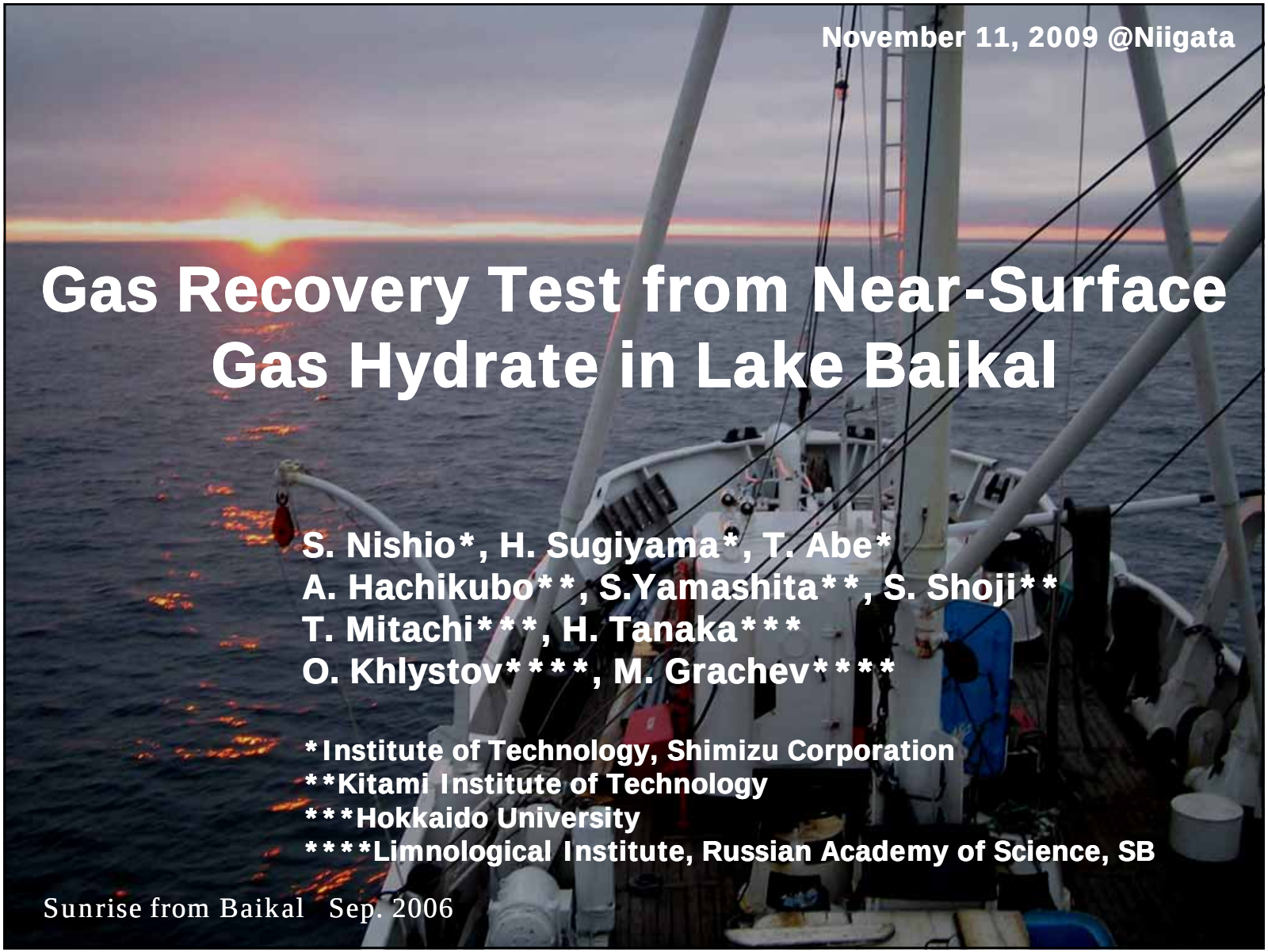

November 11, 2009 @Niigata

Gas Recovery Test from Near-Surface Gas Hydrate in Lake Baikal

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**Kitami Institute of Technology
***Hokkaido University
****Limnological Institute, Russian Academy of Science, SB

