637-Full 2 + Add6 New England Shelf Hydrogeology (EFB holding bin)

A Shallow Drilling Campaign to Access the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England.

Proponents:

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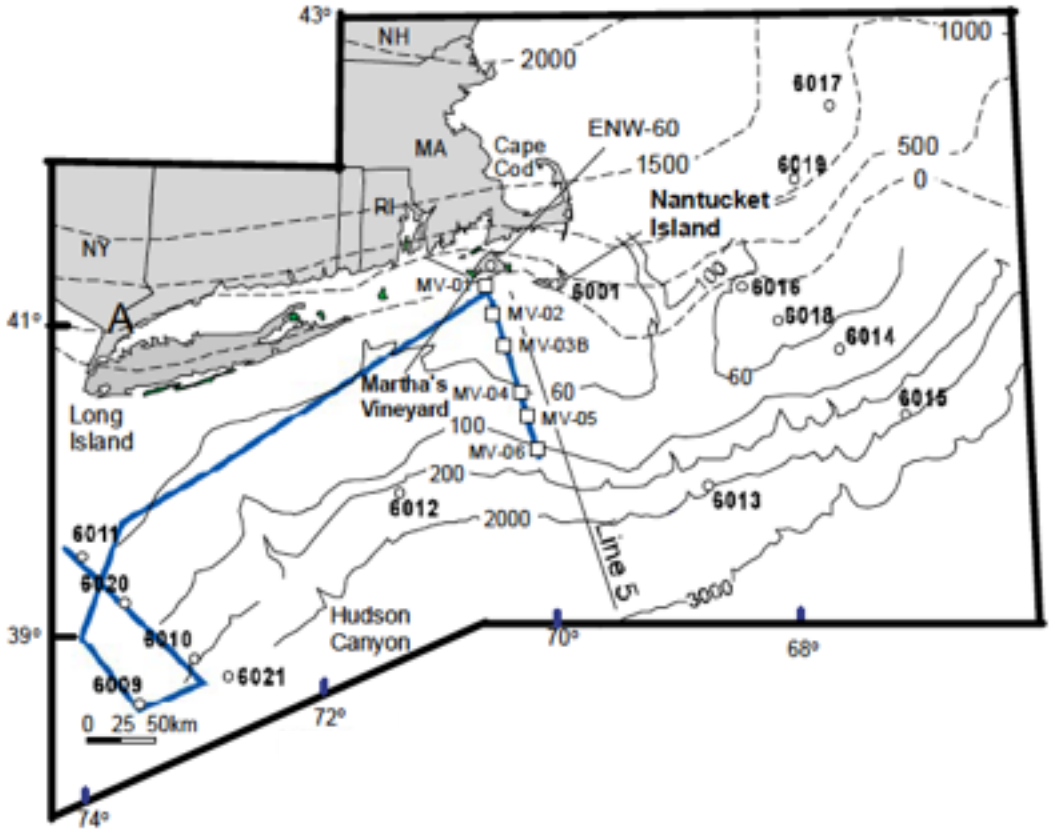
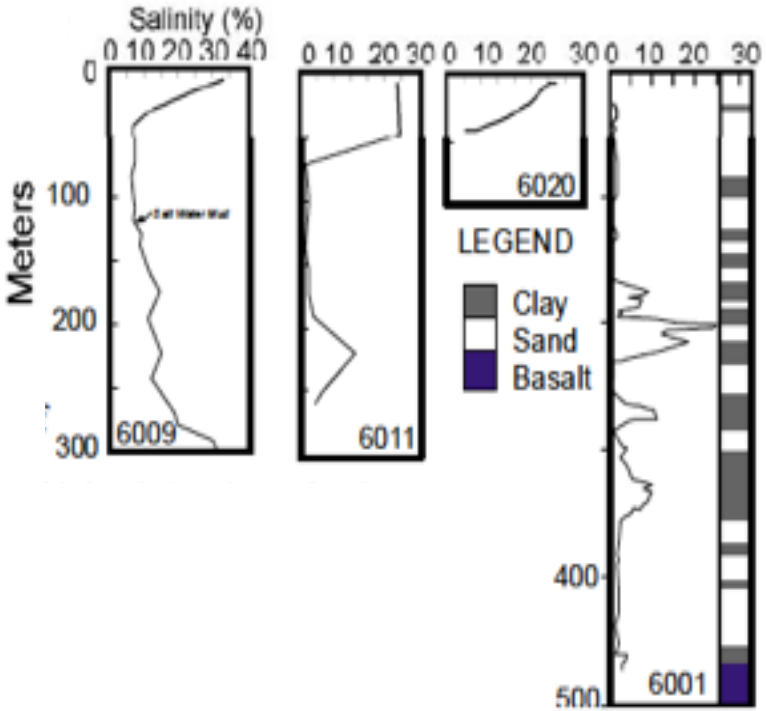
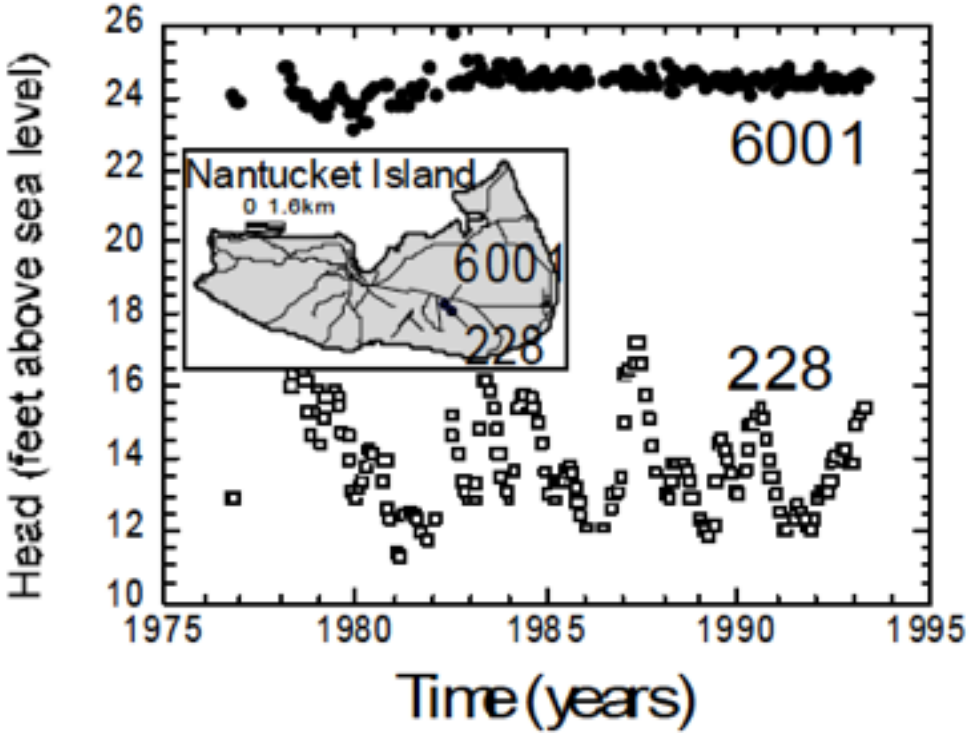


