

A polar bear is walking on a rocky shore in the foreground. The background shows a large number of birds flying in the sky over a body of water. The scene is set in a coastal or tundra environment.

Characterization and Qualification of the Methane Hydrate Resource Potential Associated with the Barrow Gas Fields

Kick-off Meeting
Morgantown, WV
January 9, 2007

Tom Walsh

A polar bear is walking on a rocky shore. The sky is filled with many birds flying. The background is a light blue sky and a dark sea.

Presentation Outline

Overview

Team

Project Objectives

Scope of Work

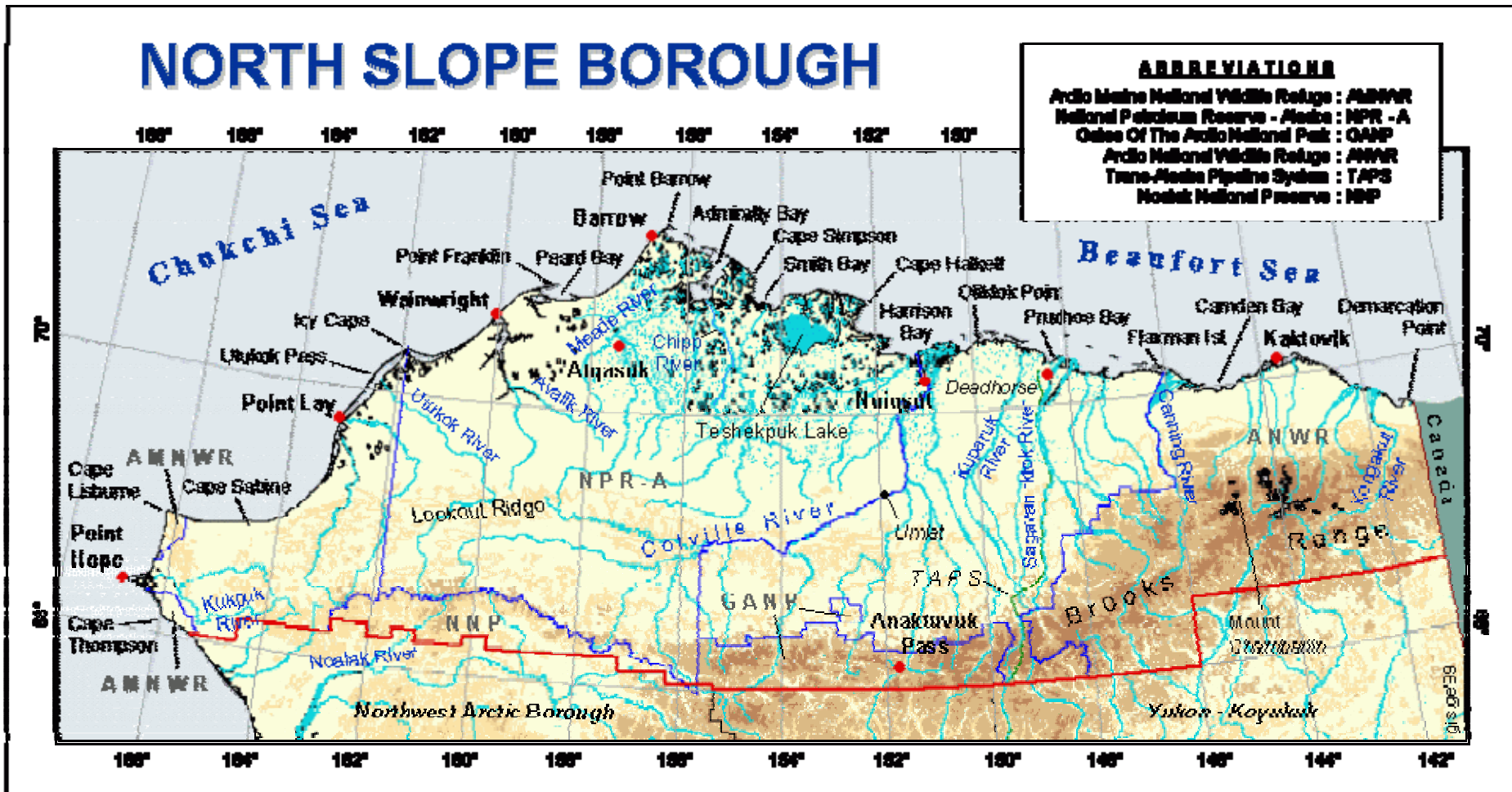
Schedule, Milestones, Deliverables

Overview

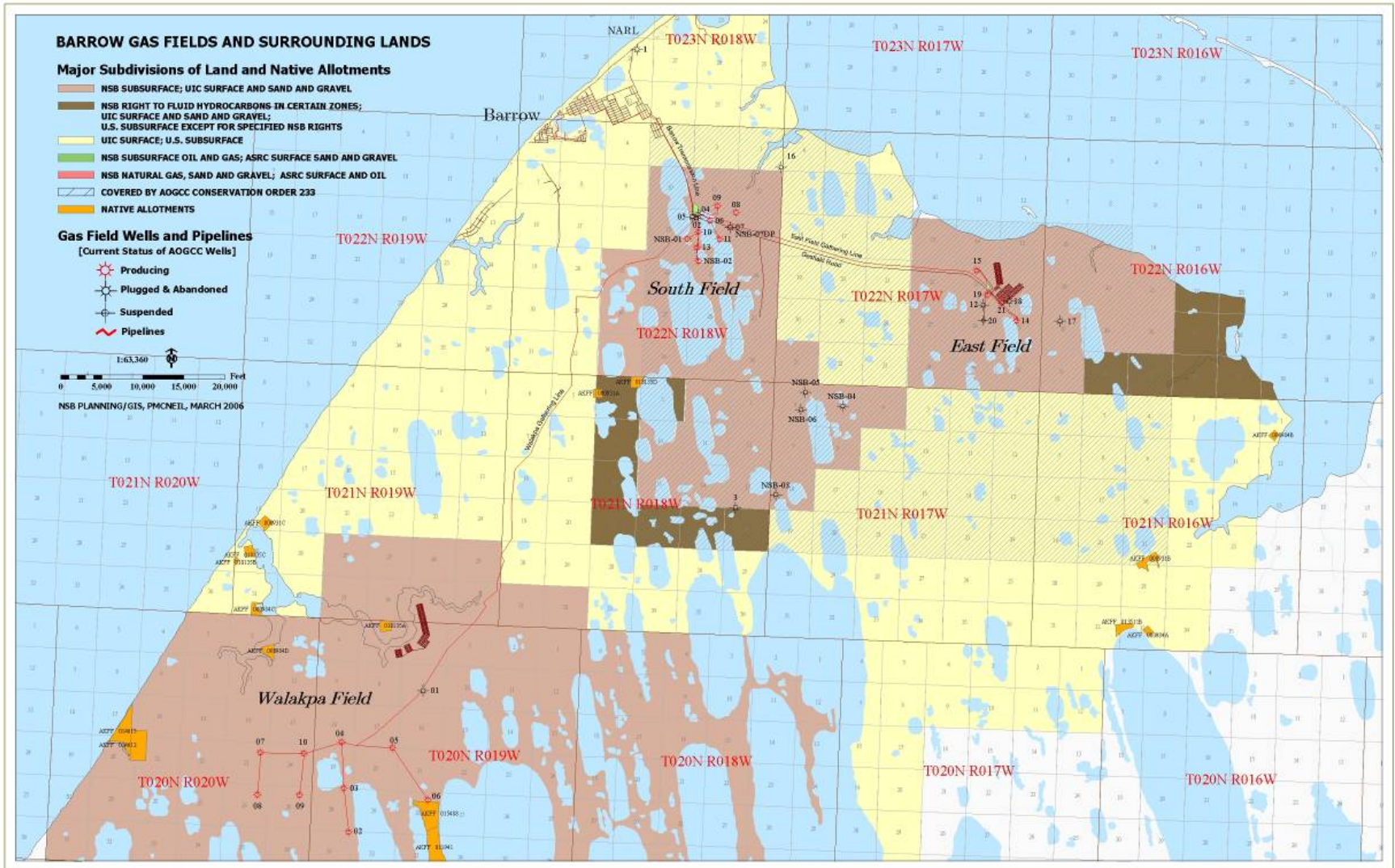
A polar bear is standing on a rocky, reddish-brown shore. The background is a bright, hazy sky filled with numerous birds in flight, likely gulls or terns. The overall scene is a natural, outdoor setting.

- Last Comprehensive Reservoir Study in 1991—Glenn and Allen
- Postulated Presence of Methane Hydrate
- Material Balance Models for East Barrow and Walakpa Fields Lend Support to Possible MH Recharge
- Potential Significant Impact on Local Resource
- Excellent Laboratory for MH Research

Location of Study



Barrow Gas Fields



Participants

The background image shows a polar bear in the foreground, walking on a rocky, reddish-brown shore. The bear is white and is facing right. In the background, there is a large number of birds, likely gulls or terns, flying in a clear blue sky. The birds are scattered across the upper two-thirds of the image. The overall scene is a natural, outdoor setting.