Sunrise from Baikal Sep. 2006

Updated Distribution of BSR around Japan July 31, 2009

MH21 Research Consortium
http://www.mh21japan.gr.jp

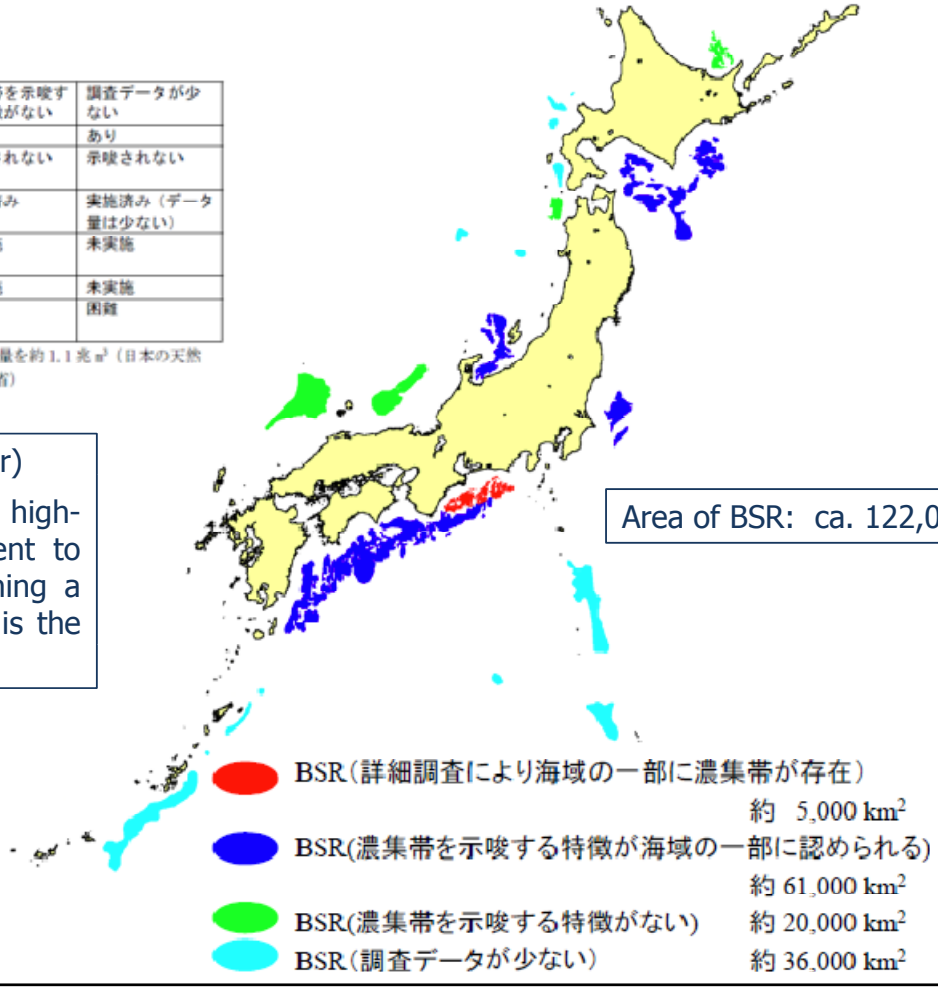
<参考> ＢＳＲ分布図（2009年）における色分けの違い

	詳細調査により濃集帯が存在	濃集帯を示唆する特徴がある	濃集帯を示唆する特徴がない	調査データが少ない
ＢＳＲ	あり	あり	あり	あり
メタンハイドレート濃集帯	示唆される	示唆される	示唆されない	示唆されない
二次元地震探査の解析	実施済み	実施済み	実施済み	実施済み（データ量は少ない）
三次元地震探査の解析	実施済み	一部実施済み	未実施	未実施
掘削調査	実施済み	未実施	未実施	未実施
賦存状態・賦存量の推定（現時点で）	可能※	困難	困難	困難

※ 東部南海トラフ海域に賦存するメタンハイドレートの原始資源量を約1.1兆m³（日本の天然ガス消費量の約13.5年分）と算定・公表（2007年・経済産業省）

BSR (Bottom Simulating Reflector)

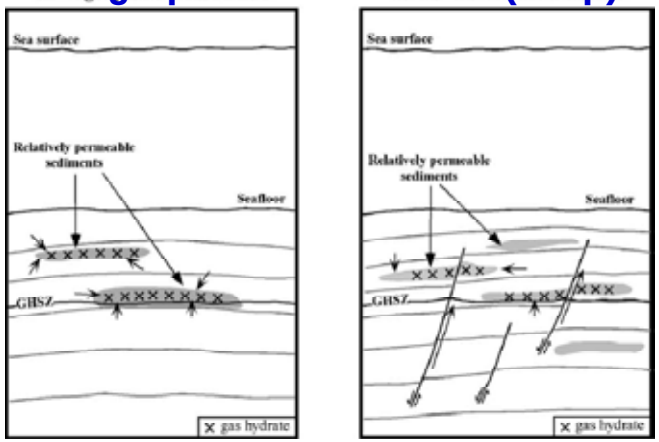
P wave velocity changes from high-velocity hydrate-bearing sediment to lower velocity sediment containing a small amount of free gas. BSR is the base of gas hydrate layer.



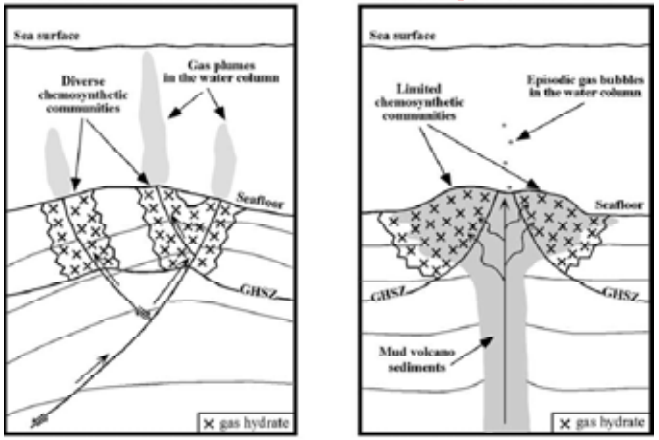
Area of BSR: ca. 122,000km²

Deep(BSR) gas hydrate and near-surface gas hydrate

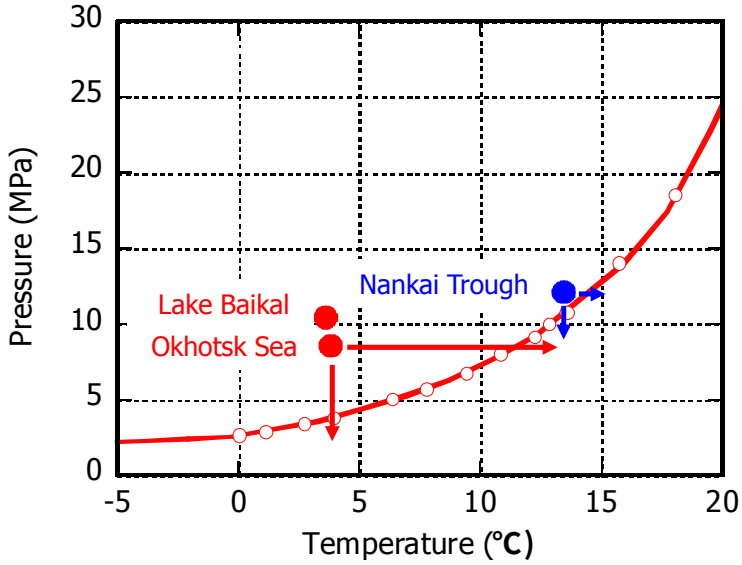
Stratigraphic accumulation (deep)



Structural accumulation (near-surface)



Milkov, A. and Sassen, R., 2002



In general, the structural accumulations occur where gas is rapidly transported from the subsurface petroleum system to the gas hydrate stability zone along mud volcanoes or faults.

