Water level data from a slug test within a shallow, sandy subterranean estuary (STE), Gloucester Point, Virginia USA in May 2021

Website: https://www.bco-dmo.org/dataset/894312
Data Type: Other Field Results
Version: 1
Version Date: 2023-05-09

Project
» Collaborative Research: Cryptic nitrogen cycling in the anoxic subterranean estuary (Subsurface cryptic N cycle)

Contributors	Affiliation	Role
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Abstract
These data were collected during a slug test in 2021 from a sandy subterranean estuary (STE) located in Gloucester Point, Virginia, USA, which is located along the York River Estuary, a tributary of the Chesapeake Bay. These data were collected in order to estimate the hydraulic conductivity of the site.

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Coverage

Spatial Extent: **Lat**:37.248884 **Lon**:-76.5053
Temporal Extent: 2021-05-11

Methods & Sampling

These water level data were collected during 2021 from a sandy subterranean estuary (STE) located in Gloucester Point, Virginia, USA. The HOBO pressure transducer was deployed in a groundwater well installed at the Gloucester Point beach along the mid-tide line of the beach. These data were collected in order to estimate the hydraulic conductivity of the site. The pressure transducer well was constructed out of PVC with 10 centimeters of slotted PVC centered at a 50-centimeter depth. The pressure transducer measured pressure and water temperature every second when sampling and was deployed for approximately 600 seconds. The pressure was converted to water level using the HOBOware software and manually measuring water depth in the well at deployment and recollection. The slug added to the well induced an initial change in the water level of 1.7 meters. The hydraulic conductivity was calculated using the Hvorslev (1951) method. The radius of the

well casing was 2.54 centimeters, the length of the well screen was 10 centimeters, the radius of the well screen was 3.0015 centimeters, and the time it took for the water level to fall to 37 percent (Normalized drawdown = 0.37) of the initial change was 411 seconds.

Data Processing Description

HOBOware software was used to process data.

BCO-DMO Processing description:
- Split the column “Location” into “Latitude” and “Longitude” columns
- Longitude values were converted to decimal degrees where negative values denote the Southern hemisphere
- Converted the “Date_Time” column to %Y-%m-%dT%H:%M:%SZ

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Data Files

File
crypticn_slugtest-1.csv (Comma Separated Values (.csv), 51.98 KB) MD5:da9b77db4d6d4f07c8b6b31f09113f87 Primary data file for dataset 894312, version 1.

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Related Datasets

IsRelatedTo

Wilson, S. J., Song, B., Anderson, I. C., Tobias, C. (2023) **Sediment grain size data collected from a shallow subterranean estuary (STE) in Gloucester Point, Virginia USA, from 2018 to 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-05-01 doi:10.26008/1912/bco-dmo.894323.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Latitude	Latitude of well location	decimal degrees
Longitude	Longitude of well location	decimal degrees
Date_Time	Date and time of measurement (GMT-04:00)	unitless
Abs_Pres	Pressure measured by pressure transducer	kilopascals
Temp	Temperature measured by pressure transducer	celsius
Water_Level	Water level determined by pressure and manual calibration at sensor deployment	meters
Time_after_slug_addition	Number of seconds after adding test water slug	unitless
Drawdown	Drawdown in water level over time	meters
Normalized_drawdown	Drawdown divided by the initial change in volume due to slug	unitless

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Instruments

Dataset-specific Instrument Name	Hobo water level data loggers (U20L)
Generic Instrument Name	Data Logger
Generic Instrument Description	Electronic devices that record data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

Dataset-specific Instrument Name	HOBO Pressure Transducer
Generic Instrument Name	Pressure Sensor
Generic Instrument Description	A pressure sensor is a device used to measure absolute, differential, or gauge pressures. It is used only when detailed instrument documentation is not available.

