JNOC-TRC

メタンハイドレート資源開発研究
資源量評価分野の研究開発

平成13年度研究成果報告会

平成14年7月2日

石油公団　石油開発技術センター

JNOC-TRC

マリックプロジェクト

サイエンスプログラム概要

メタンハイドレート研究プロジェクトチーム
内　田　　隆

１．目的

メタンハイドレート実証井Mallik 2L-38掘削成果を踏まえ，マリック生産調査井の掘削によってメタンハイドレートの成因および産状，形態，分布などからメタンハイドレート賦存様式を解明し，メタンハイドレート鉱床胚胎を予測する技術開発および南海トラフ地域のメタンハイドレート資源量評価に資する。

２．研究内容

マッケンジーデルタにおけるメタンハイドレートの生産調査井Mallik3L,4L,5L-38のサイエンスプログラム関連の研究

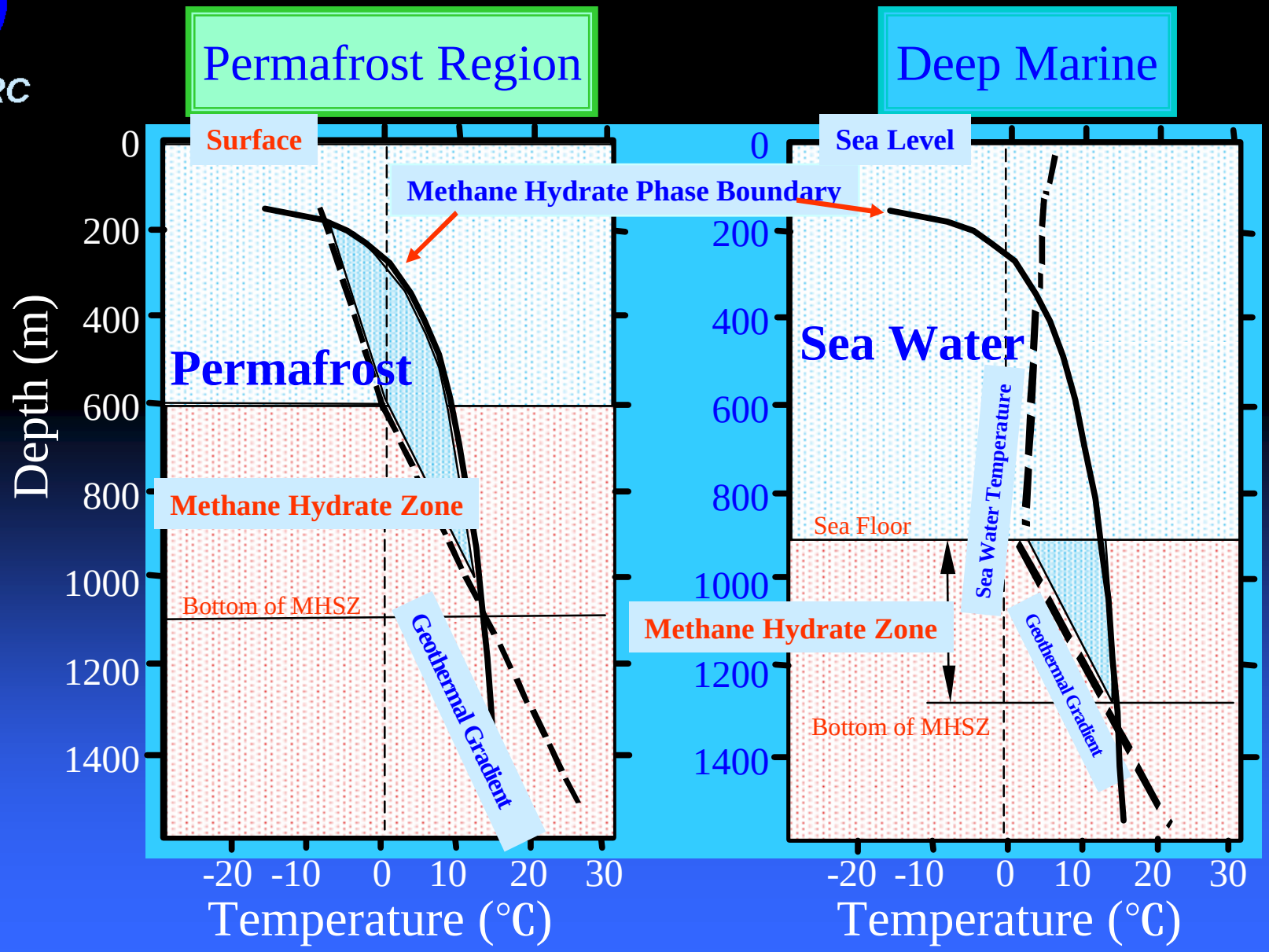
（１）事前準備及び資機材送付
（２）坑井地質作業
（３）試料分析，検層解析

Mallik Gas Hydrate Production Research Well Project

Science Program in Japan

1. Petrophysical Properties: JAPEX/JNOC-TRC
2. Biostratigraphy: JAPEX/Niigata Univ
3. Geochemistry
   - 3.1) Organic Geochemistry: JAPEX
   - 3.2) Gas Geochemistry: JAPEX
   - 3.3) Isotope Geochemistry: JAPEX
   - 3.4) Sediment Geochemistry: AIST (GSJ)
4. Microbiology: JAMSTEC
5. Gas Hydrate Characteristics
   - 5.1) Nuclear Magnetic Resonance (NMR): JAPEX
   - 5.2) Laser Raman Scattering and XRD: AIST (HNIRI)
   - 5.3) Gas Hydrate Dissociation Modeling: Tokyo Univ/ JOE/ JAPEX
   - 5.4) Gas Geochemistry (gas hydrate): JAPEX
   - 5.5) Isotope Geochemistry (gas hydrate): JAPEX
   - 5.6) Inorganic Geochemistry (gas hydrate): Tokyo University
   - 5.7) Physical property (gas hydrate): Osaka Gas
   - 5.8) Formation/dissociation kinetics (gas hydrate): JNOC/Tokyo Gas
   - 5.9) X-ray CT imaging (gas hydrate): JNOC/JAPEX
   - 5.10) Seismics (Cross-hole tomography): JNOC/JAPEX/Kyoto Univ/JGI

JNOC-TRC


Permafrost Region
Deep Marine
Surface
Sea Level
Methane Hydrate Phase Boundary
Permafrost
Sea Water
Methane Hydrate Zone
Sea Floor
Bottom of MHSZ
Sea Water Temperature
Geothermal Gradient
Depth (m)
0
200
400
600
800
1000
1200
1400
-20 -10 0 10 20 30
Temperature (℃)

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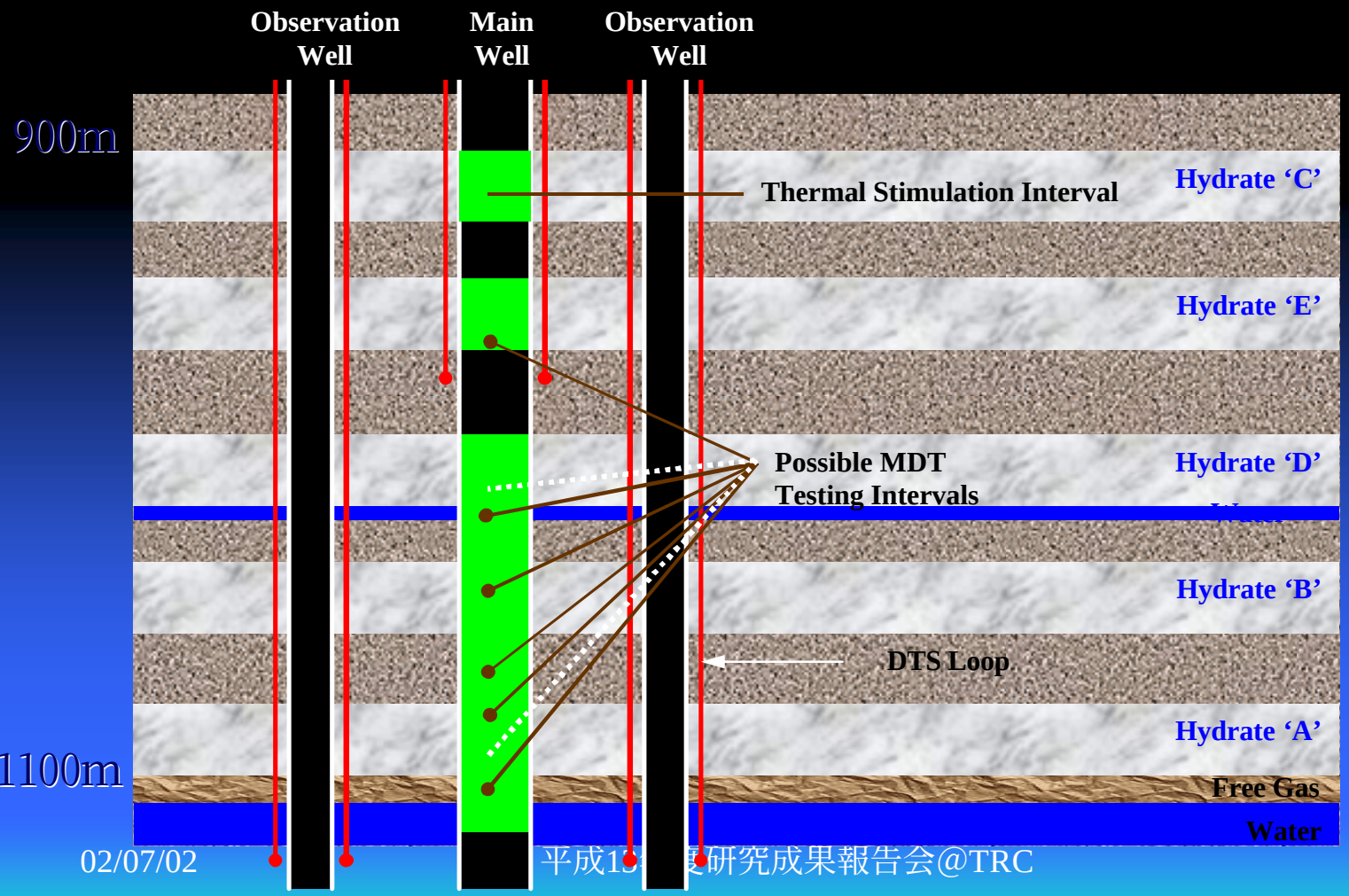
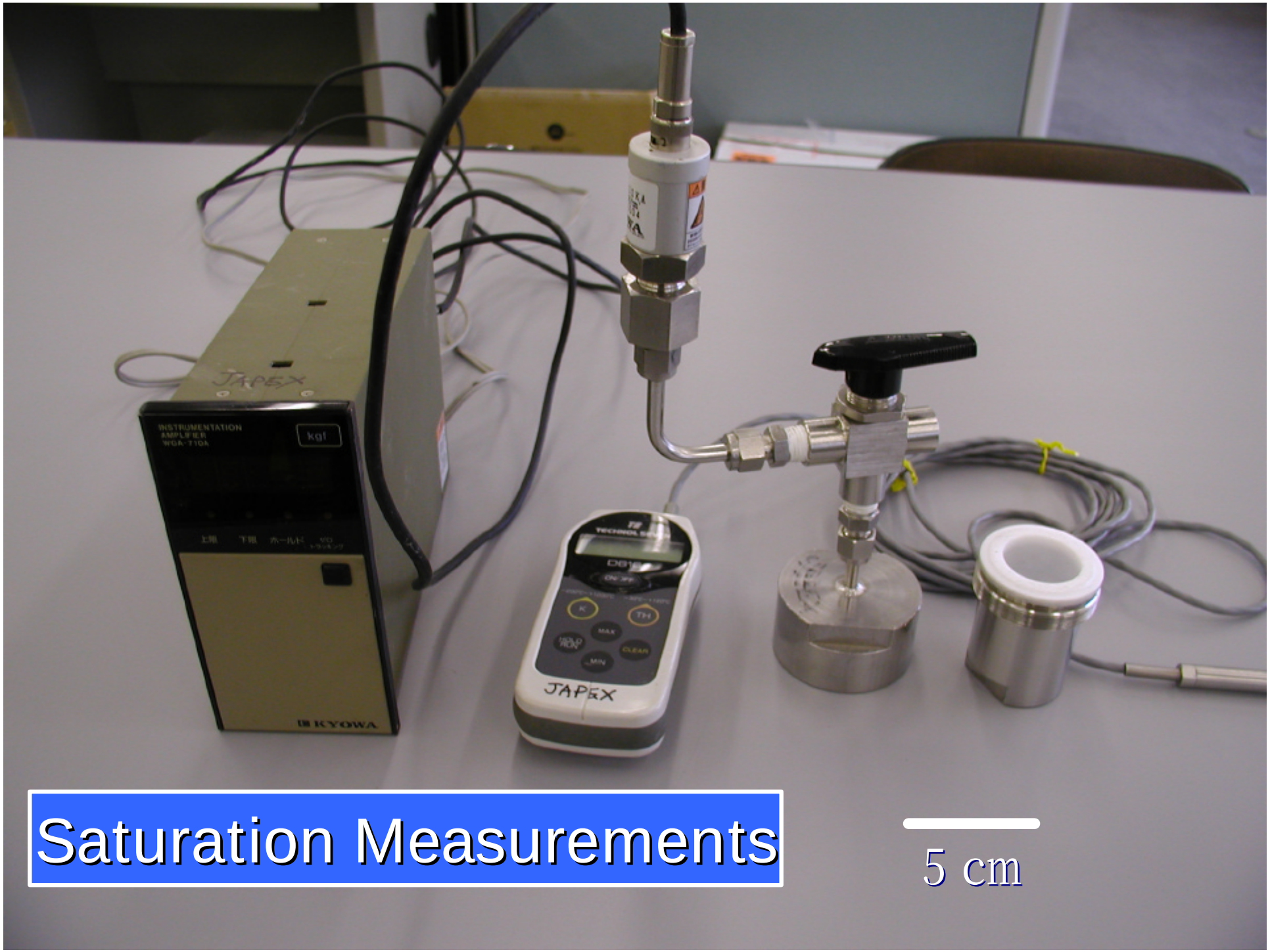
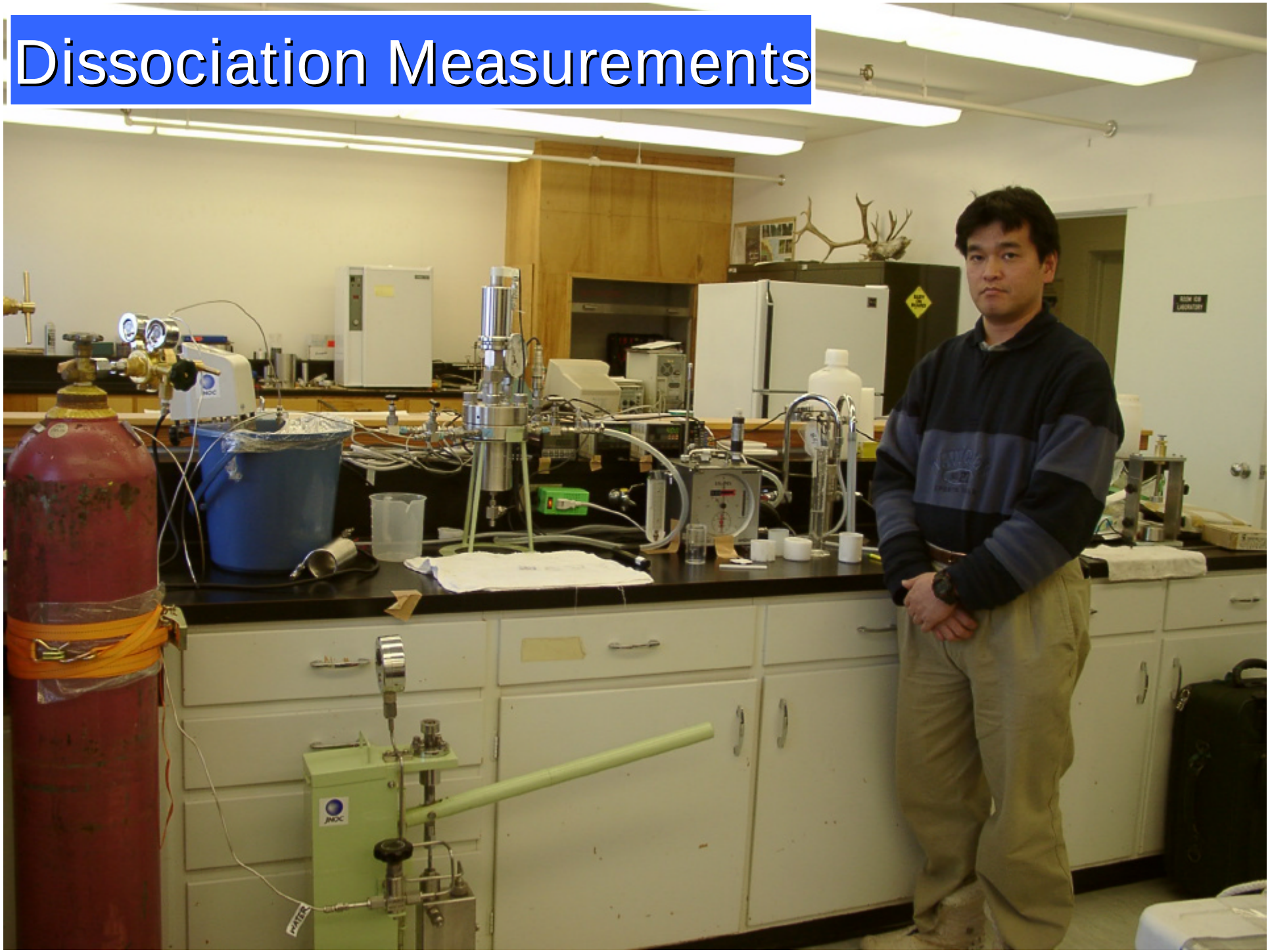
Mallik DTS Configurations



