Title: Ultra-high resolution record of Alaskan Glacial and Ocean History – a 400-meter drill site off the Bering Glacier.

Proponent(s): Alan Mix, John Jaeger, Sean Gulick, Joe Stoner, Maureen Davies, Bruce Finney, Jason Addison, Lindsay Lowe Worthington

Keywords: Glaciation, climate variability, hypoxia, Alaska

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Permission to post abstract on IODP Web site: Yes

Abstract: (400 words or less)

ABSTRACT: This is an Ancillary Project Letter to add one drill site (preferably KB-1A, but as an alternate, KB-2A) to Proposal IODP-686-FULL; Drilling of Sediments from the Southern Alaska Continental Margin: 1 -- Interactions of Tectonics, Climate, and Sedimentation, submitted by J. Jaeger, E. Cowan, S. Gulick, P. Mann, T. Pavlis, R. Powell, K. Ridgeway, J. Spotilla, J. Stoner, A.C. Mix, N.G. Pisias. Site KB-1A (and alternate KB-2A) were surveyed at the same time as other sites in IODP-686-Full, and provide opportunities for an ultra-high-resolution paleoclimate study complementary to IODP-686-Full’s objectives, which focus primarily on the interaction of tectonics and climate. New results from study of a survey piston core EW0408-85JC adjacent to site KB-1A has recently revealed an extraordinary high-fidelity record of the dynamics of North Pacific climate and the deglacial transition in the northern Gulf of Alaska. A high quality magnetic record is also preserved at this site, which will be important for relative dating of older sediments beyond the range of radiocarbon. Piston core EW0408-85JC bottomed in glacial-marine sediments late within the Last Glacial Maximum, and contained surprisingly abundant foraminifera and diatoms that provide excellent chronological control and opportunities for paleoclimate study, even during the glacial-marine interval. Site KB-1A (or -2A) thus provides a unique opportunity to study the interaction of ice and ocean systems at sub-century scale, and thus addresses high-priority IODP themes related to rapid climate change in a relatively unstudied but climatically important region. With average sediment accumulation rates of about 2 m/ky (higher during glacial intervals), only drilling can reach full glacial sediments here; we hypothesize that a ~400m APC/XCB drill core would record about two full glacial cycles. Well-dated episodes of laminated sediments indicating sedimentary hypoxia track similar events throughout the North Pacific, and have been recently found in the Bering Sea (IODP Expedition 323); thus Site KB-1A (or -2A) will link past drilling results in the marginal sea into the open Pacific. Site KB-1A (or -2A) will establish the relationship between millennial-scale dynamics of Alaskan glaciation to regional and global climate. Addition of high-resolution site KB-1A to an Alaska Margin drilling program would add minimal transit time as it is located near existing high-priority sites in proposal IODP-686-Full.
Scientific objectives for drill site KB-1A (or KB-2A) are 1) to precisely constrain the timing of multiple glacial events of the Pacific side of the northern Cordilleran Ice Sheet, to test its relation to dynamics of the Laurentide Ice Sheet; 2) To understand the role of North Pacific surface temperatures as a control on the glacial system over late Pleistocene time, with decadal resolution in the glaciated and laminated intervals; 3) To understand the dynamics of productivity and intermediate water circulation (e.g., Okazaki et al., 2010) in the Northeast Pacific, and their role in global carbon cycle; 4) To assess potential linkage between the atmosphere-ocean-ecosystem system in the Gulf of Alaska and decadal scale variations (e.g., Mantua et al., 1997) in response to changing boundary conditions; 5) To document the interrelationship between paleomagnetic intensity and secular variation in the Pacific that will be compared with drilling-derived records from the Atlantic to facilitate a test of the hypothesis that heterogeneities of the lowermost mantle influence the structure of geodynamo and, therefore, the behavior of the geomagnetic field [Cox and Doell, 1964, Hide, 1967].

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

Quadruple drill-over APC using non-magnetic core barrels when possible, perhaps with alternation to XCB in intervals of ice-proximal sedimentation; similar methods were used on Bering Sea Exp. 323. We expect alternation between intervals of hemipelagic mud, organic-rich laminations, and glacial-marine sedimentation. Preservation of a complete section as whole-round cores for CT-scanning would be advantageous.

