Comparing Methods for Analysis of Dissolved Trace Metals in Seawater

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Project Overview

Introduction

The U.S. Global Ocean Carbon and Repeat Hydrography Program conducted an ocean section study of the Southern Ocean in 2011. The primary objective of the Trace Metals team, headed by Dr. William Landing, was to identify the distribution of trace metals and their isotopes, such as Al, Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn, in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. The CLIVAR S4P cruise allowed researchers to explore and document the atmospheric deposition of the trace metals in the Southern Ocean.

Abstract

Three different analytical methods were utilized in this project to determine the trace metal content of seawater from the Southern Ocean via the CLIVAR S4P cruise. Results obtained using Automated Seawater Extraction system (ASWE) and Magnesium-hydroxide Induced Co-precipitation (MagIC) were collated and analyzed on the NHMFL Geochemistry High resolution-inductively coupled plasma-mass spectrometer (HR-ICP-MS). Comparison of the dissolved Fe (dFe) concentration, from stations 19, 57, and 97 of the CLIVAR S4P cruise, between relatively different analytical methods is a practical way of testing the validity of those methods and gives increased confidence in the results obtained.

Objective

The aim of this project was to validate the ASWE and MagIC methods by compiling vertical dFe profiles for each method and then comparing their performance against the FIA-Lume method.

Methodology

The methods used in this comparison analysis are highlighted below:

- **Shipboard FIA**
  - Flow Injection Analysis
  - Solid Phase extraction: Fe trapped, salts escape to waste
  - Fe eluted into smaller volume
  - Fe in eluate detected in portable UV-Vis spectrometer
  - Highly sensitive, instant feedback
  - Blanks are difficult to quantify

- **ASWE**
  - Automated SW Extraction system
  - Solid Phase extraction: trace metals trapped, salts escape to waste
  - Trace metals eluted into smaller volume (20-fold concentration)
  - Automated (24 samples/4 hours)

- **MagIC**
  - Mg-hydroxide Induced Coprecipitation
  - Seawater pH raised to ppt Mg(OH)2
  - Trace metals stick to Mg(OH)2
  - Sample centrifuged, supernatant discarded
  - Mg(OH)2 pellet redissolved and analyzed

Data Analysis and Comparison

dFe Vertical Profiles

Fig. 2. Dissolved iron vertical profiles illustrating the performance of the three different methods. Dissolved iron profiles for the Southern ocean that exhibit representative features for each region where Fe was sampled and analyzed. The ASWE method (gray) and the MagIC method (orange) were compared against our standard, the Shipboard FIA-Lume, Flow Injection method (blue).

Discussion

- The ASWE method compares nicely to our standard, the Shipboard FIA Flow Injection method; the vertical profiles are near identical in every station, aside from the outliers. There’s a possibility that the outliers could have been created pre-extraction, due to sample handling errors.
- The MagIC method is also comparable to our standard, but not as comparable as the ASWE method. However, it is eminent that the accuracy of this method increases over time; the MagIC data points increasingly align with the Flow Injection data points as we advance from station 19 to 97.

Next Steps

1. Complete data analysis of stations 102 and 115 of the CLIVAR S4P cruise for the ASWE and MagIC method.
2. Explore the mechanisms and factors underlying the dFe concentration in the vertical profiles

Conclusion

The ASWE and MagIC methods were validated for the accurate determination of trace metals, specifically Fe, in seawater by comparing the dFe results to our standard, the Shipboard FIA-Lume Flow Injection method.

References


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