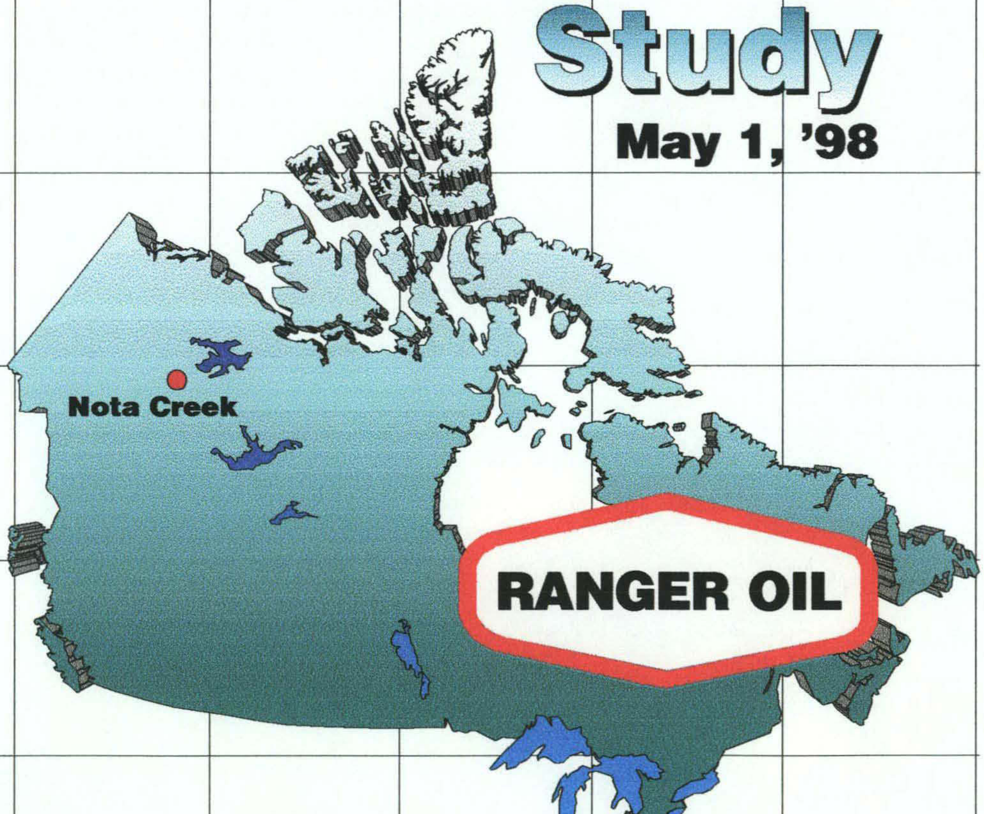
Nota Creek C-17 Petrophysical Study

May 1, '98



OAKROCK Ltd.

OAKROCK Ltd.

Box 92, Irricana, Alberta T0M 1B0 Telephone: (403) 935-4641 Fax: (403) 935-2354

May 1, 1998

Dr. Peter Goetz,
Ranger Oil Limited,
1600, 321 - 6th Avenue SW
Calgary, Alberta T2P 3H3

Dear Peter,

Re: Petrophysical Analysis of Nota Creek, N.W.T.

Enclosed is my interpretation for the lower section of the Ranger et al. Nota Creek. This well was drilled near to Norman Wells, North West Territories.

The initial report, submitted January 21, 1998, covered the interval from 170m to 585m. Formation water resistivities in the upper formations were not known at that time. However, data from the closest well was used.

After running casing to 588m, drilling continued to total depth at 1949m. This report covers the interpretation of this lower section from 588m to 1935m. In addition, the upper section has been reinterpreted, incorporating the new formation water resistivity data that was obtained through testing.

The primary objective of this study was to evaluate the potential of this well, and, where that potential exists, to determine the net pay.

