected using modeling estimates and sensor data from the AUV Sentry; a station upstream of the hydrothermal plume was also sampled as a background. Each station (except for the background) targeted the most concentrated plume at sequential distances aimed to represent increasing plume age.

Data were collected using a Sea-bird SBE 19+v2 CTD instrument package designed to continuously measure conductivity, temperature, and pressure, and all titanium housings were used to satisfy trace metal clean conditions. The CTD includes two components, the deck unit (SBE 33) and underwater unit (SBE 19+v2) for real-time monitoring. The SBE 19+v2 comes with the standard three sensors and can hold up to six additional sensors. Here we chose to supplement the CTD data with oxygen (SBE 43), transmissometry (C-Star), and turbidity (Seapoint Turbidity Meter and a 100x gain cable).

Profiles were taken at each of the five main vent sites at the Main Endeavour Field (between 48°00 N and 47°54 N) and stations up to 20 kilometers west from these sites. Stations were selected based on modeling and AUV Sentry surveys to target the hydrothermal plume. An upstream background station was also sampled north of the vent site. All samples taken were deeper than 1700 meters.

Data Processing Description

Real-time data monitoring during the cruise used the Sea-bird software Seasave Version 7.26.7.121, and data were processed after the cruise using SBE Data Processing to extract CTD data at bottle trip depths.

Flagging is consistent with the WOCE Hydrographic Program Quality Flags flagging scheme.

WOCE CTD Quality Code descriptions can be found at <https://exchange-format.readthedocs.io/en/latest/quality.html#ctd-quality-codes>, and are replicated below:

- 1: Bottle information unavailable.
- 2: No problems noted.
- 3: Leaking.
- 4: Did not trip correctly.
- 5: Not reported.
- (6): (Significant discrepancy in measured values between Gerard and Niskin bottles.)
- (7): (Unknown problem.)
- (8): (Pair did not trip correctly. Note that the Niskin bottle can trip at an unplanned depth while the Gerard trips correctly and vice versa.)
- 9: Samples not drawn from this bottle.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Imported original file "2025-1104-BCO-DMO_HydEst_CTD_Btl_combined.xlsx" (sheet 1) into the BCO-DMO data processing system.
- Removed trailing "Z" characters from ISO_DATE_TIME_START_EVENT and ISO_DATE_TIME_END_EVENT columns because these columns are reported as being in the PDT time zone.
- Renamed columns to indicate PDT local time: START_DATE to START_DATE_PDT, START_EVENT to START_TIME_PDT, ISO_DATE_TIME_START_EVENT to ISO_DATE_TIME_START_PDT, END_DATE to END_DATE_PDT, END_EVENT to END_TIME_PDT, ISO_DATE_TIME_END_EVENT to ISO_DATE_TIME_END_PDT.
- Converted ISO_DATE_TIME_START_PDT from PDT timezone to UTC datetime, output as ISO_DATE_TIME_START_UTC.
- Converted ISO_DATE_TIME_END_PDT from PDT timezone to UTC datetime, output as

ISO_DATE_TIME_END.UTC.

- Converted START_DATE_PDT and END_DATE_PDT columns from format %m-%d-%y to date output format %Y-%m-%d.
- Converted START_TIME_PDT and END_TIME_PDT columns to time type using format %H:%M.
- Saved the final file as "1008499_v1_hydest_tm-ctd_bottle.csv".

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed. See: <https://www.bco-dmo.org/how-to/standard-curation-edits>

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

Problem Description

When double-tripping Niskin-X bottles at the same depth, occasionally the signal from the duplicate Niskin-X was missed if the "fire" button was pressed too fast. This resulted in no data collected from the sensors for that bottle but still closed the bottle correctly. These bottles were flagged with "1", and data were extrapolated from its duplicate. One pair of Niskin-X firings was missing data from both bottles, so data were extrapolated from the CTD upcast (averaged over 1 meter of data).