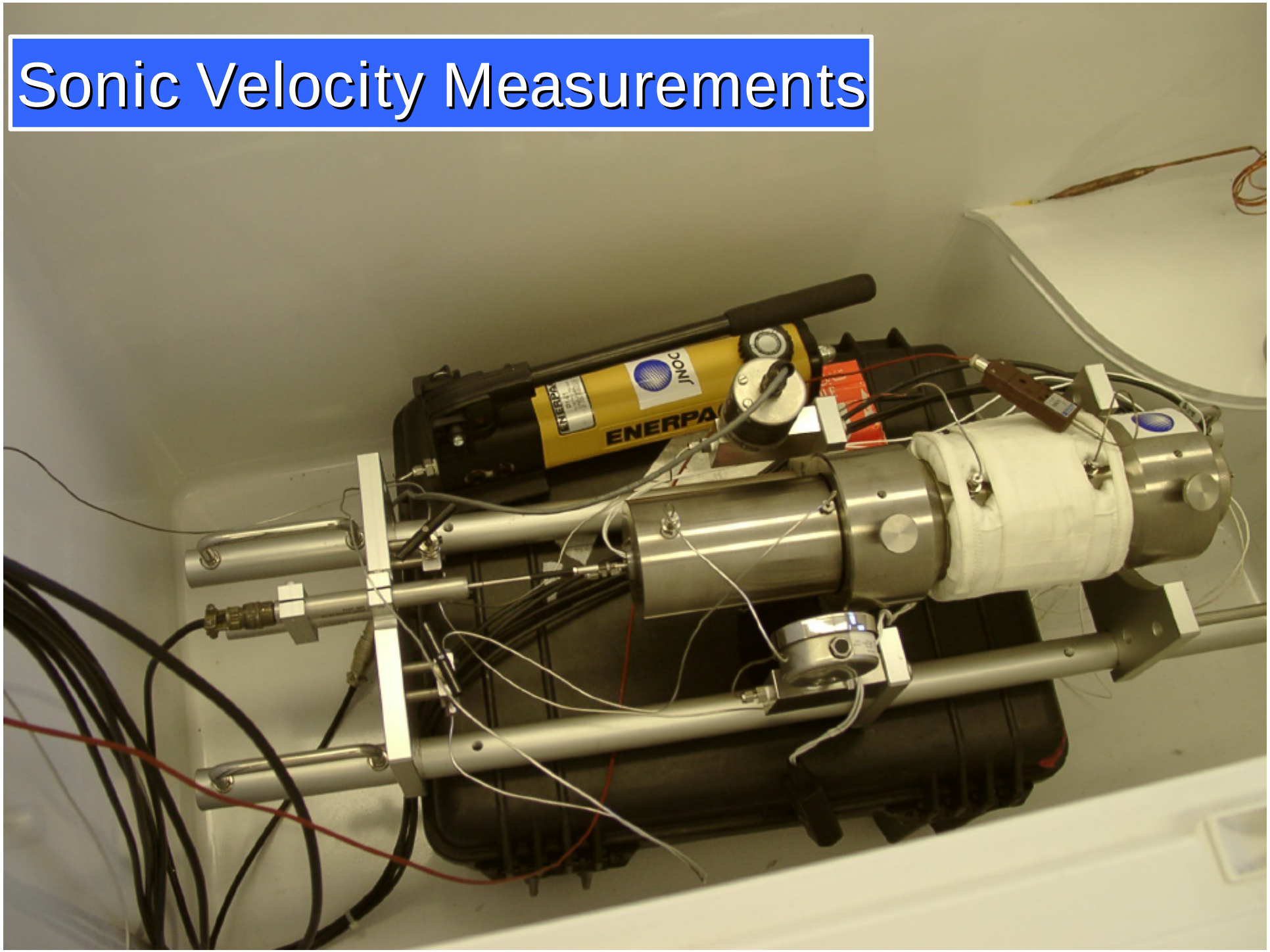


Saturation Measurements

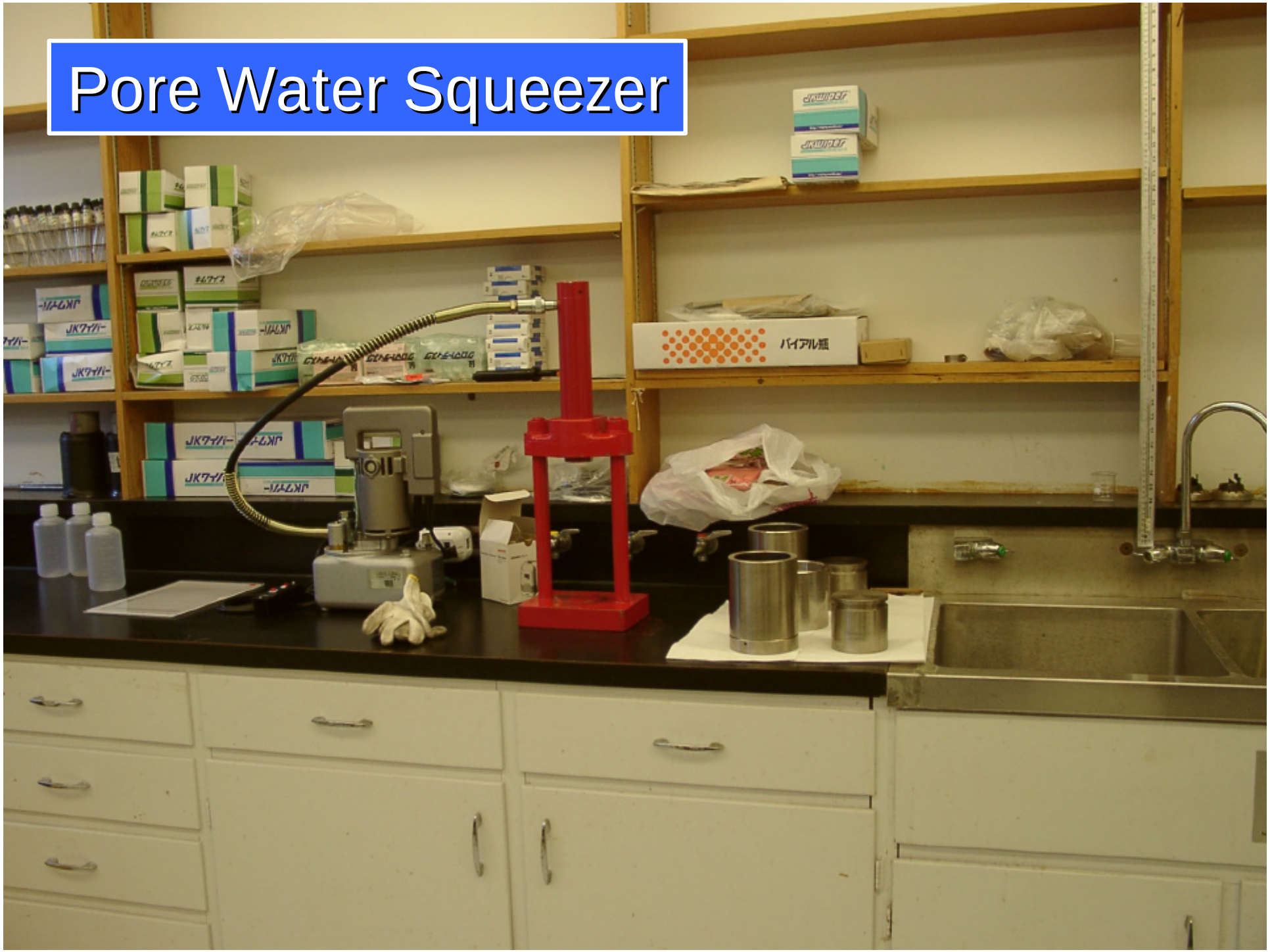
Dissociation Measurements

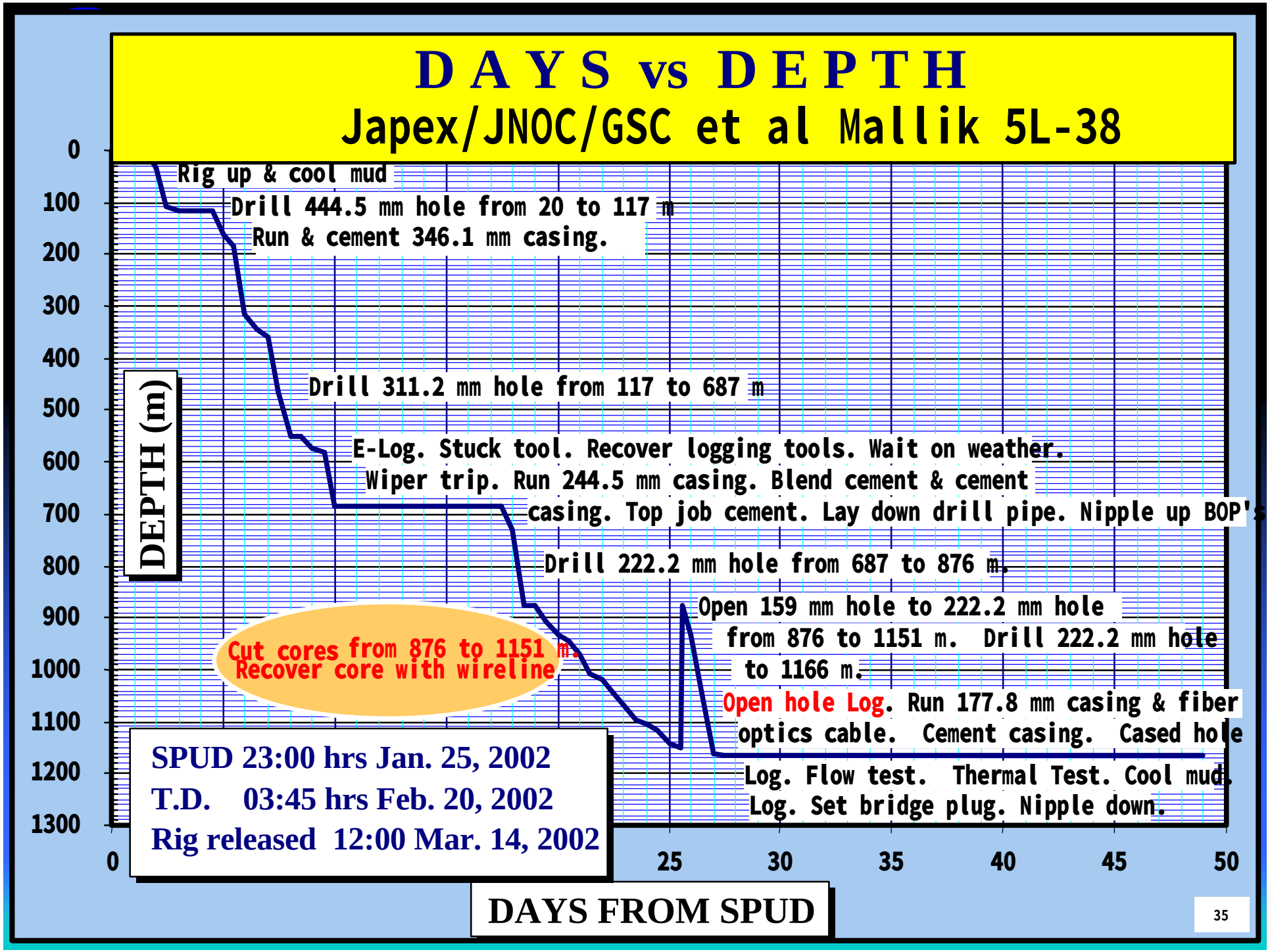


Sonic Velocity Measurements



Pore Water Squeezer




DAYS vs DEPTH
Japex/JNOC/GSC et al Mallik 5L-38
DEPTH (m)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
Rig up & cool mud
Drill 444.5 mm hole from 20 to 117 m
Run & cement 346.1 mm casing.
Drill 311.2 mm hole from 117 to 687 m
E-Log. Stuck tool. Recover logging tools. Wait on weather.
Wiper trip. Run 244.5 mm casing. Blend cement & cement
casing. Top job cement. Lay down drill pipe. Nipple up BOP's
Drill 222.2 mm hole from 687 to 876 m.
Cut cores from 876 to 1151 m.
Recover core with wireline
Open 159 mm hole to 222.2 mm hole
from 876 to 1151 m. Drill 222.2 mm hole
to 1166 m.
Open hole Log. Run 177.8 mm casing & fiber
optics cable. Cement casing. Cased hole
Log. Flow test. Thermal Test. Cool mud.
Log. Set bridge plug. Nipple down.
SPUD 23:00 hrs Jan. 25, 2002
T.D. 03:45 hrs Feb. 20, 2002
Rig released 12:00 Mar. 14, 2002
0
25
30
35
40
45
50
DAYS FROM SPUD

Sampled at Well site and IRC

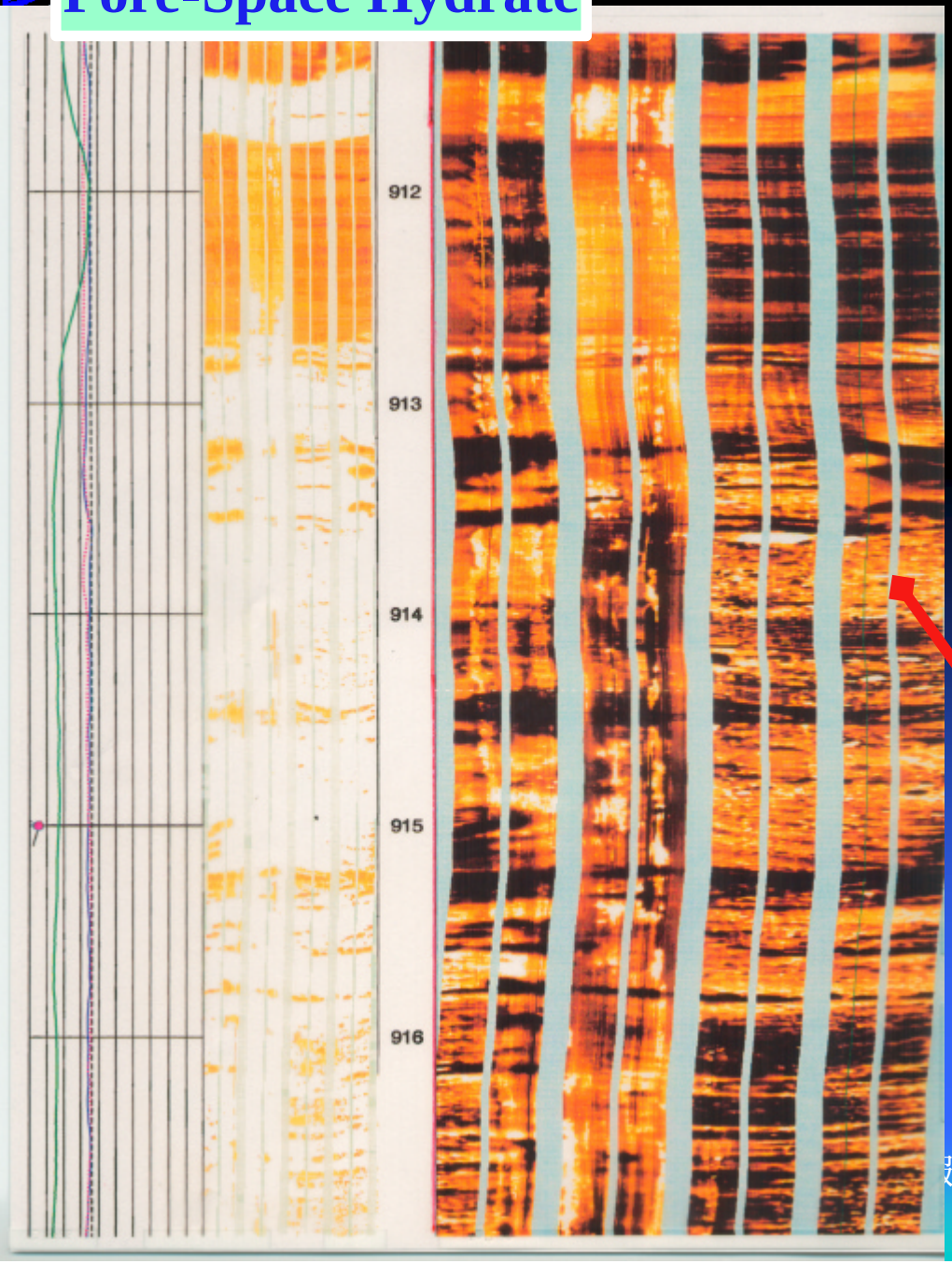
1. Well site

			no.	plan	result
GH cores	pressured core			50	41
	liquid Nitrogen			10	0
Saturation measurements	GH core			20	16
Gas sample from above	gas cylinder				16
Headspace gas				24	47
Microbiology sample				100	23

2. Inuvik Research Center

Ordinary core	organic matter		100	140
Formation water	vial		300	180
Dissociation experiments, Sonic velocity measurements				12