General history:

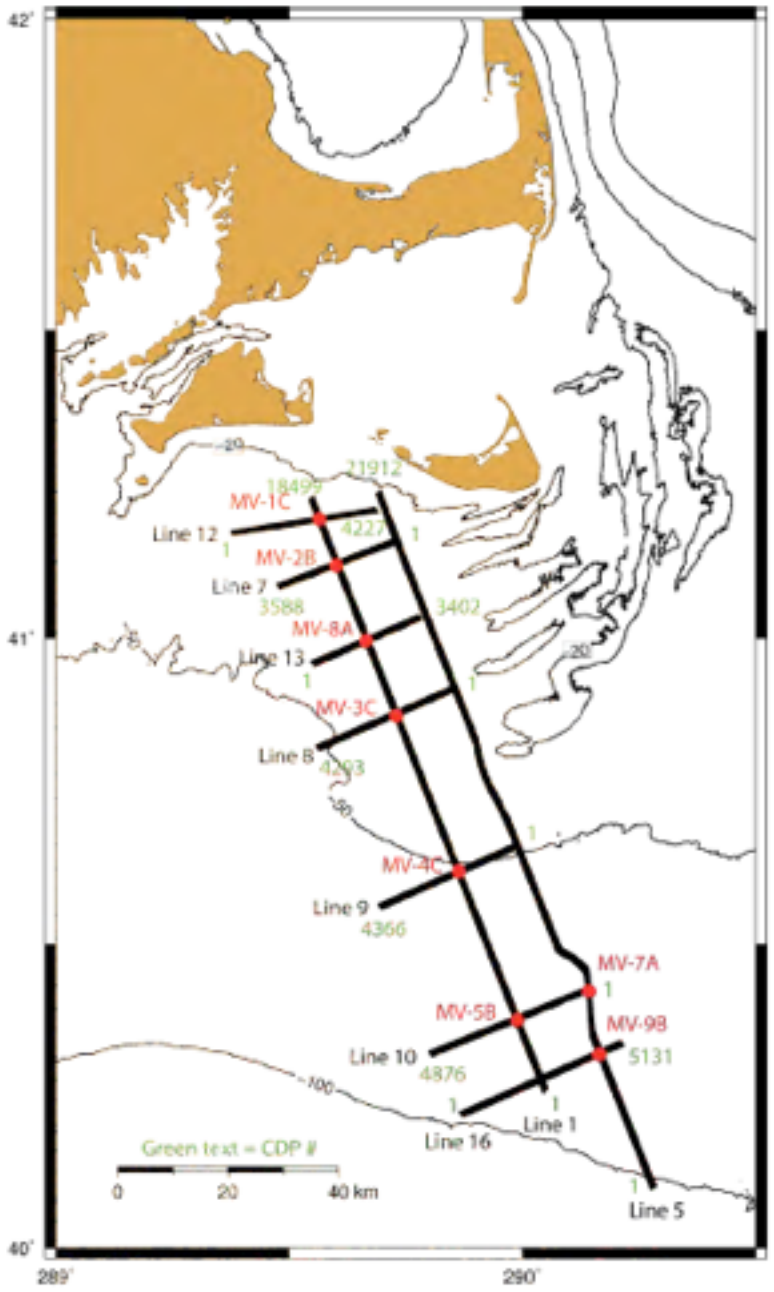
- The IODP Proposal 637-Full2 by Person et al. was submitted in April 2005, and evaluated by SEP and 5 External Reviewers in September 2005.
- Two PRLs were submitted by the proponents to address some comments and concerns raised by SSEP, EDP and STP, which included technological difficulties in sand-rich layers to meet important scientific objectives.
- Through communications with ESO, 6 addendums (637-Add1 in 2008 to Add6 in 2011) were submitted, mainly to justify the technological requirements and adjust to the budgetary constrain.
- In March 2014, EFB decision was made, "The proposed MSP expedition, at least as currently proposed, can not be scheduled within the first 5 years of the new IODP framework due to the very high costs (i.e., $20M-$40M) ", but it has been kept as "EFB holding bin", which is requiring further project modifications to reduce the budget and operational risk.
- In April 2015, EFB reviewed the revised drilling plan (Add6). EFB has seen the revised plan "may be the mid-cost range", but asked further efforts and discussions between PIs and ESO to make it a doable project with cost saving. In Add6, 10 boreholes at 5 primary sites for coring and LWD/Wireline Logging were planed, which are still expensive.