DOE-NETL

NSB

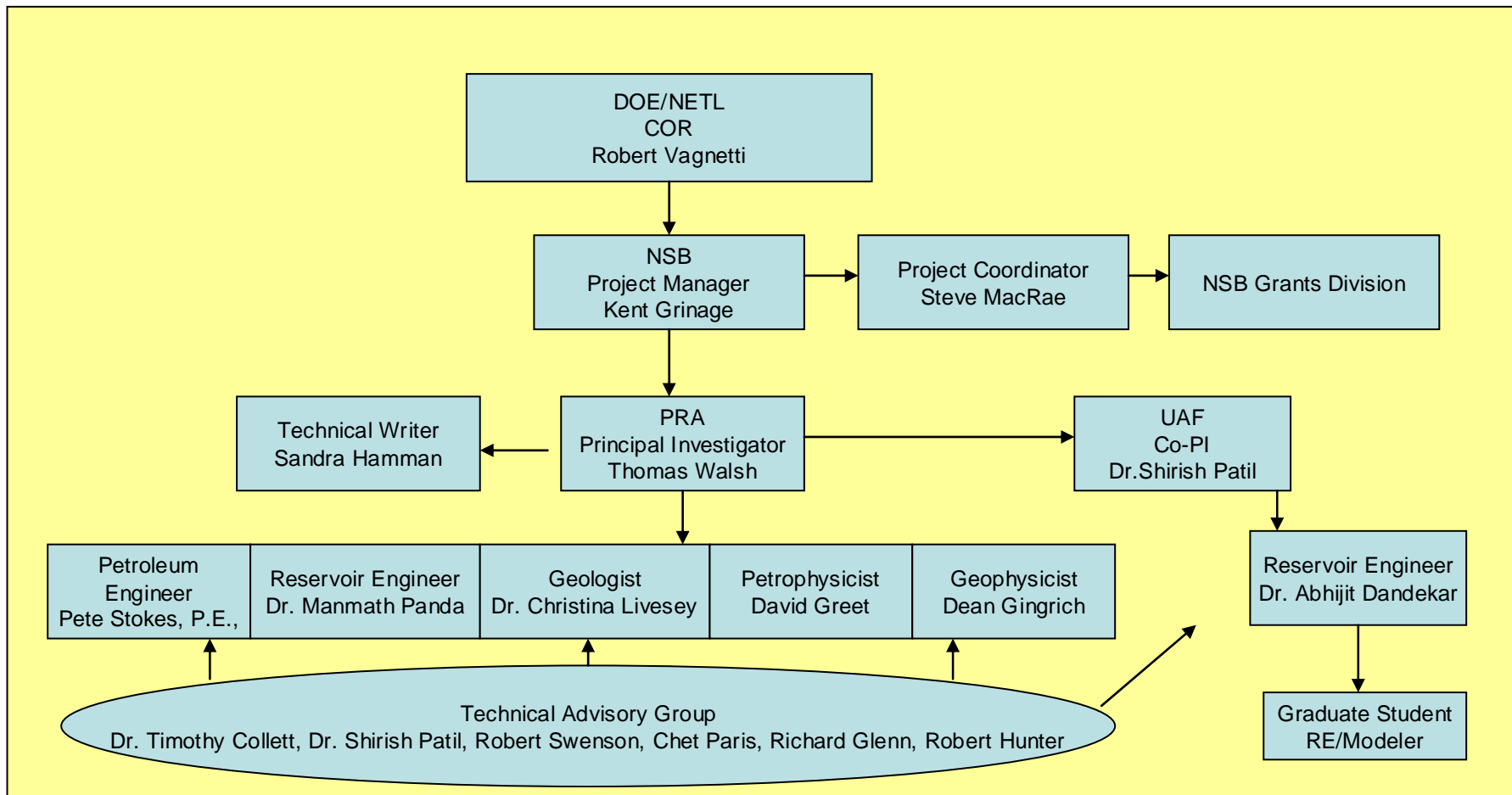
PRA

UAF

Advisory Committee

Tim Collett, Chet Paris, Bob Hunter, Bob Swenson,
Shirish Patil, Richard Glenn

Organization Chart



Objectives

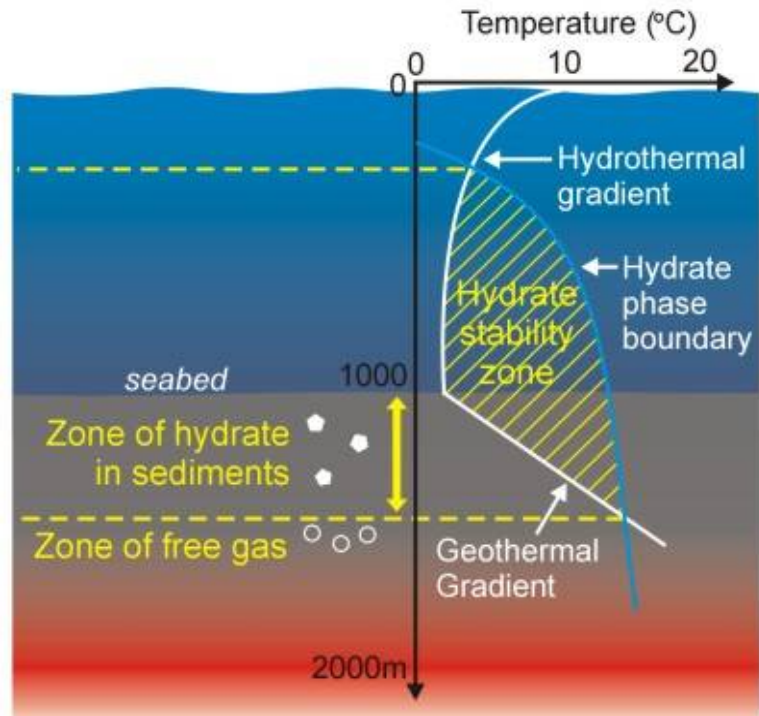
The background of the slide features a polar bear in the foreground, walking across a snowy, rocky terrain. In the background, several birds are flying in a clear sky. The overall scene is a natural, arctic environment.

- Characterize and Quantify Postulated MH Resource
- Focus on Barrow Gas Fields—EastField, South Field, Walakpa
- Phased Approach
- Integrate Prior Research Efforts/Current Knowledge
- Advance the Global MH Research Effort
- If Justified, Phase 2 plan is to drill and test dedicated methane hydrate well

Scope of Work

- Phase 1A
 - Develop Research Mgmt. Plan and Technology Status Assessment
 - Model Methane Hydrate Stability Zone
 - Sample and Analyze Produced Gas from 3 Fields
 - Exit Point if Negative Results
 - Document Results
- Phase 1B
 - Characterize Barrow Gas Field Reservoirs
 - Select Optimum Well Location
 - Develop Model and Simulate Production From the Reservoir
- Phase 2
 - Design, Drill and Production Test a Dedicated MH Well
 - **Not Funded Under This Contract**

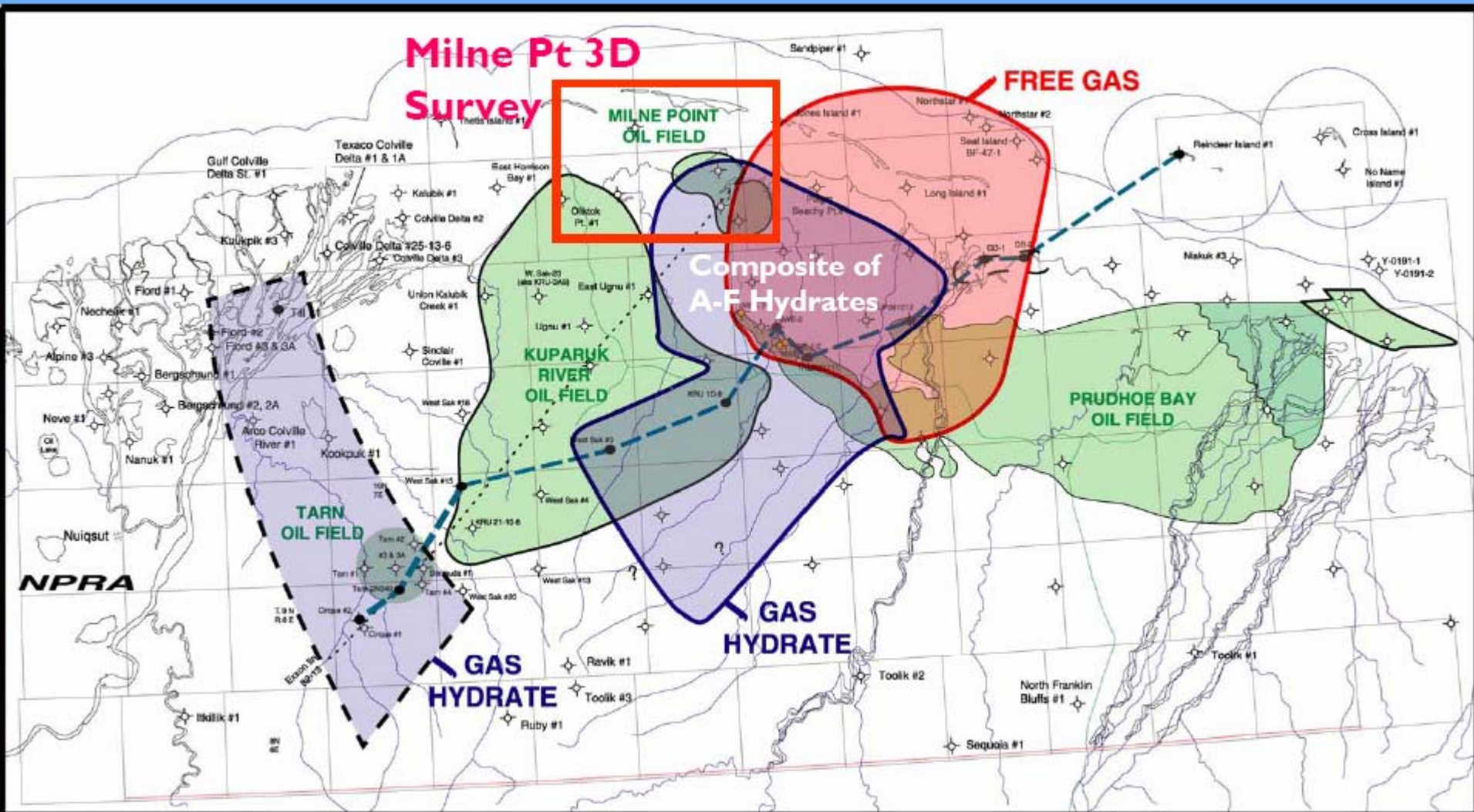
Are Methane Hydrates Present in Barrow?



