Control radon activity results from laboratory experiments to optimize the sparging chamber configuration for Radon-222 analysis

Website: https://www.bco-dmo.org/dataset/826844
Data Type: experimental
Version: 0
Version Date: 2020-10-15

Project
» Collaborative Research: Development of a Submersible, Autonomous Rn-222 Survey System (Submersible Rn-222)

Contributors	Affiliation	Role
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Abstract
These data were collected in order to optimize a new method for degassing dissolved radon-222 from water. The general premise is the use of a sparging chamber ('Bell') that is deployed underwater and uses bubbles to degas the radon. This dataset includes the control (Exchanger) results. See also the control dataset (https://www.bco-dmo.org/dataset/827014). See methodology outlined in Peterson et al., 2013 (Journal of Radioanalytical and Nuclear Chemistry). The sparging chamber is connected to a commercially-available radon-in-air monitor (RAD7; Durridge Co.) via a closed air loop. Air exiting the RAD7 circulates to the bottom of the sparging chamber where it enters via aquarium bubblers. The bubbles rise through the sparging chamber and accumulate in a headspace, from which air is pumped through desiccant back to the RAD7. Our control to which we compare the sparging chamber is the commercially-available RAD-Aqua (Durridge Co.) which sprays a water sample into a chamber rather than using bubbles. Otherwise, the setups are similar. Data contained herein are various laboratory testing configurations to optimize dimensions of the sparging chamber, number and type of bubblers, and any benefits from adding an additional sprayer capability to the top of the sparging chamber. All configurations tested are accompanied by a number of replicates.

Table of Contents

Coverage

Temporal Extent: 2010-09-21 - 2012-08-02

Dataset Description

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Methods & Sampling

See methodology outlined in Peterson et al., 2013 (Journal of Radioanalytical and Nuclear Chemistry). The sparging chamber is connected to a commercially-available radon-in-air monitor (RAD7; Durridge Co.) via a closed air loop. Air exiting the RAD7 circulates to the bottom of the sparging chamber where it enters via aquarium bubblers. The bubbles rise through the sparging chamber and accumulate in a headspace, from which air is pumped through desiccant back to the RAD7.

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Data Processing Description

BCO-DMO Processing Notes:
- data submitted in 57 Excel files, Sheet name "Exchanger_2685" and an Excel file "Sample Summary.xlsx", sheet "Run Summary", and extracted to csv
- the 57 files were concatenated and joined with the summary file, adding columns: Date, Chamber, Bubblers, Sprayer_Status, Water_Source, Bell_RAD7_SN, Exchanger_RAD7_SN.
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- added 'ISO_DateTIme' column, re-formatted date from m/d/yyyy to yyyy-mm-dd
- in 'Chamber column, replaced " with -inch
- formatted date-time column to ISO_DateTime (yyyy-mm-ddTHH:MM:SS)

[table of contents | back to top]

Related Publications

Peterson, R. N., Breier, J. A., Harmon, L. R., Brusa, J., & Hutchins, P. R. (2013). Development of a sparging chamber for field radon analysis. Journal of Radioanalytical and Nuclear Chemistry, 298(2), 1347–1357. doi:10.1007/s10967-013-2589-5
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
resource_name	file name of originally submitted Excel file; suffix -1 indicates first sheet; suffix -2 indicates second sheet	unitless
Date	ISO-formatted date when data was logged (yyyy-mm-dd)	unitless
Chamber	description of the sparging chamber: height and width??	unitless

Bubblers	?number and type of bubblers: default = ??; micro = ??; bubblestone = an aqurium air stone was used to create bubbles	unitless
Sprayer_Status	indicates whether a spray chamber was employed or not	unitless
Water_Source	water source; tap water ; high to low = ??; withers swash = ??	unitless
Bell_RAD7_SN	serial number of Bell RAD7 Radon detector	unitless
Exchanger_RAD7_SN	serial number of the Exchanger RAD7 Radon detector	unitless
Test	RAD7 test (cycle) number	unitless
ISO_DateTime	ISO-formatted date and time when data was logged (yyyy-mm-ddTHH:MM:SS)	unitless
Year	2 digit year during which data was logged	None
Month	2 digit month during which data was logged	None
Day	2 digit day of the month during which data was logged	None
Hour	2 digit hour of the day (24 hour clock) during which data was logged	None
Min	2 digit minute of the hour during which data was logged	None
Tot_Count	Total numbers of counts logged by the RAD7 during the cycle	counts
Live_Time	Time during which active counting occurred for the cycle	minutes
Win_A_pcnt	Percentage of total counts falling in Window A (radon sniff mode)	percent
Win_B_pcnt	Percentage of total counts falling in Window B (thoron 1 window)	percent
Win_C_pcnt	Percentage of total counts falling in Window C (radon Po-214 window)	percent

