CTD data and analyses of bottles from CTD rosette samples collected on R/V Hugh R. Sharp cruise HRS1415 in August 2014

Website: https://www.bco-dmo.org/dataset/717687
Data Type: Cruise Results
Version: 1
Version Date: 2017-11-06

Project
» The role of soluble Mn(III) in the biogeochemical coupling of the Mn, Fe and sulfur cycles (Soluble ManganeseIII)

Contributors	Affiliation	Role
Luther, George W.	University of Delaware	Principal Investigator
Tebo, Bradley M.	Oregon Health & Science University (IEH/OHSU)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
CTD data and analyses of bottles from CTD rosette samples collected on cruise HRS1415.

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Coverage

Spatial Extent: **N**:39.4967 **E**:-72.7283 **S**:38.2493 **W**:-76.4093
Temporal Extent: 2014-08-18 - 2014-08-24

Dataset Description

CTD data and analyses of bottles from CTD rosette samples collected on cruise HRS1415.

Field Papers published as a result of this project (methods included):
Madison, A. S, B. M. Tebo, A. Mucci, B. Sundby and G. W. Luther, III. 2013. Abundant Mn(III) in porewaters is a major component of the sedimentary redox system. *Science* 341, 875-878. http://dx.doi.org/10.1126/science.1241396

MacDonald, D. J., A. J. Findlay, S. M. McAllister, J. M. Barnett, P. Hredzak-Showalter, S. T. Krepski, S. G. Cone, J. Scott, S. K. Bennett, C. S. Chan, D. Emerson and G.W. Luther III. 2014. Using *in situ* voltammetry as a tool to search for iron oxidizing bacteria: from fresh water wetlands to hydrothermal vent sites. *Environmental Science: Processes & Impacts* 16, 2117-2126. http://dx.DOI.org/10.1039/c4em00073k

Findlay, A. J., A. Gartman, D. J. MacDonald, T. E. Hanson, T. J. Shaw and G. W. Luther, III. 2014. Distribution and size fractionation of elemental sulfur in aqueous environments: The Chesapeake Bay and Mid-Atlantic Ridge. *Geochimica Cosmochimica Acta* 142, 334-348. http://dx.doi.org/10.1016/j.gca.2014.07.032

Oldham, V. O., S. M. Owings, M. Jones, B. M. Tebo and G. W. Luther, III. 2015. Evidence for the presence of strong Mn(III)-binding ligands in the water column of the Chesapeake Bay. *Marine Chemistry* 171, 58-66. http://dx.doi.org/10.1016/j.marchem.2015.02.008

Luther, G.W. III, A.S. Madison, A. Mucci, B. Sundby and V. E. Oldham. 2015. A kinetic approach to assess the strengths of ligands bound to soluble Mn(III). *Marine Chemistry* 173, 93-99. http://dx.doi.org/10.1016/j.marchem.2014.09.006

Findlay, A. J., A. J. Bennet, T. E. Hanson and G. W. Luther, III. 2015. Light-dependent sulfide oxidation in the anoxic zone of the Chesapeake Bay can be explained by small populations of phototrophic bacteria. *Applied and Environmental Microbiology* 81(21), 7560-7569. http://dx.doi.org/10.1128/AEM.02062-15

Findlay, A. J., A. Gartman, D. J. MacDonald, T. E. Hanson, T. J. Shaw and G. W. Luther, III. 2014. Distribution and size fractionation of elemental sulfur in aqueous environments: The Chesapeake Bay and Mid-Atlantic Ridge. *Geochimica Cosmochimica Acta* 142, 334-348. http://dx.doi.org/10.1016/j.gca.2014.07.032

Oldham, V. O., A. Mucci, B. M. Tebo and G.W. Luther III. 2017. Soluble Mn(III)-L complexes are ubiquitous in oxygenated waters and stabilized by humic ligands. *Geochimica Cosmochimica Acta* 199, 238-246. http://dx.doi.org/10.1016/j.gca.2016.11.043

Olson, L. K. A Quinn, M. G. Siebecker, G.W. Luther III, D. Hastings and J. Morford. 2017. Trace metal diagenesis in sulfidic sediments: Insights from Chesapeake Bay. *Chemical Geology* 452, 47-59. http://dx.doi.org/10.1016/j.chemgeo.2017.01.018