Heriot-Watt University

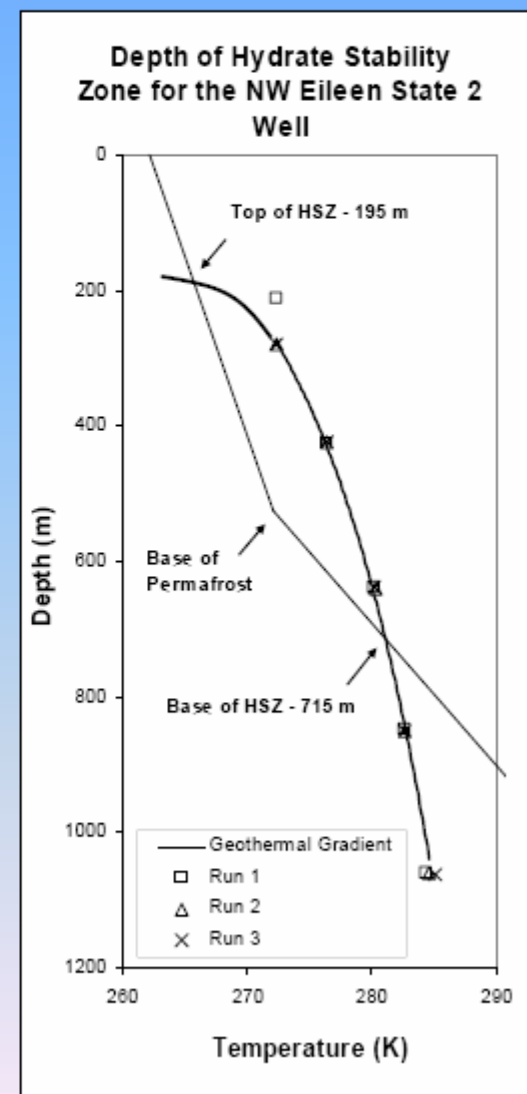
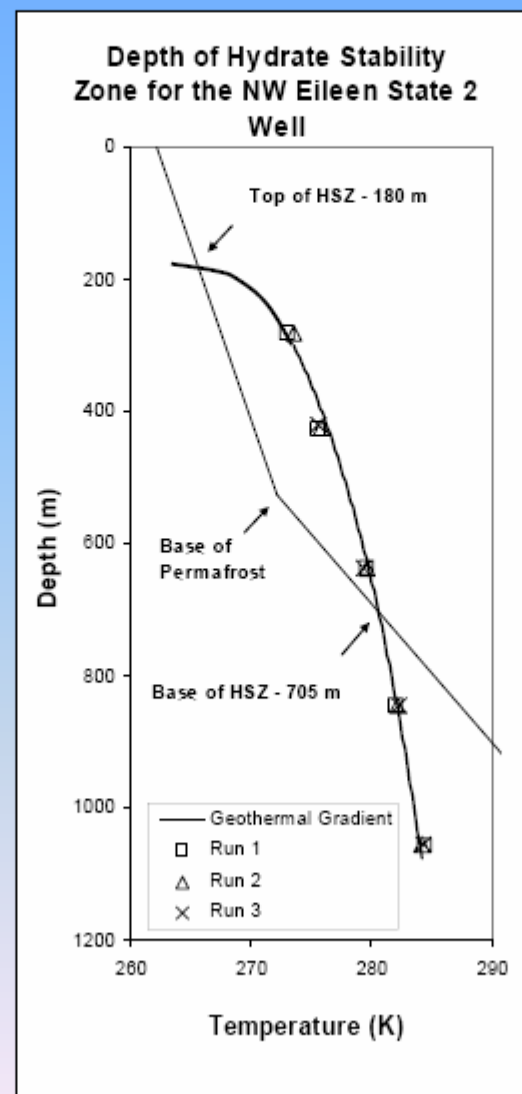
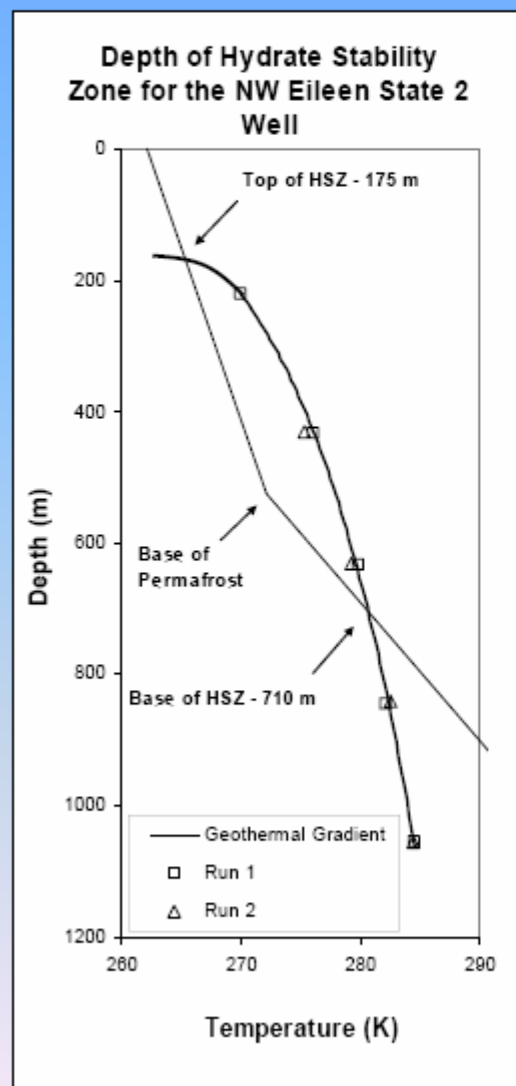
- Free methane gas and permafrost present
- Timing of migration and trap are critical
- Reservoir presence updip of free gas critical
- Methane Hydrates abundant across North Slope
- Phase 1A will model stability zone and analyze gas

Milne Point Gas Hydrate Accumulation



Phase Behavior Studies

Examples of Hydrate Stability Curves



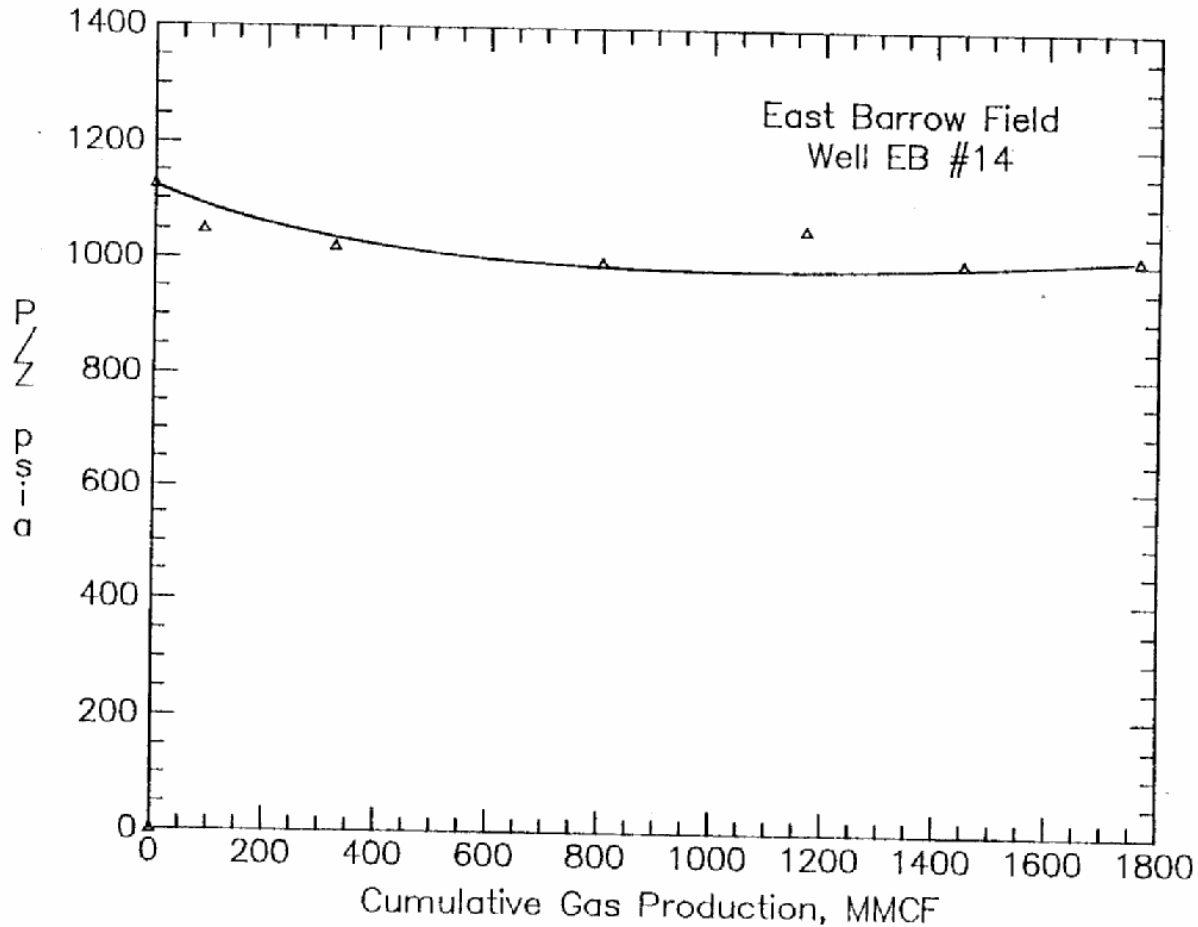
Without Porous Media (h=535)

Synthetic Porous Media (h=525)

Field Sample (h= 520)

Figure No. 11

P/Z vs. CUMULATIVE GAS PRODUCTION



24

E. Barrow #14 P/Z vs. Cumulative Production

ALLEN & CROUCH, PETROLEUM ENGINEERS

RMP

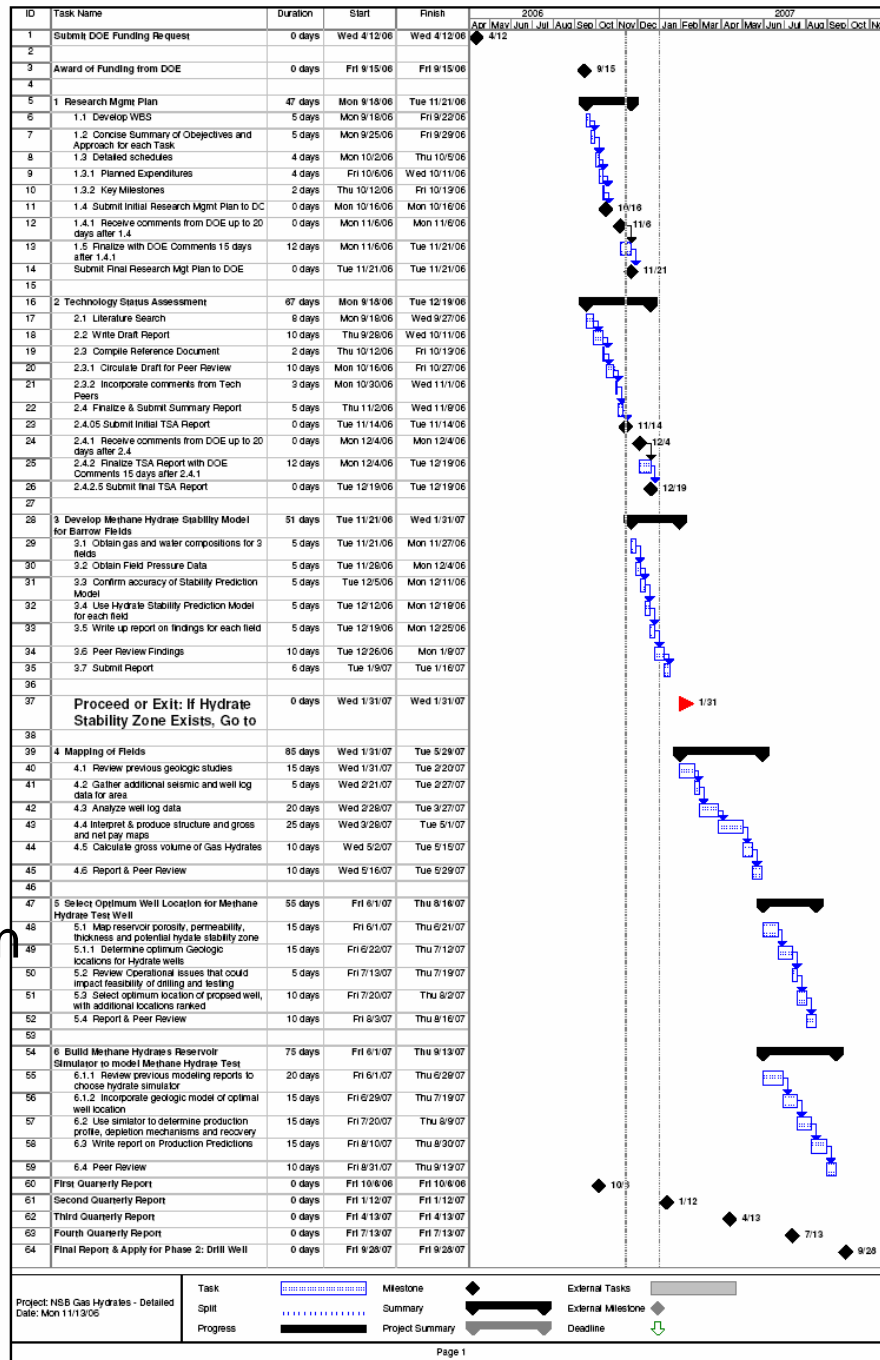
TSA

Stability
Model/Gas
Analysis

Decision Pt.