Pore-Space Hydrate



Mallik 2L-38

904m:
Common Occurrence of Pore-Space Hydrate

913.7m: Biggest Form of Pore-Space Hydrate


G S C

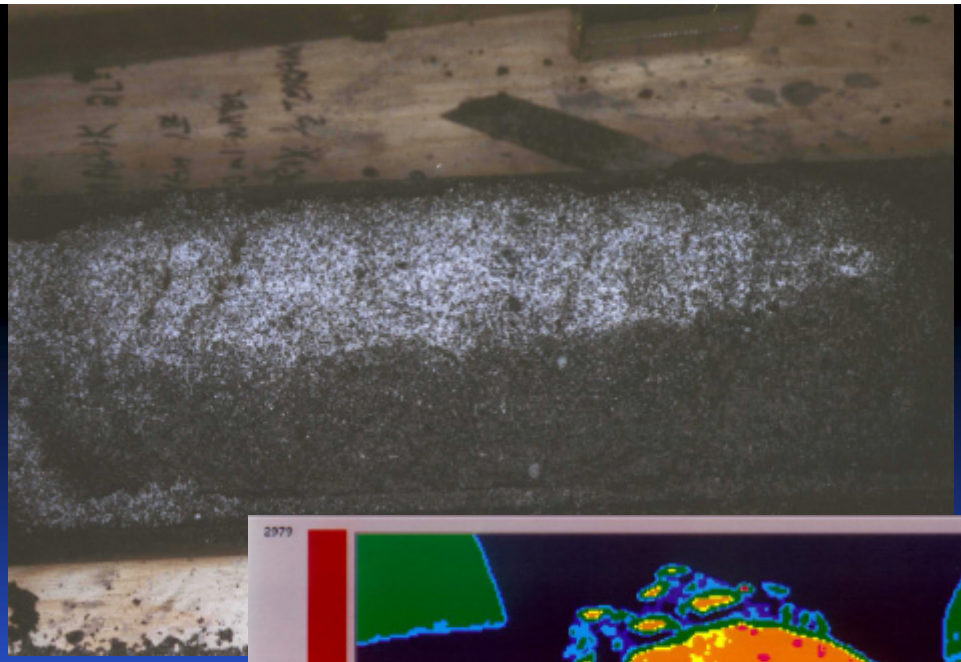

174
175
176
14F
177
178
179
15F
181
182
183
15F
184

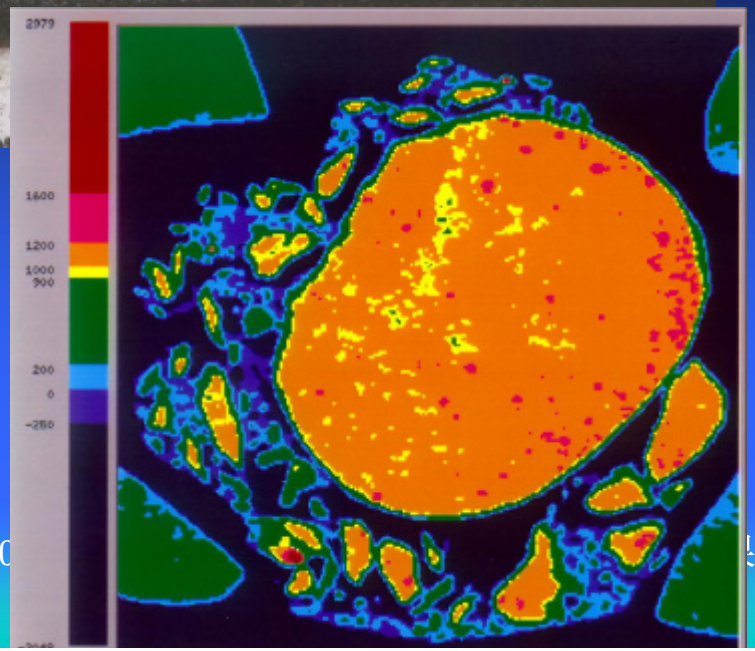
X線CTスキャナ

JNOC-TRC

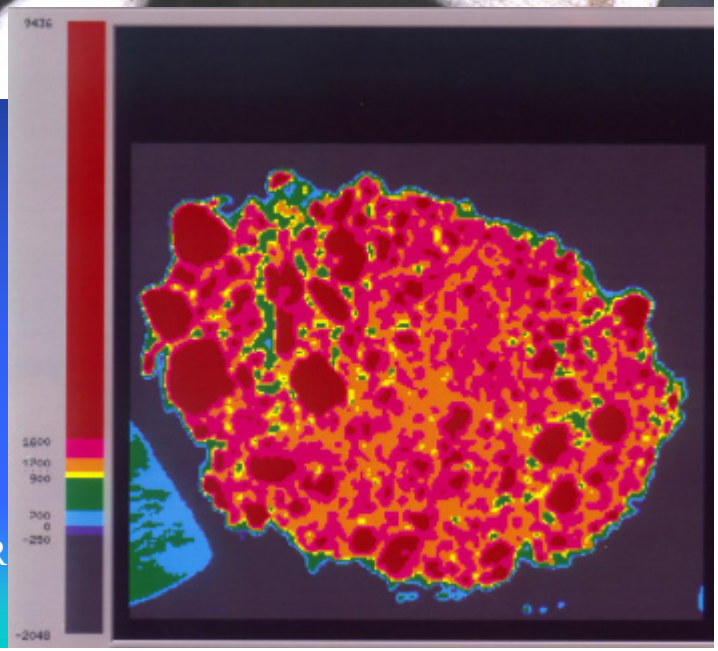
Mallik 2L-38

904m: Common Occurrence of Pore-Space Hydrate





913.7m: Biggest Form of Pore-Space Hydrate



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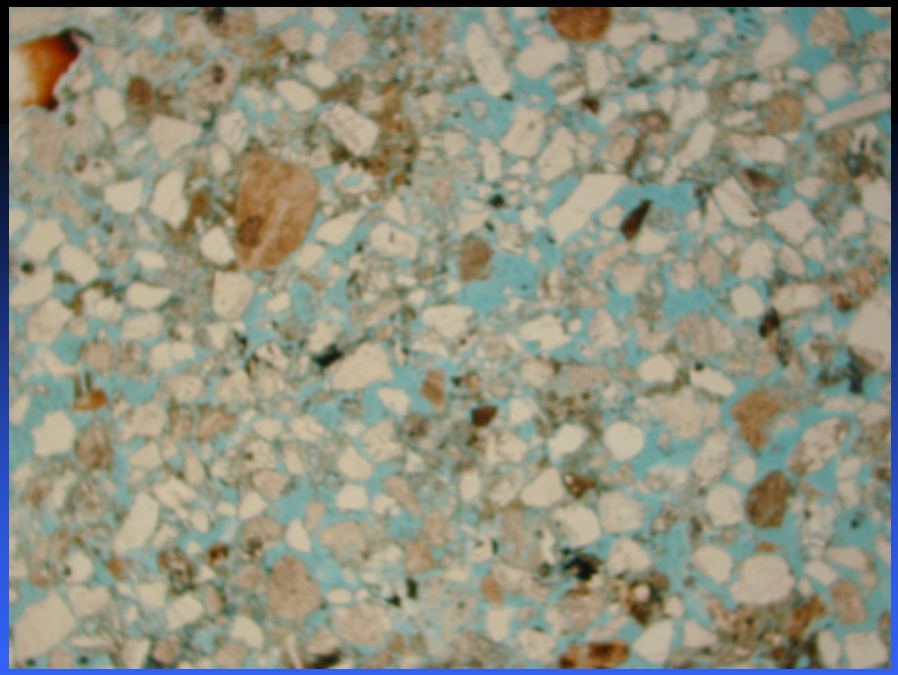
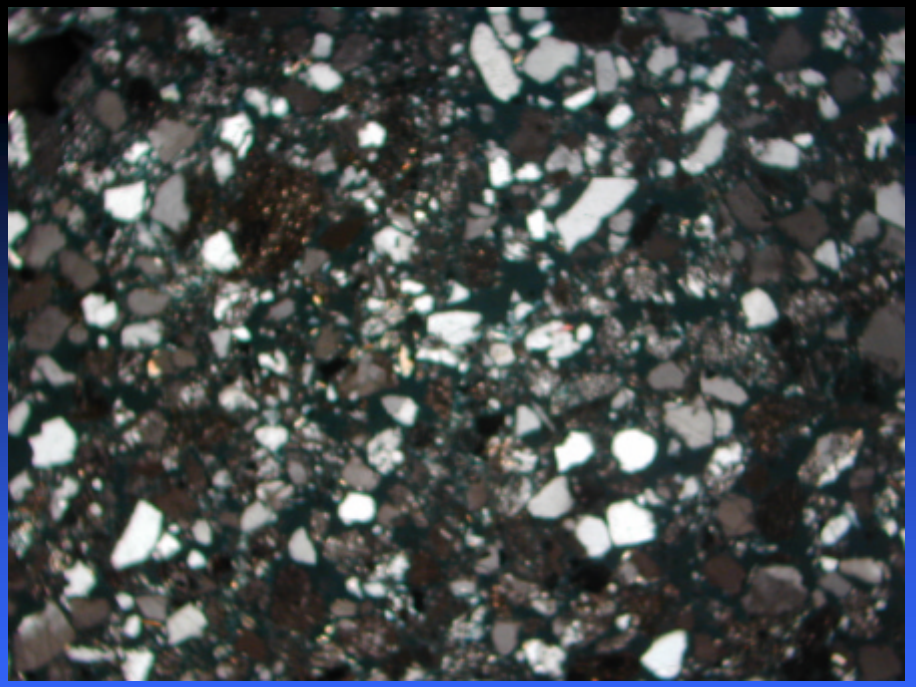
Photomicrographs of thin-section: Mallik

1mm



Open Nicol



Crossed Nicols

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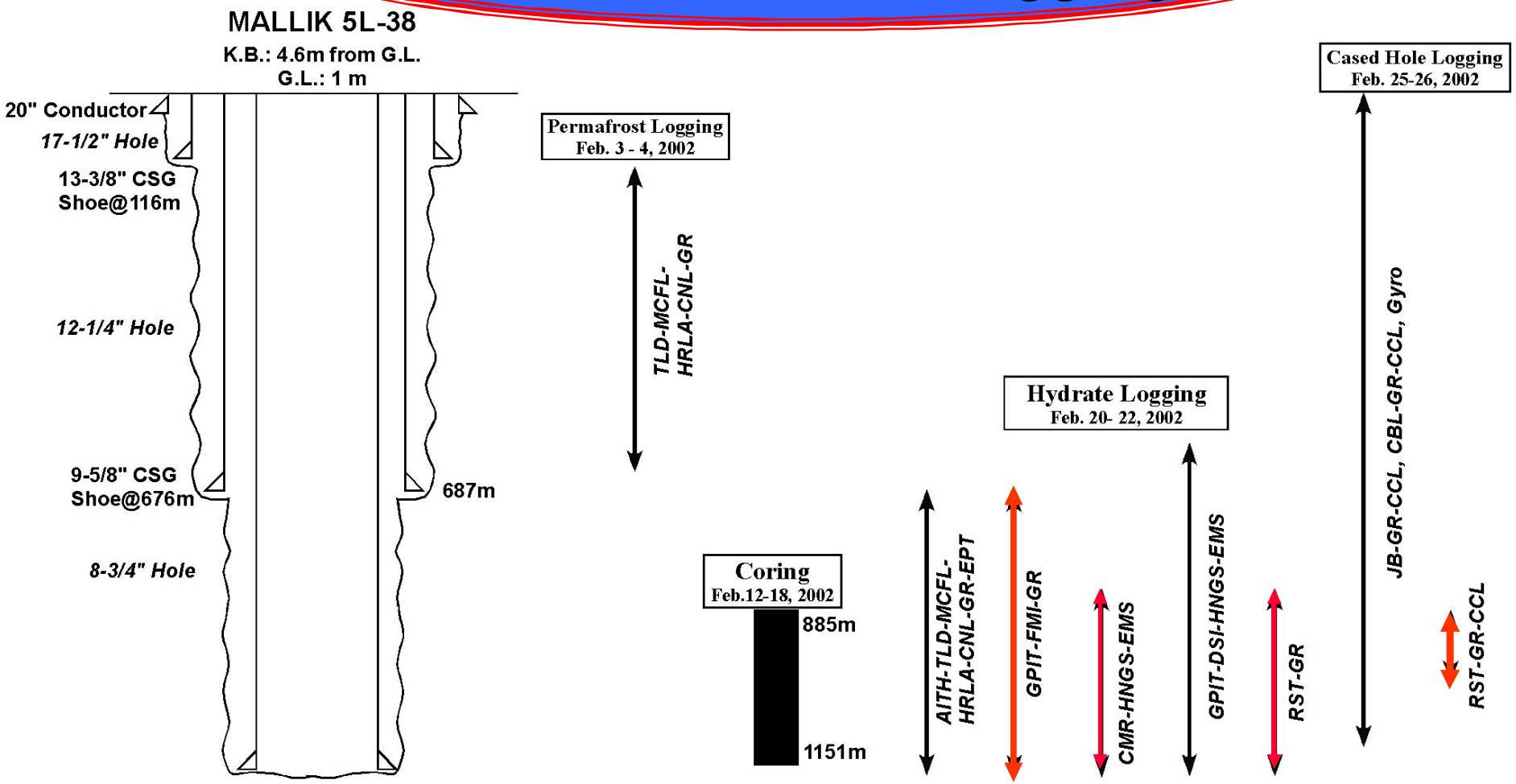
Downhole Well Logging



Mallik 5L-38 Sample Flow

Gas Hydrate Characterization
JNOC/JAPEX
AIST(HNIRI)
JAPEX/Tokyo Univ
Tokyo Gas
Osaka Gas

X-ray CT, NMR, Petrophysical Property
Laser/Raman
Dissociation Experiment
Dissociation Rate
Physical Properties

Sedimentology
JAPEX

FMI

Downhole Well Logging
JAPEX
JAPEX/Kyoto Univ

X-hole Tomography

Gas Hydrate Core | Well Log Data

Science Program Japan

Ordinary Sample | Production Data

*exclusive of ICDP

Petrophysical Properties
JAPEX

tribution

Microbiology
JAMSTEC

Biostratigraphy
JAPEX/Niigata Univ

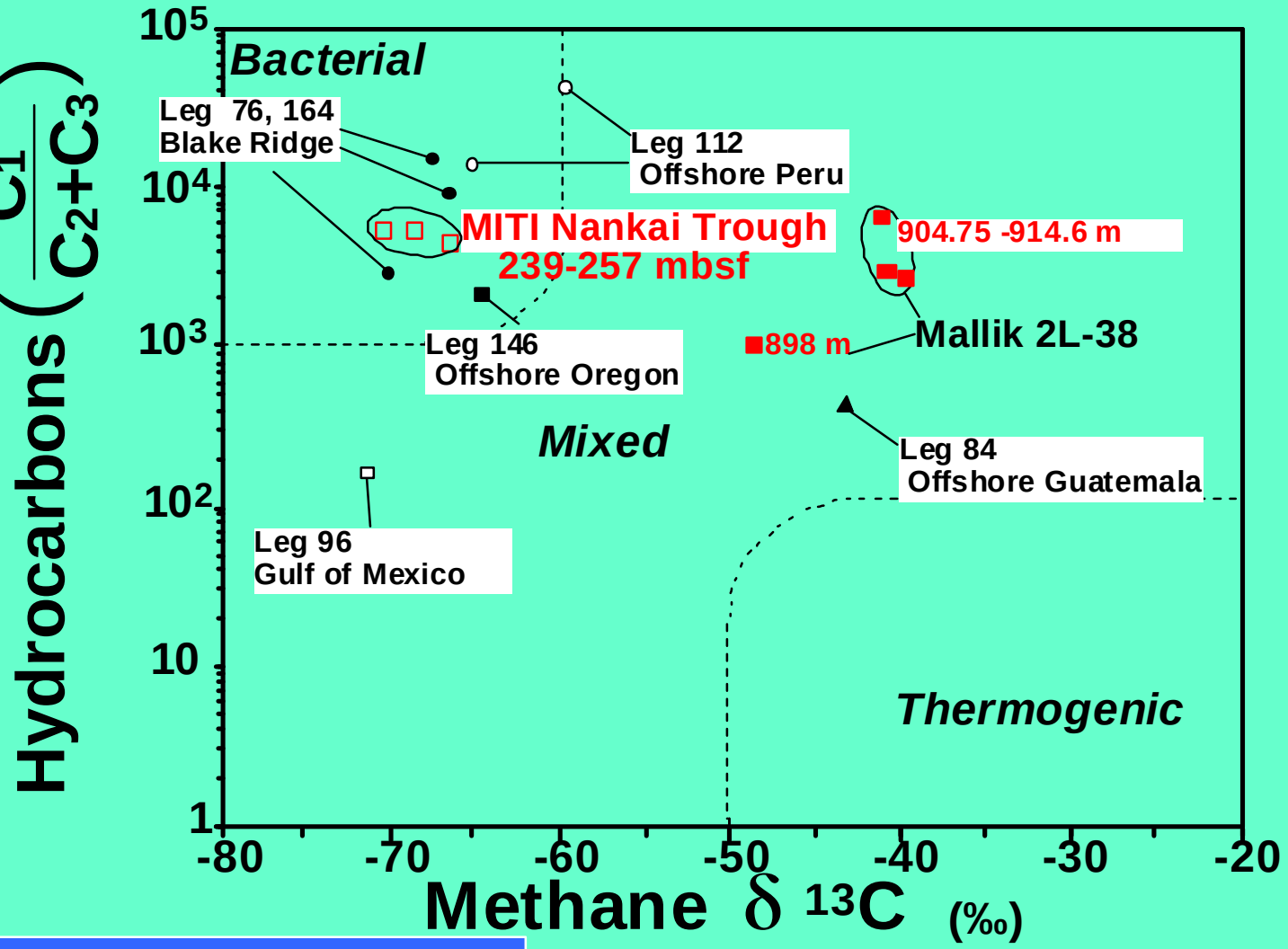
Dinoflage ate

Geochemistry
JAPEX
Tokyo Univ
AIST (GSJ)

