[PS]Provenance and Paleoenvironment of Sandy Sediments Possibly Hosting Gas Hydrate in the Eastern Margin of Japan Sea*

Takashi Uchida[1], Isao Takashima[1], Tomoya Ito[1], and Ryo Matsumoto[2]

Search and Discovery Article #50422 (2011)
Posted June 20, 2011

[1]Earth Science and Technology, Akita University, Akita, Japan. (uchidat@gipc.akita-u.ac.up)
[2]University of Tokyo, Tokyo, Japan.

*Adapted from poster presentation at AAPG Annual Convention and Exhibition, Houston, Texas, USA, April 10-13, 2011

Abstract

The MD179 project was undertaken in the eastern margin of Japan Sea by the Marion Dufresne aiming at recovery of deep seated gas and gas hydrate, methane induced carbonate, and deep sediments older than 300 ka in order to develop geologic model of gas hydrate accumulation and evaluate the possible environmental impact of gas hydrate for the last glacial-interglacial cycles.

Sediment samples below the seafloor were obtained in the Umitaka Spur, the Joetsu Channel and other areas by the UT09 and KY09-05 cruises in 2009 as well as the MD179 cruise. They have been mainly composed of muddy sediments with a small amount of sandy sediments. Thin sandy layers are intercalated with thick muddy sediments, which are often strongly bioturbated with burrows and pellets. Those sandy sediments consist of fine- to medium-grained sand grains, and are sometimes tuffaceous. The results of pore-size distribution measurements and thin-section observations indicate that porosities of muddy sediments are around 50 % but those of arenites range from 42 to 52 % of which mean pore sizes and permeabilities are larger than those of siltstones and mudstones. While the presence of gas hydrate in intergranular pores is not confirmed, the soupy occurrence in recovered sandy sediments may strongly indicate the presence of gas hydrate filling the intergranular pore system of arenite sands.

So as to know the time of deposition of coarse-grained sediments, thermoluminescence (TL) dating of constituent quartz grains and grain-size distributions are analyzed. It has been inferred that methane in gas hydrate and methane plumes are of thermogenic origin in the study area, which show the occurrences of mounds, nodules, veins, pore fillings etc. Permeable intergranular pore systems of arenite sand, fractures, faults as well as gas chimneys may have played an important role as conduits for deep thermogenic hydrocarbon gas migration.

The geological modeling of the gas hydrate formation and evolution system is concerned for energy resource potential in the Japan Sea as well as the

Nankai Trough areas. Although the chimney type accumulation may be dominated and is characterized by massive concentration of nodular and fracture filling hydrates, the sandy sediments hosting gas hydrate in their intergranular pore system may likely occur.

This study was performed as a part of the MH21 Research Consortium on methane hydrate in Japan.

14C-980238

Provenance and Paleoenvironment of Sandy Sediments Possibly Hosting Gas Hydrate in the Eastern Margin of Japan Sea

Takashi Uchida, Isao Takashima, Tomoya Ito [1)], and Ryo Matsumoto [2)]

1) Department of Earth Science and Technology, Akita University, 1-1 Tegatagakuenmachi, Akita, 0108502 Japan: uchidat@gipc.akita-u.ac.jp

2) University of Tokyo, 7-3-1 Hongo, Bunkyoku, Tokyo, 113-0033 Japan: ryo@eps.s.u-tokyo.ac.jp

AAPG 2011 Annual Convention & Exhibition
10-13 April 2011 • Houston

Abstract

The MD179 project was undertaken in the eastern margin of Japan Sea by the Marion Dufresne aiming at recovery of deep seated gas and gas hydrate, methane induced carbonate, and deep sediments older than 300 ka in order to develop geologic model of gas hydrate accumulation and evaluate the possible environmental impact of gas hydrate for the last glacial-interglacial cycles.

