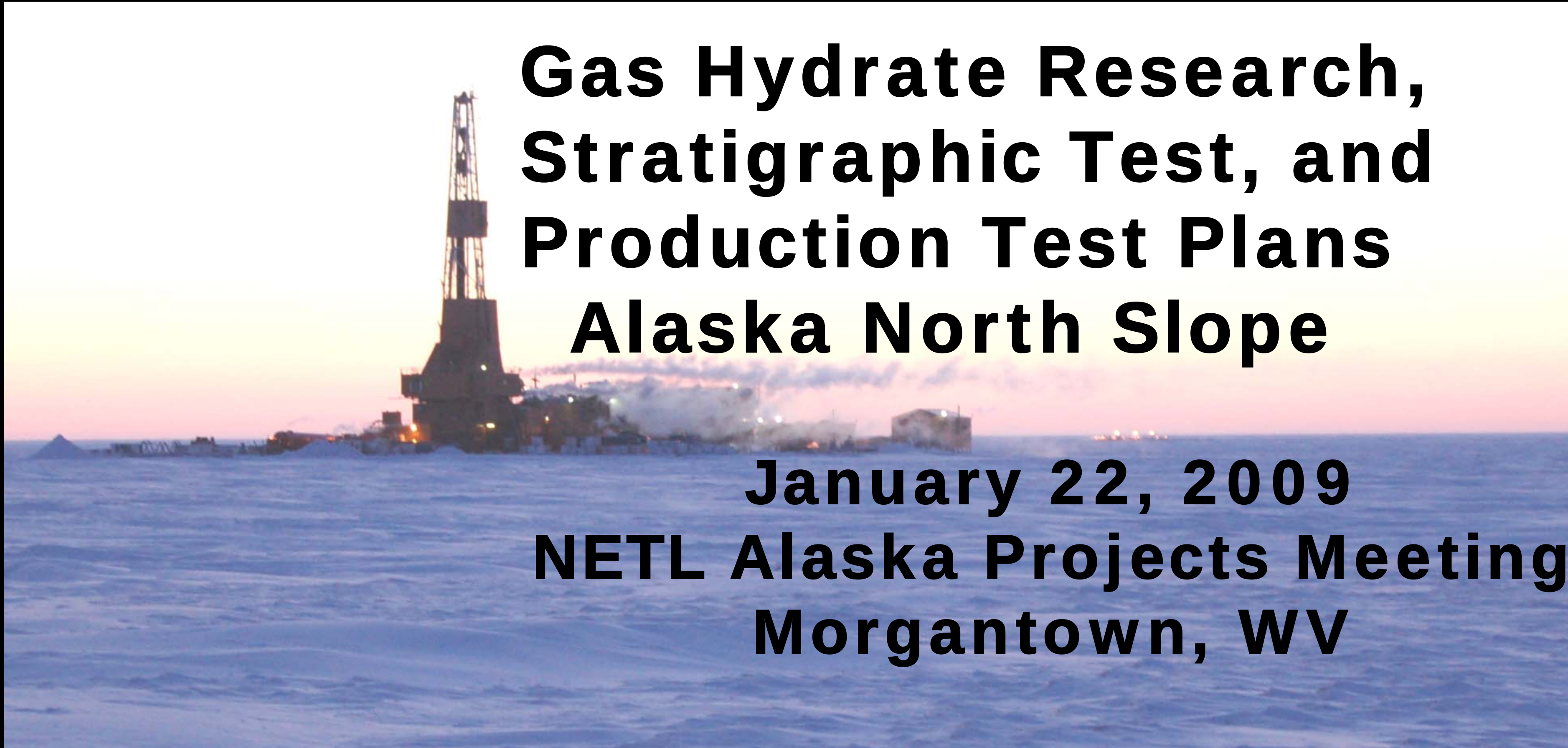

Gas Hydrate Research, Stratigraphic Test, and Production Test Plans Alaska North Slope

January 22, 2009
NETL Alaska Projects Meeting
Morgantown, WV

U.S. Department of Energy

Robert Hunter, PI, ASRC Energy
Scott Wilson, RyderScott
Steve Hancock, RPS Eng.
with Scott Digert - BP
Gordon Pospisil – BP
Ray Boswell – DOE
Rick Baker – DOE
Tim Collett - USGS

Presentation Outline

- Project Overview / Schedule
- Resource Characterization
- Stratigraphic Test Results
- Reservoir Simulation
- Production Testing
- Conclusions / Future Plans

Presentation Outline

- ➢ **Project Overview / Schedule**
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Acknowledgements
The Mount Elbert Science Party

- Myung Lee – USGS
- John Miller - USGS
- Bill Waite – USGS
- Bill Winters – USGS
- Tom Lorenson – USGS
- Tanya Inks – Int. Services, Inc.
- Dennis Urban – BPXA
- Paul Hanson – BPXA
- Warren Agena - USGS
- Kelly Rose – DOE/NETL
- Eilis Rosenbaum – DOE/NETL
- Micaela Weeks – BPXA
- Larry Vendl – BPXA
- Danny Kara - BPXA
- Rick Colwell – OSU
- Marta Torres – OSU
- Steve Hancock (RPS)
- Tim Collett (USGS)
- Ray Boswell (DOE/NETL)
- Robert Hunter (ASRC/BP)
- The Crew of the Doyon 14

ASRC Energy Services E & P Technology
Schlumberger
bp
U.S. Department of Energy
NETL
USGS science for a changing world
Oregon State University OSU
Doyon Drilling, Inc.
OMNI Laboratories, Inc.
Petroleum Engineering
M-I SWACO
REED Hycalog A Grant Prideco Company
Drill Cool Systems, Inc.

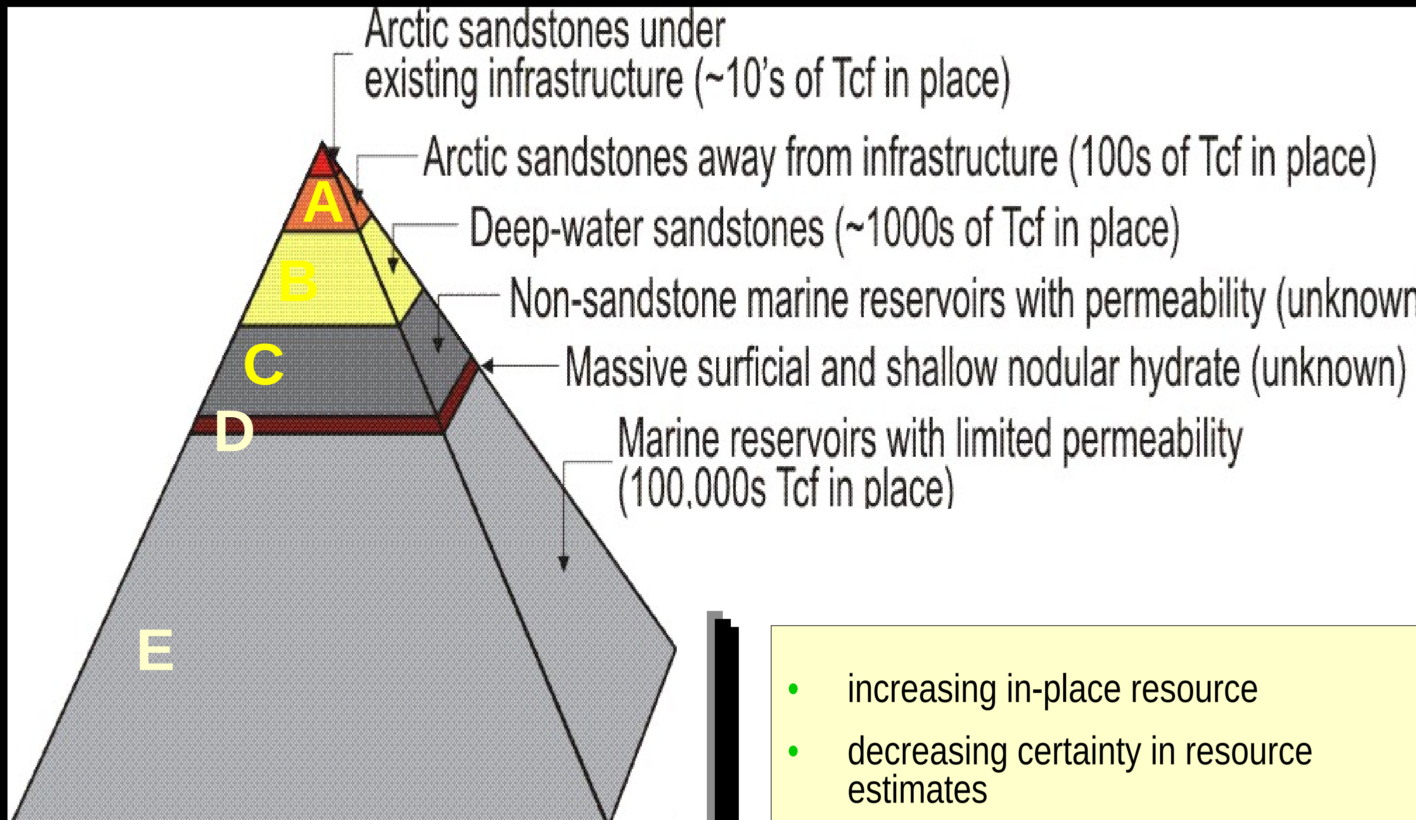
Gas Hydrate Resource Pyramid
In-Place Resource Distribution

GH-Saturated fluvial-deltaic sands – Milne Point, Alaska

GH-saturated turbidite – Nankai trough

GH-saturated fractured clays – Bay of Bengal

Massive GH seafloor mound – Gulf of Mexico

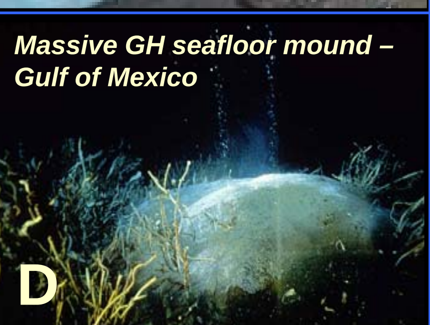


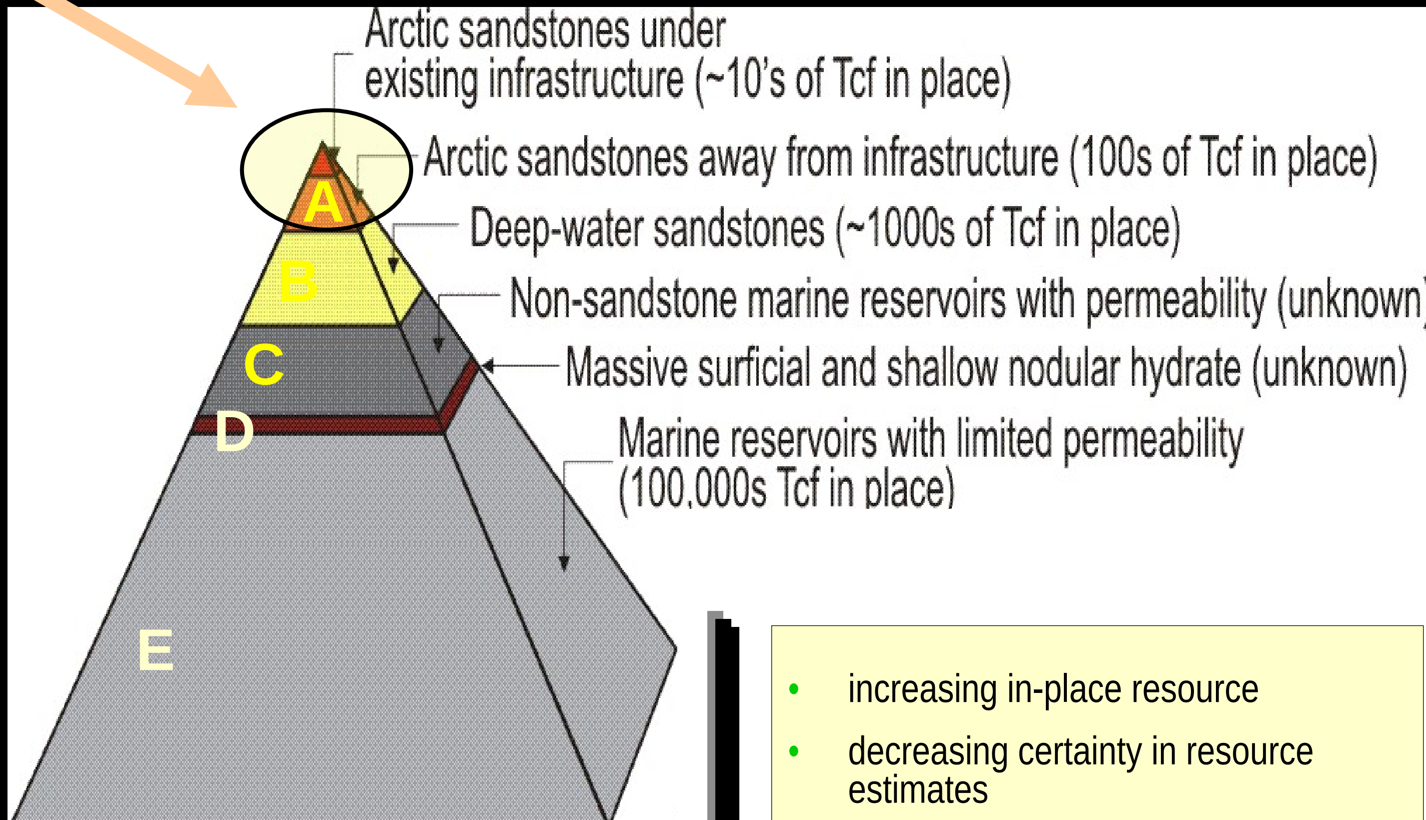
- increasing in-place resource
- decreasing certainty in resource estimates
- decreasing reservoir quality
- increasing technical challenges
- decreasing ultimate % recoverable

USGS science for a changing world

NETL

Gas Hydrate Resource Pyramid
In-Place Resource Distribution





- increasing in-place resource
- decreasing certainty in resource estimates
- decreasing reservoir quality
- increasing technical challenges
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Cooperative Agreement Objectives

Characterize, quantify, and determine commercial viability of gas hydrates in the ANS field infrastructure areas

How – Methods:

- ✓ Prove exploration & reservoir models
- ✓ Describe & Quantify ANS resource
- ➢ Conduct long-term production test

Why – Motivations:

- ➢ Understand ANS hydrate productivity
- ➢ Demonstrate ANS hydrate resource
- ➢ Leverage to potential marine resource
- ➢ Synergies to other ANS gas resources

Cooperative Agreement Motivations

Opportunities

- ✓ Determine if long-term U.S. resource
- ✓ Collaborate with Federal & State R&D
- ✓ Mid-term possible fuel gas source?
- ✓ Long-term supplemental gas source?