Proposed Sites:

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Position</th>
<th>Water Depth (m)</th>
<th>Penetration (m)</th>
<th>Brief Site-specific Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB-1A (primary)</td>
<td>59°33.32' N, 144°09.21'W</td>
<td>685</td>
<td>400 0 400</td>
<td>Glacial History, Ocean Climate Dynamics, Intermediate Water History, Paleo-geomagnetism</td>
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<tr>
<td>KB-2A (alternate)</td>
<td>59°31.93'N, 144°08.03'W</td>
<td>710</td>
<td>400 0 400</td>
<td></td>
</tr>
</tbody>
</table>
Scientific Rationale, Past Results:

Sites KB-1A and -1B were surveyed in a cruise of R/V Ewing in 2004 (Cruise EW0408; Alan Mix and John Jaeger, co-chief scientists). Geographic location relative to other proposed sites for IODP-686-FULL are shown in Fig. 1. The site is beneath the Alaska Coastal Current, ACC; Stabeno et al., 2004; Weingartner et al., 2005) at depths associated with North Pacific Intermediate Water. The site is on a relatively flat bank, on the continental slope above Khitrov Basin and Ridge. Although not formally named, we refer to the feature as Khitrov Bank, with initials “KB”.

High-resolution swath bathymetry from cruise EW0408 is in Fig. 2, and multichannel seismic (MCS) data (reprocessed and updated from Worthington et al., 2008) are shown in Fig. 3. Preferred Site KB-1A is in a zone of rapid sediment accumulation; based on the deglacial stratigraphy and dating of core EW0408-85JC, we hypothesize that the more strongly reflective intervals with high acoustic impedance are near the bases of interglacial or interstadial events (low density and biogenic rich, with meter-scale layering, overlying glacial-marine units (massive
high-density intervals, with some structure but relatively little organized acoustic contrast). We infer that the large scale seismic structures, spaced roughly 0.3 seconds apart, reflect the 100kyr cycle of glaciation; if so, average sediment accumulation rates are about 2 m/ka (likely higher in glacial time, lower in interglacial time), consistent with modern rates in ice-influenced systems (Jaeger et al., 1998). This implies that 400 m of drilling would capture about two glacial cycles.

**Sediment core EW0408-85JC has been studied via** CT-scanning, stable isotopes and radiocarbon in foraminifera, (Davies et al., submitted 2010; Paleoceanography; Fig. 4), for siliceous fossil content, and redox-related sediment chemistry (Barron et al, 2009), and for its record of paleoproduction and nutrient utilization (Addison et al., submitted, 2010). Additional studies of efficacy of organic biomarkers and other biogenic proxies in this core and the general region, based on results of Site Survey cruise EW0408 are published by Walinsky et al. (2009) and Prahl et al., (2010).
Preliminary paleomagnetic results suggest that the proposed site records geomagnetic field variability consistent on sub-millennial scales with independently dated Holocene paleosecular variation records from Alaskan Lakes (Geiss and Banerjee, 2003). These results also agree with paleointensity results from the St. Lawrence estuary (St-Onge et al., 2003), implying coherent North American flux lobe behavior and a stratigraphically-useful paleomagnetic record from the proposed site (Davies et al., 2009). Long paleomagnetic timeseries constrained by independent chronologies from radiocarbon dating and stable isotope stratigraphies would allow Pacific paleomagnetic secular variation and relative paleointensity to be compared with the many records from the Atlantic (e.g., Channell et al., 1999, 2006, Stoner et al., 2000, Lund et al., 2005). Outside of reversals and

Figure 3 - MCS Seismic data from line GOA3101. The preferred drill site KB-1A is to the left (northwest) of the faulted region in a subsiding basin (from Worthington et al., 2008) at CDP 260 on MCS Line GOA3101 south of piston core EW0408-85JC. Proposed penetration of 400 m would likely recover sediments from a few late Pleistocene glacial-interglacial cycles; less reflective intervals are interpreted as relatively massive glacial-marine sediments; more reflective intervals are likely associated with high contrast between biogenic-rich hemipelagic sediments and glacier-influenced sediments. Alternate site KB-2A is located on the crossing line 3102, but is located in a heavily faulted zone (Worthington et al., 2008) and although of interest for structural analysis it is not attractive as a paleoceanographic site. There is no evidence for gas.
excursions, few of these studies have focused on the directional record, having concentrated on relative paleointensity. By linking paleomagnetic directions and intensity between these regions we will be able to assess geomagnetic persistence, a signature of the mantle’s influence on the geodynamo and the paleomagnetic record (Gubbins et al., 2007; Stoner, 2009; Amit et al., 2010).