Oldham, V. O., M. T. Miller, Laramie T. Jensen and G.W. Luther III. 2017. Revisiting Mn and Fe removal in humic rich estuaries. *Geochimica Cosmochimica Acta* 209, 267-283. http://dx.doi.org/10.1016/j.gca.2017.04.001

Cai, W.-J, W.-J. Huang, G. Luther, III, D. Pierrot, M. Li, J. Testa, M. Xue, A. Joesoef, R. Mann, J. Brodeur, Y-Y Xu, B. Chen, N. Hussain, G. G. Waldbusser, J. Cornwell, and W. M. Kemp. 2017. Redox reactions and weak buffer capacity lead to acidification in the Chesapeake Bay. *Nature Communications* 8, Article number: 369. http://dx.doi.org/10.1038/s41467-017-00417-7

Findlay, A. J., D. M. Di Toro and G. W. Luther, III. 2017. A model of phototrophic sulfide oxidation in a stratified estuary. *Limnology & Oceanography* 62, 1853-1867. http://dx.doi.org/10.1002/lno.10539

Oldham, V. O., M. R. Jones, B. M. Tebo and G.W. Luther III. 2017. Oxidative and reductive processes contributing to manganese cycling at oxic-anoxic interfaces. *Marine Chemistry*, in press.

Methods & Sampling

Description/methods for parameters measured:

C parameters performed by Dr. Wei-Jun Cai’s group for:
TA - Open cell Gran titration with semi-automatic AS-ALK2 Apollo Scitech titrator;
pH - glass electrode, NBS buffers;
DIC - infrared CO2 analyzer (AS-C3, Apollo Scitech).
Use Dickson CRM for calibration. DIC/TA samples were filtered (0.45um) and fixed with 100 ul of saturated mercury bichloride.
Use the methods of Gran (1952) and Huang, et al. (2012).

Fe parameters:
The method of Stookey (1972) is used to determine dissolved Fe(II) and on addition if hydroxylamine Fe total. Fe(III) is determined by difference. Modified and calibrated by many including Lewis et al (2007) and MacDonald et al (2014). Typically, triplicate measurements performed.

Dissolved Mn parameters:
The porphyrin spectrophotometric method of Madison et al (2011) measures dissolved Mn(II), Mn(III) bound to weaker ligands and total Mn. Method includes calibration and intercomparison of totals with other instrumentation (ICP, AA). Detection limit is 0.050 micromolar. Detection limit (DL) is 50 micromolar with a 1 cm path length cell.

Modification of Madison for Mn(III) bound to strong ligands by adding a reducing agent to a separate subsample with the porphyrin to obtain total Mn. Mn(III) bound to strong ligand complexes is determined by difference. Typically, triplicate measurements performed. Detection limit is 3.0 nanomolar.

MnOx on unfiltered samples:
The leucoberbelein blue method is that of Altmann (1972) and Krumblein and Altmann (1973) in 1 cm cells, but can be modified for longer path length cells.

S parameters:
O2, H2S and polysulfides by the voltammetry method of Luther et al (2008).
A flow cell was also used to collect in situ O2 and H2S data as well as some additional samples. Analysis by voltammetry (Luther et al, 2008).
Solid and nanoparticulate S8 (Yücel et al 2010 and Findlay et al 2014).
Typically, triplicate measurements performed.

Methods papers used in this project:
Dissolved Mn speciation parameters:

Madison, A., B. M. Tebo, G. W. Luther, III. 2011. Simultaneous determination of soluble manganese(III), manganese(II) and total manganese in natural (pore)waters. *Talanta* 84, 374-381.
http://dx.doi.org/10.1016/j.talanta.2011.01.025

Madison, A. S, B. M. Tebo, A. Mucci, B. Sundby and G. W. Luther, III. 2013. Abundant Mn(III) in porewaters is a major component of the sedimentary redox system. *Science* 341, 875-878.
http://dx.doi.org/10.1126/science.1241396

Oldham, V. O., S. M. Owings, M. Jones, B. M. Tebo and G. W. Luther, III. 2015. Evidence for the presence of strong Mn(III)-binding ligands in the water column of the Chesapeake Bay. *Marine Chemistry* 171, 58-66.
http://dx.doi.org/10.1016/j.marchem.2015.02.008

