IODP Proposal Cover Sheet

961 - APL 2

Gulf of Mexico Glacier-Methane Link

Received for: 2019-10-01

Title	Linking sediment deposition during glacial cycles and methane hydrate occurrence
Proponents	Ann Cook, Alex Portnov, Alberto Malinverno, Steve Phillips, Kaustubh Thirumalai , Elsa Arellano Torres, Rick Colwell, Evan Soloman, Jess Hillman, Karen Weitemeyer, Peter Flemings
Keywords	glacial cycles, methane hydrate
Area	northern Gulf of Mexico

Proponent Information

Proponent	Ann Cook
Affiliation	Ohio State University
Country	United States

☑ Permission is granted to post the coversheet/site table on www.iodp.org

Abstract

Methane hydrate is an ice-like clathrate composed of CH4 and H2O found within sediments on continental slopes worldwide; however, our ability to locate and quantify the amount of hydrate below the seafloor is poor. Herein, we hypothesize that increased organic carbon deposited during glacial sea level lowstands could explain hydrate accumulations in laterally extensive marine mud units worldwide. If true, this may provide a new approach to identifying and quantifying low-concentration hydrate below the seafloor. The eustatic sea level decrease during glaciations increases the concentration and preservation of particulate organic carbon, which may be caused by higher sediment supply, shelf bypass, and higher marine biological productivity. Over time, the labile fraction of organic carbon in marine mud is consumed by microbes and eventually causes the reactions that generate methane. As more methane is generated, the dissolved methane concentration in the pore water eventually reaches solubility, and methane hydrate forms within marine mud.

We propose to test this hypothesis in the hydrate-bearing Mendenhall marine mud unit located in the Terrebonne minibasin on the northern Gulf of Mexico continental slope. At Terrebonne, we are able to leverage several existing datasets, including high resolution 2D seismic and two logging-while-drilling (LWD) scientific boreholes which measure the laterally extensive Mendenhall Unit. Modeling suggests this unit could be related to the Wisconsin glacial lowstand, ~75-11 ka.

At three sites, we will APC to 152 mbsf to determine the concentration of labile and refractory organic carbon, sediment age, glacial cycles and sedimentation rates as well as characterize the pore water geochemistry, gas geochemistry and the microbial communities in and around the Mendenhall Unit. To identify the occurrence of gas hydrate, we will use existing LWD data, infrared camera images of core and pore water geochemistry. We will integrate all of these datasets to test the hypothesis that the increased preservation of particulate organic carbon during glacial sea level lowstands affects the occurrence of methane hydrate in marine muds.

In this APL resubmission, we have addressed all reviewer concerns, and fixed problems with seismic positioning and well location. The most significant changes to the APL include increased coring (each site now has three planned coring holes) and the removal of wireline logging. We have also added two proponents with expertise in paleoceanography. Additional details on the geochemistry and microbiology measurements and sampling plans are included briefly here and in the Site Forms.

961 - APL 2

Scientific Objectives

Our objective its to test the hypothesis that laterally extensive hydrate bearing marine mud units are related to increased organic carbon concentration and preservation occurring during glacial sealevel lowstands. At three sites in the Terrebonne minibasin, we will investigate the Mendenhall Unit, a laterally extensive marine mud unit containing low concentration gas hydrate in near-vertical fractures. We propose to collect continuous sediment core at three holes at each site through the Mendenhall Unit to determine the concentration of labile and refractory organic carbon, sediment age, and sedimentation rates as well as characterize the pore water geochemistry, gas geochemistry and the microbial communities. To identify the occurrence of gas hydrate, we will use LWD data, pore water geochemistry and infrared camera images of core.

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

We request to use inferred cameras to image the temperature of the core directly after core recovery, especially at Sites TB-02A and TB-03A.

961 - APL 2

Proposed Sites (Total proposed sites: 4; pri: 3; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TB-01A (Primary)	26.6628 -91.6762	1966	152	0	152	Site TB-01A will serve as a control site to TB-02A and and TB-03A, where little to no gas hydrate is observed and the Mendenhall Unit thins or pinches out. We will core this site to 152 mbsf twice, for holes 'A' and 'B' which will allow sampling and dating of the stratigraphy surrounding the Mendenhall Unit. In addition, we will collect heat flow measurements in the 'A' hole. We will also collect a second core in the 'C' hole to ~50 mbsf for high resolution geochemistry and microbiology though the sulfate-methane transition zone.
TB-02A (Primary)	26.6633 -91.6842	1999	152	0	152	At Site TB-02A, we will core to 152 mbsf through the Mendenhall Unit to characterize the gas hydrate, organic carbon, collect heat flow measurements and develop a sediment age-glacial cycle model in the 'A' and 'B' hole. We will also collect core in a third 'C' hole to 30 mbsf for high resolution geochemistry and microbiology though the sulfate-methane transition zone. The 'C' hole is the shallowest of the 3 primary sites because we observe hydrate in the LWD data at this site at 27 mbsf.
TB-03A (Primary)	26.6615 -91.6862	2004	152	0	152	At Site TB-03A, we will core to 152 mbsf through the Mendenhall Unit to characterize the gas hydrate, organic carbon, collect heat flow measurements and develop a sediment age-glacial cycle model in the 'A' and 'B' hole. We will also collect core in a third 'C' hole to ~40 mbsf for high resolution geochemistry and microbiology though the sulfate-methane transition zone. This site will help establish the lateral variability of the Mendenhall Unit.
TB-04A (Alternate)	26.6632 -91.6800	1988	152	0	152	TB-04A is an alternate site if a primary site is not available. It is located about halfway between TB-01A and TB-02A. Objectives at this site may be different depending on what primary site/sites were cored. This site could be more focused on Mendenhall Unit characterization, or dating stratigraphy surrounding the Mendenhall Unit, for example.