IODP Proposal Cover Sheet

Gulf of Mexico Methane Hydrate

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Title	Genesis of Methane Hydrate in Coarse-Grained Systems: Northern Gulf of Mexico Slope
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Abstract

Marine methane hydrates play a significant role in the Earth's carbon cycle, could be a future source of economic natural gas, and may cause or influence submarine geohazards. Herein, we propose a drilling, well logging and coring scientific plan to investigate methane hydrates in coarse-grained systems in the Gulf of Mexico. While previous scientific ocean drilling, such as Leg 204 at Hydrate Ridge and Expedition 311 on Cascadia Margin concentrated on methane hydrates in fine-grained reservoirs, we choose to focus on coarse-grained systems because they are poorly understood and lack in situ samples, though they often have much larger concentrations of methane hydrates than fine-grained systems.

Our program proposes five drilling locations in the northern Gulf of Mexico, with either known or potential methane hydrate coarse-grained reservoirs. At each location, we propose a combination of well logging, pressure coring, conventional coring, penetrometer deployments, and in situ or pressure core testing to investigate the methane hydrate system. Well logs will measure the in situ physical properties of coarse-grained methane hydrate reservoirs. Pressure cores will preserve methane hydrate samples, providing samples for further testing and imaging. In addition, mini pressure drawdown tests will be performed on pressure core samples to observe how coarse-grained systems respond to perturbation. At least one drilling location will be selected to perform an in situ pressure draw down to obtain measurements of permeability and formation strength.

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Scientific Objectives

Our proposed drilling, coring, and testing plan will acquire data to better understand the sources and migration of methane in marine hydrate systems, the physical properties of methane hydrate in coarse-grained sediments, the geochemistry and microbiology associated with coarse-grained methane hydrate deposits, and the response of methane hydrate systems to perturbation. We aim to address three key questions:

1. What is the thermodynamic state of methane hydrates in a coarse-grained system?
2. What controls the genesis of methane hydrates in coarse-grained sedimentary systems?
3. What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?

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

Non-standard measurements including shipboard pressure coring and testing systems, state-of-the-art wireline logging tools, logging- and pressure-while-drilling tools (at previously undrilled sites), and sterile laboratories for microbiological subsampling. For pressure coring, the Aumann PCTB tool, Geotek PCATS system, and systems such as Georgia Tech IPTC/ESC testing chambers will be used. Large-diameter logging tools include NMR, FMI, and MDT borehole packer/fluid sampler; the new Blohm+Voss handling system and 6-5/8”drill pipe will be used.

Proposed Sites

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TBONE-01A	26.6628, -91.6762	1966	940	0	940	Sampling, pressure coring and testing in the well-defined "orange" sand will determine : 1) how petrophysical characteristics affect hydrate formation and concentration; 2) whether hydrate forms from bubbles or from dissolved methane in solution; 3) permeability as a function of hydrate saturation and disassociation; 4) the stability of deposits over decadal time scales; 5) the in-situ properties of high-saturation hydrate deposits. Secondary objectives within the “blue” sand (thinner sand layers with higher clay content), are to examine transport mechanisms at different pressures within the hydrate stability zone and determine the distribution of microbial and/or thermogenic methane sources.
TBONE-02A	26.6604, -91.6742	1940	940	0	940	Primary objectives are the same as for

-	-	-	-	-	-	TBONE-01A.(methane hydrate occurrences in coarse-grained systems, the dynamics of these systems over varying time and spatial scales, and the responses of hydrate deposits to natural and induced perturbations) Drilled ~330m updip from TBONE-01A, this site will allow to make crucial observations of the spatial changes in the blue and orange sand as it thins updip, as well as the penetration of a new sand layer that may contain methane hydrate refered to as the green sand.
TBONE-03A	26.6632, -91.6839	1990	990	0	990	Primary objectives are the same as for TBONE-01A and TBONE-02A (methane hydrate occurrences in coarse-grained systems, the dynamics of these systems over varying time and spatial scales, and the responses of hydrate deposits to natural and induced perturbations. TBONE-03A provides an opportunity to investigate the blue sand closer to the base of the hydrate stability than in TBONE-01A and TBONE-02A. While still made of thin interbbed layers, the sand is thicker and at higher pressure, and comparison with the updip sites will provide insight into the dynamics and transport mechanisms of the reservoir.
SIGSB-01A	27.0009, -90.4265	2033	580	0	580	A twin to Hole GC955-H, SISSB-01A will allow to test our various hypothesis regarding the reservoir characteristics that control gas hydrate formation and concentration: the pattern of hydrate occurrence may be controlled by a broad combination of grain size, lithology, faulting, permeability, and variations in methane source. This site we will allow to examine methane transport mechanisms and methane source within the hydrate stability zone and to evaluate whether hydrate forms from bubbles or from dissolved methane in solution. Finally, comparison with JIP II data will determine if the deposit has remained stable over decadal time scales.
PERDI-01A	26.1491, -95.0261	2155	459	0	459	AT PERDIDO-01A, we propose coring and logging at location of previously drilled/logged industry locations to answer: 1. What is the thermodynamic state of methane hydrates in a coarse-grained system? 2. What controls the genesis of methane hydrates in coarse-grained sedimentary systems? 3. What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?
ORCAB-01A	26.8918, -91.374	2332	772	0	772	AT ORCA-01A, we propose coring and logging at new location (not re-drills of

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ORCAB-02A	26.8981, -91.3669	2442	913	0	913	AT ORCA-02A, we propose coring and logging at new location (not re-drills of industry wells) to answer: 1. What is the thermodynamic state of methane hydrates in a coarse-grained system? 2. What controls the genesis of methane hydrates in coarse-grained sedimentary systems? 3. What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?
ORCAB-03A	26.8555, -91.3312	1863	619	0	619	AT ORCA-03A, we propose coring and logging at new location (not re-drills of industry wells) to answer: 1. What is the thermodynamic state of methane hydrates in a coarse-grained system? 2. What controls the genesis of methane hydrates in coarse-grained sedimentary systems? 3. What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?
ORCAB-04A	26.8518, -91.3355	1772	695	0	695	AT ORCA-04A, we propose coring and logging at new location (not re-drills of industry wells) to answer: 1. What is the thermodynamic state of methane hydrates in a coarse-grained system? 2. What controls the genesis of methane hydrates in coarse-grained sedimentary systems? 3. What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?
MADOG-01A	27.1714, -90.3366	1400	648	0	648	Sampling, pressure coring and testing in the dipping, laterally continuous horizon, H-1, will determine : 1) how petrophysical characteristics affect hydrate formation and concentration; 2) whether hydrate forms from bubbles or from dissolved methane in solution; 3) permeability as a function of hydrate saturation and disassociation; 4) the stability of deposits over decadal time scales; 5) the in situ properties of high-saturation hydrate deposits.
MADOG-02A	27.1676, -90.3333	1472	607	0	607	Primary objectives are the same as for MADOG-01A.(methane hydrate occurrences in coarse-grained

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