The detailed radiocarbon chronology of high-accumulation rate core EW0408-85JC and its associated trigger core and multicore provide an opportunity to place regional climate changes into a global chronostratigraphic framework. Deglacial warming and freshening of the Gulf of Alaska was coeval with the onset of Bølling interstadial warmth in the North Atlantic and Greenland. North Pacific cooling during Allerød interstadial time may reflect the influence of the Antarctic Cold Reversal, likely transmitted via the subsurface ocean. This suggests the potential for both Southern Hemisphere and Northern Hemisphere influences on North Pacific climate systems (Lund and Mix, 1998; Mix et al., 1999). Retreat of the Cordilleran Ice Sheet in the northeastern Gulf of Alaska began by 16,650 ±
170 cal ybp, based on apparent salinity reductions recorded in planktonic foraminiferal $\delta^{18}O$ and a decrease in the rate of glacial-marine sediment accumulation. The transition from the ice-proximal to laminated hemipelagic sediments at 14,790 ± 380 ybp marks the retreat of glaciers either behind sills or onto land; concomitant with these $d^{18}O$ changes are drastic fluctuations in ecosystem productivity proxies suggesting a tight linkage between regional ocean-atmosphere dynamics and the marine ecosystem, Intervals of low $\delta^{18}O$ in planktonic and benthic foraminifera reflects regional freshwater input from retreating glaciers and possible injection of low-salinity water to 580 m paleodepth driven by brine formation on the shelf, hyperpycnal flows associated with rapid glacier melting, or catastrophic release of ice-dammed lakes such as Lake Atna through Copper River and Cook Inlet (Wiedmer et al., 2010).

Productivity maxima drove sedimentary hypoxia and laminated sediments occur between 14,790 ± 380 to 12,990 ± 190 cal ybp and between 11,160 ± 130 to 10,750 ± 220 cal ybp. These productivity events likely correlate with events observed around the rim of the North Pacific (e.g., Mix et al, 1999). The high-resolution chronology links these events to episodes of global sealevel rise, leading Davies et al. (submitted) to conclude that remobilization of iron and other limiting nutrients from continental shelves and inundated estuaries during sealevel rise (e.g., Lam and Bishop, 2008; Severmann et al., 2010) contribute to events of productivity and hypoxia around the margins of the North Pacific. To assess this hypothesis will require finding similar events associated with earlier sealevel rises, a goal that demands drilling.

In summary, we propose 400-m penetration at site KB-1A (or -2A) in the Gulf of Alaska, which we expect will recover sediments from the last two glacial cycles at ultra-high resolution. Site KB-1A (or -2A) will complement the goals of 686-Full Site GOAL16B a deep-water site on Surveyor Fan. GOAL16B will record a longer record of sediment output from the Bering Glacier region, but at lower resolution and with less potential for continuous dating; the combination of these two sites will leverage off each other to provide two temporal perspectives on the same system. This APL presents a unique opportunity to obtain a closeup view of ice-ocean interactions at sub-century scales because at this site glacial-marine sediments are intercalated with hemipelagic sediments; both sediment types are rich in fossils suitable for isotope and geochemical study, and offer the potential for a high-resolution paleomagnetic record; together these tools will provide a reliable stratigraphy and chronology, and tracers of ocean-ice interaction.
References Cited:
Cox, A. and R.R. Doell, 1964, Long period variations of the geomagnetic field, Bulletin of the Seismological Society of America; December 1964; v. 54; no. 6B; p. 2243-2270
Davies, M.H., A.C. Mix, J.S. Stoner, J.A. Addison, J. Southon, 2010. The deglacial transition on the SE Alaskan Margin: meltwater input, sealevel rise, enhanced productivity, and sedimentary hypoxia, Paleoceanography (submitted)
Hide, R. 1967, Motions of the Earth's Core and Mantle, and Variations of the Main Geomagnetic Field, Science 157/3784, 55-56
Lam, P.J., and J.K.B. Bishop (2008), The continental margin is a key source of iron to the HNLC


Stabeno, P.J., N.A. Bond, A.J. Hermann, N.B. Kachel, C.W. Mordy, J.E. Overland (2004), Meteorology and oceanography of the Northern Gulf of Alaska, Continental Shelf Research, 24,