Production
JNOC/JAPEX

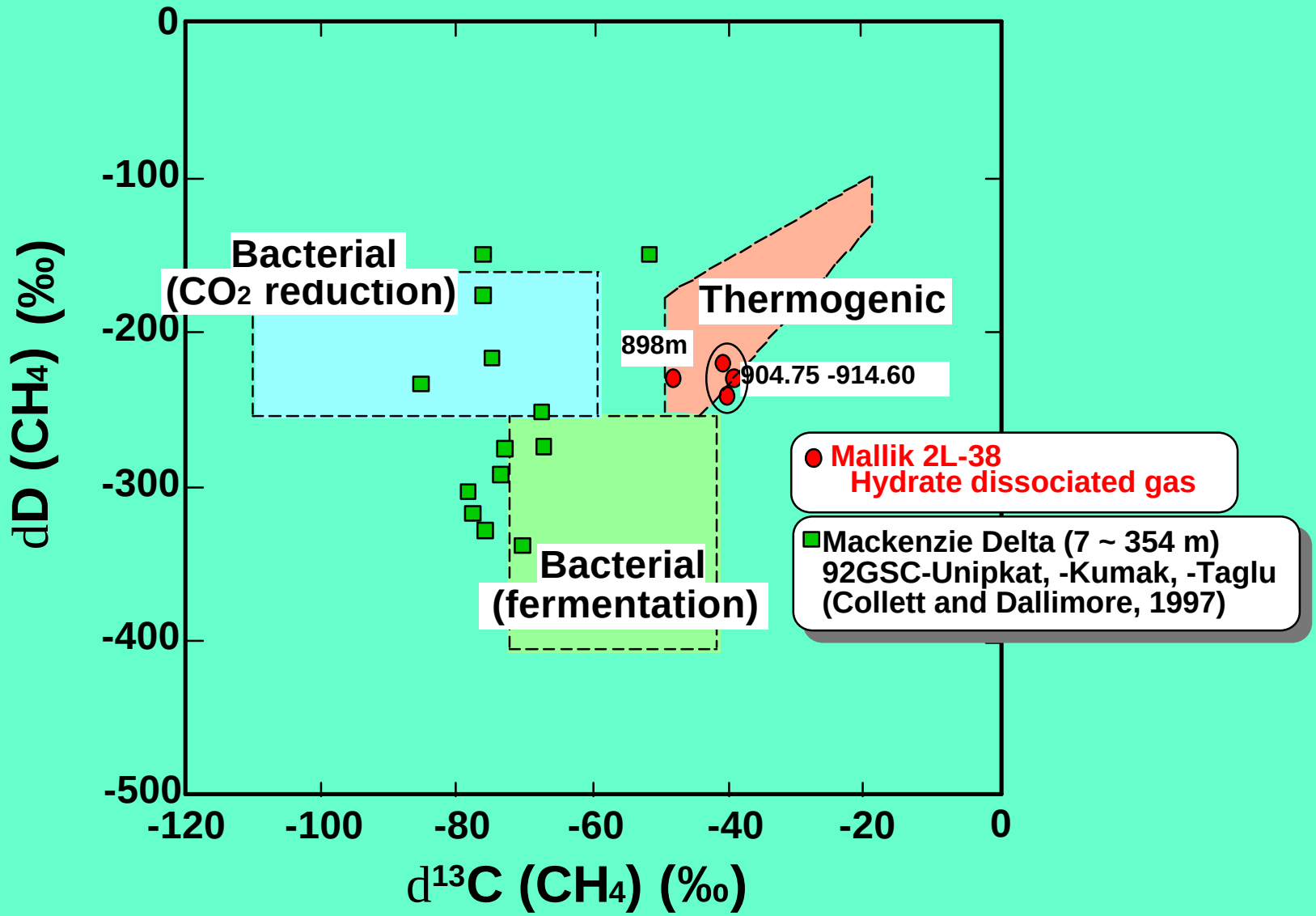
Modeling
JAPEX
JOE/Tokyo Univ

Relations between carbon isotope and methane content



Mallik 2L-38

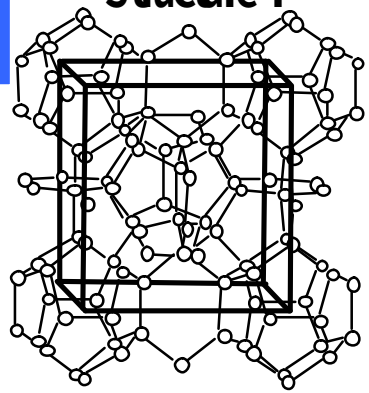
Mallik 2L-38


0
-100
-200
-300
-400
-500
-120
-100
-80
-60
-40
-20
0
dD (CH4) (‰)
d13C (CH4) (‰)
Bacterial
(CO2 reduction)
Thermogenic
898m
904.75 -914.60
Bacterial
(fermentation)
Mallik 2L-38
Hydrate dissociated gas
Mackenzie Delta (7 ~ 354 m)
92GSC-Unipkat, -Kumak, -Taglu
(Collett and Dallimore, 1997)