Table #1: Formation Tops

Formation	Top
Hume	145m
Headless	207m
Landry	227m
Arnika	256m
Bear Rock	315m
Franklin Mountain	565m
Saline River	907.5m
Mount Cap	1382m
Mount Clark	1879m
Proterozoic	1928.5m

Summary of Results

After testing proved the Arnika formation water to be very fresh, the only remaining prospects in this well are three thin carbonates in the Mount Cap, and the Mount Clark sands.

The three Mount Cap carbonates combined comprise slightly more than 2.5m of reservoir, with a combined hydrocarbon thickness of 0.13m The average porosity was just over 6 percent, with about 24 percent average water saturation. These carbonates were not tested.

Given the shaly nature of the Mount Clark sands, it would seem reasonable to limit porosity to 8 percent or greater. Using that limit, and a maximum water saturation limit of 40 percent, only slightly more than half a metre of these sands would be prospective pay. The lowest water saturations in these sands occur in the bottom sand.

....Continued on Page 2

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

These sands were tested, and salt water was recovered. This was likely Mount Clark water, since the cement bond appears to be sufficient to prevent water channeling up behind the casing. An external packer was also placed between the Mount Clark sands and the Proterozoic Dolomite.

A heavy oil was recovered on the cups when these sands were tested. One possibility is that the lower sand is filled with bitumen or a tar.

A show of hydrocarbon was calculated in the Franklin Mountain, and in particular the interval from 679m to 689m. However, since the formation water resistivities were unknown, conclusions cannot be made regarding this formation.

Unmoved hydrocarbons were calculated in the Bear Rock dolomite, and are likely bitumen. The Arnika porosity immediately above the Bear Rock was wet. It seems unlikely that there was a trap between these two formations. Without a trap, the hydrocarbons would need to be immovable to remain in the Bear Rock.

Interpretation Methods

Any log normalization must be undertaken with care. It is entirely possible to create data, or destroy data by the application of unjustified normalization. In this study the log normalization methodology used corrected for the statistical errors inherent in the logging tools.

The normalization technique was applied to the acoustic, neutron and density logs. Each of the porosity logs was normalized to a minimum of less than 1% limestone porosity in a clean carbonate section. In most cases the normalization change for each log was less than 2 porosity units for any curve, with some of the logs requiring no normalization. In all cases the "less than 1% limestone porosity" rule was applied. The methodology also took into consideration the anhydrite response as another end-point in the normalization. It was expected that properly normalized data should fall between the limestone and anhydrite lithology lines for the neutron and density logs, and between anhydrite and dolomite for the acoustic log.

The responses of the porosity logs were compared on cross-plots. It was determined that subtracting 20 kg/m3 from the bulk density was sufficient. When this was done, the three porosity logs were in agreement.

Lithology and porosity were based upon cross-plot solutions of the neutron and density logs in the carbonate and salt sections. For the sands, a shaly sand model was used. In either case the model parameters were determined from cross-plots of the log data for each interval. These parameters are listed on the attached analysis summary sheet.

Secondary porosity was calculated as the difference between the neutron/density porosity, and the porosity determined from the acoustic log. The lithology determined from the neutron and density logs was used to derive the matrix transit time used in the calculation of acoustic porosity. The value of secondary porosity is in indicating the presence of vuggy or fracture porosity.

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

Water saturations were calculated using the Modified Simandoux water saturation equation. This equation, which is also known as the Total Shale Model, has the form:

$$\frac{1}{Rt} = \frac{\phi^{m} \times Sw^{n}}{a \times Rw \times (1 - Vshale)} + \frac{Vshale \times Sw}{Rshale}$$

When the shale volume (Vshale) is zero, as in a clean sand or carbonate, this equation reduces to the basic Archie equation. This is the case with most water saturation equations.

Formation water resistivities (Rw) were based upon the water analysis results. The following table summarizes those results. Rw values were inferred from these results for those formations which were not tested.

