Specific activities of dissolved radon-222 collected from grab samples during STING I cruise AE2305 on R/V Atlantic Explorer and STING II cruise EN704 on R/V Endeavor in the Gulf of Mexico from Feb to Jul 2023

Website: https://www.bco-dmo.org/dataset/988483
Data Type: Cruise Results
Version: 1
Version Date: 2025-11-07

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

Contributors	Affiliation	Role
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Abstract
This dataset includes the specific activities of dissolved radon-222 collected from grab samples during STING I cruise AE2305 on R/V Atlantic Explorer (February to March 2023) and STING II cruise EN704 on R/V Endeavor in the Gulf of Mexico (June to July 2023). Additional data collected from underway samples during STING II are provided in the related dataset. 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 radon-222 has been measured to trace boundary sources of nutrients and metals entering the West Florida Shelf, including submarine groundwater discharge.

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Coverage

Location: West Florida Shelf
Spatial Extent: **N**:28.499118 **E**:-82.582967 **S**:27.000213 **W**:-84.6555
Temporal Extent: 2023-02-20 - 2023-07-09

Methods & Sampling

Radon samples were collected and analyzed in two ways: as discrete grab samples and continuously from the ship's underway system. This dataset contains the discrete grab samples (including February and June/July collections). The underway (continuous) measurements from July 2023 are provided in the related dataset.

For discrete radon-222 samples, six-liter seawater samples were collected into an 8 L Nalgene high density polyethylene jerrican (hereafter referred to as jerrican) with a three-port cap fitted with tubing, as described by Stringer and Burnett (2004). This approach is similar to the commercially available Big Bottle System (Big Bottle System Manual, 2018) but allows for a sufficient headspace volume of gas, to increase the total sample volume and thus a lower detection limit. Samples were immediately sealed with screw-compressor clamps on the tubing in two locations to prevent radon-222 loss from the headspace. All discrete radon-222 samples were analyzed within 48 hours of collection. Jerricans were connected either to a RAD8 or RAD7, both commercially available radon-in-air detectors (Durridge, Inc.). Detectors were initially purged with Drierite to reduce internal humidity to below 10% and background counts were recorded. Following Stringer and Burnett (2004), jerrican samples were degassed with the built-in air pump for 60 minutes in a closed-air loop. Samples were counted for a minimum of three hours ("Sniff" mode) to reach statistically significant counts. Following, sample volume was precisely measured using a graduated cylinder.

For underway radon-222 analyses, water was pumped into a showerhead gas equilibrator (RAD-AQUA, Durridge, Inc.) at a flow rate > 2 liters min^{-1} with a fifteen-minute counting interval, following Burnett et al. (2001).

For both discrete and underway measurements, data files were downloaded using CAPTURE software (Durridge, Inc.). Radon-in-air was calculated by dividing the total counts-per-minute (cpm; background corrected) in window-A by the RAD7/8 detector efficiency. For discrete samples, additional corrections were made as the ratio of total air volume (volume of tubing/drying column connector, jerrican, and chamber) to chamber air volume. For both discrete and underway measurements, in-situ seawater salinity was taken from the ship underway system or CTD (bottom waters), and temperature of the radon-222 sample from the internal air temperature of the RAD7/8 system. Radon-in-air to radon-in-water solubility corrections were made following Schubert et al. (2012), and samples were decay-corrected to the time of collection. Errors are propagated from counting statistics and detector efficiencies. Specific activities are reported as total radon-222 (supported from the in-situ decay of its parent Ra-226 plus excess radon-222).