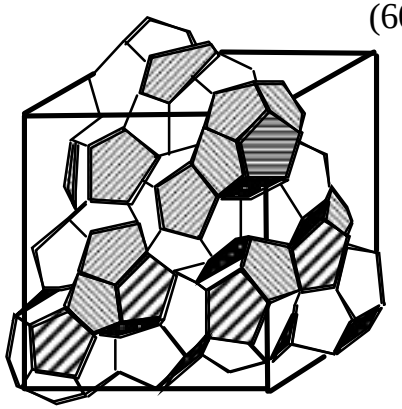
Mallik 2L-38

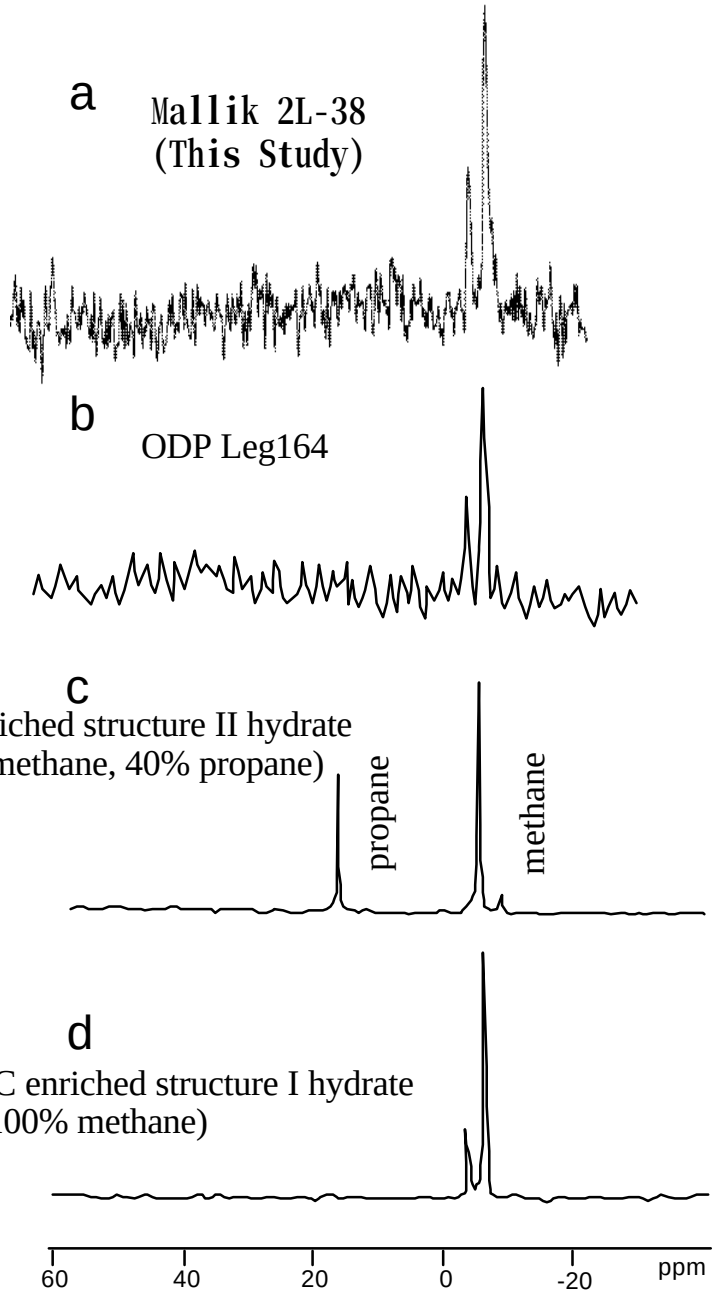
NMR

Structure-I

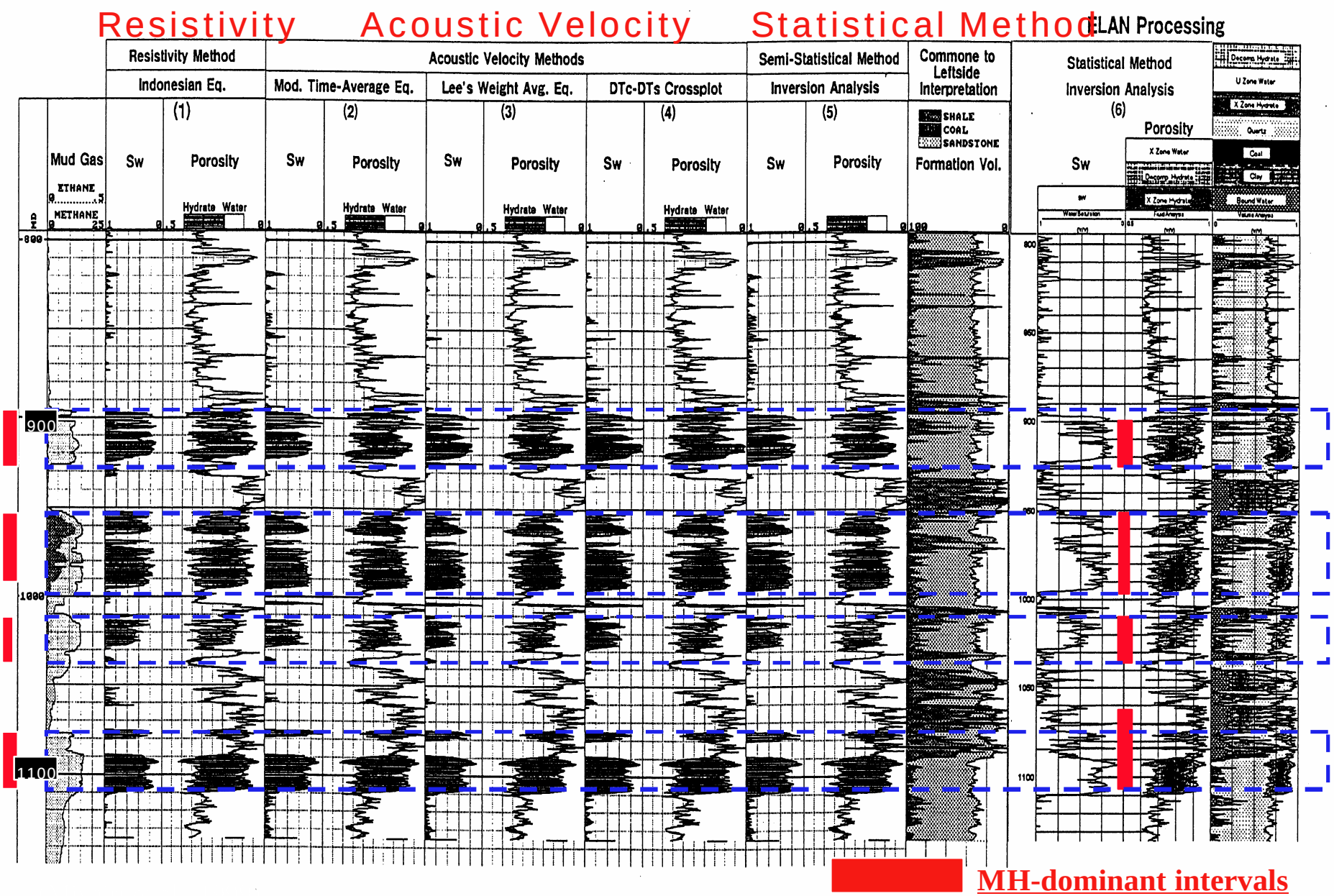


Structure-II

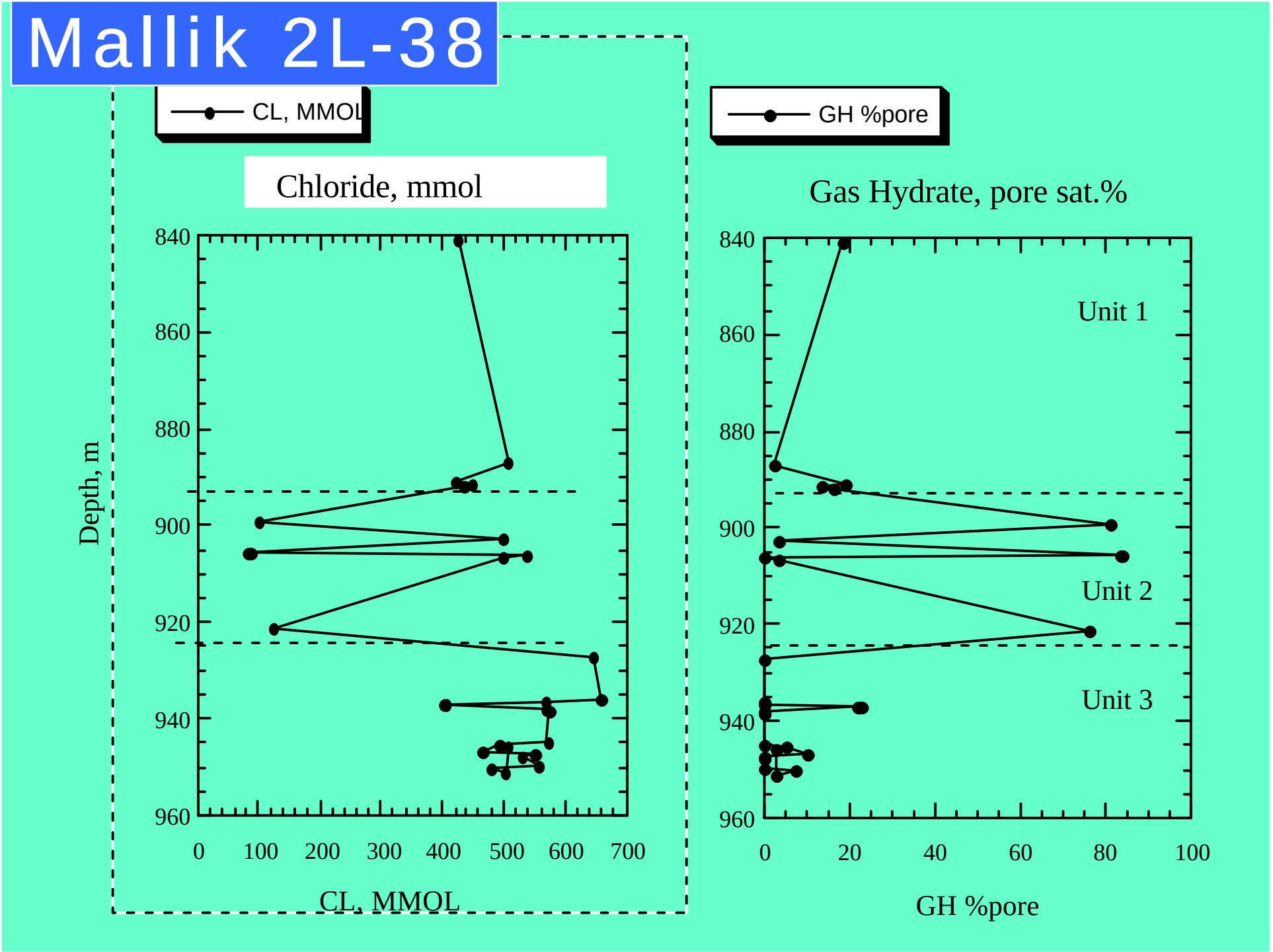




Mallik 2L-38 Result of Well Log Analyses



Mallik 2L-38


CL, MMOL
Chloride, mmol
Depth, m
840
860
880
900
920
940
960
0
100
200
300
400
500
600
700
CL, MMOL
GH %pore
Gas Hydrate, pore sat.%
Unit 1
Unit 2
Unit 3
0
20
40
60
80
100
GH %pore


石油開発技術センター研究成果報告会平成14年7月2日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まとめ

- メタンハイドレート含有砂コア試料ほかを採取し，産状を観察した
  孔隙充填型ハイドレート：Mallik2L-38，南海トラフ
- メタンハイドレート卓越4層準を確認した
  コアおよび検層解析から高飽和率を再確認
- メタンハイドレート分布下限を確認した
  コア観察，検層，DTS：安定領域下限にほぼ一致
- 永久凍土層下限を確認した
  DTS，検層

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今後の予定

コア分析関連

X線CT, 地化学分析, 岩石鉱物分析ほか：ほぼ終了

NMR, Laser-Raman

X線CT分解実験

浸透率測定

分析結果の総合解釈

検層解析

検層解析

FMIほかによる堆積相古流向解析