Win_D_pcnt	Percentage of total counts falling in Window D (thoron 2 window)	percent
HV	High voltage level	volts
HV_duty_cycle	High voltage duty cycle	percent
Temp	Air temperature within RAD7	degrees Celsius
RelHumidity	Relative humidity of sampled air	percent
Leak_curr	Leakage current	milliAmps
Batt_Volt	Battery voltage	volts
Pump_Curr	Air pump current draw	milliAmps
Flags_Byte	Bit 0 indicates whether pump is in Timed Mode; Bit 1 indicates whether pump is On continuously; Bit 2 is not defined; Bit 3 indicates whether tone is in Geiger mode; Bit 4 indicates whether beeper is activated; Bit 5 indicates if spectrum will print after each test; Bit 6 indicates if there are multiple (recycle) tests; Bit 7 indicates whether RAD7 is in Sniff test mode	unitless
Bq_m3	Radon Concentration in sampled air	becquerels per cubic meter (Bq/m3)
Error_2sigma	2-sigma uncertainty of the radon concentration in sampled air	becquerels per cubic meter (Bq/m3)
Units_Byte	Bits 0 and 1 indicate the concentration unit: 00 = counts per minute; 01 = number of counts; 10 = Bq/m3; 11 = pCi/L; Bit 2 through Bit 6 are not defined; Bit 7 indicates the temperature unit (0 = deg. F; 1 = deg. C)	unitless
Elapsed_Time	Amount of time elapsed into the entire measurement	minutes
Count_Rate_Win_A_cpm	The total counts multiplied by the % in window A (divided by 100); then divided by the Live_Time	counts per minute
Win_A_error	1-sigma uncertainty of the Window A count rate (taken as the square root of the total counts multiplied by the % in window A (divided by 100); all of which is then divided by the Live Time)	counts per minute

Rn_Activity_Air_dpm_L	Radon activity in the air calculated as the count rate in window A divided by the RAD7 Sniff Mode sensitivity; then multiplied by 2.22 to convert from pCi/L to dpm/L	decays/minute/liter (dpm/L)
Air_error	1-sigma uncertainty of the radon activity in the air (taken as column AB divided by the RAD7 Sniff mode sensitivity then multiplied by 2.22 to convert from pCi/L to dpm/L	decays/minute/liter (dpm/L)
Water_Temp	Temperature of the water; measured via an Onset Corp. HOBO water level logger	degrees Celsius
Conversion_Factor	Solubility coefficient for radon; calculated as 0.105+0.405*EXP(-0.0502*Water Temp)	unitless
Rn_Activity_Water_dpm_L	Radon activity in the water calculated as the radon activity in air multiplied by the solubility coefficient	decays/minute/liter (dpm/L)
Water_error	1-sigma uncertainty of the radon activity in the water (taken as column AD multiplied by the solubility coefficient	decays/minute/liter (dpm/L)
Smoothed	3-point smoothing function for the radon activity in water	decays/minute/liter (dpm/L)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	RAD-7 Radon Detector
Dataset-specific Description	Data presented here were analyzed with 4 different RAD7 radon-in-air monitors (Durridge Co.). These instruments were calibrated annually by the manufacturer. Relevant serial numbers and corresponding Sniff Mode Sensitivities (in pCi/L) are: 2172: 0.236 2604: 0.383 2675: 0.224 2685: 0.401
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/)

[table of contents | back to top]

Project Information

Collaborative Research: Development of a Submersible, Autonomous Rn-222 Survey System

(Submersible Rn-222)

Website: http://www.breierlab.info/RADx.html

Coverage: Coastal Carolina University; Woods Hole Oceanographic Institution

The PI's request funding to develop a submersible system capable of in situ 222Rn analysis while deployed from a remotely-operated vehicle (ROV) or autonomous underwater vehicle (AUV). Such a system would allow researchers to conduct high-resolution radon surveying through 3-D grids of bottom water and later return to sites of interest to measure a 222Rn time-series in order to quantify SGD fluxes. The system design relies on a new technique to sparge radon, while submerged, from the water for analysis via bubbling a closed air loop through a contained water column. Preliminary evidence shows this to be a viable approach.

Submarine groundwater discharge (SGD) is quickly gaining recognition as an important delivery mechanism of new and recycled nutrients to the coastal ocean. Chemical tracers such as 222Rn and radium isotopes offer excellent utility at detecting groundwater discharge zones and quantifying associated fluxes in nearshore (shallow) waters, but the traditional approaches to sampling and measuring these tracers become progressively less useful as the water column deepens, stratification strengthens, and physical mixing becomes more complex. In deeper waters (1) of the continental shelf where outcropping geological units can focus SGD, and (2) around critical habitats like coral reef ecosystems, one?s ability to measure these tracers is limited to grab sampling-scale resolution. Such resolution is generally not sufficient to understand the pathways, driving forces, and rates of these discharges, nor is it conducive to quantifying associated nutrient delivery fluxes. Prior to assessing the global significance of SGD, then, there exists great need for a tool capable of in situ, continuous measurement of geochemical tracers of SGD in deeper waters of the continental shelf.

Broader Impacts:

Since this proposed study develops a new research tool available for other scientists, the success of this study will have a large and broad impact on SGD studies in important deep basins, hydrothermal studies quantifying hydrothermal flow, and deep-water circulation and mixing studies using Rn-222 as a tracer. The investigators have included a plan for outreach to sponsor a two-semester, senior Design Clinic team of 3-4 undergraduate female engineering students from Smith College's Picker Engineering Program. This undergraduate team will gain experience working on a real-world engineering problem and this project will likewise benefit from their engineering contribution. Breier has undertaken a similar collaboration with Smith College for the NDSF microbial mat sampler project and the results to both sides have been outstanding. Breier and Singh will also mentor a MIT/WHOI Joint Program Ph.D. student as part of this project, with the hope that one of the Smith College engineering students may make this transition. Peterson will also serve as an undergraduate mentor.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1029223
NSF Division of Ocean Sciences (NSF OCE)	OCE-1028990

[table of contents | back to top]