The equilibrium condition of near-surface gas hydrate is more stable than that of deep gas hydrate.

Production Test of Near-Surface Gas Hydrate in Lake Baikal

Duration

August, 2006 – March, 2009

Overall aim

The aim of this project is to develop technologies for recovering gas hydrate from the surface sediments in the bottom of Lake Baikal, with the goal of establishing environmentally friendly and economical natural gas production technologies from gas hydrate layers.

Objectives

Assessment of physical/chemical/geotechnical properties of gas hydrate bearing sediments and

Development of new production method by application of hydrate melting

The project was funded by the JST (Japan Science and Technology Agency) Research Program on Development of Innovative Technology.

Collaboration

NER Center
Kitami Institute of Technology
Prof. Shoji, H.

Field survey
Basic properties of MH
Production simulation

Graduate School of Engineering
Hokkaido University
Prof. Mitachi, T.
Prof. Tanaka, H.

Field survey
Basic properties of sediments
Production simulation

Limnological Institute, SB
Russian Academy of Science
Dr. Grachev, M.A.

Arrangement of expedition
Field survey
Environment assessment

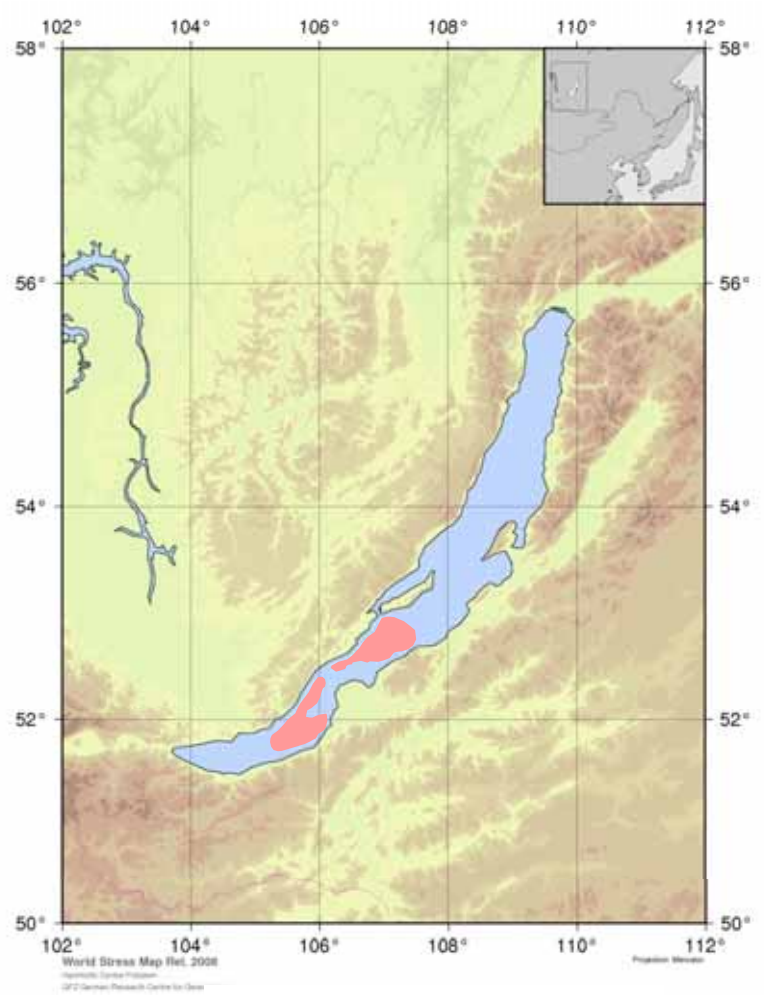
Institute of Technology
Shimizu Corporation

Project management
Field survey
Production simulation
Production test

Gas hydrate in Lake Baikal

1. BSRs were found in 1989, 1992.
2. Gas hydrate from Lake Baikal sediments were extracted in 1997 in the Southern basin of the lake.
3. Near-surface gas hydrate were recovered in 2000 in the area of the mud volcano Malen'ky using ordinary gravity cores.
4. These "volcanic" areas in Lake Baikal have some common features:
   - They are situated at the depths ca. 800-1,500 m, in the gas hydrates stability zone.
   - They are also situated in the area of BSRs.
   - They are situated in the vicinity with active faults and in the sites with a high seismicity.

(Khlystov, O., 2006)



Sampling by Gravity Corer

R/V "Vereshchagin"

