Geology and Geophysics

UNIVERSITY OF Southampton

Arctic Hydrate Dissociation as a Consequence of Climate Change: Determining the vulnerable methane reservoir and gas escape mechanisms

Background

In 2008, hundreds of plumes of bubbles of methane gas were discovered rising from the seabed west of Svalbard, in the Arctic, in water depths at and shallower than the upper limit of the methane hydrate stability zone (GHSZ). It is probable that these plumes come from methane released by the dissociation of methane hydrate beneath the seabed, caused by an increase in water temperature near the seabed of 1°C over the past 30 years [*Westbrook et al.,* 2009].

Figure 1.

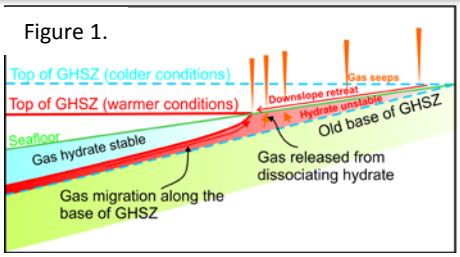

Figure 1: Schematic illustration explaining ocean warming and downslope retreat of the upper edge of the gas hydrate stability zone at the seabed.

Figure 2.

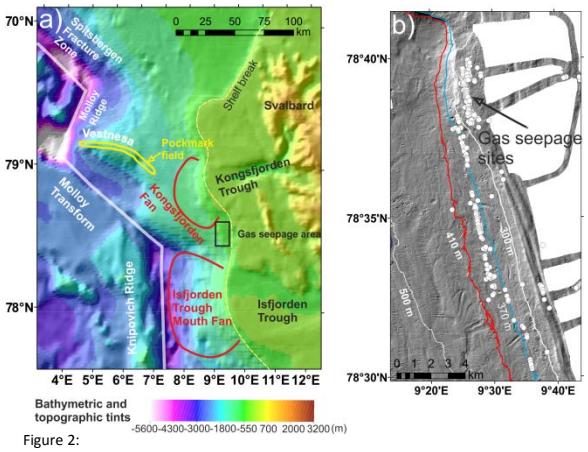

Figure 2:
(a) West Svalbard study area and gas seepage sites located between the Kongsfjorden and Isfjorden trough mouth fans, (b) Gas seeps on the upper slope (location within a black rectangular box in Figure 2a). The 370 and 410-m contours are the upper limit of methane hydrate stability limits at 2˚ and 3˚ C respectively.

Objectives

The primary objectives of this research are to determine

a) The detailed structural and sedimentary architecture of the shallow glaciomarine sedimentary sequence in the upper slope,

b) Sub-seabed distribution and amounts of hydrate and free gas, and

c) Migration pathways of free gas within the zone of gas hydrate dissociation induced by ocean warming.

Acquisition of new very high-resolution seismic and CSEM data

Very high-resolution seismic reflection images (using Ifremer's deep-tow seismic system, SYSIF) collected in summer 2011 are being analyzed for glaciomarine stratigraphy as well as gas accumulation and migration features.

Controlled-source-electromagnetic (CSEM) data are helping to find out zones of higher-than-normal electrical resistivity caused by the occurrence of free gas or hydrate in the sediments beneath the seabed.

Ocean bottom seismometer data are being used to obtain velocity model and aid in distinction between gas and hydrate based on seismic *P*-wave velocity (slow for gas and faster for hydrate).

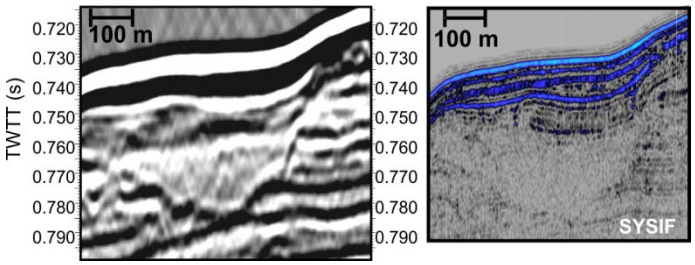

Figure 3:
A comparison between a JR211 seismic image [left one, from *Sarkar et al.,* 2011] and very high-resolution SYSIF image (right) shows impressive details of glaciomarine structures in the latter. The images are shown with the same vertical exaggeration for comparison.

Participation

Scientists within the Geophysics group involved in the project.

From left to right: Prof. Timothy A. Minshull, Prof. Graham Westbrook, Prof. Martin Sinha, Dr. Karen Weitemeyer

Related Project Pages

Our previous IPY project details can be found at http://www.noc.soton.ac.uk/gg/IPY/

Partners

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Publications: **Westbrook, G. K.,** et al. (2009), Escape of methane gas from the seabed along the West Spitsbergen continental margin, *Geophys. Res. Lett., 36,* L15608, doi:10.1029/2009GL039191.

Sarkar, S., C. Berndt, T. A. Minshull, G. K. Westbrook, D. Klaeschen, D. G. Masson, A. Chabert, and K. E. Thatcher (2012), Seismic evidence for shallow gas-escape features associated with a retreating gas hydrate zone offshore west Svalbard, *J. Geophys. Res.*, 117, B09102, doi:10.1029/2011JB009126.