Radium and thorium radionuclide measurements in coastal marsh sediments from sediment cores in South Carolina collected from 2017 to 2019

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Data Type: Other Field Results
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Project
» A New Method for Assessing the Magnitude and Impact of Shallow Seawater/Pore water Exchange in Salt Marsh Systems (Salt Marsh Water Exchange)

Contributors	Affiliation	Role
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Abstract
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Coverage

Spatial Extent: **N**:32.8948 **E**:-79.9086 **S**:32.6903 **W**:-79.9531
Temporal Extent: 2017-05-31 - 2019-09-27

Methods & Sampling

Sampling and analytical procedures:

Sediment cores were collected with the piston corer and immediately cut at 2-6 cm intervals and transferred to Teflon large mouth bottles. Care was taken to minimize settling of cores or loss of pore water prior to sectioning. A portion of approximately 15 grams was taken from each bottle and was charged with 150 ml of 18 Mohm water and stirred to form a slurry. The slurry was sonicated for 5 min. The pH of the slurry was adjusted to 8-9 by the dropwise addition of concentrated NH4OH. Following the pH adjustment, 1.0 ml of KMnO4 solution (3.0 g l-1) and 1.0 ml of MnCl2 solution (8.0 g MnCl2 4H2O l-1) was added to form a suspension of MnO2. The slurry was then filtered onto a 142 mm GF/F filter. The sample was loaded into a modified recirculation chamber (after Cai et al. 2012) for counting of 220Rn and 219Rn on the RaDeCC system. Samples were taken back to the laboratory for immediate counting to minimize error in the ratio. Samples were re-measured in the same RaDeCC system after two days and 45 days to differentiate between supported and excess 224Ra and 223Ra.

To estimate porosity, after the sample was collected and split into representative slabs, a portion of the

homogenized slab (typically 15 grams) was dried to constant mass using an oven at 60°C. Mass measurements were taken until constant mass was achieved.

Problem Report:
Noted in the data file, there were four samples that had anomalous counts. These counts were excluded from the data set and results recalculated. Both the original data calculation and the recalculation have been included in the data set. The recalculated samples are denoted with CORR at the end of the sample name and commented on.

Location:
Folly Island and Marsh, South Carolina, 32.68 N, 79.95 W
Daniel Island creek/marsh, South Carolina 32.89 N, 79.9 W

Data Processing Description

Data from the RaDeCC were in text files. The relevant numbers from the raw data are transferred to Excel spreadsheets where calculations (including decay, coincidence counts, error) are performed to obtain final results.

Excel version: Microsoft® Excel® for Microsoft 365 MSO (Version 2111 Build 16.0.14701.20254) 64-bit

BCO-DMO Data Manager Processing Notes:
* Data from source file DATASET_Cores.docx Sheet1 were imported into the BCO-DMO data system and combined into one data table.
* Parameters (column names) renamed to comply with BCO-DMO naming conventions. See https://www.bco-dmo.org/page/bco-dmo-data-processing-conventions
* Date_Time_UTC column converted to ISO 8601 format yyyy-mm-ddTHH:MMZ
* latitude and longitude rounded to 5 decimal places.
* longitude made negative (West is negative in decimal degree format)
* commas in comments replaced with semicolon for additional csv format support.
* Values "Nd" and "nd" in source file classified as missing data identifiers. Missing data values (Blank/Null) values in this dataset are displayed according to the format of data you access. For example, in csv files it will be blank values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as "nd" meaning "no data." See https://www.bco-dmo.org/page/bco-dmo-data-processing-conventions

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Related Publications

Cai, P., Shi, X., Moore, W. S., & Dai, M. (2012). Measurement of 224Ra:228Th disequilibrium in coastal sediments using a delayed coincidence counter. Marine Chemistry, 138-139, 1–6. doi:10.1016/j.marchem.2012.05.004
Methods

Cai, P., Shi, X., Moore, W. S., Peng, S., Wang, G., & Dai, M. (2014). 224Ra:228Th disequilibrium in coastal sediments: Implications for solute transfer across the sediment–water interface. Geochimica et Cosmochimica Acta, 125, 68–84. doi:10.1016/j.gca.2013.09.029
Methods