Sediment samples below the seafloor were obtained in the Umitaka Spur, the Joetsu Channel and other areas by the UT09 and KY09-05 cruises in 2009 as well as the MD179 cruise. They have been mainly composed of muddy sediments with a small amount of sandy sediments. Thin sandy layers are intercalated with thick muddy sediments, which are often strongly bioturbated with burrows and pellets. Those sandy sediments consist of fine- to medium-grained sand grains, and are sometimes tuffaceous. The results of pore-size distribution measurements and thin-section observations indicate that porosities of muddy sediments are around 50 % but those of arenites range from 42 to 52 % of which mean pore sizes and permeabilities are larger than those of siltstones and mudstones. While the presence of gas hydrate in intergranular pores is not confirmed, the soupy occurrence in recovered sandy sediments may strongly indicate the presence of gas hydrate filling the intergranular pore system of arenite sands.

So as to know the time of deposition of coarse-grained sediments, thermoluminescence (TL) dating of constituent quartz grains and grain-size distributions are analyzed. It has been inferred that methane in gas hydrate and methane plumes are of thermogenic origin in the study area, which show the occurrences of mounds, nodules, veins, pore fillings etc. Permeable intergranular pore systems of arenite sand, fractures, faults as well as gas chimneys may have played an important role as conduits for deep thermogenic hydrocarbon gas migration.

The geological modeling of the gas hydrate formation and evolution system is concerned for energy resource potential in the Japan Sea as well as the Nankai Trough areas. Although the chimney type accumulation may be dominated and is characterized by massive concentration of nodular and fracture filling hydrates, the sandy sediments hosting gas hydrate in their intergranular pore system may likely occur.

This study was performed as a part of the MH21 Research Consortium on methane hydrate in Japan.

Objectives

-- to overview the subsurface occurrences of natural gas hydrates that have ever been recovered from various fields such as Nankai Trough, Blake Ridge, Mallik as well as the eastern Japan Sea,

-- to clarify the sedimentological properties and provenances of host sandy sediments and their pore characteristics possibly containing pore-space gas hydrate.

-- to investigate the mechanism of gas hydrate concentration relevant to subsurface occurrences for a natural gas resource and their lithology controls.