<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>email</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alan C. Mix</td>
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</tr>
<tr>
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<td>Paleomagnetism, sedimentation</td>
</tr>
<tr>
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<td>College of Oceanic &amp; Atmos. Sci., 104 COAS Admin Bldg., Oregon State University</td>
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<td>Paleoceanography, Paleomagnetism</td>
</tr>
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</tr>
<tr>
<td>Sean P. S. Gulick</td>
<td>Univ. Texas Institute for Geophysics 10100 Burnet Rd Bldg 196 (R2200)</td>
<td><a href="mailto:sean@utig.ig.utexas.edu">sean@utig.ig.utexas.edu</a></td>
<td>Geophysics, Seismic Reflection, Tectonics</td>
</tr>
<tr>
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<td>Austin, Texas 78758-4445 USA</td>
<td><a href="mailto:lindsay@ig.utexas.edu">lindsay@ig.utexas.edu</a></td>
<td>Geophysics, Seismic Reflection, Tectonics</td>
</tr>
<tr>
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<td>USGS, 345 Middlefield Rd Menlo Park, CA 94025-3561 USA</td>
<td><a href="mailto:jaaddison@alaska.edu">jaaddison@alaska.edu</a></td>
<td>Sediment Geochemistry, Alaska</td>
</tr>
<tr>
<td>Bruce P. Finney</td>
<td>Biological Sciences, Idaho State University</td>
<td><a href="mailto:finney@isu.edu">finney@isu.edu</a></td>
<td>Biogeochemistry</td>
</tr>
</tbody>
</table>
IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 7 March 2002

Section A: Proposal Information

Title of Proposal:
Ultra-high resolution record of Alaskan Glacial and Ocean History – a 400-meter drill site off the Bering Glacier.

Date Form Submitted:
9-30-10

Site Specific Objectives with Priority (Must include general objectives in proposal)
1) constrain the timing of multiple glacial events of the northern Cordilleran Ice Sheet, to test its relation to dynamics of the Laurentide Ice Sheet and climate;
2) test role of North Pacific surface temperatures control of late Pleistocene glaciation, sub-century scale;
3) document dynamics of productivity and intermediate water circulation in the Northeast Pacific
4) document paleomagnetic intensity and secular variation in NE Pacific to test hypothesis that lowermost mantle heterogeneities influence Earth’s magnetic field

List Previous Drilling in Area:
none

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)

<table>
<thead>
<tr>
<th>KB-1A (primary)</th>
<th>KB-2A (alternate)</th>
<th>If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deg: 59° 59°</td>
<td>Min: 33.32’ N (-1A)</td>
<td>31.93’ N (-2A)</td>
</tr>
<tr>
<td>Deg: 144° 144°</td>
<td>Min: 09.21’W (-1A)</td>
<td>08.03’W (-2A)</td>
</tr>
</tbody>
</table>

Area or Location: SE Alaska, North Pacific

Jurisdiction: US

Distance to Land: ~ 50 nm

Coordinates System: WGS 84, Other ( )

Water Depth: 685 (prim) 710 (alt) m

Priority of Site: Primary: 1 Alt: 2
### Sediments

<table>
<thead>
<tr>
<th>Proposed Penetration:</th>
<th>Sediments</th>
<th>Basement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(m)</td>
<td>400 m</td>
<td>0 m</td>
</tr>
</tbody>
</table>

What is the total sed. thickness? [ ] >1 km  [ ] m

Total Penetration: 400 m

### General Lithologies:

Hemipelagic, intercalated with glacial-marine with small pebbles

### Coring Plan:

**Coring Plan:**

1-2-3-APC □ VPC* □ XCB □ MDCB* □ PCS □ RCB □ Re-entry □ HRGB

**Coring Plan:**

4-APC, XCB

### Wireline Logging Plan:

#### Standard Tools

- Neutron-Porosity □
- Litho-Density □
- Gamma Ray □
- Resistivity □
- Acoustic □
- Formation Image □

#### Special Tools

- Borehole Televiwer □
- Nuclear Magnetic Resonance □
- Geochemical □
- Side-Wall Core Sampling □
- Formation Fluid Sampling □
- Borehole Temperature & Pressure □
- Borehole Seismic □
- Acoustic □

#### LWD

- Density-Neutron □
- Resistivity-Gamma Ray □

### Max. Borehole Temp.:

Expected value (For Riser Drilling)

\[ \text{Expected value} \times \text{°C} \]