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Project Information

Collaborative Research: Cryptic nitrogen cycling in the anoxic subterranean estuary (Subsurface cryptic N cycle)

Coverage: Temperate (Mid-Atlantic), Sandy Beach along the York River Estuary, Gloucester Point, Virginia, USA (37.24884N/76.505324W)

NSF Award Abstract:
Nitrogen is an important nutrient that maintains high coastal ecosystem productivity. Yet excess nitrogen delivery can cause serious water quality deterioration including harmful algal blooms, fish kills, and oxygen free dead zones. Numerous nitrogen transformations regulate the balance between nitrogen delivery and nitrogen removal in coastal environments and the majority of these reactions occur in sediments where seawater passes through the subsurface and mixes with groundwater transported from uplands. This mixing zone, referred to as the subterranean estuary, is characterized by very different geochemistry than either the seawater above it or the groundwater below it. Thus, it has the potential to host a variety of unique reactions that affect nitrogen availability to the overlying water. Scientists from the College of William and Mary, Virginia Institute of Marine Science (VIMS), and the University of Connecticut (UConn) propose to examine the importance of a cryptic nitrogen cycle, a novel and potentially widespread nitrogen cycling process in the subterranean estuary. The cryptic nitrogen cycle comprises anoxic ammonium oxidation to nitrite (anoxic nitrification) coupled with anaerobic ammonium oxidation (anammox) or denitrification producing harmless dinitrogen gas. The proposed project represents highly transformative science because it has the potential to change the current paradigm detailing operation of the biogeochemical nitrogen cycle in anoxic environments. Occurrence of the cryptic nitrogen cycle would have broad implications for the nitrogen budget of terrestrial and groundwater systems and the coastal ocean. Characterization of the cryptic nitrogen cycle will allow us to better understand interactions among the nitrogen, metals, and sulfur cycles, and potential impacts of ongoing human modification of coastal environments. Educational contribution of this project focuses on graduate and undergraduate student training. Two graduate students at VIMS and UConn will receive interdisciplinary training in microbiology, molecular ecology, and biogeochemistry while several undergraduates recruited through the VIMS REU (Research Experience for Undergraduates) Program and the UConn marine science programs will also participate in the project. In addition, three summer undergraduate interns will be recruited from Hampton University, a historically Black college, and trained to enhance minority education and research in marine

science. Public outreach will be achieved through popular venues such as VIMS Marine Science Day, and the VIMS After Hours Public Lecture Series at VIMS. Tobias at UConn also provides educational contributions and outreach efforts through the UConn Marine Scholars and Early College Experience programs and an exhibit at Mystic Aquarium.

A cryptic nitrogen cycle is proposed as a new process coupling anoxic nitrification to microbial nitrogen removal pathways such as anammox and denitrification. Unlike anammox, which refers to the oxidation of ammonium by nitrite to form dinitrogen (N2) gas, anoxic nitrification occurs by oxidation of ammonium in the absence of oxygen using other common chemical oxidants such as metal oxides (namely, Fe and Mn) or sulfate, abundant in many marine and coastal systems. The thermodynamic favorability of these reactions relies on coupling nitrite formed via these oxidants with anammox or denitrification. Due to the coupling, nitrite will not accumulate or be measurable in anoxic marine systems. Thus, a cryptic N cycle responsible for nitrite production can occur as a novel N transforming process in anoxic environments, serve as a vital link to N2 production, and attenuate N loads discharging from a subterranean estuary (STE). Preliminary results from a STE in the York River Estuary located in Virginia showed substantial N2 production, representing removal of 50-75% of the fixed groundwater N, in ferruginous and sulfidic zones where neither nitrite nor nitrate were detectable. Stable isotope incubation experiments using the 15N tracer and molecular analysis of microbial communities suggest that coupled anoxic nitrification and anammox processes are the dominant N2 production pathways rather than canonical denitrification in the STE. Therefore, coupled anoxic nitrification-anammox in coastal groundwater may be a major unrecognized sink for fixed nitrogen at the land-sea interface. In addition to coastal groundwater, the cryptic N cycle has potential importance in anoxic zones and ocean basins. This proposal focuses on the STE because geochemical conditions there appear optimal for the proposed reactions to occur, and our preliminary data show strong evidence for a cryptic N cycle. The proposed work uses a combined geochemical, 15N isotope tracer and microbiological approach to evaluate environmental controls on the cryptic N cycle as well as to estimate its contribution to reduction of fixed N fluxes to the coastal ocean. Four approaches are proposed: (1) Field characterization of anoxic nitrification reactions and associated microbial communities in a subterranean estuary; (2) Laboratory incubation experiments to identify hotspots of the cryptic N cycle; (3) Controlled microcosm experiments to determine geochemical controls on anoxic nitrification; and (4) in situ assessment of anoxic nitrification to estimate the importance of the cryptic N cycle in a coastal aquifer.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1658135

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