Oldham, V. O., A. Mucci, B. M. Tebo and G.W. Luther III. 2017. Soluble Mn(III)-L complexes are ubiquitous in oxygenated waters and stabilized by humic ligands. *Geochimica Cosmochimica Acta* 199, 238-246.
http://dx.doi.org/10.1016/j.gca.2016.11.043

[[Here, we modified the method of Madison et al. (2011) for water column samples to achieve a detection limit of 3.0 nM (3 times the standard deviation of a blank) by using a 100-cm liquid waveguide capillary cell and the addition of a heating step as well as a strong reducing agent for Mn Speciation [Mn3+ = MnT – Mn2+]. See Table 1 in this paper for recovery tests. As weak Mn(III)-L complexes could not be measured in our previous work (Oldham et al, 2015; paper above), this method was used throughout this cruise.]]

MnOX solids:

Altmann, H.H., 1972. Bestimmung von inWasser gelöstem Sauerstoffmit Leukoberbelinblau I. Fresenius' Z. Anal. Chem. 6, 97–99.

Krumbein, W. E., and H. J. Altmann. 1973. ‘A New Method for the Detection and Enumeration of Manganese Oxidizing and Reducing Microorganisms’. Helgoländer Wissenschaftliche Meeresuntersuchungen 25 (2-3): 347–56. doi:10.1007/BF01611203.

Dissolved Fe speciation parameters:

Stookey L.L. 1970. Ferrozine- A New Spectrophotometric Reagent for Iron. Anal. Chem. 42, 779-781.

Lewis, B. L., B. T. Glazer, P. J. Montbriand, G. W. Luther, III, D. B. Nuzzio, T. Deering, S. Ma, and S. Theberge. 2007. Short-term and interannual variability of redox-sensitive chemical parameters in hypoxic/anoxic bottom waters of the Chesapeake Bay. *Marine* Chemistry 105, 296-308.

O2 and H2S, polysulfides:

Luther, III, G. W., B. T. Glazer, S. Ma, R. E. Trouwborst, T. S. Moore, E. Metzger, C. Kraiya, T. J. Waite, G. Druschel, B. Sundby, M. Taillefert, D. B. Nuzzio, T. M. Shank, B. L. Lewis and P. J. Brendel. 2008. Use of voltammetric solid-state (micro)electrodes for studying biogeochemical processes: laboratory measurements to real time measurements with an *in situ* electrochemical analyzer (ISEA). *Marine Chemistry* 108, 221-235.
http://dx.doi.org/10.1016/j.marchem.2007.03.002

Luther, G. W., III, and A. S. Madison. 2013. Determination of Dissolved Oxygen, Hydrogen Sulfide, Iron(II), and Manganese(II) in Wetland Pore Waters. In: Methods in Biogeochemistry of Wetlands, R.D. DeLaune, K.R. Reddy, C.J. Richardson, and J.P. Megonigal, editors. SSSA Book Series, no. 10. SSSA, Madison, WI. p. 87-106.
http://dx.doi.org/10.2136/sssabookser10.c6

S8:

Yücel, M., S. K. Konovalov, T. S. Moore, C. P. Janzen and G. W. Luther, III. 2010. Sulfur speciation in the upper

Black Sea sediments. *Chemical Geology* 269, 364-375. http://dx.doi.org/10.1016/j.chemgeo.2009.10.010

pH and inorganic carbon parameters:

Gran G. 1952. Determination of the equivalence point in potentiometric titrations, Part II. *Analyst*, 77: 661-671.

Huang W.-J., Wang Y., and Cai W.-J. 2012. Assessment of sample storage techniques for total alkalinity and dissolved inorganic carbon in seawater. *Limnology and Oceanography: Methods*, 10: 711-717.

Data Processing Description

BCO-DMO Processing:
- added columns for cast, station, and description (were contained as headers/rows);
- modified parameter names to conform with BCO-DMO naming conventions;
- replaced blanks/missing data with "nd" ("no data");
- replaced "#N/A" with "NA";
- replaced "ND" (in all caps) with "not_detected";
- coverted lat and lon from degrees and decimal minutes to decimal degrees;
- added date-time in ISO8601 format using original date and time_GMT fields;
- 06 Nov 2017: corrected station number for cast 6 (change from 6 to 5) per PI.