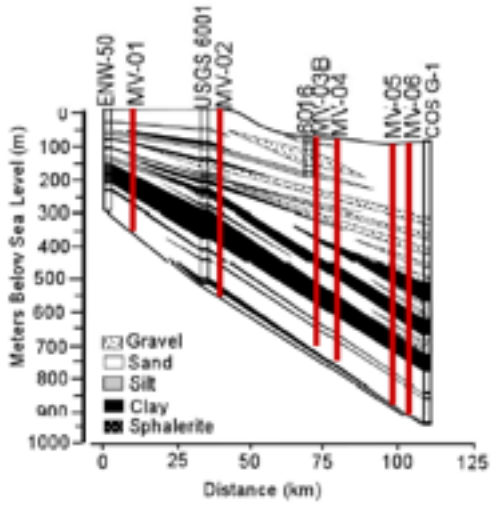
Summary of Major Scientific Objectives

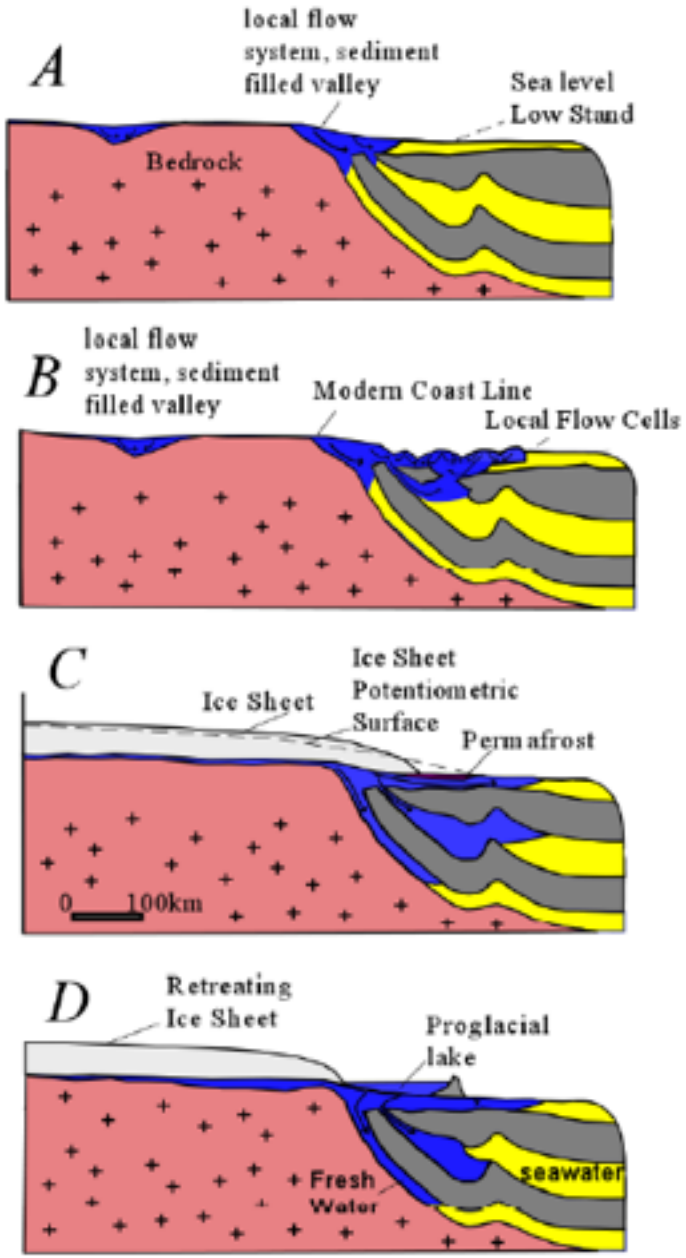
- To understand the origin(s) and distribution of freshwater in the offshore continental shelf and its incursion mechanism(s), including the overpressure aquifer and discontinuity
- To understand the rates of methane and nutrient production in situ and C/N/P fluxes into the ocean through flushing
- To understand the nature and ecological roles of microbial communities associated with the low/high salinity sedimentological setting



Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
MV-1C (Primary)	41.1936 N 70.4350 W	33	350		350	Characterize freshwater zone
MV-2B (Primary)	41.1171 N 70.3953 W	37	350		350	Characterize freshwater-brackish water transition
MV-3C (Primary)	40.8746 N 70.2697 W	42	550		550	Characterize brackish-seawater transition
MV-4C (Primary)	40.6185 N 70.1370 W	52	650		650	Characterize brackish-seawater transition
MV-5B (Primary)	40.3771 N 70.0119 W	79	650		650	Characterize seawater zone
MV-7A (Alt.)	40.42248N 69.85826W	76	650		650	Characterize seawater zone
MV-8A (Alt.)	40.9976 N 70.3334 W	41	350		350	Characterize brackish-seawater transition
MV-9B (Alt.)	40.33204N 69.83924W	79	650		650	Characterize seawater zone