Reservoir
Characterization

Dynamic
Simulation/
Select Opt.
Location



Project: NSB Gas Hydrates - Detailed
Date: Mon 11/13/06

Task: [Blue bar] Milestone: [Diamond] External Tasks: [Grey bar]

Split: [Dotted line] Summary: [Grey bar] External Milestone: [Diamond]

Progress: [Black bar] Project Summary: [Grey bar] Deadline: [Green arrow]

Page 1

Milestone Plan

ID	Milestone	Due date	% Complete	Proposed change	Cost To-date	% Budget
1	Research Management Plan	12/14/ 06	100			
2	Technology Status Assessment	1/13/07				
3	Methane Stability Model/Gas Analysis	2/23/07				
4	Phase IA Final Report	3/26/07				
5	DECISION POINT	3/26/07				
6	Map of Barrow and Walakpa GF	7/13/07				
7	Select location for test well	9/21/07				
8	Gas Hydrate Reservoir Simulator	11/30/07				
9	Phase I Final Report	12/21/07				
10	DECISION POINT	12/21/07				

Deliverables

A polar bear is walking on a rocky shore in the foreground. The background shows a large number of birds flying in the sky over a body of water. The scene is slightly blurred, giving it a sense of motion and activity.

- Datasets Formatted to Specific Standards
- Periodic, Topical and Final Reports
- Research Management Report
- Technology Status Assessment Report
- Methane Hydrate Stability Model
- Detailed Reservoir Characterization
- Production Simulation Results
- Technical Paper Presentation

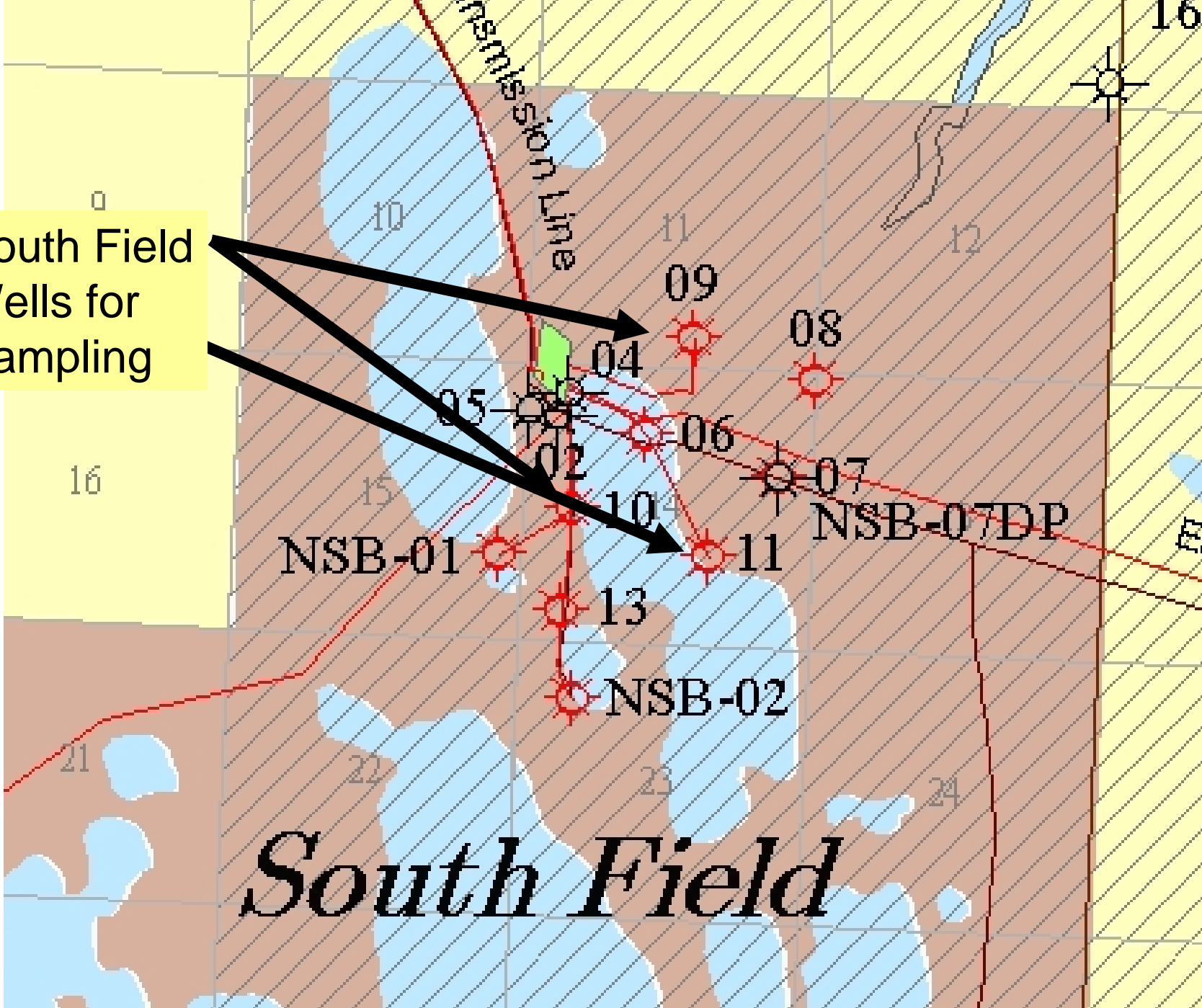
Wells To Be Sampled:

South Pool: Wells S Barrow #'s 9, 10 & 11

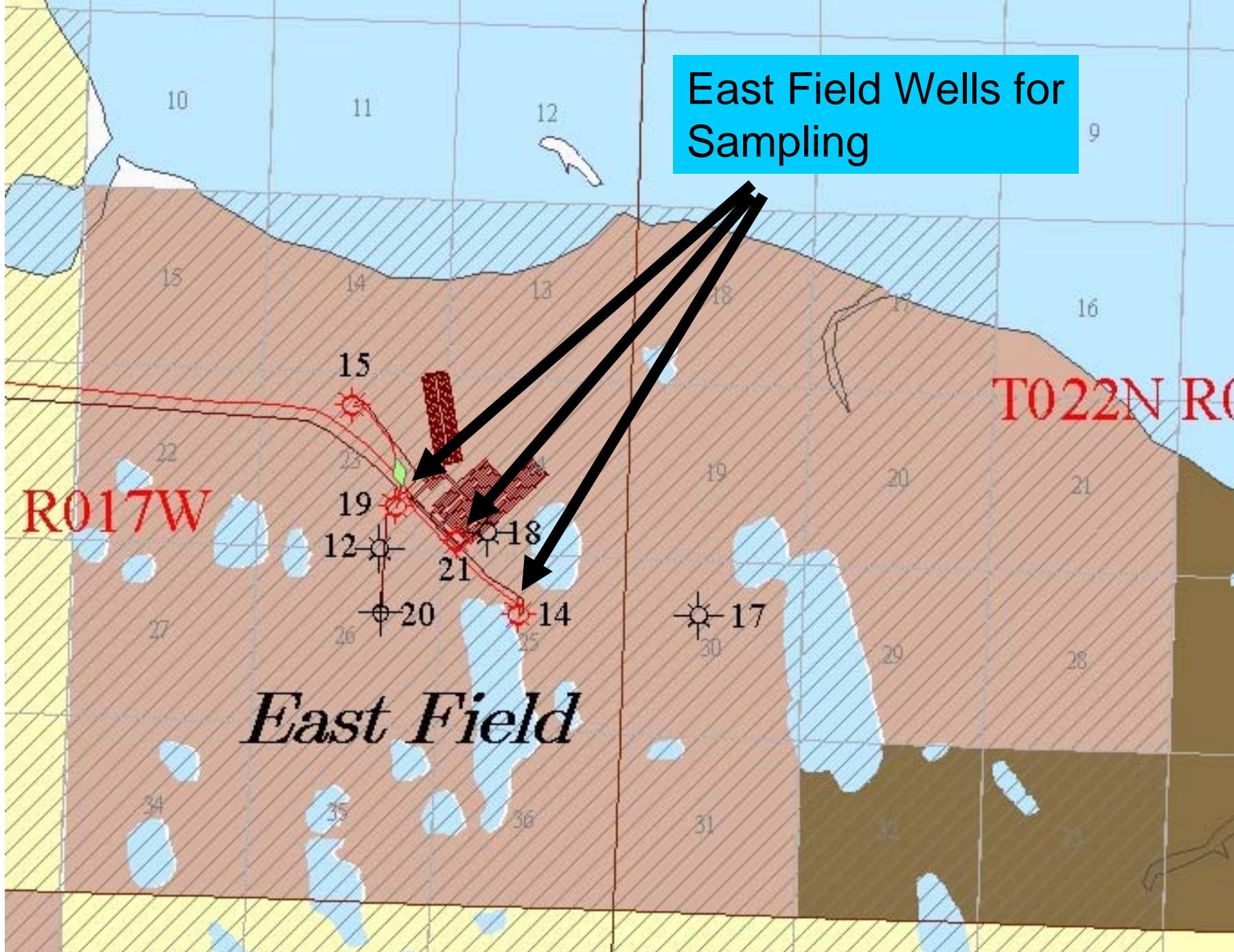
East Pool: Wells E Barrow #'s 14, 19 & 21