BCO-DMO Processing Description

- Imported "BCO-DMO_STING_Radon_Grab_Dataset.csv" into the BCO-DMO system
- Converted "DateTime" into ISO 8601 format (YYYY-MM-DDTHH:MM) and renamed field to "ISO_DateTime_Local"
- Converted "ISO_DateTime_Local" to create a new field "ISO_DateTime_UTC" in UTC timezone
- Created a new field "Rn222_flag" and populated Rn222_flag = 'BDL' where Rn222 was below detection
- Removed "BDL" string from the "Rn222" and "Rn222_err" fields so that the fields can be typed as numbers
- Exported file as "988483_v1_sting_radon_grab.csv"

Problem Description

Minimum detectable activity (MDA) for radon-222 underway analysis is 0.02 dpm/L at the 90% confidence interval, following Currie (1968). Minimum detectable activities for radon-222 discrete sample analysis are 0.04 – 0.09 dpm/L for February (95% confidence interval) and 0.04 – 0.08 dpm/L (95% confidence interval) in June/July, following Currie (1968). Ranges in MDA's reflect differences across individual detectors. Underway measurements and discrete samples below these thresholds are reported as Below Detection Limit ("BDL").

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Data Files

File
988483_v1_sting_radon_grab.csv (Comma Separated Values (.csv), 5.17 KB) MD5:55802723011ec010c9c15aab0d028791 Primary data file for dataset ID 988483, version 1

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Related Publications

Big Bottle System Manual, January 2018, DURRIDGE Company Inc., Billerica, MA. https://durridge.com/documentation/Big%20Bottle%20System%20Manual%20Aerator%20Cap%20Rev%20C.pdf
Methods

Burnett, W. C., Kim, G., & Lane-Smith, D. (2001). A continuous monitor for assessment of 222Rn in the coastal ocean. Journal of Radioanalytical and Nuclear Chemistry, 249(1), 167–172. https://doi.org/10.1023/a:1013217821419 https://doi.org/10.1023/A:1013217821419
Methods

Currie, L. A. (1968). Limits for qualitative detection and quantitative determination. Application to radiochemistry. Analytical Chemistry, 40(3), 586–593. doi:10.1021/ac60259a007
Methods

Schubert, M., Paschke, A., Lieberman, E., & Burnett, W. C. (2012). Air–Water Partitioning of 222Rn and its Dependence on Water Temperature and Salinity. Environmental Science & Technology, 46(7), 3905–3911. https://doi.org/10.1021/es204680n
Methods

Stringer, Christina E.; Burnett, William C.. SAMPLE BOTTLE DESIGN IMPROVEMENTS FOR RADON EMANATION ANALYSIS OF NATURAL WATERS. Health Physics 87(6):p 642-646, December 2004. | DOI: 10.1097/01.HP.0000137181.53428.04
Methods

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Related Datasets

IsRelatedTo

Tamborski, J., Lindgren, A., Alorda-Kleinglass, A., Buck, K. N., Boiteau, R. M., Chappell, P. D., Conway, T. M., Smith, C., Knapp, A. N. (2025) **Specific activities of dissolved radon-222 collected from underway samples during STING II cruise EN704 on R/V Endeavor in the Gulf of Mexico in Jul 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-11-07 doi:10.26008/1912/bco-dmo.988549.1 [view at BCO-DMO]
Relationship Description: Specific activities of dissolved radon-222 collected by different methods for STING I and STING II

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Parameters

Parameter	Description	Units
Station	Station number; grab samples only	unitless
Sample_ID	ID code = cruise_YYMMDD_station; "S" refers to "surface"; "D" refers to "deep'"; grab samples only	unitless
ISO_DateTime_Local	Date and time of sample collection, Eastern Time	unitless
ISO_DateTime_UTC	Date and time of sample collection, UTC	unitless
Latitude	Latitude of station	decimal degrees
Longitude	Longitude of station	decimal degrees
Depth	Depth of sample collection	meters
Salinity	Salinity, measured underway or by CTD	psu
Internal_Temperature	Internal temperature of RAD7/8 instrument	degrees Celsius
Rn222	Rn-222 isotope specific activity, in-water	dpm/L
Rn222_flag	BDL = Indicates that the measurement is below detection limit	unitless
Rn222_err	Rn-222 isotope specific activity uncertainty, in-water	dpm/L

