

Dissolved trace metals and macronutrients from samples collected using GoFlo on R/V Melville MV1405 (IRN-BRU) cruise in the California Current System in July 2014

Website: <https://www.bco-dmo.org/dataset/942928>

Data Type: Cruise Results

Version: 1

Version Date: 2024-11-05

Project

» [Accomplishment Based Renewal: An iron limitation mosaic within the central California Current System](#) (iron limitation mosaic)

| Contributors | Affiliation | Role |
|-------------------------------------|---|------------------------|
| Bruland, Kenneth W. | University of California-Santa Cruz (UCSC) | Principal Investigator |
| Coale, Tyler | University of California-Santa Cruz (UCSC) | Scientist |
| Till, Claire P. | University of California-Santa Cruz (UCSC) | Student |
| Mickle, Audrey | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

Abstract

This dataset is a suite of dissolved trace metal concentrations, along with macronutrient concentrations, collected using a GoFlo on R/V Melville cruise MV1405 (IRN-BRU) while investigating the mosaic of the California Current System in July 2014. It includes depth profiles of an active upwelling site nearshore over the shelf in northern California (Station 2), a more aged upwelling site offshore of the shelf break in southern Oregon (Station 28), a station in the Santa Barbara Basin that got suboxic in the lower depths of the water column (Station 29), and a set of stations (9, 12 and 15) that show two cyclonic eddies, one two months younger (station 9) than the other (station 15), but both coming from roughly the same place and moving offshore, with station 12 in between them in an offshoot of the California Current. The chief scientist of the cruise was Ken Bruland. Trace metal samples were analyzed by Claire Till (nee Parker) as his graduate student. Nutrient samples were analyzed by Tyler Coale. See related datasets for additional samples using a regular rosette (macronutrient concentrations) and surface samples from a TowFish (macronutrient and dissolved trace metal concentrations) collected on MV1405.

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Coverage

Location: The California Current System, 33-44N, 118-128W, surface to 1500m max

Spatial Extent: N:42.667 E:-120.026 S:34.231 W:-126.752

Temporal Extent: 2014-07-06 - 2014-07-24

Methods & Sampling

Nitrate-nitrite, Phosphate, Silicate, Nitrite

Samples were collected from teflon-coated Go-Flos on a non-metal line. Samples were analyzed shortly after collection at sea using standard spectrophotometric methods (Parsons 1984) on a Lachat QuickChem 8000 Flow Injection Analysis System.

Dissolved trace metals

Depth profiles were taken using individual teflon-coated GoFlo bottles on a non-metal line, which were sampled in a trace metal clean van at sea. Samples were filtered directly from the GoFlo through 0.2 μm Acropak Supor membrane capsule filters into pre-cleaned LDPE bottles. The acropaks were pre-cleaned and flushed with at least 250 mL of sample before sampling. Sample bottles were pre-cleaned cleaned rigorously as per the GEOTRACES cookbook (Cutter et al., 2014), and were rinsed with sample three times before filling. Samples were acidified at sea to a pH of ~ 1.7 with quartz-distilled 6 M HCl (4 mL per liter) and stored for analysis post-cruise. Samples were analyzed for trace metals after the cruise with the method of Biller and Bruland (2012), with modifications as described in Parker et al. (2016). Briefly, this involves buffering the seawater to $\text{pH } 6.0 \pm 0.2$ immediately before pre-concentrating on PA1 resin. The resin was extracted with 1 N optima nitric acid with rhodium as an internal standard. Extracts were analyzed on the Thermo Fisher Element 2 extended range ICP-MS at UC Santa Cruz.

Iron was additionally analyzed shipboard with a flow injection analysis method published in Lohan et al. (2006) with modifications as described in Biller et al. (2013). Briefly, this method involves pre-concentrating the iron on a toyopearl column at pH 2, eluting it into a buffered (pH ~ 5.7) reaction stream that contains DPD, a molecule that turns pink when oxidized by iron. H_2O_2 is also in the reaction stream, which re-oxidizes the iron, so that each iron molecule can react with multiple DPD molecules, another mechanism to increase the iron signal. The reaction stream absorbance is measured with a flow through spectrophotometer.