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

Data Files

File
1008499_v1_hydest_tm-ctd_bottle.csv (Comma Separated Values (.csv), 77.74 KB) MD5:bd6e291038b4099f6934608c4fedf5be
Primary data file for dataset ID 1008499, version 1

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

Related Datasets

IsRelatedTo

Fitzsimmons, J. N., Dick, K. (2026) **Upcast sensor data (1 m-binned) from the trace metal CTD on the Hydrothermal Estuaries expedition to the Juan de Fuca hydrothermal plume, Northeast Pacific Ocean, aboard R/V Atlantis (AT50-15) in August and September 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-10-01
doi:10.26008/1912/bco-dmo.1008753.1 [view at BCO-DMO]

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

Parameters

Parameter	Description	Units
EXPCODE	expedition code assigned by the CCHDO: NODCSHIPCodeYearMonthDay	unitless
CRUISE_ID	Cruise ID	unitless

CRUISE_NAME	Cruise name	unitless
EVENTNO	Event number	unitless
STNNBR	Station number	unitless
CASTNO	Cast number	unitless
START_DATE_PDT	Date the cast started (PDT)	unitless
START_TIME_PDT	Time the cast started (PDT)	unitless
ISO_DATE_TIME_START_PDT	Date/Time the cast started (ISO formatted) (PDT)	unitless
ISO_DATE_TIME_START_UTC	Date/Time the cast started (ISO formatted) (UTC)	unitless
END_DATE_PDT	Date the cast ended (PDT)	unitless
END_TIME_PDT	Time the cast ended (PDT)	unitless
ISO_DATE_TIME_END_PDT	Date/Time the cast ended (ISO formatted) (PDT)	unitless
ISO_DATE_TIME_END_UTC	Date/Time the cast ended (ISO formatted) (UTC)	unitless
START_EVENT_LAT	Latitude cast started	decimal degrees
START_EVENT_LON	Longitude cast started	decimal degrees
END_EVENT_LAT	Latitude cast ended	decimal degrees
END_EVENT_LON	Longitude cast ended	decimal degrees
BTMDEPTH	Depth of ocean floor	meters
BTLNBR	Niskin-X bottle number	unitless
BTLPOS	Niskin-X bottle position on the rosette	unitless

SAMPNO	Unique Niskin-X (or other sample) identifier (sequential across all casts of expedition)	unitless
BTL_FLAG_W	Bottle Quality Flag (see WOCE Flag definitions)	unitless
CTDPRS	CTD pressure (from sensor)	decibars
CTDPRS_FLAG_W	CTD pressure quality flag (see WOCE Flag definitions)	unitless
CTDDEPTH	Depth processed from pressure by the Seabird software	meters
CTDTMP	CTD temperature (from sensor); ITS-90	degrees Celsius
CTDTMP_FLAG_W	CTD temperature quality flag (see WOCE Flag definitions)	unitless
CTDSAL	CTD salinity is the calculated corrected value of salinity derived from the conductivity sensors on the CTD at the time of sampling	PSS-78
CTDSAL_FLAG_w	CTD salinity quality flag (see WOCE Flag definitions)	unitless
CTDOXY	CTD oxygen (from sensor)	micromoles per kilogram (umol/kg)
CTDOXY_FLAG_W	CTD oxygen quality flag (see WOCE Flag definitions)	unitless
TRANSM	Light transmission (0-100%) calculated from calibrated transmissometry sensor using SeaBird software	percent (%)
TRANSM_FLAG_W	CTD light transmission quality flag (see WOCE Flag definitions)	unitless
TURBIDITY	Turbidity (0-5 V DC)	Volts
TURBIDITY_FLAG_W	CTD turbidity quality flag (see WOCE Flag definitions)	unitless

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

Instruments

Dataset-specific Instrument Name	Sea-bird SBE 19+v2
Generic Instrument Name	Sea-Bird SBE 19plus V2 SEACAT CTD
Dataset-specific Description	This is a CTD instrument package designed to continuously measure conductivity, temperature, and pressure, and all titanium housings were used to satisfy trace metal clean conditions. The CTD includes two components, the deck unit (SBE 33) and underwater unit (SBE 19+v2) for real-time monitoring. The SBE 19+v2 comes with the standard three sensors and can hold up to six additional sensors. Here we chose to supplement the CTD data with oxygen (SBE 43), transmissometry (C-Star), and turbidity (Seapoint Turbidity Meter and a 100x gain cable).
Generic Instrument Description	Self-contained self-powered CTD profiler. Measures conductivity, temperature and pressure (Digiquartz sensor) in both profiling (samples at 4 scans/sec) and moored (sample rates of once every 5 seconds to once every 9 hours) mode. Available in plastic or titanium housing with depth ranges of 600m and 7000m respectively. Miniature submersible pump provides water to the conductivity cell. Compared to the previous 19plus, the V2 incorporates an electronics upgrade and additional features, with six differentially amplified A/D input channels, one RS-232 data input channel, and 64 MB FLASH memory.

