IODP Proposal Cover Sheet

637 - Add 8

New England Shelf Hydrogeology

Received for:

Title	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
Proponents	Brandon Dugan, Mark Person, Daniel Lizarralde, Rob Evans, Kerry Key, Deborah Hutchinson, Henk Kooi, Boris van Breukelen, Jennifer McIntosh, Peter Sauer, Kathy Licht, Aaron Micallef, Robert van Geldern, Susanne Stadler
Keywords	Pleistocene, Hydrogeology, Submarine Groundwater Discharge
Area	New England continental shelf

Proponent Information

Proponent	Brandon Dugan
Affiliation	Colorado School of Mines
Country	United States

☑ Permission is granted to post the coversheet/site table on www.iodp.org

Abstract

In many coastal settings worldwide, the distribution of freshwater within continental shelf sediments is far out of equilibrium with modern sea level. One of the most remarkable examples is found on the Atlantic continental shelf off New England where groundwater within shallow Pliocene-Pleistocene sand aquifers over 100 km offshore has low salinity (3000 mg/l or less). On Nantucket Island, a 514m deep borehole penetrating the entire Cretaceous-Tertiary sedimentary package shows considerable variations in salinity with extremely fresh (<1000 mg/l) water in sand aquifers, higher salinity (30-70% of seawater) in thick clay/silt layers, and intermediate-to-low salinity in thin confining units. IODP Expeditions 313and 317 also showed abrupt freshwater-saltwater boundaries linked to lithology. This demonstrates the disequilibrium nature of such systems; diffusion tends to eliminate such patterns. Pore fluid within Pleistocene to upper Cretaceous sands beneath Nantucket Island is also found to be modestly overpressured, ~4m relative to 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 lowstands including vertical infiltration of freshwater associated with local flow cells on the shelf; (2) sub-ice-sheet recharge during the last glacial maximum; and (3) recharge from pro-glacial lakes. We further hypothesize that the overpressures could be due to: (1) Pleistocene sediment loading; or (2) fluid density differences associated with emplacement of a thick freshwater lens over saltwater (analogous to excess pressures in the gas legs of petroleum reservoirs). We argue these different recharge mechanisms and overpressure models can be distinguished through drilling, coring, logging, and fluid sampling. Noble gas and environmental isotope data will be necessary to completely evaluate recharge models.

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 systems. It will contribute to the development of 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, nitrogen, and other nutrients to the ocean. Successful drilling will test process-based models for shelf freshwater off New England. These models can then be applied to other shelf freshwater systems around the world.

Scientific Objectives

We argue that targeted drilling and coring including hydrogeochemical, microbiological, isotopic, and noble gas analysis and measurement of hydraulic properties and fluid pressures will yield a process-based understanding for the origin and volumes of offshore freshwater, how these fluids influence local and global biogeochemical cycles, and how they record climate cycles.

We propose a three site, shallow-water drilling campaign on the Atlantic continental shelf off Martha's Vineyard, MA, USA to test our hypotheses and to map offshore freshwater resources. Our transect takes advantage of boreholes on Martha's Vineyard (ENW-05) and Nantucket (6001), builds on previous AMCOR and IODP analyses, and is motivated by geophysical observations (stratigraphy, resistivity). Our transect will provide samples from the freshwater, freshwater-seawater transition, and seawater zones allowing complete characterization of the system. Based on paleohydrologic reconstructions, we have developed 2D and 3D models of the freshwater distribution and have predicted the freshwater-seawater transition is <30km offshore. Electromagnetic data suggest the transition may extend approximately 40km offshore. Drilling will directly test these geophysical interpretations and provide additional constraints for hydrogeological models.

Our drilling campaign will require one MSP. We propose a program similar to IODP Exp. 313 to increase recovery in unconsolidated sand units and a casing/screening program to facilitate collection of pristine pore fluid samples for geochemical and microbiological analyses. Post-expedition numerical models will include simulation of groundwater residence time and noble gas transport for comparison with field measurements. This highly interdisciplinary work will be one of the first focused hydrogeological-biogeochemical-microbiological studies of shelf systems.

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

Well tests in cased/screened sites, collection of noble gas samples

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

yes

Science Communications Plain Language Summary

Using simple terms, describe in 500 words or less your proposed research and its broader impacts in a way that can be understood by a general audience.

Groundwater flow from the continent, within the continental shelf, and seeping from the continental shelf and slope into the ocean represents a highly dynamic fluid flow system and potential freshwater resource that is under-sampled and under-characterized. It is estimated that the New England shelf may contain 1300 cubic km of freshwater; for perspective, the City of New York uses 1.5 cubic km of freshwater per year. To fully understand driving forces for these dynamic fluid flow systems and associated biogeochemical cycling within the shelf, we need to directly sample the sediments, fluids, and biology of the shallow subsurface. This proposed work will use three sites on the continental shelf south of Massachusetts, USA to extend our understanding freshwater resources within passive margin sediments. This will expand our characterization of water, chemical, and nutrient 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 also provide validation and testing of process-based models that can be used to understand fluid fluxes in other margin settings worldwide.

Proposal History

Submission Type: Resubmission from previously submitted proposal

Review Response

This addendum includes a summary of P637 and its alignment with the 2050 Science Framework as requested by the ECORD Facilities Board after their September 2021 meeting.

Proposed Sites (Total proposed sites: 4; pri: 4; alt: 0; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
MV-08A (Primary)	40.9976 -70.3334	41	550	0	550	MV-8A will characterize the freshwater endmember.
MV-04C (Primary)	40.6185 -70.1370	52	550	0	550	MV-4C will characterize the freshwater-to-seawater transition zone or the seawater endmember of the transect.
MV-03C (Primary)	40.8746 -70.2697	42	550	0	550	MV-3C will characterize the freshwater-to-seawater transition zone of the transect.
MV-05B (Primary)	40.3771 -70.0119	79	650	0	650	MV-5B will characterize the seawater endmember of the transect.

637 - Add 8

Contact Information

Contact Person:	Brandon Dugan
Department:	Geophysics
Organization:	Colorado School of Mines
Address:	924 16th Street, Geophysics Dept, Colorado School of Mines Golden CO 80127 United States
E-mail/Phone:	dugan@mines.edu; Phone: 3032733512

Proponent List

First Name	Last Name	Affiliation	Country	Role	Expertise
Brandon	Dugan	Colorado School of Mines	United States	Principal Lead and Data Lead	Hydrogeology, Geomechanics, Geohazards
Mark	Person	New Mexico Tech	United States	Other Lead	Hydrogeology, Basin-scale Flow Modeling
Daniel	Lizarralde	Woods Hole Oceanographic Institution	United States	Other Proponent	Marine Geophysics, Margin Processes
Rob	Evans	Woods Hole Oceanographic Institution	United States	Other Proponent	Electromagnetic Methods, Marine Geophysics
Kerry	Key	Lamont-Doherty Earth Observatory	United States	Other Proponent	Electromagnetic Methods, Marine Geophysics
Deborah	Hutchinson	US Geological Survey	United States	Other Proponent	Marine Geology and Geophysics
Henk	Kooi	VU University	Netherlands	Other Proponent	Hydrogeology, Offshore Freshwater
Boris	van Breukelen	Delft University of Technology	Netherlands	Other Proponent	Contaminant Hydrology, Biogeochemistry
Jennifer	McIntosh	University of Arizona	United States	Other Proponent	Aqueous Geochemistry, Isotope Geochemistry
Peter	Sauer	Indiana University	United States	Other Proponent	Biogeochemistry, Paleoclimatology
Kathy	Licht	Indiana University-Purdue University	United States	Other Proponent	Glacial Geology, Quaternary Geology
Aaron	Micallef	University of Malta	Malta	Other Proponent	Geomorphology, Seafloor Exploration
Robert	van Geldern	Friedrich-Alexander-Universität Erlangen-Nürnberg	Germany	Other Proponent	Isotope Hydrology, Biogeochemical Cycles
Susanne	Stadler	Bundesanstalt für Geowissenschaften und Rohstoffe	Germany	Other Proponent	Isotope Hydrogeology, Hydrobiogeochemistry

Addendum to IODP Proposal 637 – Alignment with the 2050 Science Framework

Science Lead: Brandon Dugan (dugan@mines.edu)

Data Lead: Brandon Dugan (dugan@mines.edu)

Introduction

Coastal hydrological systems are important as they provide significant freshwater to coastal communities around the world. These resources are typically exploited by groundwater wells that produce from unconfined or confined aquifers with well screen depths of less than 100 m. In 2000, coastal groundwater production along the US Atlantic and Pacific coastlines was about 19.5 km^3 [Barlow and Richard, 2010]. To put this number in perspective, this represents about 2.4% of annual global groundwater withdraws of 800 km^3/yr [Konikow and Kendy, 2005]. Sea-level rise poses a unique issue to coastal freshwater sustainability [Werner and Simmons, 2009; Werner et al. 2013]. In this context, offshore fresh groundwater systems that occur within continental shelves below sea level are of particular interest. The global occurrence of this offshore fresh and brackish groundwater along coastlines [Post et al., 2013] (Figure 1) is volumetrically significant, but not a well-studied future reserve for a growing coastal population. Additionally, coastal freshwater resources are particularly susceptible to contamination due to their proximity to seawater [Post, 2005]. To date, the residence times of these freshwater resources are unknown. This leads to the questions including: were they emplaced during the last glacial maximum (LGM) or do they represent some long-term average of Pleistocene low-stand sea-level conditions? Of further interest is a potential hydraulic connection to onshore meteoric recharge systems [Michael and Kahn, 2016]. It is currently unclear whether offshore groundwater is replenished through long-time scale flow paths through permeable crystalline basement rocks that crop out on the mainland or if these systems represent non-renewable reserves decoupled from the modern, active hydrologic cycle. As coastal populations continue to grow and sea-level rises, stresses on these vulnerable resources will increase. *It is therefore crucial to understand the hydrodynamics of these systems, to characterize their extent, to establish their relation to equilibrium conditions, and to define their potential as a resource.*

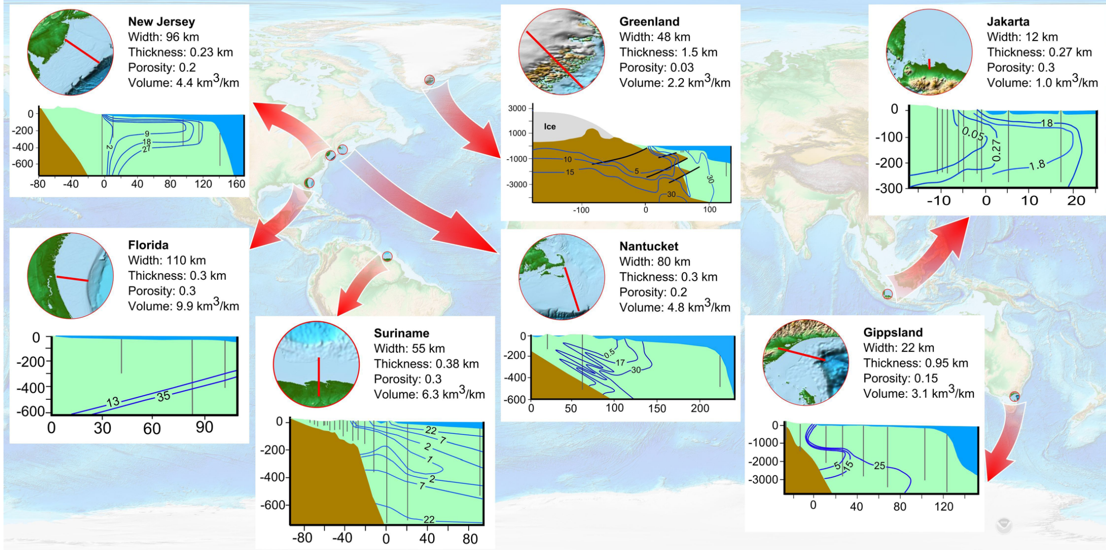


Figure 1. Offshore freshwater cross-sections around the world from Post et al. [2013]. Blue contour lines indicate total dissolved solid (TDS) concentrations in parts per thousand (ppt); horizontal and vertical axes of cross sections are distance (km) and elevation (m) relative to mean sea level; vertical grey lines indicate well locations where salinity is inferred from water samples and borehole logs.

The northeast coast of the United States is perhaps the best understood example of an offshore freshwater system with multiple studies trying to determine the origin and volume of offshore freshwater [e.g., Meisler et al. 1984; Person et al. 2003; Lofi et al. 2013]. Drilling campaigns beginning in the 1970s documented that the Atlantic continental shelf hosts vast quantities of offshore freshwater in sub-seafloor depths >100 m within marine clastic deposits [Hathaway et al. 1979]. Cohen et al. [2010] estimate that there are about 1300 km^3 of sequestered freshwater along the Atlantic continental margin between New Jersey and Maine; for perspective, the City of New York uses 1.5 km^3 of freshwater per year. However, little is known about the origin of this freshwater or the timing of fluid emplacement. Thus the *primary objectives of the proposed research are to understand the spatial distribution of sub-seafloor freshwater, emplacement mechanisms of groundwater, porewater geochemistry, microbe diversity and activity, and anomalous pressure distribution*. This project would characterize the offshore freshwater extent and the transition to seawater which can be linked to submarine groundwater discharge on the shelf-slope break [Skarke et al., 2014, 2018] and to anomalous freshwater onshore [Marksamer et al., 2007]. Globally, offshore fresh groundwater occurs at many other locations below continental shelves (Figure 1) [Post et al., 2013], and these aquifers are prospective water reserves for densely populated, near-shore regions. *Understanding the processes driving emplacement of the fresh water lenses offshore New England will also lead to a better fundamental understanding of this worldwide hydrogeological phenomenon and its impact on biogeochemical cycling.* This is essential for protection and sustainable management of these valuable resources in the near future and for better understanding biogeochemical cycling in shelf environments.

Motivation and Need for IODP Drilling

Prior drilling campaigns and paleohydrogeologic modeling studies provide evidence of freshwater extending far offshore [e.g., Meisler et al., 1984]. This freshwater may provide a buffer to increased demand, especially during periods of intense drought. There is growing evidence that passive margin sediments host large volumes of paleo-freshwater, and it is hypothesized that these waters were emplaced during the past 2 million years as a result of Pleistocene glaciations [Edmunds, 2001; Person et al., 2003, 2007, 2012; Lemieux et al., 2008; Jiráková et al., 2011; McIntosh et al., 2012; Neuzil, 2012; Zhang et al. 2018]. Continental sedimentary basins and passive margins have been influenced by the Laurentide ice sheet and aquifer-ice sheet coupling may explain the emplacement of fresh groundwater to depths up to 1000 m [McIntosh and Walter, 2005; Bense and Person, 2008; McIntosh et al., 2011]. Evidence of glacially emplaced freshwater in basins comes from many sources, including ^{14}C and noble gas ages [Morrisey et al., 2010; Darling, 2011; Klump et al. 2008; Schlegel et al., 2011] and oxygen isotope data [Rozanski, 1985; Vaikmäe et al., 2001; Darling, 2004; Négrel and Petelet-Giraud, 2011; McIntosh et al., 2012; van Geldern et al., 2014]. These observations motivated numerous modeling studies that evaluated how sub-glacial meltwater may create non-equilibrium conditions and may drive freshwater deep into sedimentary basins [Person et al., 2007, 2012; Post et al., 2013; Siegel et al., 2014]. IODP drilling offshore New Jersey (IODP Expedition 313 [Mountain et al., 2009]) has revealed non-equilibrium salinity conditions, but documents significant impact from modern meteoric recharge [van Geldern et al., 2013].

A number of mechanisms have been proposed to explain the emplacement of freshwater within continental shelf sediments during glacial periods. Early studies focused on the shore-normal hydraulic gradient associated with primary topography of the continental shelf as the prime driving force for fresh water recharge during sea-level lowstands [Meisler et al. 1984] (Figure 2). More recently, Groen et al. [2000] argued that local flow systems associated with secondary topography of the subaerially exposed and incised shelf are essential to emplace meteoric water far out onto the continental shelf (Figure 2). Person et al. [2003] emphasized the role of sub-ice-sheet recharge (Figure 2), whereas Mulligan and Uchupi [2003] and Person et al. [2012] suggested recharge from pro-glacial lakes (Figure 2). The mechanism proposed by Groen et al. [2000] would be particularly viable if confining units are discontinuous, a situation indicated by drilling off New Jersey [Mountain et al., 2009]. A problem that some of the above mechanisms face is that freshwater incursion far offshore is indicative of a permeable environment whereas observed (Nantucket, well 6001) and interpreted (offshore New Jersey) excess fluid pressures suggest a low-permeability environment [Marksamer et al., 2007; Dugan and Flemings 2000; Lofi et al., 2013].

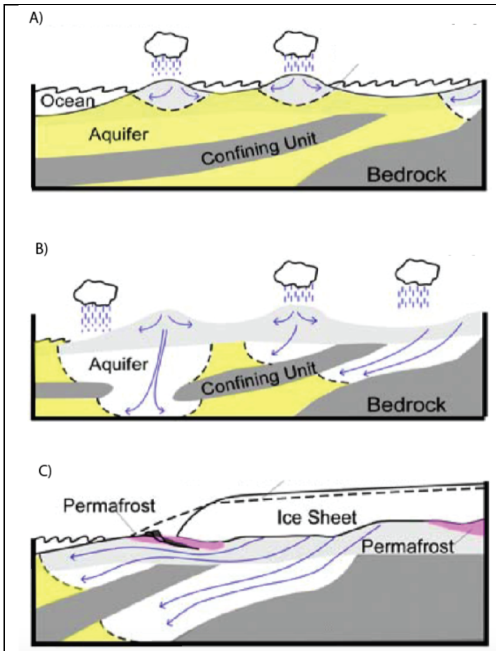


Figure 2. Conceptual models of freshwater emplacement. Freshwater-saturated sediments are light gray and white; saltwater-saturated sediments are yellow. The freshwater-saltwater interface is marked with a dashed blacked line. A) Equilibrium freshwater lens under present-day meteoric recharge produces a small lens of freshwater under islands [Glover, 1959]. B) Meteoric recharge to exposed aquifers and increased gradient during sea-level low-stand drives the freshwater-saltwater interface deeper and farther offshore [e.g., Kooi and Groen, 2001; Meisler et al., 1984]. C) Sub-ice sheet recharge during a glacial period; high pressure from glacial advances drives freshwater deeper and pushes the freshwater-saltwater interface farther offshore [e.g., Person et al., 2003; Marksamer et al. 2007; Siegel et al., 2014].