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Instruments

Dataset-specific Instrument Name	Water Sampler
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	Discrete grab samples were taken from Niskin bottles on the rosette water sampler (bottom waters) and from the ship underway system (February surface waters only) into 8 L jerricans.
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	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Discrete grab samples were taken from Niskin bottles on the rosette water sampler (bottom waters) and from the ship underway system (February surface waters only) into 8 L jerricans.
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	Ship underway system
Generic Instrument Name	Pump - Surface Underway Ship Intake
Dataset-specific Description	Radon samples were collected and analyzed in two ways: as discrete grab samples and continuously from the ship underway system.
Generic Instrument Description	The 'Pump-underway ship intake' system indicates that samples are from the ship's clean water intake pump. This is essentially a surface water sample from a source of uncontaminated near-surface (commonly 3 to 7 m) seawater that can be pumped continuously to shipboard laboratories on research vessels. There is typically a temperature sensor near the intake (known as the hull temperature) to provide measurements that are as close as possible to the ambient water temperature. The flow from the supply is typically directed through continuously logged sensors such as a thermosalinograph and a fluorometer. Water samples are often collected from the underway supply that may also be referred to as the non-toxic supply. Ideally the data contributor has specified the depth in the ship's hull at which the pump is mounted.

Dataset-specific Instrument Name	RAD7 radon-in-air monitors (Durridge Co.)
Generic Instrument Name	RAD-7 Radon Detector
Dataset-specific Description	Jerricans were connected either to a RAD8 or RAD7, both commercially available radon-in-air detectors (Durridge, Inc.). The DURRIDGE RAD7 is a radon and thoron detector. The RAD7 is a computer-driven electronic detector, with pre-programmed set-ups for common tasks. It's built to withstand everyday use in the field. A rugged case encloses the detector, which is self-contained and self-sufficient.
Generic Instrument Description	The DURRIDGE RAD7 is a radon and thoron detector. The RAD7 is a computer-driven electronic detector, with pre-programmed set-ups for common tasks. It's built to withstand everyday use in the field. A rugged case encloses the detector, which is self-contained and self-sufficient. The RAD7 comes with a built-in air pump, rechargeable batteries, and a wireless infrared printer. (https://durridge.com/products/rad7-radon-detector/)

Dataset-specific Instrument Name	RAD8 radon-in-air monitors (Durridge Co.)
Generic Instrument Name	RAD8 Radon Detector
Dataset-specific Description	Jerricans were connected either to a RAD8 or RAD7, both commercially available radon-in-air detectors (Durridge, Inc.). The DURRIDGE RAD8 is a next-generation radon and thoron detector. The RAD8 is a computer-driven electronic detector, with pre-programmed set-ups for common tasks. It's built to withstand everyday use in the field. A rugged case encloses the detector, which is self-contained and self-sufficient.
Generic Instrument Description	The DURRIDGE RAD8 is a next-generation radon and thoron detector. The RAD8 is a computer-driven electronic detector, with pre-programmed set-ups for common tasks. It's built to withstand everyday use in the field. A rugged case encloses the detector, which is self-contained and self-sufficient. (https://durridge.com/products/rad8-radon-monitor/)

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Deployments

AE2305

Website	https://www.bco-dmo.org/deployment/929020
Platform	R/V Atlantic Explorer
Start Date	2023-02-18
End Date	2023-03-07
Description	Start and End port: St. Petersburg, Florida

EN704

Website	https://www.bco-dmo.org/deployment/929032
Platform	R/V Endeavor
Start Date	2023-07-01
End Date	2023-07-13
Description	Start and End port: St. Petersburg, Florida

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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 (Gulf of Mexico DON and Fe)

Coverage: Gulf of Mexico, 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
NSF Division of Ocean Sciences (NSF OCE)	OCE-2149091
NSF Division of Ocean Sciences (NSF OCE)	OCE-2148989
NSF Division of Ocean Sciences (NSF OCE)	OCE-2148812

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