Generally, the measurements from these two methods for Fe agreed well; where there was a problem with one or the other dataset, we only report one dataset.

BCO-DMO Processing Description

- Imported original file "IRNBRU TM and macronutrient GoFlo data.xlsx" into the BCO-DMO system.
- Combined "Latitude_degrees" and "Latitude_mins"
- Combined "Longitude_degrees" and "Longitude_mins"
- Converted Latitude and Longitude to decimal degrees
- Converted "date" from %m-%d-%y to ISO format %Y-%m-%d and changed parameter name to "Sampling_date"
- Renamed fields to comply with BCO-DMO naming conventions, removing special characters and spaces
- Saved the final file as "942928_v1_iron_limitation_goflo.csv"

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Data Files

| File |
|---|
| 942928_v1_iron_limitation_goflo.csv (Comma Separated Values (.csv), 6.58 KB) MD5:9fd544cf6cc4120a689f6267e4d7ee88 |
| Primary data file for dataset ID 942928, version 1 |

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Related Publications

Abdala, Z. M., Clayton, S., Einarsson, S. V., Powell, K., Till, C. P., Coale, T. H., & Chappell, P. D. (2022). Examining ecological succession of diatoms in California Current System cyclonic mesoscale eddies. *Limnology and Oceanography*, 67(11), 2586–2602. Portico. <https://doi.org/10.1002/lno.12224>
Results

Billar, D. V., & Bruland, K. W. (2012). Analysis of Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb in seawater using the Nobias-chelate PA1 resin and magnetic sector inductively coupled plasma mass spectrometry (ICP-MS). *Marine Chemistry*, 130-131, 12-20. doi:[10.1016/j.marchem.2011.12.001](https://doi.org/10.1016/j.marchem.2011.12.001)
Methods

Billar, D. V., Coale, T. H., Till, R. C., Smith, G. J., & Bruland, K. W. (2013). Coastal iron and nitrate distributions during the spring and summer upwelling season in the central California Current upwelling regime. *Continental Shelf Research*, 66, 58-72. <https://doi.org/10.1016/j.csr.2013.07.003>
Methods

Boiteau, R. M., Till, C. P., Coale, T. H., Fitzsimmons, J. N., Bruland, K. W., & Repeta, D. J. (2018). Patterns of iron and siderophore distributions across the California Current System. *Limnology and Oceanography*, 64(1), 376-389. Portico. <https://doi.org/10.1002/lno.11046>
Results

Bruland, K. W., Rue, E. L., & Smith, G. J. (2001). Iron and macronutrients in California coastal upwelling regimes: Implications for diatom blooms. *Limnology and Oceanography*, 46(7), 1661-1674. Portico. <https://doi.org/10.4319/lno.2001.46.7.1661>
Methods

Cutter, G.A., Andersson, P., Codispoti, L., Croot, P., Francois, R., Lohan, M., Obata, H., van der Loeff, M. R. (2014) Sampling and Sample-Handling Protocols for GEOTRACES Cruises (cookbook) Version 2.0; December 2014. http://www.geotraces.org/images/stories/documents/intercalibration/Cookbook_v2.pdf
Methods

Lohan, M. C., Aguilar-Islas, A. M., & Bruland, K. W. (2006). Direct determination of iron in acidified (pH 1.7) seawater samples by flow injection analysis with catalytic spectrophotometric detection: Application and intercomparison. *Limnology and Oceanography: Methods*, 4(6), 164-171. Portico. <https://doi.org/10.4319/lom.2006.4.164>
Methods

McNair, H. M., Brzezinski, M. A., Till, C. P., & Krause, J. W. (2017). Taxon-specific contributions to silica production in natural diatom assemblages. *Limnology and Oceanography*, 63(3), 1056-1075. Portico. <https://doi.org/10.1002/lno.10754>
Results