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Data Files

File
RosetteSamples_HRS1415.csv(Comma Separated Values (.csv), 43.48 KB) MD5:edc5f5df8851749f25e6f7511bc3be26 Primary data file for dataset ID 717687

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Related Publications

Cai, W.-J., Huang, W.-J., Luther, G. W., Pierrot, D., Li, M., Testa, J., … Kemp, W. M. (2017). Redox reactions and weak buffering capacity lead to acidification in the Chesapeake Bay. Nature Communications, 8(1). doi:10.1038/s41467-017-00417-7
Methods

Findlay, A. J., Bennett, A. J., Hanson, T. E., & Luther, G. W. (2015). Light-Dependent Sulfide Oxidation in the Anoxic Zone of the Chesapeake Bay Can Be Explained by Small Populations of Phototrophic Bacteria. Applied and Environmental Microbiology, 81(21), 7560–7569. doi:10.1128/aem.02062-15
https://doi.org/10.1128/AEM.02062-15
Methods

Findlay, A. J., Di Toro, D. M., & Luther, G. W. (2017). A model of phototrophic sulfide oxidation in a stratified estuary. Limnology and Oceanography, 62(5), 1853–1867. doi:10.1002/lno.10539
Methods

Findlay, A. J., Gartman, A., MacDonald, D. J., Hanson, T. E., Shaw, T. J., & Luther, G. W. (2014). Distribution and size fractionation of elemental sulfur in aqueous environments: The Chesapeake Bay and Mid-Atlantic Ridge. Geochimica et Cosmochimica Acta, 142, 334–348. doi:10.1016/j.gca.2014.07.032
Methods

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Methods

Krumbein, W. E., & Altmann, H. J. (1973). A new method for the detection and enumeration of manganese oxidizing and reducing microorganisms. Helgoländer Wissenschaftliche Meeresuntersuchungen, 25(2-3), 347–356. doi:10.1007/bf01611203 https://doi.org/10.1007/BF01611203
Methods

Luther, G. W., Glazer, B. T., Ma, S., Trouwborst, R. E., Moore, T. S., Metzger, E., … Brendel, P. J. (2008). Use of voltammetric solid-state (micro)electrodes for studying biogeochemical processes: Laboratory measurements to real time measurements with an in situ electrochemical analyzer (ISEA). Marine Chemistry, 108(3-4), 221–235. doi:10.1016/j.marchem.2007.03.002
Methods

Luther, G. W., Madison, A. S., DeLaune, R. D., Reddy, K. R., Richardson, C. J., & Megonigal, J. P. (2013). Determination of Dissolved Oxygen, Hydrogen Sulfide, Iron(II), and Manganese(II) in Wetland Pore Waters. SSSA Book Series. doi:10.2136/sssabookser10.c6
Methods

Luther, G. W., Madison, A. S., Mucci, A., Sundby, B., & Oldham, V. E. (2015). A kinetic approach to assess the strengths of ligands bound to soluble Mn(III). Marine Chemistry, 173, 93–99. doi:10.1016/j.marchem.2014.09.006
Methods

MacDonald, D. J., Findlay, A. J., McAllister, S. M., Barnett, J. M., Hredzak-Showalter, P., Krepski, S. T., … Luther III, G. W. (2014). Using in situ voltammetry as a tool to identify and characterize habitats of iron-oxidizing bacteria: from fresh water wetlands to hydrothermal vent sites. Environ. Sci.: Processes Impacts, 16(9), 2117–2126. doi:10.1039/c4em00073k
Methods

Madison, A. S., Tebo, B. M., & Luther, G. W. (2011). Simultaneous determination of soluble manganese(III), manganese(II) and total manganese in natural (pore)waters. Talanta, 84(2), 374–381. doi:10.1016/j.talanta.2011.01.025
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Madison, A. S., Tebo, B. M., Mucci, A., Sundby, B., & Luther, G. W. (2013). Abundant Porewater Mn(III) Is a Major Component of the Sedimentary Redox System. Science, 341(6148), 875–878. doi:10.1126/science.1241396
Methods

Oldham, V. E., Jones, M. R., Tebo, B. M., & Luther, G. W. (2017). Oxidative and reductive processes contributing to manganese cycling at oxic-anoxic interfaces. Marine Chemistry, 195, 122–128. doi:10.1016/j.marchem.2017.06.002
Methods