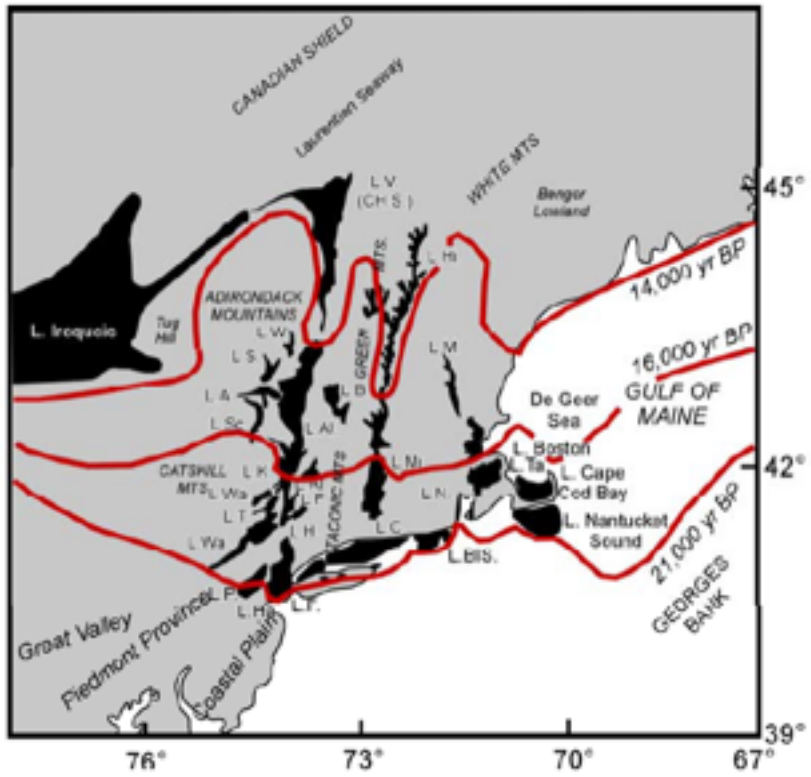
- 5 primary drilling sites on the New England continental shelf are proposed, and some site selections were revised based on comments from SSP.
- Drilling 2 holes per site is requested, each for the purpose of coring/ wireline and LWD. (= 10 holes)