Challenges

- ✓ Uncertain resource potential & risk
- ✓ Align with existing O&G operations
- ✓ Minimize impact to ANS development
- ✓ Manage stakeholder expectations
- ✓ Clarify goals, priorities, & timing

U.S. Department of Energy

Cooperative Agreement

- Assess Gas Hydrate Resource
- Jointly Decide Project Progression
- Use Alaska North Slope as Lab
- Require Clear Decision GATES
- Cost-shared/Yearly Appropriations
- Phases 1-2 (2003-2005)
    - Characterization & Modeling
- Phase 3a (2006-1Q2009)
    - Stratigraphic Test Ops/Analyses
- Phase 3b (2Q2009+)
    - Long-term Production Testing

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ANS Cooperative Research Program

Assess Resource Potential in 3 Phases:

Year	Phase	Major Task
2003 – 04	1.	Resource Characterization/Modeling
2005	2.	Schematic Regional Modeling
2006 - 09 Current	3a.	Acquire Stratigraphic Test Well Data Analyze Core, Logs, & MDT test
2009+ Planned	3b.	Acquire Additional Well Data Long-term Production Test

- Determine Technical & Commercial Viability

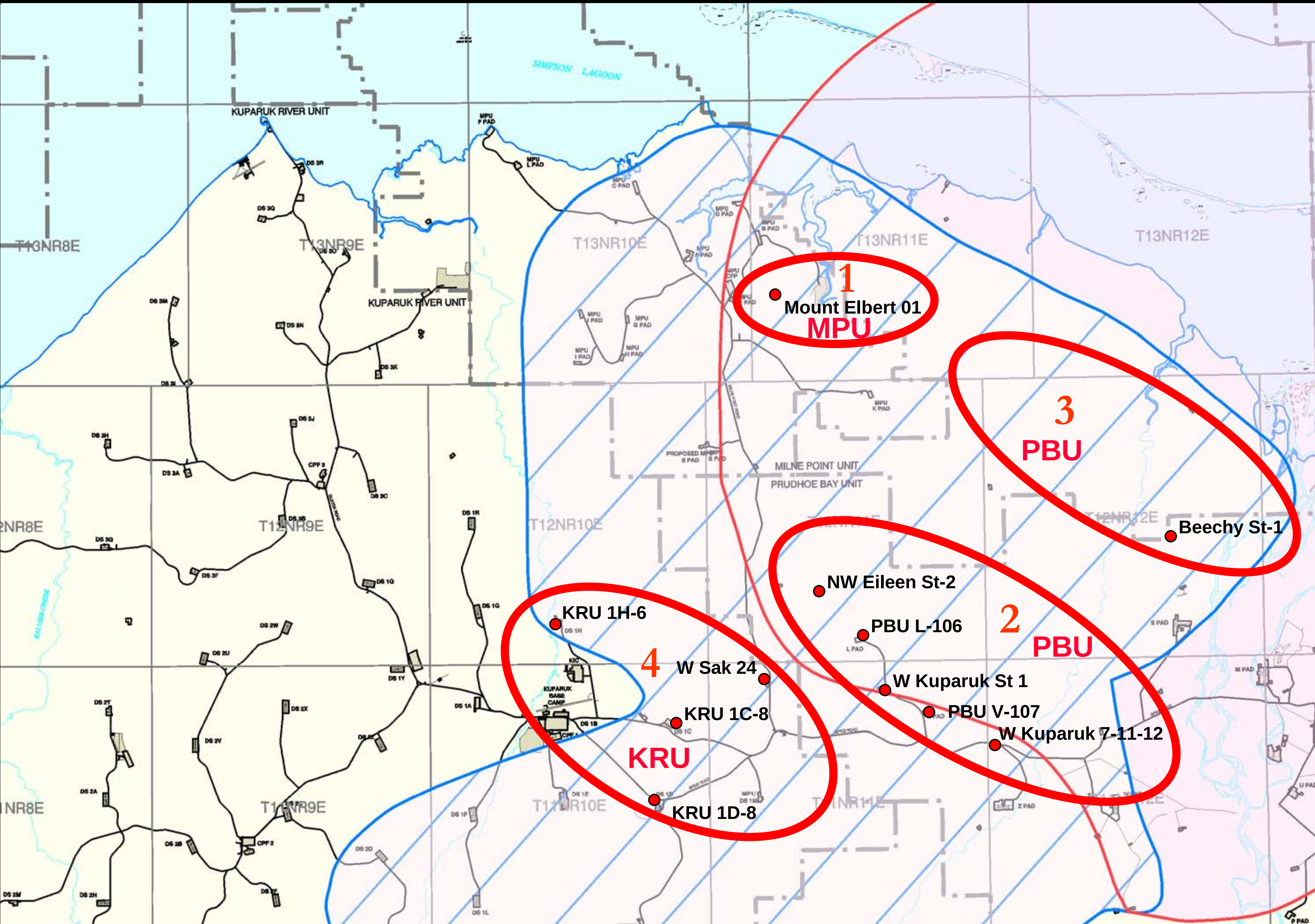
ANS Cooperative Research Program

Budget vs. Cost	Phase	Major Task
$2.5MM/ $2.8MM	1.	Resource Characterization/Modeling
$0.8MM/ $0.9MM	2.	Schematic Regional Modeling
$4.8MM/ $6.3MM Operations	3a.	Acquire Stratigraphic Test Well Data Analyze Core, Logs, & MDT test
>$10MM?	3b.	Acquire Additional Well Data Long-term Production Test

TOTAL: $20MM+

- Determine Technical & Commercial Viability

PREVIEW: 4 Long-term Production Test Sites



Project Phase 3b – 2009+
Parameters for a Successful Production Test

- Site with continuous, long-term access
  - Maximize likelihood for success
  - Conduct long-term test operations
  - Build on past success, learn from others
- Designed to determine the potential productivity of gas hydrate reservoirs
  - Validate simulations, test methods
  - Maximize knowledge, not just rate
  - Demonstrate technical recovery
  - Try multiple completions/stimulations
- Carefully manage risks
  - Maintain operationally simple
  - Meet all HSE requirements
  - Minimize impacts to existing operations
  - Optimize reservoir conditions

Phase 3b Schedule

Timing	Major Task
1Q2009	1. Stakeholder Alignment/Site Selection
2Q2009	2. Select Production Test Site
3-4Q2009	3. Production Test Detailed Design, Well Package, Risk Assessment, Preparation
2010+ Planned	4. Acquire Additional Well Data Implement Long-term Production Test

- Determine Technical & Commercial Viability

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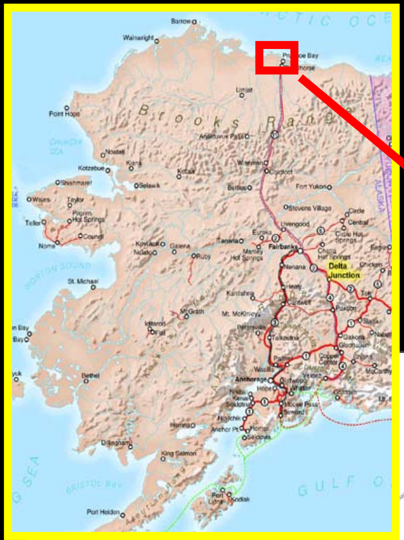
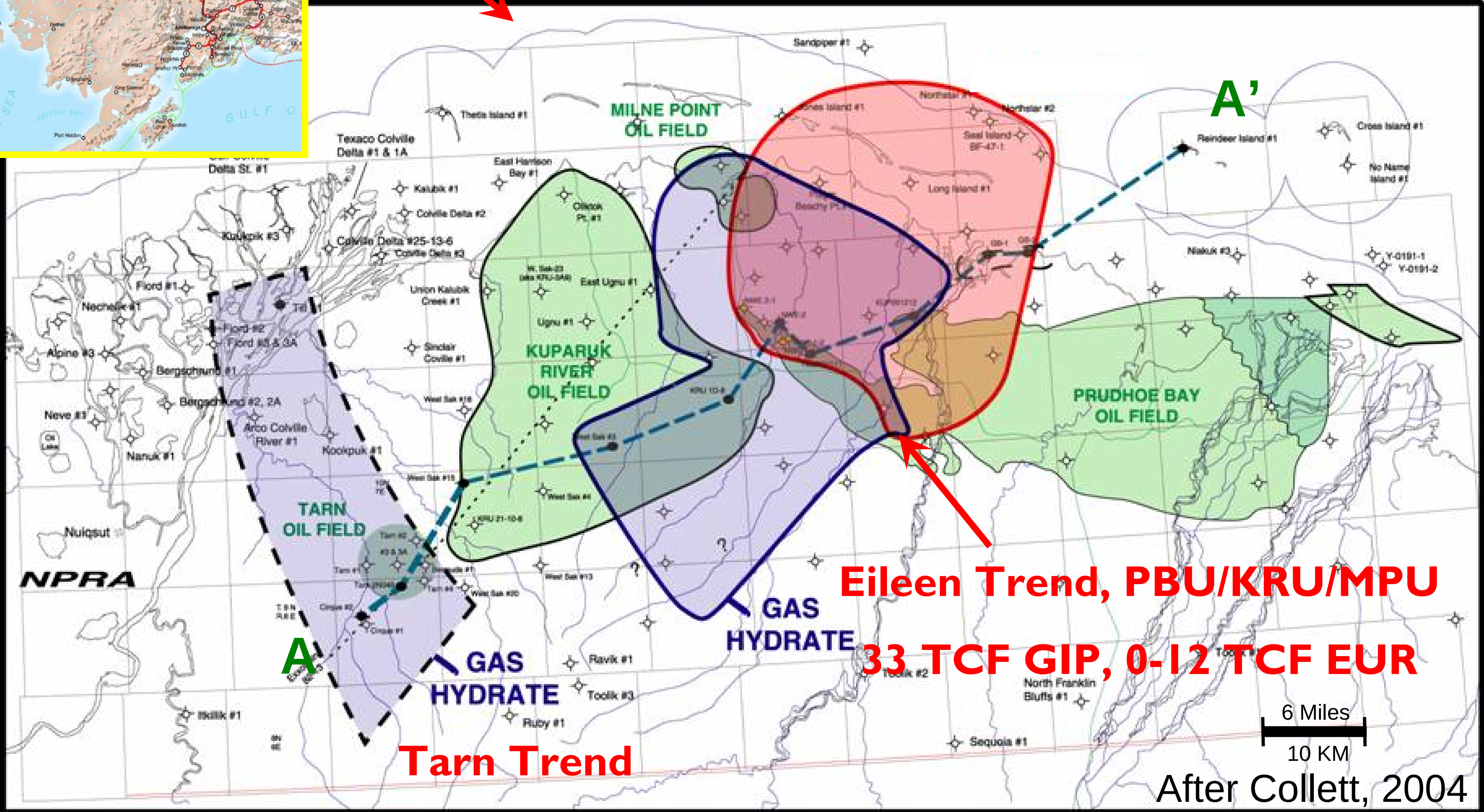
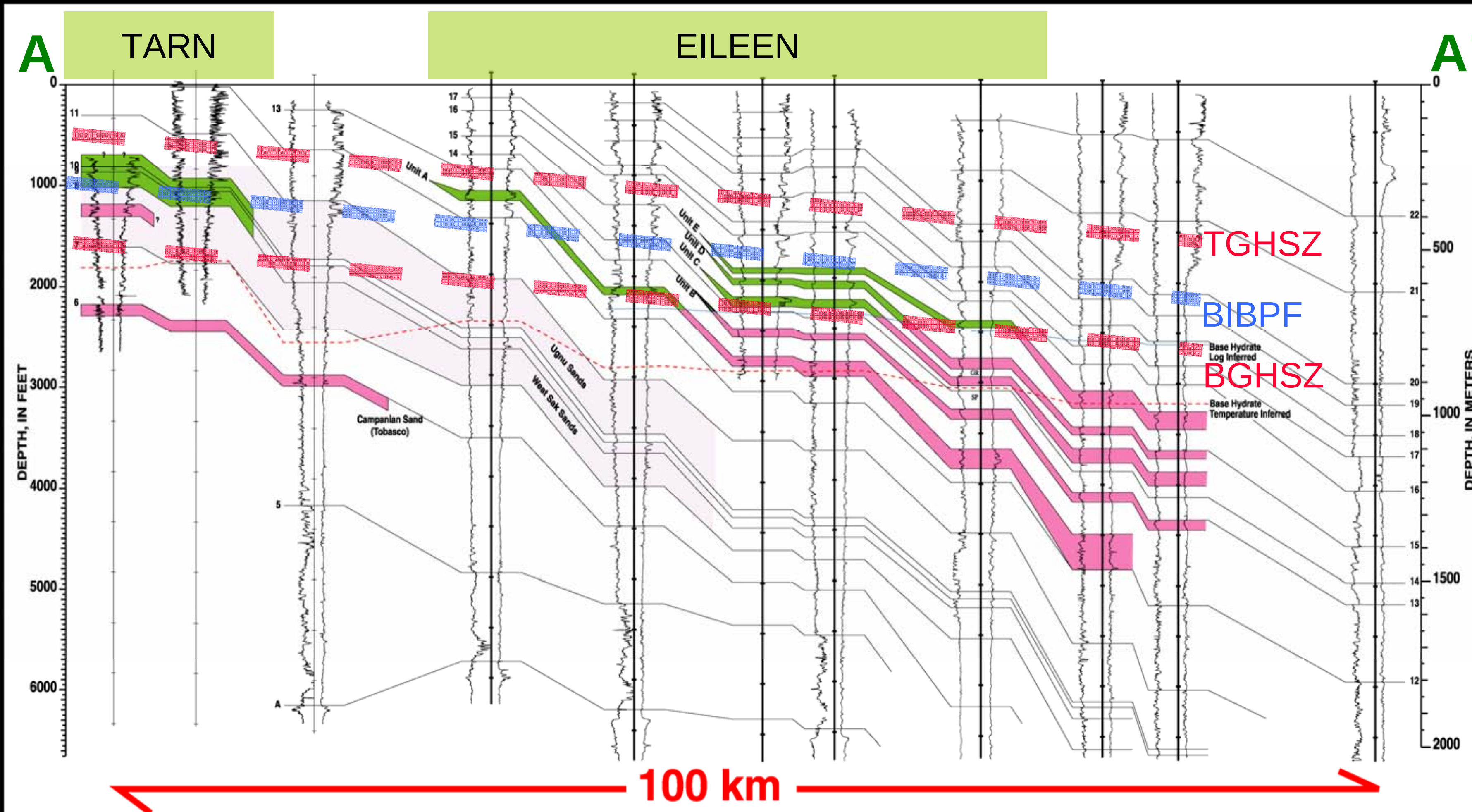
Introduction