その他

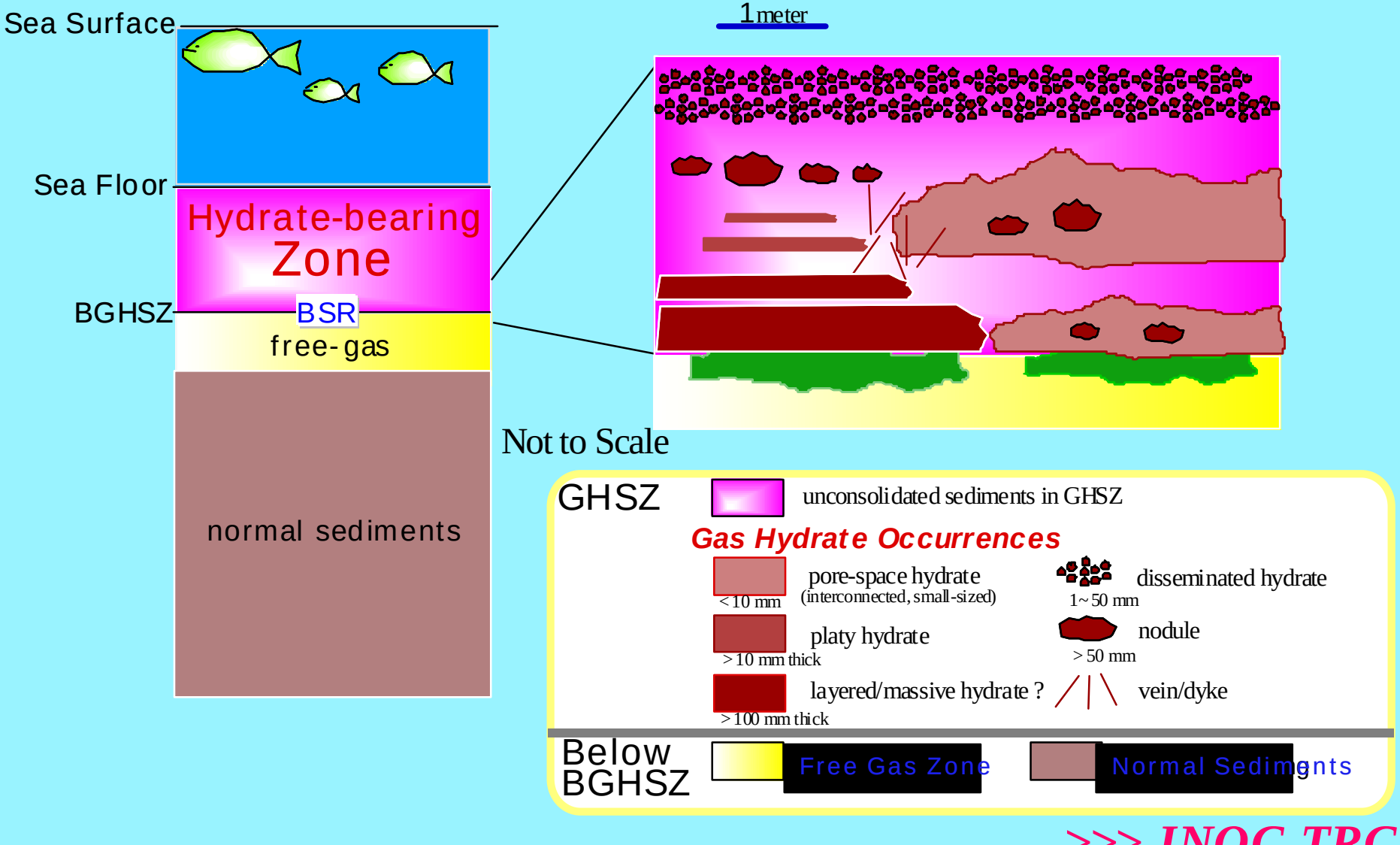
マリックサイエンスワークショップ：2002年11月以降

成果の公開：2004年8月までに

Samples to Japan

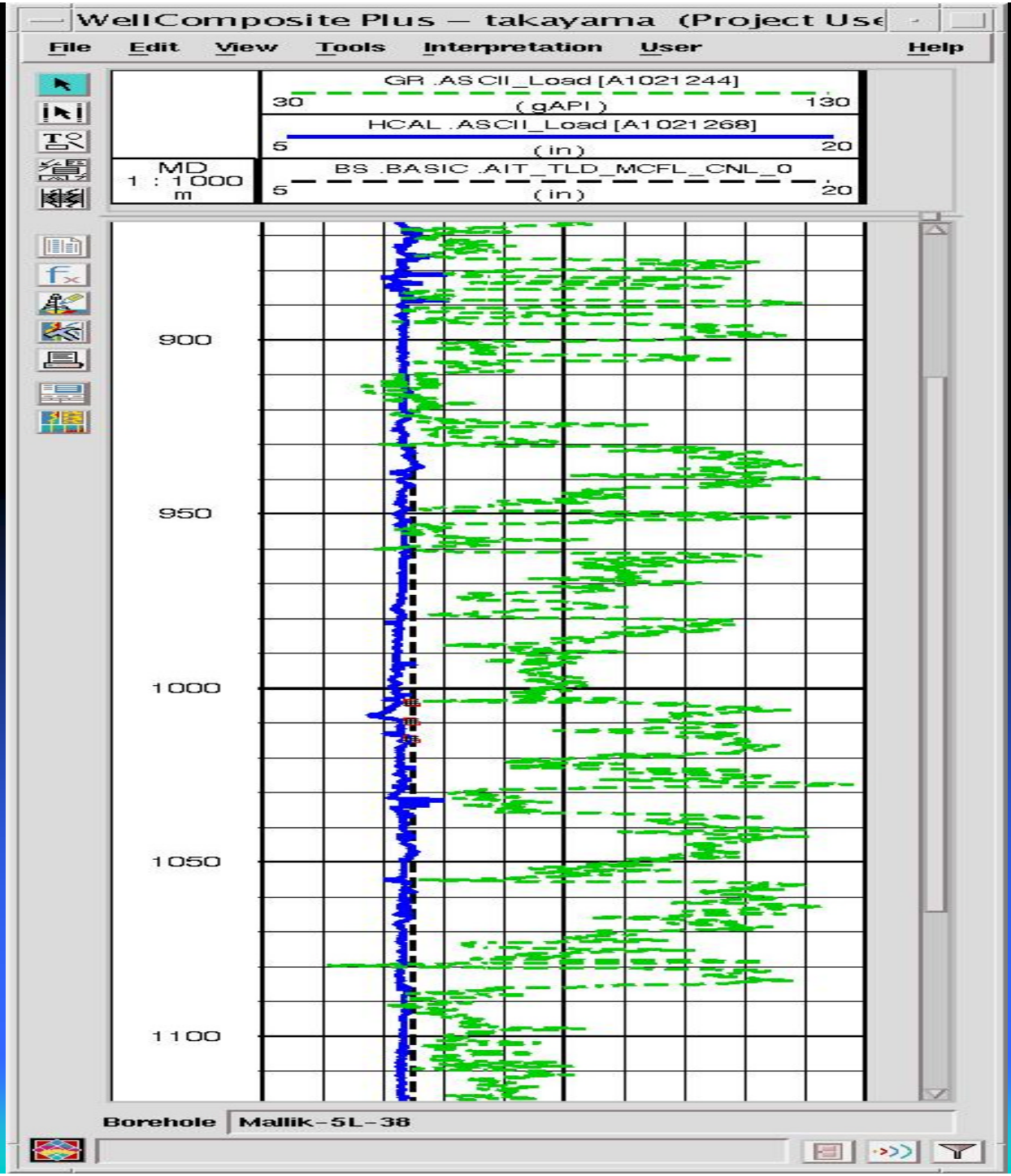
			no.	result
(1) Petrophysical property	ordinary core			12
(2) Paleontology	headspace sample			10
(3) Geochemistry				
Organic geochemistry	headspace sample			20
Gas geochemistry	headspace sample			47
Inorganic geochemistry	ordinary core (formation water)			180
Isotope geochemistry	headspace sample			10
Sediment geochemistry	ordinary core			140
(4) Microbiology	microbiology sample			23
(5) Gas hydrate measurement				
X-ray CT	GH core all	JNOC/JAPEX		41
NMR	GH core	JAPEX		3
Laser-Raman, XRD	GH core	AIST(HNIRI)		4
Dissociation modeling	GH core	Tokyo Univ/JAPEX		5
Physical property	GH core	Osaka Gas		5
Formation/dissociation kinetics.	GH core	Tokyo Gas		4
Petrophysical property	GH core	JAPEX/JNOC		4
Gas geochemistry	gas sample	JAPEX		16

