Radium isotope measurements from bottom waters in the South Atlantic Bight from 2015-2020 (SAB BMA project)

Website: https://www.bco-dmo.org/dataset/882140
Data Type: Cruise Results
Version: 1
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Project
» Groundwater sources of "new" N for benthic microalgal production in the South Atlantic bight (SAB BMA)

Contributors	Affiliation	Role
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Abstract
These are measurements of radium isotopes collected from bottom waters in the South Atlantic Bight during 2015-2020. These data were used to verify an episode of submarine groundwater discharge that occurred in August 2019.

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Coverage

Spatial Extent: **Lat**:32 **Lon**:-79
Temporal Extent: 2015-06-02 - 2020-05-11

Methods & Sampling

Methods & Sampling

Bottom water samples were obtained by lowering a submersible pump to near the seafloor and filling two 26-liter carboys. Subsamples for salinity were usually taken from each sample and measured with a YSI conductivity meter to confirm the CTD measurement. Radium samples were filtered through a column of Mn-fiber to quantitatively remove Ra [Moore, 1976]. The Mn-fiber was returned to the lab, where short-lived radium isotopes (223Ra, half-life = 11.4 days, and 224Ra, half-life = 3.66 days) were measured using a delayed-coincidence counting system [Moore and Arnold, 1996]. After the short-lived measurements were complete, Ra and Mn were stripped from the Mn-fiber and radium was coprecipitated with BaSO4 and transferred to a small tube. 226Ra and 228Ra were measured by gamma spectrometry after 222Rn had equilibrated with 226Ra [Moore et al., 1985]. The RaDeCC systems were calibrated for 224Ra with a NIST standard solution of 232Th adsorbed to Mn-fiber and for 223Ra by the technique of Moore and Cai [2013]. The gamma detector was calibrated with NIST standard solutions for 226Ra and 228Ra in a BaSO4 matrix [Moore, 1984].

Samples were taken from R/V Trinity, owned by a private charter company called Charleston SCUBA. This company is no longer in operation.

Data Processing Description

Processing notes from researcher:

The 224Ra and 223Ra counting data were analyzed using the procedure detailed in Moore and Arnold [1996] to correct for chance coincidence events. The gamma spectra for 228Ra and 226Ra were analyzed using the program HYPERMET, which employs multiple iterations to fit each peak in the spectra to an energy range [Phillips and Marlow, 1996]. The energy ranges are assigned to specific radionuclides based on the measurements of NIST standards.

BCO-DMO processing notes:

- Added a date field (a concatenation of the year, day and month fields)
- Replaced spaces in column names with underscores "_"
- Removed units and special characters from column names
- Renamed column names that started with numerical characters (e.g., 226Ra is now Measured_226_Ra)

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Data Files

File
ra_data_report-1.csv (Comma Separated Values (.csv), 2.56 KB) MD5:613fb39569b43301e0fd8da18edcef36 Primary data file for dataset ID 882140

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Related Publications

George, C., Moore, W. S., White, S. M., Smoak, E., Joye, S. B., Leier, A., & Wilson, A. M. (2020). A New Mechanism for Submarine Groundwater Discharge From Continental Shelves. Water Resources Research, 56(11). Portico. https://doi.org/10.1029/2019wr026866 https://doi.org/10.1029/2019WR026866
Results

Moore, W. S. (1976). Sampling 228Ra in the deep ocean. Deep Sea Research and Oceanographic Abstracts, 23(7), 647–651. doi:10.1016/0011-7471(76)90007-3
Methods

Moore, W. S. (1984). Radium isotope measurements using germanium detectors. Nuclear Instruments and Methods in Physics Research, 223(2-3), 407–411. doi:10.1016/0167-5087(84)90683-5
Methods

Moore, W. S. (2008). Fifteen years experience in measuring 224Ra and 223Ra by delayed-coincidence counting. Marine Chemistry, 109(3-4), 188–197. doi:10.1016/j.marchem.2007.06.015
Methods

Moore, W. S., & Arnold, R. (1996). Measurement of 223Ra and224Ra in coastal waters using a delayed coincidence counter. Journal of Geophysical Research: Oceans, 101(C1), 1321–1329. doi:10.1029/95jc03139 https://doi.org/10.1029/95JC03139
Methods