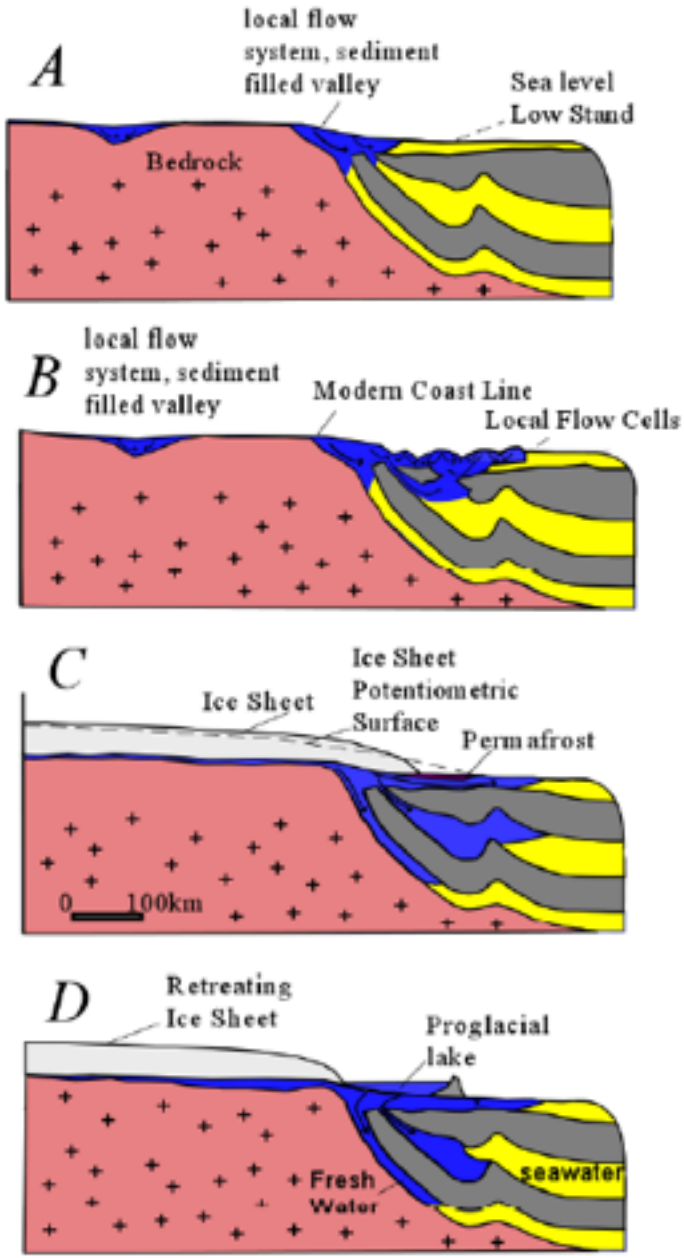




Hypothesis for the freshwater incursion

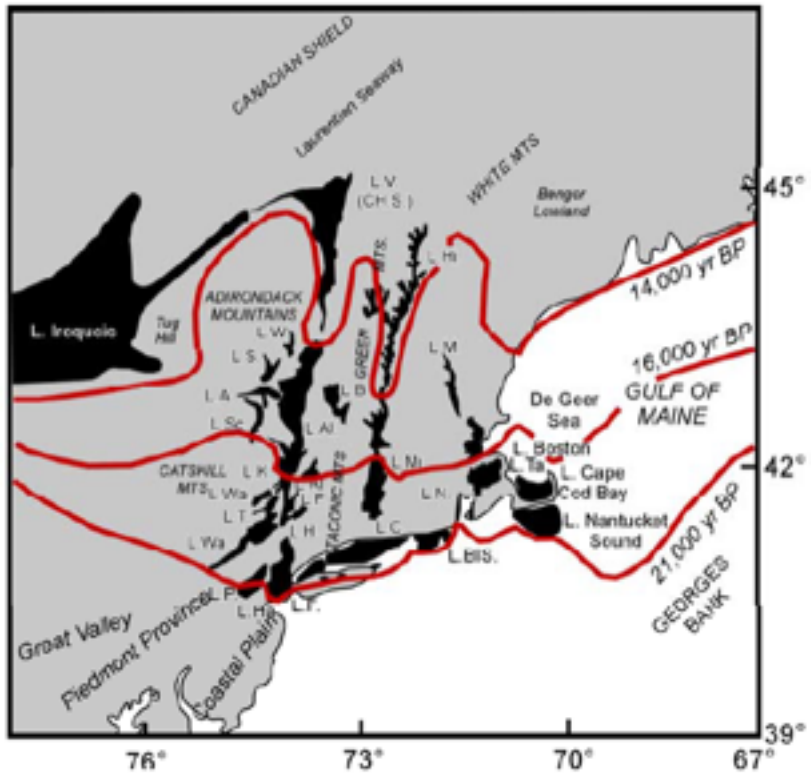
1. Meteoric recharge during Pleistocene sea-level low stands (A: lateral, B: vertical)
2. Sub-ice-sheet recharge during the LGM (C)
3. Recharge from pro-glacial lake (D)
4. Combination of A-D





Hypothesis for the over pressure condition

1. Pleistocene sediment loading
2. Fluid density differences associated with a think freshwater lens
3. Combination of 1 and 2



