Dissolved barium concentration and barium isotope measurements from seawater profiles and coastal groundwater in the Gulf of Aqaba (northern Red Sea) from October 2015 to August 2017

Website: https://www.bco-dmo.org/dataset/1004832
Data Type: Other Field Results
Version: 1
Version Date: 2026-08-12

Project
» The Speed, Signature, and Significance of Barium Transformations in Seawater (The Three S's)

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Abstract
This dataset contains dissolved barium concentrations and barium stable isotope compositions measured in filtered and acidified seawater samples collected from vertical profiles at Station A in the Gulf of Aqaba (northern Red Sea) in 2015 and 2016, together with one coastal groundwater sample collected in 2017 at the Interuniversity Institute for Marine Sciences in Eilat. Seawater samples span approximately 0 to 700 meters water depth. Reported variables include dissolved barium concentration, barium isotope composition relative to NIST SRM 3104a, associated 2 standard deviation uncertainties, and replicate counts. Seawater samples were collected using trace metal clean procedures following GEOTRACES protocols.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
  - BCO-DMO Curation Notes
  - Problem Description
- Related Publications
- Related Datasets
- Parameters
- Instruments
- Project Information
- Funding

Coverage

Location: Gulf of Aqaba (northern Red Sea)
Spatial Extent: **N**:29.502 **E**:34.917 **S**:29.467 **W**:34.917
Temporal Extent: 2015-10-26 - 2017-08-24

Dataset Description

These data correspond to the seawater and groundwater entries in Table 2 of Mayfield et al. (2024).

Methods & Sampling

Samples were collected as part of the *Red Sea Dust, Marine Particulates and Seawater Time Series* program. Dissolved seawater samples were collected from vertical profiles at Station A in the Gulf of Aqaba using trace metal clean sampling procedures following GEOTRACES protocols. Seawater was collected using acid-cleaned, Teflon-coated GO-Flo bottles and transported to a clean laboratory within 1 to 2 hours. Samples were filtered through an acid-cleaned Acropak 500 cartridge filter (0.8/0.2 micrometer polyethersulfone), acidified with trace metal clean hydrochloric acid to pH less than or equal to 2, and stored refrigerated in acid-cleaned polypropylene vials prior to analysis. One coastal groundwater sample was collected from a shallow well near the shoreline at the Interuniversity Institute for Marine Sciences in Eilat and was processed for dissolved barium concentration and barium isotope analysis.

Data Processing Description

Barium isotope compositions are reported in delta notation (δ138Ba) relative to NIST SRM 3104a. Instrumental mass bias and isotope ratios were corrected using a double-spike technique. A spiked standard was analyzed every fifth sample, and sample values were normalized to bracketing standards. Analytical precision is reported as the greater of long-term reproducibility (plus or minus 0.03 per mil, 2 standard deviations) or the standard error of replicate analyses. Data processing and calculations were performed using MATLAB R2018a. Dissolved barium concentrations were determined using isotope dilution and were corrected for procedural blanks. In one batch of seawater samples, elevated blank levels required larger corrections (see Problems/Issues); replicate analyses confirmed that corrected concentrations and isotope compositions were consistent with samples processed under lower blank conditions.

BCO-DMO Curation Notes

- Loaded table "Dissolved Samples.xlsx" from Excel file and "nd" values as missing data
- Converted sample_collection_date column from string format "%m-%d-%y" to date type with output format "%Y-%m-%d"
- Renamed table dissolved_samples-1 to 1004832_v1_dissolvedbarium

Problem Description

Elevated procedural blanks were observed during one batch of dissolved sample processing, corresponding to approximately 15 % of total barium in those samples. Blank corrections were applied, and reanalysis of selected samples confirmed that corrected concentrations and isotope compositions were consistent with independently processed samples.

[table of contents | back to top]

Related Publications

Bates, S. L., Hendry, K. R., Pryer, H. V., Kinsley, C. W., Pyle, K. M., Woodward, E. M. S., & Horner, T. J. (2017). Barium isotopes reveal role of ocean circulation on barium cycling in the Atlantic. Geochimica et Cosmochimica Acta, 204, 286–299. doi:10.1016/j.gca.2017.01.043
Methods

Cutter, Gregory, Casciotti, Karen, Croot, Peter, Geibert, Walter, Heimbürger, Lars-Eric, Lohan, Maeve, Planquette, Hélène, van de Flierdt, Tina (2017) Sampling and Sample-handling Protocols for GEOTRACES Cruises (Cookbook). Version 3, August 2017. Toulouse, France, GEOTRACES International Project Office,

139pp. & Appendices. http://hdl.handle.net/11329/409
Methods

Horner, T. J., Kinsley, C. W., & Nielsen, S. G. (2015). Barium-isotopic fractionation in seawater mediated by barite cycling and oceanic circulation. Earth and Planetary Science Letters, 430, 511–522. doi:10.1016/j.epsl.2015.07.027
Methods

Mayfield, K. K., Horner, T. J., Torfstein, A., Auro, M. E., Crockford, P. W., & Paytan, A. (2024). Barium cycling in the Gulf of Aqaba. Frontiers in Earth Science, 12. https://doi.org/10.3389/feart.2024.1178487
Results

[table of contents | back to top]