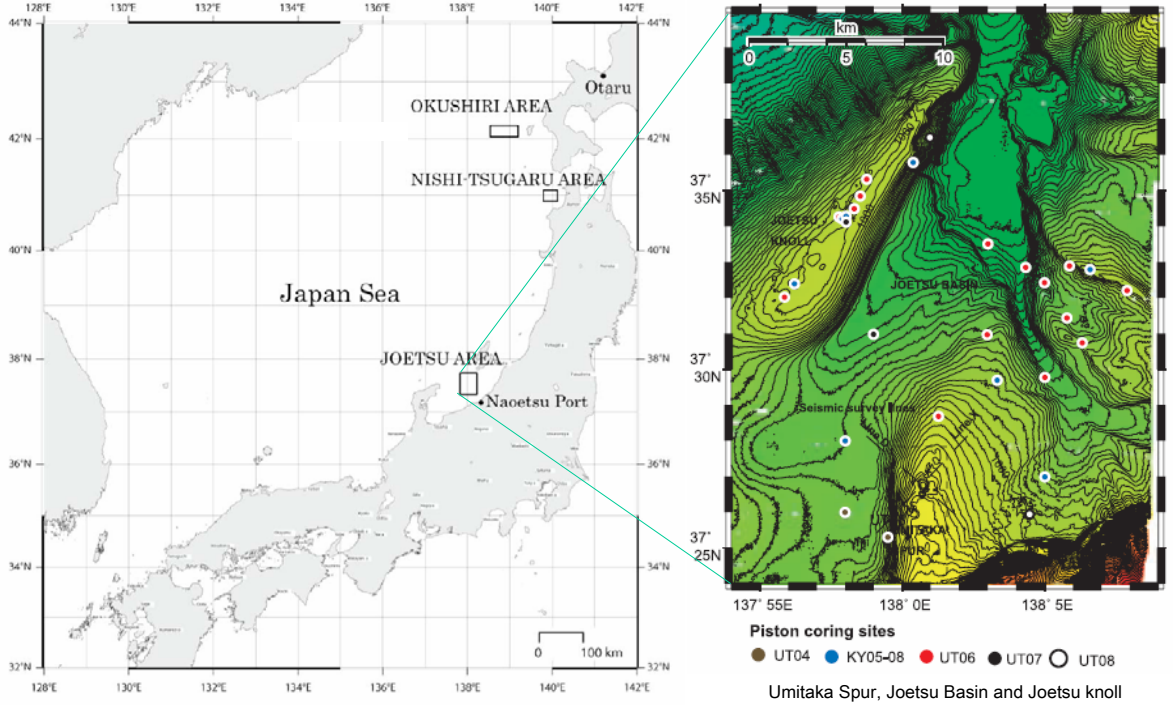
Background

The potential of gas hydrate as a future energy resource has stimulated a number of intensive research programs worldwide.

In 1998, 2002 and 2007 the Mallik production research well programs were conducted at the Mackenzie Delta, and in 2000 and 2004 the METI Nankai Trough wells and METI Tokaioki to Kumanonada wells were successfully drilled at the eastern Nankai Trough.

Additionally, the extensive efforts have been done on clarifying the Quaternary sedimentary environment and climate in the eastern Japan Sea since 2003.

Study Areas of the MD179 Japan Sea Gas Hydrate Cruise



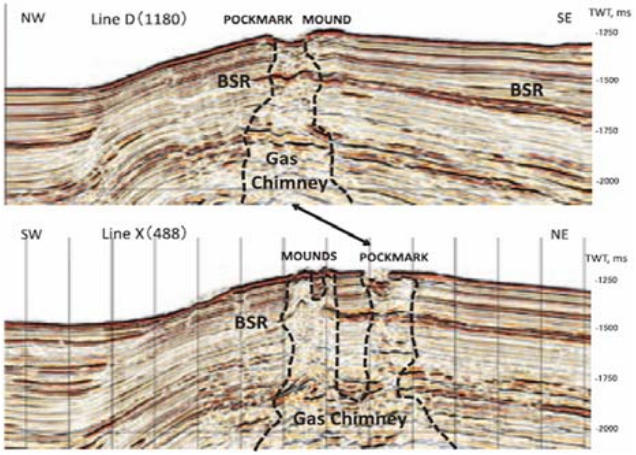
THE UNIVERSITY OF TOKYO

AIST

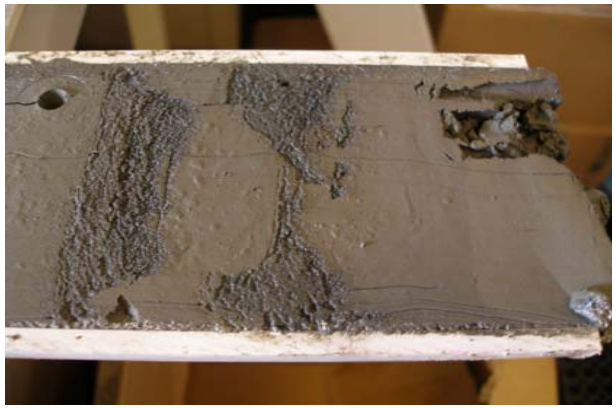
Department of Earth Science and Technology
Akita University