Dataset-specific Instrument Name	SBE 43
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	The SBE 19+v2 comes with the standard three sensors and can hold up to six additional sensors. Here we chose to supplement the CTD data with oxygen (SBE 43), transmissometry (C-Star), and turbidity (Seapoint Turbidity Meter and a 100x gain cable).
Generic Instrument Description	The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. More information from the manufacturer: https://www.seabird.com/products/sbe-43-dissolved-oxygen-sensor

Dataset-specific Instrument Name	Seapoint Turbidity Meter
Generic Instrument Name	Seapoint Turbidity Meter
Dataset-specific Description	The SBE 19+v2 comes with the standard three sensors and can hold up to six additional sensors. Here we chose to supplement the CTD data with oxygen (SBE 43), transmissometry (C-Star), and turbidity (Seapoint Turbidity Meter and a 100x gain cable).
Generic Instrument Description	The Seapoint Turbidity Meter detects light scattered by particles suspended in water, generating an output voltage proportional to turbidity or suspended solids.

Dataset-specific Instrument Name	C-Star transmissometer
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	The SBE 19+v2 comes with the standard three sensors and can hold up to six additional sensors. Here we chose to supplement the CTD data with oxygen (SBE 43), transmissometry (C-Star), and turbidity (Seapoint Turbidity Meter and a 100x gain cable).
Generic Instrument Description	The C-Star transmissometer has a novel monolithic housing with a highly integrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: https://www.seabird.com/c-star-transmissometer/product?id=60762467717

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

Deployments

AT50-15

Website	https://www.bco-dmo.org/deployment/989978
Platform	R/V Atlantis
Start Date	2023-08-25
End Date	2023-09-14
Description	See more information from R2R: https://www.rvdata.us/search/cruise/AT50-15

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

Project Information

Collaborative Research: Hydrothermal Estuaries: What Sets the Hydrothermal Flux of Fe and Mn to the Oceans? (Hydrothermal Estuaries)

Coverage: Juan de Fuca Ridge

NSF Award Abstract:

Like volcanoes on land, the mid-ocean ridges that cross the ocean floor are not continuously erupting; however, the magmatic heat present just beneath the surface can continue to drive hot springs, just like the ones found within the crater of the "super volcano" at Yellowstone. In our recent work, we have shown that the chemicals released into the oceans from seafloor hot-springs can be dispersed all across the oceans. Now our interest has focused in on one element in particular, iron. This is one of the most abundant elements in every planetary body in the Universe yet it is vanishingly rare in Earth's oceans today. Set against that, it is essential to just about every form of life on Earth from the simplest and most ancient strains of microbes to the most complex animals including humans. In Earth's oceans, the lack of this "essential micro-nutrient" has been found to limit how much life can flourish near both the south and north poles in the Pacific Ocean in the sunlit surface ocean even though the supply of sunlight and other major nutrients (phosphorous, nitrogen) should be more than adequate. Our newest research suggests that iron released from hydrothermal plumes (where the concentrations coming from vents are more than 1 million times higher than normal ocean water) could play a major role. Despite undergoing massive dilution as hydrothermal solutions leave the vents and traverse thousands of kilometers through the oceans, we believe that at least some of the iron released from