Oldham, V. E., Miller, M. T., Jensen, L. T., & Luther, G. W. (2017). Revisiting Mn and Fe removal in humic rich estuaries. Geochimica et Cosmochimica Acta, 209, 267–283. doi:10.1016/j.gca.2017.04.001
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Oldham, V. E., Mucci, A., Tebo, B. M., & Luther, G. W. (2017). Soluble Mn(III)–L complexes are abundant in oxygenated waters and stabilized by humic ligands. Geochimica et Cosmochimica Acta, 199, 238–246. doi:10.1016/j.gca.2016.11.043
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Oldham, V. E., Owings, S. M., Jones, M. R., Tebo, B. M., & Luther, G. W. (2015). Evidence for the presence of strong Mn(III)-binding ligands in the water column of the Chesapeake Bay. Marine Chemistry, 171, 58–66. doi:10.1016/j.marchem.2015.02.008
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Olson, L., Quinn, K. A., Siebecker, M. G., Luther, G. W., Hastings, D., & Morford, J. L. (2017). Trace metal diagenesis in sulfidic sediments: Insights from Chesapeake Bay. Chemical Geology, 452, 47–59. doi:10.1016/j.chemgeo.2017.01.018
Methods

Yücel, M., Konovalov, S. K., Moore, T. S., Janzen, C. P., & Luther, G. W. (2010). Sulfur speciation in the upper Black Sea sediments. Chemical Geology, 269(3-4), 364–375. doi:10.1016/j.chemgeo.2009.10.010
Methods

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Parameters

Parameter	Description	Units
Cast	Cast identifier	unitless

Station	Station identifier	unitless
lat	Latitude; positive values = North	decimal degrees
lon	Longitude; positive values = East	decimal degrees
date	Date of sampling formatted as m/dd/yyyy	unitless
Description	Description and/or notes related to the sampling location or event	unitless
Bottle_Num	Bottle number	unitless
time_local	Time of sampling (local time zone) formatted as HH:MM	unitless
time_GMT	Time of sampling (GMT) formatted as HH:MM	unitless
depth	Sample depth	meters (m)
temp	Water temperature	degrees Celsius
sal	Salinity	unitless
CTD_O2	Oxygen measured by CTD	micromolar (uM)
O2_sat_100pcnt	100% oxygen saturation	micromolar (uM)
O2_sat	Percent oxygen saturation	unitless (percent)
fluor_chla	Chlorophyll fluorescence. Reported in voltage (from the RV Sharp fluorometer sensor).	volts
TA	Total alkalinity mesaured by open cell Gran titration with semi-automatic AS-ALK2 Apollo Scitech titrator	microles per kilogram (uM/kg)
DIC	Dissolved inorganic carbon measured by infrared CO2 analyzer (AS-C3, Apollo Scitech)	microles per kilogram (uM/kg)
pH	pH (primary) measured by glass electrode, NBS buffers	unitless (pH scale)
Particulate_MnOx	Particulate Manganese oxide (MnOx). DL= 0.01 uM or 10 nM.	micromolar (uM)
Particulate_MnOx_stdev	Standard deviation of Particulate Manganese oxide	micromolar (uM)
Dissolved_Mn2plus	Dissolved Mn2+	micromolar (uM)
Dissolved_Mn2plus_stdev	Standard deviation of dissolved Mn2+	micromolar (uM)
Dissolved_Mn3plus	Dissolved Mn3+ where Mn3+ = [MnT - Mn2+]	micromolar (uM)
Dissolved_Mn3plus_stdev	Standard deviation of dissolved Mn3+	micromolar (uM)
Dissolved_MnT	Dissolved MnT	micromolar (uM)
Dissolved_MnT_stdev	Standard deviation of dissolved MnT	micromolar (uM)
Dissolved_sulfide	Dissolved sulfide	micromolar (uM)
Dissolved_filtered_Fe2plus	Dissolved filtered Fe2+. DL for Fe is 0.100 micromolar.	micromolar (uM)
Dissolved_filtered_Fe2plus_stdev	Standard deviation of dissolved filtered Fe2+	micromolar (uM)
Particulate_unfiltered_Fe2plus	Particulate unfiltered Fe2+	micromolar (uM)
Particulate_unfiltered_Fe2plus_stdev	Standard deviation of particulate unfiltered Fe2+	micromolar (uM)
Dissolved_filtered_Fe3plus	Dissolved filtered Fe3+	micromolar (uM)
Dissolved_filtered_Fe3plus_stdev	Standard deviation of dissolved filtered Fe3+	micromolar (uM)
Particulate_unfiltered_Fe3plus	Particulate unfiltered Fe3+	micromolar (uM)
Particulate_unfiltered_Fe3plus_stdev	Standard deviation of particulate unfiltered Fe3+	micromolar (uM)