To better understand the dynamics of these onshore-offshore hydrologic systems, a dedicated hydrogeological expedition is required. We propose a transect drilling approach to focus on the interactions between glacial dynamics, sea-level variations, and groundwater flow along the US Atlantic continental shelf extending from Massachusetts, USA (Figures 3,4). This shelf experienced glaciations in the late Pleistocene in combination with sea-level change throughout the entire Pleistocene [Oldale and O'Hara, 1984; Uchupi et al., 2001; Siegel et al., 2012]. Glacial loading, sea-level fluctuations, and meteoric recharge processes have all been suggested as driving mechanisms that emplaced freshwater nearly 100 km offshore New Jersey down to depths of several hundred meters below the sea floor (mbsf) [Hathaway et al., 1979; Kohout et al., 1988; Cohen et al., 2010; Lofi et al., 2013; Post et al., 2013; van Geldern et al., 2013]. *Dedicated drilling, coring, and analyses focused on the onshore-offshore hydrogeological system are required to fully understand emplacement processes and dynamics.*

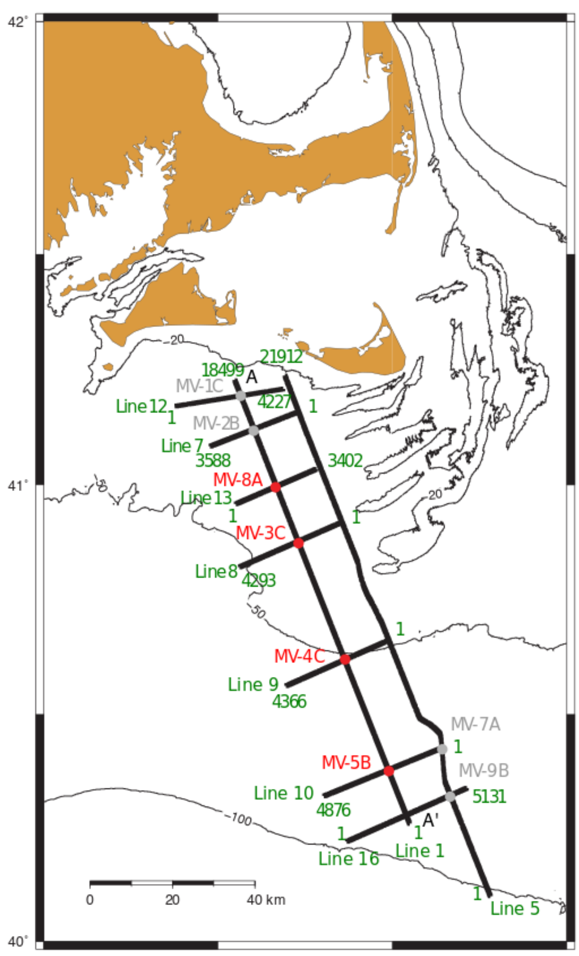


Figure 3. Basemap of IODP 637 study region including proposed sites (primary sites = solid red circles and red numbers; alternate sites = solid grey circles and grey numbers) high-resolution MCS data (black lines, green line numbers), and CDPs (green number). Cross section A-A' (Line 1) is shown in Figure 4.

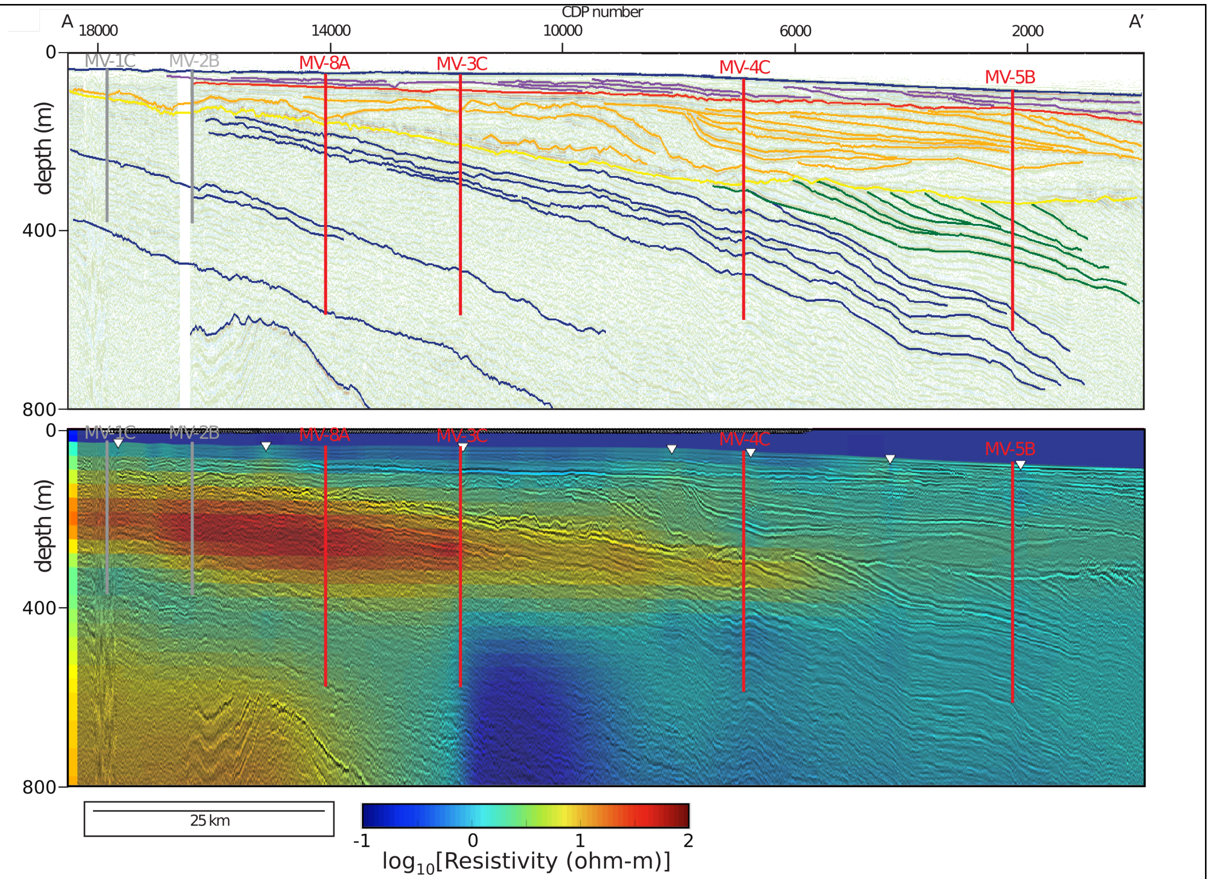


Figure 4. Top – Depth-converted and interpreted seismic line A-A' (located in Figure 3) showing location and proposed depths of primary sites MV-8A, MV-3C, MV-4C, and MV-5B (red lines, red numbers). Also shown are locations and proposed depths for alternate sites MV-1C and MV-2B (grey lines, grey numbers). Details on seismic processing and interpretation are provided in Siegel et al. [2012]. Bottom – Resistivity profile based on joint inversion of controlled-source electromagnetic and magnetotelluric data overlain on depth-converted seismic line A-A' (located in Figure 1) [Gustafson et al., 2019]. Resistive zones are interpreted to be freshwater zones. Primary sites are labeled in red and alternate sites are labeled in grey.

Three-Site Drilling Approach

A significant component to IODP proposal 637 is drilling and sampling the freshwater endmember, the seawater endmember, and the transition between the endmembers. The proposed drilling strategy is to drill MV-8A first to 550 mbsf (Figure 4). This will sample the freshwater endmember which is predicted to be bounded on top and bottom by seawater. The second site to be drilled will be MV-4C to 550 mbsf (Figure 4). This could be the seawater endmember based on numerical modeling results or the freshwater-seawater transition based on electromagnetic and magnetotelluric data. If MV-4C is the seawater endmember, the third site to be drilled would be MV-3C to 550 mbsf (Figure 4) to sample the seawater-freshwater transition. If MV-4C sample the freshwater-seawater transition, the third site to be drilled would be MV-5B to 550 mbsf (Figure 4) to sample the seawater endmember, as predicted by numerical models and electromagnetic and magnetotelluric data.

Alignment with the 2050 Scientific Framework

Below we summarize the key scientific questions that will be addressed through completion of the P637 and their linkages to the 2050 Science Framework [Koppers and Coggon, 2020].

1) What is the distribution of freshwater, fluid pressures, and temperatures across the Atlantic continental shelf in New England? We will directly sample water chemistry, pressures, and temperatures across in the freshwater zone, the freshwater-saltwater transition, and the seawater zone and characterize how they relate to the glacial loading history.
2) How old is the groundwater and when was it emplaced? The deepest onshore freshwater is possibly Pleistocene in age and linked to glaciations. This will be tested with groundwater age dating.
3) Was freshwater recharged by basal melting of large ice sheets, infiltration from large proglacial lakes, direct recharge from precipitation, or a combination of these processes? If the latter, what is their relative importance and can their distribution and the age patterns be unraveled through hydrogeological process models? Isotopic and age data and hydrologic parameter information that we will collect are required to fully constrain system dynamics and flow through time for the onshore component of this onshore-offshore freshwater system that may extend 80 km offshore.
4) Do fluid pressures reflect the current fluid density distribution and modern sea level or are overpressuring mechanisms (e.g., rapid sediment loading) involved? Onshore well data suggest non-equilibrium fluid pressure. Documenting the vertical and horizontal pressure distribution on the shelf and linking it with process will test models for the origin of fluid overpressures as well as the timing of overpressure generation.

5) What are the current concentrations and production/consumption rates of methane, nutrients, and rare Earth elements in shelf sediments? What controls them? Nutrients and methane have been studied in the mid-continent and in near-shore environments. Our proposal targets offer a better understanding of an active shelf environment.
6) What are the rates of decomposition of sedimentary organic matter and which redox processes/microbial communities are involved? What sources of carbon do the shelf microbes utilize? Which factors determine the spatial distribution and activity of microbial communities in the shelf? Dedicated organic matter sampling and microbiological analyses along our proposed transect are required to address these questions and will provide a first step to establishing how they change in the offshore environment.
7) What are the magnitudes of long-term fluxes of methane and nutrients from the shelf due to periodic flushing during the Pleistocene? We have developed process-based models for fluxes from the onshore to the offshore environment and drilling will provide model inputs (e.g., hydrological parameters) and test data for models (e.g., modern conditions that can be tested against forward models under different sea-level and glacial cycles).
8) Does the emplacement of ice sheet meltwaters in confined aquifers create a unique environment for methane? Vertical and horizontal profiling of waters emplaced at different times and under different hydrological conditions will provide new information to address this question.
9) What is the sea-level history along this glaciated margin? Integrating core age and lithology data with the sequence stratigraphy will contribute to addressing this question.

Answering questions 1-4 and 9 will provide new insights on shelf hydrogeology that will contribute to *Strategic Objective [SO] 3: Earth's Climate System (Ice sheets and sea-level rise), SO 4: Feedbacks in the Earth System (Ice sheet grounding and stability), SO 6: Global Cycles of Energy and Matter (Matter cycling: water, freshwater aquifers), and Enabling Element [EE] 2: Land to Sea (Fluid flow across the coastlines)*. Answering Questions 5-6 will provide new insights on shelf hydrogeology that will contribute to *SO 1: Habitability and Life on Earth (Microbial influence on biogeochemical cycles*), *SO 6: Global Cycles of Energy and Matter (Matter cycling: water, freshwater aquifers, Matter cycling: carbon)*, *Flagship Initiative [FI] 4: Diagnosing Ocean Health (Nutrient availability in the ocean), and FI 5: Exploring Life and its Origin (Defining the* *rules of microbial life)*. As a project with direct societal impact, it will also be an asset for *EE1: Broader Impacts and Outreach.*

References

Barlow, P.M., Reichard, E.G., 2010, Saltwater intrusion in coastal regions of North America, Hydrogeology Journal, 18(1), 247-260.

Bense, V.F., Person, M.A., 2008, Transient hydrodynamics within intercratonic sedimentary basins during glacial cycles, Journal of Geophysical Research, 113(F4), 2003–2012.

Cohen, D., Person, M., Wang, P., Gable, C.W., Hutchinson, D., Marksamer, A., Dugan, B., Kooi, H., Groen, K., Lizarralde, D., Evans, R.L., Day-Lewis, F.D., Lane, J.W. Jr., 2010, Origin and Extent of Fresh Paleowaters on the Atlantic Continental Shelf, USA, Ground Water, 48(1), 143-158.

Darling, W.G., 2004, Hydrological factors in the interpretation of stable isotopic proxy data present and past: a European perspective, Quaternary Science Reviews, 23, 743-770.

Darling, W.G., 2011, The isotope hydrology of quaternary climate change, Journal of Human Evolution, 60(4), 417-427.

Dugan, B., Flemings, P.B., 2000, Overpressure and fluid flow in the New Jersey continental slope: Implications for slope failure and cold seeps, Science, 289, 288-291.

Edmunds, W.M, 2001, Palaeowaters in European coastal aquifers; the goals and main conclusions of the PALAEAUX Project, Geological Society Special Publication, 189, 1-16.

Glover, R.E., 1959, The pattern of freshwater flow in a coastal aquifer, Journal of Geophysical Research, 64(4), 457-459.

Groen, J., Velstra, J., Meesters, A.G.C.A., 2000, Salinization processes in paleowaters in coastal sediments of Suriname: evidence from δ^{37}Cl analysis and diffusion modelling, Journal of Hydrology, 234(1-2), 1-20.

Gustafson, C., Key, K., Evans, R.L., 2019, Aquifer systems extending far offshore on the U.S. Atlantic margin, *Scientific Reports*, https://doi.org/10.1038/s41598-019-44611-7.

Hathaway, J.C., Poag, C.W., Valentine, P.C., Millerk, R.E., Schultz, D.M., Manheim, F.T., Kohout, F.A., Bothner, M.H., Sangrey, D.A., 1979, U.S. Geological Survey core drilling on the Atlantic Shelf, Science, 206(4418), 515-527.

Jiráková, H., Huneau, F., Celle-Jeanton, H., Hrkal, Z., Le Coustumer, P., 2011, Insights into palaeorecharge conditions for European deep aquifers, Hydrogeology Journal, 19(8), 1545-1562.

Klump, S., Grundl, T., Purtschert, R., Kipfer, R., 2008, Groundwater and climate dynamics derived from noble gas, ^{14}C, and stable isotope data, Geology, 36(5), 395-398.

Kohout, F.A., Meisler, H., Meyer, F.W., Johnston, R.H., Leve, G.W., Wait, R.L., 1988, Hydrogeology of the Atlantic continental margin, In: The Atlantic continental margin, U.S., 463-480.

Konikow, L.F., Kendy, E., 2005, Groundwater depletion: A global problem, Hydrogeology Journal, 13(1), 317-320.

Koppers, A.A.P., Coggon, R., (eds), 2020, Exploring Earth by Scientific Ocean Drilling: 2050 Science Framework. 124 pp., https://doi.org/10.6075/J0W66J9H.

Kooi, H., Groen, K., 2001, Offshore continuation of coastal groundwater systems; predictions using sharp-interface approximations and variable-density flow modelling, Journal of Hydrology, 246, 19-35.

Lemieux, J-M., Sudicky, E.A., Peltier, W.R., Tarasov, L., 2008, Dynamics of groundwater recharge and seepage over the Canadian landscape during the Wisconsinian glaciation, Journal of Geophysical Research, 113, 1-18.

Lofi, J., Inwood, J., Proust, J.N., Monteverde, D.H., Loggia, D., Basile, C., Otsuka, H., Hayashi, T., Stadler, S., Mottl, M.J., Fehr, A., 2013, Fresh-water and salt-water distribution in passive margin sediments: Insights from Integrated Ocean Drilling Program Expedition 313 on the New Jersey Margin, Geosphere, 9(4), 1009-1024.

Marksamer, A.J., Person, M., Day-Lewis, F.D., Lane, J.W., Cohen, D., Dugan, B., Kooi, H., Willett, M., 2007, Integrating geophysical, hydrochemical, and hydrologic data to understand the freshwater resources on Nantucket Island, Massachusetts, in: Hyndman, D.W., Day-Lewis, F.D., Singha K. (eds), Data integration in subsurface hydrology, AGU Water Resources Monograph 171, doi:10.1029/172GM12.

McIntosh, J.C., Garven, G., Hanor, J.S., 2011, Impacts of Pleistocene glaciation on large-scale groundwater flow and salinity in the Michigan Basin, Geofluids, 11, 18-33.

McIntosh, J.C., Schlegel, M.E., Person, M., 2012, Glacial impacts on hydrologic processes in sedimentary basins: evidence from natural tracer studies, Geofluids, 12, 7-21.

McIntosh, J.C., Walter, L.M., 2005, Volumetrically significant recharge of Pleistocene glacial meltwaters into epicratonic basins: Constraints imposed by solute mass balances, Chemical Geology, 222, 292-309.

Michael, H.A., Khan, M.R., 2016, Impacts of physical and chemical aquifer heterogeneity on basin-scale solute transport: Vulnerability of deep groundwater to arsenic contamination in Bangladesh, Advances in Water Resources, 98, 147-158, https://doi.org/10.1016/j.advwatres.2016.10.010.

Meisler, H., Leahy, P.P., Knobel, L.L., 1984, Effects of eustatic sea-level change on saltwater-freshwater relations in the Northern Atlantic coastal plain, US Geological Survey Water Supply Paper 2255.

Morrissey, S.K., Clark, J.F., Bennett, M., Richardson, E., Stute, M., 2010, Groundwater reorganization in the Floridan aquifer following Holocene sea-level rise, Nature Geoscience, 3, 683-687.

Mountain, G., Proust, J-N., McInroy, D., Cotterill, C., Expedition 313 Scientists, 2009, Proceedings of the IODP Expedition 313, doi:10.2204/iodp.proc.313.2010.

Mulligan, A., Uchupi, E., 2003, New interpretation of glacial history of Cape Code may have important implications for groundwater contaminant transport, EOS Transactions, 84(19), 177.

Négrel, P., Petelet-Giraud, E., 2011, Isotopes in groundwater as indicators of climate changes, TrAC Trends in Analytical Chemistry, 30(8), 1279-1290.

Neuzil, C., 2012, Hydromechanical effects of continental glaciation on groundwater systems, Geofluids, 12, 22-37.

Oldale, R.N., O'hara, C.J., 1984, Glaciotectonic origin of the Massachusetts coastal end moraines and a fluctuating late Wisconsinan ice margin, GSA Bulletin, 95, 61-74.

Person, M., Dugan, B., Swenson, J.B., Urbano, L., Stott, C., Taylor, J., Willett, M., 2003, Pleistocene hydrogeology of the Atlantic continental shelf, New England, GSA Bulletin, 115, 1324-1343.

Person, M., Marksamer, A., Dugan, B., Sauer, P.E., Brown, K., Bish, D., Licht, K.J., Willett, M., 2012, Use of a vertical $\delta^{18}O$ profile to constrain hydraulic properties and recharge rates across a glacio-lacustrine unit, Nantucket Island, Massachusetts, USA, Hydrogeology Journal, 20, 325-336, doi:10.1007/s10040-011-0795-1.

Person, M., McIntosh, J., Bense, V., Remenda, V.H., 2007, Pleistocene hydrology of North America: The role of ice sheets in reorganizing groundwater flow systems, Reviews of Geophysics, 45, RG3007, doi:10.1029/2006RG000206.

Post, V.E.A., 2005, Fresh and saline groundwater interaction in coastal aquifers: is our technology ready for the problems ahead?, Hydrogeology Journal, 13(1), 120-123.

Post, V.E.A., Groen, J., Kooi, H., Person, M., Ge, S., Edmunds, W.M., 2013, Offshore fresh groundwater as a global phenomenon, Nature, 504, 71-78, doi:10.1038/nature12858.

Rozanski, K., 1985, Deuterium and oxygen-18 in European groundwaters - Links to atmospheric circulation in the past. Chemical Geology, 52(3-4), 349-363.

Schlegel, M.E., Zhou, Z., McIntosh, J.C., Ballentine, C.J., Person, M.A., 2011, Constraining the timing of microbial methane generation in organic-rich shale using noble gases, Illinois Basin, USA, Chemical Geology, 287, 27-40.

Siegel, J., Dugan, B., Lizarralde, D., Person, M., DeFoor, W., Miller, N., 2012, Geophysical evidence of a late Pleistocene glaciation and paleo-ice stream on the Atlantic Continental Shelf offshore Massachusetts, USA, Marine Geology, 303-306, 63-74.

Siegel, J., Person, M., Dugan, B., Cohen, D., Lizarralde, D., Gable, C., 2014, Influence of late Pleistocene glaciations on the hydrogeology of the continental shelf offshore Massachusetts, USA, Geochemistry Geophysics Geosystems, 15, doi:10.1002/2014GC005569.

Skarke, A., Ruppel, C., Kidiwela, M., Baldwin, W., Danforth, W., 2018, Expanded U.S. Atlantic Margin Seep Inventory Yields Insight into Methane Dynamics (Abstract OS33C-1913), *American Geophysical Union 2018 Fall meeting*, Washington, DC.

Skarke, A., Ruppel, C., Modis, K., Brothers, D., Lobecker, E., 2014, Widespread methane leakage from the sea floor on the northern US Atlantic margin, *Nature Geoscience*, https://doi.org/10.1038/NGEO2232.

