Dissolved iron and iron isotopes for SGD well, river, and estuary samples collected between November 2022 and March 2024 along the West Florida Shelf

Website: https://www.bco-dmo.org/dataset/995970
Data Type: Cruise Results, Other Field Results
Version: 1
Version Date: 2026-04-06

Project
» Collaborative Research: Linking iron and nitrogen sources in an oligotrophic coastal margin: Nitrogen fixation and the role of boundary fluxes (West Florida Shelf DON and Fe)

Contributors	Affiliation	Role
Conway, Timothy M.	University of South Florida (USF)	Principal Investigator
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Mickle, Audrey	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Dissolved iron concentration and iron isotope ratios (δ56Fe) collected from rivers, estuaries, and submarine groundwater wells along the West Florida Shelf from November 2022 to March 2024 as part of the STING GEOTRACES Process Study (GApr18), where STING = Submarine Groundwater Discharge, Trichodesmium, Iron & Nitrogen in the Gulf of Mexico. Rivers include the Alafia, Caloosahatchee, Hillsborough, Manatee, and Peace rivers, at upstream and downstream locations. Estuaries include surveys along Tampa Bay, Charlotte Harbor, and the Caloosahatchee River Estuary. Three submarine groundwater well transects are included. This project investigates how boundary sources, including rivers and submarine groundwater discharge, deliver important nutrients and metals to the coastal ecosystems of the West Florida Shelf. Here, dissolved iron concentrations and isotope ratios have been measured to trace boundary sources of iron entering the West Florida Shelf.

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Coverage

Location: West Florida Shelf. STING: Submarine Groundwater Discharge, Trichodesmium, Iron & Nitrogen in the Gulf of Mexico
Spatial Extent: **N**:29.09216 **E**:-81.847330594924 **S**:26.38724 **W**:-81.847330594924
Temporal Extent: 2022-11-14 - 2024-03-08

Methods & Sampling

Sample Collection

SGD Wells

Submarine groundwater samples were collected by U.S. Geological survey (USGS) small boat from three offshore well transects, each with three well location. Samples were taken from well head (GWd) and from surface (SB) and bottom waters (BW). Divers, using acid-cleaned Teflon tubing attached to a trace metal clean diaphragm pump. First, bottom waters were collected, then the well uncapped, adequately purged, and sampled. All samples were filtered through 0.2 um Acropak Supor Cartridges (Pall, USA) into acid-cleaned LDPE bottles. NC5, NC10, NC15 = Nature Coast Transect, IRB25, IRB30, IRB35 = Indian Rocks Transect, VH45, VH50, VH55 = Venice Headlands Transect. More details are provided in Hunt (2025).

Rivers and Estuaries

River Sample sites were located on land and samples were collected from five rivers (Hillsborough, Alafia, Manatee, Peace, and Caloosahatchee), using trace metal clean protocols. Estuary samples were collected in collaboration with Mote Marine Laboratory via small boat (RV Eugenie Clark), also using trace metal clean protocols. All water samples for dissolved Fe and d56Fe were syringe filtered using acid-cleaned 50 mL Henke Jet HDPE syringes and 0.2 um PVDF membrane Titan3 syringe filters into acid-cleaned LDPE bottles. AR1-2 = Alafia River, HB1-2 = Hillsborough, MR1-2 = Manatee, PR1 = Peace River, CR1 = Caloosahatchee, CS and E= Estuary sample locations. More details are provided in Hunt (2025).

Sample Processing

Samples were acidified back on shore at the University of South Florida (USF) using 2.4 mL 10 M Teflon-distilled HCl per liter of sample and stored for at least 6 months before processing. Samples were then processed for dissolved Fe isotope and concentration analysis at the University of South Florida following Sieber et al. (2019), modified from Conway et al (2013). Briefly, an Fe double-spike was added prior to batch extraction using Nobias PA-1 chelating resin, followed by purification by anion-exchange chromatography using AG-MP1 resin. Concentration and isotope analyses were performed on a Thermo Neptune Plus MC-ICPMS (Multicollecter Inductively Coupled Plasma Mass Spectrometer) in the Tampa Bay Plasma Facility at the University of South Florida using the double spike technique via a ~100 uL min^{-1} PFA nebulizer and Apex Ω introduction system, Pt Jet Sampler cone and an Al X skimmer cone.

Sample Analysis

Dissolved Fe stable isotope ratios are expressed in delta notation ($\delta^{56}Fe$) relative to the IRMM-014 standard. A secondary Fe standard, NIST-3126, was analyzed over 56 sessions to provide an estimate of long-term instrumental precision. We obtain a value of +0.36 ± 0.06‰ (2SD, n = 772; runs = 56), in agreement with consensus values (Hunt 2025; Conway et al., 2013). Therefore, we consider a 2SD uncertainty of 0.06‰ as an estimate of analytical precision, and have applied it to all samples, except for low concentration samples where the larger internal error is considered a more conservative estimate of uncertainty. Dissolved Fe concentrations were calculated using the isotope dilution technique based on on-peak blank, interference and mass-bias corrected $^{57}Fe/^{56}Fe$ ratios measured simultaneously with isotope analysis. We express uncertainty (1SD) on Fe concentrations as 2%, based on Conway et al. (2013).