### Mud Logging:

Cuttings Sampling Intervals

- from _____ m to _____ m, _____ m intervals
- from _____ m to _____ m, _____ m intervals

Basic Sampling Intervals: 5m

### Estimated days:

- Drilling/Coring:  
- Logging:  
- Total On-Site:

### Future Plan:

Longterm Borehole Observation Plan/Re-entry Plan

### Hazards/Weather:

Please check following List of Potential Hazards

- Shallow Gas □
- Hydrocarbon □
- Shallow Water Flow □
- Abnormal Pressure □
- Man-made Objects □
- H₂S □
- CO₂ □

- Complicated Seabed Condition □
- Soft Seabed □
- Currents □
- Fractured Zone □
- Fault □
- High Dip Angle □

- Hydrothermal Activity □
- Landslide and Turbidity Current □
- Methane Hydrate □
- Diapir and Mud Volcano □
- High Temperature □
- Ice Conditions □

What is your Weather window? (Preferable period with the reasons)

**Summer**
## IODP Site Summary Forms:

**Proposal #:** Site #: KB-1A, KB-2A  **Date Form Submitted:** 9/30/10

<table>
<thead>
<tr>
<th>Data Type</th>
<th>SSP Requirements</th>
<th>Exists In DB</th>
<th>Details of available data and data that are still to be collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>High resolution seismic reflection</td>
<td></td>
<td></td>
<td>Primary Line(s): GOA3101 CDP 250 (primary) CDP640 (alt) Crossing Lines(s): GOA3102 (alt) Lines being reprocessed, will be uploaded to SSDB in October GOA3101.jpg GOA3102.jpg</td>
</tr>
<tr>
<td>Deep Penetration seismic reflection</td>
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<td></td>
<td>Primary Line(s): Location of Site on line (SP or Time only) Crossing Lines(s):</td>
</tr>
<tr>
<td>Seismic Velocity†</td>
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<td></td>
</tr>
<tr>
<td>Seismic Grid</td>
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<tr>
<td>Refraction (surface)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refraction (near bottom)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5 kHz</td>
<td></td>
<td></td>
<td>Location of Site on line (Time)</td>
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<tr>
<td>Swath bathymetry</td>
<td></td>
<td></td>
<td>EW0408, EM1002 high-resolution bathy. KB1_EM1002.jpg</td>
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<tr>
<td>Side-looking sonar (surface)</td>
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<tr>
<td>Side-looking sonar (bottom)</td>
<td></td>
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<tr>
<td>Photography or Video</td>
<td></td>
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<tr>
<td>Heat Flow</td>
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<tr>
<td>Magnetics</td>
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<tr>
<td>Gravity</td>
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<tr>
<td>Sediment cores</td>
<td></td>
<td></td>
<td>EW0408-85JC</td>
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<tr>
<td>Rock sampling</td>
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<tr>
<td>Water current data</td>
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<td>Ice Conditions</td>
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<tr>
<td>OBS microseismicity</td>
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<tr>
<td>Navigation</td>
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<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SSP Classification of Site:** **SSP Watchdog:** **Date of Last Review:** **SSP Comments:**
X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites;
R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required
for holes deeper than 400m.
### IODP Site Summary Forms:

**Proposal #:** Site #: KB-1A, KB-21  
**Date Form Submitted:** 9-30-10

<table>
<thead>
<tr>
<th>Measurement Type</th>
<th>Scientific Objective</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutron-Porosity</td>
<td>Core-log integration -- standard</td>
<td>1</td>
</tr>
<tr>
<td>Litho-Density</td>
<td>Core-log integration-- standard</td>
<td>1</td>
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<tr>
<td>Natural Gamma Ray</td>
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<tr>
<td>Resistivity-Induction</td>
<td></td>
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<tr>
<td>Acoustic</td>
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<tr>
<td>FMS</td>
<td>Core-log integration-- standard</td>
<td>2</td>
</tr>
<tr>
<td>BHTV</td>
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<tr>
<td>Resistivity-Laterolog</td>
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<tr>
<td>Magnetic/Susceptibility</td>
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<tr>
<td>Density-Neutron (LWD)</td>
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<td></td>
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<tr>
<td>Resistivity-Gamma Ray</td>
<td></td>
<td></td>
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<tr>
<td>(LWD)</td>
<td></td>
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</tr>
<tr>
<td>Other: Special tools (CORK, PACKER, VSP, PCS, FWS, WSP)</td>
<td>Discussion of optimal logging plan needed.</td>
<td></td>
</tr>
</tbody>
</table>