Analytical approaches

Table 3. Proposed Isotope Tracers that will be used to Date Groundwater

Isotope tracer	Half life (kyr)	Age range (kyr)	Complications of method
^{14}C	5.730	<50	Dilution by non-atmospheric carbon (without ^{14}C activity)
^{81}Kr	229	>50-1000	$2m^3$ of water needed for extraction
^{36}Cl	301	>40-3000	Dilution by stable oceanic chlorine
^{4}He	-	Unlimited	Correction for deep ^{4}He flux

	^{14}C, ^{4}He, ^{81}Kr age (ka)	$\delta^{18}O$ ‰	$\delta^{2}H$ ‰	Ne (ccSTP/kg)	"Excess air" ΔNe %	Recharge Temperature reflects
Meteoric groundwater	<20 or interglacial	-6 to -10	-35 to -50	$2*10^{-5}$ to $5*10^{-5}$	30 to 100	Water table
Subglacial meltwater	20-30 or glacial	-45 to -35	< -350	$6*10^{-4}$ to $2*10^{-3}$	> 500	No unique solution
Proglacial lake/ surface water	20-30 or glacial	-45 to -20	< -350	$2*10^{-5}$	1 – 5	Lake surface

- Dating using ^{81}Kr is only possible with 2000L of pore water.
- Neon and water isotopes are useful for determining the origin(s)

Analytical approaches

LWD, including NMR, and MDT Fluid Sampling

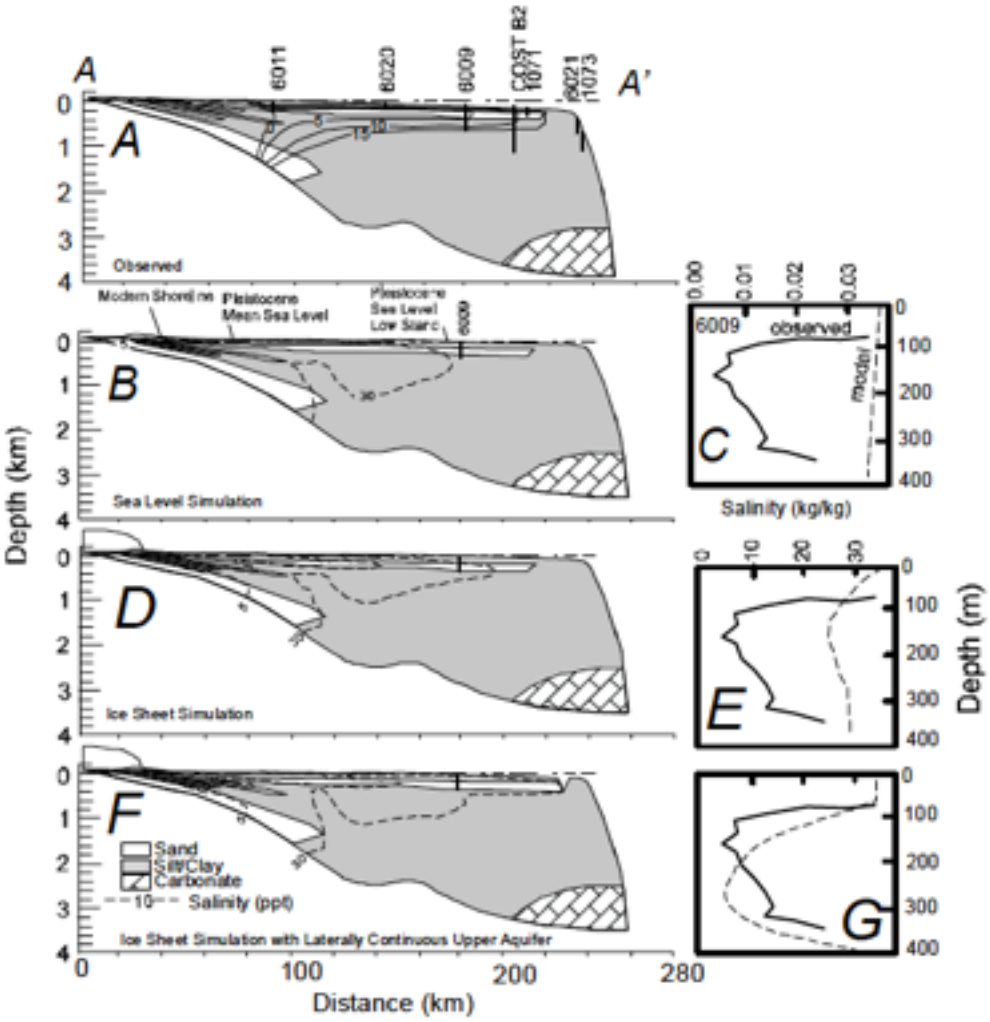
Standard Tools		Special Tools				LWD	
Neutron-Porosity	☐	Borehole Televiewer	☐	Formation Fluid Sampling	■	Density-Neutron	■
Litho-Density	☐	Nuclear Magnetic Resonance	☐	Borehole Temperature & Pressure	■	Resistivity-Gamma Ray	■
Gamma Ray	☐	Geochemical	■	Borehole Seismic	☐	Acoustic	■
Resistivity	☐	Side-Wall Core Sampling	☐				
Acoustic	☐						
Formation Image	☐			Others (MDT)		Others ( )	