pH_secondary	pH (secondary) measured by glass electrode, NBS buffers	unitless (pH scale)
nanoparticulate_S0	Nanoparticulate S(0) (	micromolar (uM)
ISO_DateTime_UTC	Date and time of sampling formatted to ISO8601 standard (yyyy-mm-ddTHH:MM); constructed using original date and time_GMT fields.	yyyy-MM-dd'T'HH:mm:ss.SS

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Instruments

Dataset-specific Instrument Name	AS-ALK2 Apollo Scitech titrator
Generic Instrument Name	Automatic titrator
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	AS-C3, Apollo Scitech infrared CO2 analyzer
Generic Instrument Name	CO2 Analyzer
Generic Instrument Description	Measures atmospheric carbon dioxide (CO2) concentration.

Dataset-specific Instrument Name	
Generic Instrument Name	CTD Sea-Bird
Dataset-specific Description	Samples were collected using R/V Sharp's Sea-Bird CTD.
Generic Instrument Description	Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics, no specific unit identified. This instrument designation is used when specific make and model are not known. See also other SeaBird instruments listed under CTD. More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	
Generic Instrument Name	CTD-fluorometer
Dataset-specific Description	R/V Sharp's CTD fluorometer
Generic Instrument Description	A CTD-fluorometer is an instrument package designed to measure hydrographic information (pressure, temperature and conductivity) and chlorophyll fluorescence.

Dataset-specific Instrument Name	
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	
Generic Instrument Name	Oxygen Sensor
Dataset-specific Description	O2 sensor equipped on R/V Sharp's CTD rosette
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed

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Deployments

HRS1415

Website	https://www.bco-dmo.org/deployment/717689
Platform	R/V Hugh R. Sharp
Start Date	2014-08-18
End Date	2014-08-25

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Project Information

The role of soluble Mn(III) in the biogeochemical coupling of the Mn, Fe and sulfur cycles (Soluble ManganeseIII)

Coverage: Chesapeake Bay and coastal Atlantic Ocean

Description from NSF award abstract:
The research conducted by investigators in the School of Marine Science and Policy at the University of Delaware and within the Department of Environmental and Biomolecular Systems of Oregon Health and Science University will examine the importance of soluble Mn(III) in the biogeochemical cycling of Mn. To date, most studies of Mn in marine environments have not considered Mn(III), the intermediate oxidation state between the soluble reduced state (Mn(II)) and the more insoluble oxidized state (Mn(IV)). The presence and stability of Mn(III) in marine systems, especially those where oxygen levels are reduced, changes the dynamics and stability, solubility and fate and transport of Mn in these locations, and at interfaces between oxic and low oxygen environments. This is not understood at present and the proposed research is poised to provide new information concerning the Mn cycle and is potentially transformative research. The PIs have developed new methods to examine Mn(III) levels in the environment and this capability will bolster the successful accomplishment of the project's goals. The studies will not only focus on understanding the cycling of Mn

between its various oxidation states but will determine the concentration and distribution of Mn(III) in stratified coastal ocean waters and in sediment porewaters. The study will also examine the potentially important role of Mn(III) in mediating and influencing the biogeochemical cycling of Mn with that of Fe and S, which are both important components of the major ocean chemical cycles. A better understanding of the biogeochemistry of Mn will inform not only scientists interested in metal cycling in the ocean but also those focused on studies across redox transition zones. The proposed research has an international component and the investigators have developed plans to broadly disseminate their results to students at all levels and to the community. The Principal Investigators have a strong history in education and graduate student and post-doctoral support and mentoring and this will continue under the current grant.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1155385

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