GEOMAR REPORT

RV SONNE

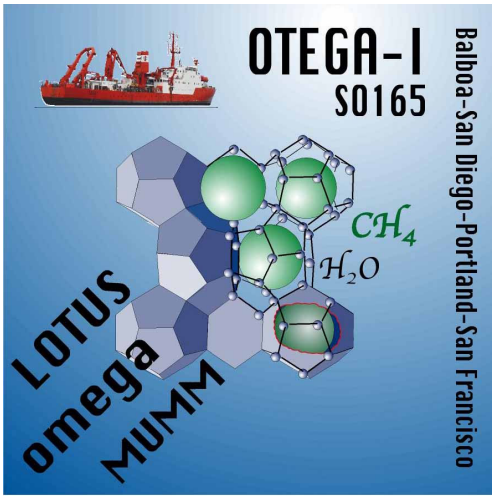
CRUISE REPORT SO165

OTEGA-I

LOTUS – OMEGA – MUMM

Balboa-San-Diego-Portland-San Francisco

June 29 – August 20, 2002



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Edited by
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with contributions of cruise participants

GEOMAR
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Preface

O. Pfannkuche

Natural gas hydrates represent an immense hydrocarbon resource underlying large portions of the world's ocean margins. There is increasing evidence that natural gas hydrates played a significant role in enhancing the pace of past global climate change through the release of methane, a greenhouse gas some 20 times more active than carbon dioxide. Thus the understanding of the origin, structure, and behaviour of near-surface gas hydrates and their interaction with the sedimentary and oceanic environment is critical in evaluating and quantifying their role in the global carbon cycle. International interest in science and engineering research on natural gas hydrates has been remarkably enhanced in the last decade. German investigation namely by GEOMAR contributed substantially to our present knowledge on marine gas hydrates. The finding of near sediment surface gas hydrate deposits at Hydrate Ridge (Cascadia Subduction Zone off Oregon, USA) resulted in two large international campaigns TECFLUX I (Tectonically Induced Material Fluxes) in 1999 and TECFLUX II in 2000. Investigations were mainly carried out by Canadian, German and US scientists. Results of the these campaigns gave direction to the establishment of a special research focus "Gas hydrates in the Geosystem" funded by the German Ministry of Education and Research within the research topic "Geotechnologies", ***http://www.geotechnologien.de/***.

Marine geo-science and biogeochemical investigations of naturally occurring gas hydrates are an overall focus at the GEOMAR Research Centre, ***http://www.gashydrate.de/***. In this context the following three collaborative projects as part of the national programme "Geotechnologies" are co-ordinated here:

- **INGGAS** - Integrated Geophysical Characterisation and Quantification of Gas Hydrates, *http://www.geomar.de/~mbreitzk/inggas/index.html*
- **OMEGA** - Shallow Marine Gas Hydrates: Dynamics of a Sensitive Methane Reservoir, *http://www.gashydrate.de/projekte/omega/index.html*
- **LOTUS** - Long-term Observatory for the Study of Control Mechanisms of the Formation and Destabilisation of Gas Hydrates, *http://www.geomar.de/~jgreiner/web_LOTUS/index.html*.

OMEGA and LOTUS are closely co-operating with the Max Planck Institute for Marine Microbiology: The MPI coordinates the collaborative gas hydrate project:

- **MUMM** - Methane in Gashydrate-bearing Marine Sediments –Turnover Rates and Microorganisms, *http://www.mpi-bremen.de/deutsch/biogeo/ mumm2.html*.

This cruise report presents the working programme, station list and first results of OMEGA, LOTUS and MUMM investigations on near sediment surface gas hydrates at Hydrate Ridge gained during SONNE Cruise No.165 (June 29 –August 21, 2002).

Acknowledgements

On behalf of all participants we would like to thank the master of FS SONNE, H. Andresen and his crew for the continued interest, flexibility and their contribution to provide an always pleasant and professional atmosphere on board. The expedtion was financed by the Federal Ministry of Education and Research in Bonn (BMBF) grant no. 03G0165A. Project review and scheduling of the SONNE cruise was handled efficiently by the Projektträger Jülich.

1. Introduction

O. Pfannkuche

Understanding the origin, structure, and behaviour of near-surface gas hydrates and their interaction with the sedimentary and oceanic environment is critical in evaluating and quantifying their role in the global carbon cycle. Previous investigations have shown that massive gas hydrates close to the sediment/water interface may act as a sensitive C-reservoir due to their exposed position near the stability limit. These hydrates generate extremely high and variable fluxes of methane and influence their immediate and far-field environments.

There is growing evidence that the destabilization of gas hydrates and the resulting release of methane may be one of the most powerful influences on past abrupt climatic changes of the earth system. However, in climate research the release of methane from gas hydrates has hardly been considered in model calculations since little information exists on the geochemical cycle of methane in marine hydrates. It is not clear which proportion of methane released at the sediment-water interface reaches the atmosphere or whether the passage of large amounts of methane into the atmosphere is prevented by oxidization in the sediment boundary layer or in the overlying water column by methane-oxidizing organisms. Previous results from the TECFLUX programme suggest that a large proportion of the methane released from deeper sediments is oxidized to CO_2 in the upper sediment layers. The pathways of methane oxidation and the micro-organisms involved have not been identified yet, thus, the regulation of methane turnover in marine sediments is not understood. This is partly due to sampling problems since the quick decomposition of gas hydrates and the outgassing of methane during retrieval destroys the natural zonation of microbial and chemical processes.
Furthermore it is not known whether the exhalation of methane from the sediments into the water column represents a constant flux or if variations occur that are controlled by environmental factors. In addition, little information exists concerning the life time and temporal activity of gas hydrate deposits and methane vents, and therefore no quantitative evaluation of temporal oscillations in gas hydrate source strengths has been possible to date. Even the residence time of methane in the form of gas hydrate is totally unknown.

These defiencies in our knowledge on marine gas hydrates led to the establishment of the collaborative research projects MUMM, LOTUS and OMEGA within in the German national research focus GEO-Technologies which combined their efforts in SONNE Cruise No. 165/OTEGA I.

Shallow gas hydrates are known from sediments of several areas of the world but there are few sites known so far where massive gas hydrate layers outcrop at the sediment water interface. At “Hydrate Ridge” on the continental margin off Oregon (Fig 1.) mixed methan-sulfide hydrates and carbonates form a massive pavement along the crest of a ridge at water depths between 600 and 1000m which are partly exposed. Vent fields from which methane charged low salinity fluids containing sulfide, ammonia, ^4He and isotopically light CO_2 are associated with these exposures. The discharge of fluids stimulates an extraordinary large benthic carbon turnover that is in the order of one magnitude higher than at comparable ocean depth. Extensive coverage of the seafloor by bacterial mats, *Calyptogena* clams with