Uchupi, E., Driscoll, N., Ballard, R.D., Bolmer, S.T., 2001, Drainage of late Wisconsin glacial lakes and the morphology and late quaternary stratigraphy of the New Jersey–southern New England continental shelf and slope, Marine Geology, 172, 117-145.

Vaikmäe, R., Vaullner, L., Loosli, P.H., Bloser, P., Juillard-Tardent, M., 2001, Paleogroundwater of glacial origin in the Cambrian-Vendian aquifer of northern Estonia, (in) Paleowaters in Coastal Europe: Evolution of groundwater since the Late Pleistocene, (W. M. Edmunds and C. J. Milne, eds.), The Geological Society, 17-27.

van Geldern, R., Baier, A., Subert, H.L., Kowol, S., Balk, L., Barth, J.A.C., 2014, Pleistocene paleo-groundwater as a pristine fresh water resource – evidence from stable and radiogenic isotopes, Science of the Total Environment, 496, 107-115, doi:10.1016/j.scitotenv.2014.07.011.

van Geldern, R., Hayashi, T., Böttcher, M.E., Mottl, M.J., Barth, J.A.C., Stadler, S., 2013, Stable isotope geochemistry of pore waters and marine sediments from the New Jersey shelf: Methane formation and fluid origin, Geosphere, 9, 96-112, doi:10.1130/GES00859.1.

Werner, A.D., Bakker, M., Post, V.E.A., Vandenbohede, A., Lu, C., Ataie-Ashtiani, B., Simmons, C.T., Barry, D.A., 2013, Seawater intrusion processes, investigation and management: recent advances and future challenges, Advances in Water Resources, 51, 3-26.

Werner, A.D., Simmons, C.T., 2009, Impact of sea-level rise on sea water intrusion in coastal aquifers, Groundwater, 47(2), 197-204.

Zhang, Y., Person, M., Voller, V., Cohen, D., McIntosh, J., Grapenthin, R., 2018, Hydromechanical Impacts of Pleistocene Glaciations on Pore Fluid Pressure Evolution, Rock Failure, and Brine Migration Within Sedimentary Basins and the Crystalline Basement, Water Resources Research, 54(10), 7577-7602.

DR. BRANDON DUGAN
Associate Professor
Department of Geophysics
Colorado School of Mines
Golden, CO 80401
303.273.3512
dugan@mines.edu

PROFESSIONAL PREPARATION

University of Minnesota	Minneapolis, MN	Geo-Engineering	B.GeoE., 1997
Pennsylvania State University	State College, PA	Geosciences	Ph.D., 2003
Postdoctoral Institution:			
US Geological Survey	Woods Hole, MA	Coastal & Marine Geology	2003-2004

APPOINTMENTS

2016-present	Associate Professor of Geophysics and Baker Hughes Chair in Petrophysics and Borehole Geophysics, Colorado School of Mines
2012-2016	Associate Professor of Earth Science, Rice University
2005-2012	Assistant Professor of Earth Science, Rice University
2004-2005	Adjunct Assistant Professor of Earth Science, Rice University
2003-2004	USGS Mendenhall Post-Doctoral Fellow, USGS-Woods Hole

PRODUCTS

1. **Dugan, B.**, Sheahan, T.C., 2012, Offshore Sediment Overpressures of Passive Margins: Mechanisms, Measurement, and Models, *Reviews of Geophysics*, 50, RG3001, doi:10.1029/2011RG000379.
2. Hüpers, A., Torres, M.E., Owari, S., McNeill, L.C., **Dugan, B.**, Henstock, T., Milliken, K.L., Petronotis, K.E., Backman, J., Bourlange, S., Chemale, Jr., F., Chen, W., Colson, T.A., Frederik, M.C.G., Guèrin, G., Hamahashi, M., House, B.M., Jeppson, T.N., Kachovich, S., Kenigsburg, A.R., Kuranaga, M., Kutterolf, S., Mitchison, F.L., Mukoyoshi, H., Nair, N., Pickering, K.T., Pouderoux, H.F.A., Shan, Y., Song, I., Vannucchi, P., Vrolijk, P.J., Yang, T., Zhao, X., 2017, Release of mineral-bound water prior to subduction tied to shallow seismogenic slip off Sumatra, *Science*, 356, 841-844, doi:10.1126/science.aal3429.
3. Siegel, J., Lizarralde, D., **Dugan, B.**, Person, M., 2014, Glacially generated overpressure on the New England continental shelf: Integration of full-waveform inversion and overpressure modeling, *Journal of Geophysical Research*, 119, 3393-3409, doi:10.1002/2013JB010278.
4. Siegel, J., Person, M., **Dugan, B.**, Cohen, D., Lizarralde, D., Gable, C., 2014, Influence of Late Pleistocene Glaciations on the Hydrogeology of the Continental Shelf Offshore Massachusetts, USA, *Geochemistry, Geophysics, Geosystems*, 15, doi:10.1002/2014GC005569.
5. Siegel, J., **Dugan, B.**, Lizarralde, D., Person, M., *DeFoor, W., *Miller, N., 2012, Geophysical evidence of a late Pleistocene glaciation and paleo-ice stream on the Atlantic Continental Shelf, offshore Massachusetts, USA, Marine Geology, 303-306, 63-74, doi:10.1016/j.margeo.2012.01.007.

OTHER SIGNIFICANT PRODUCTS

1. Daigle, H., Bangs, N.L., **Dugan, B.**, 2011, Transient hydraulic fracturing and gas release in methane hydrate settings: A case study from southern Hydrate Ridge, *Geochemistry, Geophysics, Geosystems*, 12(12), Q12022, doi:10.1029/2011GC003841.

2. **Dugan, B.**, 2012, Petrophysical and Consolidation Behavior of Mass Transport Deposits from the Northern Gulf of Mexico, IODP Expedition 308, *Marine Geology*, 315-318, 98-107, doi:10.1016/j.margeo.2012.05.001.
3. Huffman, K.A., Saffer, D., **Dugan, B.**, 2016, In situ stress magnitude and rock strength in the Nankai accretionary complex: a novel approach using paired constraints from downhole data in two wells, *Earth, Planets and Space*, 68:123, doi:10.1186/s40623-016-0491-4.
4. McNeill, L.C., **Dugan, B.**, Backman, J., Pickering, K.T., Pouderoux, H.F.A., Henstock, T.J., Petronotis, K.E., Carter, A., Chemale Jr., F., Milliken, K.L., Kutterolf, S., Mukoyoshi, H., Chen, W., Kachovich, S., Mitchison, F.L., Bourlange, S., Colson, T.A., Frederik, M.C.G., Guèrin, G., Hamahashi, M., House, B.M., Hüpers, A., Jeppson, T.N., Kenigsberg, A.R., Kuranaga, M., Nair, N., Owari, S., Shan, Y., Song, I., Torres, M.E., Vannucchi, P., Vrolijk, P.J., Yang, T., Zhao, X., Thomas, E., 2017, Understanding Himalayan Erosion and the Significance of the Nicobar Fan, *Earth and Planetary Science Letters*, 475, 134-142, doi:10.1016/j.epsl.2017.07.019.
5. Sawyer, D.E., Flemings, P.B., **Dugan, B.**, Germaine, J.T., 2009, Retrogressive failures recorded in mass transport deposits in the Ursa Basin, Northern Gulf of Mexico, *Journal of Geophysical Research*, 114, B10102, doi:10.1029/2008JB006159.

SYNERGISTIC ACTIVITIES

1. IODP Environmental Protection and Safety Panel Member [2010-present]
2. Journal of Geophysical Research-Solid Earth Associate Editor [2017-2019]
3. GeoPRISMS Steering and Oversight Committee Member [2013-2017]
4. Consortium for Ocean Leadership Distinguished Lecturer [2012-2013]
5. Co-chief scientist of IODP Expeditions 338 Expeditions 338 (NanTroSEIZE Stage 3 – Plate Boundary Deep Riser 2) [2012-2013] and 362 (Sumatra Seismogenic Zone) [2016]

BIOGRAPHICAL SKETCH
MARK PERSON
Department of Earth & Environmental Sciences, NM Tech
MSEC 208, 810 Leroy Place, Socorro, NM 87801
575-835-5634 (voice), 575-835-6436 (fax), mperson@nmt.edu

Professional Preparation

Franklin and Marshall College,	Geology	B.S.	1980
New Mexico Tech,	Hydrology	M.A.	1987
Johns Hopkins University,	Geology	Ph.D.	1990
Paris School of Mines	Hydrogeology	Post-doc.	1990-1991

Appointments

2015-present	Hydrology Program Director, New Mexico Tech
2009-present	Professor of Hydrology, New Mexico Tech
2001-2009	Boyce Chair of Geosciences, Professor of Hydrogeology, Indiana University
2000	Professor, University of Minnesota
1997-2000	Associate Professor, University of Minnesota
1993-2000	Gibson Hydrogeology Chair, University of Minnesota
1993-1997	Assistant Professor, University of Minnesota
1991-1993	Assistant Professor, University of New Hampshire

Five Publications Most Relevant to Proposed Activity

DeFoor, W. Person, M., Larsen, H.C., Lizarralde, D. Cohen, D. and B. Dugan, 2011, Ice sheet–derived submarine groundwater discharge on Greenland's continental shelf, *Water Resources Research*, doi:10.1029/2011WR010536

Cohen, D., Person M. , Wang, P. Gable, C. Hutchinson, D., Marksamer, A. Dugan, B. Kooi, H. Groen, K., Lizarralde, D. and R. L. Evans, Origin and Extent of Fresh Paleowaters Beneath the Atlantic Continental Shelf, 2010, *Groundwater*, Volume 48 Issue 1, p. 143 – 158.

Person, M. Bense, V., Cohen, D., Banerjee, A. 2012, Models of ice-sheet hydrogeologic interactions: a review, *Geofluids*, doi: 10.1111/j.1468-8123.2011.00360.x

Siegel J, Person M, Dugan B, Cohen D, Lizarralde D, Gable C, 2014, Influence of late Pleistocene glaciations on the hydrogeology of the continental shelf offshore Massachusetts, USA Geochemistry, Geophysics, Geosystems, doi: 10.1002/2014GC005569, p. 1-20.

Post, V. Groen, J., Kooi, H. Person, M., Ge, S. 2013, Review: Offshore fresh groundwater reserves – A global phenomenon, Nature, v. 504, p. 71-84, doi:10.1038/nature12858

5 Other Publications

Bense V. F., M. A. Person (2008), Transient hydrodynamics within intercratonic sedimentary basins during glacial cycles, J. Geophys. Res., 113, F04005, doi:10.1029/2007JF000969.

Person M., J. McIntosh, V. Bense, V. H. Remenda, 2007, Pleistocene hydrology of North America: The role of ice sheets in reorganizing groundwater flow systems, *Rev. Geophys*., 45, RG3007, doi:10.1029/2006RG000206.

McIntosh, J., Schlegel, J., Person, M. , 2011, Glacial impacts on hydrologic processes in sedimentary basins: evidence from natural tracer studies, Geofluids, DOI: 10.1111/j.1468-8123.2011.00344.x

Iverson, N. and Person, M., 2012, Glacier-bed geomorphic processes and hydrologic conditions relevant to nuclear waste disposal. *Geofluids*, doi: 10.1111/j.1468-8123.2011.00355.x

Marksamer, A.J., Person, M.A., Day-Lewis, F.D., Lane, J.W., Cohen, D., Dugan, B., Kooi, H. and Willett, M., 2007. *Integrating geophysical, hydrochemical, and hydrologic data to understand the freshwater resources on Nantucket Island, Massachusetts* (pp. 143-159). American Geophysical Union.

Synergistic Activities

1. Editor, Geofluids
2. Birdsall-Dreiss Distinguished Lecturer for Geological Society of America, Hydrogeology Division, 1997. Presented lectures on paleohydrogeology at over 30 universities, national labs, and geological soceities across the country.
3. Lead PI on NSF Doctoral Training Grant (GRT) on fluid-rock interactions in the Earth's crust (GEOFLUIDS). As part of this $538,000 program, 11 doctoral students have been produced. Some of these students are now professors at peer institutions.
4. Developed educational computer software package for.aquifer pumping test analysis (MACPUMP). The package was published as a USGS open file report. Mentored an undergraduate UROP student in the development of this package. This student (Fred Day-Lewis) went on to graduate school at Stanford University and will become an assistant professor of hydrogeology at Bucknell University later this year.
5. Developed USGS paleogroundwater modeling package *RIFT2D.* This public domain code allows hydrologists and geologists to reconstruct fossil groundwater flow systems within sedimentary basins. The model has been used in classes at Stanford University.

Collaborators & Other Affiliations (last 48 months)

Collaborators (* = graduate student co-author at the time the work was done)**:**
NM Tech: Fred Phillips, Shari Kelley, John Wilson.
***External**:* Chris Neuzil (US Geological Survey, Reston); Laura Crossey, Karl Karlstrom (University of New Mexico), Jenifer McIntosh (University of Arizona), Denis Cohen (NM Tech); Jeff Hanor (Louisiana State University); Steve Ingebritsen (US Geological Survey, Menlo Park); John Rupp (Indiana Geological Survey); Mike Celia (Princeton), Vincent Post (German Geological Survey, BGR), Brandon Dugan (Colorado School of Mines), John Swenson (University of Minnesota-Duluth), Shemin Ge (University of Colorado)

Students:
MS: Dina Toupin, Jim Wieck, Stratton French, James Taylor, Brian Mailloux, Elise Bekele, Prasenjit Roy, Kuldeep Chaudary, Karin Goff, Brian Mailloux, Sheryl Filby, Ye Zhang, Todd Engelder, Amlan Banerjee Andee Marksammer, Catherine Goetz, Whitney Defoor, Yipeng Zhang, Jeff Pepin, Junhao Hu. Total: 20 students
Ph.D.: John Swenson, Elise Bekele (African American Minority), Jennifer York, Ye Zhang, Lensyl Urbano (Trinidian American), Amlan Banerjee, Amy Jordan; total: 7 students

Thesis and Post-doctoral Advisors:
Post-doc: Ghislain de Marsily, Paris IV University
Ph.D: Grant Garven, Johns Hopkins University
M.A: Fred Phillips, New Mexico Tech.

BIOGRAPHICAL SKETCH

DANIEL LIZARRALDE

Woods Hole Oceanographic Institution
Mail Stop 22
Woods Hole, MA 02543

Tel: 508 289-2942
Fax: 508 289-2187
E-mail: danl@whoi.edu

A. PROFESSIONAL PREPARATION

Virginia Polytechnical and State University — Blacksburg, VA
Geophysics, B. Sc. — *1985*

Texas A&M University — College Station, TX
Geophysics, M. Sc. — *1990*

MIT/WHOI Joint Program in Oceanography — Cambridge/Woods Hole, MA
Geology and Geophysics, Ph. D. — 1997

Danish Lithosphere Center — Copenhagen, Denmark
Marine Geophysics, Post Doctoral Scholar, — May 1, 1997 – December 31, 199*8*

B. APPOINTMENTS

Woods Hole Oceanographic Institution
Associate Scientist — 8/05 - Present

Georgia Institute of Technology
Assistant Professor — 1/99 - 2/06

C. PUBLICATIONS

(i) 5 most relevant to this proposal

Miller, N. C., and D. Lizarralde, Finite-frequency wave propagation through outer rise fault zones and seismic measurements of upper mantle hydration, *Geophys. Res. Lett., 43,*7982–7990, doi:10.1002/2016GL070083, 2016.

Lin, P.-Y. P, J. B. Gaherty, G. Jin, J. A. Collins, D. Lizarralde, R. L. Evans, and G. Hirth, High-resolution seismic constraints on flow dynamics in the oceanic asthenosphere, *Nature, 535*, 538-541, doi:10.1038/nature18012, 2016.

Siegel, J., M. Person, B. Dugan, D. Cohen, D. Lizarralde, and C. Gable, Influence of late Pleistocene glaciations on the hydrogeology of the continental shelf offshore Massachusetts, USA, *Geochem. Geophys. Geosyst., 15*, doi:10.1002/ 2014GC005569, 2014.

Siegel, J., D. Lizarralde, B. Dugan, and M. Person, Glacially Generated Overpressure on the New England Continental Shelf: Integration of Full-Waveform Inversion and Overpressure Modeling, *J. Geophys. Res. Solid Earth*, 119, 2293-2409, doi: 10.1002/2013JB010278, 2014.

Cohen, D., M. Person, P. Wang, C.W. Gable, D. Hutchinson, A. Marksamer, B. Dugan, H. Kooi, K. Groen, D. Lizarralde, R.L. Evans, F.D. Day-Lewis, and J. W. Lane Jr., Origin and Extent of Fresh Paleowaters on the Atlantic Continental Shelf, USA, *Ground Water, 48*, 143-158, doi: 10.1111/j.1745-6584.2009.00627, 2010.

(i) 5 Other products

Miller, N. C., and D. Lizarralde, Thick evaporites and early rifting in Guaymas Basin, Gulf of California, *Geology*, *41, 283-286,* doi:10.1130/G33747, 2012.

Roland, E., D. Lizarralde, J. A. Collins and J. J. McGuire, Seismic velocity constraints on the material properties that control earthquake behavior at the Quebrada-Discovery-Gofar transform faults, East Pacific Rise, *J. Geophys. Res, 117,* B11102, doi:10.1029/2012JB009422, 2012.

Sutherland, F. H., G. M. Kent, A. J. Harding, P. J. Umhoefer, N. W. Driscoll, D. Lizarralde, J. M. Fletcher, G. J. Axen, W. S. Holbrook, A. González-Fernández, and P. Lonsdale, Mid-Miocene to early Pliocene Oblique Extension in the southern Gulf of California, *Geosphere, 8*, 752-770, doi:10.1130/GES00770.1, 2012.

Lizarralde, D., S.A. Soule, J.S. Seewald, and G. Proskurowski, Carbon release by off-axis magmatism in a young, sedimented spreading centre, *Nature Geosciences*, *4*, doi:10.1038/NGEO1006, 2011.

Lizarralde, D., G. J. Axen, H. E. Brown, J. Fletcher, A. González-Fernández, A. J. Harding, W. S. Holbrook, G. M. Kent, P. Paramo, F. Sutherland, and P. J. Umhoefer, Variation in styles of rifting in the Gulf of California, *Nature, 448*, doi:10.1038/nature06035, 466-469, 2007.

D. Five Synergistic Activities

Marcus G. Langseth Oversight Committee	2015 - Present
MG&G Datasystems Advisory Committee	2006 – 2014
Editorial Board, *Lithosphere*, GSA	2008 – 2012
Associate editor, G-Cubed	2006 – 2010
OBSIP Oversight Committee	2001 – 2005

CURRICULUM VITAE
Rob. L. Evans

Marine Geophysicist
Department Chair
Department of Geology and Geophysics
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
Phone: 508-289-2673
e-mail: revans@whoi.edu

Education

1985-1988	B.Sc. (Hons) Physics	Bristol University
1988-1991	Ph.D. Marine Geophysics	Bullard Labs, Cambridge University
1991-1994	Post Doctoral Fellow	Dept. Physics, University of Toronto.

Graduate Supervisor: Dr. Martin. C. Sinha (Cambridge)

Postdoctoral Sponsor: Prof. R. Nigel Edwards (Toronto)

Professional Experience

2017-	Department Chair	Dept. of Geology and Geophysics, W.H.O.I.
2015	Visiting Scientist	Earthquake Research Institute, Tokyo, Japan.
2015	Visiting Professor	Kobe University, Japan
2011-	Senior Scientist	Dept. Geology and Geophysics, W.H.O.I.
2009	Visiting Scientist	Institute de Physique du Globe de Paris
2002-2011	Associate Scientist (Tenured)	Dept. Geology and Geophysics, W.H.O.I.
1998-2002	Associate Scientist	Dept. Geology and Geophysics, W.H.O.I.
1994-1998	Assistant Scientist	Dept. Geology and Geophysics, W.H.O.I.

