

Trace Metals from RVIB Nathaniel B. Palmer NBP0606 in the Antarctica, Drake Passage, Scotia Sea, Bransfield Strait from July to August 2006 (BWZ project)

Website: <https://www.bco-dmo.org/dataset/3801>

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Project

» [Blue Water Zone](#) (BWZ)

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Dataset Description

Dissolved Al, Fe and Mn concentrations (filtered by 0.45um PES filter)

Methods & Sampling

Sampling method:

The samples were collected for trace metal determinations at 46 stations between 1 July and 15 August, 2006 from the RV NB Palmer using a custom-built trace metal clean rosette consisting of an epoxy painted Al rosette frame containing 12x12 L GO-FLO bottles (Measures et al., 2008). The frame also housed an SBE 911 CTD system that included an SBE 43 dissolved oxygen sensor and a Wet labs FL1 fluorometer. The rosette frame was lowered using a 4 conductor Kevlar cable coated with polyurethane which was passed over a Nylatron plastic block and wound on to a normal, but clean, hydraulic winch. Sample bottles were closed while the rosette was moving upwards through clean water at ~5-10 m/minute. Immediately after the package was recovered, the tops of the GO-FLOs were covered with plastic bags and the bottles were removed from the frame and carried into the clean van for sub-sampling. The GO-FLO bottles were pressurized to 10 psi using 0.2 µm-filtered compressed air and samples filtered through 0.45 µm pore size acid washed, 47 mm polysulphone filters (Pall Supor 450 P/N 60173). All sub-sampling was undertaken in the clean van using rigorous trace metal protocols.

Analytical method:

Samples obtained with this system and processed in this manner have been shown during the SAFE

intercomparison cruise (Johnson et al., 2007) and GEOTRACES intercalibration cruise to produce trace metals (Al, Fe and Mn) that are, within analytical uncertainty, identical to those obtained using other currently accepted sampling methodologies for trace elements.

1. Dissolved Al using FIA

Dissolved Al was determined using the Flow Injection Analysis (FIA) method of Resing and Measures (1994) within a few hours of sample collection on board. Samples were drawn into pre-numbered 125 ml PMP bottles after three rinses and were stored in plastic bags in the dark at room temperature before determination which was usually within 12 -36 hours of collection. Prior to determination samples were acidified by the addition of 125 μ l sub-boiling distilled 6N HCl (hereinafter 6N HCl) and were microwaved in groups of 4 for 3 minutes in a 900 W microwave oven to achieve a temperature of 60 \pm 10 degC. Samples were allowed to cool for at least 1 hour prior to determination. Samples were determined in groups of 8.

A shipboard mixed standard (Al and Fe) was prepared in the shore-based laboratory by serial dilution of commercial Al standards into distilled water which was acidified with the equivalent of 4 ml sub-boiled 6N HCl/L. Standards for instrument calibration were prepared daily from filtered seawater by acidifying 1 L of low Fe seawater from a previous cast with 1 ml of 6N HCl and microwaving for 5 minutes. After 1 hour, 200 \pm 2 ml of the cooled seawater was added to each of three 250 ml PMP bottles each of which had been rinsed three times with the microwaved seawater and shaken dry. Working standards were prepared by adding spikes of the mixed standard to these bottles, to yield a standard curve. The system blank from the addition of the acid and buffer to samples was determined by double spiking a replicate sample i.e. by adding 2 x 125 μ l 6N HCl and 5 ml of sample buffer to the replicate bottle and comparing the resulting signal to the original sample. Calculation of sample concentrations was by dividing the peak height derived from sample using the A/D software by the calculated slope of the standard curve. A 3-minute pre-concentration of sample (\sim 9 ml) onto an 8-hydroxyquinoline (8-HQ) resin column yielded a detection limit of 0.53 nM Al and a precision of 6.5% at 2.7 nM.