Moore, W. S., & Cai, P. (2013). Calibration of RaDeCC systems for 223Ra measurements. Marine Chemistry, 156, 130–137. doi:10.1016/j.marchem.2013.03.002
Methods

Moore, W. S., Key, R. M., & Sarmiento, J. L. (1985). Techniques for precise mapping of226Ra and228Ra in the

ocean. Journal of Geophysical Research, 90(C4), 6983. https://doi.org/10.1029/jc090ic04p06983
https://doi.org/10.1029/JC090iC04p06983
Methods

Moore, W. S., Vincent, J., Pickney, J. L., & Wilson, A. M. (2022). Predicted Episode of Submarine Groundwater Discharge Onto the South Carolina, USA, Continental Shelf and Its Effect on Dissolved Oxygen. Geophysical Research Letters, 49(24). Portico. https://doi.org/10.1029/2022gl100438
https://doi.org/10.1029/2022GL100438
Results

Phillips, G. W., & Marlow, K. W. (1976). Automatic analysis of gamma-ray spectra from germanium detectors. Nuclear Instruments and Methods, 137(3), 525–536. doi:10.1016/0029-554x(76)90472-9
https://doi.org/10.1016/0029-554X(76)90472-9
Methods

Van der Loeff, M. M. R., & Moore, W. S. (n.d.). Determination of natural radioactive tracers. Methods of Seawater Analysis, 365–397. doi:10.1002/9783527613984.ch13
Methods

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Parameters

Parameter	Description	Units
Sample_Number	Expedition-based sample identifier	unitless
Station	Reference sites	unitless
Latitude	Latitude; a positive value indicates a Northern coordinate	decimal degrees
Longitude	Longitude; a negative values indicates a Western coordinate	decimal degrees
Year	Year sample collected	unitless
Month	Month sample collected	unitless
Day	Day sample collected	unitless
Date	Date sample collected	unitless
Total_Depth	Depth of water column	meters
Sample_Depth	Depth of sampling	meters
Measured_226Ra	Measured Radium-226 activity in the bottom water	decays per minute per liter
Measured_228Ra	Measured Radium-228 activity in the bottom water	decays per minute per liter
Measured_224Ra	Measured Radium-224 activity in the bottom water	decays per minute per liter
Measured_223Ra	Measured Radium-223 activity in the bottom water	decays per minute per liter

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Instruments

Dataset-specific Instrument Name	Gamma Spectrometer, ORTEC
Generic Instrument Name	Gamma Ray Spectrometer
Dataset-specific Description	After the short-lived measurements were complete, Ra and Mn were stripped from the Mn-fiber and radium was coprecipitated with BaSO4 and transferred to a small tube. 226Ra and 228Ra were measured by gamma spectrometry after 222Rn had equilibrated with 226Ra [Moore et al., 1985].
Generic Instrument Description	Instruments measuring the relative levels of electromagnetic radiation of different wavelengths in the gamma-ray waveband.

Dataset-specific Instrument Name	Submersible pump, Granger
Generic Instrument Name	Pump
Dataset-specific Description	Bottom water samples were obtained by lowering a submersible pump to near the seafloor and filling two 26-liter carboys.
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

Dataset-specific Instrument Name	RaDeCC System
Generic Instrument Name	Radium Delayed Coincidence Counter
Dataset-specific Description	The Mn-fiber was returned to the lab, where short-lived radium isotopes (223Ra, half-life = 11.4 days, and 224Ra, half-life = 3.66 days) were measured using a delayed-coincidence counting system [Moore and Arnold, 1996].
Generic Instrument Description	The RaDeCC is an alpha scintillation counter that distinguishes decay events of short-lived radium daughter products based on their contrasting half-lives. This system was pioneered by Giffin et al. (1963) and adapted for radium measurements by Moore and Arnold (1996). References: Giffin, C., A. Kaufman, W.S. Broecker (1963). Delayed coincidence counter for the assay of actinon and thoron. J. Geophys. Res., 68, pp. 1749-1757. Moore, W.S., R. Arnold (1996). Measurement of 223Ra and 224Ra in coastal waters using a delayed coincidence counter. J. Geophys. Res., 101 (1996), pp. 1321-1329. Charette, Matthew A.; Dulaiova, Henrieta; Gonneea, Meagan E.; Henderson, Paul B.; Moore, Willard S.; Scholten, Jan C.; Pham, M. K. (2012). GEOTRACES radium isotopes interlaboratory comparison experiment. Limnology and Oceanography - Methods, vol 10, pg 451.

