Groundwater well water level data collected from porewater profiles within a shallow, sandy subterranean estuary (STE) in Gloucester Point, Virginia USA, from 2018 to 2020

Website: https://www.bco-dmo.org/dataset/886319
Data Type: Other Field Results
Version: 1
Version Date: 2023-01-04

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

Contributors	Affiliation	Role
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Abstract
These water level data were collected during 2018-2020 from a sandy subterranean estuary (STE) located in Gloucester Point, Virginia, USA using HOBO pressure transducers deployed in groundwater wells. The pressure transducers measured pressure and water temperature every 15 minutes when sampling and were deployed seasonally.

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Coverage

Spatial Extent: **Lat**:37.248884 **Lon**:-76.505324
Temporal Extent: 2018-04-01 - 2020-06-05

Methods & Sampling

These water level data were collected during 2018-2020 from a sandy subterranean estuary (STE) located in Gloucester Point, Virginia, USA (37.248884, -76.505324). HOBO pressure transducers were deployed in groundwater wells installed at the Gloucester Point beach along the mid-tide and low-tide lines of the beach. Three pressure transducer wells were constructed out of PVC with 10 centimeters (cm) of slotted PVC centered at 50, 70, and 100 cm depths along the mid-tide line and one at 100 cm depth along the low tide line. The mid-tide line wells were 1 meter apart from one another across the beach face along the mid-tide line. The 100c m wells at the mid- and low-tide lines were 3 meters apart. The pressure transducers measured pressure and water temperature every 15 minutes when sampling and were deployed seasonally. Pressure was converted to water level using the HOBOware software and by manually measuring water depth in the well at

deployment and recollection.

Data Processing Description

BCO-DMO Processing:
- concatenated data from 4 separate Excel sheets (one per well) into one data table;
- added Latitude and Longitude columns;
- converted date-time local to ISO 8601 format and added column for UTC date-time;
- renamed fields to comply with BCO-DMO naming conventions.

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Data Files

File
water_level.csv (Comma Separated Values (.csv), 6.64 MB) MD5:b9e8d870c3b439473f1c15da425aeba0 Primary data file for dataset ID 886319

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Parameters

Parameter	Description	Units
Well_ID	Well ID number: MTL 100 = Mid tide line groundwater well with screened pvc centered at depth = 100 cm; MTL 70 = Mid tide line groundwater well with screened pvc centered at depth= 70 cm; MTL 50 = Mid tide line groundwater well with screened pvc centered at depth= 50 cm; LTL 100 = Low tide line groundwater well with screened pvc centered at depth= 100cm.	unitless
ISO_DateTime_Local	Date and time in local time zone (US EST/EDT) in ISO 8601 format	unitless
ISO_DateTime_UTC	Date and time in UTC in ISO 8601 format	unitless
Waterlevel_m	The calculated water level in meters from the top of the well; all wells normalized to a single datum to allow for comparison	meters (m)
AbsPres_kPa	Raw pressure recorded by HOBO pressure transducer in kPa	kilo Pascals (kPa)
Temp_C	Temperature in the water level well in degrees C measured by HOBO pressure transducer	degrees Celsius
AbsPresBarom_kPa	Barometric pressure recorded by HOBO pressure transducer in kPa in upland well	kilo Pascals (kPa)
Latitude	Latitude of the sampling location	degrees North
Longitude	Longitude of the sampling location	degrees East

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Instruments

Dataset-specific Instrument Name	HOBO water level data loggers (U20L)
Generic Instrument Name	Onset HOBO U20L water level logger series
Generic Instrument Description	The HOBO U20L is designed for monitoring changing water levels in a variety of applications including tidal areas, streams, lakes, wetlands, and groundwater. It outputs pressure, water level, and temperature data. The instrument can record samples, sensor measurements at each logging interval, and events data, occurrences such as a bad battery or host connected. The samples are recorded as absolute pressure values, which are later converted to water level readings using software. Absolute pressure is atmospheric pressure plus water head. The deployment of an additional HOBO U20L at the surface can be used to compensate for barometric pressure changes. Each instrument is individually calibrated. They require a coupler and optic base station or HOBO waterproof shuttle to connect to a computer. The instrument is operated with a 3.6 V lithium battery. This series contains 3 models, U20L-01, U20L-02, and U20L-04, with different operation ranges, calibrated ranges, and burst pressures. The pressure sensor is temperature compensated between 0 and 40 degrees Celsius (C), and calibrated between 69 and a maximum of 400 kPa (depending on the model). Its accuracy is within 0.3 % of the full scale for absolute pressure, and 0.1 % FS for water level readings. The temperature sensor operates between -20 and 50 degrees C, with an accuracy of 0.44 deg C, and a resolution of 0.1 deg C. The drift is 0.1 deg C per year.

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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-1657801

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