

IODP Proposal Cover Sheet

909 - Full

NW Greenland Glaciated Margin

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| Title | Cenozoic evolution of the northern Greenland ice sheet (NORTH ICE) | | |
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| Keywords | Arctic, climate, interglacial, ocean circulation | Area | Baffin Bay |

Proponent Information

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Abstract

Understanding the evolution of the Greenland Ice Sheet (GrIS) holds the key to the origin of northern hemisphere glaciations, and possibly the mechanisms of the amplification of glacial cycles since the late Pliocene. To address current knowledge gaps in the evolution and variability of the GrIS and its role in Earth's climate system we propose to drill along a transect crossing the northwest Greenland margin toward Baffin Bay. The mission strategy is to retrieve a composite stratigraphic succession along this transect representing the Late Cenozoic era from late Oligocene to Holocene. The proposed drill sites will specifically target high-accumulation-rate deposits associated with contourite drifts and potential interglacial deposits within a trough-mouth-fan system that is superbly covered by seismic data. The scope is to test if the northern GrIS underwent near-complete deglaciations in the Pleistocene and assess recent models for the change in orbital cyclicities through the Mid-Pleistocene transition. Moreover, the proposal will examine a possible linkage between the general decrease in pCO₂ from the Oligocene to the early Miocene and arrival of cold and possibly glacially-dominated environments in NW Greenland and establish the timing for tectonic margin adjustments inferred from the seismic record. Finally, records will be produced that can test hypothesis that glacial expansion of the northern GrIS is linked with intensification of northern hemisphere glaciations (3.3-2.8 Ma) and unravel marine heat transport through the western North Atlantic and Baffin Bay as a potential cause for the Pliocene high Arctic warmth. The detailed information obtained from these paleoclimate archives will be of great value for predictive models addressing how the GrIS may respond to global warming in the near future. The overall aim is to investigate the full range of forcing and feedbacks - oceanic, atmospheric, orbital, tectonic - that influence the GrIS over a range of time scales, as well as conditions prevailing at the time of glacial inception and deglacial to interglacial periods. The scientific objectives of this proposal are of key significance in addressing the challenges "How do ice sheets and sea level respond to a warming climate?" and "How does Earth's climate system respond to elevated levels of atmospheric CO₂?" under the Climate and Ocean Change theme of the IODP science plan.

Scientific Objectives

1. Test the hypothesis that the northern GrIS at intervals within the frequency range of orbital eccentricity (~100-400 ka) underwent near-complete deglaciation.
2. Test the hypotheses that the general decrease in pCO₂ from the Oligocene (~500 ppm) to the early Miocene (<300 ppm) are linked to cold and possibly glacially- dominated environments in NW Greenland.
3. Provide information on timing, sedimentary processes and changes in denudation rates related to tectonic margin adjustments inferred from the seismic record.
4. Test the hypothesis that glacial expansion of the northern GrIS is linked with intensification of NHG (3.3-2.8 Ma).
5. Assess recent models for the change in orbital cyclicities through the Mid-Pleistocene transition.
6. Test the hypothesis that the high Arctic warmth of the early-mid Pliocene is related to heat advection through the western North Atlantic and Baffin Bay.

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

Proposed Sites (Total proposed sites: 10; pri: 7; alt: 3; N/S: 0)