2. Dissolved Fe and Mn using ICPMS

Filtered sub-samples were taken for shore-based determination of dissolved Fe and Mn by Inductively Coupled Plasma Mass Spectrometry (ICP MS) using the protocol of Milne et al. (2010), which is briefly described here. Stored samples were acidified to 0.024 M HCl by the addition of sub-boiled 6N HCl and kept for at least one year prior to analysis. Aliquots of the acidified samples (15 ml) were spiked with 125 μ L of an ^{57}Fe isotope solution (^{56}Fe : ^{57}Fe = 0.073:0.971, total Fe concentration 152 nM) and then left for >24 hours to equilibrate. Pre-concentration and extraction of the samples was performed using a flow injection manifold with an in-line micro-column containing \sim 200 μ L of Toyopearl AF Chelate-650M resin. Prior to extraction of the sub-samples, the system was cleaned with sub-boiled HNO_3 (1 M). The isotope spiked samples were buffered to pH 6 using 900 μ L of 2 M ammonium acetate (pH 9.1) prepared from sub-boiled acetic acid and isopiestic distilled NH_3 , and then pumped at 2 mL min^{-1} through the column for 6 minutes. The column was then rinsed with 1 mL DI water to remove the seawater matrix, and the adsorbed trace elements were eluted with 1 mL 1.0 M sub-boiled HNO_3 . Extracted samples were analyzed for their $^{56}\text{Fe}/^{57}\text{Fe}$ ratio and Mn concentration on an ICP MS (Thermo Scientific, Element 2, Medium-Resolution) with the desolvating apparatus (Elemental Scientific, Apex-Q) with self-aspirating nebulizer (Elemental Scientific, a 400 μ L min^{-1} PFA). Dissolved Fe concentrations were calculated by isotope dilution. Mn concentrations were calculated using an external standard curve. Fe and Mn sample concentrations were corrected for the blank that was measured in the acids and buffer that were used in the preconcentration and elution process. The acid blank was 0.034 ± 0.003 nM (Fe, n=3) and 0.013 ± 0.005 nM (Mn, n=8). Detection limits for both Fe and Mn were calculated using 3 standard deviations of replicate measurements of the acid blank and were approximately 0.009 nM (Fe) and 0.015 nM (Mn). Determination of Fe and Mn concentrations in the SAFe open ocean reference material and GEOTRACES shallow standards were in good agreement with the inter-laboratory averages.

Related Files and References:

Johnson, K.S. et al. 2007. Developing Standards for Dissolved Iron in Seawater, EOS, trans American Geophysical Union, 88, 131.

Measures, C.I. et al. 2008. A commercially available rosette system for trace metal clean sampling. Limnol. Oceanogr. Methods. 6, 384-394.

Milne, A. et al. 2010. Determination of Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb in seawater using high resolution magnetic sector inductively coupled mass spectrometry (HR-ICP-MS). Analytica Chimica Acta. 665, 200-207.

Resing, J. Measures, C.I., 1994. Fluorometric determination of Al in seawater by FIA with in-line pre concentration. Anal. Chem. 66, 4105-4111.

Data Processing Description

Quality flag: Assignment of quality flag is by the data generator based on analytical and methodological considerations. Scheme is based on simple flags i.e. good (0), questionable (4), bad (8).

BCO-DMO Processing/Edits

- Generated from file: "BWZ2006TM.xls" contributed by Yiwu Zhu
- Longitude converted to +/- hemisphere convention by -= 360.0 to original values
- Parameter names modified to conform to BCO-DMO conventions (blanks to underscores, etc.)
- "nd" (no data) inserted in black cells

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Data Files

File
BWZ2006TM.csv (Comma Separated Values (.csv), 37.60 KB) MD5:e2ae43bbbc45cffdda9b5d602518828f
Primary data file for dataset ID 3801

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Parameters

Parameter	Description	Units
Station	Station number	dimensionless
Station_Cast	Station number with CTD cast number appended	dimensionless
Latitude	Station latitude (South is negative)	decimal degrees
Longitude	Station longitude (West is negative)	decimal degrees
Depth_Bottom	Bottom Depth	meters
Depth	Sample Depth	meters
Temperature	Temperature (ITS-90)	degrees Celsius
Salinity	Salinity	PSU
Al	Al	nM
QF_Al	Al Quality Flag	dimensionless
ICPMS_Fe	ICPMS Fe	nM
QF_ICPMS_Fe	ICPMS Fe Quality Flag	dimensionless
ICPMS_Mn	ICPMS Mn	nM
QF_ICPMS_Mn	ICPMS Mn Quality Flag	dimensionless

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Instruments

Dataset-specific Instrument Name	CTD Sea-Bird SBE 911plus
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Flow Injection Analyzer
Generic Instrument Name	Flow Injection Analyzer
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Wet labs FL1 fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	Wet labs FL1 fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	GO-FLO Bottle
Generic Instrument Name	GO-FLO Bottle
Dataset-specific Description	12x12 L GO-FLO bottles
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	Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Extracted samples were analyzed for their ⁵⁶ Fe/ ⁵⁷ Fe ratio and Mn concentration on an ICP MS (Thermo Scientific, Element 2, Medium-Resolution) with the desolvating apparatus (Elemental Scientific, Apex-Q) with self-aspirating nebulizer (Elemental Scientific, a 400 µL min ⁻¹ PFA)
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

Dataset-specific Instrument Name	SBE 43 Dissolved Oxygen Sensor
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
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 Sea-Bird Electronics

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Deployments

NBP0606

Website	https://www.bco-dmo.org/deployment/57976
Platform	RVIB Nathaniel B. Palmer
Start Date	2006-07-01
End Date	2006-08-15
Description	NBP (Nathaniel B. Palmer) R/V Nathaniel B. Palmer July2006: The research was conducted in the same region of the Drake Passage as the AMLR cruise. Samples were obtained aboard the R/V Nathaniel B. Palmer Lat/Lon bounding box -60.4991Lat, -58.5613Lon -62.3599Lat, -58.0392Lon -60.2783Lat, -57.4509Lon -61.2683Lat, -54.2852Lon

