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IODP Proposal Cover Sheet

637-Full2

☐ **New** ■ **Revised** ☐ **Addendum**

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Title:	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
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Keywords: *(5 or less)*	Pleistocene, Hydrogeology, Submarine Groundwater Discharge	Area:	New England Continental Shelf

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Permission to post abstract on IODP-MI Sapporo Web site: ■ Yes ☐ No

Abstract:

In many coastal settings around the world the distribution of freshwater within continental shelf sediments is far out of equilibrium with modern sea level conditions. One of the most remarkable examples of this can be found on the Atlantic continental shelf off New England where groundwater within shallow Pliocene-Pleistocene sand units over 100 km offshore Long Island are remarkably fresh (~ 3000 mg/l salinity). On Nantucket Island to the North, a 514 meter-deep borehole penetrating the entire Cretaceous–Tertiary sedimentary package showed considerable vertical variations in salinity with extremely fresh (< 1000 mg/l) waters in sand aquifers, higher salinity levels (between 30–70% seawater) in thick clays/silts and intermediate to low salinities in thin confining units, attesting to marked disequilibrium conditions because diffusion tends to eliminate such patterns. Pore fluids within Pleistocene to Upper Cretaceous sands beneath Nantucket Island were also found to be modestly over-pressured by about 4 m above the local water table.

We hypothesize that the rapid incursion of freshwater on the continental shelf in New England could have been caused by one or more of the following mechanisms: (1) Meteoric recharge during Pleistocene sea-level low-stands including vertical infiltration of freshwater associated with local flow cells that may have developed on the continental shelf during sea level low stands; (2) Sub-ice-sheet recharge during the last glacial maximum; (3) Recharge from pro-glacial lakes. We further hypothesize that the overpressures could be due to either:
(1) Pleistocene sediment loading; or (2) fluid-density differences associated with the emplacement of a thick fresh water lens overlying saltwater (analogous to excess pressures observed in gas legs of petroleum reservoirs).
We argue that these different recharge mechanisms can be distinguished using environmental isotope and noble gas data.

This work will extend our understanding of the current and past states of fluid composition, pressure and temperature in continental shelf environments. It will help better constrain rates, directions, and mechanisms of groundwater flow and chemical fluxes in continental shelf environments. *It will contribute to developing new tools for measuring freshwater resources in marine environments.* The apparent transient nature of continental shelf salinity patterns could have important implications for microbial processes and long-term fluxes of carbon and nitrogen and other nutrients to the global ocean.

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Scientific Objectives:

We argue here that targeted drilling for the collection of hydrogeochemical, microbiological, isotopic, and noble gas samples, measurement of hydraulic properties and fluid pressures will permit us to unravel the origin of the offshore groundwaters and to quantify the role of continental shelves in global biogeochemical and climate cycles.

We propose to conduct a shallow (< 1000 mbsf) drilling campaign on the Atlantic continental shelf off Martha's Vineyard, Massachusetts to evaluate the above hypotheses and map the distribution of freshwater resources. We propose to drill six sites along a transect off Martha's Vineyard, MA. This transect takes advantage of existing borehole 6001 on Nantucket Island and ENW-50 on Martha's Vineyard. The sites were selected to obtain a suite of hydrogeochemical/microbiological samples across the freshwater-saltwater mixing zone. Based on paleohydrologic reconstructions by the PIs, the freshwater-saltwater mixing zone should be ~40 km offshore of Martha's Vineyard.

Our planned drilling campaign utilizing Rotosonic drilling in combination with cased/screened wells and packer systems for sampling should help us to overcome prior water/sediment sampling problems experienced on prior ODP and AMCOR drilling campaigns. Post cruise mathematical modeling including direct simulation of groundwater residence times and noble gas transport will be compared to observed pore fluid data to aid in our interpretation. The proposed work is highly interdisciplinary and would be the first to focus almost exclusively on the coupled hydrogeological/ biogeochemical/microbiological processes operating on the continental shelf.

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

Collection of noble gas samples

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
MV- 01	N 41:30 E 70:46	18	350		350	Characterize freshwater leg of transect
MV- 02	N 40:57 E 70:40	19	550		550	Characterize saltwater-freshwater transition zone
MV- 03B	N 40:39 E 70:33	48	650		650	Characterize saltwater-freshwater transition zone
MV- 04	N 40:32 E 70:20	59	750		750	Characterize saltwater-freshwater transition zone
MV- 05	N 40:22 E 70:15	80	775		775	Characterize saltwater-freshwater transition zone
MV- 06	N 40:12 E 70:10	109	800		800	Characterize saltwater- leg of transect