deep sea hot springs can survive this journey and make a significant impact on how much life exists in Earth's polar oceans and how much CO₂ it draws down from the atmosphere. To investigate that idea, this project will study the fate of iron released from a hydrothermal vent over a length scale that hasn't been studied before - from the first 1km through the ocean out to 100km away from the vent-site. This will fill a gap in our knowledge between what happens right at a vent-site (as studied by research submarines) and what happens to ocean chemistry all across Earth's entire ocean basins (as studied by a huge international research project called GEOTRACES). Our work will use a 3D computational model to predict where the plume of material from a vent in the Northeast Pacific Ocean should escape to after it is erupted from some vents at a volcanic system called the Juan de Fuca Ridge. We will then use an advanced autonomous free-swimming robot to search out in the predicted plume area, first to test the accuracy of our predicted model and, second, to collect samples from the hydrothermal plume from where it first forms to as far out as we can follow it. The samples we collect will include both filtered seawater and the particulate material (whether mineralogical or microbiological) that we can extract from the filters. Together, this will allow us to track the fate of the iron and other key physical and geochemical tracers down-plume away from the vents, to work out where it ends up (in the water and in the sediments) and also how fast those processes happen. The work we do will also help plan how to conduct similar robotics-based exploration on future space missions beyond Earth where it has been hypothesized that seafloor events also exist (e.g. Saturn's moon Enceladus) and where, if we are really lucky, we may find that life is hosted based on the energy from seafloor volcanoes, just as happens here on Earth. We have a resident artist embedded in our program who has already begun experimenting with the use of air-flow and sound in her sculptures to help communicate the complex nature of these plumes. She will join our cruise, and work with our team post-cruise to design and hopefully build a sculpture that that could potentially result in a large and long-term outdoor installation.

The international GEOTRACES program has revealed that iron (Fe) is released ubiquitously from submarine ridges to the deep ocean. Results from US GEOTRACES section GP16 showed that both dissolved and particulate (colloidal) Fe may persist so far as to be able to influence primary productivity in High-Nutrient/Low-Chlorophyll (HNLC) regions of the Southern Ocean. As a complement to these sectional studies, we propose a detailed process study to elucidate the mechanisms by which hydrothermally sourced Fe can persist across the oceans at the scale that GEOTRACES has revealed. Specifically, while the "persistent" Fe in a hydrothermal plume appears to behave quasi-conservatively from 100km to 4000km across the SE Pacific Ocean, it is also known that the majority of the Fe present at the Southern EPR on that US GEOTRACES GP16 cruise did not persist over the 100km separation between that station and the next deep ocean station beyond the ridge crest. To fill that gap, this project will conduct a coupled modelling and field study to investigate the fate of hydrothermally sourced Fe at ranges of 0-1, 1-10 and 10-100km down-plume away from a well established vent-source. To begin, we will use the detailed micro-bathymetry and the long-term current meter data available from the Main Endeavour Segment of the Juan de Fuca Ridge to implement a recently developed 3D theoretical plume dispersion model that can predict both the detailed 3D dispersion trajectory and the rate of flow within the hydrothermal plume away from two long-studied and well characterized Main Endeavour Field (MEF) vents. At sea, we will use that predictive model to guide Sentry autonomous underwater vehicle (AUV) surveys that will follow the plume "down-wind" and "across-plume" to compile a 3D survey using in-situ sensors [optical, redox, conductivity, temperature, depth (CTD)] that will allow us to (1) confirm (and better constrain) the predictive model, and to (2) map out the shape and trajectory of the plume to provide context for discrete water column samples that we will collect - both from the AUV and from a trace metal clean CTD-rosette. Sampling from the AUV will use the latest generation of SUPR samplers designed for the CLIO trace-metal-clean water sampler. This will suffice for samples of dissolved, colloidal and particulate trace metals and collection of filtered material for grain-by-grain mineralogical and biogeochemical analyses. That sampling program will be backed up by larger volume sampling down-plume using a CTD-rosette to augment our AUV-based program with helium isotope analyses (to track extents of physical plume dilution at increasing distances downwind and across plume) and for complementary ligand and organic compound analyses to investigate the role that organic complexation might play in protecting reduced species of Fe [and manganese (Mn), too] against oxidative precipitation and removal from the oceanic water column. Post cruise, our combination of biogeochemical measurements and improved 3D physical modelling will not only be able to provide new insights into the processes that control the fluxes of Fe and Mn to the oceans from hydrothermal venting but also the length scales over which those processes take effect. Finally, because our 3D theoretical model includes velocities, we also anticipate being able to deduce the rates at which these processes occur.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851078

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