Five Most Relevant Products

Hoefel, F. and **R.L. Evans**, Impact of Low Salinity Porewater on Seafloor Electromagnetic Data: a Means of Detecting Submarine Groundwater Discharge? Estuarine, Coastal and Shelf Science, 52, 179-189, 2001.

Evans, R.L., Using controlled source electromagnetic techniques to map the shallow section of seafloor: From the coastline to the edges of the continental slope, Geophysics, 72, 105-116, 2007.

Ashton, A., J. Donnelly, **R.L. Evans**, A Discussion of the Potential Impacts of Climate Change on the Shorelines of the Northeastern USA, Mitigation and Adaptation of Strategies for Global Change, 13, 719-743, 2008.

D. Cohen, M. Person, P. Wang, C.W. Gable, D. Hutchinson, A. Marksamer, B. Dugan, H. Kooi, K. Groen, D. Lizarralde, **R.L. Evans**, F.D. Day-Lewis, and J.W. Lane, Origin and Extent of Fresh Paleowaters on the Atlantic Continental Shelf, Groundwater, 48, 143-158, 2010.

R.L. Evans and D. Lizarralde, The Competing Impacts of Geology and Groundwater on Electrical Resistivity Around Wrightsville Beach, N.C., Continental Shelf Research, 31, 841-848 , 2011.

Five Other Significant Products

Evans, R.L., P. Tarits, A.D. Chave, A. White, G. Heinson, J.H. Filloux, H. Toh, N. Seama, H. Utada, J.R. Booker and M. Unsworth, Asymmetric electrical structure in the mantle beneath the East Pacific Rise at 17S, Science, 286, 756-759, 1999.

Evans, R.L., G. Hirth, K. Baba, D. Forsyth, A. Chave and R. Mackie, Geophysical controls from the MELT area for compositional controls on oceanic plates, Nature, 437, 249-252, 2005.

C.-W.Chen, S. Rondenay, **R.L. Evans** and D.B. Snyder, Geophysical detection of relict metasomatism from an Archaean subduction zone, Science, 326, 1089-1091, 2009.

Naif, S., K. Key, S. Constable, **R.L. Evans**, Melt-rich channel observed at the lithosphere-asthenosphere boundary, Nature, 495, 356-359, doi:10.1038/nature11939, 2013.

McGary, R.S., R.L. Evans, P.E. Wannamaker, J. Elsenbeck, S. Rondenay, From slab to surface: Imaging the complete pathway for melt and fluids beneath Mount Rainier in the Cascadia subduction system, Nature, doi:10.1038/nature13493, 511, 338-341, 2014.

Synergistic Activities

Science advisor to Mass. Coastal Zone Management on Beach Scraping at Plum Island 2010

Member of the Interagency Transportation, Land Use, and Climate Change Cape Cod Pilot Project (Department of Transport), 2010

Secretary of AGU Ocean Sciences (Marine Geology and Geophysics) section 2010-2012

GeoPRISMS Steering and Oversight Committee 2011-2014

IRIS Electromagnetic Advisory Committee (EMAC), Chair, 2014-

Thesis Advisor to 2 students

Shane McGary, Graduated Jan 2013, now at James Madison University.

Emily Sarafian (Tursack), Graduated May 2017, now at Corning, Corning, NY.

Postgraduate Sponsor (in last 5 years) to

Tetsuo Matsuno (Kobe University, Kobe, Japan)

Biographical Sketch

Kerry Key

Lamont-Doherty Earth Observatory
Columbia University
61 Rt 9W
Palisades, NY 10964
+1 (845)365-8604, kkey@ldeo.columbia.edu

(a) Professional Preparation

University of California, San Diego	Earth Sciences	B.S.	1998
Scripps Institution of Oceanography, University of California, San Diego	Geophysics	Ph.D.	2003
Scripps Institution of Oceanography, University of California, San Diego	Marine EM	Postdoc	2003-2008

(b) Appointments

Associate Professor	Lamont-Doherty Earth Observatory, Columbia University	2017-present
Visiting Associate Professor	Lamont-Doherty Earth Observatory, Columbia University	2017
Associate Professor	Scripps Institution of Oceanography, University of California, San Diego	2013-2017
Associate Research Geophysicist	Scripps Institution of Oceanography, University of California, San Diego	2012-2013
Assistant Research Geophysicist	Scripps Institution of Oceanography, University of California, San Diego	2008-2012

(c) Publications

(i) Five products most closely related to the proposed project

Naif, S., K. Key, and S. Constable (2016), Porosity and fluid budget of a water-rich megathrust revealed with electromagnetic data at the Middle America Trench, *Geochem. Geophy. Geosyst*., 4495-4516.

Naif, S., K. Key, S. Constable, R.L. Evans (2015), Water-rich bending faults at the Middle America Trench, *Geochem. Geophys. Geosyst.,* 16, 2582-2597.

Key, K., S. Constable, L. Liu, and A. Pommier (2013), Electrical image of passive mantle upwelling beneath the northern East Pacific Rise, *Nature*, 495, 499–502.

Naif, S., K. Key, S. Constable, and R. Evans (2013), Melt-rich channel observed at the lithosphere-asthenosphere boundary, *Nature*, 495, 356–359.

Key, K., S. Constable, T. Matsuno, R. Evans and D. Myer (2012), Electromagnetic detection of plate hydration due to bending faults at the Middle America Trench, *Earth and Planetary Science Letters,* 351–352, 45–53.

(ii) Five Other Publications

Key, K. (2016), MARE2DEM: a 2-D inversion code for controlled-source electromagnetic and magnetotelluric data, *Geophysical Journal International*, 201, 571–588.

Key, K. (2012), Marine electromagnetic studies of seafloor resources and tectonics*, Surveys in Geophysics*, 33,135–167.

Ray, A. and K. Key (2012), Bayesian inversion of marine CSEM data with a trans-dimensional self parametrizing algorithm, *Geophysical Journal International*, 191, 1135–1151.

Key, K. and J. Ovall (2011), A parallel goal-oriented adaptive finite element method for 2.5D electromagnetic modeling, *Geophysical Journal International,* 186, 137–154.

Key, K. and S. Constable (2011), Coast effect distortion of marine magnetotelluric data: Insights from a pilot study offshore northeastern Japan, *Physics of the Earth and Planetary Interiors,* 184**,** 194–207**.**

(d) Synergistic Activities

• GeoPRISMS Steering and Oversight Committee member	2014-present
• Associate Editor, *Geophysics*	2006-2009, 2013-2015
• Co-Instructor, SEG Continuing Education Course: Marine Electromagnetic Methods for Hydrocarbon Exploration	2006-2011
• Author of open-source 2D CSEM and MT modeling and inversion software MARE2DEM: http://mare2dem.ucsd.edu	

- Author of open-source 1D CSEM and MT modeling and inversion software: http://marineemlab.ucsd.edu/Projects/Occam/1DCSEM

Dr. Deborah Hutchinson
Research Geologist
U.S. Geological Survey
Woods Hole, MA 02543
508-457-2263
dhutchinson@usgs.gov

Education

Ph.D.	1984	Geological Oceanography	University of Rhode Island
M.Sc.	1977	Geology	University of Toronto
B.A.	1974	Geology/Geography	Middlebury College

Positions

2002-present	Project Chief, USGS Law of the Sea Studies
2002-2010	Project Chief, USGS Gas Hydrates Studies
2000-2006	Senior Scientific Advisor, USGS Coastal and Marine Knowledge Bank Project
1996-2002	Chief Scientist/Center Director, USGS Coastal and Marine Woods Hole Field Center
1989-1996	Project Chief, USGS, Structural and stratigraphic studies of Lake Baikal
1992-1996	Project Chief, USGS, Database of U.S. Atlantic margin stratigraphy
1990-1996	Team member, USGS, Characterization of gas hydrates using seismic techniques
1988-1993	Project Co-chief, USGS, Midcontinent Rift beneath Lake Superior – GLIMPCE program
1983-1988	Project Chief, USGS, Continental margin shallow crustal structure
1974-1984	Project support and Research Scientist, USGS, Atlantic margin studies

Significant Products

1. **Hutchinson, D.R.**, Jackson, H.R., Houseknecht, D., Li, Q., Shimeld, J.W., Chian, D., Saltus, R.W.,and Oakey, G.N., 2017 (accepted), *Significance of Northeast-trending features in the Canada Basin, Arctic Ocean*: Geochemistry, Geophysics, Geosystems, 39 manuscript pages, 7 figures.

2. Greene, J.A., Tominaga, M., Miller, N.C., Hutchinson, D.R., and Karl, M.R., 2017 (accepted), *Refining the Formation and Early Evolution of the Eastern North American Margin (ENAM): New Insights from Multiscale Magnetic Anomaly Analyses:* Journal of Geophysical Research, 34 manuscript pages, 9 figures, http://onlinelibrary.wiley.com/doi/10.1002/2017JB014308/epdf

3. Chian, D., Jackson, H.R., **Hutchinson, D.R.,** Shimeld, J.W., Oakey, G.N., Lebedeva-Ivanova, N., Li, Q., Saltus, R.W., and Mosher, D.C., 2016*, Distribution of Crustal Types in the Canada Basin, Arctic Ocean*: Tectonophysics, 692 (8-30).

4. Shimeld, J., Li, Q., Chian, D., Lebedeva-Ivanova, N., Jackson, R., Mosher, D., and **Hutchinson, D.**, 2016, *Seismic velocities within the sedimentary succession of the Canada Basin and southern Alpha-Mendeleev Ridge, Arctic Ocean: Evidence for accelerated porosity reduction:* Geophysical Journal International, 204 (1), 1-20. http://gji.oxfordjournals.org/content/204/1/1.full

5. U.S. Geological Survey, 2007, *Facing tomorrow's challenges—U.S. Geological Survey science in the decade 2007–2017*: U.S. Geological Survey Circular 1309, x + 70 p. (Contributors, in alphabetical order: Ayers, M.A., Baron, J.S., Beauchemin, P.R., Gallagher, K.T., Goldhaber, M.B. (chair), **Hutchinson, D.R**., Lebaugh, J.W., Sayre, R., Schwarzbach, S.E., Schweig, E.S., Thormodsgard, J., van Riper, C, III, Wilde, W.).

Other Significant Products

1. Mosher, D.C., Shimeld, J., **Hutchinson, D.R.,** Chian, D., Lebedeva-Ivanova, N., Jackson, R., 2012, *Canada Basin Revealed*: Arctic Technology Conference, December, 2012, OTC 23797, 11 pp.

2. Mosher, D.C., Shimeld, J.W., **Hutchinson, D**., Lebedeva-Ivanova, N, and Chapman, C.B., 2012. *Submarine Landslides in Arctic Sedimentation: Canada Basin*. In: Yamada, Y., Kawamura, K., Ikehara, K., Ogawa, Y., Urgeles, R., Mosher, D., Chaytor, J. and Strasser, M. (eds). Submarine Mass Movements and Their Consequences V, Advances in Natural and Technological Hazards Research, Vol. 31, p. 147-158.

3. **Hutchinson, D.R.,** and Ferrero, R., 2011, Marine Mammals and Anthropogenic Noise, in Holland-Bartels, L., and Pierce, B., eds., *An evaluation of the science needs to inform decisions on Outer Continental Shelf Every Development in the Chukchi and Beaufort Seas, Alaska*: USGS Circular 1370, 165-202.

4. **Hutchinson, D.R.,** Ruppel, C.D., Roberts, H.S., Carney, R., Smith, M., 2011, *Gas hydrates in the Gulf of Mexico*, in Buster, N.A., and Holmes, C.W., eds., Volume 1, Gulf of Mexico- its origin (history, archaeology, and geology): College Station, Texas, Texas A & M University Press, Chapter 15, pp. 247-275.

5. **Hutchinson, D.R.,** Boswell, Ray, Collett, Tim, Dai, J., Dugan, B., Frye, M., Jones, E., McConnell, Dan, Rose, K., Ruppel, C., Shedd, W., Shelander, D., and Wood, W., 2009*, Gulf of Mexico gas hydrate Joint Industry Project Leg II: Green Canyon 955 site selection*: Department of Energy, 2009 Gulf of Mexico JIP – Leg II Reports, http://www.netl.doe.gov/technologies/oil-gas/publications/Hydrates/2009Reports/GC955SiteSelect.pdf, 51 pp.

SYNERGISTIC ACTIVITIES

2013-2016, Secretary, Geology and Geophysics subgroup of the Ocean Sciences Section, AGU, elected.
2012-2016, Member, Marcus Langseth Science Oversight Committee (UNOLS), Invited nomination.
2009-present, Executive Committee of the U.S. Interagency Task Force on the Extended Continental Shelf (Senior Agency Representative), appointed
2008-present, Working Group of the U.S. Interagency Task Force on the Extended Continental Shelf (co-Chair), appointed
2008-present, Joint Management Committee for USGS-GSC cooperative studies in the Arctic Ocean (co-chair), appointed
2010-2011, DOI/USGS OCS Team to evaluate the science needs to inform decisions on Outer Continental Shelf energy development in the Chukchi and Beaufort Seas, Alaska, appointed
2009-2010, Science Advisory Board of the USGS Powell Center (member), appointed
Geological Society of America (fellow), elected
10/2005, Expert review for Geoscience for Ocean Management (National Mapping and Informatics Strategy), Geological Survey of Canada.
1993 – 1995 Associate Editor, Journal of Geophysical Research
1989 – 1992 Associate Editor, Bulletin Geological Society of America
1991 – 1994 member, JOI/USSAC, U.S. Science Advisory Committee to Ocean Drilling Program,

DR. HENK KOOI
Sr. Advisor/researcher
Deltares
PO Box 85467
3501 AL, Utrecht, The Netherlands
+31 652416328
henk.kooi@deltares.nl

PROFESSIONAL PREPARATION

University of Utrecht	Utrecht, NL	Geophysics	MSc, 1987
VU University Amsterdam	Amsterdam, NL	Geology/Tectonics	Ph.D. 1991

APPOINTMENTS

2015-present	Sr. Advisor/researcher, Department Subsurface and Groundwater Systems, Deltares
2006-2015	Associate Professor of Hydrogeology, VU University Amsterdam
2000-2006	Assistant Professor of Hydrogeology, VU University Amsterdam
1994-2000	Post-doctoral Fellow, VU University Amsterdam
1991-1994	Killam Post-Doctoral Fellow, Dalhousie University, Halifax, Canada

PRODUCTS

1. Post, V.E.A.,Groen, J., **Kooi, H.**, Person, M., Ge, S., Edmunds, W.M., 2013, Offshore fresh groundwater reserves as a global phenomenon, *Nature*, 504, 71-78, doi:10.1038/nature12585
2. **Kooi, H.**, and J. Groen, 2001, Offshore continuation of coastal groundwater systems; predictions using sharp-interface approximations and variable-density flow modelling. *Journal of Hydrology*, 246, 19-35.
3. Marksamer, A.J., M.A. Person, F.D. Day-Lewis, J.W. Lane Jr., D. Cohen, B. Dugan, **H. Kooi** and M. Willett, 2007, Integrating geophysical, hydrochemical, and hydrologic data to understand the freshwater resources on Nantucket Island, Massachusetts, *Geophysical Monograph Series* 171, 143-160, DOI: 10.129/172GM12
4. **Kooi, H.**, J. Groen and A. Leijnse, 2000, Modes of seawater intrusion during transgression. *Water Resources Research* 36, 3581-3590.
5. Ge, S., B. Bekins, J. Bredehoeft, K. Brown, E.E. Davis, S.M. Gorelick, P. Henry, **H. Kooi**, A.F. Moench, C. Ruppel, M. Sauter, E. Screaton, P.K. Swart, T. Tokunaga, C.I. Voss, and F. Whitaker, 2003, Fluid flow in sub-seafloor processes and future ocean drilling. *EOS*, 84, 151-152.

OTHER SIGNIFICANT PRODUCTS

1. Post, V.E.A., and **H. Kooi**, 2003, On rates of salinization by free convection in high-permeability sediments; insights from numerical modelling and application to te Dutch coastal area. *Hydrogeology Journal*, 11, 549-559
2. Cohen, D., M. Person, P. Wang, C.W. Gable, D. Hutchinson, A. Marksamer, B. Dugan, **H. Kooi**, J. Groen, D. Lizarralde, R.L. Evans, F.D. Day-Lewis, and J.W. Lane Jr., 2009, Origin and Extent of Fresh Paleowaters on the Atlantic Continental Shelf, USA. *Ground Water*, doi: 10.1111/j.1745-6584.2009.00627.x
3. **Kooi, H.**, 2008), Groundwater Palaeohydrology. In: Climate and the Hydrological Cycle, M.F.P. Bierkens, A.J. Dolman, P.A. Troch (Eds). *IAHS Special publication* 8, 235-254
4. **Kooi, H.**, 1997, Insufficiency of compaction disequilibrium as the sole cause of high pore fluid pressures in pre-Cenozoic sediments, *Basin Research*, 9, 227-241.

5. **Kooi, H.**, 2016, Groundwater flow as a cooling agent of the continental lithosphere, *Nature Geoscience*, 9(2), doi:10.1038/ngeo2642

SYNERGISTIC ACTIVITIES

1. Member of the Hydrology Program Planning Group (PPG) of IODP [2002-2006]
2. Hydrogeology Journal Associate Editor [2000-2006]
3. Core Member UNESCO GRAPHIC program [2006-2015]
4. Member of the Commission for Land Subsidence and Sea-level Change of the Netherlands Geodetic Commision [1998-2005]

BIOGRAPHICAL SKETCH

Boris van Breukelen
Assistant Professor Hydrochemistry
Department of Water Management, Faculty of Civil Engineering and Geosciences,
Delft University of Technology
Stevinweg 1, 2628 CN Delft, the Netherlands
Born: 12-12-1972, Amsterdam, the Netherlands
Telephone: +31-(0)15-2785227; E-mail: b.m.vanBreukelen@tudelft.nl

Scientific Career

- Assistant Professor, since Sept 2015, Delft University of Technology
- Assistant Professor, 2002- Sept 2015, VU University Amsterdam
- Researcher, 1997-2002, VU University Amsterdam
- PhD degree, 2003, VU University Amsterdam
- Doctorandus degree in Environmental Sciences, 1997, VU University Amsterdam

Scientific Profile

Elucidating biogeochemical reaction networks in groundwater through field monitoring and modelling. Environmental assessment and optimisation of technologies for aquifer use to secure and/or provide good water quality: Managed Aquifer Recharge (MAR); Aquifer Storage and Recovery (ASR); Subsurface Iron and Arsenic Removal (SIR and SAR); Enhanced in situ Biodenitrification (EIB); Aquifer Thermal Energy Storage (ATES); Monitored Natural Attenuation (MNA) with Compound Specific stable Isotope Analysis (CSIA) of chlorinated solvents and aromatic hydrocarbons in groundwater, and of pesticides in catchment studies. Exploring biogeochemical modelling for water treatment technologies improvement.

Key Qualifications

Reactive transport modelling (RTM) including of isotope fractionation processes to unravel biogeochemical reaction networks; Groundwater Biogeochemistry and in relation to Microbial Ecology; Pathogen removal; Hydrogeochemical Monitoring Strategies (macro chemistry; trace metals; nutrients; organic micropollutants) on Groundwater and Surface water; Drilling and water and sediment sampling methods; Column and Batch Experiments; Push-Pull Tests; Geophysical Exploration Methods; Assessment and Optimisation of Technologies for Aquifer use.

Awards

- Hydrology Prize 2002, best publication in Hydrology, Netherlands Hydrological Society
- Escher Prize 1998, best MSc-thesis Earth Sciences in the Netherlands

Research Achievements

- 51 ISI peer-reviewed scientific publications: 11 as first-author, 15 as last/senior author, 15 in *Environ. Sci. Technol.* (IF=5.4); H index = 22; 1211 times cited.
- Supervises as co-promotor 5 PhD students.
- Completed PhD student graduations: 5 (as co-promotor on ATES; EIB; MAR; CSIA-RTM; SAR) and 3 (as co-supervisor on microbial ecology in relation to degradation).
- Member of thesis committee and doctorate examination committee in 10 PhD graduations.
- Invited speaker at 9 intl. conferences (Gordon Research; AGU spring/fall; CMWR XXII)

Current funded projects as PI

- 2017-2021: NWO (National Science Foundation) Topsector Water AGRIMAR project. Coordinator and daily supervisor for both PhD students on chemical water quality and plant pathogen removal. Proposal ranked 1^{st}/28 proposals. Score: 1.2 on scale 1.0 (highest) - 9.0 (lowest). Funding (total): 630 k€.