Related Datasets

IsRelatedTo

Horner, T. J., Mayfield, K. K., Auro, M., Paytan, A., Torfstein, A. (2026) **Solid-phase barium, aluminum, phosphorus, particle flux, and barium isotope measurements from sediment traps, aerosols, and sediments in the Gulf of Aqaba (northern Red Sea) from January 2013 to August 2016.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-07-13 http://lod.bco-dmo.org/id/dataset/1002515 [view at BCO-DMO]
Relationship Description: Particulate/sediment data for the same project

[table of contents | back to top]

Parameters

Parameter	Description	Units
sample_type	Sample type or material class for each row (for example, seawater or groundwater).	unitless
latitude	Latitude of the sampling location in decimal degrees north.	decimal degrees
longitude	Longitude of the sampling location in decimal degrees east.	decimal degrees
site	Sampling site associated with the sample.	unitless
sample_collection_date	Date the sample was collected, in ISO format (YYYY-MM-DD)	unitless
water_depth_m	Sample collection depth in meters. For seawater rows, this is water-column depth; for the groundwater row, this is the reported sample depth.	m
d138Ba_permil	Barium isotopic composition reported in delta notation relative to NIST SRM 3104a.	permil
d138Ba_2sd_permil	Two standard deviation uncertainty associated with d138Ba.	permil
ba_concentration_nmol_kg	Dissolved barium concentration.	nmol kg-1
ba_concentration_2sd_nmol_kg	Two standard deviation uncertainty associated with dissolved barium concentration.	nmol kg-1
num_replicates_chemistry	Number of independent replicates processed through ion chromatography.	count
num_measurements_isotope	Number of mass spectrometry measurements used to calculate the reported isotope value.	count

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	General Oceanics
Generic Instrument Name	GO-FLO Bottle
Dataset-specific Description	Seawater samples were collected using acid-cleaned, Teflon-coated GO-Flo bottles (General Oceanics).
Generic Instrument Description	A GO-FLO (also written as "Go-Flo") bottle is used to collect discrete water samples at depth, often for analyses of pigments, nutrients, plankton, etc. The GO-FLO sampling bottle, made by General Oceanics, is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Dataset-specific Instrument Name	Thermo Finnigan Neptune
Generic Instrument Name	Thermo Finnigan Neptune inductively coupled plasma mass spectrometer
Dataset-specific Description	Barium isotope analyses were conducted using a ThermoFinnigan Neptune multi-collector inductively coupled plasma mass spectrometer. Samples were processed using a double-spike method and purified using ion exchange chromatography prior to analysis.
Generic Instrument Description	A laboratory high mass resolution inductively coupled plasma mass spectrometer (ICP-MS) designed for elemental and isotopic analysis. The instrument is based on a multicollector platform, comprising eight moveable collector supports and one fixed center channel equipped with a Faraday cup and, optionally, an ion counter with or without a retardation lens. The Faraday cup is connected to a current amplifier, whose signal is digitized by a high linearity voltage to frequency converter. The instrument was originally manufactured by Thermo Finnigan, which has since been replaced by Thermo Scientific (part of Thermo Fisher Scientific). This model is no longer in production.

[table of contents | back to top]

Project Information

The Speed, Signature, and Significance of Barium Transformations in Seawater (The Three S's)

Coverage: Eastern Tropical Pacific, Subtropical South Pacific, Sub-Antarctic Pacific, and Southern Oceans

NSF Award Abstract:
The biological cycling of carbon in the oceans entrains many other elements, some directly (like nutrients that are essential for life) and some indirectly, as they become chemically involved in the processes that are affecting carbon. One such element is barium (Ba). Particles of the mineral barite (barium sulfate) have been found to form in association with microbial consumption of organic material in the ocean’s “twilight zone.” These particles settle to the ocean floor, and their presence in sediments has been used to infer changes in the conditions in the ocean back in time. Both the amount of barite in sediments and the isotope composition of Ba in barite are potentially sensitive to processes occurring in the twilight zone. However, several long-standing questions remain about Ba cycling in the oceans, which complicates the interpretation of barium-based proxy records. Examples of remaining questions include how much barium enters the oceans at mid-ocean ridge hydrothermal sites, and what controls the precipitation and dissolution of barite in the water column. This project seeks to tackle these questions using new approaches, on three scheduled research expeditions in the Pacific and Southern Oceans. In doing so, this project will support the education, training, and career

development of a graduate student, postdoctoral researcher, and junior investigator. Undergraduate students from underrepresented groups will be recruited to conduct complementary shore-based experiments.

This proposal seeks to answer four questions central to the utility of barium-based proxies in oceanography: What are the major inputs of new Ba to the ocean? What are their isotopic compositions? What controls the amount of pelagic barite precipitated during the remineralization of organic matter? What influences its isotopic composition? These questions will be addressed using a field-centric approach combining: in situ and shipboard tracer-incubation experiments, AUV-led adaptive sampling of Ba cycling ‘hotpots’, and section-based surveying of the surrounding oceanographic features. This multi-pronged approach will be used to investigate: the flux and isotopic composition of Ba released from the largest hydrothermal fields in the ocean, the Southern East Pacific Rise, with a focus on low-temperature venting; rates and signatures of pelagic barite precipitation associated with different phytoplankton assemblages in the Southern Ocean; and, the importance of environmental conditions, such as low ambient oxygen concentrations, in setting the efficiency of barite precipitation in the Eastern Tropical Pacific. The significance of each transformation will be assessed, which may lead to ruling out the importance of certain processes, or identifying new dependencies that could form the basis of new proxies.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2023456

[table of contents | back to top]