Study Area Location





Eileen/Tarn Gas Hydrate Trends



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Introduction

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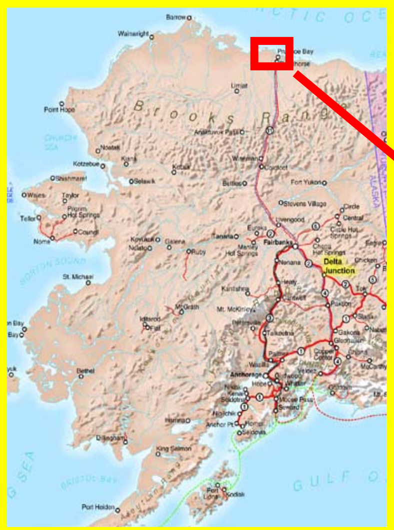
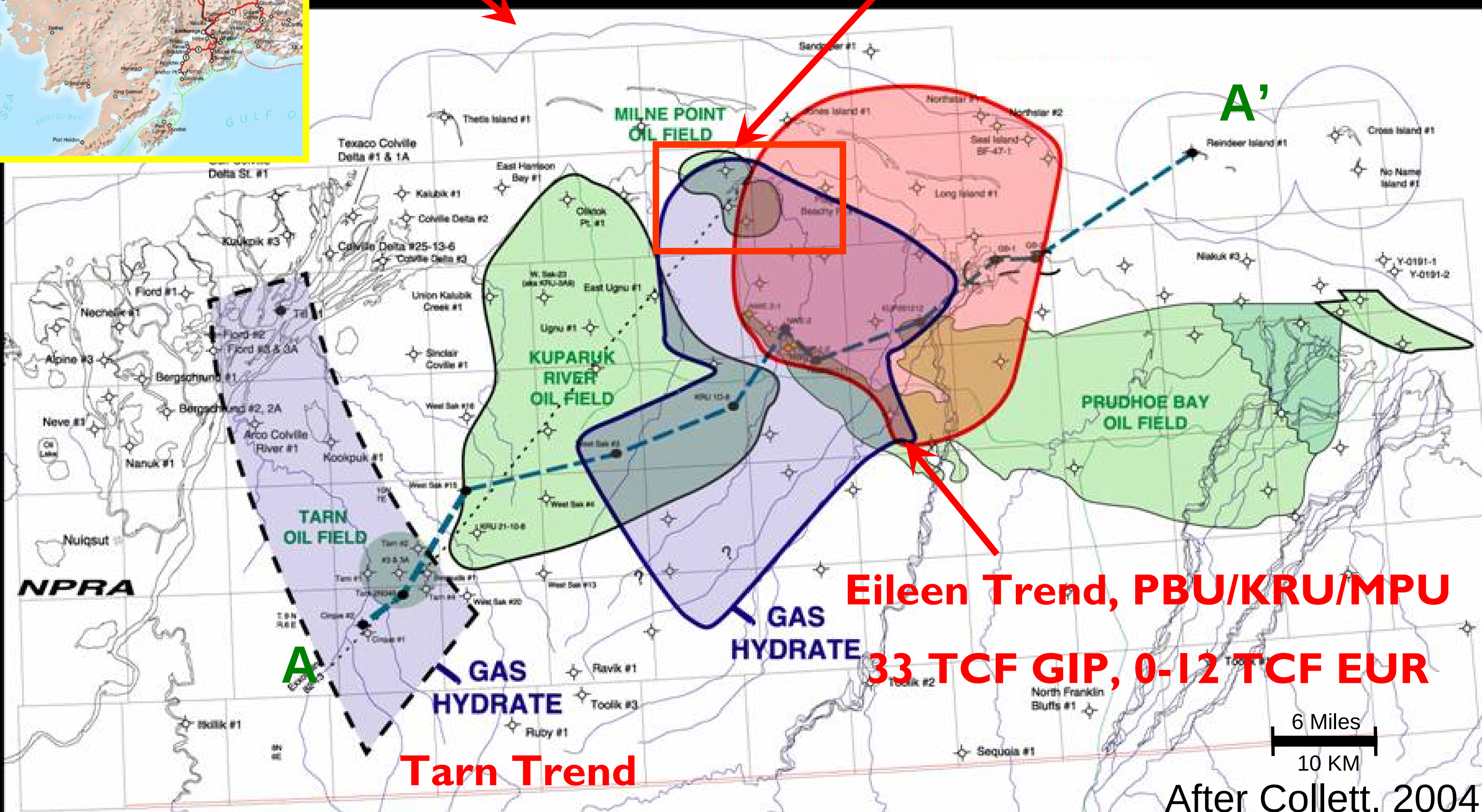
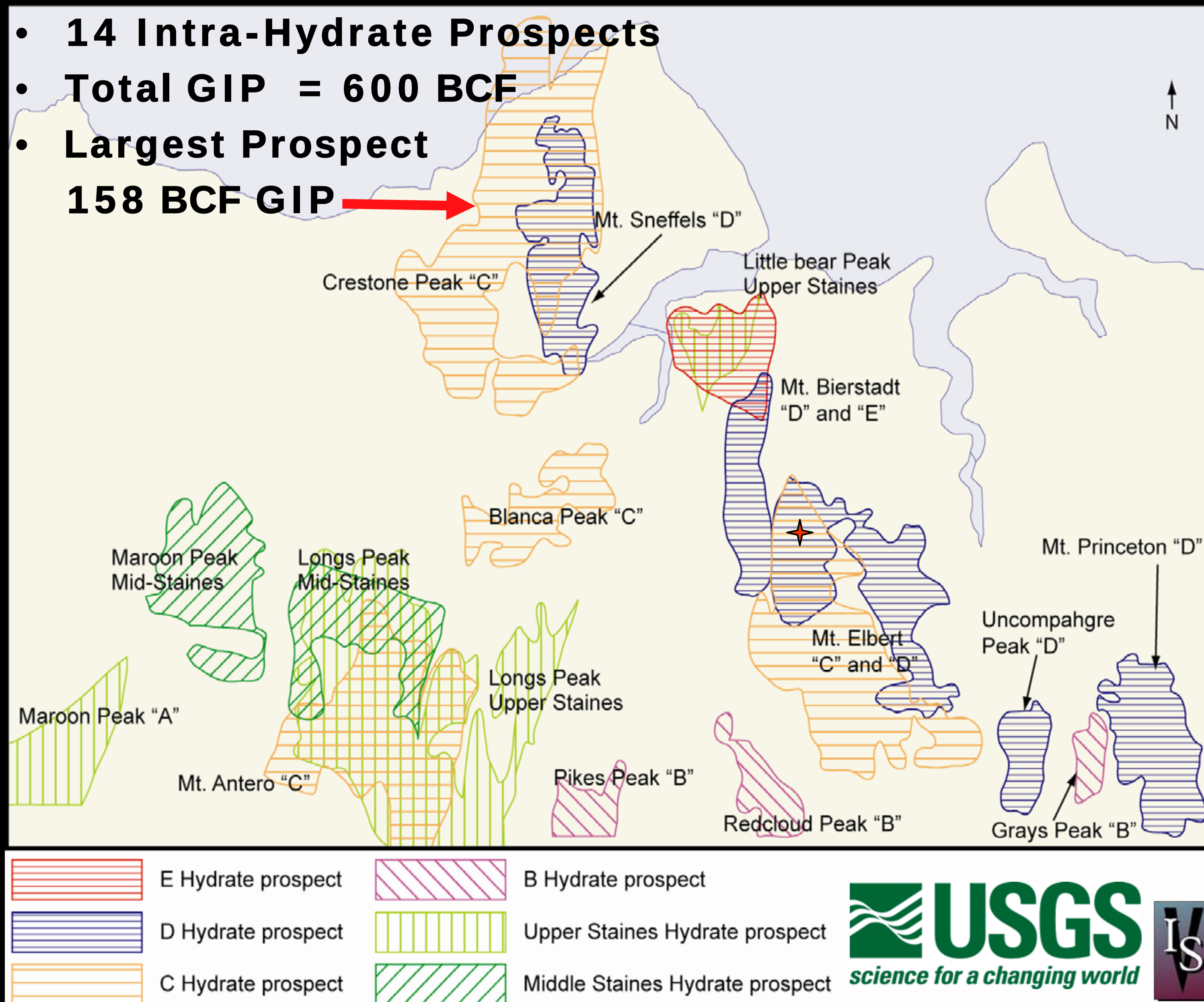




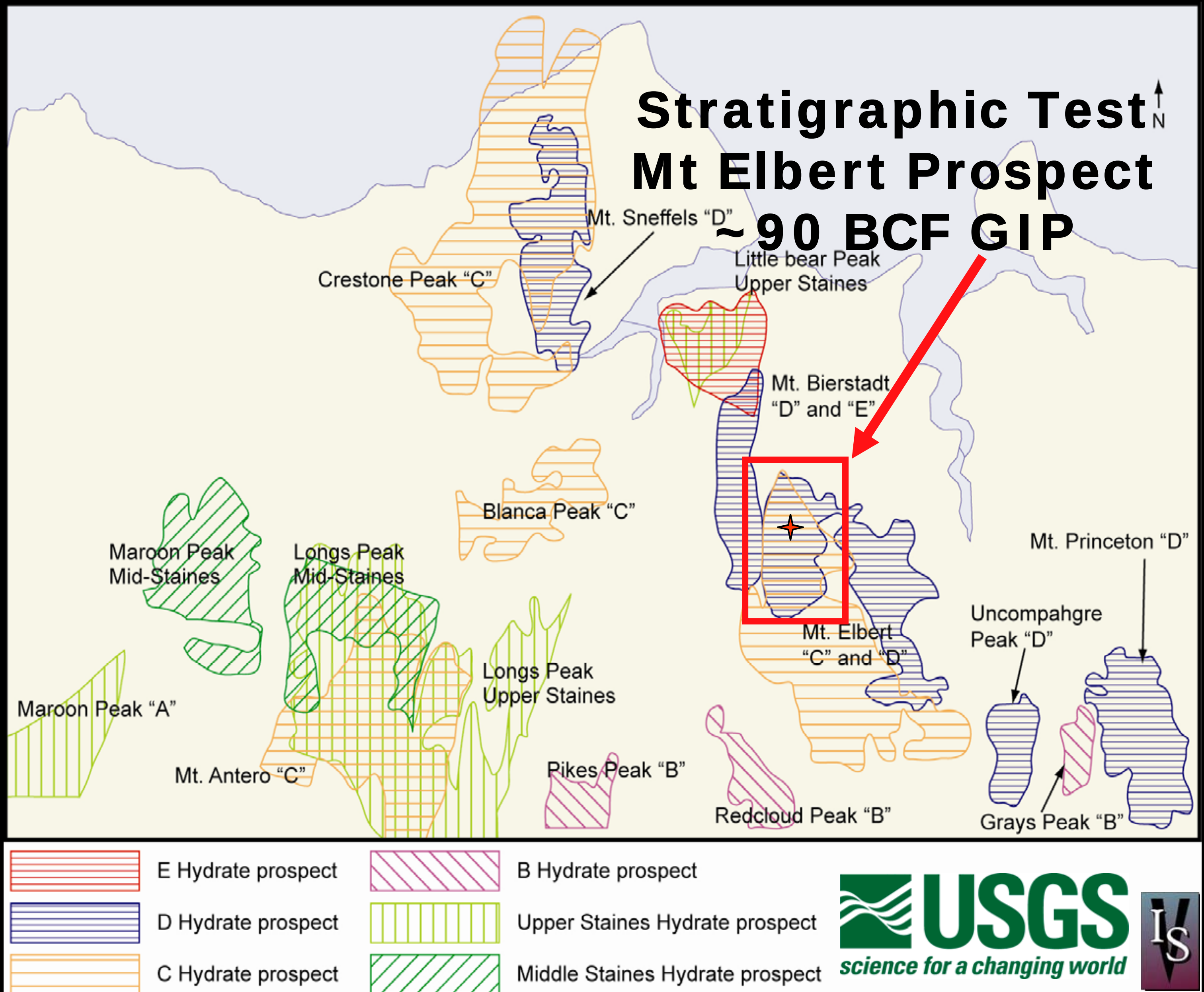
Milne Point Unit Gas Hydrate Prospects

- **14 Intra-Hydrate Prospects**
- **Total GIP = 600 BCF**
- **Largest Prospect 158 BCF GIP**



Courtesy; Inks, T., Lee, M., Taylor, D., Agena, W., Collett, T. and Hunter, R., in press

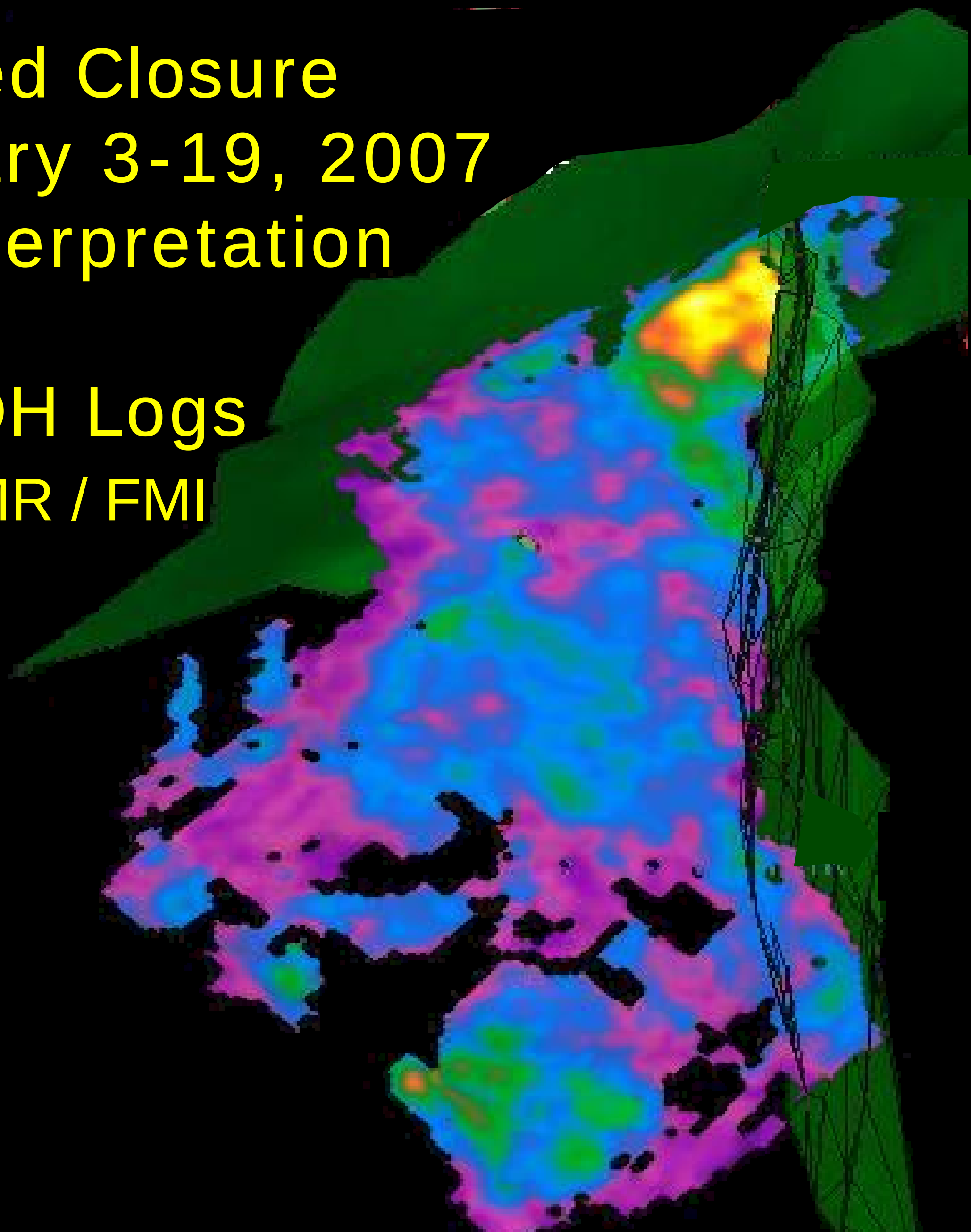
Milne Point Unit Gas Hydrate Prospects



Courtesy; Inks, T., Lee, M., Taylor, D., Agena, W., Collett, T. and Hunter, R., in press

Mt. Elbert Prospect Seismic Amplitude

- 3-Way, Fault-Bounded Closure
- Drilling/Data: February 3-19, 2007
- Validated Seismic Interpretation
- Acquired 430’ Core
- Acquired Extensive OH Logs
  - GR/Res/N/D/ Dipole/ NMR / FMI