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Project Information

Groundwater sources of "new" N for benthic microalgal production in the South Atlantic bight (SAB BMA)

Coverage: South Atlantic Bight (32 N, 79 W)

NSF Award Abstract:
Continental shelves are highly productive, with both ecological and economic importance. Benthic microalgae (BMA) are key primary producers in these location. As much as 6x the water column biomass of primary producers is compressed into a layer only a few mm thick on the sediment surface. The source(s) of fixed nitrogen (N) supporting such highly concentrated BMA biomass is currently unknown. Recent studies of sub-seafloor groundwater flow at the University of South Carolina have demonstrated that upwelling saline groundwater likely supplies high concentrations of nutrients in the ridge-swale habitats in the South Atlantic Bight (SAB). The investigators suggest that groundwater input of fixed N into surficial sediments is the primary source of N supporting BMA biomass and production in the mid-shelf region of the SAB. The purpose of this project is to determine the primary source of fixed N supporting BMA biomass in the surface sediments of the shallow shelf waters (<30 m), using the SAB as a field area. A secondary objective is to apply novel and innovative methods to directly quantify groundwater inputs of N into surficial sediments. Research results will fully document the spatio-temporal distributions of BMA and phytoplankton biomass and community structure in the mid-shelf region of the SAB and relate the observed patterns to groundwater inputs of fixed N sources as well as hydrographic and climatic conditions. This research will provide full support and tuition for 2 graduate students, summer support for undergraduate assistants, and involve upper level undergraduates as lab interns. The study team will also work with the Baruch Institute and other partners to develop an "Ocean Schoolyard" program to meet the needs of teachers, students, and community audiences. The project will also provide partial support for Girls Go for I.T., a coding summer camp designed to attract middle-school-aged girls to careers in I.T. and STEM fields.

The specific objectives of the study are to (1) quantify spatial and temporal variations in N fluxes associated with hydrodynamic exchange and upward groundwater flow (2) document spatial and temporal variations in BMA biomass and (3) measure the delta15N of fixed nitrogen sources (well water, porewater and water column ammonium and nitrate; sediments), the BMA, and phytoplankton. The sampling area will be restricted to the 10 - 30 m isobath region of the SAB off the coast of Charleston, SC. Samples will be collected at both the existing groundwater well field and other regions of the shelf. At each of the groundwater wells in the well field, SCUBA divers will collect fluids from the wells to determine well water inorganic nutrient concentrations (nitrate + nitrite, ammonium, orthophosphate, silicon) and the delta 15N of well water ammonium and nitrate (when present). In nearby sediments, samples will be collected for BMA biomass and community composition, surface porewater inorganic nutrients (nitrate + nitrite, ammonium, orthophosphate, silicon), C and N of sediments, sediment grain size analysis, and delta 15N of BMA, ammonium, nitrate (when present), and sediments. Line transects, consisting of 5 sampling locations along a 50 m transect, will be conducted in each of the 4 depth strata. At 10 m intervals along each transect, divers will collect samples the same as above for the well field. Water column samples will be collected for HPLC measurements of phytoplankton biomass and community composition, inorganic nutrient concentrations (nitrate + nitrite, ammonium, orthophosphate, silicon), seston CHN, delta 15N of phytoplankton, and the delta 15N of ammonium and nitrate. The researchers will use heat as a tracer to map the depth of hydrodynamic exchange and monitor the rate of vertical groundwater flow. Results from that analysis will also allow them to then simulate transport of a conservative tracer that can be compared to observed nutrient concentrations to BMA abundance and community composition.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736557

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