Parker, C. E., Brown, M. T., & Bruland, K. W. (2016). Scandium in the open ocean: A comparison with other group 3 trivalent metals. *Geophysical Research Letters*, 43(6), 2758-2764. Portico. <https://doi.org/10.1002/2016gl067827> <https://doi.org/10.1002/2016GL067827>
Methods

Parsons, T. R., Maita, Y., & Lalli, C.M. (1984). A manual of chemical and biological methods for seawater analysis. Pergamon Press. doi:10.1016/c2009-0-07774-5 <https://doi.org/10.1016/C2009-0-07774-5>
Methods

Till, C. P., Solomon, J. R., Cohen, N. R., Lampe, R. H., Marchetti, A., Coale, T. H., & Bruland, K. W. (2018). The iron limitation mosaic in the California Current System: Factors governing Fe availability in the shelf/near-shelf region. *Limnology and Oceanography*, 64(1), 109-123. Portico. <https://doi.org/10.1002/lno.11022>
Results

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Related Datasets

IsRelatedTo

Coale, T., Bruland, K. W. (2024) **Macronutrient concentrations from samples collected using rosette on R/V Melville MV1405 (IRN-BRU) cruise in the California Current System in July 2014**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-11-18 doi:10.26008/1912/bco-dmo.942883.1 [[view at BCO-DMO](#)]

Till, C. P., Coale, T., Bruland, K. W. (2024) **Dissolved trace metals and macronutrients from samples collected using a tow-fish system on R/V Melville MV1405 (IRN-BRU) cruise in the California Current System in July 2014**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-11-20 doi:10.26008/1912/bco-dmo.943015.1 [[view at BCO-DMO](#)]

Parameters

| Parameter | Description | Units |
|----------------------|--|-----------------|
| Sample_date | Date of sample collection | unitless |
| Latitude | Latitude of sampling site, negative values = South | decimal degrees |
| Longitude | Longitude of sampling site, negative values = West | decimal degrees |
| Station_number | Station identification | unitless |
| Station_notes | Station notes | unitless |
| Depth | Sample depth | m |
| Nitrate_plus_nitrite | Nitrate and nitrite concentration | umol/kg |
| Phosphate | Phosphate concentration | umol/kg |
| Silicate | Silicic concentration | umol/kg |
| Fe | Iron concentration | nmol/kg |
| Y | Yttrium concentration | pmol/kg |
| Cd | Cadmium concentration | pmol/kg |
| La | Lanthanum concentration | pmol/kg |
| Pb | Lead concentration | pmol/kg |
| Ce | Cerium concentration | pmol/kg |
| Sc | Scandium concentration | pmol/kg |
| Mn | Manganese concentration | nmol/kg |
| | | |

| | | |
|----|-----------------------|---------|
| Co | Cobalt concentration | pmol/kg |
| Ni | Nickel concentration | nmol/kg |
| Cu | Copper concentration | nmol/kg |
| Zn | Zinc concentration | nmol/kg |
| Ga | Gallium concentration | pmol/kg |

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Instruments

| | |
|---|--|
| Dataset-specific Instrument Name | Teflon coated GO-Flo bottles |
| Generic Instrument Name | GO-FLO Bottle |
| Dataset-specific Description | Samples were collected with Teflon coated GO-Flo bottles (General Oceanics). |
| Generic Instrument Description | GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle 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 | Lachat QuickChem 8000 Flow Injection Analysis System |
| Generic Instrument Name | Lachat QuikChem 8000 flow injection analyzer and Ion Chromatography (IC) system |
| Dataset-specific Description | Nutrients were analyzed with a Lachat QuickChem 8000 Flow Injection Analysis System. |
| Generic Instrument Description | The Lachat QuikChem 8000 can operate flow injection analysis and ion chromatography simultaneously and independently on the same instrument platform. Instrument includes sampler, dilutor, sampling pump, electronics unit, and data station. Analysis takes 20-60 seconds, with a sample throughput of 60-120 samples per hour. Measurements are in the range of parts per trillion to parts per hundred. |