Weight: 800kg, Length: 5m

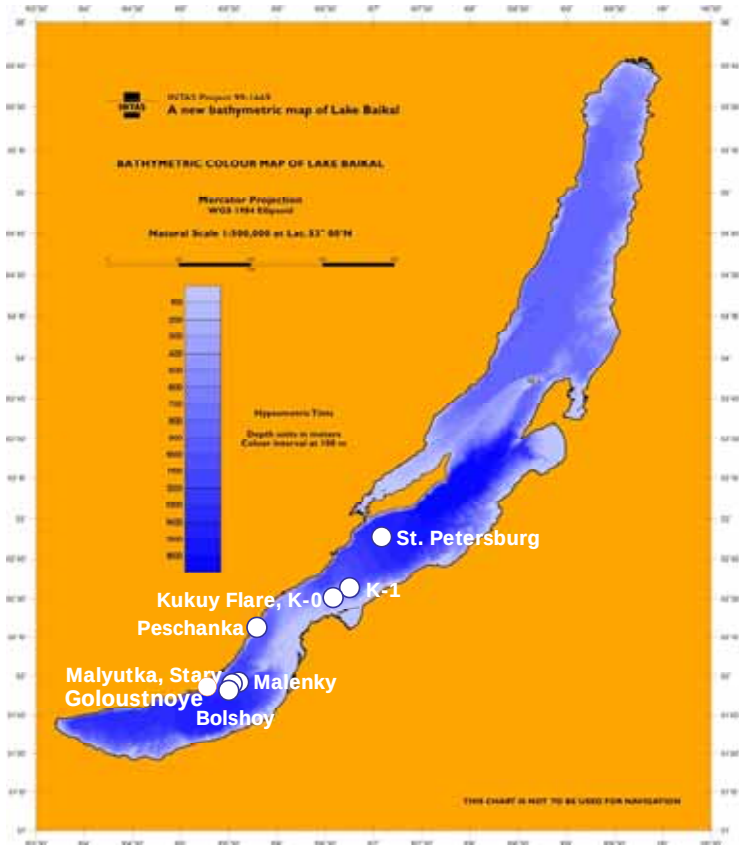
Winch up Corer

Gas hydrates in core sample

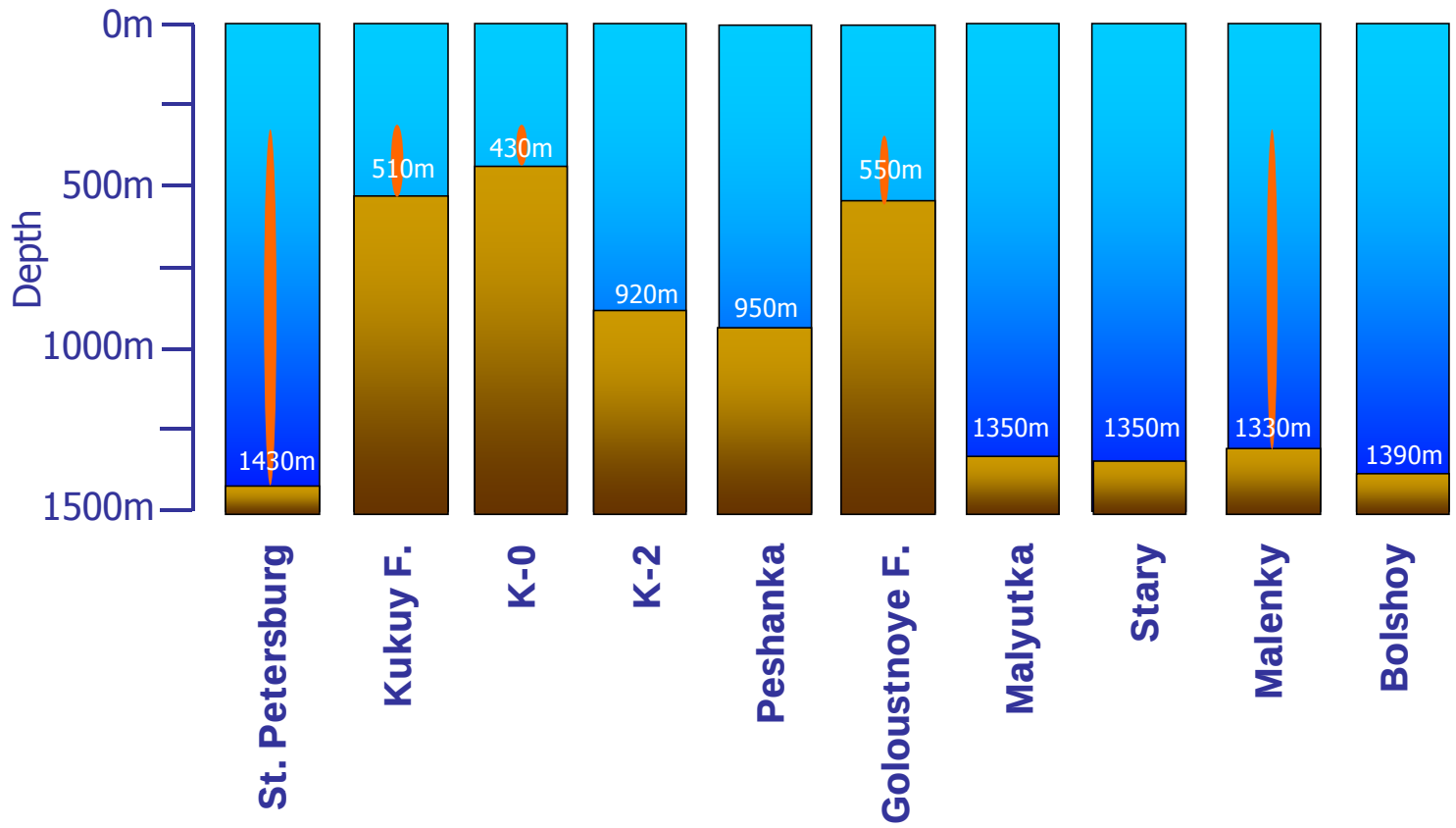
Veined gas hydrate

Massive gas hydrate

Test Stations in Lake Baikal



Test Stations in Lake Baikal

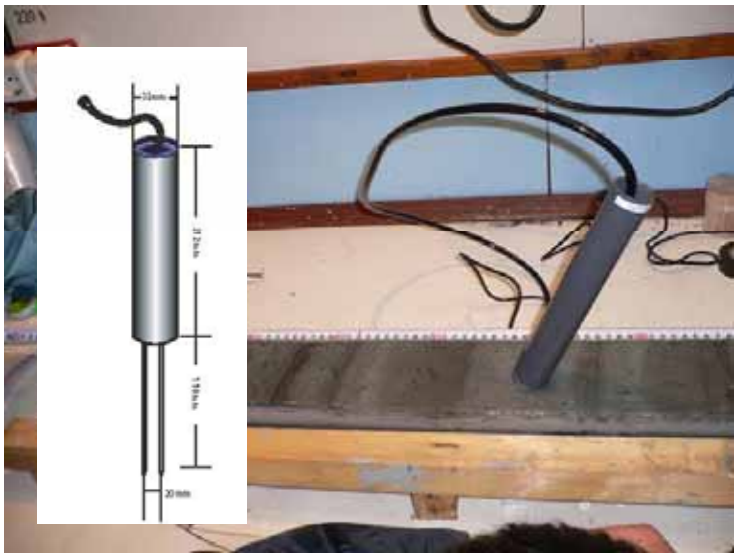


Baikal expeditions after 2005

JST Project

	Exp. days	Participants from Japan	Exp. sites	# of cores	# of CPT
Mar. 2005	19	8	Malenky	28	
Sep. 2005	11	8	Bolshoy Kukuy Malenky	6 8 4	
Sep. 2006	21	10	Kukuy St.Petersburg Peschanka Malenky Malyutka Stary Bolshoy	48 3 3 4 5 1 3	
Sep. 2007	19	8	Malenky Peschanka Irkutsk Goloustnoye Flare Others	11 35 2 2 2	4 12 1 1 -
Mar. 2008	18	9	Goloustnoye Flare	16	9
Jun. 2008	19	7	Goloustnoye Flare	12	-
Aug. 2008	17	9	Goloustnoye Flare	1	9
Total	124	59		194	36