Mt. Elbert Prospect Seismic Amplitude

- 3-Way, Fault-Bounded Closure
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- Validated Seismic Interpretation
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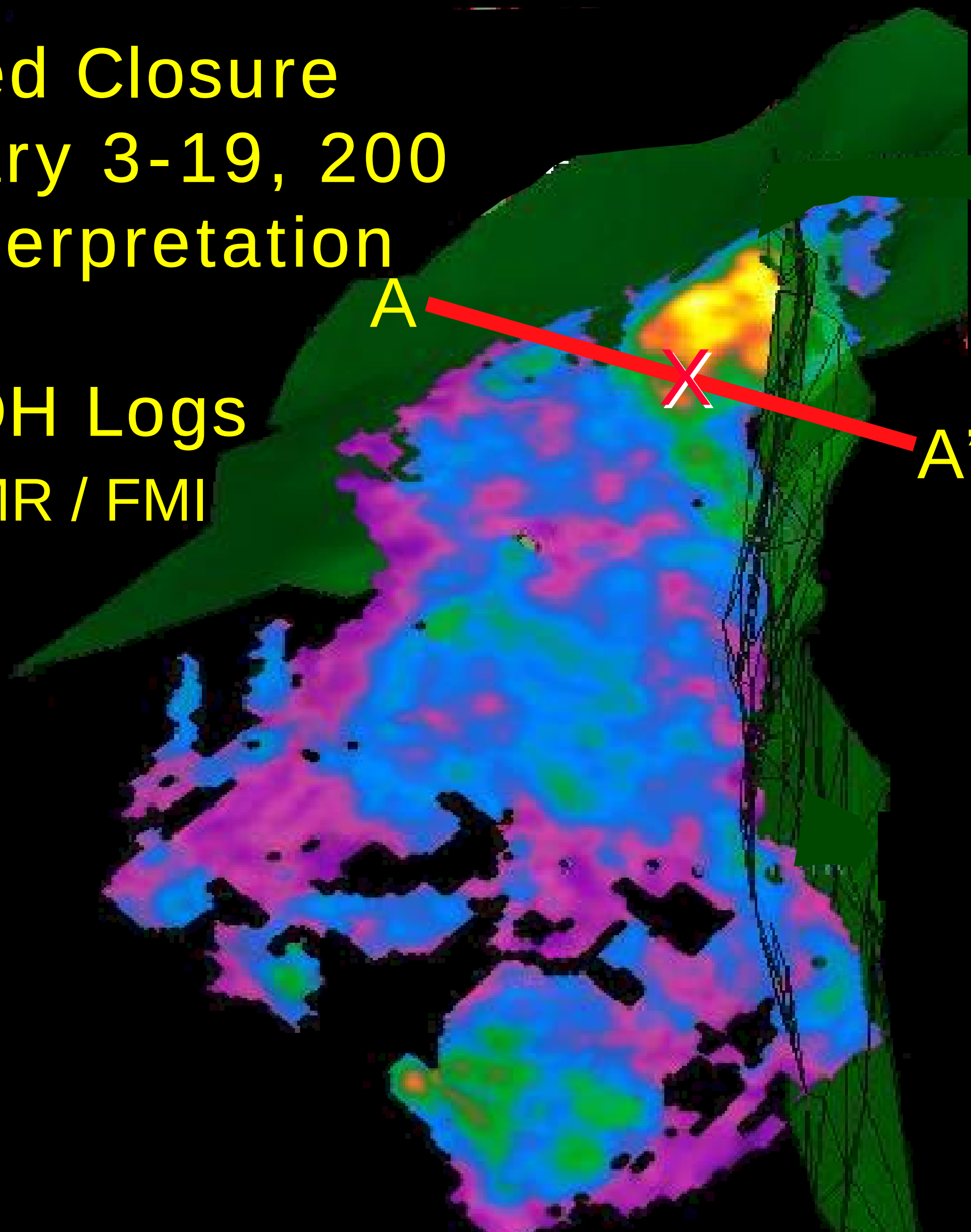

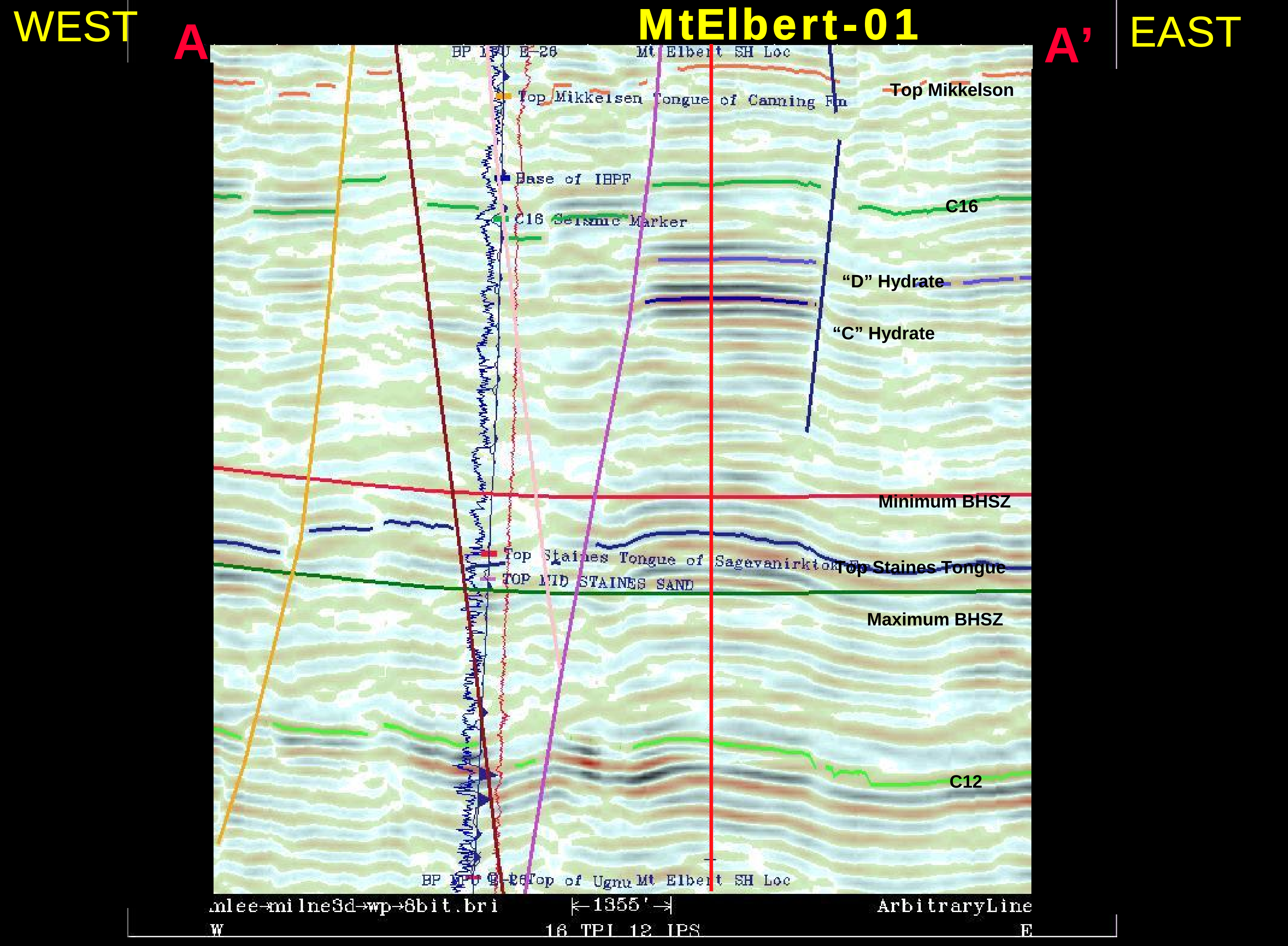
WEST
A
MtElbert-01
A'
EAST
BP 1 IPU E-28
Mt Elbert SH Loc
Top Mikkelsen Tongue of Canning Fm
Top Mikkelson
Base of IBPF
C16 Seismic Marker
C16
"D" Hydrate
"C" Hydrate
Minimum BHSZ
Top Staines Tongue of Sagavanirktok Fm
Top Staines Tongue
TOP MID STAINES SAND
Maximum BHSZ
C12
Top of Ugnu
Mt Elbert SH Loc
mlee→milne3d→wp→8bit.bri
1355'
ArbitraryLine
W
16 TPI 12 IPS
E

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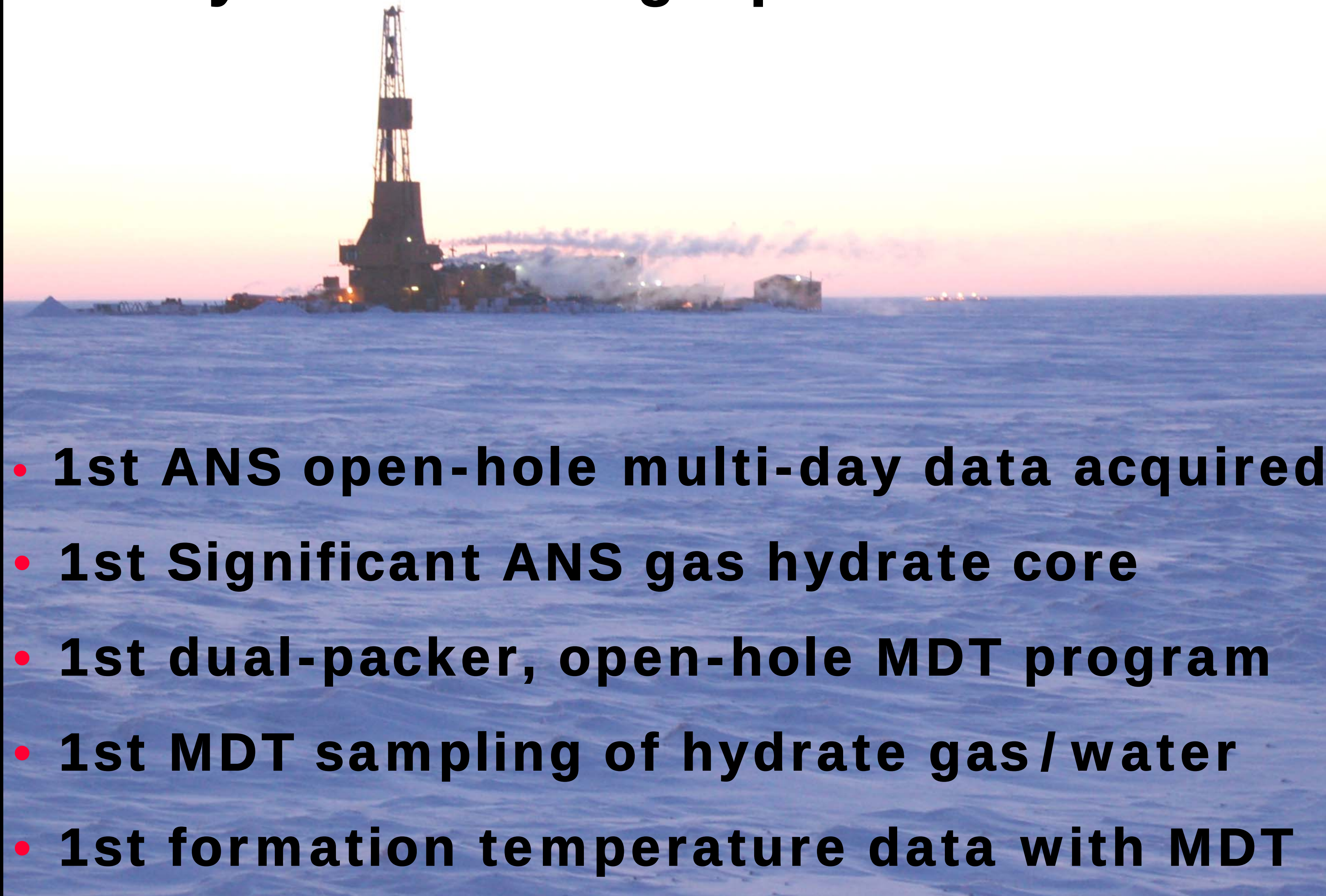
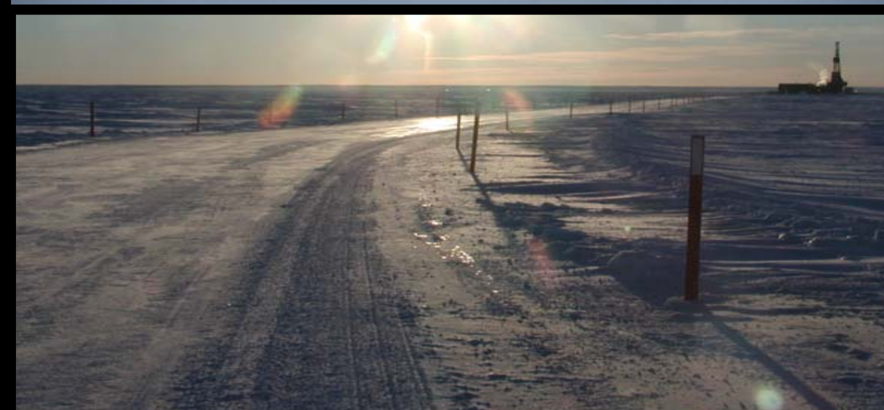
Gas Hydrate Stratigraphic Test "Firsts"



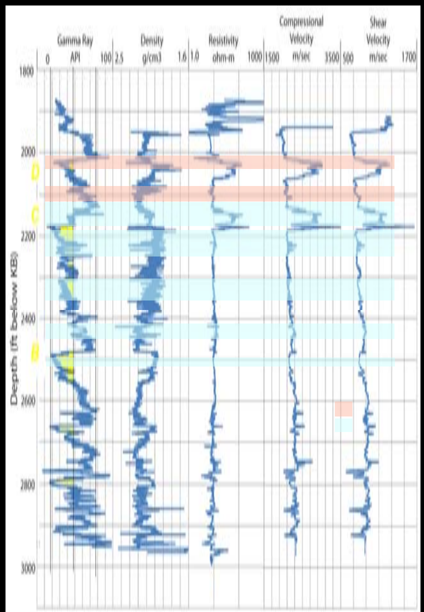
- 1st ANS open-hole multi-day data acquired
- 1st Significant ANS gas hydrate core
- 1st dual-packer, open-hole MDT program
- 1st MDT sampling of hydrate gas/water
- 1st formation temperature data with MDT

MPU Mount Elbert Site Preparation



Downhole Log Acquisition Program

- Excellent Hole Conditions
  - Use of chilled, oil-based drilling fluids
- Full Log Suite Obtained
  - Gamma Ray (lithology)
  - Resistivity (hydrocarbon)
  - Neutron and Density (porosity)
  - Acoustics (Hydrate Indicator- Dipole Sonic)
  - Magnetic Resonance (distribution, nature, and saturation of fluids)



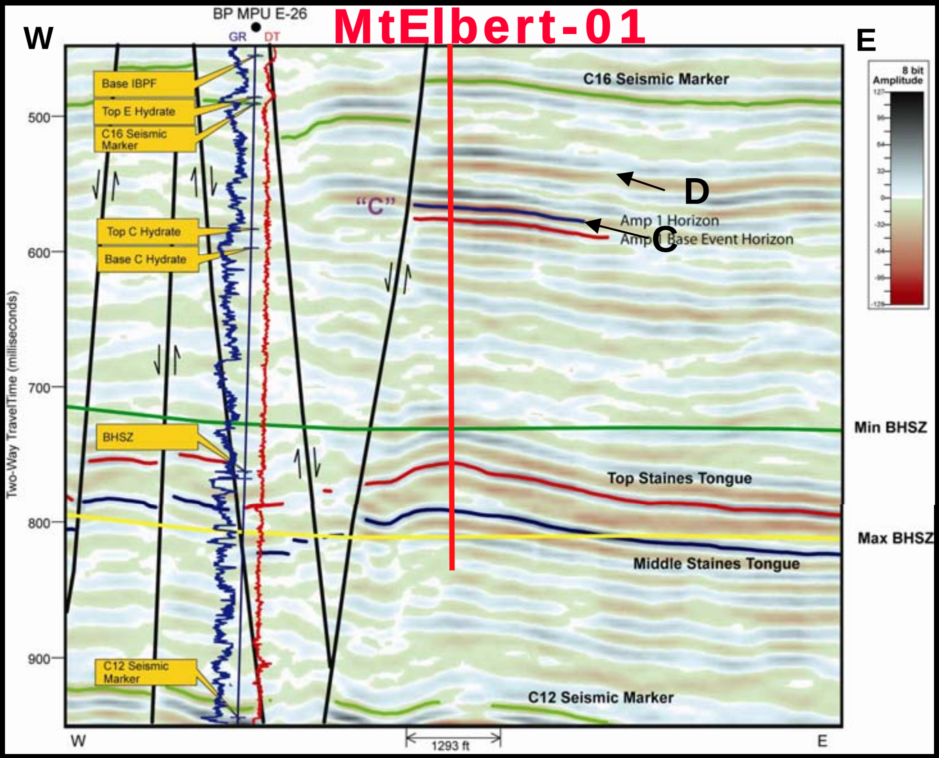
Mount Elbert: Delineate & Validate

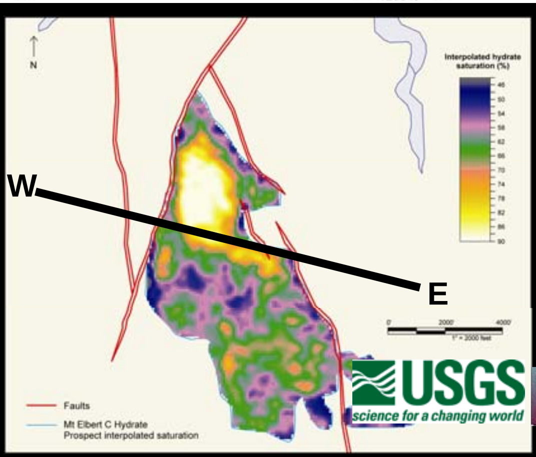
PREDICTION

- Prospect within undrilled, 3-way fault-bounded trap
- Seismic attributes estimate reservoir thickness and saturation for Zones C & D
  - Upper "D" sand: 46' thick with 68% Gas Hydrate Saturation
  - Lower "C" sand: 70' thick with 85% Gas Hydrate Saturation
- Thickest previous total GH seen in MPU wells ~20 ft.