Data Processing Description

Data was processed in Microsoft Excel using an in-house double spike reduction scheme from Sieber et al (2021), based on Siebert et al (2001).

BCO-DMO Processing Description

- Loaded sheet 1 from "BCO-DMO_STING_Rivers_Estuaries_Wells_Conway V1.0.xlsx" (xlsx format) using filename as resource name; missing values treated as empty string, "nd", and "NaN"; duplicate headers deduplicated
- Converted DateTime field from "%m/%d/%y %H:%M" to "%Y-%m-%dT%H:%M" datetime format, stored back to DateTime field
- Edited row 57: set Longitude to "-81.97959" from "81.97959"
- Renamed deduplicated fields: "n (1)" to "n_dFe", "n (2)" to "n_d56Fe", "DateTime" to "DateTime_Local", "2SD" to "SD_2", to comply with BCO-DMO naming conventions (parameter should not start with number)

- Converted DateTime_Local from "%Y-%m-%dT%H:%M" (America/New_York) to "%Y-%m-%dT%H:%MZ" (UTC), stored in new field DateTime_UTC
- Exported file to "995970_v1_sting_fe_and_fe_isotopes.csv"

Problem Description

We use the SeaDataNet scheme to flag data, as recommended by GEOTRACES, where data we believe is accurate is flagged as 1, and data we believe is accurate but have less replicates is flagged as 2.

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Data Files

File	
995970_v1_sting_fe_and_fe_isotopes.csv	(Comma Separated Values (.csv), 17.32 KB) MD5:f4f9d1fda761dda6d1ad51c14e4a362e
Primary data file for dataset ID 995970, version 1	

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Related Publications

Conway, T. M., Rosenberg, A. D., Adkins, J. F., & John, S. G. (2013). A new method for precise determination of iron, zinc and cadmium stable isotope ratios in seawater by double-spike mass spectrometry. Analytica Chimica Acta, 793, 44–52. doi:10.1016/j.aca.2013.07.025
Methods

Hunt, Hannah R., "Isotopic Fingerprints of the Coastal Margins: Tracing Dissolved Iron Sources from Land to Sea" (2025). USF Tampa Graduate Theses and Dissertations. https://digitalcommons.usf.edu/etd/10872
Methods

Sieber, M., Conway, T. M., de Souza, G. F., Hassler, C. S., Ellwood, M. J., & Vance, D. (2021). Isotopic fingerprinting of biogeochemical processes and iron sources in the iron-limited surface Southern Ocean. Earth and Planetary Science Letters, 567, 116967. https://doi.org/10.1016/j.epsl.2021.116967
Methods

Sieber, M., Conway, T. M., de Souza, G. F., Obata, H., Takano, S., Sohrin, Y., & Vance, D. (2019). Physical and biogeochemical controls on the distribution of dissolved cadmium and its isotopes in the Southwest Pacific Ocean. Chemical Geology, 511, 494–509. doi:10.1016/j.chemgeo.2018.07.021
Methods

Siebert, C., Nägler, T. F., & Kramers, J. D. (2001). Determination of molybdenum isotope fractionation by double-spike multicollector inductively coupled plasma mass spectrometry. Geochemistry, Geophysics, Geosystems, 2(7), n/a–n/a. doi:10.1029/2000gc000124
Methods

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Parameters

Parameter	Description	Units
Sample_ID	Sample identification	unitless
Station_ID	Station identification for submarine groundwater discharge wells, rivers, and estuaries; see Methods section for description of station codes and corresponding locations	unitless
STING_ID	STING project identification (Submarine Groundwater Discharge, Trichodesmium, Iron & Nitrogen in the Gulf of Mexico)	unitless
DateTime_UTC	Date and time of sample collection (UTC)	unitless
DateTime_Local	Date and time of sample collection (US Eastern Time)	unitless
Latitude	Latitude of sample collection; a positive value indicates a Northern coordinate	decimal degrees
Longitude	Longitude of sample collection; a negative value indicates an Western coordinate	decimal degrees
dFe	Dissolved iron (Fe) concentration	nanomoles per kilogram (nmol kg-1)
SD	1 standard deviation of Dissolved (Fe) concentration	nanomoles per kilogram (nmol kg-1)
n_dFe	Number of analyses used in calculating dFe	unitless
dFe_FLAG	Quality flag for Dissolved iron (Fe) concentration where 1= 'good value' And 2='probably good value'	unitless
d56Fe	Dissolved δ56Fe relative to the IRMM-014 Standard, which = (((56Fe/54Fe)(sample))/((56Fe/54Fe)(IRMM-014)) - 1)x1000	per mil
SD_2	2 standard deviations of dissolved δ56Fe analysis	per mil
n_d56Fe	Number of analyses used in calculating δ56Fe	unitless
d56Fe_FLAG	Quality flag for dissolved δ56Fe values where 1= 'good value' And 2='probably good value'	unitless