Measurement of water content and shear strength of core samples

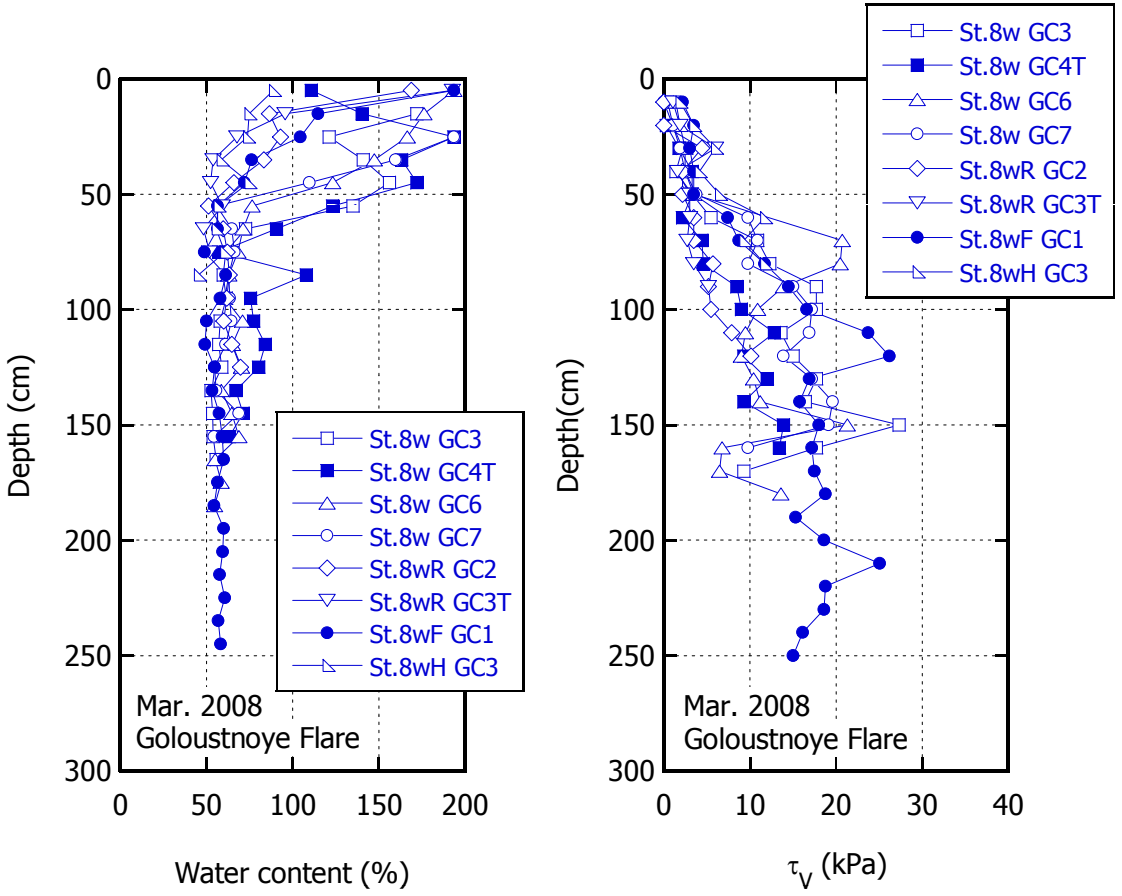


TDR type Water Content Probe
(manufactured by IMCO)

Portable Vane Shear Test

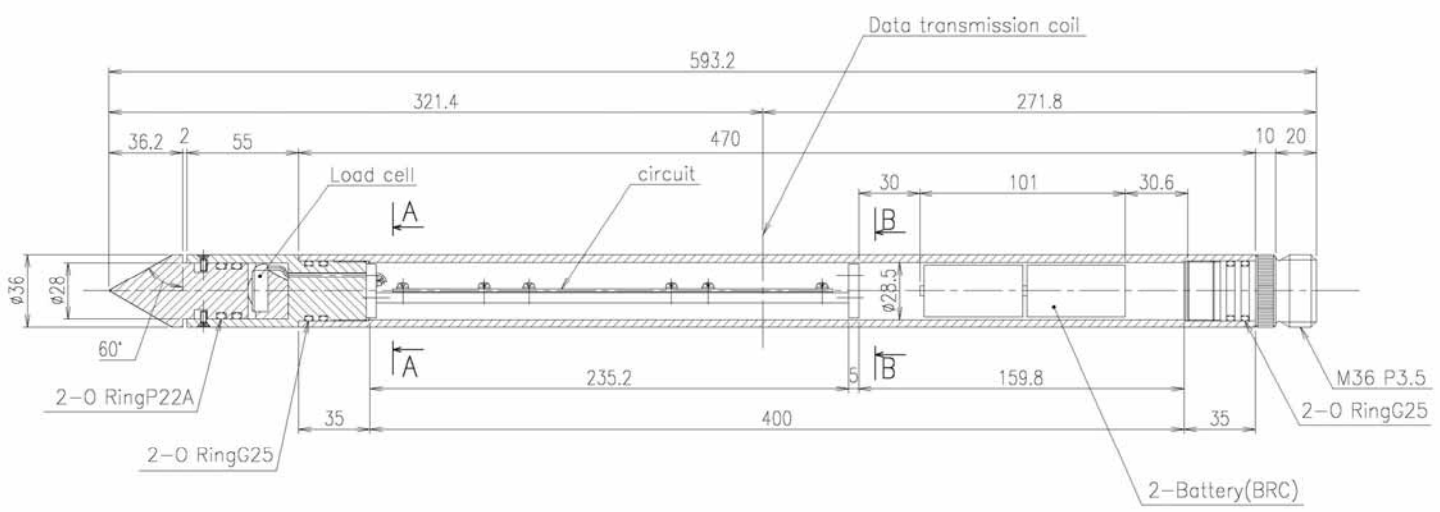
measurement of maximum torque for the vane rotation in sample

Water content and shear strength of core samples @ Goloustnoye F.