Occurrences of Natural Gas Hydrates

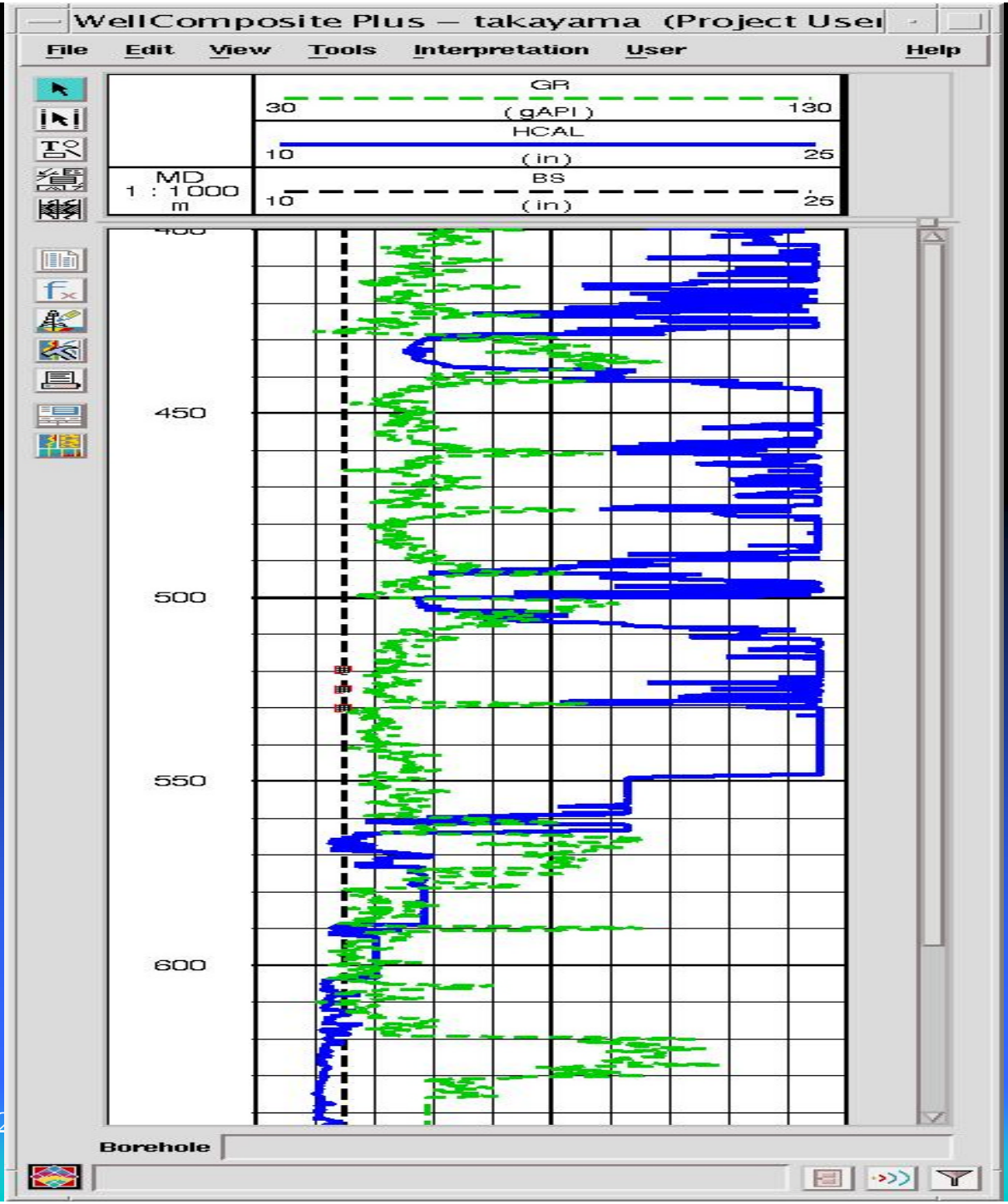


>>> JNOC TRC

JNOC-TRC


WellComposite Plus – takayama (Project Use
File
Edit
View
Tools
Interpretation
User
Help
GR .ASCII_Load [A1021244]
30
(gAPI)
130
HCAL .ASCII_Load [A1021268]
5
(in)
20
MD
1 : 1000
m
BS .BASIC .AIT_TLD_MCFL_CNL_0
5
(in)
20
900
950
1000
1050
1100
Borehole
Mallik-5L-38

JNOC-TRC


WellComposite Plus – takayama (Project User
File
Edit
View
Tools
Interpretation
User
Help
GR
30
(gAPI)
130
HCAL
10
(in)
25
MD
1 : 1000
m
BS
10
(in)
25
450
500
550
600
Borehole

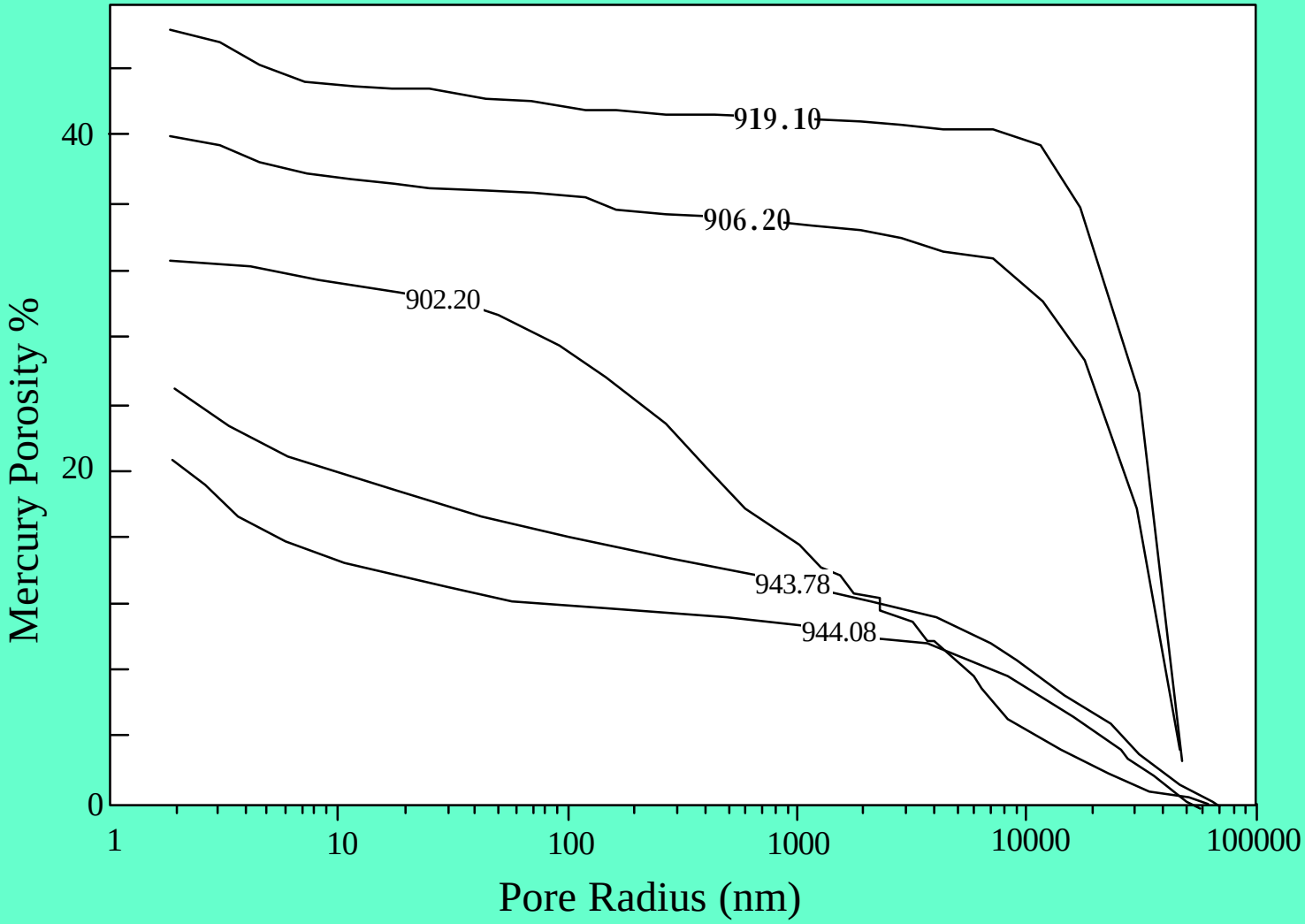
JNOC-TRC

コア分析／測定機器

日　本 :弾性波／比抵抗測定装置　W1.0m
　　ガスハイドレート分解測定装置（圧力容器）
　　ガスハイドレート分解速度測定装置　W1.4m T1.7m
　　スクイーザー
　　イオンメーター
ドイツ :加圧下での弾性波／比抵抗測定装置　W2.8m
　　コアスキャン装置　W2.0m　堆積学的観察用
　　質量分析計　W0.5m　現場でのマッドガス測定
カナダ :前回に準じる。IRC設備を主にする
米　国 :前回に準じる。ピクノメーターほか