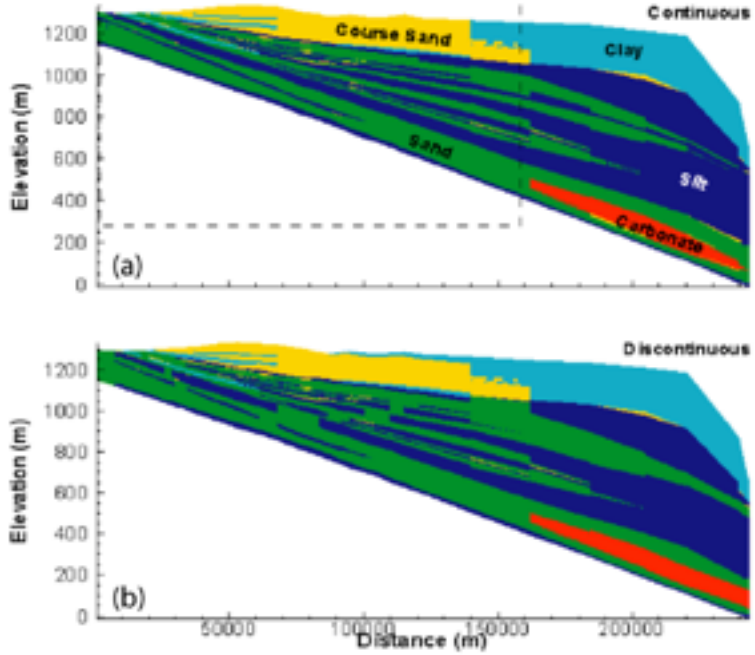
Thick Sand-Layer Coring & Casing-Packer Plan

- Sonic drilling (Rotosonic)
- Screen mesh casing?
- Wireline logging run using MDT/piezoprobe tools?
- MP38/55 packer system

- NMR tool is available for wireline?

Post cruise modeling work





from Add2

- ✓ Construct 2D and 3D models
- ✓ Reactive transport modeling with PHWAT code
- ✓ Biogeochemical dynamics

need transect data…..

Microbiology & Biogeochemistry

- Most microbiological and biogeochemical analyses planned in this project will be able to conduct with lower volume of samples and higher precision of the currently available techniques developed since ODP Leg 201 in 2002.
- Quality assurance and controls (QA/QC) should be carefully documented; e.g., how do the proponents distinguish indigenous microbial communities from potential contaminants, especially for sand layers?
- Strong microbiological/biogeochemical hypotheses are missing in this proposal –e.g., the environment seems to be an ideal place to study "dispersal and evolution of microbial communities".
- If microbial activity will be measured by radio-tracers (^{14}C, ^{35}S), it should be injected onboard immediately after core retrieval. This means, radio-isotope van (container lab) will be necessary on the MSP.
- Besides rate measurements, it remains unclear to me how the proponents will estimate the flux of nutrients from sediments to the overlying ocean and atmosphere through episodic flushing events. (biogeochemical modeling?)