- 2015-2020: NWO UDW Δ-MAR project. Funding (total): 801 k€. Main supervisor of one PhD student on water quality of MAR for drinking water provision in coastal Bangladesh.

Completed funded projects as PI

- 2010-2015: EU Marie Curie Initial Training Network (ITN) CSI:ENVIRONMENT: "Isotope forensics meets biogeochemistry – linking sources and sinks of organic contaminants": Main supervisor of 2 PhDs and work package leader. Funding 2 PhDs: 479.5 k€.
- 2010-2014: USA ESTCP project ER-201029 "Integrated CSIA – RTM approach for assessment of chlorinated solvent degradation" with Uni. of Oklahoma and GSI Environmental Inc., Texas: 160 kUS$
- 2007: SNOWMAN EU project "ENACT: extending the NA of chlorinated solvents toolbox": 21/136 k€.
- 2000-2007: 7 small national applied research projects (incl. NOBIS/SKB/NOVEM): in total ~140 k€.
- Contributed (PhD supervision, publications) to Wetsus, NWO WOTRO, BTO, and CATO-2 projects.

Utilisation

- Collaboration companies: IWACO, Tauw, IFTechnology, Acacia Water, GSI Environmental
- Collaboration end-users: Waternet, PWN, Oasen, Vitens, Ministry of Infrastructure and the Environment
- Collaboration others: UNICEF

Teaching

- MSc level: Fundamentals of Water Treatment (3/4 ects, 2015→); Hydrochemistry (6/6 ects, 2002-2015); Contaminant Hydrology (3/3 ects, 2004-2011); Transport Processes (3/6 ects, 2012-2015); Field Hydrology Instruction in the Netherlands and Portugal (1-4 wks; 10×). BSc level: Geochemical Modelling (BSc, 1/1 ects, 2016→); Soils and Environment (2/6 ects; 2005-2013).
- Supervised ~50 MSc/BSc student research projects.
- Course developer and sole instructor of professional courses in RTM (1-4 days; 6× since 2009).

Selection of relevant papers for the IODP proposal 637

- Khadra, W.; Stuyfzand, P.J.; **van Breukelen, B.M.**, 2017. Hydrochemical effects of saltwater intrusion in a limestone and dolomitic limestone aquifer in Lebanon. *Applied Geochemistry*, 79, 36-51.
- **Van Breukelen, B.M.;** Bonte, M., 2016. Comment on "Thermally Released Arsenic in Porewater from Sediments in the Cold Lake Area of Alberta, Canada". *Environmental Science & Technology*, 50, 7263-7264.
- Bonte, M., Röling, W.F.M., Zaura, E., van der Wielen, P.W.J.J., Stuyfzand, P.J. and **van Breukelen, B.M**., 2013. Impacts of Shallow Geothermal Energy Production on Redox Processes and Microbial Communities. *Environmental Science & Technology*, 47: 14476−14484.
- Karlsen, R.H., Smits, F. J. C., Stuyfzand, P.J., Olsthoorn, T.N., **van Breukelen, B.M**., 2012. A Post audit and inverse modeling in reactive transport: 50 years of artificial recharge in the Amsterdam water supply dunes. *Journal of Hydrology*, 454-455: 7-25
- **Van Breukelen, B.M**., Griffioen, J., 2004. Biogeochemical processes at the fringe of a landfill leachate pollution plume: potential for dissolved organic carbon, Fe(II), Mn(II), NH_4 and CH_4 oxidation. *Journal of Contaminant Hydrology*, 73(1-4): 181-205.
- **Van Breukelen, B.M.**, Röling, W.F.M., Groen, J., Griffioen, J., Van Verseveld, H.W., 2003. Biogeochemistry and isotope geochemistry of a landfill leachate plume. *Journal of Contaminant Hydrology*, 65(3-4): 245-268.

Jennifer C. McIntosh Curriculum Vitae, Fall 2017
University of Arizona, Dept. of Hydrology & Atmospheric Sciences Tel: 520-626-2282
1133 E. James E. Rogers Way, Tucson, AZ 85721 Email: mcintosh@hwr.arizona.edu

(a) Professional Preparation

Whitman College, Walla Walla, WA	Geology-Chemistry	B.A., 1998
University of Michigan, Ann Arbor, MI	Geology	M.S., 2000
University of Michigan, Ann Arbor, MI	Geology	Ph.D., 2004
Johns Hopkins University, Baltimore, MD	Earth & Planetary Sciences	Postdoc 2004-2006

(b) Appointments

2014 **Visiting Scholar**, Center for Biofilm Engineering, Montana State University, Bozeman, MT
2012- **Joint Associate Professor**, University of Arizona, Geosciences, Tucson, AZ
2012- **Associate Professor, Distinguished Scholar,** University of Arizona, Hydrology and Water Resources, Tucson, AZ
2007- **Adjunct Research Geologist**, United States Geological Survey
2007- **Joint Assistant Professor**, University of Arizona, Geosciences, Tucson, AZ
2006-2012 **Assistant Professor**, University of Arizona, Hydrology and Water Resources, Tucson, AZ
2004-2006 **Morton K. and Jane Blaustein Postdoctoral Research Fellow**, Johns Hopkins University

(c) Publications

i) most closely related publications

McIntosh, J.C., Schlegel, M.E., Person, M. (2012) Glacial impacts on hydrologic processes in sedimentary basins: evidence from natural tracer studies. *Geofluids*, vol. 12, 7-21.

McIntosh, J.C., Garven, G., Hanor, J.S. (2011) Impacts of Pleistocene glaciation on large-scale groundwater flow and salinity in the Michigan Basin. *Geofluids*, 11, 18–33, doi: 10.111/j.1468-8123.2010.00303.x.

Schlegel, M.E., Zheng, Z., McIntosh, J., Person, M., Ballentine, C. (2011) Constraining the timing of microbial methane generation in an organic-rich shale using noble gases, Illinois Basin, USA. *Chemical Geology*, doi:10.1016/j.chemgeo.2011.04.019.

Schlegel, M.E., McIntosh, J.C., Bates, B., Kirk, M., and Martini, A.M. (2011) Comparison of fluid geochemistry and microbiology of multiple organic-rich reservoirs in a sedimentary basin: evidence for controls on methanogenesis and microbial transport. *Geochimica et Cosmochimica Acta*, vol. 75, pp. 1903-1919.

Brown, K.B., McIntosh, J.C., Baker, V., and Gosch, D. (2010) Isotopically-depleted Late Pleistocene groundwater in Columbia River Basalts: evidence for recharge of Glacial Lake Missoula floodwaters? *Geophysical Research Letters*, vol. 37, pp. 5, doi:10.1029/2010GL044992.

ii) other significant publications

McIntosh, J.C., Schaumberg, C., Perdrial, J., Harpold, A., Vázquez-Ortega, A., Rasmussen, C., Vinson, D., Zapata-Rios, X., Brooks, P.D., Meixner, T., Pelletier, J., Derry, L., and Chorover, J. (2017) Geochemical evolution of the Critical Zone across variable time scales informs concentration-discharge relationships: Jemez River Basin Critical Zone Observatory. *Water Resources Research*, 53, pp. 1-28, doi:10.1002/2016WR019712.

Li, Li, Maher, K., Navarre-Sitchler, A., Druhan, J., Lawrence, C., Meile, C., Moore, J., Perdrial, J., Sullivan, P., Thompson, A., Jin, L., Bolton, E., Brantley, S., Dietrich, W., Mayer, U., Steefel, C.I., Valocchi, A., Zachara, J., Kocar, B., Mcintosh, J., Bao, C., Tutolo, B.M., Beisman, J., Kumar, M., and Sonnenthal, E. (2017) Expanding the role of reactive transport modeling in earth and environmental sciences. *Earth Science Reviews*, vol. 165, pp. 280-301.

Hamilton, S., Grasby, S., McIntosh, J., and Osborn, S. (2015) The effect of long-term, regional pumping on hydrochemistry and dissolved gas content in an undeveloped shale gas-bearing aquifer in southwestern Ontario. *Hydrogeology Journal,* vol. 23(4), pp. 719-739.

Hopkins, C.A., McIntosh, J.C., Eastoe, C., Dickinson, J., and Meixner, T. (2014) Evaluation of the importance of clay confining units on groundwater flow in alluvial basins using solute and isotope tracers. *Hydrogeology Journal,* vol. 22(4), pp. 829-849.

Bates, B., McIntosh, J.C., Lohse, K., and Brooks, P. (2011) Influence of groundwater flowpaths, residence times, and nutrients on the extent of microbial methanogenesis in coalbeds: Powder River Basin, USA. *Chemical Geology,* vol. 284, pp. 45-61.

(d) Synergistic Activities

Associate Editor, Water Resources Research (2013-2016) and Hydrogeology Journal (2010-2013)

New Mexico EPSCoR (*Energize New Mexico*) Advisory Board Member (2013-2018)

Director of Graduate Studies, Hydrology and Water Resources Program, Department Hydrology and Atmospheric Sciences, UA

Co-organizer for IAEA International workshop on isotopic techniques for fingerprinting sources of contamination related to oil/gas production and hydraulic fracturing (2016), and lead for EPA Chemical and Analytical Technical Workshop session on "Fingerprinting" in support of EPA study on Hydraulic Fracturing (Feb 2011)

Invited Participant in NSF Workshop on Expanding the Role of Reactive Transport Modeling (RTM) within the Biogeochemical Sciences (2014), and NSF IODP-ICDP Workshop on Onshore-Offshore Drilling and Sampling to Understand Freshwater Resources along the New England Continental Shelf (2017)

Biographical Sketch: PETER EVAN SAUER (10/2017)

Assistant Research Scientist
Biogeochemistry Laboratories
Department of Geological Sciences
Indiana University
Bloomington, IN 47405 USA

Tel: (812)-855-6591
Fax: (812)-855-7961
E-mail: pesauer@indiana.edu

Home Page: http://geology.indiana.edu/sauer/index.html

Professional Preparation:

Carleton College, Northfield, Minn, USA	Geology	B.A.	1988
Univ. of Colorado at Boulder, USA	Geological Sciences	PhD	1997
Woods Hole Oceanographic Institution, Mass., Isotope and Organic Geochemistry		Post-doc	1997-2001

Professional Experience:

2001-	Assistant Research Scientist, Biogeochemistry Laboratories, Department of Geological Sciences, Indiana University, Bloomington.
1999-2001:	Postdoctoral Investigator, Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution.
1997-99:	UCAR / Visiting Scientist Program Post-Doctoral Fellow at Woods Hole Oceanographic Institution.
1992-97:	Research assistant and teaching assistant, University of Colorado at Boulder.
1990-92:	Chancellor's Fellow, University of Colorado at Boulder.
1988-90:	Geophysicist, USGS Branch of Geophysics, Menlo Park, California.

Five Products Most Relevant to This Proposal:

Gröcke, D.R., Sauer, P.E., Bridault, A., Drucker, D.G., Germonpré, M., Bocherens, H., 2017. Hydrogen isotopes in Quaternary mammal collagen from Europe. Journal of Archaeological Science: Reports 11, 12-16. https://doi.org/10.1016/j.jasrep.2016.11.020

Topalov, K., A. Schimmelmann, P.D. Polly, P.E. Sauer, M. Lowry (2013) Environmental, trophic, and ecological factors influencing bone collagen δ^2H. Geochimica et Cosmochimica Acta 111, 88-104. http://dx.doi.org/10.1016/j.gca.2012.11.017

Cadieux, S.B., White, J.R., Sauer, P.E., Peng, Y., Goldman, A.E., Pratt, L.M., 2016. Large fractionations of C and H isotopes related to methane oxidation in Arctic lakes. Geochim Cosmochim Ac 187, 141-155. 10.1016/j.gca.2016.05.004

Sauer, P.E., Eglinton, T.I., Hayes, J.M., Schimmelmann, A., Sessions, A.L. 2001. Compound-specific D/H ratios of lipid biomarkers from sediments as a proxy for environmental and climatic conditions. *Geochimica et Cosmochimica Acta*, 65: 213-222. http://dx.doi.org/10.1016/S0016-7037(00)00520-2

Sauer, P. E., Schimmelmann, A., Sessions, A. L., and Topalov, K., (2009), Simplified batch equilibration for D/H determination of non-exchangeable hydrogen in solid organic material: Rapid Communications in Mass Spectrometry. 23: 949-956. http://dx.doi.org/10.1002/rcm.3954

Selected Additional Publications:

Webster, K.D., Lagarde, L.R., Sauer, P.E., Schimmelmann, A., Lennon, J.T., Boston, P.J., 2017. Isotopic evidence for the migration of thermogenic methane into a sulfidic cave, cueva de villa luz, Tabasco, Mexico. Journal of Cave and Karst Studies 79, 24-34. 10.4311/2016es0125

Tulipani, S., Grice, K., Greenwood, P.F., Haines, P.W., Sauer, P.E., Schimmelmann, A., Summons, R.E., Foster, C.B., Böttcher, M.E., Playton, T., Schwark, L., 2015. Changes of palaeoenvironmental conditions recorded in Late Devonian reef systems from the Canning Basin, Western Australia: A biomarker and stable isotope approach. Gondwana Research 28, 1500-1515. https://doi.org/10.1016/j.gr.2014.10.003

Ciotoli, G., Etiope, G., Florindo, F., Marra, F., Ruggiero, L., Sauer, P.E., 2013. Sudden deep gas eruption nearby Rome's airport of Fiumicino. Geophysical Research Letters 40, 2013GL058132. 10.1002/2013gl058132

Sauer, P. E., 2010, Use of stable isotopes to study climate. In Beauchemin, D., and Matthews, D. E., eds., Elemental and Isotope Ratio Mass Spectrometry, Elsevier, p. 925-931.

Sauer P. E., Miller G. H., and Overpeck J. T., 2001. Oxygen isotope ratios of organic matter in arctic lakes as a paleoclimate proxy: field evidence and laboratory investigations. *Journal of Paleolimnology*, 25: 43-64. http://dx.doi.org/10.1023/A:1008133523139

Synergistic Activities: 1. Developed and improved measurement techniques for isotopic measurements of sedimentary materials and gases for paleoclimate and biogeochemical work. 2. Perform analyses, analytic training, and assistance in research design for on-campus and extramural researchers at all levels (undergraduate students, graduate students, postdocs, and professors) at the Stable Isotope Research Facility (SIRF) at Indiana University. 3. Sponsored undergraduate research projects for through University fellowships (Indiana Univ. and Colorado U), including programs specifically for under-represented minorities. 4. Previous research has contributed materials to course design of introductory Earth Systems courses, Global Change, and Historical Geology, and Environmental Geology. 5. Included Inuit (Native Americans) in Baffin Island, Nunavut, in our field research teams, exposing them to scientific research in their homeland.

Kathy J. Licht
Department of Earth Sciences
Indiana University Purdue University Indianapolis
723 W. Michigan St., Indianapolis, IN 46202
E-mail: klicht@iupui.edu

Professional Preparation

St. Norbert College	Natural Science	B.S., 1992
University of Colorado – Boulder	Geological Sciences	M.S., 1995
University of Colorado – Boulder	Geological Sciences	PhD., 1999

Appointments
Associate Professor, Indiana University Purdue University at Indianapolis. (2006-present)
Adjunct Research Scientist, Lamont-Doherty Earth Observatory
Affiliate, IUPUI Center for Earth and Environmental Science
Assistant Professor, Indiana University Purdue University at Indianapolis. (2000 – 2006)
Limited-term Lecturer, Purdue University - West Lafayette. (Spring 2000)
Postdoctoral Research Associate, University of Colorado - Boulder. (1999-2000),
Graduate Research Assistant, University of Colorado - Boulder. (1992 – 1999)

Products
5 publications most closely related to the proposed project
*Bader, N.A., Licht, K.J., Kaplan, M.R., *Kassab, C., and Winckler, G., 2017. East Antarctic ice sheet stability since the mid-Pleistocene recorded in a high-elevation ice-cored moraine. *Quaternary Science Reviews* 159, p.88-102.
Kaplan, M.R., Licht, K., Winckler, G., Schaefer, J.M., *Bader, N., Mathieson, C., Roberts, M., *Kassab, C.M., Schwartz, R., and Graly, J.G., 2017. Late Pleistocene stability of the East Antarctic ice sheet, as seen from the Transantarctic Mountains. *Geology* doi:10.1130/G39189.1
*Kassab, C.M., *Brickles, S.L., Licht, K.J., and Monaghan, G.W., 2017. Exploring the use of zircon geochronology as an indicator of Laurentide Ice Sheet till provenance, Indiana, USA. *Quaternary Research*, 1-12. doi:10.1017/qua.2017.71.
Licht, K.J., and Hemming, S., 2017. Analysis of Antarctic glacigenic sediment provenance through geochemical and petrologic applications (Invited Review). *Quaternary Science Reviews* 164, 1-24.
Licht, K.J., and *Palmer, E.F., 2013. Erosion and transport by Byrd Glacier, Antarctica during the last glacial maximum. *Quaternary Science Reviews* 62, 32-48.
*student co-author

5 other significant publications
Farmer, G.L., and Licht, K.L., 2016. Generation and Fate of Glacial Sediments in the central Transantarctic Mountains based on Radiogenic Isotopes and Implications for Reconstructing Past Ice Dynamics. *Quaternary Science Reviews* 150, p.98-109.
Anderson, J.B., Conway, H., Bart,P.J., Witus, A.E., Greenwood, S.L., McKay, R.M., Hall, B.L., Ackert, R.P., Licht, K., Jakobsson, M., and Stone, J.O., 2014. Ross Sea paleo-ice sheet drainage and deglacial history during and since the LGM. *Quaternary Science Reviews* 100, 31-54.
Licht, K.J., *Hennessy, A.J., and *Welke, B.M., 2014. The U/Pb detrital zircon signature of West Antarctic ice stream tills in the Ross Embayment, with implications for LGM ice flow reconstructions. *Antarctic Science* 26, 87-697.
Golledge, N.R., Levy, R.H., McKay, R., Fogwill, C.J., White, D.A., Graham, A., Smith, J.A., Hillenbrand, C-D., Licht, K.J., Denton, G.H., Ackert, Jr., R.P., Maas, S.M., and Hall, B.L., 2013. Glaciology and geological implications for a modeled glacial-maximum configuration Antarctic ice sheet. *Quaternary Science Reviews* 78, 225-247.
*Palmer, E.F., Licht, K.J., Swope, R.J., and Hemming, S.R., 2012. Nunatak moraines as a repository of what lies beneath the East Antarctic ice sheet, *in* Rasbury, E.T., Hemming, S.R., and Riggs, N.R., eds., Mineralogical and Geochemical Approaches to Provenance. *Geological Society of America Special Paper* 487, 97–104, doi:10.1130/2012.2487(05).

Synergistic Activities

- Organizer of NSF-sponsored Interdisciplinary Antarctic Earth Sciences Meetings. 2017 - Whidbey Is, WA and 2015 - Loveland, CO
- U.S. White House *State of STEM* Science event. Skype Q & A from Antarctica with 150 5th-12th graders. January 2016.
- Classroom visits with follow up Skype calls to classrooms from Antarctica. Park Tudor School Grade 5 (120 kids), Indianapolis Public School #34 Grade 4 (35 kids). December 2014 & 2015. Twitter @IUPUIonice was created to share our science goals and research experience in Antarctica. 109 followers.
- SUNY College of Environmental Science and Forestry presentation: Antarctica's ice in Earth's climate system for Women in Environmental and Scientific Professions Speaker Series and guest for Environmental Career Strategies for Women series. March 2015.
- IUPUI course for non-majors titled 'The Geology of Antarctica'. Taught each academic year since 2011. The course integrates basic geological concepts with examples from current research projects in Antarctica.