Walakpa Gas Field: Wells #'s 5, 8 & 10

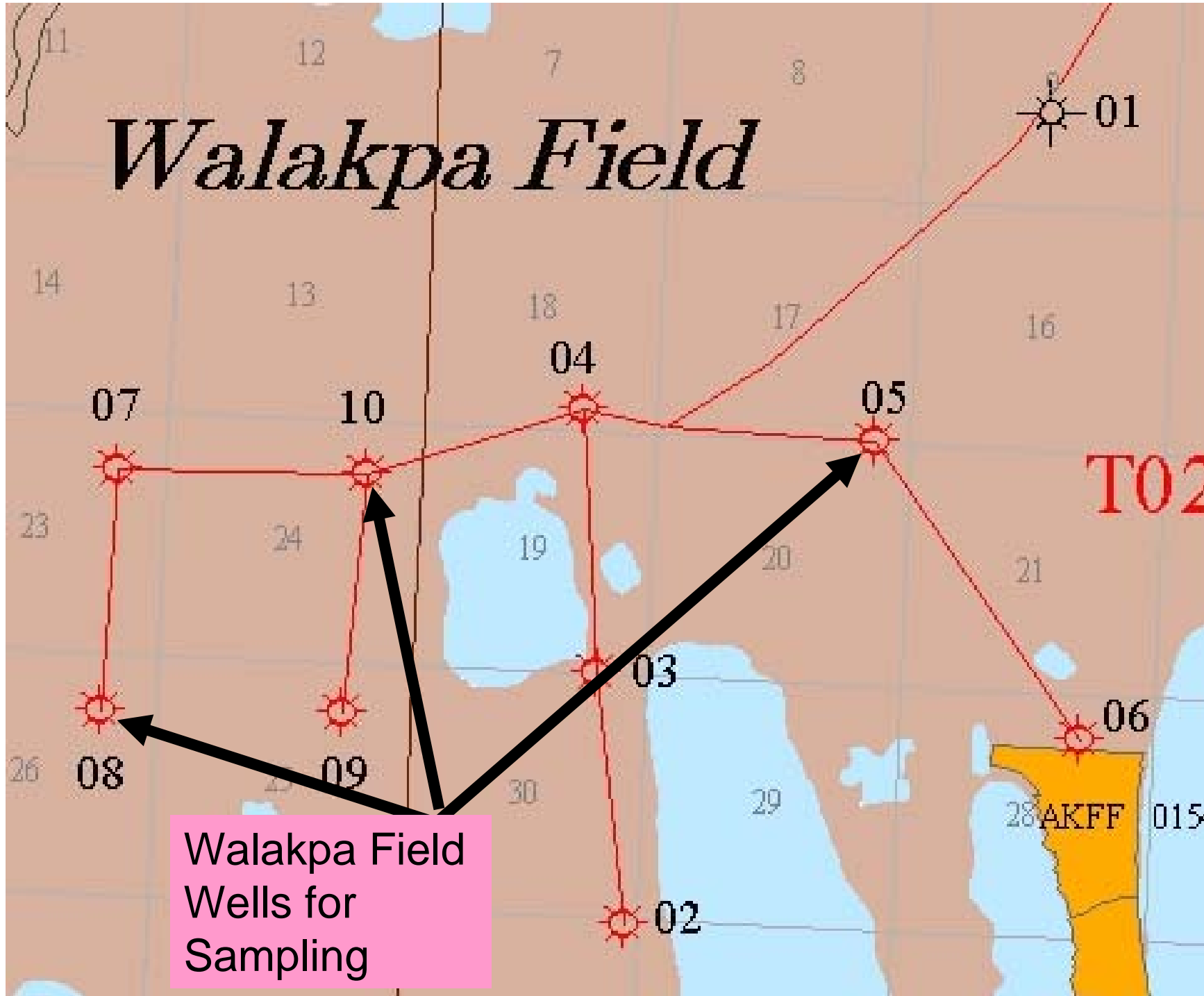
South Field
Wells for
Sampling



East Field Wells for Sampling



Walakpa Field



Walakpa Field
Wells for
Sampling

Walakpa Field Slides

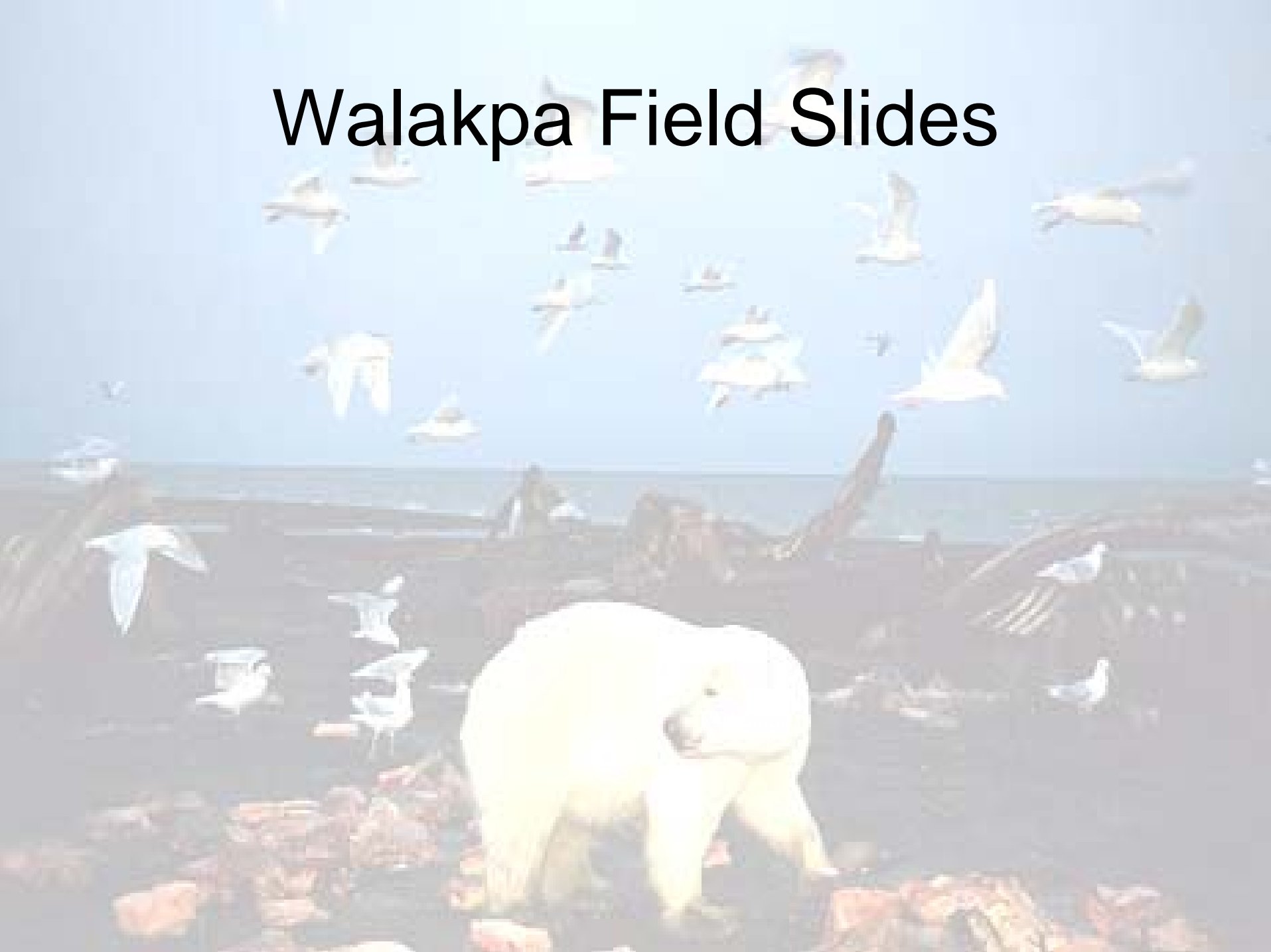


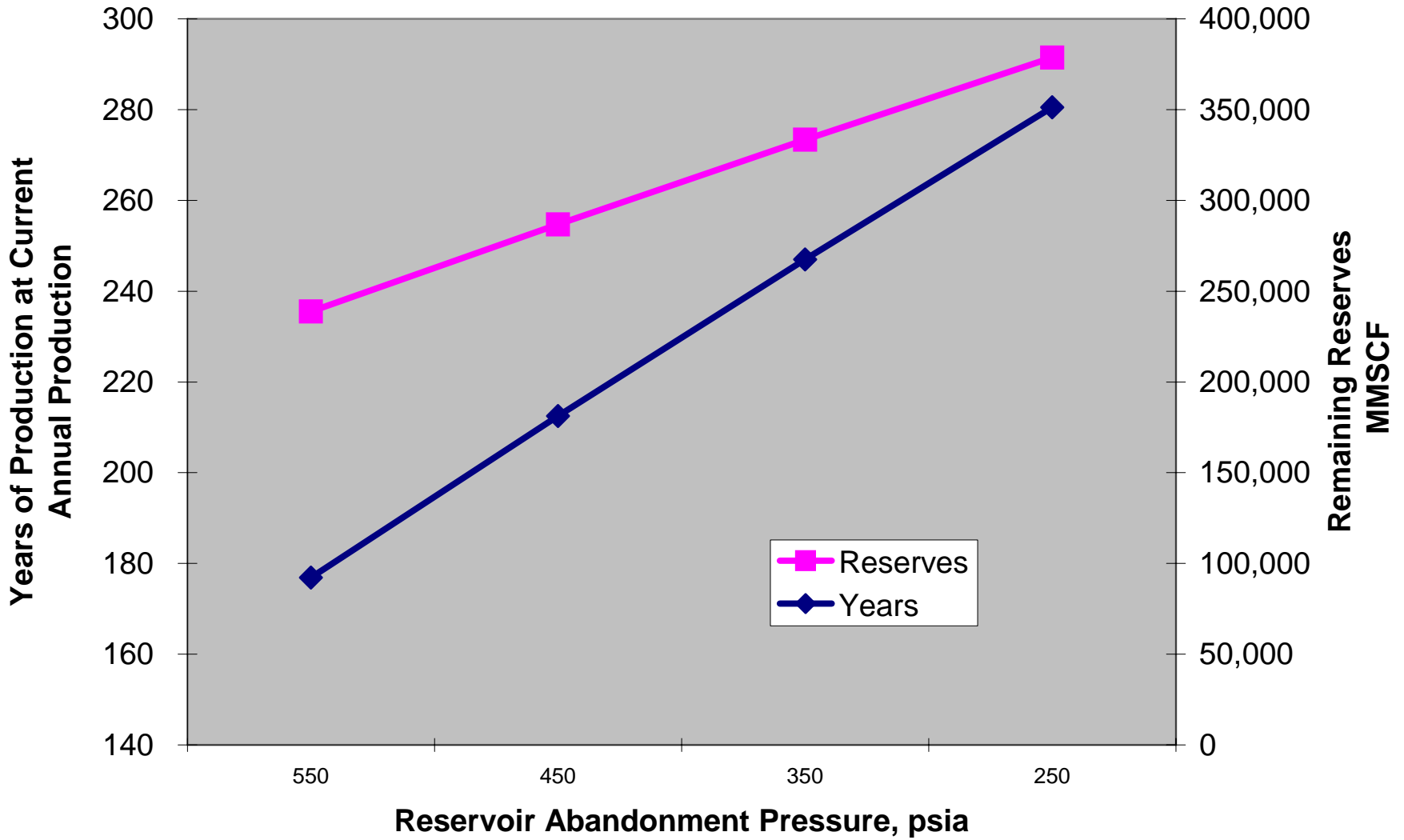
Table 1
Walakpa Field 2005 Reserves Study
Original Gas-in-Place and Reserves from Material Balance P/Z vs. Cum Prod. Plots

	Walakpa #2	Walakpa #3	Walakpa #4	Walakpa #5	Walakpa #6	Walakpa #7	Walakpa #8	Walakpa #9	Walakpa #10	All Wells*	Walakpa Field**
Initial Pressure, psia	1037.50	1036.02	1037.70	1039.73	1035.20	1037.00	1037.00	1035.60	1036.40	1036.91	1036.92
1996 Pressure, psia	1040.18	1031.70	1016.10	1025.00	1032.00	1027.80	1024.00	1026.00	1025.60	1027.60	1027.51
2005 Pressure, psia	1024.42	1007.40	1004.97	1003.50	1011.66	1008.11	1012.96	1009.70	1004.27	1009.67	1009.60
Cum. Prod. Thru 2/96, MMCF	0.00	432.76	437.78	450.63	0.00	388.75	441.76	425.91	485.70	3063.29	3063.29
Cum. Prod. Thru 3/05, MMCF	531.43	1742.77	1840.81	1851.78	1162.73	1684.35	1838.43	1839.45	1936.38	14428.13	14428.13
Original Gas-in-Place, MMCF	33,665	53,653	58,320	48,500	47,882	54,283	76,455	67,288	55,900	495,946	500,344
Ultimate Reserves to 250 psia, MMCF	26,430	42,173	45,817	38,190	37,586	42,664	60,017	52,821	43,933	389,631	393,086
Remaining Reserves (4/05) to 250 psia, MMCF	25,899	40,430	43,976	36,338	36,423	40,980	58,179	50,982	41,997	375,203	378,658
Ultimate Recovery Factor @ 250 psia, %	78.5%	78.6%	78.6%	78.7%	78.5%	78.6%	78.5%	78.5%	78.6%	78.6%	78.6%
OGIP Recovered (3/05), %	2.0%	4.1%	4.0%	4.8%	3.1%	3.9%	3.1%	3.5%	4.4%	3.7%	3.7%
Ultimate Reserves Recovered (3/05) @ 250 psia, %	1.6%	3.2%	3.2%	3.8%	2.4%	3.1%	2.4%	2.7%	3.5%	2.9%	2.9%