RESULTS

- Validated seismic methods
- Extensive Open-hole Logs
- 430' core, 261 subsamples
- 100' gas hydrate-bearing
- Comprehensive OH MDT





Pre-drill Saturation Estimate – C sand

Courtesy; Inks, T., Lee, M., Taylor, D., Agena, W., Collett, T. and Hunter, R., in press

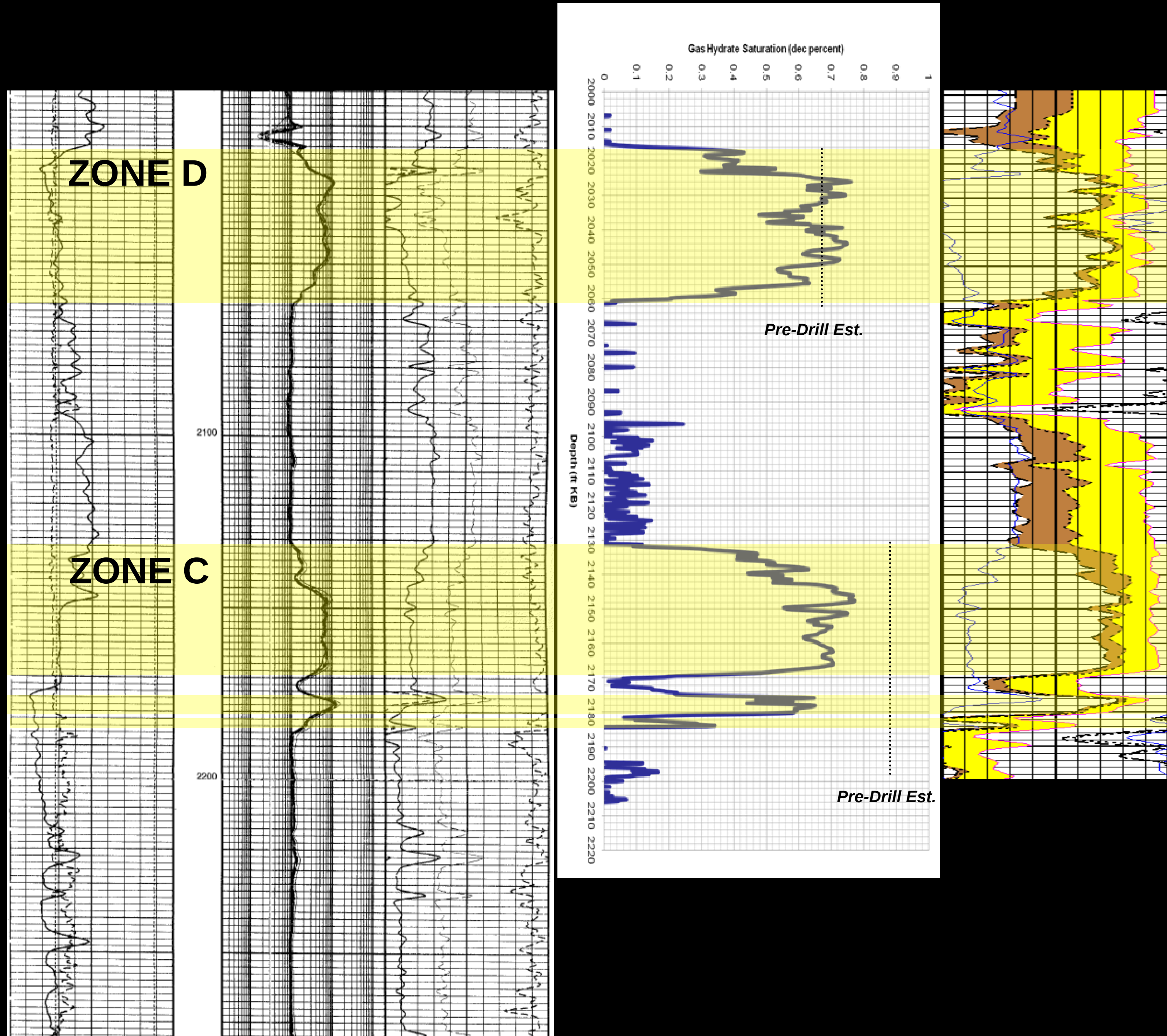
Gas Hydrate Prediction vs. Actual

GH Thickness
Pre-drill: 46 ft
Actual: ~44 ft

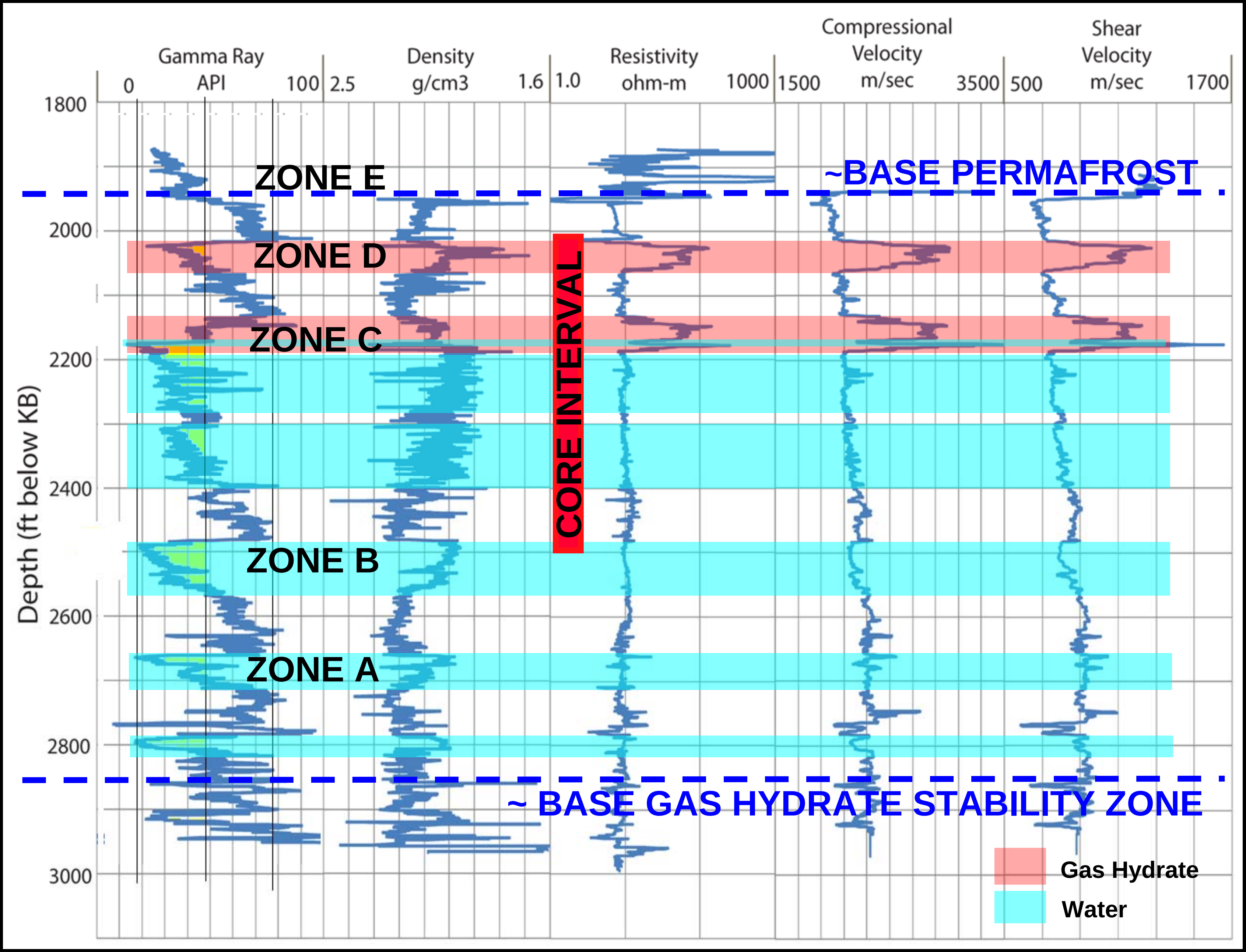
GH Saturation
Pre-drill: 68%
Actual: ~75%

GH Thickness
Pre-drill: 70 ft
Actual: ~43 ft
(perched water)

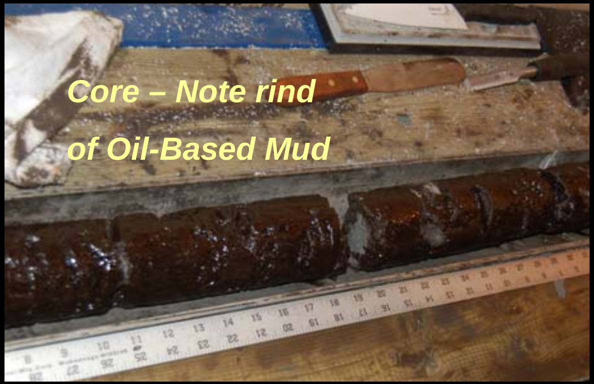
GH Saturation
Pre-drill: 89%
Actual: ~75%

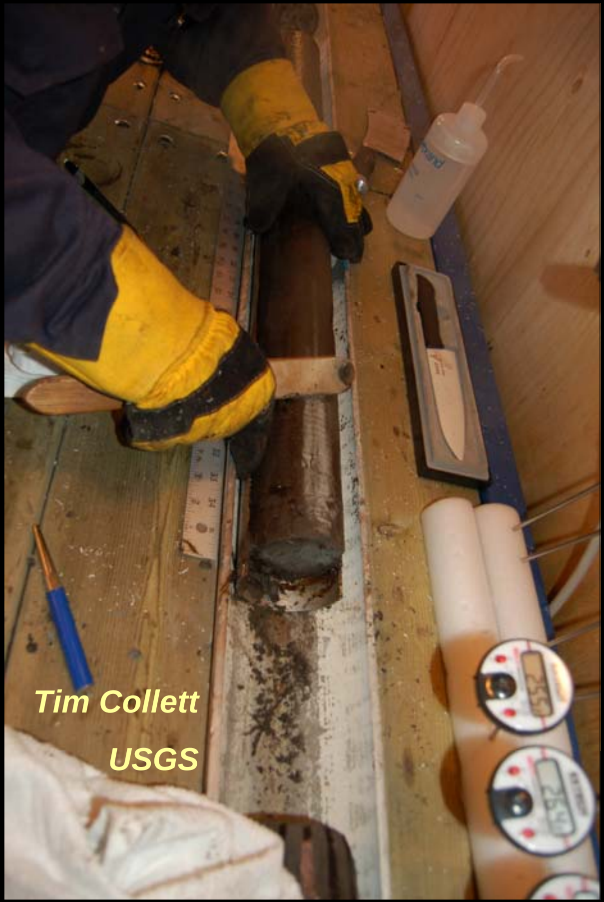


Mount Elbert-01 Log Data Summary



Core Sub-Sampling in the Cold Trailer

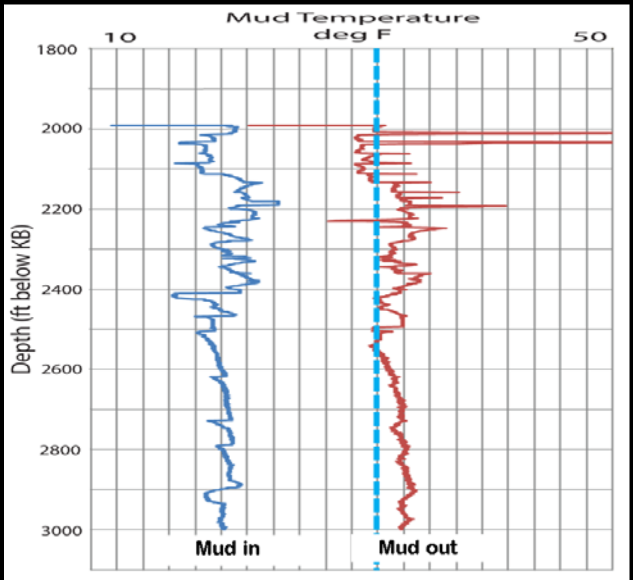




Core liner cut, core examined, described, sampled, & archived

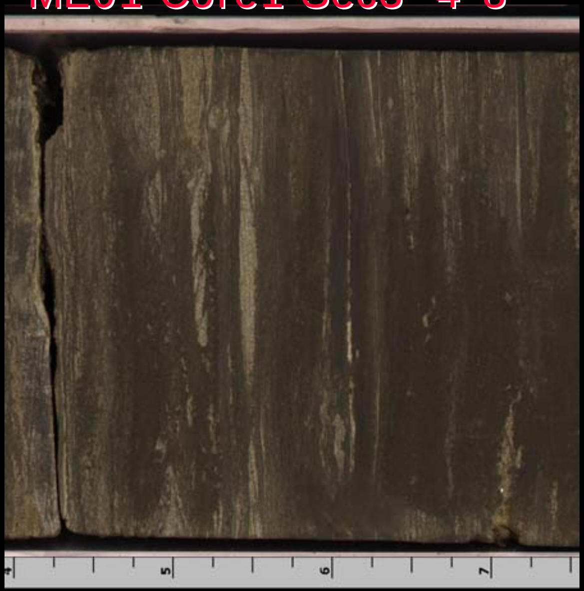
Core Program Summary

- Outstanding performance
  - Oil-based mud chilled to ~30º F
  - 23 cores, 504' core, 85% recovery
- 261 subsamples collected onsite
  - 7 preserved in liquid nitrogen
  - 4 preserved in pressure vessels
  - 52 physical properties
  - 46 porewater geochemistry
  - 5 thermal properties
  - 86 microbiology
  - 46 organic geochemistry
  - 15 petrophysics
- Recipients: NETL, LBNL, PNNL, ORNL, CSM, NRCan, USGS, ConocoPhillips, OSU, OMNI Lab, UAF

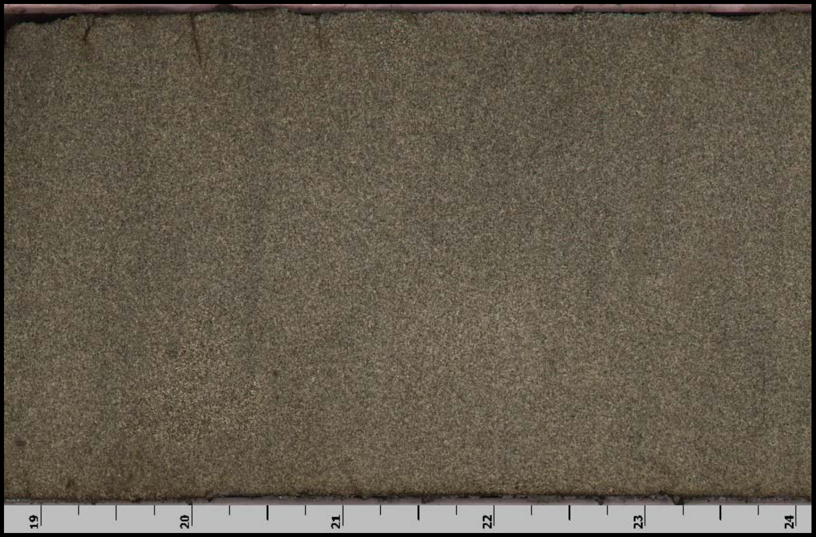


Core Sedimentology

Shale Top-Seal
ME01 Core1 Sec3 4-8"



