IODP Proposal Cover Sheet

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Newfoundland Neogene Sediment Drifts

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Title	Newfoundland Oligo-Miocene sediment drifts: transition from the Paleogene greenhouse to the modern icehouse
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Abstract

The Newfoundland sediment drifts accumulated under the Deep Western Boundary Current that transports waters formed in the North Atlantic into the global ocean. Consequentially, Newfoundland sediments record a global 'end member' of deep-water overturning and cryosphere evolution, and preserve a detailed history of both terrestrial and marine high-latitude ecosystems. Our objective is to compare the Newfoundland record with those in other ocean basins to test questions about the global and regional components of the carbonate compensation depth, the origin of major biogenic blooms, the bipolar development of glaciations, and the role of gateways, nutrient recycling and latitudinal habitat differentiation in the major radiations of whales, fish and plankton.

Unfortunately, well-resolved marine records of the Oligo-Miocene are scarce in the Northern Hemisphere, restricting our view of the early transition into glacial climates and ecosystems in the Northern Hemisphere. Analysis of Newfoundland drift sediments will test hypotheses about the interaction between deep-water circulation, global temperature, atmospheric pCO2, ice-sheet dynamics, and ecosystems that all experience state changes in the Oligo-Miocene interval. For deep-water circulation, a high quality North Atlantic 'end member' for the Oligo-Miocene will be established, allowing the reconstruction of the conveyor belt and ocean heat fluxes. A new Oligo-Miocene depth transect (of at least ~1600 m depth range; 4925-3320 m), will capture the dynamics and chemistry of southern component waters and northern-sourced deep waters as Arctic glaciation is unfolding. Further, records drilled during Expedition 342 can be used to complete a Paleocene to Miocene series of depth transects to reconstruct the Cenozoic CCD for comparison with the well-resolved Pacific CCD history.

Unlike most places in the Atlantic, bottom currents flowing over the Newfoundland Ridges have prevented the Oligo-Miocene sequence from becoming buried under a thick Plio-Pleistocene blanket; hence it is possible to piston core these relatively old sediments which are known to have excellent microfossil preservation as well as magnetostratigraphy and orbital records. Our drilling plan starts with drilling a single, logged borehole through the whole Oligo-Miocene sequence (~900 m thick) to provide a high quality reference site that ties the reflector stratigraphy into all the other drill sites. We then plan to drill a series of offset, shallow-penetration, triple-APC-cored sites that will recover the entire Oligo-Miocene record in un-lithified sediments with preserved magnetostratigraphic records. Finally, we will drill three relatively deep penetration sites near the Oligocene and Miocene CCD. In total, we have identified 8 primary sites.

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Scientific Objectives

The proposed drilling of Oligo-Miocene sediment drifts deposited on the Southeast Newfoundland Ridge can be used to address the following four key research questions that will allow a rigorous test of leading and sometimes contradicting hypotheses:

1) Do Oligo-Miocene biogenic blooms and CCD fluctuations primarily reflect global changes in weathering, interbasinal exchanges, or more regional tectonics (such as gateway dynamics)?

2) What caused the Middle Miocene Climatic Optimum (MMCO) and was the North Atlantic overturning circulation a major driver of it?

3) Is the overturning circulation an underlying cause or a positive feedback to the cryospheric history of the Oligo-Miocene Northern Hemisphere?

4) Does the establishment of distinctive polar ecosystems substantially follow a tectonic driver (such as opening the Drake Passage) or are these ecosystems primarily set up by polar glaciation?