Project Information

Blue Water Zone (BWZ)

Coverage: Antarctica, Drake Passage, N: -52.6061, S: -65.1877 , E: -52.965, W: -68.325

NSF Proposal Title: Collaborative Research: Plankton Community Structure and Iron Distribution in the Southern Drake Passage and Scotia Sea

The Shackleton Fracture Zone (SFZ) in Drake Passage of the Southern Ocean defines a boundary between low and high phytoplankton waters. Low chlorophyll water flowing through the southern Drake Passage emerges as high chlorophyll water to the east, and recent evidence indicates that the Southern Antarctic Circumpolar Current Front (SACCF) is steered south of the SFZ onto the Antarctic Peninsula shelf where mixing between the water types occurs. The mixed water is then advected off-shelf with elevated iron and phytoplankton biomass. The SFZ is therefore an ideal natural laboratory to improve the understanding of plankton community responses to natural iron fertilization, and how these processes influence export of organic carbon to the ocean interior. The bathymetry of the region is hypothesized to influence mesoscale circulation and transport of iron, leading to the observed patterns in phytoplankton biomass. The position of the Antarctic Circumpolar Current (ACC) is further hypothesized to influence the magnitude of the flow of ACC water onto the peninsula shelf, mediating the amount of iron transported into the Scotia Sea. To address these hypotheses, a research cruise will be conducted near the SFZ and to the east in the southern Scotia Sea. A mesoscale station grid for vertical profiles, water sampling, and bottle incubation enrichment experiments will complement rapid surface surveys of chemical, plankton, and hydrographic properties. Distributions of manganese, aluminum and radium isotopes will be determined to trace iron sources and estimate mixing rates. Phytoplankton and bacterial physiological states (including responses to iron enrichment) and the structure of the plankton communities will be studied. The primary goal is to better understand how plankton productivity, community structure and export production in the Southern Ocean are affected by the coupling between bathymetry, mesoscale circulation, and distributions of limiting nutrients. The proposed work represents an interdisciplinary approach to address the fundamental physical, chemical and biological processes that contribute to the abrupt transition in chl-a which occurs near the SFZ. Given recent indications that the Southern Ocean is warming, it is important to advance the understanding of conditions that regulate the present ecosystem structure in order to predict the effects of climate variability. This project will promote training and learning across a broad spectrum of groups. Funds are included to support postdocs, graduate students, and undergraduates. In addition, this project will contribute to the development of content for the Polar Science Station website, which has been a resource since 2001 for instructors and students in adult education, home schooling, tribal schools, corrections education, family literacy programs, and the general public.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Hewes, C. D., Reiss, C.S., Kahru, M., Mitchell, B.G., and Holm-Hansen, O.. "Control of phytoplankton biomass by dilution and mixed layer depth in the western Weddell-Scotia Confluence (WSC)," *Marine Ecology Progress Series*, v.366, 2008, p. 15.

Hiscock, M., Lance, V., Apprill, A., Bidigare, R., Mitchell, B., Smith Jr. W., Barber, R.. "Photosynthetic maximum quantum yield increases are an essential component of the Southern Ocean phytoplankton response to iron," *Proceedings of the National Academy of Sciences*, v.105(2), 2008, p. 4775.

Holm-Hansen, O., Kahru, M., Hewes, C.. "Deep chlorophyll a maxima (DCMs) in pelagic Antarctic waters. II. Relation to bathymetric features and dissolved iron concentrations," *Marine Ecology-Progress Series*, v.297, 2005, p. 71.

Hopkinson, B., Mitchell, B. G., Reynolds, R. A., Wang, H., Selph, K., Measures, C., Hewes, C., Holm-Hansen, O., Barbeau, K.. "Iron limitation Across Chlorophyll Gradients in the Southern Drake Passage: Phytoplankton Responses to Iron Addition and Photosynthetic Indicators of Iron Stress," *Limnology and Oceanography*, 2007, p. 2540.

Hopkinson, B., Mitchell, B. G., Reynolds, R. A., Wang, H., Selph, K., Measures, C., Hewes, C., Holm-Hansen, O., Barbeau, K.. "Iron limitation Across Chlorophyll Gradients in the Southern Drake Passage: Phytoplankton

Responses to Iron Addition and Photosynthetic Indicators of Iron Stress," *Limnology and Oceanography*, v.52, 2007, p. 2540.

Kahru, M., Mitchell, B. G., Gille, S. T., Hewes, C. D. and Holm-Hansen, O.. "Eddies enhance biological production in the Weddell-Scotia Confluence of the Southern Ocean," *Geophys. Res. Lett.*, 34,, v.24, 2007, p. L14603.

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Funding

Funding Source	Award
NSF Antarctic Sciences (NSF ANT)	ANT-0443403

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