DR. AARON MICALLEF

Senior lecturer in marine geology
University of Malta
Msida, MSD 2080, Malta
phone: (+356) 99051124
aaron.micallef@um.edu.mt

PROFESSIONAL PREPARATION

University of Southampton	Southampton, UK	Marine Geology	Ph.D., 2008
University of Oxford	Oxford, UK	Geomorphology	M.Sc., 2003

APPOINTMENTS

2012-present	Marie Curie fellow, Senior lecturer in marine geology, University of Malta, Malta
2010-2012	Marie Curie fellow, University of Barcelona, Spain
2009-2010	Lecturer, University of Malta, Malta

10 SELECTED PUBLICATIONS

1. **Micallef, A**., Mountjoy, J.J., 2011. A topographic signature of a hydrodynamic origin for submarine gullies. *Geology,* 39, 115-118.
2. **Micallef, A.**, Berndt, C., Debono, G., 2011. Fluid flow systems of the Malta Plateau, Central Mediterranean Sea. *Marine Geology,* 284, 74-85.
3. **Micallef, A**., Berndt, C., Masson, D.G., Stow, D.A.V., 2007b. A technique for the morphological characterization of submarine landscapes as exemplified by debris flows of the Storegga Slide. *Journal of Geophysical Research*, 112, F02001.
4. **Micallef, A**., Berndt, C., Masson, D.G., Stow, D.A.V., 2008. Scale invariant characteristics of the Storegga Slide and implications for large-scale submarine mass movements. *Marine Geology,* 247, 46-60.
5. **Micallef, A**., Foglini, F., Le Bas, T., Angeletti, L., Maselli, V., Pasuto, A., Taviani, M., 2013a. The submerged paleolandscape of the Maltese Islands: Morphology, evolution and relation to Quaternary environmental change. *Marine Geology*, 335, 129-147.
6. **Micallef, A**., Masson, D.G., Berndt, C., Stow, D.A.V., 2007a. Morphology and mechanics of submarine spreading: A case study from the Storegga Slide. *Journal of Geophysical Research*, 112, F03023.
7. **Micallef, A**., Masson, D.G., Berndt, C., Stow, D.A.V., 2009. Development and mass movement processes of the north-eastern Storegga Slide. *Quaternary Science Reviews,* 28, 433-448.
8. **Micallef, A**., Mountjoy, J., Barnes, P.M., Canals, M., Lastras, G., 2014b. Geomorphic response of submarine canyons to tectonic activity: Insights from the Cook Strait canyon system, New Zealand. *Geosphere*, 10, 905-929.
9. **Micallef, A**., Mountjoy, J., Krastel, S., Crutchley, G.J., Koch, S., 2015. Shallow gas and the development of a weak layer in submarine spreading, Hikurangi margin (New Zealand), in: Lamarche, G., Mountjoy, J., Bull, S., Hubble, T., Krastel, S., Lane, E., **Micallef, A**., Moscardelli, L., Mueller, C., Pecher, I., Woelz, S. (Eds.), Submarine Mass Movements and Their Consequences. Springer International Publishing, Heidelberg, pp. 419-426.
10. **Micallef, A**., Ribó, M., Canals, M., Puig, P., Lastras, G., Tubau, X., 2014c. Space-for-time substitution and the evolution of a submarine canyon–channel system in a passive progradational margin. *Geomorphology*, 221, 34-50.

DR. HABIL. SUSANNE STADLER

Privatdozent (Associate Professor) in Environmental Sciences, Technical University of Braunschweig, Germany and Research Scientist, Federal Institute for Geosciences and Natural Resources (BGR)

Stilleweg 2, D-30655 Hanover, Germany phone: +49 (511) 643 3545
susanne.stadler@bgr.de

PROFESSIONAL PREPARATION

Technical University of Braunschweig, Germany, Department of Architecture, Civil Engineering and Environmental Sciences, Habilitation 2015
University of Karlsruhe, Germany, Applied Geology, Ph.D., 2004
University of Heidelberg, Germany, Environmental Geochemistry/Hydrogeology, MSc. Equiv., Geology, 2001
Research Assistant at the Institute of Environmental Geochemistry and the Institute of Environmental Physics at the University of Heidelberg, Germany, 1999-2001
University of Heidelberg, Germany, Translation studies English/French, MSc. Equiv. 1997

APPOINTMENTS

2009-present: Research Scientist at the Federal Institute for Geosciences and Natural Resources (BGR), Hanover (Geological-Geotechnical Safety Analyses - Modelling, Numerical Methods – (maternity leave: 2014/2015)
2007-2009 Research Scientist (Postdoc) at the Leibniz Institute for Applied Geophysics (LIAG), Hanover, Germany, Geochronology and Isotope Hydrology, and Lecturer at the Technical University of Darmstadt, Germany
2005-2007 Assistant Prof./Lecturer, Technical University Bergakademie Freiberg, Germany, Hydrogeology
2001-2004 Federal Institute for Geosciences and Natural Resources, Hanover, Groundwater Quality and Protection

10 SELECTED PUBLICATIONS

1) Houben, G., Noell, U., Vassolo, S., Grissemann, C., Geyh, M., **Stadler**, S., Dose, E.J., Vera, S. (2014): The freshwater lens of Benjamín Aceval, Chaco, Paraguay: a terrestrial analogue of an oceanic island lens. - Hydrogeology Journal, Volume 22 (8): 1935-1952. doi: 10.1007/s10040-014-1169-2
2) Breuker, A., **Stadler**, S., Schippers, A. (2013): Microbial community analysis of deeply buried marine sediments of the New Jersey shallow shelf (IODP Expedition 313). FEMS Microbiology Letters 85 (3): 578-592. doi: 10.1111/1574-6941.12146.
3) Pürschel, M., Gloaguen, R., **Stadler**, S. (2013): Geothermal activities in the Main Ethiopian Rift: Hydrogeochemical characterization of geothermal waters and geothermometry applications (Dofan-Fantale, Gergede-Sodere, Aluto-Langano) - Geothermics 47: 1– 12. doi: 10.1016/j.geothermics.2013.01.001
4) Van Geldern, R., Hayashi, T., Böttcher, M. E., Mottl, M. J., Barth, J. A.C., **Stadler**, S. (2013): Stable isotope geochemistry of pore waters and marine sediments from the New Jersey shelf: Methane formation and fluid origin. – Geosphere 9(1): 96-112. doi:10.1130/GES00859.1.
5) **Stadler**, S., Sültenfuß, J., Holländer, H., Bohn, C. Jahnke, C., Suckow, A. (2012): Isotopic and geochemical indicators for groundwater flow and multi-component mixing near disturbed salt anticlines. Chemical Geology 294-295: 226-242. doi: 10.1016/j.chemgeo.2011.12.006
6) De Lucia, M., Bauer, S., Beyer, C., Kühn, M., Nowak, T., Pudlo, D., Reitenbach, V., **Stadler**, S. (2012): Modelling CO_2 -induced fluid-rock interactions in the Altensalzwedel gas Reservoir. Part I - From experimental data to a reference geochemical model. - Environmental Earth

Science 67(2): 563-572. doi: 10.1007/s12665-012-1725-9
7) **Stadler**, S., Geyh, M. A., Plöthner, D., Königer, P. (2012): The deep Cretaceous Aquifer in the Aleppo and Steppe Basins of Syria: Assessment of the meteoric origin and geographic source of the groundwater – Hydrogeology Journal 20(6): 1007-1026. doi: 10.1007/s10040-012-0862-2
8) **Stadler**, S., Talma, A.S., Tredoux, G., Wrabel, J. (2012): Identification of sources and infiltration regimes of nitrate in the semi-arid Kalahari and implications for groundwater management. Water SA 38 (2): 213-224. doi: 10.4314/wsa.v38i2.6
9) **Stadler**, S., Sültenfuß, J., Holländer, H., Bohn, C. Jahnke, C., Suckow, A. (2012): Isotopic and geochemical indicators for groundwater flow and multi-component mixing near disturbed salt anticlines. Chemical Geology 294-295: 226-242. doi: 10.1016/j.chemgeo.2011.12.006
10) Engelhardt, I., Piepenbrink, M., Trauth, N., **Stadler**, S., Kludt, C, Schulz, M., Schüth, C., Ternes, T. (2011): Comparison of Tracer Methodologies to Quantify Hydrodynamic Exchange within the Hyporheic Zone. – Journal of Hydrology 400: 255–266. doi:10.1016/j.jhydrol.2011.01.033.

DR. ROBERT VAN GELDERN
Privatdozent (Associate Professor) in Geology
GeoZentrum Nordbayern
Friedrich-Alexander University Erlangen-Nuremberg (FAU) phone: +49-9131-85-22514
Schlossgarten 5, 91054 Erlangen, Germany robert.van.geldern@fau.de

PROFESSIONAL PREPARATION

University of Erlangen-Nuremberg	Erlangen (GER)	Geology	Habilitation, 2015
Leibniz Institute for Applied Geophysics	Hanover (GER)	Isotope hydrology	2004-2008
University of Erlangen-Nuremberg	Erlangen (GER)	Geology	PhD, 2004
University of Erlangen-Nuremberg	Erlangen (GER)	Geology	Diploma degree, 1998

APPOINTMENTS

2015-present	Associate Professor of Geology, University of Erlangen-Nuremberg, Germany
2009-2014	Assistant Professor of Geology, University of Erlangen-Nuremberg, Germany
2004-2009	Research Scientist, Leibniz Institute for Applied Geophysics, Hanover, Germany

10 SELECTED PUBLICATIONS

1. Attermeyer, K., Flury, S., Jayakumar, R., Fiener, P., Steger, K., Arya, V., Wilken, F., **van Geldern, R.** and K. Premke. Invasive floating macrophytes reduce greenhouse gas emissions from a small tropical lake. *Scientific Reports,* in press.
2. Daessle, L.W., **van Geldern, R.**, Orozco-Durán, A. and J.A.C. Barth. 2016. The 2014 water release into the arid Colorado River delta and associated water losses by evaporation. *Science of the Total Environment*, 542, 586-590, doi:10.1016/j.scitotenv.2015.09.157.
3. **van Geldern, R.**, P. Schulte, M. Mader, A. Baier, and J. A. C. Barth. 2015. Spatial and temporal variations of pCO_2, dissolved inorganic carbon and stable isotopes along a temperate karstic watercourse. *Hydrological Processes,* 29, 3423-3440, doi:10.1002/hyp.10457.
4. **van Geldern, R.**, M. E. Nowak, M. Zimmer, A. Szizybalski, A. Myrttinen, J. A. C. Barth, and H.-J. Jost. 2014. Field based stable isotope analysis of CO_2 by mid-infrared laser spectroscopy for carbon capture and storage monitoring. *Analytical Chemistry,* 86, 12191-12198, doi:10.1021/ac5031732.
5. **van Geldern, R.**, J. Kuhlemann, R. Schiebel, H. Taubald, and J. A. C. Barth. 2014. Stable water isotope patterns in a climate change hotspot: The isotope hydrology framework of Corsica (western Mediterranean). *Isotopes in Environmental and Health Studies,* 50, 184-200, doi:10.1080/10256016.2013.839559.
6. **van Geldern, R.**, A. Baier, H. L. Subert, S. Kowol, L. Balk, and J. A. C. Barth. 2014. Pleistocene paleo-groundwater as a pristine fresh water resource – evidence from stable and radiogenic isotopes. *Science of the Total Environment,* 496, 107-115, doi:10.1016/j.scitotenv.2014.07.011.
7. **van Geldern, R.**, T. Hayashi, M. E. Böttcher, M. J. Mottl, J. A. C. Barth, and S. Stadler. 2013. Stable isotope geochemistry of pore waters and marine sediments from the New Jersey shelf: Methane formation and fluid origin. *Geosphere,* 9, 96-112, doi:10.1130/GES00859.1.
8. **van Geldern, R.**, and J. A. C. Barth. 2012. Optimization of instrument setup and post-run corrections for oxygen and hydrogen stable isotope measurements of water by isotope ratio infrared spectroscopy (IRIS). *Limnology and Oceanography: Methods,* 10, 1024-1036, doi:10.4319/lom.2012.10.1024.
9. Schulte, P., **R. van Geldern**, H. Freitag, A. Karim, P. Négrel, E. Petelet-Giraud, A. Probst, J. L. Probst, K. Telmer, J. Veizer, and J. A. C. Barth. 2011. Applications of stable water and

carbon isotopes in watershed research: Weathering, carbon cycling, and water balances. *Earth-Science Reviews,* 109, 20-31, doi:10.1016/j.earscirev.2011.07.003.
10. **van Geldern, R.**, M. M. Joachimski, J. Day, U. Jansen, F. Alvarez, E. A. Yolkin, and X. P. Ma. 2006. Carbon, oxygen and strontium isotope records of Devonian brachiopod shell calcite. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 240, 47-67, doi:10.1016/j.palaeo.2006.03.045.

IODP Site Forms

Form 1 – General Site Information

637 - Add 8

Section A: Proposal Information

Proposal Title	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
Date Form Submitted	2022-04-29 08:17:15
Site-Specific Objectives with Priority (Must include general objectives in proposal)	MV-8A will characterize the freshwater endmember.
List Previous Drilling in Area	AMCOR wells 6001, 6009, 6020, 6021; COST wells B-2, G-1, G-2, ODP Leg 174A, IODP Exp. 313

Section B: General Site Information

Site Name:	MV-08A	Area or Location:	New England continental shelf
If site is a reoccupation of an old DSDP/ODP Site, Please include former Site#			
Latitude:	Deg: 40.9976	Jurisdiction:	USA
Longitude:	Deg: -70.3334	Distance to Land: (km)	44
Coordinate System:	WGS 84		
Priority of Site:	Primary: ✓ Alternate: ☐	Water Depth (m):	41

Section C: Operational Information

	Sediments	Basement
Proposed Penetration (m):	550	0
	Total Sediment Thickness (m): 550	
		Total Penetration (m): 550
General Lithologies:	Silt, sand, clay	Not applicable, no basement penetration

Coring Plan: (Specify or check)

APC ☑ XCB ☑ RCB ☐ Re-entry ☐ PCS ☐

Wireline Logging Plan:

Standard Measurements		Special Tools		Other tools:
WL	☑	Magnetic Susceptibility	☐	
Porosity	☑	Borehole Temperature	☐	
Density	☑	Formation Image (Acoustic)	☐	
Gamma Ray	☑	VSP (walkaway)	☐	
Resistivity	☑	LWD	☐	
Sonic (Δt)	☑			
Formation Image (Res)	☑			
VSP (zero offset)	☐			
Formation Temperature & Pressure	☑			

Other Measurements: Pump tests

Estimated Days: Drilling/Coring: 19 Logging: 4 Total On-site: 23

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

Potential Hazards/ Weather:

Shallow Gas	☐	Complicated Seabed Condition	☐	Hydrothermal Activity	☐
Hydrocarbon	☐	Soft Seabed	☐	Landslide and Turbidity Current	☐
Shallow Water Flow	☐	Currents	☐	Gas Hydrate	☐
Abnormal Pressure	☐	Fracture Zone	☐	Diapir and Mud Volcano	☐
Man-made Objects (e.g., sea-floor cables, dump sites)	☐	Fault	☐	High Temperature	☐
H_2S	☐	High Dip Angle	☐	Ice Conditions	☐
CO_2	☐				

Sensitive marine habitat (e.g., reefs, vents):

Preferred weather window: Summer

Other:

Generated: 2023-07-11T22:52:49+00:00

Proposal #: 637 - Add 8	Site #: MV-08A	Date Form Submitted: 2022-04-29 08:17:15

Data Type	In SSDB	Details of available data and data that are still to be collected
1a High resolution seismic reflection (primary)	yes	Line: Line 1 Position: CDP 14100 Data already approved by site characterization panel. Depth approved to 350 mbsf by EPSP so will request depth extension approval.
1b High resolution seismic seismic reflection (crossing)	yes	Line: Line 13 Position: CDP 1700 Data already approved by site characterization panel. Depth approved to 350 mbsf by EPSP so will request depth extension approval.
2a Deep penetration seismic reflection (primary)		
2b Deep penetration seismic reflection (crossing)		
3 Seismic Velocity	yes	
4 Seismic Grid		
5a Refraction (surface)		
5b Refraction (bottom)		
6 3.5 kHz		
7 Swath bathymetry		
8a Side looking sonar (surface)		
8b Side looking sonar (bottom)		
9 Photography or video		
10 Heat Flow		
11a Magnetics		
11b Gravity		
12 Sediment cores	yes	
13 Rock sampling		
14a Water current data		
14b Ice Conditions		
15 OBS microseismicity		
16 Navigation	yes	
17 Other		

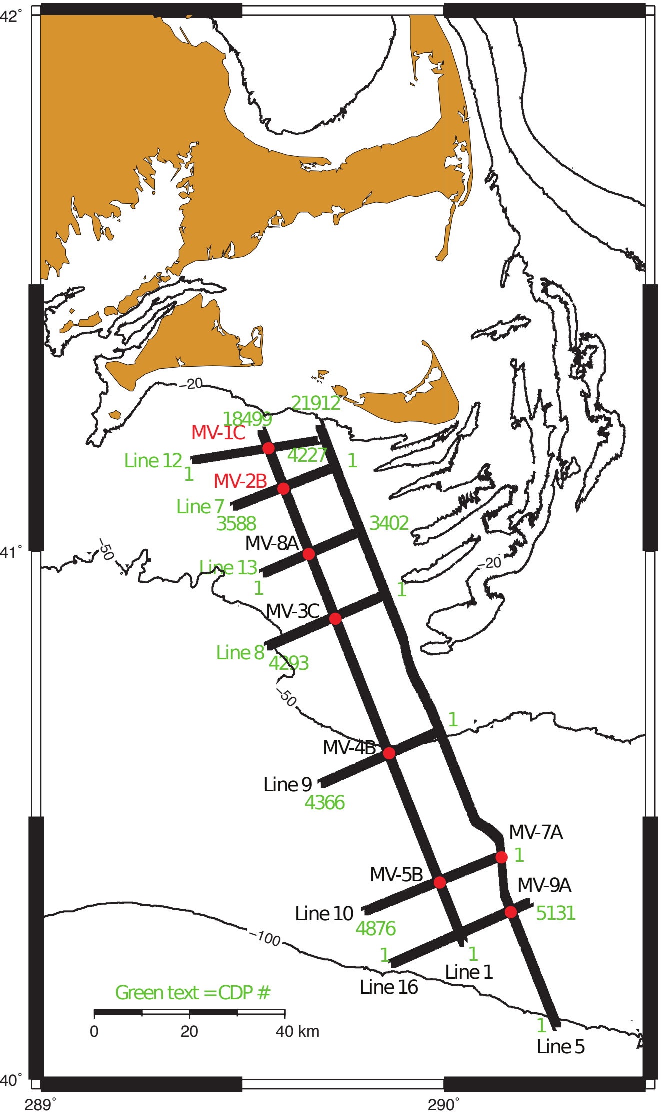
Proposal #: 637 - Add 8	Site #: MV-08A	Date Form Submitted: 2022-04-29 08:17:15