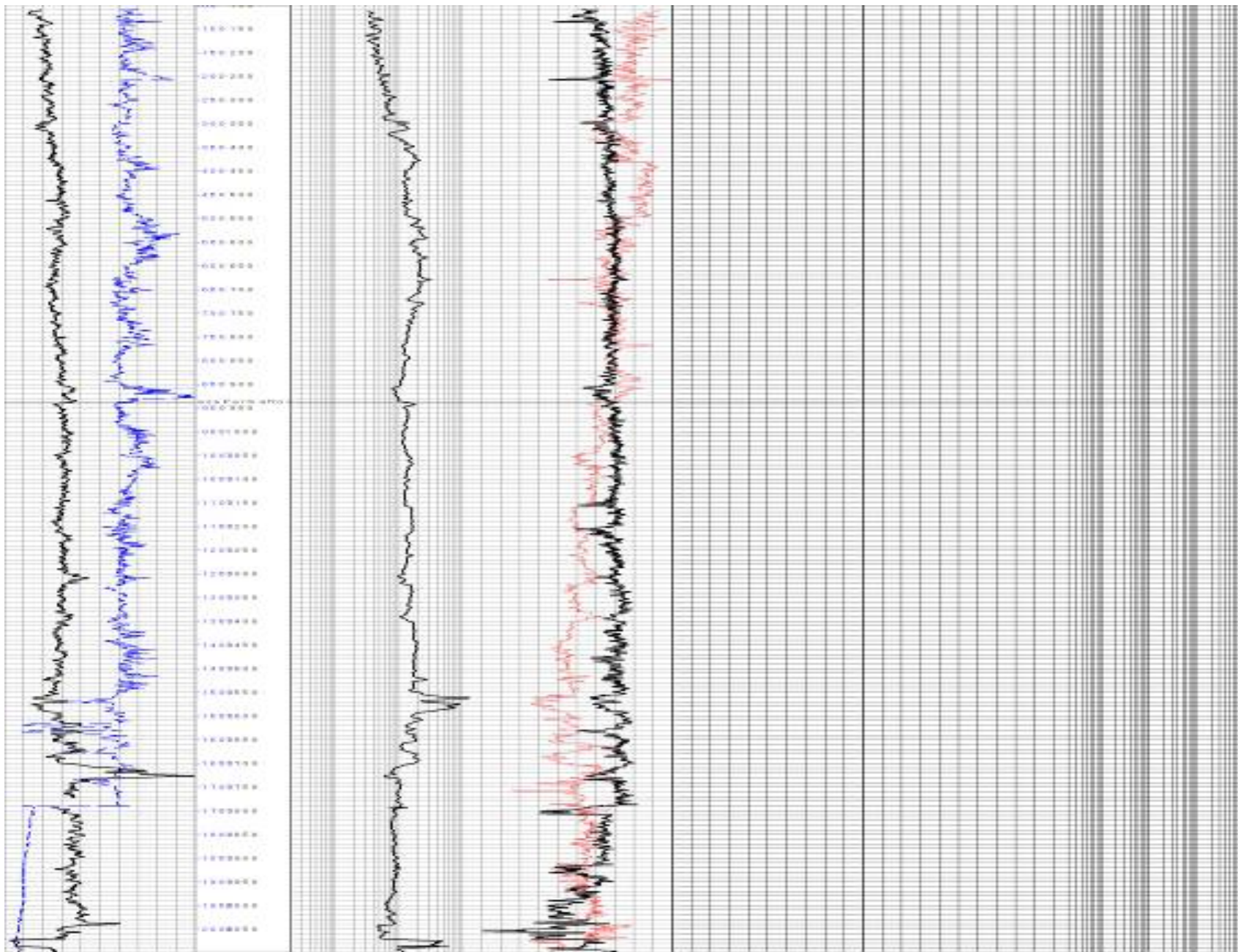
*Using Simple Average of Well Pressures

** Using Average Pressure weighted by Volumetrics corrected to Field Datum of -2302' SS

Figure 1: Walakpa Field 2005 Reserves Study



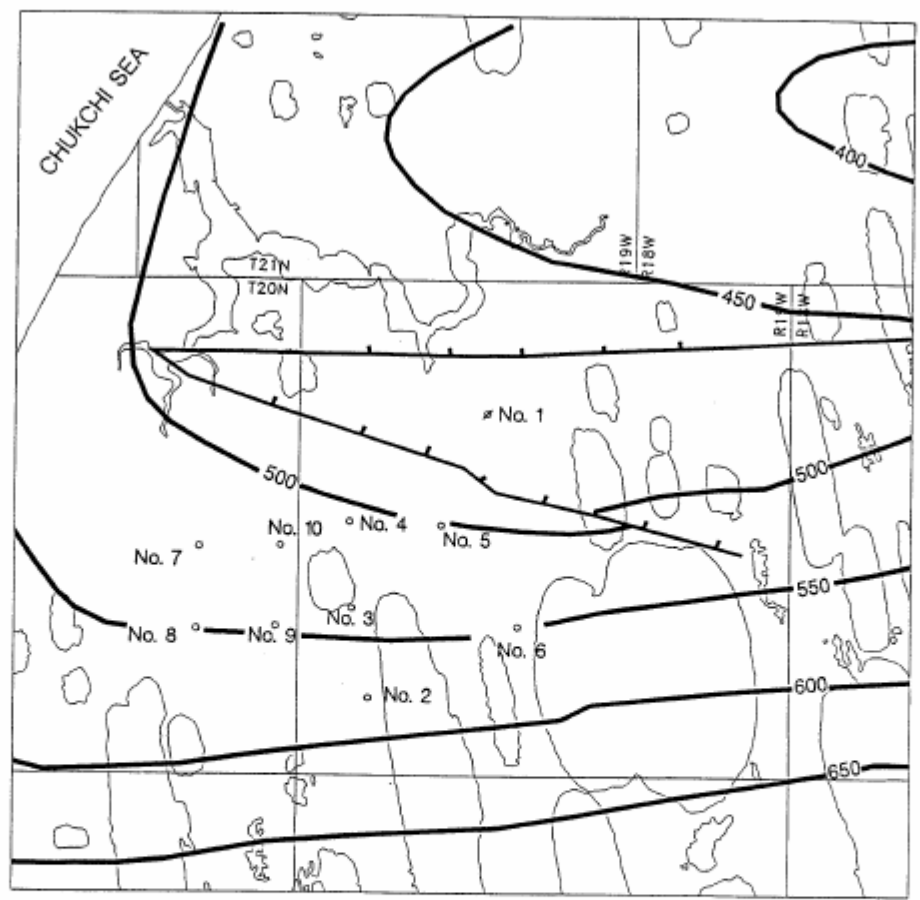
Base Permafrost in Walakpa #1 Well



STRATIGRAPHIC TABLE OF THE WALAKPA DEVELOPMENT AREA

MAX. DEPTH	MIN. DEPTH	LITHOLOGY	FORMATION	AGE	
100		sandstone, shale and conglomerate	Gubik Formation	Quaternary	
1000	400	light grey silty claystone with rare, thin (0 - 1 ft.) silty sand layers	Nanushuk Group	Albian - Aptian	Lower Cretaceous
2200	1600	grey shale with carbonaceous silty beds	Terak Formation		
2550	2020	fissile to blocky carbonaceous black shale	'pebble shale'	Neocomian	
2580	2040	light brown-grey silty sandstone, massive sandstone, and basal conglomerate	Walakpa Sandstone		
2780	2240	dark brown-grey shale with thin (<10 ft.) silty beds	Kingak Shale	Upper Jurassic	
		Total Depth Drilled			

Figure 3. Stratigraphic table of the Walakpa area.



EXPLANATION

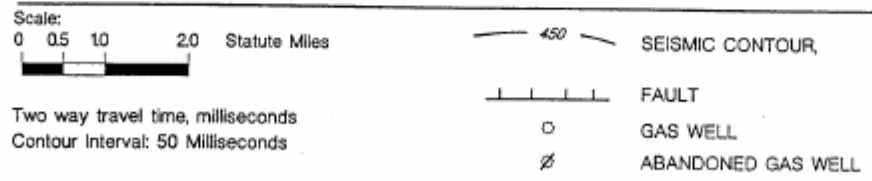
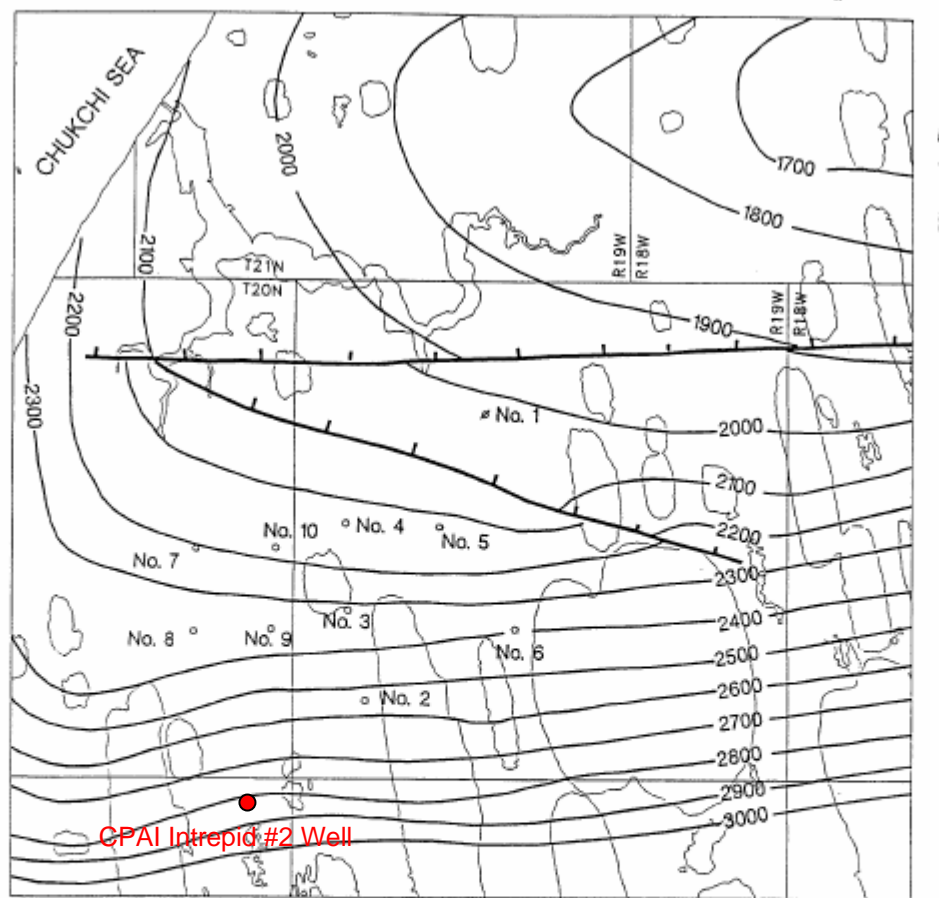


Figure 4. Seismic structural map of the Walakpa gas field.