**Do you need to use the conical side-entry sub (CSES) at this site?** Yes [ ] No [x]  
**Are high temperatures expected at this site?** Yes [ ] No [x]  
**Are there any other special requirements for logging at this site?** Yes [ ] No [ ]  

If “Yes” Please describe requirements:________________________

What do you estimate the total logging time for this site to be:_________  
Depends on penetration

For help in determining logging times, please contact the ODP-LDEO Wireline Logging Services group at:  
borehole@ldeo.columbia.edu  
http://www.ldeo.columbia.edu/BRG/brg_home.html  
Phone/Fax: (914) 365-8674 / (914) 365-3182

Note: Sites with greater than 400 m of penetration or significant basement penetration require deployment of standard toolstrings.
<table>
<thead>
<tr>
<th></th>
<th>Summary of Operations at site: (Example: Triple-APC to refusal, XCB 10 m into basement, log as shown on page 3.)</th>
<th>Quad APC to refusal, XCB to 400m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Based on Previous DSDP/ODP drilling, list all hydrocarbon occurrences of greater than background levels. Give nature of show, age and depth of rock:</td>
<td>None known</td>
</tr>
<tr>
<td>3</td>
<td>From Available information, list all commercial drilling in this area that produced or yielded significant hydrocarbon shows. Give depths and ages of hydrocarbon-bearing deposits.</td>
<td>None known</td>
</tr>
<tr>
<td>4</td>
<td>Are there any indications of gas hydrates at this location?</td>
<td>no</td>
</tr>
<tr>
<td>5</td>
<td>Are there reasons to expect hydrocarbon accumulations at this site? Please give details.</td>
<td>no</td>
</tr>
<tr>
<td>6</td>
<td>What “special” precautions will be taken during drilling?</td>
<td>normal</td>
</tr>
<tr>
<td>7</td>
<td>What abandonment procedures do you plan to follow:</td>
<td>normal</td>
</tr>
<tr>
<td>8</td>
<td>Please list other natural or manmade hazards which may effect ship’s operations: (e.g. ice, currents, cables)</td>
<td>Marine mammals, weather in Gulf of Alaska.</td>
</tr>
<tr>
<td>9</td>
<td>Summary: What do you consider the major risks in drilling at this site?</td>
<td>Normal.</td>
</tr>
<tr>
<td>Sub-bottom depth (m)</td>
<td>Key reflectors, Unconformities, faults, etc</td>
<td>Age</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>0-400</td>
<td>misc</td>
<td>pleist</td>
</tr>
</tbody>
</table>
IODP Site Summary Forms: Form 6 – Lithologic Summary

High-resolution EM1002 swath bathymetry (From Cruise EW0408) in the vicinity of the proposed drill sites (and core site EW0408-85JC) plotted atop the NOAA bathymetric chart. Proposed drill site KB-1A is just south of the site cored, at 685 m water depth, KB-2A on the crossing point of seismic lines GOA3101 and GOA3102, 710 m water depth. Downslope sediment transport (from upper left) appears to be shunted by small channels into deeper water at the right (eastward), leaving modern hemipelagic sediment (and past glacial-marine sediment) accumulating on the outer (southern) portions of this bank, in a slope basin. File KB1_EM1002.jpg

Figure 3 - MCS Seismic data from line GOA3101. The preferred drill site KB-1A is to the left (northwest) of the faulted region in a subsiding basin (from Worthington et al., 2008) at CDP 260 on MCS Line GOA3101 south of piston core EW0408-85JC. Proposed penetration of 400 m would likely recover sediments from a few late Pleistocene glacial-interglacial cycles; less reflective intervals are interpreted as relatively massive glacial-marine sediments; more reflective intervals are likely associated with high contrast between biogenic-rich hemipelagic sediments and glacier-influenced sediments. Alternate site KB-2A is located on the crossing line 3102, but is located in a heavily faulted zone (Worthington et al., 2008) and although of interest for structural analysis it is not attractive as a paleoceanographic site. There is no evidence for gas. Lines being reprocessed, will be uploaded to SSDB in October 2010. Files GOA3101.jpg GOA3102.jpg