IODP Proposal Cover Sheet

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New England Slope Hydrogeology (APL)

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Title	Investigating groundwater flow, submarine groundwater discharge, and slope stability on the Atlantic continental slope offshore Massachusetts, New England, USA
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Keywords	submarine groundwater, slope stability
Area	New England Continental Slope

Proponent Information

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Abstract

Multiple studies have shown that passive margins are dynamic hydrologic systems. Two primary examples of this are (1) documentation and interpretation that freshwater within continental shelf sediments is far out of equilibrium with modern sea level and (2) geophysical analyses confirming active seepage from the continental slope is common in many locations. While these are global phenomena, one location where they are co-located and accessible for study is the Atlantic continental shelf and slope offshore Massachusetts, USA. IODP proposal 637: New England Continental Shelf Hydrogeology is a mission-specific proposal to drill, sample, and analyze the fluids on the continental shelf with aims to constrain the hydrogeologic system, origin and emplacement of the freshwaters in the continental shelf, and to understand the impacts of this dynamic flow system on microbiological abundance and productivity. The research proposed in this APL augments and advances IODP proposal 637 by extending characterization to the slope hydrogeologic system at one site near active seepage and at one site where there is no seepage.

We hypothesize that glacial loading and sedimentation processes can create a freshwater source and generate fluid overpressures in shelf and slope sediments. Sub-ice-sheet recharge associated with glacial maxima provide a viable source for freshwater and a loading source that generates overpressure. High-sedimentation rates during glacial retreat also create overpressure. While these processes operate at different temporal and spatial time scales, they can be separated and quantified by dedicated expeditions that quantify hydrologic properties, fluid chemistry, and sedimentation history that are combined with detailed hydrogeological modeling of the system. Together IODP proposal 637 and this APL constrain the regional hydrogeological system from the shoreline to the ocean. Independently, this APL provides an efficient (5.4 days) means to directly sample and understand seepage along the slope and its driving mechanisms and will provide insights of how the seepage on the slope is linked to fluid flow processes within the shelf.

This work will extend our understanding fluid flow – driving mechanisms, pathways, and rates – in passive margin settings which impacts seepage and slope stability. This will also expand our characterization of chemical fluxes in this environment which will provide important constraints for understanding microbial abundance, diversity, and productivity and long-term fluxes of carbon, nitrogen, and other nutrients to the ocean. The results of this effort will provide validation and testing of process-based models that can be used to understand fluid fluxes in other margin settings worldwide.

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Scientific Objectives

Targeted drilling and coring including hydrogeological, hydrogeochemical, microbiological, and sedimentological analyses and in situ pressure and temperature measurements on the continental slope offshore Massachusetts, USA will provide direct characterization of processes acting in the shallow subseafloor that drive seepage from the slope into the ocean. These data provide necessary inputs and calibration for process-based models that account for driving forces and temporal evolution of these dynamic, and at times ephemeral, flow systems. Additionally, the work provides data that will help us understand the potential linkages between the freshwater in the shelf and active seepage on the slope.

We propose a two site drilling campaign on the Atlantic continental slope offshore Massachusetts, USA to assess hydrogeological, hydrochemical, and microbiological systems of the slope. Each site will include two holes. The first hole will use APC/XCB to 400 mbsf and will use standard IODP analyses to describe physical properties, fluid and sediment chemistry, lithology, age, and microbial communities. The second hole will be dedicated to in situ pressure measurements and collection of cores for microbiological and geotechnical studies. In situ pressure measurements and spot core locations will be informed by data from Hole A at each site. The proposed drilling, sampling, and measurement campaign has applications for Challenges 5, 7, 10, 12, and 14 of the IODP 2013-2023 science plan and also for Strategic Objectives SO#1 and SO#7, Flagship Initiative FI#3 and FI#5, and the Land to Sea Enabling Element proposed in the 2050 Science Framework document “Exploring Earth Through Scientific Ocean Drilling”.

Non-standard measurements technology needed to achieve the proposed scientific objectives

In situ formation pressure measurements with the temperature dual pressure (T2P) probe using the probe delivery tool (PDT – an update to the motion decoupled hydraulic delivery system, MDHDS).

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Proposed Sites (Total proposed sites: 2; pri: 2; alt: 0; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
MVS-01B (Primary)	39.8833 -69.7274	496	500	0	500	Document hydrogeological properties, geomechanical properties, fluid chemistry/age, fluid pressure, microbial abundance and diversity in a region of active subseafloor fluid flow and slope instability and active seafloor seepage.
MVS-02B (Primary)	39.9094 -70.6984	539	500	0	500	Document hydrogeological properties, geomechanical properties, fluid chemistry/age, fluid pressure, microbial abundance and diversity in a region of active subseafloor fluid flow and slope instability but no seafloor seepage.