EXPLANATION

Scale:
0 0.5 1.0 2.0 Statute Miles

Vertical Datum: Sea Level

Contour Interval: 100 Feet

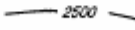



-  2500 CONTOUR
-  FAULT, HATCHURED ON DOWNTHROWN SIDE
-  GAS WELL
-  ABANDONED GAS WELL

Figure 5. Walakpa gas field structure.

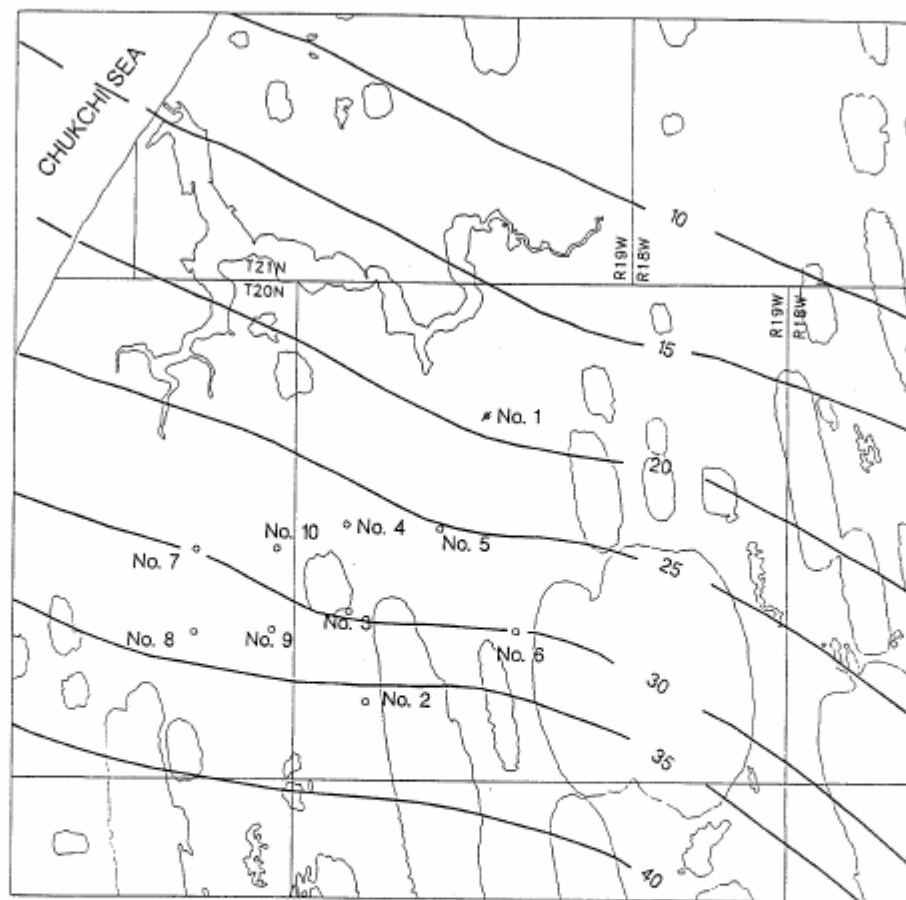
Table 1a. Summary of Reservoir Data: Walakpa Nos. 1-5, Walakpa Gas Field, Alaska

Well No.	1	2	3	4	5
Subsea Depth (ft), Walakpa sandstone	2020	2555	2325	2120	2121
Thickness (ft), Walakpa sandstone	20	37	28	26	25
Net Pay (ft)	16	29	24	23	22
Avg. Porosity (%)	21	21	21	21	21
Avg. Permeability (md)	62	116	187	175	171

Table 1b. Summary of Reservoir Data: Walakpa Nos. 6-10, Walakpa Gas Field, Alaska

Well No.	6	7	8	9	10
Subsea Depth (ft), Walakpa sandstone	2401	2210	2350	2346	2180
Thickness (ft), Walakpa sandstone	30	30	33	32	28
Net Pay (ft)	25	23	26	28	24
Avg. Porosity (%)	20	24	23	22	23
Avg. Permeability (md)	109	*	*	*	*

* - Not Available



EXPLANATION

Scale:
0 0.5 1.0 2.0 Statute Miles

— 25 — CONTOUR, FT

Contour Interval: 5 Feet

○ GAS WELL
 ∕ ABANDONED GAS WELL

Figure 6. Gross pay map of the Walakpa Sandstone.

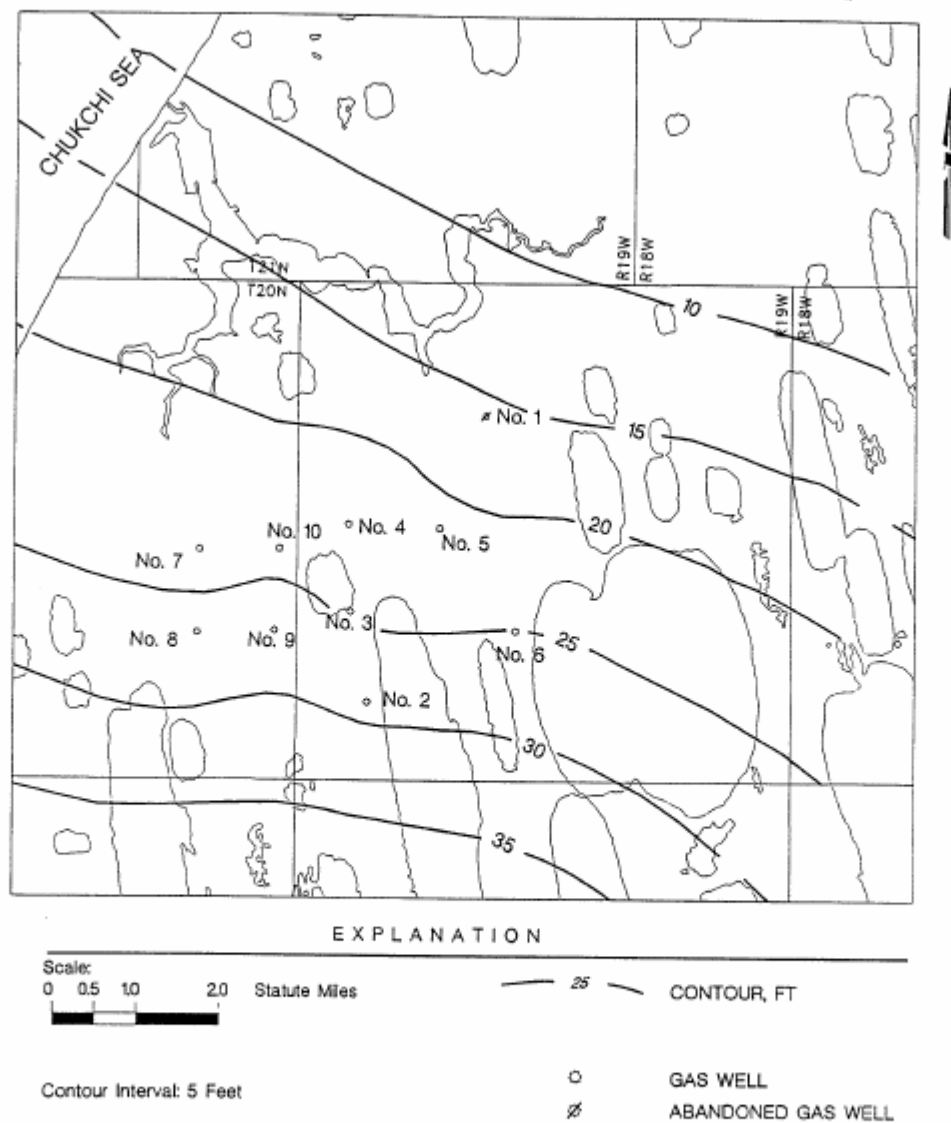
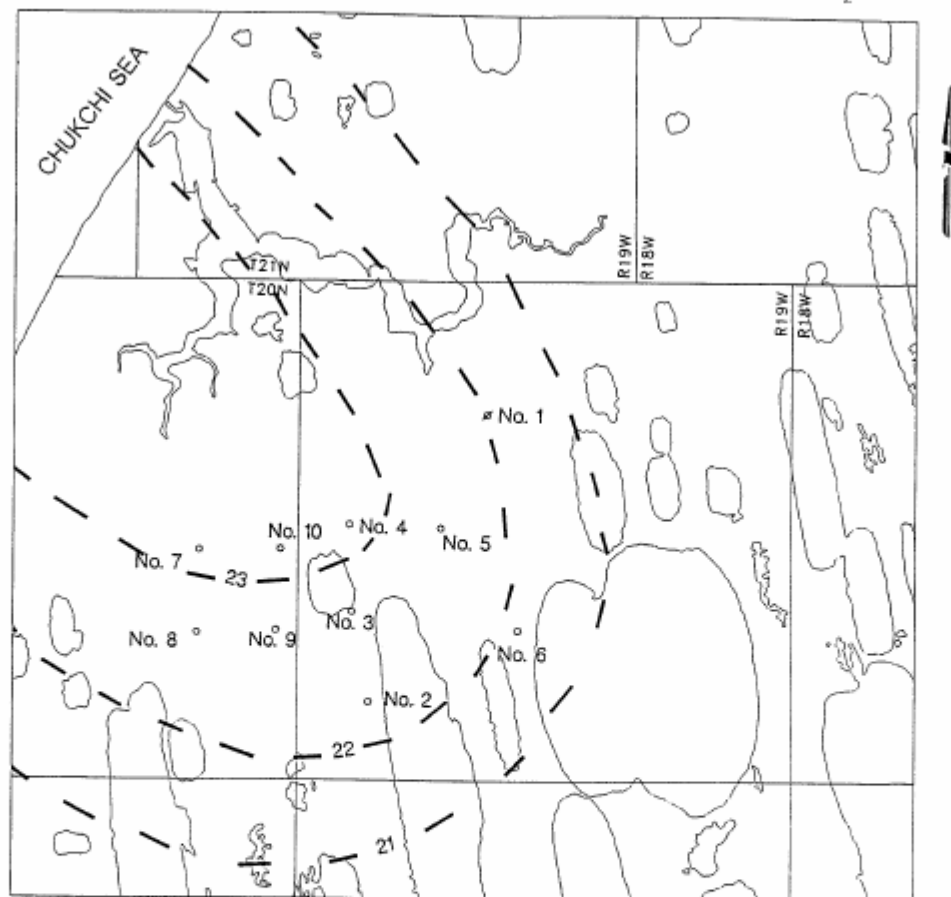


Figure 7. Net pay map of the Walakpa Sandstone.



EXPLANATION

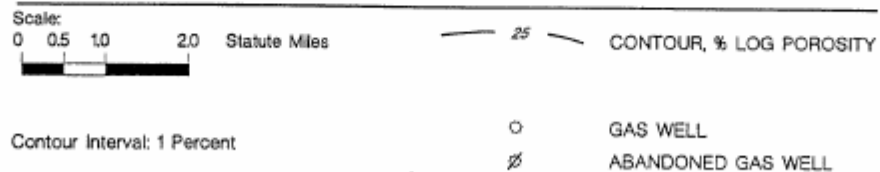


Figure 8. Bulk porosity map of the Walakpa Sandstone.