ZONE D Gas Hydrate-bearing sand
ME01 Core3 Sec2 19-24"



Zone D Pebble Conglomerate
ME01 Core2 Sec5 0-12"

ZONE C Gas Hydrate-bearing sand
ME01 Core7 Sec2 28-33"

Petrophysical Data from Core

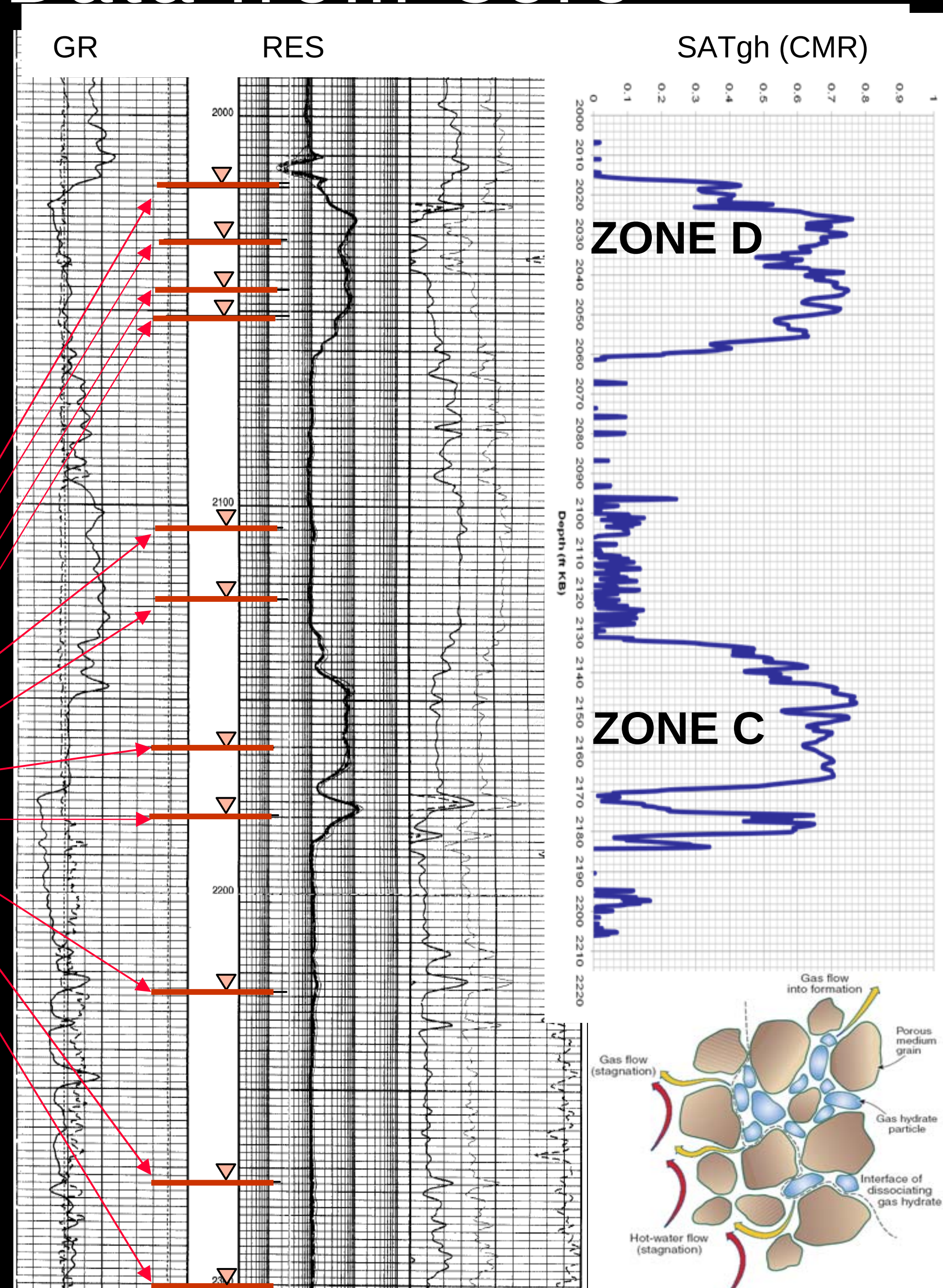
SUMMARY OF ROUTINE CORE ANALYSES RESULTS

Vacuum Oven Dried at 140°F

BP Alaska
MT. Elbert - 01 Well

Alaska, USA
File: HH-36510

Core Number	Sample Number	Sample Depth, feet	Net Confining Stress, psi	Median Grain Size, microns	Permeability, millidarcys		Porosity, percent		Grain Density, gm/cc
					to Air	Klinkenberg	Ambient	NCS	
2	2-2-8	2017.10	572	10.27	12.2	10.1	33.2	33.1	2.70
2	2-2-21-27B	2018.35	572	6.76	4.74	3.78	32.6	32.5	2.71
2	2-5-17	2032.40	576	94.54	2100.	2020.		42.6	2.71
3	3-7-3	2045.90	580	74.55	1370.	1310.		43.0	2.71
3	3-5-28-34B	2051.45	582	88.60	1630.	1570.		42.3	2.72
5	5-8-1-6A	2106.60	597	6.94	1.46	1.15	32.0	31.9	2.72
6	6-5-30-36A	2124.75	602	25.25	145.	131.		34.2	2.72
8	8-12-12	2163.40	613	58.42	675.	636.		41.0	2.71
9	9-1-2-7A	2180.25	618	210.07	7650.	7470.		39.9	2.67
12	12-3-6-12A	2224.15	631	15.58	1.01	0.789	29.0	28.9	2.74
14	14-4-30-33A	2274.70	645	7.97	2.68	2.12	27.5	27.4	3.21
15	15-17-5	2301.10	652	62.24	815.	772.		40.1	2.71
21	21-4-30-35A	2433.35	690	12.80	1.31	1.03	29.4	29.3	2.71
22	22-4-20-23B	2454.95	696	9.99	1.34	1.06	30.4	30.3	2.70
23	23-22-7	2470.60	700	7.23	0.887	0.685	30.5	30.4	2.72
23	23-5-0-5B	2482.15	704	10.80	0.770	0.586	29.5	29.4	2.71
		Average values:		43.87	900.	871.	30.5	34.8	2.74



Petrophysical Grain Size Data from Core

BP Alaska
MT. Elbert-01 Well

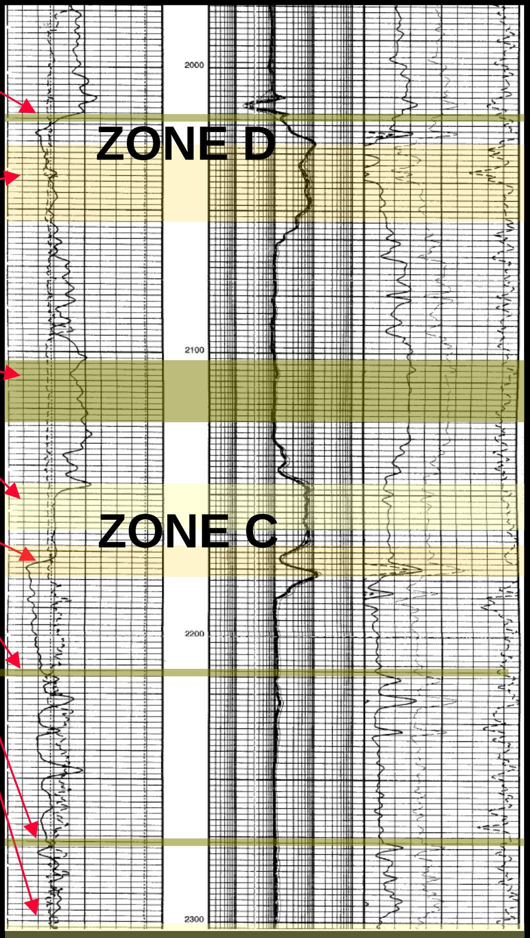
OMNI Laboratories, Inc.

Conventional Core Plug Trim
File: HH-36510
Date: 2-21-08

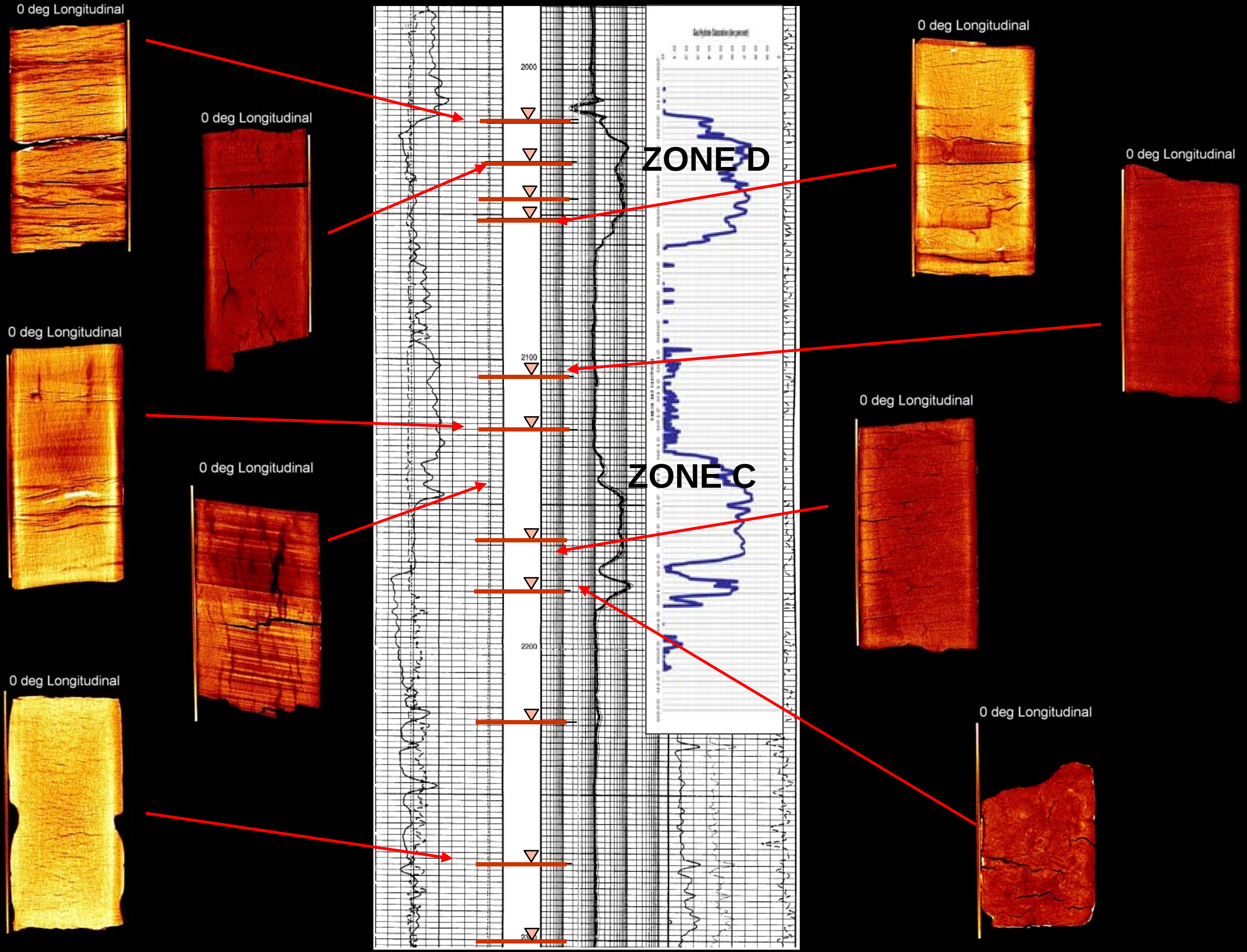
LASER GRAIN SIZE SUMMARY

Core Run	Depth, feet	ID Number	Sand Crs %	Sand Med %	Sand Fine %	Sand Vf %	Sand Total	Silt Crs %	Silt Med %	Silt Fine %	Silt Vf %	Silt Total	Clay %
2	2016.00	2-1-17	0.0	0.0	0.5	2.7	**3.1**	7.2	13.1	20.6	24.4	**65.3**	31.6
2	2017.10	2-2-8	0.0	0.0	0.1	5.8	**5.9**	15.7	17.3	18.5	18.6	**70.1**	24.0
2	2018.35	2-2-21-27B	0.0	0.0	0.0	1.3	**1.3**	8.3	15.0	20.3	23.0	**66.6**	32.1
2	2026.70	2-14-17	0.0	0.3	22.9	42.6	**65.8**	14.4	5.9	5.9	3.5	**29.8**	4.4
2	2032.40	2-5-17	0.0	0.6	28.9	43.6	**73.1**	11.4	4.3	4.6	2.8	**23.1**	3.8
2	2035.40	2-8-14-20A	0.0	0.0	17.0	42.0	**58.9**	18.9	6.5	6.6	4.1	**36.0**	5.1
3	2045.90	3-7-3	0.0	0.0	16.2	43.6	**59.8**	16.7	5.3	6.9	4.6	**33.6**	6.7
3	2051.45	3-5-28-34B	0.0	0.0	16.7	60.0	**76.8**	7.5	1.9	6.0	3.3	**18.7**	4.5
5	2106.60	5-8-1-6A	0.0	0.0	0.0	0.5	**0.5**	4.0	15.7	25.3	22.4	**67.4**	32.1
6	2124.75	6-5-30-36A	0.0	0.0	0.1	12.2	**12.3**	29.6	20.8	13.0	10.6	**73.9**	13.8
7	2146.70	Whole Core	0.0	0.0	7.5	32.2	**39.7**	22.7	10.3	10.1	7.6	**50.6**	9.7
8	2163.40	8-12-12	0.0	0.0	9.6	36.7	**46.2**	24.0	7.5	7.7	6.1	**45.3**	8.5
8	2169.20	8-5-9-13A	0.0	0.0	13.1	44.1	**57.2**	21.9	6.0	6.2	3.8	**37.9**	4.9
9	2180.25	9-1-2-7A	0.5	32.4	55.7	6.9	**95.4**	0.5	1.7	0.7	0.9	**3.9**	0.7
12	2224.15	12-3-6-12A	0.0	0.1	1.3	5.8	**7.2**	18.6	23.9	16.4	12.1	**71.0**	21.8
14	2274.70	14-4-30-33A	0.0	0.0	0.0	1.2	**1.2**	8.2	18.7	22.3	21.5	**70.7**	28.1
15	2301.10	15-17-5	0.0	0.0	9.9	39.6	**49.5**	24.3	7.4	7.1	5.0	**43.8**	6.7
18	2363.20	18-18-5A	0.0	0.0	0.1	1.5	**1.6**	11.6	23.1	21.6	18.4	**74.7**	23.8
20	2414.85	20-2-32-36A	0.0	0.0	2.9	28.8	**31.7**	29.4	10.4	9.8	8.3	**57.9**	10.4
21	2433.35	21-4-30-35A	0.0	0.0	0.0	2.4	**2.4**	16.2	24.7	20.4	15.9	**77.2**	20.4
22	2454.95	22-4-20-23B	0.0	0.0	0.0	0.5	**0.5**	7.5	23.3	27.5	19.5	**77.8**	21.7
23	2470.60	23-22-7	0.0	0.0	0.0	0.3	**0.3**	3.7	14.8	27.6	26.3	**72.4**	27.3
23	2482.15	23-5-0-5B	0.0	0.0	0.0	1.9	**1.9**	12.2	23.0	23.0	18.3	**76.5**	21.6

Sand > 50%
Sand 20%-50%
Sand < 20%



Core CTscans



Core XRD Results

Note high pyrite in transgressive top of D (but not in C). Note also 10%+ feldspars in D sand except in cleanest sands at top of regressive section