JOGMEC
JAPEX

Retrieved sediment cores on the MD179 Cruise

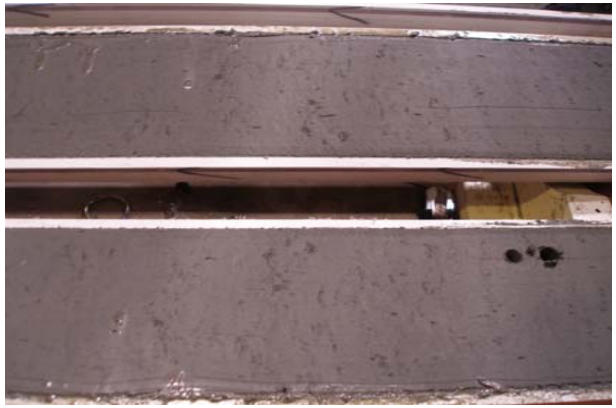


The seismic profile showing BSRs, pockmarks and mounds in the Umitaka Spur, where possible gas chimneys are recognized (Matsumoto et al., 2009)

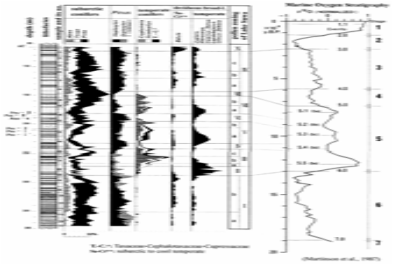


Thinly laminated silts with some sandy intercalations

Nodule gas hydrates contained in silty sediments

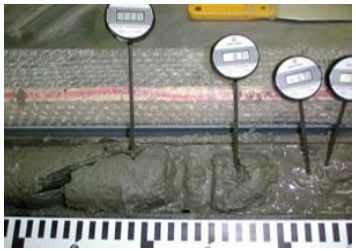


Strong bioturbations within silty sediments

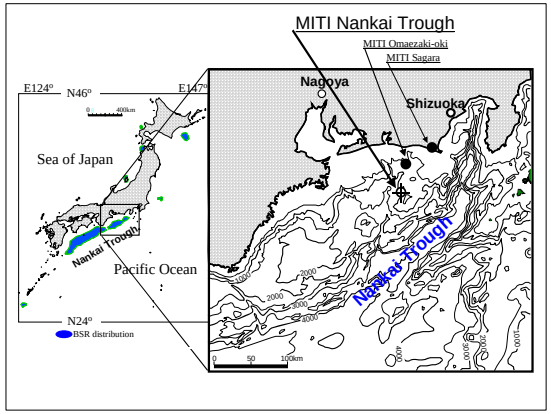


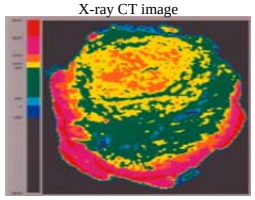
Comparing the pollen zoning of sediment cores drilled in the Lake Suwa with the marine isotope stratigraphy (Kumon et al., 2009)

Nankai Trough



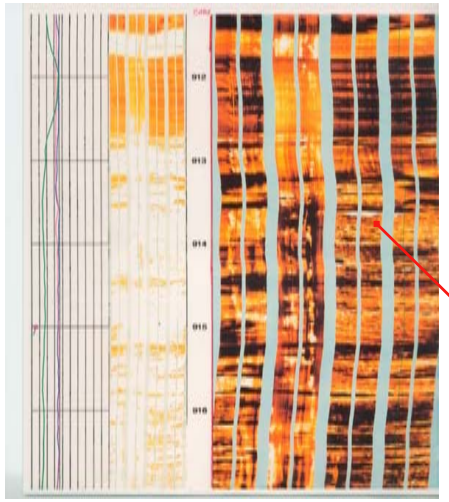
Uchida et al. (2004)



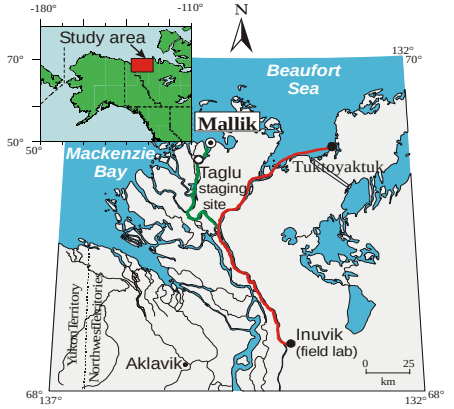


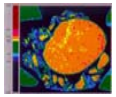
X-ray CT image

Mackenzie Delta

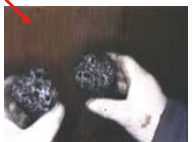


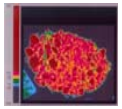
Uchida et al. (2005)





