IODP Proposal Cover Sheet

Creeping Gas Hydrate Slides

841 - Apl 2

Title	Creeping Gas Hydrate Slides: Slow Deformation of Submarine Landslides on the Hikurangi Margin
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Abstract

Submarine slides are thought to occur as catastrophic events, and as such pose a significant geohazard potentially causing tsunamis and damaging seafloor installations. Dissociation of gas hydrate to overpressured gas and water has long been proposed as a driver of seafloor destabilization; however, clear evidence for this process has yet to be found. We now see evidence that gas hydrate itself may lead to seafloor weakening through creeping seafloor deformation.

Slow deformation is common in terrestrial landslides, but has only been recently documented for submarine systems in the Tuaheni Landslide Complex (TLC) east of New Zealand's North Island. The TLC displays morphological features that are typical of active, creeping terrestrial slides, and intriguingly, the upper limit of creeping coincides with the feather edge of gas hydrate stability.

We hypothesize that interstitial gas hydrate, like ice, may exhibit viscous behaviour leading to slow deformation as observed in terrestrial rock glaciers. We have acquired geophysical data (including a recent 3-D seismic survey) and are planning remote drilling with the MeBo-200 system in 2016 to study creeping deformation of the TLC. To complete our testing of the role of gas hydrates in creeping, we require undisturbed (pressurized) gas-hydrate-bearing samples for subsequent laboratory studies. In-situ pore pressure measurements are essential to rule out alternative hypotheses of overpressure-driven sliding. This requires use of the JOIDES Resolution (JR) with its reliable pressure-coring and laboratory-transfer capabilities (to minimize the risk of gas hydrate dissociation and re-formation), robust logging-while drilling (LWD) tools, and state-of-the art pressure-temperature penetrometers.

IODP drilling has been approved in principle for our study area (Proposal 781A-Full). We wish to use this opportunity to test our hypothesis and propose a four-day drilling program to 1) conduct LWD, including pressure-while-drilling, 2) deploy pressure-temperature penetrometers to calibrate LWD pore-pressure data, and 3) retrieve samples with pressure cores for detailed shore-based analyses of the gas hydrate habitat and long-term deformation tests.

LWD deployment is already planned for 781A-Full while penetrometers are supported by IODP. We have allocated external baseline funding to support pressure coring and are seeking further support outside IODP. Our proposed proof-of-concept study is expected to shed light on a new mechanism for submarine sliding that could constitute a paradigm shift for the effect of gas hydrates on seafloor stability with significant implications for Challenges 12 (earthquakes, landslides, tsunamis), 13 (flow of carbon) and 14 (fluids) of the IODP 2013-2023 Science Plan.

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Scientific Objectives

We plan to test the following hypotheses comprising three possible mechanisms that relate gas hydrate to slow deformation and as antithesis, a process that does not involve gas hydrates:
H1: Do interstitial gas hydrates in sediments of the active Tuaheni Landslide Complex lead to creeping, viscous seafloor deformation (main hypothesis)?
H2: Does overpressure at the base of gas hydrate stability lead to hydrofracturing, seafloor weakening, and creeping within the gas hydrate zone (alternative hypothesis)?
H3: Does overpressure at the base of gas hydrate stability lead to creeping beneath the gas hydrate zone (alternative hypothesis; variation of conventional hypothesis).
A: Is the active Tuaheni Landslide Complex caused by repeated small-scale failure associated with build-up and release of overpressure (antithesis)?

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

Pressure coring

Proposed Sites

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TLC-03B	-38.826701, 178.503063	679	180	0	180	Determine properties of gas-hydrate-bearing sediments outside slide mass.
TLC-08A	-38.821152, 178.50454	679	160	0	160	Determine properties of gas-hydrate-bearing sediments outside slide mass.
TLC-09A	-38.851043, 178.466011	663	200	0	200	Determine properties of gas-hydrate-bearing sediments outside slide mass.
TLC-02B	-38.787887, 178.448318	559	200	0	200	Determine if gas hydrate or free gas present. Determine potential overpressure.
TLC-06A	-38.772925, 178.455337	539	200	0	200	Determine if gas hydrate or free gas present. Determine potential overpressure.
TLC-07A	-38.780844, 178.474295	602	180	0	180	Determine if gas hydrate or free gas present. Determine potential overpressure.

TLC-01B	-38.822309, 178.466201	691	160	0	160	Determine presence of methane hydrate within landslide debris. Characterize distribution of hydrate. Determine overpressure at base of landslide debris and below hydrate stability. Collect pressure cores for shore-based studies on interstitial distribution of hydrates and mechanical properties.
TLC-04A	-38.827956, 178.465359	695	160	0	160	Determine presence of methane hydrate within landslide debris. Characterize distribution of hydrate. Determine overpressure at base of landslide debris and below hydrate stability. Collect pressure cores for shore-based studies on interstitial distribution of hydrates and mechanical properties.
TLC-05A	-38.778913, 178.492611	671	160	0	160	Determine presence of methane hydrate within landslide debris. Characterize distribution of hydrate. Determine overpressure at base of landslide debris and below hydrate stability. Collect pressure cores for shore-based studies on interstitial distribution of hydrates and mechanical properties.