OMNI LABORATORIES, INC.
X-RAY DIFFRACTION
(WEIGHT %)

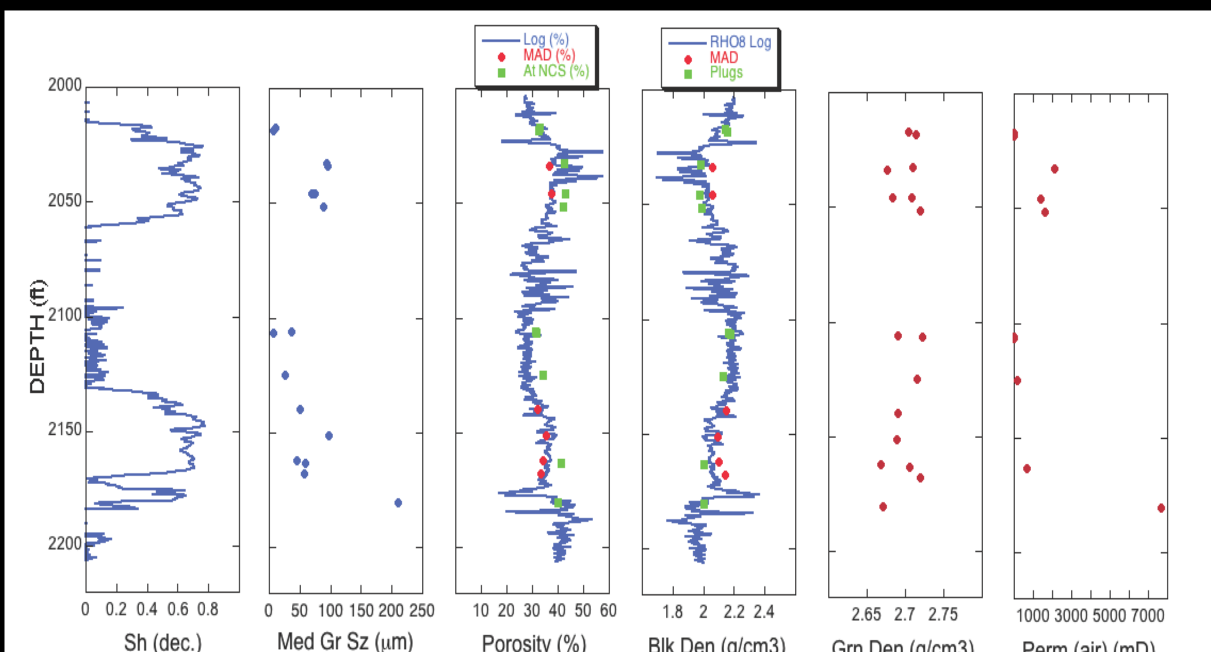
OMNI Laboratories, Inc.

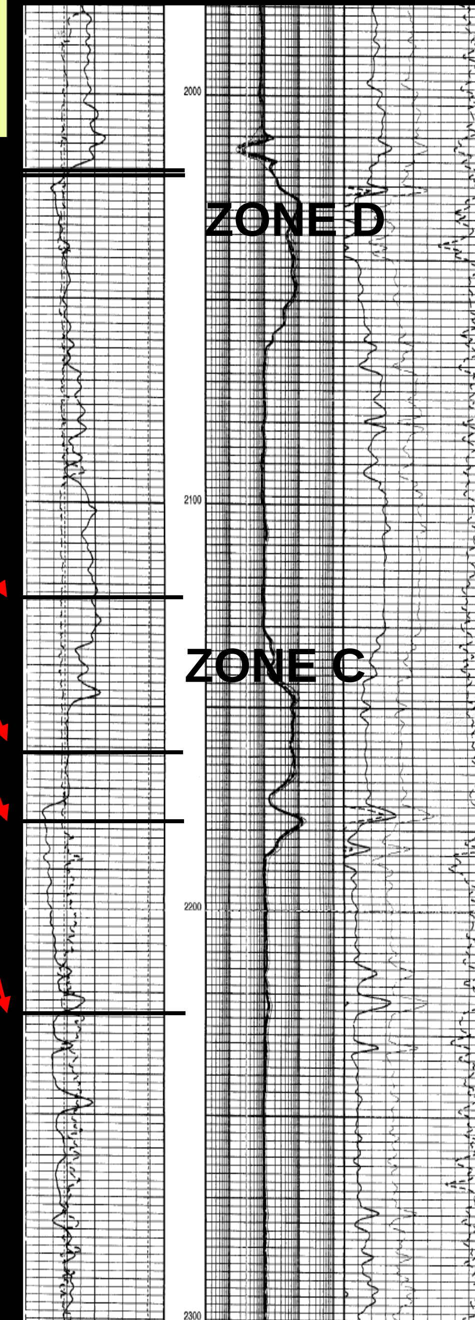
Client: BP Exploration Alaska
Well: Mt. Elbert 01
Area: Milne Point Field, North Slope Borough, Alaska
Sample Type: Conventional Core

File No: HH-36510
Date: 02/28/08
Analyst: G. Walker

Sample Identity	CLAYS				CARBONATES			OTHER MINERALS						TOTALS			
	Chlorite	Kaolinite	Illite	Mx I/S*	Calcite[1]	Dol/Ank	Siderite	Quartz	K-spar	Plag.	Pyrite	Zeolite	Barite	Clays	Carb.	Other	
2-2-8	12	3	13	2	0	0	Tr	54	1	6	9	0	0	30	Tr	70	2017’
2-2-21-27B	14	3	17	3	0	0	Tr	47	1	7	8	0	0	37	Tr	63	2018’
6-5-30-36A	7	2	9	1	0	0	Tr	67	1	12	1	0	0	19	Tr	81	2124’
8-12-12	6	1	7	1	0	0	Tr	73	1	10	1	0	0	15	Tr	85	2163’
9-1-2-7A	2	1	2	Tr	0	0	Tr	90	1	3	1	0	0	5	Tr	95	2180’
12-3-6-12A	11	2	12	2	0	0	Tr	61	1	10	1	0	0	27	Tr	73	2224’
22-4-20-23B	13	3	15	3	0	0	Tr	53	1	11	1	0	0	34	Tr	66	2454’
AVERAGE	9	2	11	2	0	0	Tr	64	1	8	3	0	0	24	Tr	76	

* Randomly interstratified mixed-layer illite/smectite; Approximately 90-95% expandable layers
[1] May include the Fe-rich variety



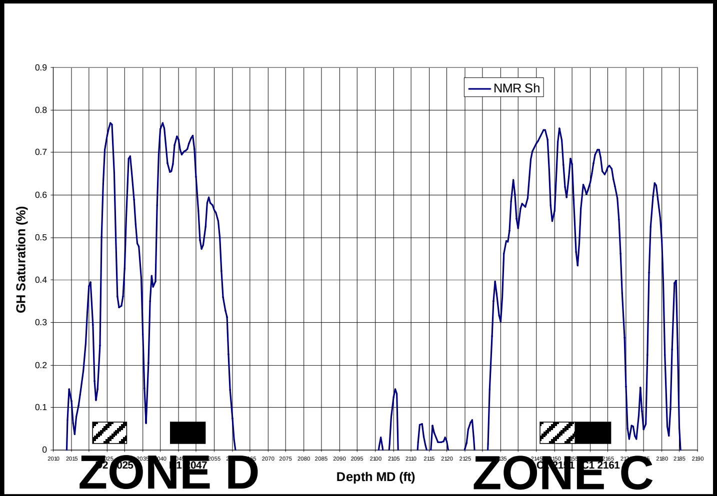


Core Sampling
Onsite Pore-Water Geochemistry Lab

Core samples are squeezed to extract/examine pore water samples and analyzed for thermal properties

Downhole Data Acquisition
Modular Dynamics Testing (MDT)

- Tests reservoir response to fluid withdrawal and pressure reduction
- Indication of reservoir quality and performance
- Tests conducted at four locations two per pay zone
- Critical data for reservoir simulation calibration and potential production test



Modular Dynamic Testing (MDT)

- Extensive and repeatable flow and pressure transient data obtained from 4 extended Dual-Packer OH MDT's
  - Collected formation temperature data tracking cooling and warming events during flow and build-up periods – an industry first
  - 4 gas samples obtained from each test interval
  - Observed rapid cooling (and potential freezing of pore water) during gas hydrate dissociation/gas flow
  - Produced free pore water from gas hydrate zone without causing gas hydrate dissociation
  - 1 pore water sample obtained from D1 test interval

Presentation Outline

- Project Overview / Schedule
- Resource Characterization
- Stratigraphic Test Results
- ➢ **Reservoir Simulation**
- Production Testing
- Conclusions / Future Plans

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➢ **Conclusions / Future Plans**

Core sampling at Mt Elbert well site – February, 2007

Mt Elbert Gas Hydrate Well Summary

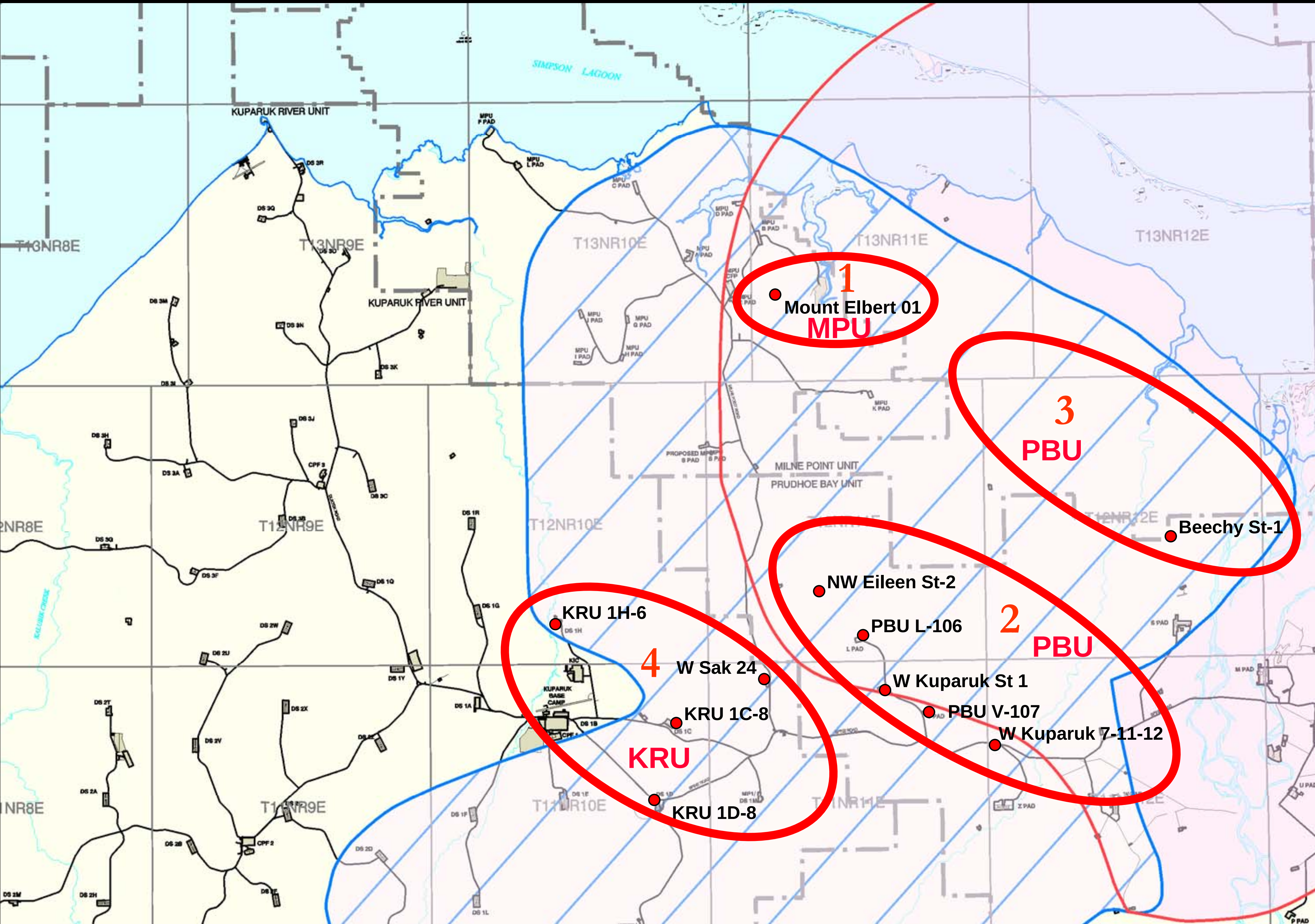
- Demonstrated safe data collection in shallow unconsolidated, GH-bearing sediments
  - good hole = outstanding core recovery and log suite
- Confirmed GH reservoir in close conformance to pre-drill predictions
  - ability to prospect for hydrate using G&G approach
  - improved confidence in broader ANS GH resource assessment
- Coring, Logging, Pressure Testing Program
  - fully integrated data and sample set
  - moveable fluids in fully-saturated reservoirs quantified and accessed
  - gas release via depressurization
- Acquisition and analysis of complete and integrated dataset for cost of ~$6.0 million

Project Phase 3b – beyond 2009+

Parameters for a Successful Production Test

- Site with continuous, long-term access
  - Maximize likelihood for success
  - Conduct long-term operations
  - Build on past success, learn from others
- Designed to determine the potential productivity of gas hydrate reservoirs
  - Validate simulations
  - Maximize knowledge, not just rate
  - Demonstrate technical recovery
  - Test multiple completion scenarios
- Carefully manage risks
  - Maintain operationally simple
  - Meet all HSE requirements
  - Minimize impacts to existing operations
  - Optimize reservoir conditions

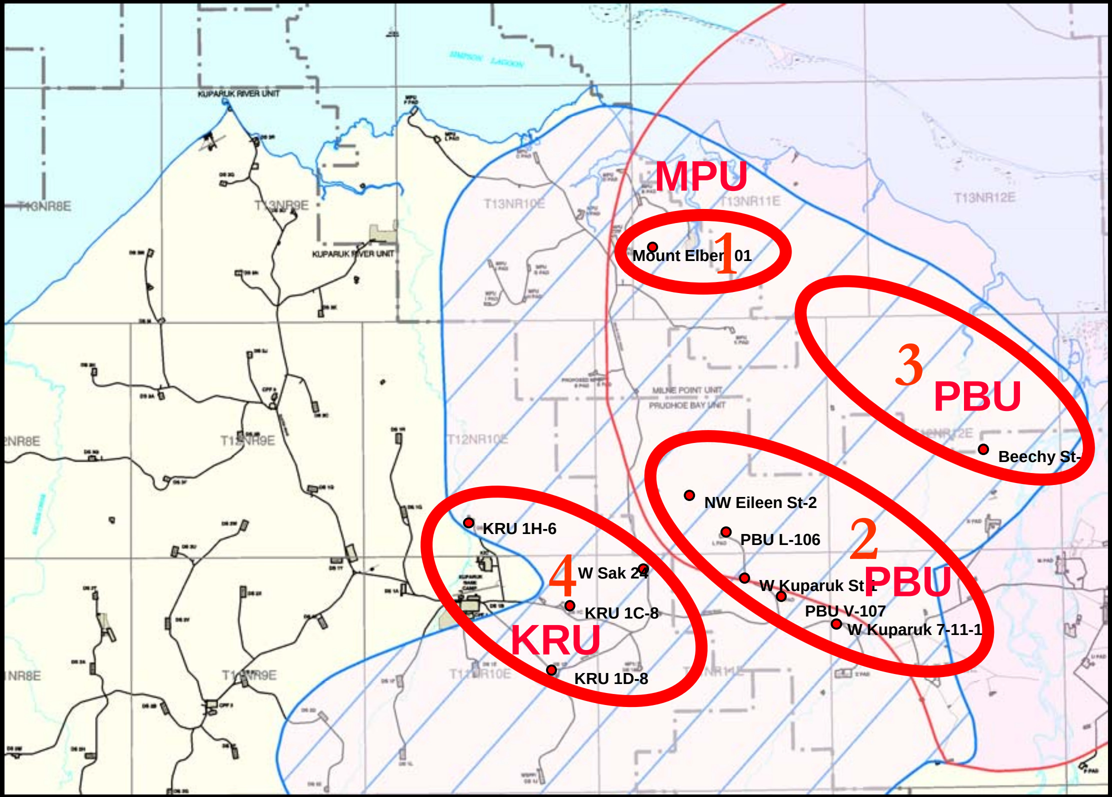
Site Evaluation – Long-term Production Test



