

# IODP Proposal Cover Sheet

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New

Revised

Addendum

Please fill out information in all gray boxes

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Title:	Arctic Ocean Paleooceanography: Towards a Continuous Cenozoic Record from a Greenhouse to an Icehouse World (ArcOP)		
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Keywords: (5 or less)	Arctic Ocean, Paleooceanography, Cenozoic	Area:	Lomonosov Ridge

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Permission to post abstract on IODP-MI Web site:  Yes

## Abstract: (400 words or less)

Prior to 2004, geological sampling in the Arctic Ocean was mainly restricted to near-surface Quaternary sediments. Thus, the long-term Pre-Quaternary geological history is still poorly known. With the successful completion of IODP Expedition 302 (ACEX) in 2004, a new era in Arctic research has begun. Employing a novel multi-vessel approach, the first Mission Specific Platform (MSP) expedition of IODP has proven that drilling in permanently ice-covered regions is possible. During ACEX, >400 meters of Cenozoic sediment on Lomonosov Ridge were penetrated, providing new unique insights into the Cenozoic Arctic paleo-oceanographic and climatic history. While highly successful, ACEX also has three important limitations. The ACEX sequence possibly contains a large hiatus spanning the time interval from late Eocene to middle Miocene (based on the original biostratigraphic age model) or an interval of strongly reduced sedimentation rates (later Os-Re-isotope-based age model). This is a critical time interval representing the transition from the early Cenozoic Greenhouse world to the late Cenozoic Icehouse world. Furthermore, generally poor recovery during ACEX prevented detailed and continuous reconstruction of Cenozoic climate history. Finally, a higher-resolution

reconstruction of Arctic rapid climate change during Neogene to Pleistocene times, could not be reached during ACEX.

Overall goal of the proposed drilling campaign ArcOP is the recovery of a complete stratigraphic sedimentary record on southern Lomonosov Ridge to meet our highest priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean. Furthermore, sedimentation rates two to four times higher than those of ACEX permit higher-resolution studies of Arctic climate change. As demonstrated in the proposal, this goal can be achieved by careful site selection, appropriate drilling technology, and applying multi-proxy approaches to paleoceanographic, paleoclimatic, and age-model reconstructions. At this stage, we still propose one primary deep drill site (LR-11B) with three APC/XCB/RCB holes, supplemented by a short APC drill site (LR-10B), to recover multiple sections of the sediment sequence to ensure complete recovery for construction of a composite section. Later, within the New IODP Program beyond 2025 and under the 2050 Science Framework, the present 708 proposal/addendum will be updated, considering the outcome and new results of IODP expeditions 400, 403 and 404 carried out in the northern subpolar North Atlantic in 2023 and 2024.

ArcOP objectives are key elements in the IODP 2050 Science Framework, Strategic Objective 3 (“Earth’s Climate System”) and Flagship Initiative 1 (“Ground Truthing Future Climate Change”).

Scientific Objectives: *(250 words or less)*

A complete stratigraphic sedimentary sequence representing the continuous Cenozoic climate history of the central Arctic Ocean will be studied to answer the following key questions:

- Did the Arctic Ocean climate follow the global climate evolution during its course from early Cenozoic Greenhouse to late Cenozoic Icehouse conditions?
- Are the Early Eocene Climate Optimum (poorly recovered in the ACEX record) and the Oligocene, Mid-Miocene and Pliocene warmings also reflected in ArcOP records?
- Did extensive glaciations (e.g., OI-1 and Mi-1) develop synchronously in both the Northern and Southern Hemispheres?
- What is the timing of repeated major (Plio-)Pleistocene Arctic glaciations as postulated from sediment echosounding and multi-channel seismic reflection profiling?
- What was the history and variability of seasonal vs. perennial sea ice?
- When and how did the change from a warm, fresh-water-influenced, biosilica-rich and poorly ventilated Eocene ocean to a cold, fossil-poor, and oxygenated Neogene ocean occur?
- How critical was the exchange of water masses between the Arctic Ocean and the Atlantic and Pacific for the long-term climate evolution as well as rapid climate change?
- What is the history of Siberian river discharge and how critical is it for sea-ice formation, water mass circulation and climate change?
- How do the new ArcOP records correlate with the terrestrial ICDP record from the Siberian Lake El'gygytgyn as well as the new results to be obtained with subpolar North Atlantic IODP expeditions 400, 403 and 404?
- What is the cause of the major hiatus recovered in the ACEX record? Does this hiatus in fact exist?

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

The sites are located in the seasonally ice-covered central Arctic Ocean (southern Lomonosov Ridge), and will need mission specific vessels to perform the drilling in the pack ice (marginal ice zone). A well organized ice-management strategy and support by an icebreaker (e.g., *Oden*) are needed.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
LR-01A (Alternate site for LR-11B)	80.9502 °N 142.9717 °E	1402	1225		1225	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LR-02A (Alternate site for LR-11B)	80.9650 °N 142.4717 °E	1458	1300		1300	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LORI-5B (Alternate site for LR-11B)	83.8005 °N 146.4750 5E	1333	1250		1250	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)

<p>LR-03A (Alternate site for LR-11B)</p>	<p>81.1825°N 142.0918°E</p>	<p>1013</p>	<p>1185</p>		<p>1185</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)</p>
<p>LR-04C (Alternate site for LR-11B)</p>	<p>81.3531°N 141.2484° E</p>	<p>875</p>	<p>930</p>		<p>930</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)</p>

<p>LR-05B (Alternate site for LR-11B)</p>	<p>81.3256°N 141.4248°E</p>	<p>906</p>	<p>1050</p>		<p>1050</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)</p>
<p>LR-06A (Alternate site for LR-11B)</p>	<p>81.4568°N 140.7299°E</p>	<p>779</p>	<p>800</p>		<p>800</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)</p>

<p><b>LR-11B</b> (Primary site)</p>	<p>81.4365°N 140.8405 °E</p>	<p>794</p>	<p>900</p>		<p>900</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (<b>Primary Deep Site</b>)</p>
<p><b>LR-10B</b> (Primary supplementary site, located 6.5 km NNW of Site LR-11B)</p>	<p>81.4836 °N 140.5855 °E</p>	<p>890</p>	<p>50</p>		<p>50</p>	<p>Recovery of the undisturbed uppermost (Quaternary) sedimentary section (<b>Primary Shallow Site</b>)</p>
<p>LR-07A (Alternate site for LR-11B)</p>	<p>81.6851°N 142.3074°E</p>	<p>764</p>	<p>740</p>		<p>740</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)</p>

<p>LR-08A (Alternate site for LR-11B)</p>	<p>82.4215°N 142.1678°E</p>	<p>1450</p>	<p>865</p>		<p>865</p>	<p>Recovery of a complete stratigraphic sedimentary record on the Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)</p>
<p>LR-09A (Alternate site for LR-11B)</p>	<p>82.8274°N 142.4677°E</p>	<p>1251</p>	<p>750</p>		<p>750</p>	<p>Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)</p>