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

none

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Proposed Sites (Total proposed sites: 25; pri: 8; alt: 17; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
NFR-01A (Primary)	40.835245 -47.721541	3320	900	0	900	Stratigraphic test site to identify the ages of the major and minor reflectors from the Pleistocene to the upper Eocene; data used to plan shallow penetration, offset sites. Site is located on a crossing of SCS Lines 43 and 56 making it possible to extend the seismic stratigraphy throughout SENR.
NFR-02A (Primary)	40.889215 -47.643687	3380	300	0	300	Lower Pliocene through upper Miocene; shallow penetration site (300 m); This site, together with NFR-03A, 04A, and 05A, will collect a composite ~750 m sequence of Miocene-Oligocene sediments with APC to maximize core quality, microfossil preservation and magnetic stratigraphy.
NFR-03A (Primary)	40.926778 -47.589625	3500	300	0	300	Middle Miocene; shallow penetration site (300 m); This site, together with NFR-02A, 04A, and 05A, will collect a composite ~750 m sequence of Miocene-Oligocene sediments with APC to maximize core quality, microfossil preservation and magnetic stratigraphy.
NFR-04A (Primary)	40.967666 -47.530591	3550	250	0	250	Lower Miocene; shallow penetration site (250 m); This site, together with NFR-02A, 03A, and 05A, will collect a composite ~750 m sequence of Miocene-Oligocene sediments with APC to maximize core quality, microfossil preservation and magnetic stratigraphy.
NFR-05A (Primary)	41.038692 -47.516385	3550	250	0	250	Lower Miocene through the Oligocene (to E/O boundary); shallow penetration site (250 m); This site, together with NFR-02A, 03A, and 04A, will collect a composite ~750 m sequence of Miocene-Oligocene sediments with APC to maximize core quality, microfossil preservation and magnetic stratigraphy.
NFR-06A (Primary)	40.085712 -47.745961	4250	300	0	300	Oligocene deep water section through the E/O boundary; represents the lower end of the Oligocene depth transect (together with NFR-05A and Leg 342 sites) desiged to reconstruct the Oligocene CCD
NFR-07A (Primary)	40.312480 -49.670012	4420	700	0	700	Deep water Miocene section largely above the CCD; should capture primarily a carbonate-bearing section above the CCD with occasional excursions of carbonate poor sediments during CCD shoaling events.
NFR-08A (Primary)	40.185178 -49.834010	4925	700	0	700	Miocene deep water sequence straddling the CCD; This site is intended to evaluate fine-scale variations in the Miocene CCD by detecting occurrences (or absence) of carbonate sediments. The site is expected to be partly carbonate-free but the chronology of the site will be transferred from shallower water sites by use of log-to-log correlations and biostratigraphic control in the intervals where carbonate is present or through the use of dinocysts and siliceous microfossils.
NFR-09A (Alternate)	41.099113 -47.485762	3800	250	0	250	Oligocene to the E/O boundary; mid depth site that pins the shallow water excursions of the CCD in the Oligocene; forms depth transect to reconstruct the CCD in combination with Site NFR-06A and Leg 342 sites. This site penetrates a sequence similar in seismic character to IODP U1411 so it also represents an opportunity to obtain a 3 APC-cored E/O record; IODP U1411 was only double-cored owing to time and weather constraints
NFR-10A (Alternate)	40.864283 -47.880816	3280	250	0	250	Shallow water (3280 m) Pleistocene-Miocene section with expanded Pleistocene record; intended to recover an expanded Pleistocene-upper Miocene record in combination with Site NFR-11A
NFR-11A (Alternate)	40.875400 -47.943644	3370	400	0	400	Recover an expanded Pliocene and upper Miocene record on crest of the SENR. Drilling to 400 m would allow to capture the entire Pliocene sequence at shallow (3360 m) water depth. Site in combination to NFR-10A to recover (in combination) an expanded Pleistocene-upper Miocene section.
NFR-12A (Alternate)	40.868711 -47.601645	3400	250	0	250	Very expanded upper to middle Miocene section accessible through APC coring. Represents an alternate in the depth transect of offset boreholes represented by primary sites NFR-02A to -05A
NFR-13A (Alternate)	40.978834 -47.514364	3540	250	0	250	Lower Miocene to upper Oligocene section available through APC coring; represents an alternate for the basal Miocene in the depth transect of offset boreholes in Primary sites NFR-02A to -05A

Proposed Sites (Continued; total proposed sites: 25; pri: 8; alt: 17; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
NFR-14A (Alternate)	40.390731 -48.763151	3830	500	0	500	Middle of the proposed Miocene depth transect (at 3830 m). Carbonate content of sediments is expected to be variable, reflecting variations in the CCD. Section expected to be mainly middle and upper Miocene.
NFR-15A (Alternate)	40.653000 -46.975398	3720	250	0	250	Pliocene to upper Miocene at moderate depth (3720 m); drilling to ~500 m would capture most of the Miocene section
NFR-16A (Alternate)	40.714483 -49.503335	3750	250	0	250	Expanded Eocene section with E/O at shallow burial depth
NFR-17A (Alternate)	40.173750 -49.848685	5000	500	0	500	This site represents the lower end of the Miocene depth transect. Minimal carbonate content expected to recover the deep end of Miocene CCD excursions; alternate to deep water primary site NFR-08A.
NFR-18A (Alternate)	40.098820 -47.789333	4200	400	0	400	Expanded lower to middle Miocene and Oligocene to the E/O Boundary
NFR-19A (Alternate)	40.098776 -47.680846	4260	250	0	250	Recovery of an expanded mid depth (4260 m) Oligocene succession to complete the middle of an Oligocene depth transect.
NFR-20A (Alternate)	39.968619 -48.959689	4620	500	0	500	Expanded Miocene record in deep water (4620 m) just above the Miocene CCD; should capture record of CCD shoaling but largely be above the CCD and so record good biostratigraphy and magnetochronology; alternative site to other deep water primary sites (NFR-07A)
NFR-21A (Alternate)	40.608510 -47.032209	3600	250	0	250	Pliocene-upper Miocene sequence for offset coring; alternative to primary sites (NFR-02A to -05A) that are used to capture a full Miocene-Oligocene sequence in APC cored sites
NFR-22A (Alternate)	40.301233 -47.423836	3920	250	0	250	Middle and Upper Miocene at a mid depth site (3920 m); mid part of Miocene depth transect for Miocene CCD reconstruction
NFR-23A (Alternate)	40.195797 -47.557755	4120	250	0	250	Lower Miocene to the O/M boundary and upper Oligocene. Mid-depth transect (4120 m)for Miocene-Oligocene CCD reconstruction
NFR-24A (Alternate)	40.269925 -49.724799	4550	500	0	500	Expanded middle and lower Miocene sequence just above Miocene CCD; alternative site to NFR-07A to pin the shallow excursions of the Miocene CCD
NFR-25A (Alternate)	39.873587 -49.097721	5070	500	0	500	Alternate to Primary site NFR-08A for Miocene deep water (5070 m) at the Miocene CCD; used to reconstruct short-term depressions of the CCD; dated by transferring biochronology and magnetic chronology from shallower water sites using core-based logs; given available time, this site could also be logged, enabling correlation using downhole logs. Site expected to contain intervals of carbonate that can provide calcareous biochronology; dinocysts and siliceous microfossils also provide chronology.