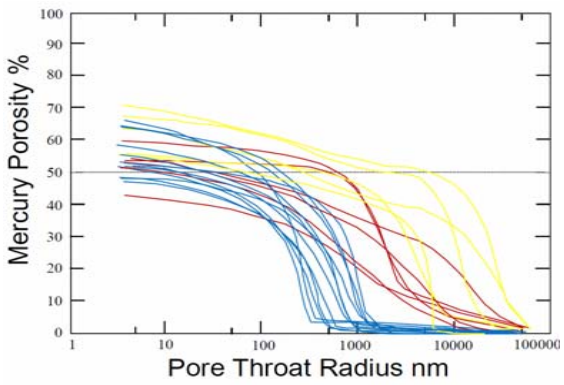
X-ray CT image

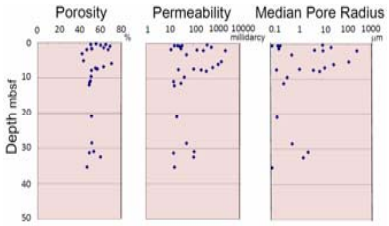


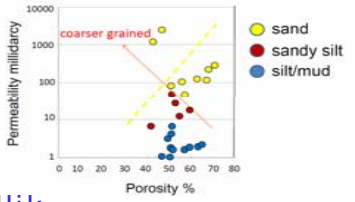


913.7m: Biggest Form of Pore-Space Hydrate

Pore Characteristics of Gas Hydrate-Bearing Sands

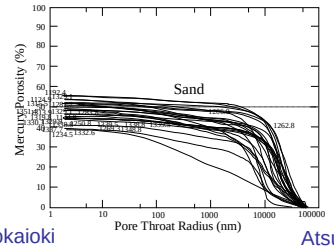






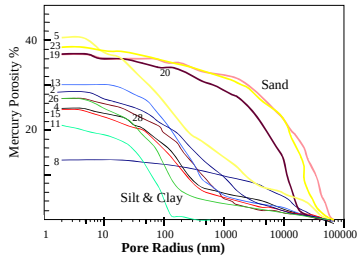
Nankai Trough

Uchida et al. (2009)



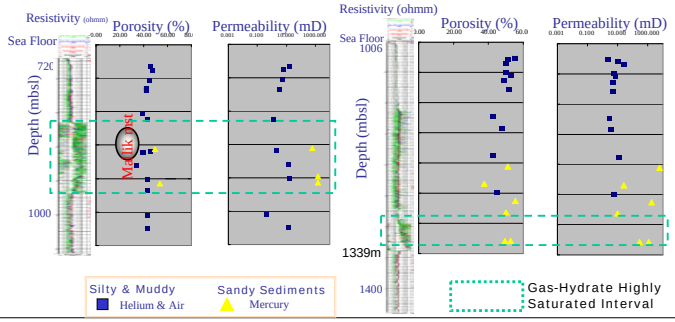
Mallik

Uchida et al. (2005)