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Instruments

Dataset-specific Instrument Name	Diver
Generic Instrument Name	Diving Mask and Snorkel
Dataset-specific Description	Divers, using acid-cleaned teflon tubing attached to a trace metal clean diaphragm pump.
Generic Instrument Description	A diving mask (also half mask, dive mask or scuba mask) is an item of diving equipment that allows underwater divers, including, scuba divers, free-divers, and snorkelers to see clearly underwater. Snorkel: A breathing apparatus for swimmers and surface divers that allows swimming or continuous use of a face mask without lifting the head to breathe, consisting of a tube that curves out of the mouth and extends above the surface of the water.

Dataset-specific Instrument Name	Thermo Neptune Multicollecter Inductively Coupled Plasma Mass Spectrometer
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Concentration and isotope analyses were performed on a Thermo Neptune Plus MC-ICPMS (Multicollecter Inductively Coupled Plasma Mass Spectrometer) in the Tampa Bay Plasma Facility at the University of South Florida using the double spike technique via a ~100 uL min-1 PFA nebulizer and Apex Ω introduction introduction system, Pt Jet Sampler cone and an Al X skimmer cone.
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	Trace metal clean diaphragm pump
Generic Instrument Name	Pump
Dataset-specific Description	Divers, using acid-cleaned teflon tubing attached to a trace metal clean diaphragm pump.
Generic Instrument Description	A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps

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Project Information

Collaborative Research: Linking iron and nitrogen sources in an oligotrophic coastal margin: Nitrogen fixation and the role of boundary fluxes (West Florida Shelf DON and Fe)

Coverage: Gulf of Mexico/America, West Florida Shelf

NSF Award Abstract:
This project will investigate how groundwater discharge delivers important nutrients to the coastal ecosystems of the West Florida Shelf. Preliminary studies indicate that groundwater may supply both dissolved organic nitrogen (DON) and iron in this region. In coastal ecosystems like the West Florida Shelf that have very low nitrate and ammonium concentrations, DON is the main form of nitrogen available to organisms. Nitrogen cycling is strongly affected by iron availability because iron is essential for both photosynthesis and for nitrogen fixation. This study will investigate the sources and composition of DON and iron, and their influence on the coastal ecosystem. The team will sample offshore groundwater wells, river and estuarine waters, and conduct two expeditions across the West Florida Shelf in winter and summer. Investigators will participate in K-12 and outreach activities to increase awareness of the project and related science. The project will fund the work of six graduate and eight undergraduate students across five institutions, furthering NSF's goals of education and training.

Motivated by preliminary observations of unexplained, tightly-correlated DON and dissolved iron concentrations across the West Florida Shelf (WFS), the proposed work will quantify the flux and isotopic signatures of submarine groundwater discharge (SGD)-derived DON and iron to the WFS, and evaluate the bioavailability of this temporally-variable source using four seasonal near-shore campaigns sampling offshore groundwater wells, estuarine, and riverine endmembers and two cross-shelf cruises. The work will evaluate whether SGD stimulates nitrogen fixation on the WFS, and the potential for the stimulated nitrogen fixation to further modify the chemistry of DON and dissolved iron in the region. The cross-shelf cruises will investigate hypothesized periods of maximum SGD and Trichodesmium abundance (June), and reduced river discharge and SGD (February), thus comparing two distinct biogeochemical regimes. The concentrations and isotopic compositions of DON and dissolved iron, molecular composition of DON, and the concentration and composition of iron-binding ligands will be characterized. Nitrogen fixation rates and Trichodesmium spp. abundance and expression of iron stress genes will be measured. Fluxes of DON and iron from SGD and rivers will be quantified with radium isotope mass balances. The impacts of SGD on nitrogen fixation and DON/ligand production will be constrained with incubations of natural phytoplankton communities with submarine groundwater amendments. Two hypotheses will be tested: 1) SGD is the dominant source of bioavailable DON and dissolved iron on the WFS, and 2) SGD-alleviation of iron stress changes the dominant Trichodesmium species on the WFS, increases nitrogen fixation rates and modifies DON and iron composition. Overall, the work will establish connections between marine nitrogen and iron cycling and evaluate the potential for coastal inputs to modify water along the WFS before export to the Atlantic Ocean. This study will thus provide a framework to consider these boundary fluxes in oligotrophic coastal systems and the relative importance of rivers and SGD as sources of nitrogen and iron in other analogous locations, such as coastal systems in Australia, India, and Africa, where nitrogen fixation and SGD have also been documented.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2148836

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