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Parameters

Parameter	Description	Units
Core_Section	Name of core, leading number represents lowest depth from surface. C# represents core number taken that month, ##1# denotes the month and year.	Centimeters cm, in leading number of core section name
Year_Collection	Year sample was collected in format YYYY	Years
Date_Collection	Date (EST/EDT) sample was collected in format MM-DD-YY	unitless
Time_EST_EDT	Time (EST/EDT) sample was collected in format hh:mm	unitless
Date_Time_UTC	Date and time of collection (UTC) in ISO 8601 format YYYY-MM-DDThh:mmZ	unitless
Tide_Description	State of tide when sample was taken, includes time of relevant tide if applicable in format hh:mm(EST/EDT)	unitless
Latitude_decimal	Latitude of sample location	decimal degrees
Longitude_Decimal	Longitude of sample location	decimal degrees
Core_condition_Observations	Brief description of core content	unitless
Porosity	Ratio of water content to sediment by weight (grams/grams)	Unitless
Ra224	Radium 224 measured	Decays per minute per gram (dpm/g)
Error_Ra224	Error in measured 224 Radium	Decays per minute per gram (dpm/g)
Th228	Thorium 228 measured	Decays per minute per gram (dpm/g)
Error_Th228	Error in Thorium 228 measured	Decays per minute per gram (dpm/g)
Water_Flux	Calculated water flux	Liters per meter squared per day
Comments	Comments on counting errors	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Push Corer
Dataset-specific Description	Corer,(push coring method with plunger) manufactured in house at University of South Carolina. Consists of plastic tube and plunger assembly to allow for minimal sediment disruption and loss of pore water.
Generic Instrument Description	Capable of being performed in numerous environments, push coring is just as it sounds. Push coring is simply pushing the core barrel (often an aluminum or polycarbonate tube) into the sediment by hand. A push core is useful in that it causes very little disturbance to the more delicate upper layers of a sub-aqueous sediment. Description obtained from: http://web.whoi.edu/coastal-group/about/how-we-work/field-methods/coring/

Dataset-specific Instrument Name	
Generic Instrument Name	Radium Delayed Coincidence Counter
Dataset-specific Description	Radium Delayed Coincidence Counter, Manufactured by Scientific Computer Instruments. Used to measure 220Rn and 219Rn which allows for the quantification of 224Ra and 228Th.
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

A New Method for Assessing the Magnitude and Impact of Shallow Seawater/Pore water Exchange in Salt Marsh Systems (Salt Marsh Water Exchange)

NSF Award Abstract:
Tidal marshes are critical junctions between marine and terrestrial chemical processes. The chemical and physical processes that tidal marsh sediments undergo determine the nature of the transformation and accumulation of particulate organic carbon (POC) at the marine to terrestrial interface. Physical transport of pore water through marsh sediments greatly influences the availability of carbon and nutrients that can undergo transformative reactions at the marine to terrestrial interface. Past studies have shown that there is a discrepancy between predicted rates of pore water flow and calculated estimates from tracer studies. Because this flow is crucial to the chemistry of sediment at the terrestrial to marine interface, which is the first junction of the chemical species exported to the ocean, it is important to explain the discrepancy between expected rates of flow and observed rates. This study will use a known tracer method based on natural isotopic ratios (224Radon/228Thorium) and will develop a new method (223Radon/ 227Actinium) to evaluate the export of POC due to pore water flow in tidal marsh sediments, which will have much broader impacts to the overall marine carbon budget. Results from this work will also be integrated into workshops that will educate students and teachers from outside of oceanography about oceanographic carbon and climate research. Presentations will also be developed in collaboration with the South Carolina State Museum as part of the Science Café series. Additionally, one graduate student and one undergraduate student will be supported by this funding.

Predicted advection rates of pore water in very fine-grained tidal marsh sediments have been shown to significantly differ from rates calculated using tracer studies. Because tidal marshes are a crucial chemical link at the marine terrestrial interface, and advection has a significant impact on the availability of chemical species to undergo diagenetic reactions at this interface, it is of significant importance to evaluate this discrepancy. Export of particulate organic carbon (POC) and dissolved organic carbon (DIC), in particular, are of interest, due to the impact on microbial communities within sediments. This research aims to validate the method of 224Ra/228Th disequilibrium to calculate pore water exchange rates. Previous studies using this method have provided evidence for more rapid pore water exchange than would generally be expected in such fine-grained sediments, which are less permeable than coarser grained sediment. Additionally, this research will attempt to develop the disequilibrium method for 223Ra/227Ac. The researchers will evaluate the impact of advection rates on the export of chemical species in salt marshes.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559274

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