Four areas under evaluation within Eileen trend for Production Test Site

Key Criteria

- Probability of Success
  - Reservoir presence and quality
  - Temperature
  - Nature of contacting units (pressure support?)
  - Modeling results
  - Operational flexibility (multiple zones)
- Ease of Access
- Logistics/Facilities
- Program Complexity



Site Comparison and Risk Detail

MPU/KRU option PBU L option /down-dip

Parameter	MP E-pad	MP B-pad	KRU *W Sak 24*	KRU 1H	PBU L-pad	PBU Kup St. *3-11-11*	PBU *downdip*
Temp[1]	H	H	H	H	M	M	L
Ownership[2]	L	L	M-L	M-L	H	H	H
Access[3]	M*	M*	L	L	L	L	H
Geo Risk[4]	L	L	M	M	L	L	H
Data[5]	L	L	M	M	L	M	H
Well Risk[6]	L-M	L-M	M	M	M	M	H
Facilities[7]	L	L	M	L	L	M	H
Gas[8]	H	H	H	H	H	H	H
Interference[9]	L	?	L	H?	H?	L	L
Water[10]	L	L	M	L	L	M	H
Market[11]	L?	L?	L	L?	M	M	M
Options[12]	M-H	M-H	H	H	L	L	M-H

General comparison of test site options

Target	Depth	Contact	H (ft)	Sw/Swirr (%)	Phi (%)	K (mD)	T (oC)	Pressure gradient	Salinity (ppt)
Milne Point Unit – Mount Elbert Prospect									
C-sand	2132	Water	52	35/25	35	1000	3.3 - 3.9	9792	5
D-sand	2014	Water?	47	35 -	40	1000	2.3 – 2.6	9792	5
Prudhoe Bay Unit – L-pad vicinity									
C2-sand	2318	Shale	62	25	40	1000	5.0 – 6.5	9792	5
C1-sand	2226	Shale	56	25	40	1000	5.0 – 6.5	9792	5
D-sand	2060	Shale	50						
E-sand	1915	Shale	50						
Prudhoe Bay Unit Down-Dip from L-pad									
C-sand	2500	?	60*	25	40	1000	~12	9792	5
Kuparuk River Unit – West Sak 24 vicinity									
B-sand	2260	Shale?	40	35	40	1000	2.0 – 3.0	9792	5

KRU and MPU units are very similar, both colder and are treated as one scenario for modeling

- **MPU/KRU-like reservoirs**
- **PBU L-pad-like reservoirs**
- **Warmer reservoirs such as those that occur down-dip of the PBU L-Pad area**

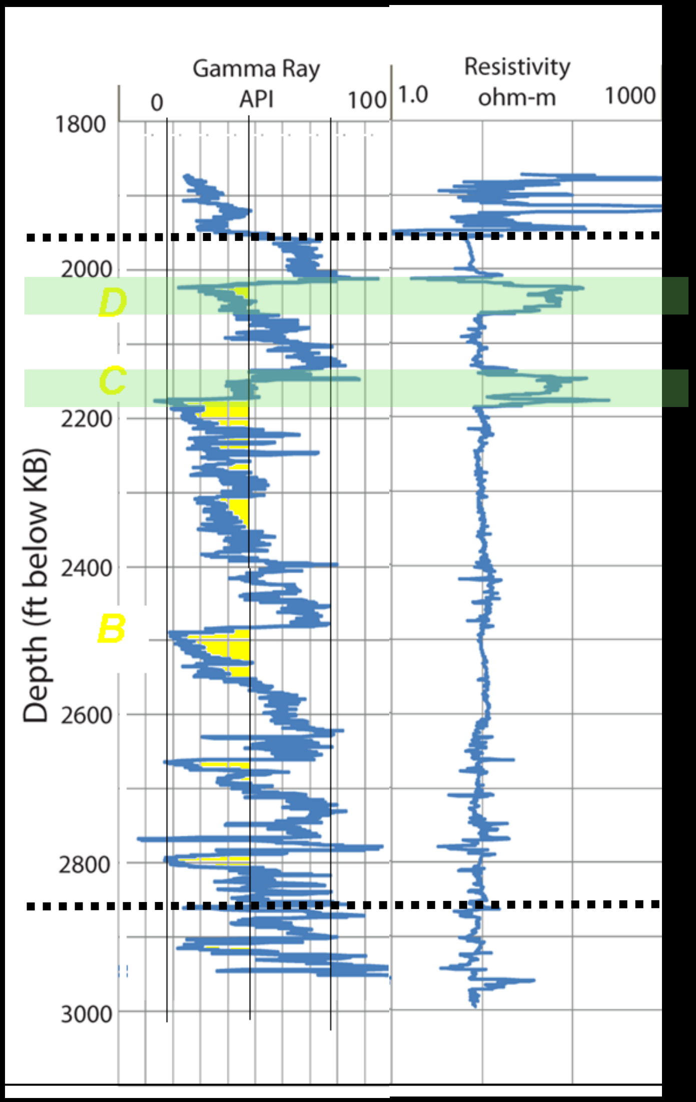
Milne Point (or Kuparuk River) unit option

Favorable

- Low geologic risk
- Ease of access to land and facilities

Unfavorable

- High risk of poor test results
  - Low formation temperature (2-3 C)
  - Lower zone (at least) likely in contact with free water
- No surface location for vertical well
  - must drill directionally
- Fewer options –2 possible zones
- Lateral extent unclear



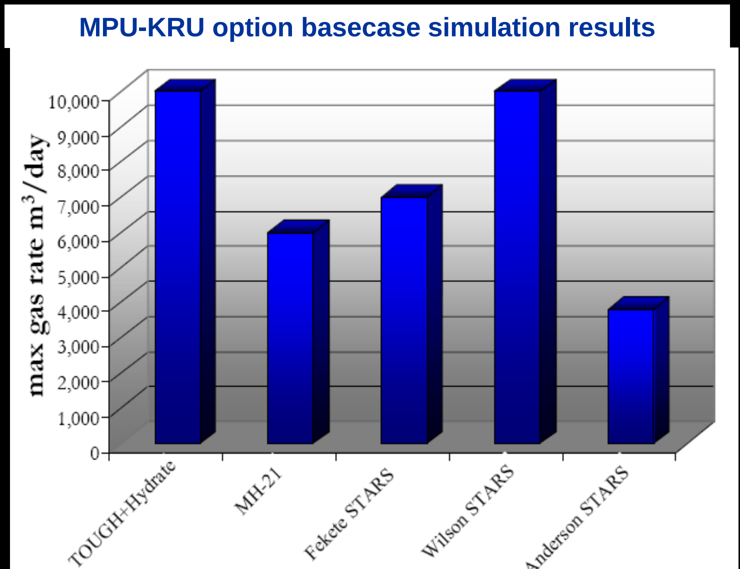
Prudhoe Bay down-dip option

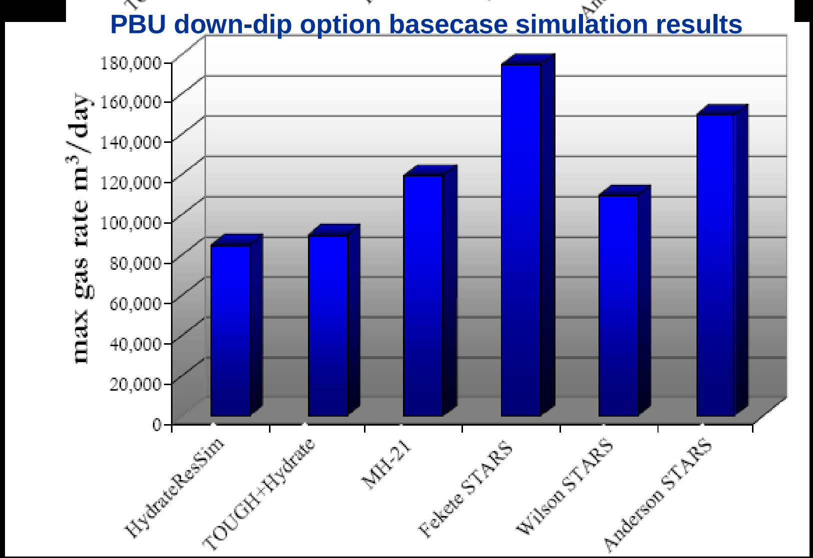
Favorable

- Temperatures as high as 12C
- Most favorable simulation results

Unfavorable

- Much higher geologic risk
  - very few nearby well penetrations
  - uncertainty as to reservoir presence and fill
  - Potentially limited reservoir options
- No viable surface site infrastruction or facilities
  - Extended reach well or near permanent gravel pad at prohibitive cost

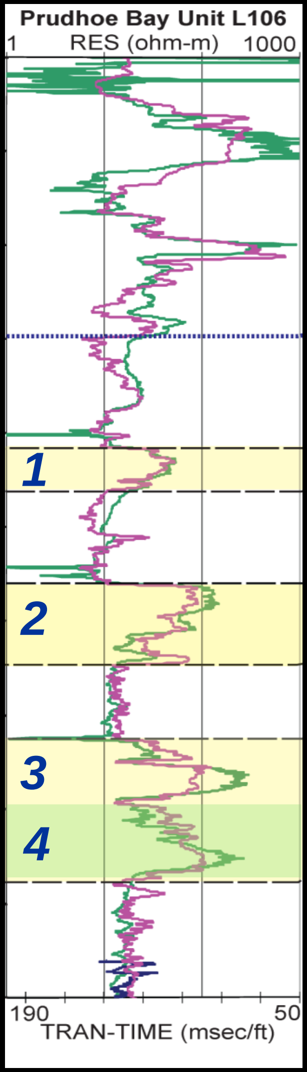




W. Prudhoe L-pad vicinity option

Favorable

- **Acceptable technical risk**
  - Moderate temperature (3-6 C)
  - Expect at least scalable production rates
  - Can drill vertically
  - Multiple zones each ~15m thick
- **Acceptable geologic risk**
  - Close offset to high-quality log suites
  - Clean, fully saturated sands
  - Recent 3D data in hands of industry partners



Unfavorable

- **Complex contractural arrangement**
  - Would require approval of all Stakeholders

The Team

INDUSTRY

- BP Exploration Alaska
- Arctic Slope Regional Corporation
- Ryder Scott Company
- RPS - APA Energy
- Interpretation Services, Inc.
- Doyon Drilling, Inc.
- ReedHycalog (Corion)
- Drill Cool Systems, Inc.
- Omni Laboratories
- Schlumberger
- MI Swaco

GOVERNMENT

- US Geological Survey
- Department of Energy

ACADEMIA

- U. Alaska-Fairbanks
- U. Arizona
- Oregon State University

- Backup Misc.

Contribution to R&D Community
Results, Reporting, Publications, Presentations

- DOE Reports: 15 major DOE Technical Reports, 4Q02-2Q08
- 1 Topical Report on Drilling and Data Acquisition Planning, 6/05
    - Published 2005 Regional Modeling in June 2006 Q Report
- DOE Advisory Committee / other Government presentations
- Present project updates - technical conferences/public meetings
    - Annual AAPG Meeting Oral/Poster Sessions 2002 – 2008
    - 2002-04: >20 external presentations
    - 2005-08: ~20 external presentations
    - M.S. Thesis: 3 + 2 pending UA and 5 + 1 pending UAF
    - >30 professional publications
- Participate openly in Model Comparison Studies: 2005 – 2008
- Industry-standard input - Operations designs and production test

THEMATIC VOLUME PROPOSAL
JOURNAL OF MARINE AND PETROLEUM GEOLOGY
SCIENTIFIC RESULTS OF 2007 USDOE-BP-USGS "MOUNT ELBERT" HYDRATE STRATIGRAPHIC TEST
MILNE POINT UNIT, ALASKA NORTH SLOPE

Eds. Dr. Ray Boswell, U.S. DOE, National Energy Technology Lab
Dr. Tim Collett, U.S. Geological Survey
Dr. Brian Anderson, West Virginia University/NETL-IAES
Robert Hunter, ASRC Energy Services

Our proposed time schedule is as follows:
First submission deadline to guest editors: March 1, 2009.
Completion of initial reviews: May 1, 2009.
Completion of review-revision process: July 1, 2009.
Appearance on the web: August 15, 2009.
Hardcopy: Jan-Feb, 2010.

THEMATIC VOLUME PROPOSAL

Introductory Materials (Hunter, ed.)

1. R. Hunter (ASRC Energy): Research overview and Stratigraphic Test
2. M. Lee (USGS): 3D seismic analysis of Mount Elbert prospect
3. T. Collett (USGS): Regional geologic framework
4. R. Boswell (DOE): Geologic controls of gas hydrate, Milne Point
5. S. Wilson (RyderScott Co.) Regional production modeling

Coring Program (Boswell, ed.)

6. K. Rose (DOE): Core operations and sedimentology
7. B. Winters (USGS): Physical and grain-size properties
8. B. Winters (USGS): Geotechnical behavior
9. T. Lorenson (USGS): Gas geochemistry
10. M. Torres (Oregon St. U.): Porewater geochemistry
11. F. Colwell (Oregon St. U.): Microbial community diversity
12. T. Kneafsey (LBNL): Core disturbance and handling
13. L. Stern (USGS): SEM and XRD imaging and characterization
14. H. Lu (Natural Resources Canada): Characteristics of gas hydrate
15. A. Johnson (U. Alaska-Fairbanks): Gas-Water Relative Permeability

THEMATIC VOLUME PROPOSAL

Well Logging Program (Collett, ed.)

16. T. Collett (USGS): Operations and core/log data
17. M. Lee (USGS): Data analysis
18. Y. Sun (Texas A&M): High-resolution dielectric properties

19-21: TBD: Advanced log analyses

MDT Program (Anderson, ed.)

22. B. Anderson (West Va. U.): Operations summary and interpretation
23. M. Pooladi-Darvish (U. Calgary): MDT data - implications
24. M. Kurihara (Japan Oil Eng.: MDT/Mallik data findings

Production Modeling (Anderson, ed.)

25. B. Anderson (West Va. U.): Regional production modeling overview
26. J. Rutqvist (LBNL): Geo-mechanics during production testing
27. G. Moridis (LBNL): Evaluation of gas production testing
28. M. White (PNNL): Production of Gas Hydrate using CO2 Injection

Proactions & Reactions
Project Management Challenges

- **Gates / Phases / Decisions**
  - 2001 – Present: Industry / Government Alignment
    - Underestimated time needed to maintain/grow alignment
  - 2002 – 2004: Reservoir Description & Modeling
    - Recommended MPU field area Field Operations
    - Regional Eileen trend resource potential not evident
    - Led to 2005 Redirection → Regional Development Model
    - Maintained & Increased Industry support for Operations
  - 2006-07: Field Operations Approved / Executed
    - 2006 → Third-party delays with Drilling Rig
      - Optimized Safety, Drilling, & Data Acquisition program
    - 2007 → Budget Overruns ~$1.1MM
      - Documented Costs → Strong Industry & DOE Commitment
      - Demonstrated ability to Implement Operations / Acquire Data

Methane Hydrate Resource Petroleum System Components

- Source – Thermogenic - Biogenic
- Migration – Fault Systems
- Reservoir – Sub-Permafrost
  Shallow Sands
- Trap – Complex Structural and
  Stratigraphic through 4D
- Seal – Can Self-Seal
- Stability – Pressure/Temperature
- Gas/Water – Clathrate Structure