IODP Proposal Cover Sheet

885 - Full

Ulleung Basin Gas Hydrates

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Title	Ulleung Basin gas hydrtaes and submarine landslides: climate-driven harzards?
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Abstract

Submarine slope failure and derived sediment gravity flows are recognized as a major sedimentary process in basins worldwide. Their large failure volumes and long-runout distances pose significant tsunami hazard for offshore and coastal facilities, and thus it is important to understand the mechanisms and processes involved in the initiation of slope failure. One hypothesis currently being debated is that sea level fluctuations and ocean bottom temperature changes can cause gas hydrate dissociation and/or dissolution and/or gas exsolution and expansion leading to submarine slope failure. However, evidence that propagation in seafloor sediments of pressure and thermal perturbations associated with climate change induce slope instability is lacking, and more importantly there has not been a dedicated study to investigate these feedbacks. To move forward in our understanding of the roles of climate, sedimentation patterns, geomechanical properties of gas-hydrate bearing sediments and slope stability, we propose to acquire an expanded Quaternary record of mass-wasting activity, gas emissions, climatic/paeloceanographic proxies and physical properties to better constrain the gas hydrate-slope failure system. The Ulleung Basin, situated between the Korean peninsula and the Japanese archipelago, is an optimal study region because: (1) the high abundance of gas hydrates, particularly at the southern end of the basin (2) more than 50% of the >1000 m thick Plio-Quaternary succession is comprised of Mass Transport Deposits (MTDs), (3) high susceptibility of background sedimentary cycles to climate changes, and (4) extensive Site Survey Data has already been collected in this region which ensures proper site selection. The fundamental science objective of this proposal will not only improve our understanding of the hydrate-slope failure link in relation to climate induced perturbations, but will enhance our understanding of dynamic behavior of the MTDs and further help to address societally relevant problems related to assessing geohazards to adjacent land-masses.

885 - Full

Scientific Objectives

This proposed drilling program addresses the following scientific interrelated hypotheses that are related to the pre-failure, failure and post-failure stages and the hazard from offshore slope failures:
H1) Climate-modulated sedimentary cyclicity and margin architecture precondition the slope for failure and control its size and style.
H2) Climate-induced stress and temperature variations drive perturbation of gas hydrate systems which trigger submarine landslides.
H3) Magnitude, timing, frequency and clustering of submarine landslides determine the hazard from submarine slope failures and derived tsunami.

To test these hypotheses, we propose the following scientific objectives that can only be achieved by drilling:
O1) Investigate how climate-modulated sedimentation, stratigraphy and fluid flow control slope failure.
O2) Understand the development of weak layers.
O3) Constrain the influence of past sea level and temperature changes on perturbations to the gas hydrate system.
O4) Test whether dissociation or dissolution is the preferential way by which gas hydrates originate slope failure.
O5) Constrain timing and frequency of submarine landslides and potential clustering in relation to major climatic changes.
O6) Assess the hazard from submarine slope failures and derived tsunamis.

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

LWD logging to collect near-seafloor data in sediments after minimal drilling disturbance.*
SET-P, T2P pressure probes to estimate pore pressure.*
Pressure core sampler (PCS) to determine gas hydrate saturation and physical properties of the cores at in situ pressures

*We are working to secure funding for additional costs related to the use of these tools.

885 - Full

Proposed Sites (Total proposed sites: 7; pri: 7; alt: 0; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
UBSL-1A (Primary)	36.2776645 130.035543	1312	441	0	441	Expanded, mostly biogenic, in-situ sequence on the western slope. BSR present in the sedimentary column. This site will provide climatic, oceanographic and age constraints for MTDs in the basin. It will also provide mechanical characteristics of sediments on the western slope that contain weak layers correlated to adjacent gliding planes. Presence of gas hydrates will allow testing the role of dissociation and dissolution in triggering slope failure (O1, O2, O3, O4, O5).
UBSL-2A (Primary)	35.70256007 130.3387065	983	200	0	200	Expanded, mostly terrigenous, in-situ sequence on the southern slope but close to large slope failures. BSR present in the sedimentary column. This site will provide climatic, oceanographic and age constraints for MTDs in the western slope and basin. It will also provide mechanical characteristics of sediments on the southern slope and will help constrain fluid flow, pore pressure and past methane emissions. Presence of gas hydrates will allow to test the role of dissociation and, particularly, dissolution in triggering slope failure (O1, O2, O3, O4, O5).
UBSL-3A (Primary)	35.5995854829 130.182136115	425	400	0	400	In-situ sequence adjacent to submarine slope failure scars. BSR or enhanced reflection intersects the slope nearby recent submarine landslides. This location will reveal past and recent gas hydrate phase changes, likely related to dissociation, and define the geothermal gradient and current state of stress thanks to pore pressure measurements (O3, O4).
UBSL-4A (Primary)	35.8020029737 130.326835848	1273	246	0	246	Sequence of stacked MTDs near landslide evacuation area. BSR present in the sedimentary column. This site will address past gas hydrate phase changes and define the geothermal gradient and current state of stress. It will also help constrain landslide stages, emplacement style and rheology in a proximal setting (O3, O4, O6).
UBSL-5A (Primary)	36.144711651 130.33538338	1615	386	0	386	Sequence of stacked MTDs in proximal setting. This site will constrain landslide stages, emplacement style and rheology in a proximal setting (O6).
UBSL-6A (Primary)	36.4780088327 130.335365247	2056	353	0	353	Sequence of stacked MTDs. This site will provide material for direct dating of slope failure events and will help constrain landslide stages, emplacement style and rheology (O5, O6).
UBSL-7A (Primary)	36.79474939 130.2357338	2213	780	0	780	Sequence of stacked MTDs in distal setting. This site will provide material for direct dating of slope failure events in a distal setting and will help constrain landslide stages, emplacement style and rheology (O5, O6).