| Site Name | Position (Lat, Lon) | Water Depth (m) | Penetration (m) | | | Brief Site-specific Objectives |
|--------------------|---------------------|-----------------|-----------------|-----|-------|--|
| | | | Sed | Bsm | Total | |
| MB-01B (Primary) | 72.9679 -63.0539 | 1878 | 450 | 0 | 450 | Recover a high-resolution paleoceanographic record of a middle-late Pleistocene sediment drift system corresponding to the most recent part of the trough-mouth-fan history. Site MB-1B overlaps stratigraphically with the strata drilled at site MB-2B but with expanded intervals of units 9, 10 and 11 as the principal drilling objective. High priority for scientific objectives 1 and 5. |
| MB-02B (Primary) | 73.1184 -63.7855 | 1957 | 515 | 0 | 515 | Recover a high-resolution paleoceanographic record of a middle-late Pleistocene sediment drift system corresponding to the most recent part of the trough-mouth-fan history. Site MB-2B overlaps stratigraphically with the strata drilled at site MB-1B but with an expanded interval of unit 8 as the main drilling objective. High priority for scientific objectives 1 and 5. |
| MB-03B (Primary) | 73.5032 -62.4861 | 498 | 375 | 0 | 375 | Recover deglacial and interglacial intervals of potentially early-middle Pleistocene age within top-set strata of the trough-mouth fan. Site MB-3B will recover deposits onlapping the prograding units 6, 7, 8 and 9 (TD = top unit 6). High priority for scientific objectives 1 and 5. |
| MB-04B (Primary) | 73.8711 -62.0342 | 630 | 230 | 0 | 230 | Recover deglacial and interglacial intervals of potentially early-middle Pleistocene age within top-set strata of the trough-mouth fan. Site MB-4B targets strata that onlaps top of unit 3. High priority for scientific objectives 1 and 5. |
| MB-05B (Primary) | 74.2116 -61.3397 | 710 | 500 | 0 | 500 | (1) Capture a thin wedge of progradational deposits that may correspond to the earliest shelf-based glaciations in NW Greenland; (2) Recover Neogene contourite drift sediments of likely Pliocene age that can elucidate paleoceanographic conditions prior to the major basinward expansion of the Greenland Ice Sheet. Site MB-5B targets the stratigraphically younger interval of the drift deposit that overlaps with the section drilled at site MB-6B. High priority for scientific objectives 3, 4 and 6. |
| MB-06B (Primary) | 74.1180 -60.8729 | 620 | 530 | 0 | 530 | Recover Neogene contourite drift sediments of likely Pliocene age that can elucidate paleoceanographic conditions prior to the major basinward expansion of the Greenland Ice Sheet. Site MB-6B overlaps stratigraphically with the lowermost section drilled at site MB-5B. The main target is an expanded section of the drift deposit that may potentially capture a continuous high-resolution early Pliocene record. TD is placed above a strong reflector covering a major slide scar. High priority for scientific objectives 3, 4 and 6. |
| MB-07A (Primary) | 74.5136 -60.6792 | 730 | 1250 | 0 | 1250 | To recover an upper Miocene interval and continue coring through the Middle Miocene horizon (d1) with TD at horizon d2 of possible Oligocene age. The scope is to elucidate past ocean and terrestrial climates in NE Baffin Bay/Greenland and the onset of ephemeral glaciation in NW Greenland. High priority for scientific objectives 2 and 3. |
| MB-08A (Alternate) | 73.4870 -62.2682 | 495 | 350 | 0 | 350 | Recover deglacial and interglacial intervals of potentially early-middle Pleistocene age within top-set strata of the trough-mouth fan. The site penetrates horizons onlapping the prograding units 6, 7 and 8 (TD = top unit 6). Site MB-08A is an alternate site to MB-03B. High priority for scientific objectives 1 and 5. |
| MB-09A (Alternate) | 73.9650 -61.4959 | 580 | 250 | 0 | 250 | Recover deglacial and interglacial intervals of potentially early- middle Pleistocene age within top-set strata of the trough-mouth fan. The site targets strata that onlap horizon 1 (top of oldest prograding unit). Site MB-09A is alternate to MB-4B. High priority for proposal objectives 1 and 5. |
| MB-10A (Alternate) | 74.4584 -61.1792 | 685 | 1300 | 0 | 1300 | To recover an upper Miocene interval and continue coring through the Middle Miocene horizon (d1) with TD at horizon d2 of possible Oligocene age. The scope is to elucidate past ocean and terrestrial climates in NE Baffin Bay/Greenland and the onset of ephemeral glaciation in NW Greenland. High priority for scientific objectives 2 and 3. Site MB-10A is an alternate position to site MB-07B. |