- 0-50cm depth: High water content (very soft sediment)
  50cm- depth: ca. 60%
- Shear strengths increase with depth (20kPa @250cm depth).

Deep Water-CPT Probe



ϕ:36mm L:593mm W:2.6kg

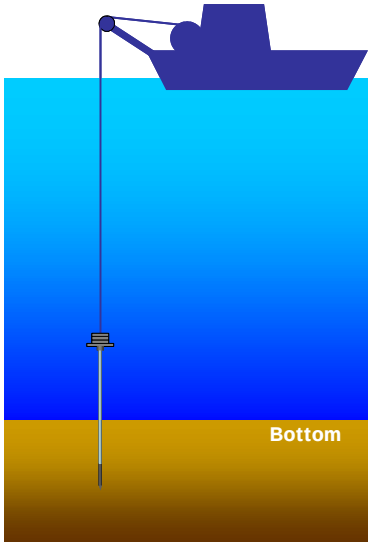
Loadcell: 20kN

Data Logger

1. Max Data: 1,000,000S
2. Max sampling rate: 200Hz
3. data DL: 1,000,000S/1hour

Development of Deep-Water CPT

Deep water CPT



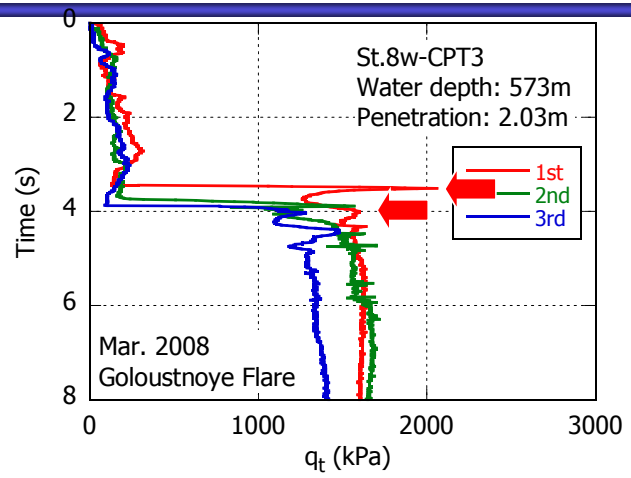
1. Measurement of gas hydrate depth and strength by CPT tip resistance
2. Penetration by weights
3. Penetration rate: ca. 0.5m/s

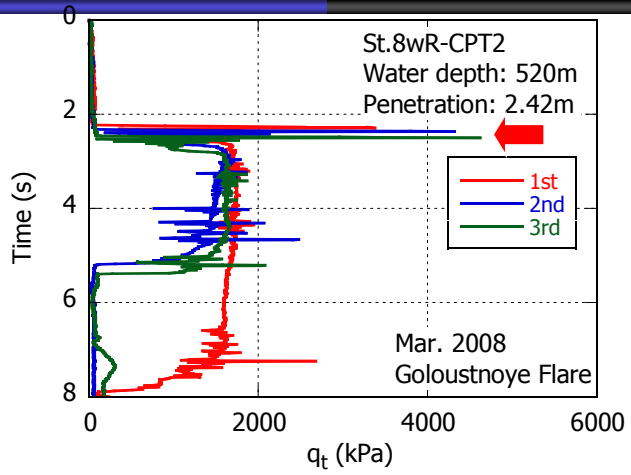
CPT by MIR Submersible

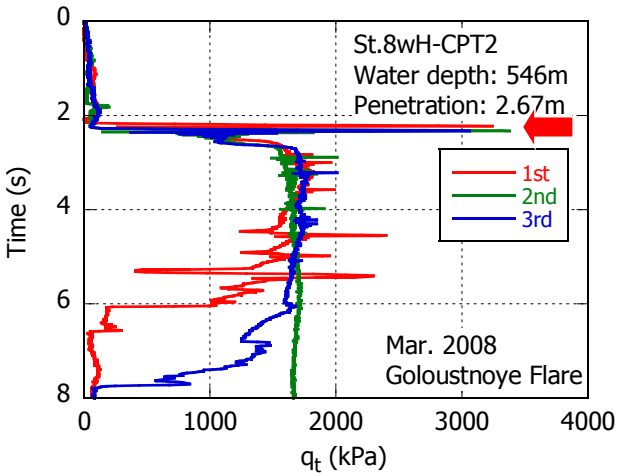
MIR diving to confirm the morphology of lake bottom

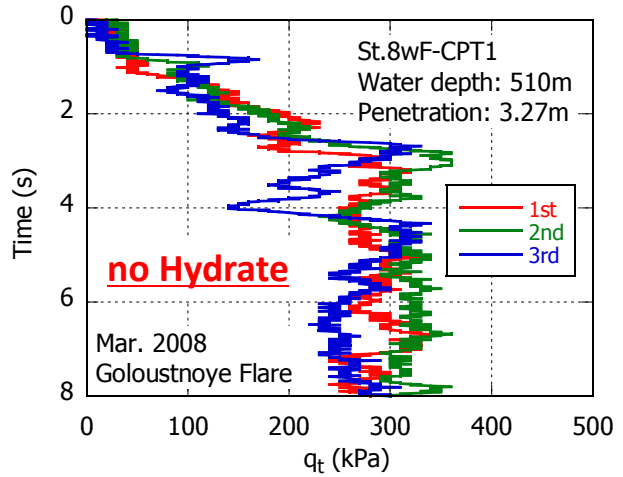
CPT using MIR manipulator

Results of Deep-Water CPT @Goloustnoye F.