Pore-Size Distribution

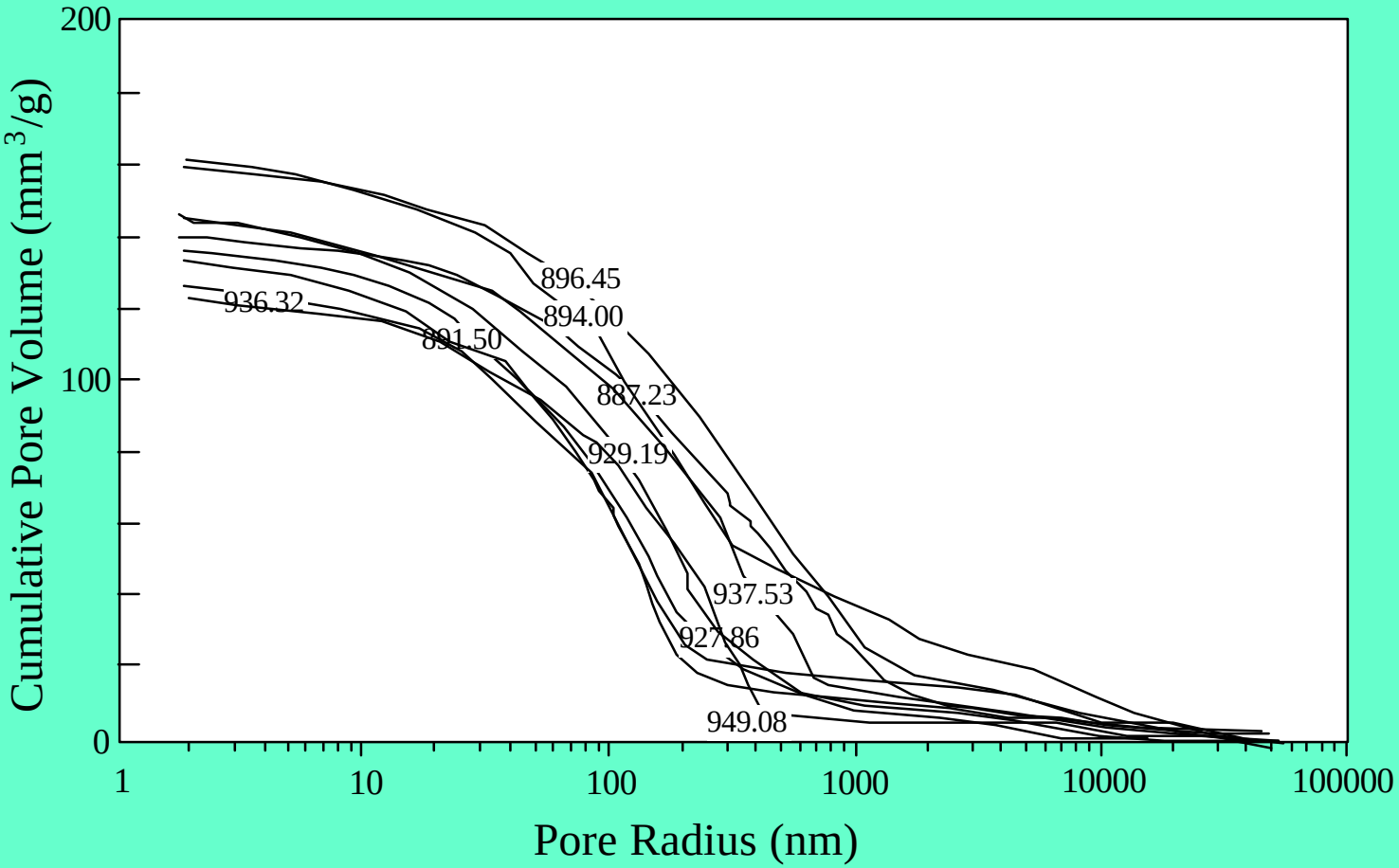
Mallik 2L-38 Sandy Sediments



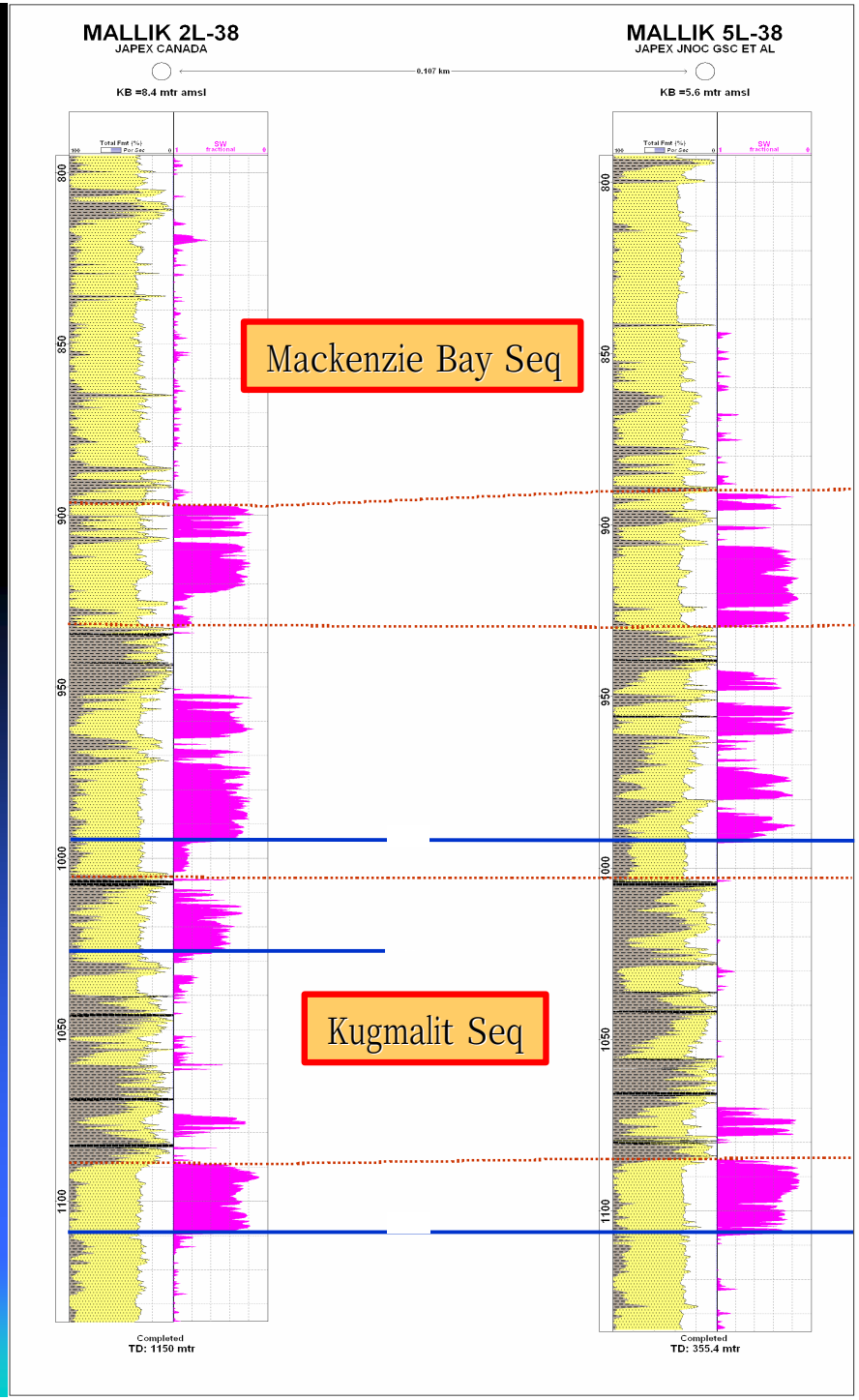
Pore-Size Distribution

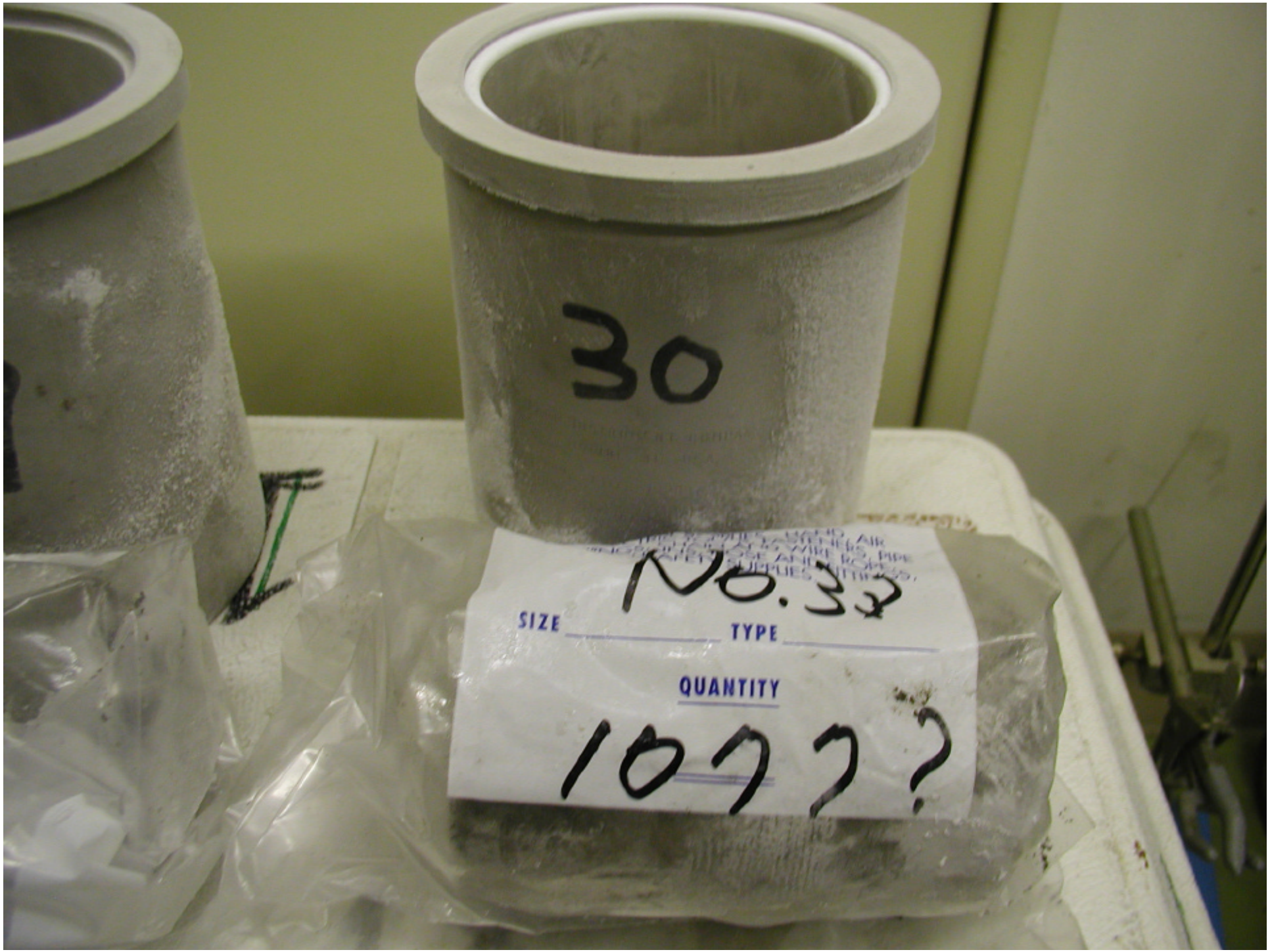
Mallik 2L-38

Silt to Mud



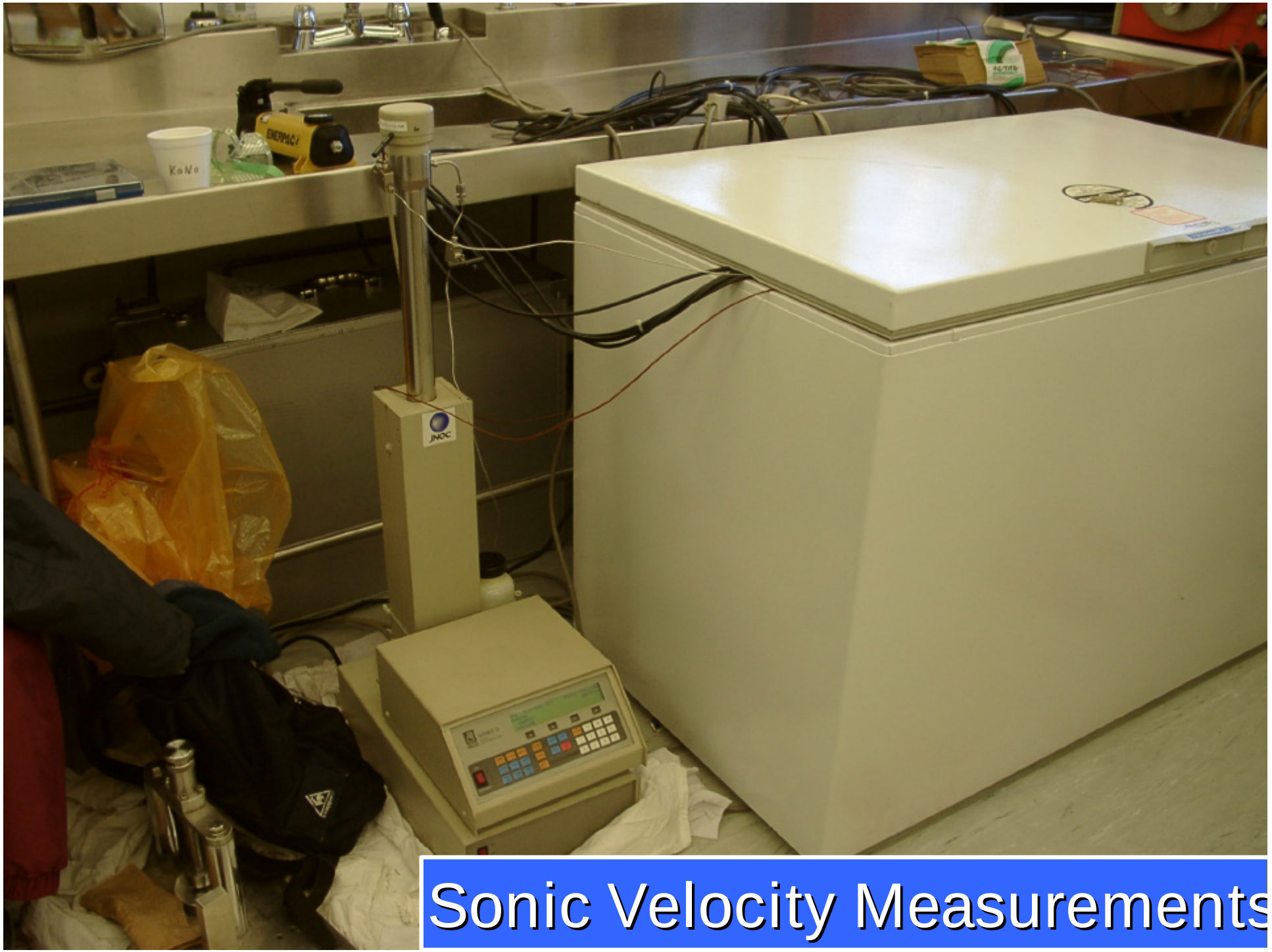
JNOC-TRC


MALLIK 2L-38
JAPEX CANADA
KB =8.4 mtr amsl
0.107 km
MALLIK 5L-38
JAPEX JNOC GSC ET AL
KB =5.6 mtr amsl
Total Fmt (%)
SW
fractional
800
850
900
950
1000
1050
1100
Mackenzie Bay Seq
Kugmalit Seq
Completed
TD: 1150 mtr
Completed
TD: 355.4 mtr


30
NO. 32
SIZE
TYPE
QUANTITY
1077?


NOTICE
AREA
Dale


08
Hydrate
Water
Contact


Sonic Velocity Measurements