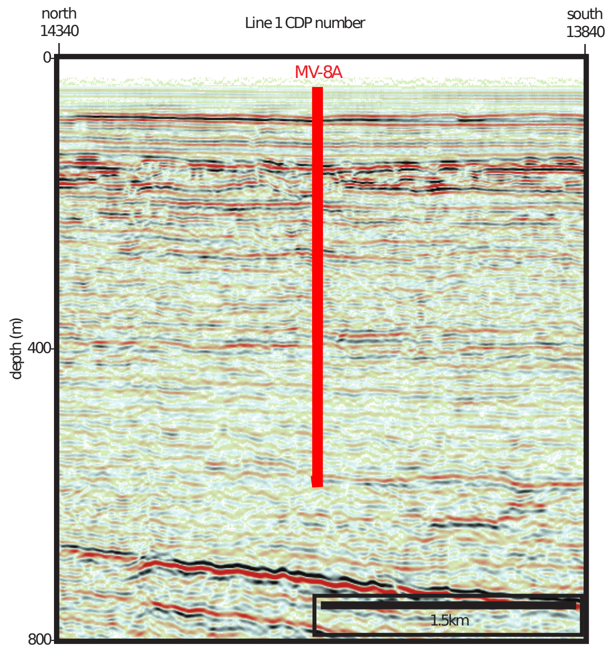
Pollution & Safety Hazard	Comment
1. Summary of operations at site	APC to refusal followed by XCB to TD. Will core/case/log/sample following strategy employed on Exp 313.
2. All hydrocarbon occurrences based on previous DSDP/ODP/IODP drilling	None
3. All commercial drilling in this area that produced or yielded significant hydrocarbon shows	None
4. Indications of gas hydrates at this location	None
5. Are there reasons to expect hydrocarbon accumulations at this site?	None
6. What "special" precautions will be taken during drilling?	Maybe some low ovepressures; have been evaluated by EPSP and approved to 350 mbsf; depth extension to be requested.
7. What abandonment procedures need to be followed?	Standard IODP procedures
8. Natural or manmade hazards which may affect ship's operations	Fishing
9. Summary: What do you consider the major risks in drilling at this site?	Shallow water, unlithified sediments

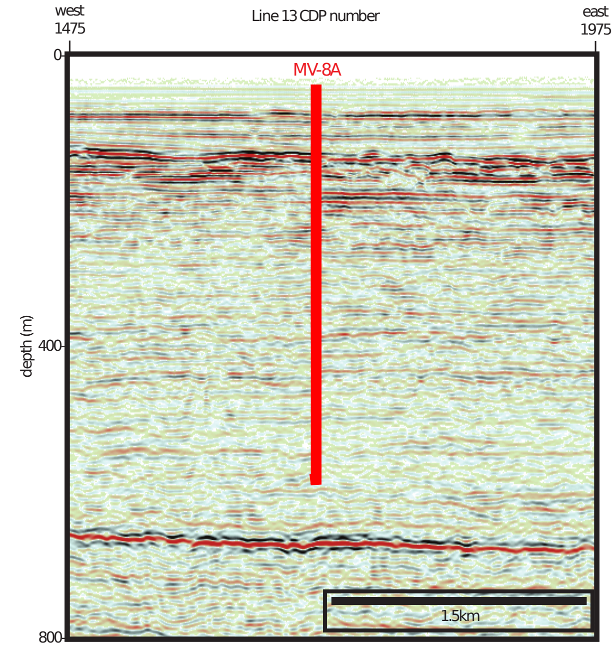
Proposal #: 637 - Add 8	Site #: MV-08A	Date Form Submitted: 2022-04-29 08:17:15

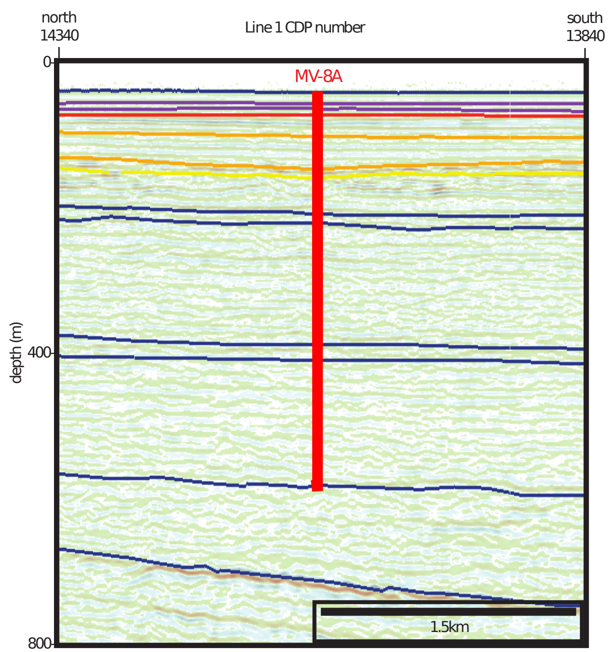
Subbottom depth (m)	Key reflectors, unconformities, faults, etc	Age (My)	Assumed velocity (km/s)	Lithology	Paleo-environment	Avg. accum. rate (m/My)	Comments
0 - 550		< Cretaceous	1.75	silt, sand, clay			

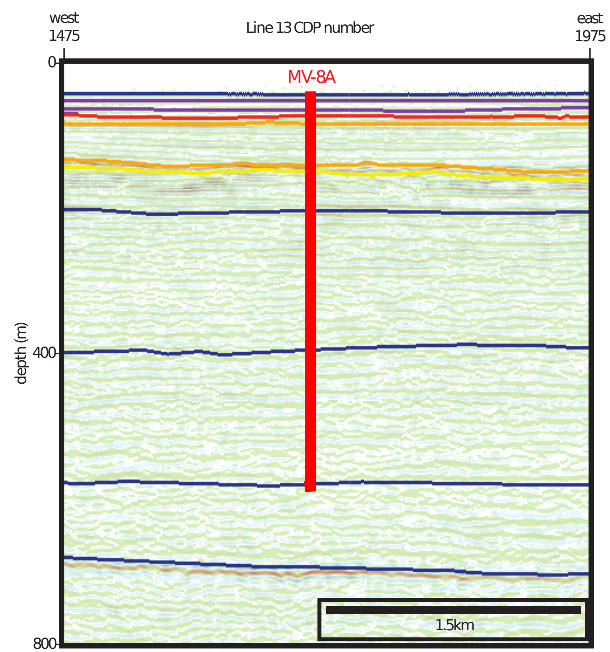
Site Summary Form
Proposal 637
Site MV-8A
Line 1 CDP 14100, Line 13 CDP 1700











SSDB Data Files: *CDP Trackline Map; Raw and Interpreted Seismic Figures; SEG-Y Data; Navigation Data*

IODP Site Forms

Form 1 – General Site Information

637 - Add 8

Section A: Proposal Information

Proposal Title	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
Date Form Submitted	2022-04-29 08:17:15
Site-Specific Objectives with Priority (Must include general objectives in proposal)	MV-4C will characterize the freshwater-to-seawater transition zone or the seawater endmember of the transect.
List Previous Drilling in Area	AMCOR wells 6001, 6009, 6020, 6021; COST wells B-2, G-1, G-2, ODP Leg 174A, IODP Exp. 313

Section B: General Site Information

Site Name:	MV-04C	Area or Location:	New England continental shelf
If site is a reoccupation of an old DSDP/ODP Site, Please include former Site#			
Latitude:	Deg: 40.6185	Jurisdiction:	USA
Longitude:	Deg: -70.1370	Distance to Land: (km)	87
Coordinate System:	WGS 84		
Priority of Site:	Primary: ✓ Alternate: ☐	Water Depth (m):	52

Section C: Operational Information

	Sediments	Basement
Proposed Penetration (m):	550	0
	Total Sediment Thickness (m): 550	
		Total Penetration (m): 550
General Lithologies:	Silt, sand, clay	Not applicable, no basement penetration

Coring Plan: (Specify or check)

APC ☑ XCB ☑ RCB ☐ Re-entry ☐ PCS ☐

Wireline Logging Plan:

Standard Measurements		Special Tools		Other tools:
WL	☑	Magnetic Susceptibility	☐	
Porosity	☑	Borehole Temperature	☐	
Density	☑	Formation Image (Acoustic)	☐	
Gamma Ray	☑	VSP (walkaway)	☐	
Resistivity	☑	LWD	☐	
Sonic (Δt)	☑			
Formation Image (Res)	☑			
VSP (zero offset)	☐			
Formation Temperature & Pressure	☑			

Other Measurements: Pump tests

Estimated Days:

Drilling/Coring:	Logging:	Total On-site:
19	4	23

Observatory Plan:

Longterm Borehole Observation Plan/Re-entry Plan

Potential Hazards/ Weather:

						Preferred weather window
Shallow Gas	☐	Complicated Seabed Condition	☐	Hydrothermal Activity	☐	Summer
Hydrocarbon	☐	Soft Seabed	☐	Landslide and Turbidity Current	☐	
Shallow Water Flow	☐	Currents	☐	Gas Hydrate	☐	
Abnormal Pressure	☐	Fracture Zone	☐	Diapir and Mud Volcano	☐	
Man-made Objects (e.g., sea-floor cables, dump sites)	☐	Fault	☐	High Temperature	☐	
H_2S	☐	High Dip Angle	☐	Ice Conditions	☐	
CO_2	☐					
Sensitive marine habitat (e.g., reefs, vents)						

Other:

Proposal #: 637 - Add 8	Site #: MV-04C	Date Form Submitted: 2022-04-29 08:17:15

Data Type	In SSDB	Details of available data and data that are still to be collected
1a High resolution seismic reflection (primary)	yes	Line: Line 1 Position: CDP 6861 Located 250 m from intersection with Line 9. Approved by site characterization panel and EPSP to 650 mbsf; plan to drill to 550 mbsf.
1b High resolution seismic seismic reflection (crossing)	yes	Line: Line 9 Position: CDP 1821
2a Deep penetration seismic reflection (primary)		
2b Deep penetration seismic reflection (crossing)		
3 Seismic Velocity	yes	
4 Seismic Grid		
5a Refraction (surface)		
5b Refraction (bottom)		
6 3.5 kHz		
7 Swath bathymetry		
8a Side looking sonar (surface)		
8b Side looking sonar (bottom)		
9 Photography or video		
10 Heat Flow		
11a Magnetics		
11b Gravity		
12 Sediment cores	yes	
13 Rock sampling		
14a Water current data		
14b Ice Conditions		
15 OBS microseismicity		
16 Navigation		
17 Other		

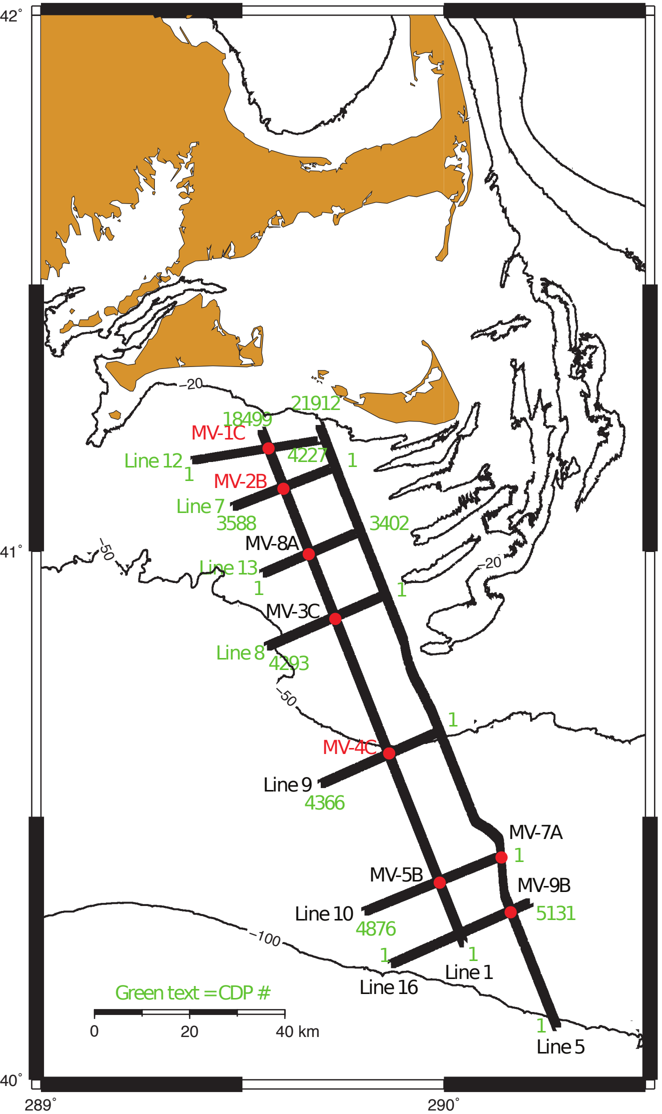
Proposal #: 637 - Add 8	Site #: MV-04C	Date Form Submitted: 2022-04-29 08:17:15

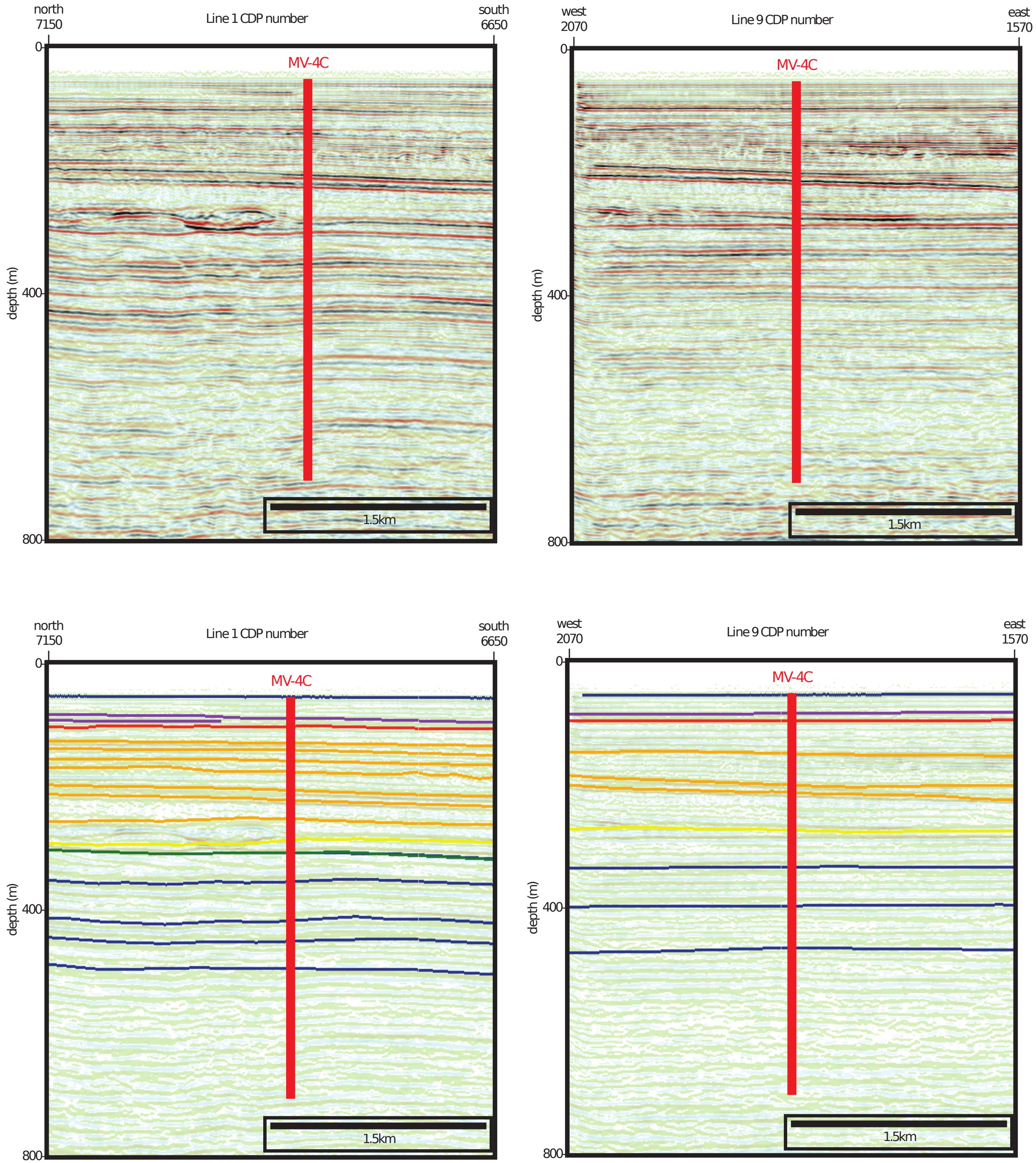
Pollution & Safety Hazard	Comment
1. Summary of operations at site	APC to refusal followed by XCB to TD. Will core/case/log/sample following strategy employed on Exp 313.
2. All hydrocarbon occurrences based on previous DSDP/ODP/IODP drilling	None
3. All commercial drilling in this area that produced or yielded significant hydrocarbon shows	None
4. Indications of gas hydrates at this location	None
5. Are there reasons to expect hydrocarbon accumulations at this site?	None
6. What "special" precautions will be taken during drilling?	Maybe some low ovepressures; have been evaluated by EPSP and approved
7. What abandonment procedures need to be followed?	Standard IODP procedures
8. Natural or manmade hazards which may affect ship's operations	Fishing
9. Summary: What do you consider the major risks in drilling at this site?	Shallow water, unlithified sediments

Proposal #: 637 - Add 8	Site #: MV-04C	Date Form Submitted: 2022-04-29 08:17:15

Subbottom depth (m)	Key reflectors, unconformities, faults, etc	Age (My)	Assumed velocity (km/s)	Lithology	Paleo-environment	Avg. accum. rate (m/My)	Comments
0 - 650		< Cretaceous	1.75	silt, sand, clay			

Site Summary Form
Proposal 637
Site MV-4C
Line 1 CDP 6861*, Line 9 CDP 1821
(*located 250 m from intersection with Line 9)





SSDB Data Files: *CDP Trackline Map; Raw and Interpreted Seismic Figures; SEG-Y Data; Navigation Data*

IODP Site Forms

Form 1 – General Site Information

637 - Add 8

Section A: Proposal Information

Proposal Title	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
Date Form Submitted	2022-04-29 08:17:15
Site-Specific Objectives with Priority (Must include general objectives in proposal)	MV-3C will characterize the freshwater-to-seawater transition zone of the transect.
List Previous Drilling in Area	AMCOR wells 6001, 6009, 6020, 6021; COST wells B-2, G-1, G-2, ODP Leg 174A, IODP Exp. 313

Section B: General Site Information

Site Name:	MV-03C
If site is a reoccupation of an old DSDP/ODP Site, Please include former Site#	
Latitude:	Deg: 40.8746
Longitude:	Deg: -70.2697
Coordinate System:	WGS 84
Priority of Site:	Primary: ✓ Alternate: ☐

Area or Location:	New England continental shelf
Jurisdiction:	USA
Distance to Land: (km)	56
Water Depth (m):	42

Section C: Operational Information

	Sediments	Basement
Proposed Penetration (m):	550	0
	Total Sediment Thickness (m): 550	
		Total Penetration (m): 550
General Lithologies:	Silt, sand, clay	Not applicable, no basement penetration

Coring Plan:
(Specify or check)

APC ☑ XCB ☑ RCB ☐ Re-entry ☐ PCS ☐

Wireline Logging Plan:

Standard Measurements		Special Tools		Other tools:
WL	☑	Magnetic Susceptibility	☐	
Porosity	☑	Borehole Temperature	☐	
Density	☑	Formation Image (Acoustic)	☐	
Gamma Ray	☑	VSP (walkaway)	☐	
Resistivity	☑	LWD	☐	
Sonic (Δt)	☑			
Formation Image (Res)	☑			
VSP (zero offset)	☐			
Formation Temperature & Pressure	☑			

Other Measurements: Pump tests.