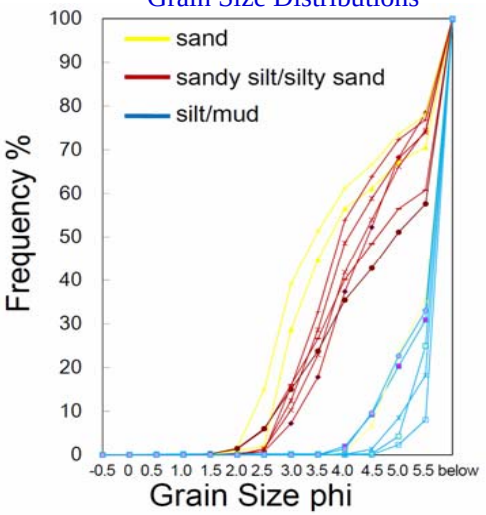
Tokaioki

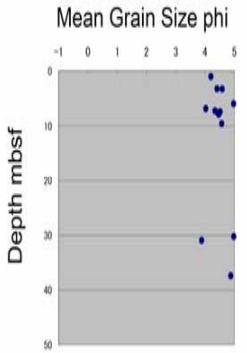
Atsumi Knoll

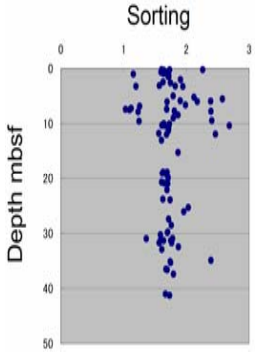


Sedimentological Properties of Sandy Sediments

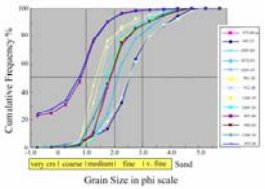
Grain Size Distributions



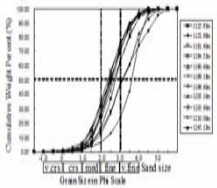




Malllik Uchida et al. (2005)

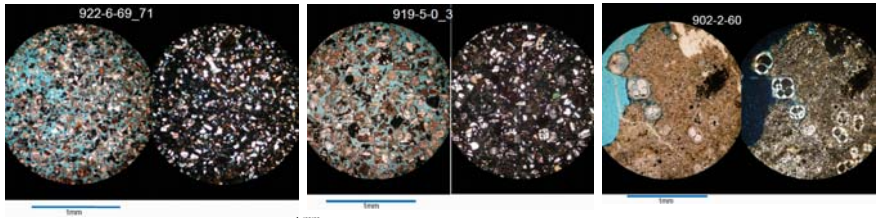


Nankai Trough Uchida et al. (2004)

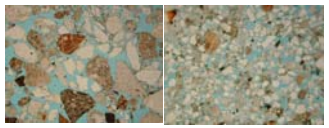


Photomicrographs of Thin Sections

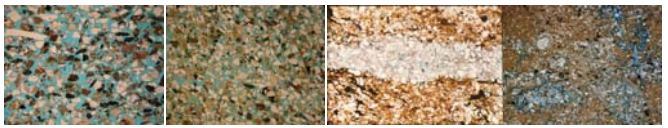
JapanSea



Mallik



Nankai Trough



Summary and Conclusions

(1) Small amounts of sandy sediment are retrieved as thin intercalations in Pleistocene silty layers. These coarser sediments might have been transported approximately around 3 to 30 ka, where supplying sediments may not be abundant due to sea level fluctuation during Pleistocene ice age.

(2) Pore-space hydrates are observed to occur primarily in fine- to medium-grained sands filling the intergranular pore systems of arenite sands, and have been recognized in the Mallik as well as in the Nankai Trough areas, which are considered to be common even in the subsurface sandy sediments at the eastern margin of Japan Sea.

(3) Concentration of gas hydrate may need primary intergranular pores large enough to occur within a host sediment that may be arenite sand without matrix grains deposited in such as channels.

This appears to be a similar mode for conventional oil and gas accumulations. It is suggested that the distribution of a porous and coarser-grained host sandy sediments is one of the most important factors to control the occurrence of gas hydrates, as well as physicochemical conditions.

Acknowledgment

This study was performed as a part of the MH21 Research Consortium on methane hydrate in Japan.
We thank the AIST, JOGMEC, the MH21 consortium and JAPEX Research Center as well as the MD179 onboard scientists for their financial and technical supports.

Department of
Earth Science and Technology
Akita University

THE UNIVERSITY OF TOKYO