- Estimation of Depth, strength and state of Hydrate in sediment
- Useful measurement tool for detecting Hydrate sediment layer

Gas Recovery Test from Near-Surface Gas Hydrate
(August 22-31, 2008)

1. Hydrate less than 1m depth from the bottom
2. Massive hydrate
3. Shallow water

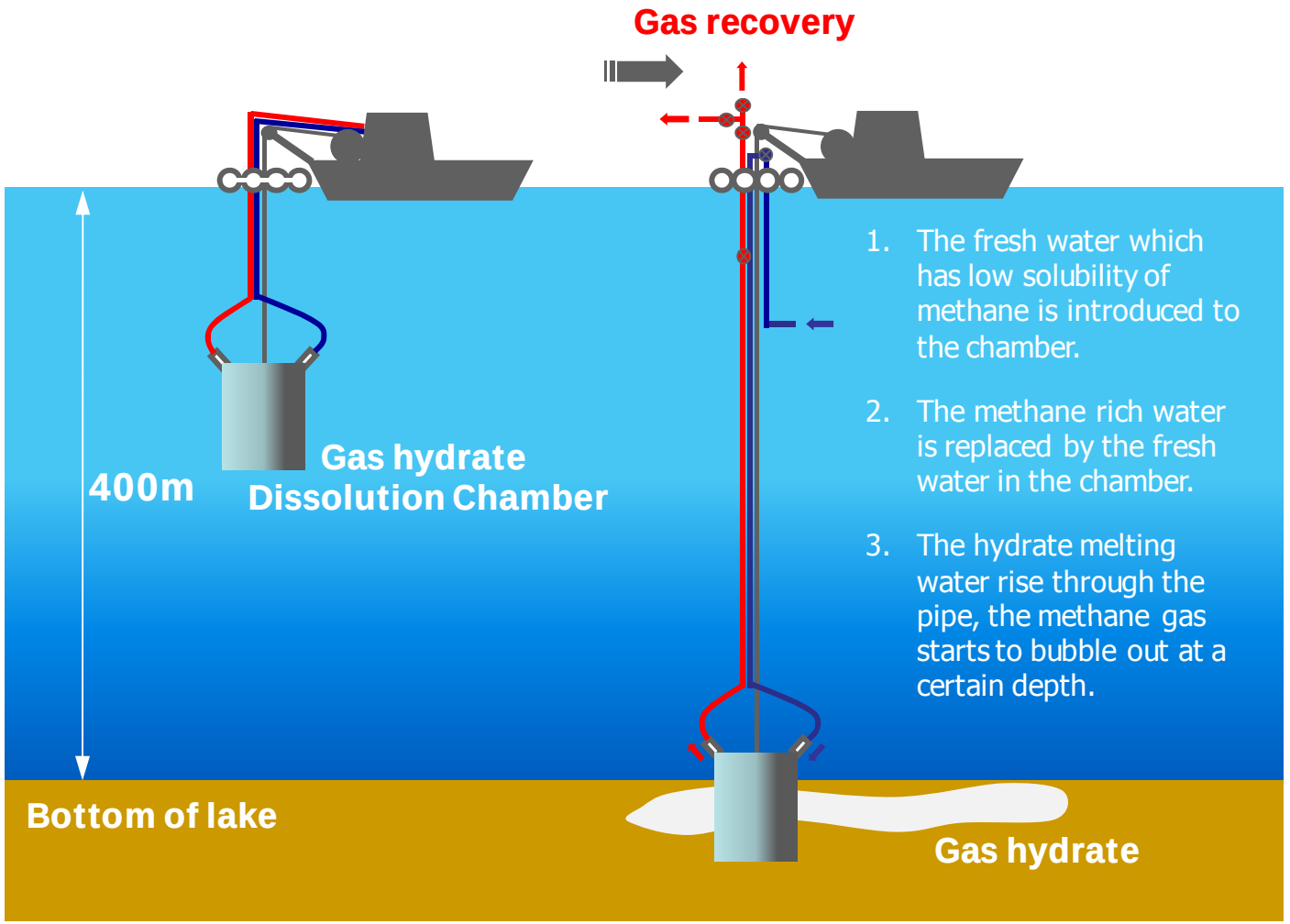
Optimum test site

Goloustnoye flare site

12 Participants

- SIT: 3
- KIT: 2
- HU: 2
- Meas. Partner: 2
- LIN, RAS: 3

Outline of gas recovery test

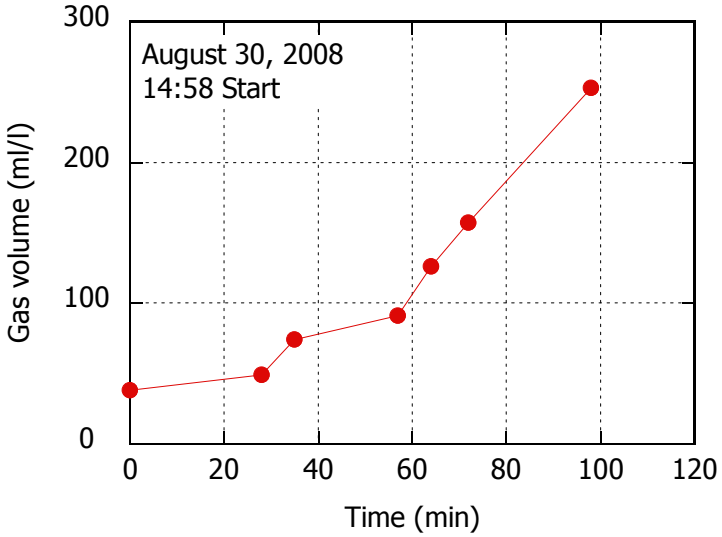


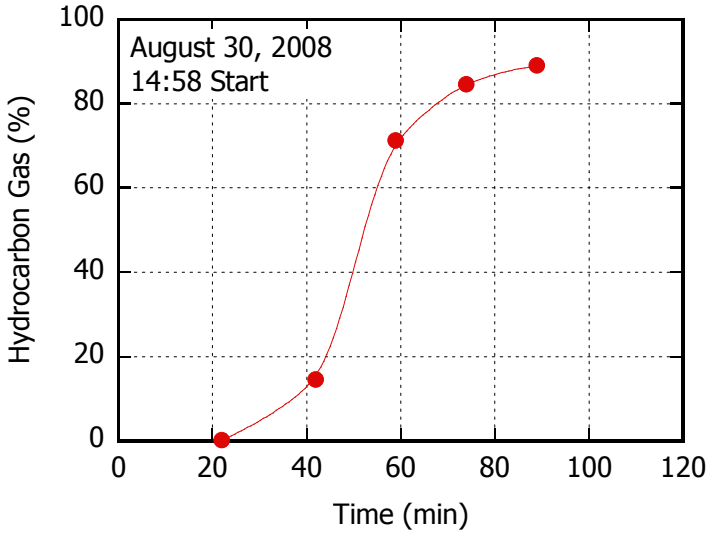
1. The fresh water which has low solubility of methane is introduced to the chamber.
2. The methane rich water is replaced by the fresh water in the chamber.
3. The hydrate melting water rise through the pipe, the methane gas starts to bubble out at a certain depth.

Gas Hydrate Dissolution Chamber

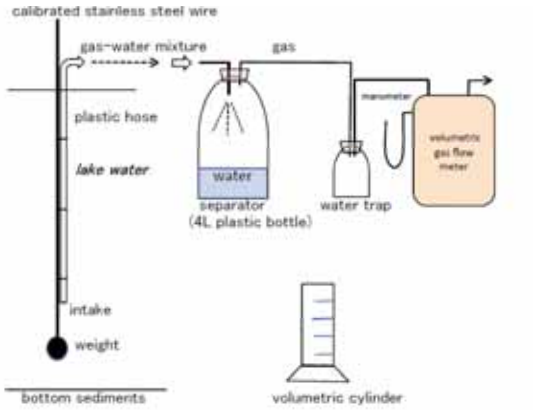
Diameter: 1.2m, Height: 2m
with 16 Horizontal water-jet, 16 Vertical water-jet at the tip

Gas recovery test results-1



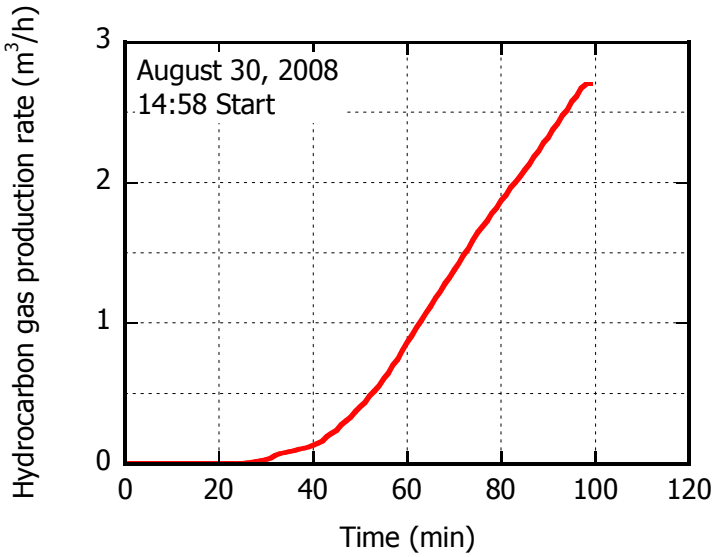


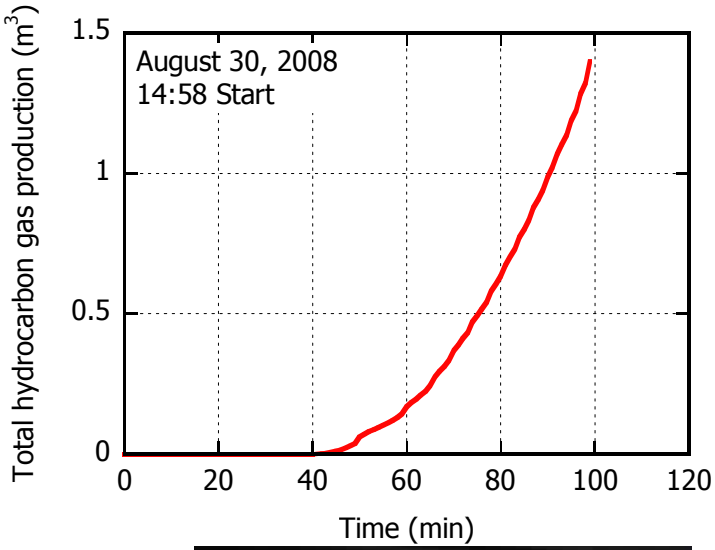
1. The total flow was 15.5m^3/h and the flow rate at the tip of water jet was 10.7m/s.
2. The value of gas volume ratio reached 0.25.
3. The concentration of hydrocarbon gas came close to 90% at the end of test.



Gas volume measurement system

Gas recovery test results-2





1. The gas recovery rate was 2.7m^3/h (Total gas volume : 1.4m^3/100min).
2. Ethane concentration: 1%, Propane concentration: 40ppm.
3. The isotopic composition of recovery gas came to that of hydrate dissociation gas.

Fire from gas hydrate

We could recover the gas from gas hydrate.

Summary

1. In Aug. 2008, Shimizu Corporation succeeded in gas recovery test from the gas hydrate deposit at the bottom of Lake Baikal in collaboration with Limnological Institute (Russian Academy of Science), Kitami Institute of Technology and Hokkaido University.
2. This is the world's first attempt of gas hydrate recovery in offshore.
3. The water depth of test site was about 400m. A steel chamber with a diameter of 1.2 m and equipped with 32 water jet nozzles was used for gas recovery. We attempted to recover gas hydrate by dissolving it in water and pumping it up.
4. The value of gas volume ratio reached 0.25 and the concentration of hydrocarbon gas came close to 90% at the end of test.
5. The gas recovery rate was 1.4m^3/100min.
6. According to the measurements of the volume composition and the isotopic composition of recovery gas, the recovered hydrocarbon gas originates from the gas hydrate layer.