Estimated Days:

Drilling/Coring:	Logging:	Total On-site:
19	4	23

Observatory Plan:

Longterm Borehole Observation Plan/Re-entry Plan

Potential Hazards/ Weather:

Shallow Gas	☐	Complicated Seabed Condition	☐	Hydrothermal Activity	☐
Hydrocarbon	☐	Soft Seabed	☐	Landslide and Turbidity Current	☐
Shallow Water Flow	☐	Currents	☐	Gas Hydrate	☐
Abnormal Pressure	☐	Fracture Zone	☐	Diapir and Mud Volcano	☐
Man-made Objects (e.g., sea-floor cables, dump sites)	☐	Fault	☐	High Temperature	☐
H_2S	☐	High Dip Angle	☐	Ice Conditions	☐
CO_2	☐				

Preferred weather window: Summer

Sensitive marine habitat (e.g., reefs, vents):

Other:

Proposal #: 637 - Add 8	Site #: MV-03C	Date Form Submitted: 2022-04-29 08:17:15

Data Type	In SSDB	Details of available data and data that are still to be collected
1a High resolution seismic reflection (primary)	yes	Line: Line 1 Position: CDP 11751 Site approved by site characterization panel and EPSP to 550 mbsf.
1b High resolution seismic seismic reflection (crossing)	yes	Line: Line 8 Position: CDP 1785
2a Deep penetration seismic reflection (primary)		
2b Deep penetration seismic reflection (crossing)		
3 Seismic Velocity	yes	
4 Seismic Grid		
5a Refraction (surface)		
5b Refraction (bottom)		
6 3.5 kHz		
7 Swath bathymetry		
8a Side looking sonar (surface)		
8b Side looking sonar (bottom)		
9 Photography or video		
10 Heat Flow		
11a Magnetics		
11b Gravity		
12 Sediment cores	yes	
13 Rock sampling		
14a Water current data		
14b Ice Conditions		
15 OBS microseismicity		
16 Navigation		
17 Other		

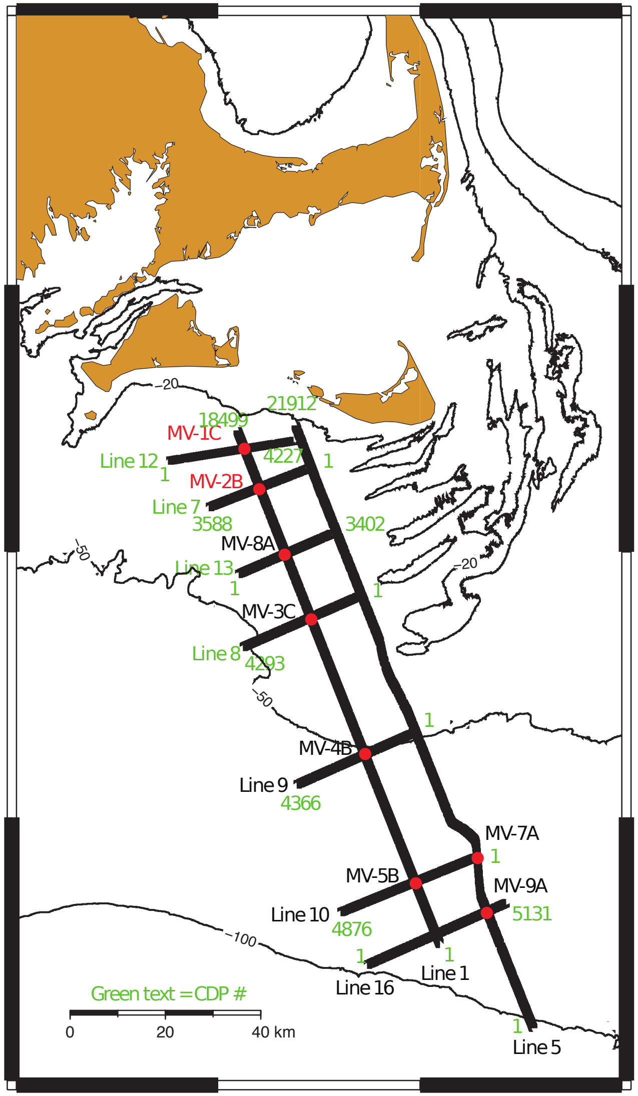
Proposal #: 637 - Add 8	Site #: MV-03C	Date Form Submitted: 2022-04-29 08:17:15

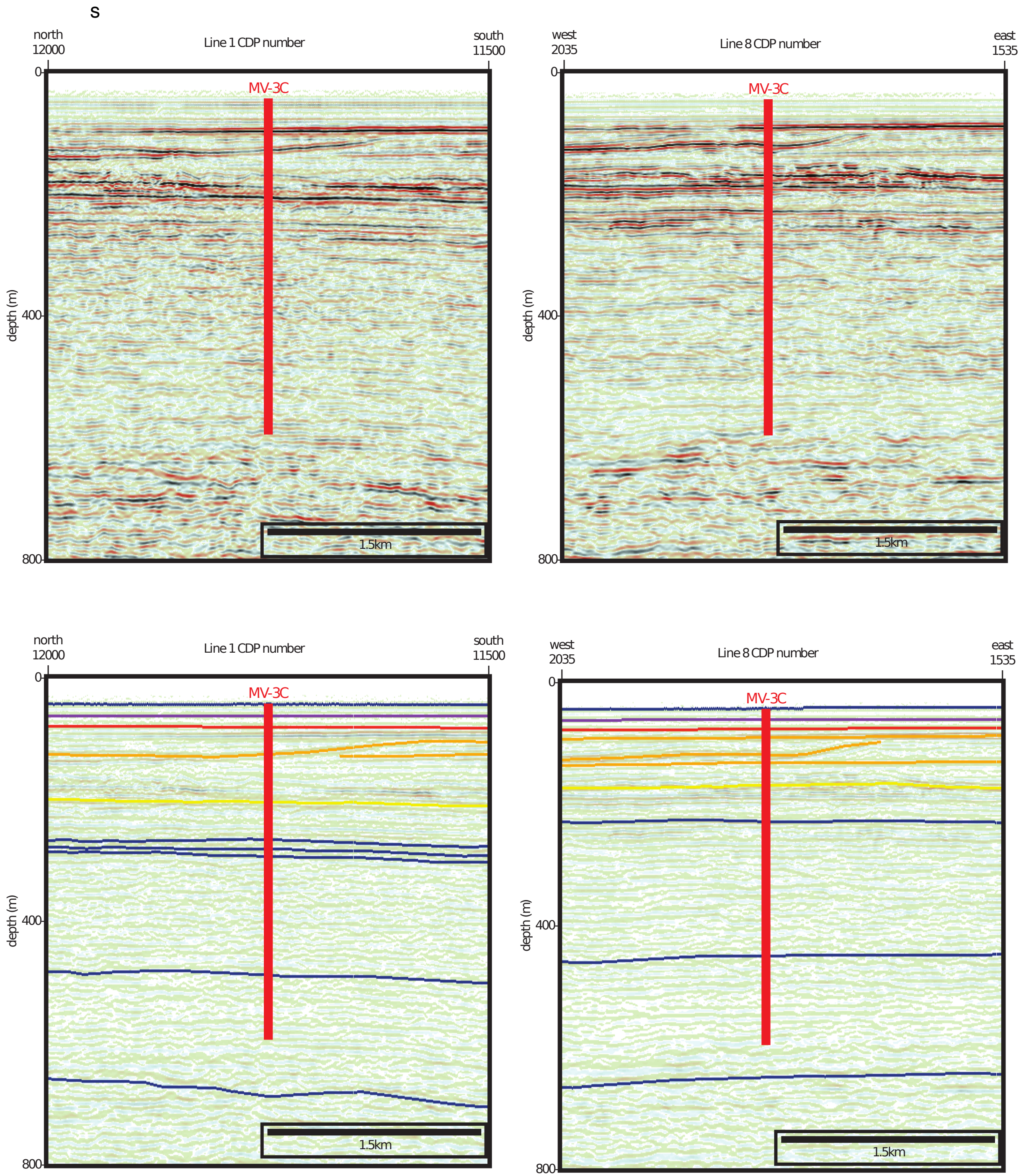
Pollution & Safety Hazard	Comment
1. Summary of operations at site	APC to refusal followed by XCB to TD. Will core/case/log/sample following strategy employed on Exp 313.
2. All hydrocarbon occurrences based on previous DSDP/ODP/IODP drilling	None
3. All commercial drilling in this area that produced or yielded significant hydrocarbon shows	None
4. Indications of gas hydrates at this location	None
5. Are there reasons to expect hydrocarbon accumulations at this site?	None
6. What "special" precautions will be taken during drilling?	Maybe some low ovepressures; have been evaluated by EPSP and approved
7. What abandonment procedures need to be followed?	Standard IODP procedures
8. Natural or manmade hazards which may affect ship's operations	Fishing
9. Summary: What do you consider the major risks in drilling at this site?	Shallow water, unlithified sediments

Proposal #: 637 - Add 8	Site #: MV-03C	Date Form Submitted: 2022-04-29 08:17:15

Subbottom depth (m)	Key reflectors, unconformities, faults, etc	Age (My)	Assumed velocity (km/s)	Lithology	Paleo-environment	Avg. accum. rate (m/My)	Comments
0 - 550		< Cretaceous	1.75	silt, sand, clay			

Site Summary Form
Proposal 637
Site MV-3C
Line 1 CDP 11751, Line 8 CDP 1785





SSDB Data Files: *CDP Trackline Map; Raw and Interpreted Seismic Figures; SEG-Y Data; Navigation Data*

IODP Site Forms

Form 1 – General Site Information

637 - Add 8

Section A: Proposal Information

Proposal Title	A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England
Date Form Submitted	2022-04-29 08:17:15
Site-Specific Objectives with Priority (Must include general objectives in proposal)	MV-5B will characterize the seawater endmember of the transect.
List Previous Drilling in Area	AMCOR wells 6001, 6009, 6020, 6021; COST wells B-2, G-1, G-2, ODP Leg 174A, IODP Exp. 313

Section B: General Site Information

Site Name:	MV-05B	Area or Location:	New England continental shelf
If site is a reoccupation of an old DSDP/ODP Site, Please include former Site#			
Latitude:	Deg: 40.3771	Jurisdiction:	USA
Longitude:	Deg: -70.0119	Distance to Land: (km)	116
Coordinate System:	WGS 84		
Priority of Site:	Primary: ✓ Alternate: ☐	Water Depth (m):	79

Section C: Operational Information

	Sediments	Basement
Proposed Penetration (m):	650	0
	Total Sediment Thickness (m) 650	
		Total Penetration (m): 650
General Lithologies:	Silt, sand, clay	Not applicable, no basement penetration

Coring Plan: (Specify or check)

APC ☑ XCB ☑ RCB ☐ Re-entry ☐ PCS ☐

Wireline Logging Plan:

Standard Measurements		Special Tools		
WL	☑	Magnetic Susceptibility	☐	Other tools:
Porosity	☑	Borehole Temperature	☐	
Density	☑	Formation Image (Acoustic)	☐	
Gamma Ray	☑	VSP (walkaway)	☐	
Resistivity	☑	LWD	☐	
Sonic (Δt)	☑			
Formation Image (Res)	☑			
VSP (zero offset)	☐			
Formation Temperature & Pressure	☑			

Other Measurements:

Estimated Days:	Drilling/Coring: 19	Logging: 4	Total On-site: 23

Observatory Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

Potential Hazards/ Weather:

						Preferred weather window
Shallow Gas	☐	Complicated Seabed Condition	☐	Hydrothermal Activity	☐	Summer
Hydrocarbon	☐	Soft Seabed	☐	Landslide and Turbidity Current	☐	
Shallow Water Flow	☐	Currents	☐	Gas Hydrate	☐	
Abnormal Pressure	☐	Fracture Zone	☐	Diapir and Mud Volcano	☐	
Man-made Objects (e.g., sea-floor cables, dump sites)	☐	Fault	☐	High Temperature	☐	
H_2S	☐	High Dip Angle	☐	Ice Conditions	☐	
CO_2	☐					
Sensitive marine habitat (e.g., reefs, vents)						

Other:

Proposal #: 637 - Add 8	Site #: MV-05B	Date Form Submitted: 2022-04-29 08:17:15

Data Type	In SSDB	Details of available data and data that are still to be collected
1a High resolution seismic reflection (primary)	yes	Line: Line 1 Position: CDP 2250 Approved by site characterization panel and EPSP to 650 mbsf; plan to drill to 550 mbsf
1b High resolution seismic seismic reflection (crossing)	yes	Line: Line 10 Position: CDP 2115
2a Deep penetration seismic reflection (primary)		
2b Deep penetration seismic reflection (crossing)		
3 Seismic Velocity	yes	
4 Seismic Grid		
5a Refraction (surface)		
5b Refraction (bottom)		
6 3.5 kHz		
7 Swath bathymetry		
8a Side looking sonar (surface)		
8b Side looking sonar (bottom)		
9 Photography or video		
10 Heat Flow		
11a Magnetics		
11b Gravity		
12 Sediment cores	yes	
13 Rock sampling		
14a Water current data		
14b Ice Conditions		
15 OBS microseismicity		
16 Navigation		
17 Other		

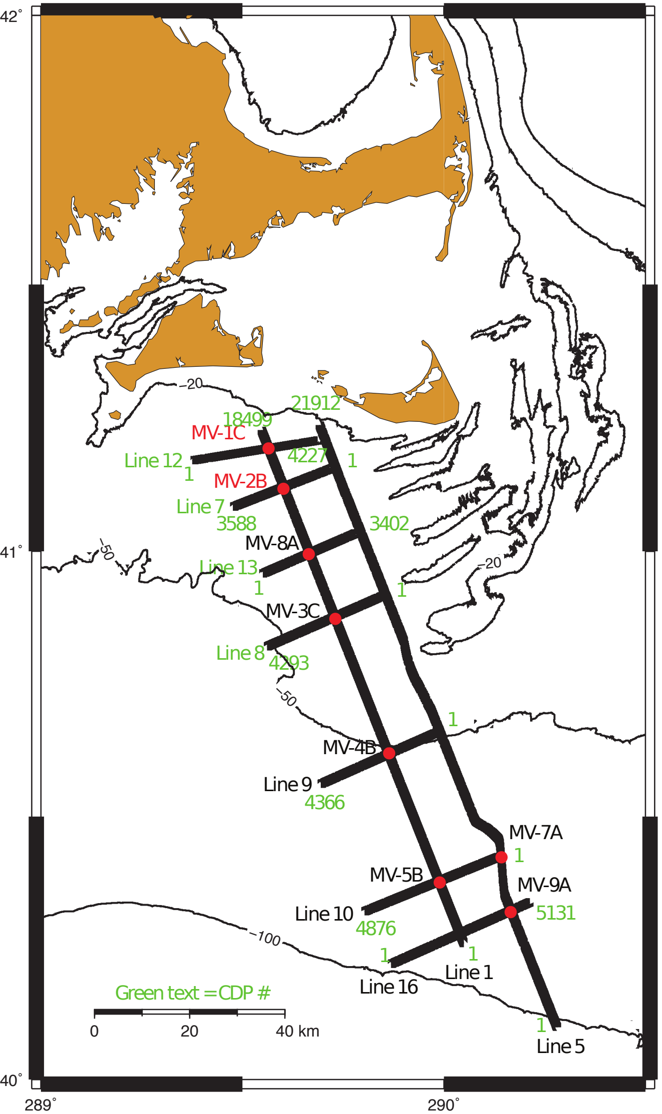
Proposal #: 637 - Add 8	Site #: MV-05B	Date Form Submitted: 2022-04-29 08:17:15

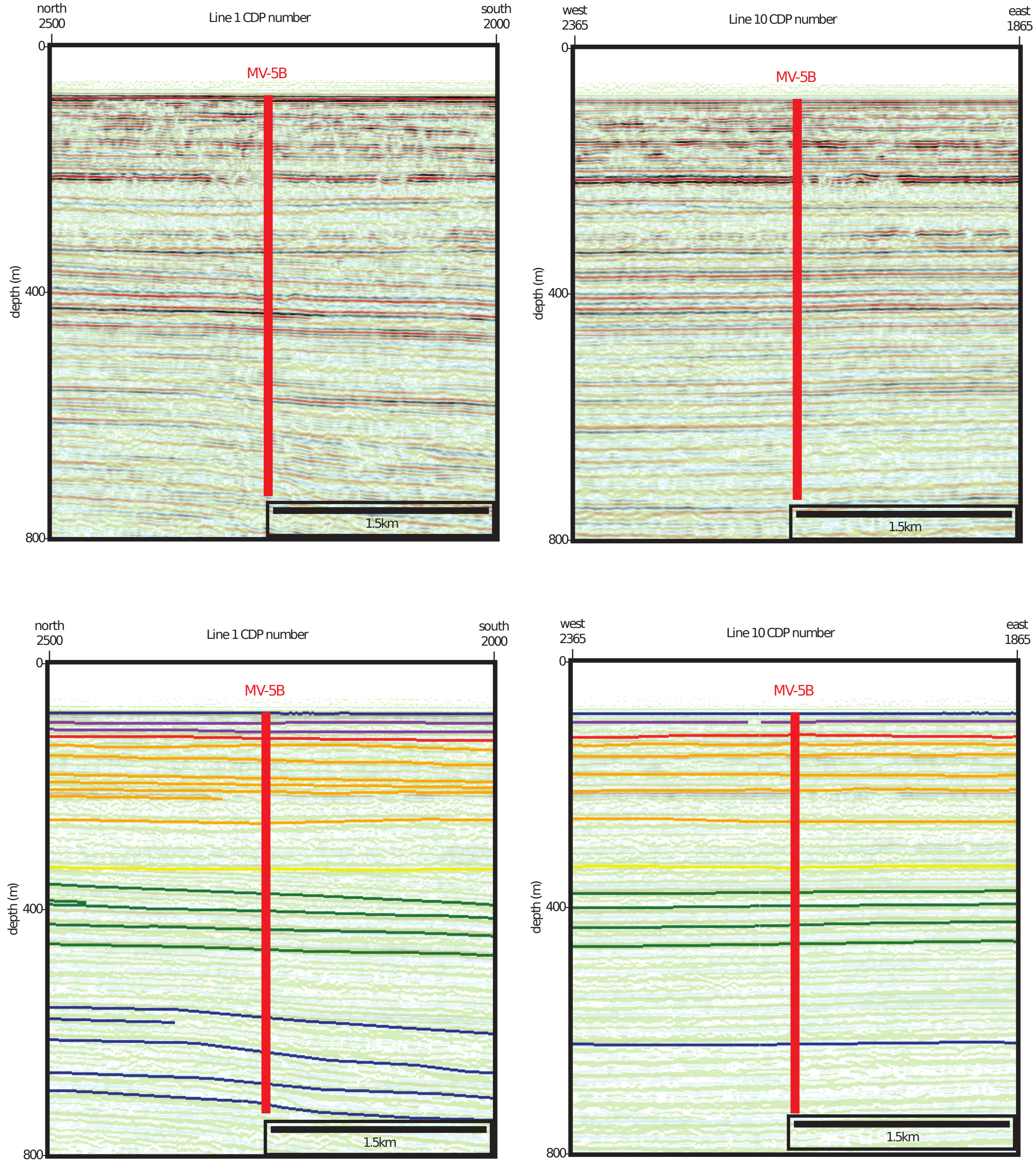
Pollution & Safety Hazard	Comment
1. Summary of operations at site	APC to refusal followed by XCB to TD. Will core/case/log/sample following strategy employed on Exp 313.
2. All hydrocarbon occurrences based on previous DSDP/ODP/IODP drilling	None
3. All commercial drilling in this area that produced or yielded significant hydrocarbon shows	None
4. Indications of gas hydrates at this location	None
5. Are there reasons to expect hydrocarbon accumulations at this site?	None
6. What "special" precautions will be taken during drilling?	Maybe some low ovepressures; have been evaluated by EPSP and approved
7. What abandonment procedures need to be followed?	Standard IODP procedures
8. Natural or manmade hazards which may affect ship's operations	Fishing
9. Summary: What do you consider the major risks in drilling at this site?	Shallow water, unlithified sediments

Proposal #: 637 - Add 8	Site #: MV-05B	Date Form Submitted: 2022-04-29 08:17:15

Subbottom depth (m)	Key reflectors, unconformities, faults, etc	Age (My)	Assumed velocity (km/s)	Lithology	Paleo-environment	Avg. accum. rate (m/My)	Comments
0 - 650		< Cretaceous	1.75	silt, sand, clay			

Site Summary Form 6
Proposal 637
Site MV-5B
Line 1 CDP 2250, Line 10 CDP 2115





SSDB Data Files: *CDP Trackline Map; Raw and Interpreted Seismic Figures; SEG-Y Data; Navigation Data*