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IODP Proposal Cover Sheet

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■ **New** ☐ **Revised** ☐ **Addendum**

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	Please check if this is Mission proposal ☐
Title:	ALASKAN BEAUFORT MARGIN: INVESTIGATING THE IMPACT OF WARMING SINCE THE LAST GLACIAL MAXIMUM ON CLIMATE-SENSITIVE SEDIMENTS IN THE ARCTIC
Proponent(s):	Carolyn Ruppel (USGS), Timothy Collett (USGS), Kai-Uwe Hinrichs (University of Bremen), Leonid Polyak (Ohio State), Julie Brigham-Grette (UMass), Paul Overduin (Alfred Wegener Institute), Marta Torres (Oregon State), Matthew Hornbach (Southern Methodist U), Frederick Colwell (Oregon State), Brandon Dugan (Rice University), John Pohlman (USGS), Matthew Wooller (UAF), Michael Whiticar (U Victoria, Canada),
Keywords: *(5 or less)*	Climate change, subsea permafrost, gas hydrate, Last Glacial Maximum — Area: Alaskan Beaufort shelf and slope

Contact Information:

Contact Person:	Carolyn Ruppel		
Department:	Coastal and Marine Geology/USGS Gas Hydrates Project		
Organization:	U.S. Geological Survey		
Address	384 Woods Hole Rd., Woods Hole MA 02543		
Tel.:	(508) 457-2339	Fax:	(508) 457-2310
E-mail:	cruppel@usgs.gov		

Permission to post abstract on IODP Web site: ■ Yes ☐ No

Abstract: (*400 words or less)*

The impact of past and future climate change on climate-susceptible phases (gas hydrates and permafrost) trapped in marginal marine sediments in the Arctic is a compelling problem with implications for global atmospheric methane levels, carbon cycling, ocean acidification/anoxia, and future warming on the Earth system over human timescales. Drilling across the Alaskan Beaufort passive margin from the shallow shelf (subsea permafrost and gas hydrate) to the upper continental slope (deepwater gas hydrate) provides an unprecedented opportunity to 'catch climate change in progress,' as explored in recent USSSP- and IODP-sponsored workshops. Since ~20 ka, inundation of circum-Arctic Ocean continental shelves due to sea level rise has led to thawing and landward retreat of flooded permafrost, dissociation of gas hydrate, and the onset of methane production in shallow sediments. Simultaneously, the feather edge of stability for the global upper continental slope gas hydrate system shifted upslope to re-equilibrate, although recent decades have seen warming of Arctic Ocean intermediate water and dissociation of these hydrates. Drill sites on the Alaskan Beaufort Sea shelf will be pinned to onshore locations where permafrost and gas hydrate have been well-characterized through prior non-IODP drilling. The shelf IODP sites will sample from nearshore relict subsea permafrost to the now permafrost-free outer shelf while also capturing a record of sea level changes and

paleoclimate back to the Pliocene. Drill sites from the shelf break (~100 m) seaward will sample across the upper feather edge of hydrate stability for the contemporary and LGM systems and downslope to the well-established, stable gas hydrate system in an area of widespread slope failures. The drilling will capture the two gas hydrate settings most vulnerable to climate-driven release of sequestered methane, produce the first high-quality reconstruction of post-LGM regional sea level fluctuations, provide terrestrial and marine proxies for Pliocene to Holocene paleoclimate studies, extend onshore geologic findings offshore, determine the response of microbiological communities to shifting salinity, temperature, and permafrost/hydrate states in the sediments, and constrain the complex hydrogeology associated with gas migration, freshwater and brine distribution in contemporary/former permafrost complexes, and fluid systems at the shelf break.

Addresses ISP challenges related to: #2 Sea Level; #4 Ocean chemistry changes; #5, #7 microbial life; #12 submarine slides; #13 carbon cycling; #14 fluid flow

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Scientific Objectives: (*250 words or less*)

A transect from the inner shelf to the upper continental slope on the Alaskan Beaufort Margin (ABM) will constrain how climate change that commenced at the end of the Last Glacial Maximum (warming and sea level rise) has affected climate-sensitive (permafrost and hydrate-bearing sediments) deposits in two Arctic settings that are also considered highly vulnerable to contemporary and future climate change. The goals are to:

(1) Determine the current and paleo-distribution of permafrost (shelf) and gas hydrate (shelf and upper slope) and constrain the rates of system response to climate perturbations since the Last Glacial Maximum by sampling the full thickness of relict subsea permafrost, areas where permafrost/hydrate has completely thawed/dissociated, and the out-of-equilibrium upper edge of gas hydrate stability on the upper continental slope.

(2) By coring sediments (as old as Pliocene) through which the permafrost and hydrate phase boundaries have migrated since the LGM, reconstruct paleoclimate for the Quaternary and Pliocene, using multiple proxies appropriate for high latitudes.

(3) Obtain a much-needed regional sea level curve by recovering the full thickness of Holocene and Late Pleistocene sediments.

(4) Determine the contributions of hydrate dissociation, new methane generation, and methane migration from depth to total methane and inform predictions of future methane emissions.

(5) Determine the distribution of fresh and briny pore fluids in the relict permafrost/thawed permafrost zones and how these flow systems interact with upper slope sediments.

(6) Study microbial communities in relict/thawed permafrost settings and across the re-equilibrating upper slope gas zone.

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

- This is a combined MSP and riserless program.
- Pressure coring and advanced pressure core analyses required, but non-IODP developments in industry/government hydrates drilling may be transferrable to IODP.
- Permafrost drilling at 1 MSP site, but the capabilities and technology exist (contact co-proponent Collett).

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ABM-01A (MSP)	70º 17.6N; -146º 9.05	20	600	0	600	Full thickness relict subsea permafrost
ABM-02A (MSP	70º 23N; -146º 2	30	600	0	600	Relict gas hydrate
ABM-03A (MSP)	70 º 43.8N; -145º 42.3	80	600 desired	0	600	Fully thawed/dissociated area with fairly complete Holocene drape
ABM-04A (JR)	70º 47.9N; -145º 38.6	100	600	0	600	LGM shoreline/maximum permafrost extent; full Holocene section and Plio-Pleistocene onlap units from upper slope
ABM-05A (JR)	70º 51.7N; -145º 34.4	200	300	0	300	Above current uppermost extent of slope gas hydrate
ABM-06A (JR)	70º 55.7N; -145º 32	350	300	0	300	Through upper feather edge of out-of-equilibrium, contemporary gas hydrate zone
ABM-07A (JR)	70º 57.5N; -145º 29.5	450	300	0	300	Through upper feather edge of LGM gas hydrate zone
ABM-8A (JR)	71º N; -145º 28.1	600	300	0	300	Through established gas hydrate zone, relatively unaffected by LGM to contemporary climate change
ABM-9A(JR)	71º 4N; -145º 20.9	1350	350	0	350	Complete Holocene to Late Pleistocene section on slope in slope-fill basin(?)