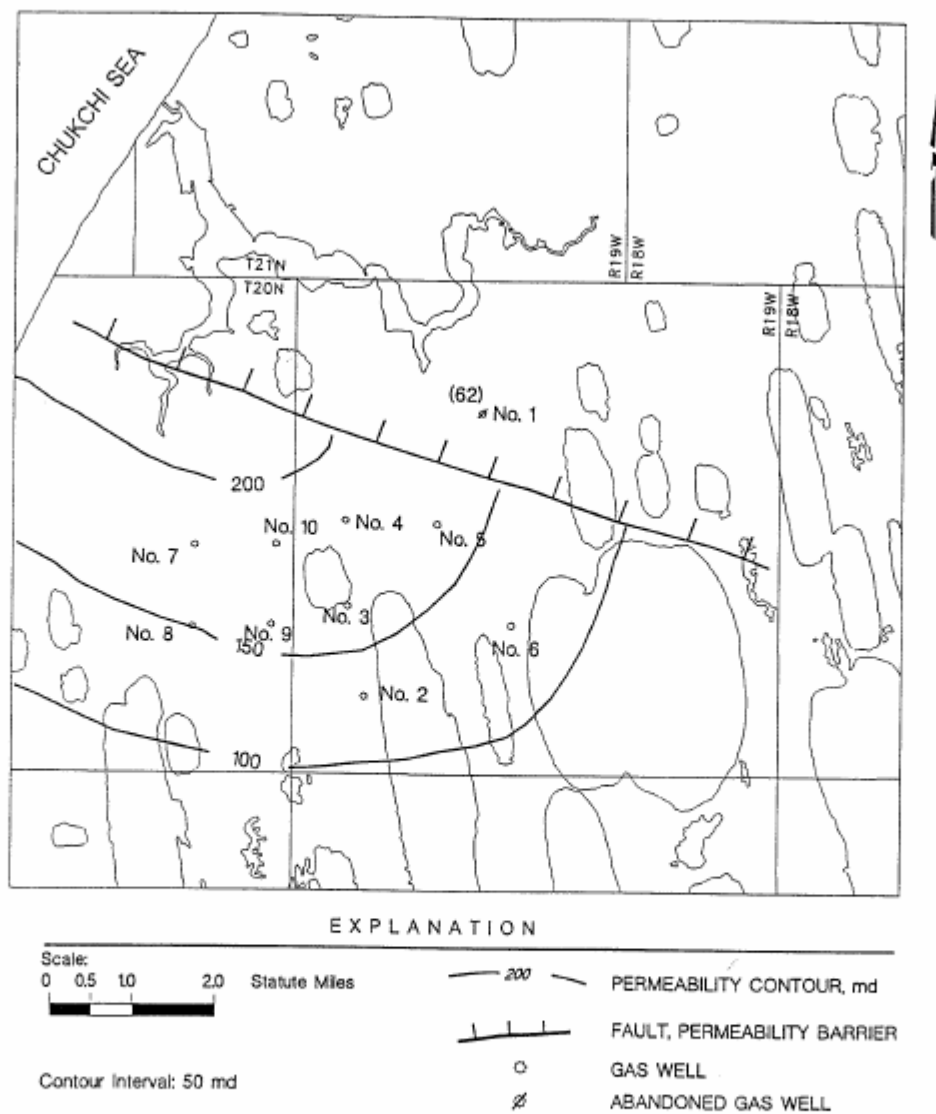


Figure 9. Estimated reservoir permeability of the Walakpa field.

Table 2. Walakpa Field Gas Chemistry, Molecular Composition (Mole %)

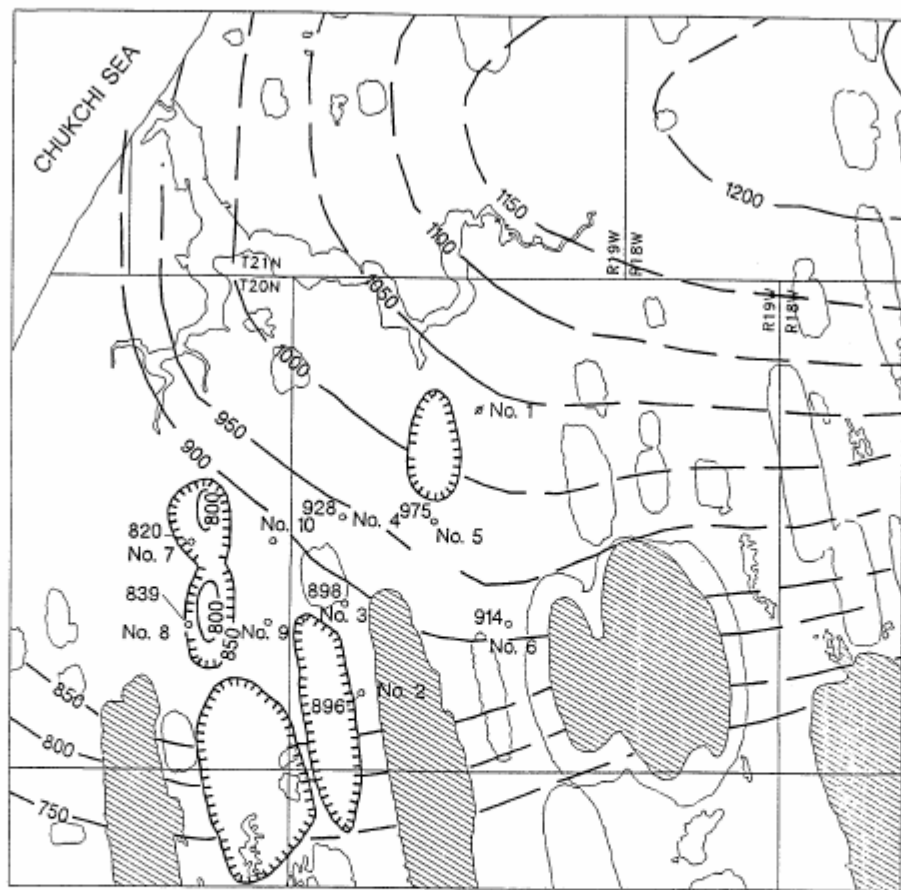
Walakpa Well No.	1	2	3	4	5	6
Methane	98.72	97.08	97.173	97.778	98.101	96.438
Ethane	0.01	2.13	1.946	1.911	-ND-	2.689
Propane	-TR-	0.48	0.291	0.288	-ND-	0.119
i-Butane	-TR-	0.08	0.004	0.004	-ND-	-ND-
n-Butane	-TR-	0.09	0.006	0.006	-ND-	-ND-
i-Pentane	-TR-	-TR-	0.002	0.001	-ND-	-ND-
n-Pentane	-TR-	-TR-	-ND-	-ND-	-ND-	-ND-
Nitrogen	1.27	0.14	5.991*	5.532*	6.573*	1.250
Carbon Dioxide	-NT-	-TR-	0.001	0.006	-ND-	-ND-

TR - Trace

NT - Not Tested

ND - Not Detected

*Nitrogen results are recognized to be too high because of instrumental problems.



EXPLANATION

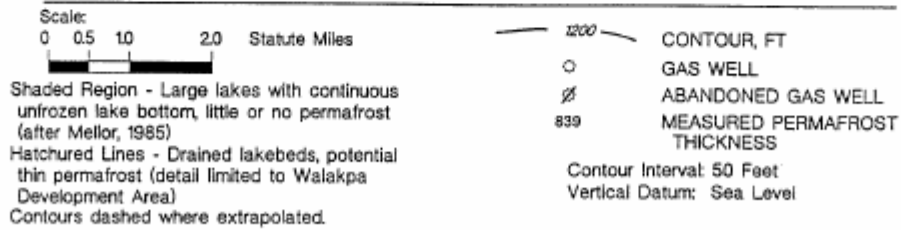


Figure 10. Estimated maximum permafrost thickness, Walakpa gas field.

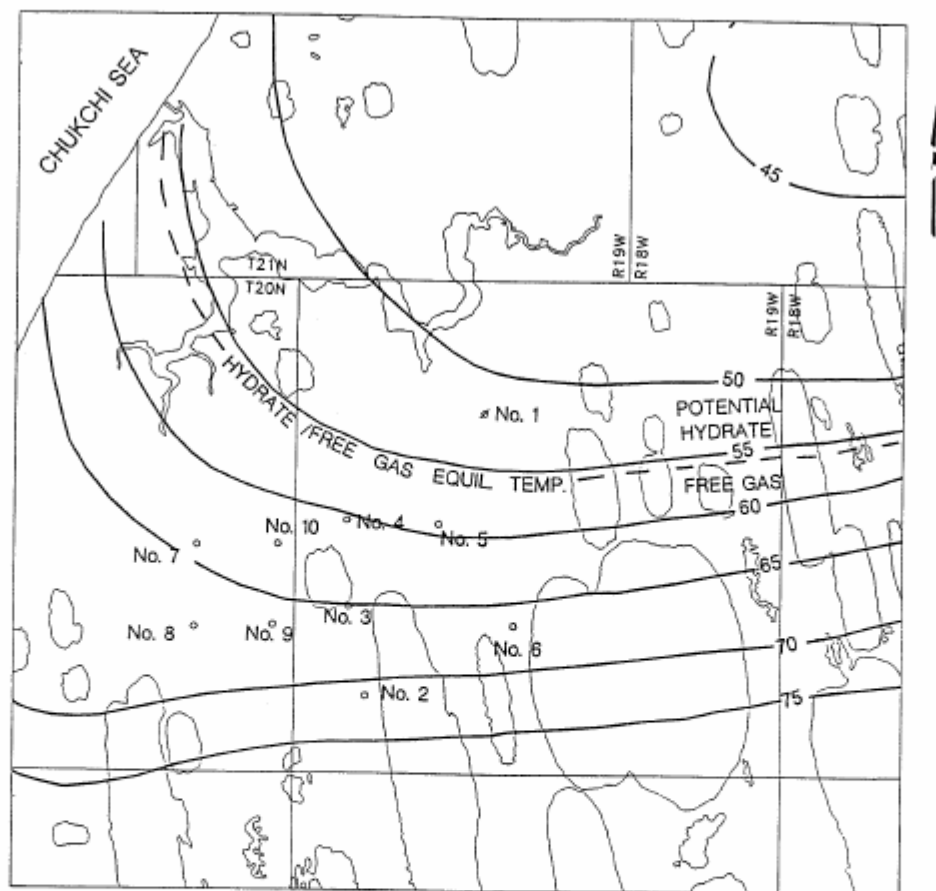
Table 3a. Geothermal Data for the Walakpa Gas Field, Alaska

Well No.	2	3	4	5	6
Depth to Base of Permafrost (ft, subsea)	896	898	928	1004	914
Reservoir Temperature (° F)	72.0	64.5	60.4	57.4	66.1
Geothermal Gradient (° F/100 ft)	2.32	2.25	2.36	2.25	2.27

Table 3b. Geothermal Data for the Walakpa Gas Field, Alaska

Well No.	7	8	9	10
Depth to Base of Permafrost (ft, subsea)	820	839	875*	890*
Reservoir Temperature (° F)	65.3	67.7	67*	62*
Geothermal Gradient (° F/100 ft)	2.25	2.03	-	-

* - estimated



EXPLANATION



Figure 11. Estimated reservoir temperature of the Walakpa field.