| | |
|---|--|
| Dataset-specific Instrument Name | Thermo Element XR magnetic sector inductively coupled plasma mass spectrometer (ICP-MS) |
| Generic Instrument Name | Thermo Scientific ELEMENT XR high resolution inductively coupled plasma mass spectrometer |
| Dataset-specific Description | Trace metal extracts were analyzed with a Thermo Element XR magnetic sector inductively coupled plasma mass spectrometer (ICP-MS) |
| Generic Instrument Description | A high-resolution (HR) inductively coupled plasma (ICP) mass spectrometer (MS) composed of a dual mode secondary electron multiplier (SEM) and a Faraday detector. The ELEMENT XR instrument has a dynamic range of 5×10^7 to 1×10^{12} counts per second (cps), and allows simultaneous measurement of elements at concentrations over 1000 ug/g. |

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Deployments

MV1405

| | |
|--------------------|---|
| Website | https://www.bco-dmo.org/deployment/559966 |
| Platform | R/V Melville |
| Start Date | 2014-07-03 |
| End Date | 2014-07-26 |
| Description | Deployment MV1405 on R/V Melville. Cruise took place during July 2014. |

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Project Information

Accomplishment Based Renewal: An iron limitation mosaic within the central California Current System (iron limitation mosaic)

NSF Award Abstract:

Eastern boundary upwelling systems have long been recognized for their high phytoplankton productivity. Carr and Kearns (2003), in a detailed comparison of eastern boundary current systems, reported that biomass sustained by a given macronutrient concentration in Atlantic eastern boundary current systems was twice as large as those systems in the Pacific. The authors concluded "It is not clear whether the apparent difference in biomass supported by available nutrients is due to differences in the efficiency of the phytoplankton community, perhaps related to the availability of iron, or to grazing pressure." They suggested that the width of the shelf might be considered a proxy for the benthic availability of iron. The lowest biomass for a given macronutrient concentration was in the Peru-Humboldt Current and in the northern California region of the California Current System, both areas with low dust inputs and a relatively narrow shelf.

In this Accomplishment Based Renewal project, a marine trace metal geochemist at the University of California - Santa Cruz and his students and colleagues will continue a decades-old quest to understand the role of iron in the central California Current System (cCCS). Field efforts will combine continuous underway iron and nutrient data in surface waters and a series of vertical profiles. The focus will include three regions within the cCCS: a variety of active Fe-replete and Fe-deplete coastal upwelling regimes, the eddy-rich California Current transition zone that is Fe-limited and has elevated nitrate but relatively low and uniform chlorophyll concentrations, and the offshore, oligotrophic California Current. They will map surface and depth distributions of Fe and other micro- and macronutrients. There are four specific goals dealing with characterizing the

organic Fe(III)-binding organic ligands, determining Fe(II) and Fe(III) concentrations in hypoxic waters over the shelf, examining the exchange between particulate and dissolved forms of Fe, and studying the roles of eddies in the eddy-rich transition waters of the cCCS.

Broader Impacts

Direct Benefits to Science: There is a great deal of interest in the CCS because of its importance in terms of phytoplankton productivity and the support of higher trophic levels. Until now, the emphasis in studies of the CCS has been on relationships between physics and biology. This study will insert the important role of micronutrient chemistry into the picture. It will also serve an important role in securing ship time in advance and providing logistical support for other collaborative studies. This is extremely valuable and cost effective for collaborating scientists since with the hydrography, nutrient and trace metal data provided, they can focus on their complimentary research efforts.

Outreach and Education: The project will provide funding for two current graduate students at UCSC, where they will also receive course training in a curriculum that includes i) scientific communication, ii) careers in marine science, and iii) grant writing. A broader impact goal of this project is to facilitate teaching and learning on marine science-related topics through translating research objectives into widely distributed educational materials for classroom use. To accomplish this, the team will partner with the Seymour Discovery Center at the Long Marine Lab, UCSC. The Discovery Center receives 14,000 visitors each year, and the project will provide funds to develop an interactive display on limiting nutrients and phytoplankton bloom development in the CCS.

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Funding

| Funding Source | Award |
|--|-----------------------------|
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1259776 |

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