Table #2: Formation Water Resistivities (Rw)

Formation	Rw (Ωm at 25°C)	Test Intervals (m)
Arnika	1.08	293.5 to 295.5, 303.0 to 306.0
Mount Clark	0.04	1894.5 to 1898.0, 1900.5 to 1906.0
Proterozoic	0.04	1929.0 to 1953 (open hole test)

Using the reported Rmf value, and the shallow resistivity curve, the water saturation in the invaded zone was calculated. The difference between this saturation and the water saturation calculated previously has been shown as moved hydrocarbon on the analysis plots. The presence of moved hydrocarbons is an additional indication that the zone is permeable, and could produce fluids or gas. Moved hydrocarbons were only calculated over the upper portion of the hole. An oil based mud was used in the lower portion, because of the salts, and a mud resistivity was not measured.

Permeability was calculated as a function of porosity and water saturation. The equation used was based upon two assumptions. The first was that an intergranular or intercrystaline pore system exists. The second assumption was that the formation was at irreducible water saturation. Except for production due to fractures, it is reasonable to assume that intergranular or intercrystaline porosity controls the permeability in these formations.

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

This quantitatively derived permeability equation is as follows:

$$\log K = \frac{\ln(\phi \times (1 - Sw))}{0.59} + 5.0$$

where: K is the permeability,
ϕ is the effective (non-shale) porosity, and
Sw is the water saturation.

The theoretical model upon which this equation is based upon a simple relationship. Given the condition of irreducible water saturation, the smaller the pore size, the greater the portion of the pore that will be occupied by water.

If we accept the limitations imposed by these assumptions, it is possible to obtain meaningful permeability data from well logs. This form of permeability equation has been tested and compared to core permeability data in carbonate reservoirs in many areas of the world. It has consistently provided reliable results.

A number of factors combine to define hydrocarbon pay. The calculation of net pay for a formation is the simple sum of the hydrocarbon volumes present.

$$NetPay = \sum \phi \times (1 - Sw) \times thickness$$

To determine the hydrocarbon volume that could contribute to production requires that limits, or cut-offs be applied. These include a minimum porosity limit, and a maximum water saturation limit. A number of cases were defined, as defined in the following table.

Table #2: Net Pay Cut-Offs by Formation

Formation	Porosity Cut-Offs	Water Saturation Cut-Offs
Mount Cap (1548m to 1580m)	3, 4, 5,and 6 percent	20, 30, and 40 percent
Mount Clark (1886m to 1908m)	4, 6, 8, and 10 percent	40, 60, and 100 percent

Summaries of the net pay results are attached in Tables 3 and 4.

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

Discussion of Results

The primary goal of this interpretation was to evaluate the potential of this well, and to determine the net pay in each formation. This has been accomplished. The hydrocarbon potential has been evaluated and reported below.

Arnika/Bear Rock Reviewed

Early expectations from these formations turned out to be false. The original interpretation used an Rw derived from the interpretation of Bluefish A-49. In that well, which had tested water, an Rw of 0.1 Ωm at 25^{O}C resulted in water saturations approaching 100 percent. Using the same Rw in the Arnika and Bear Rock formations at Nota Creek resulted in significant hydrocarbon reserves being calculated. Upon testing, however, the formation water in these formations at Nota Creek were found to be much fresher than at Bluefish. The water produced on test had an Rw of 1.08Ωm at 25^{O}C.

It was noted that increasing the Rw resulted in the Arnika formation appearing to be wet, while hydrocarbon was still calculated in the Bear Rock. One difference is that none of the hydrocarbon now calculated in these formations was moved by invasion. One likely interpretation is that the remaining hydrocarbons are bitumen.

Franklin Mountain Dolomite

Originally this formation was called the Mount Kindle, and it appears by that name in the original petrophysical report.

This formation is dolomitic with many argilaceous and shale intervals. Porosities are less than 3 percent, with the exception of an interval from 680m to 682m. Across that 2m interval porosities reach 6 percent. Considering the volume of vuggy porosity calculated, there is very little intercrystaline porosity in this formation.

Water saturations in the Franklin formation are uncertain, since the resistivity of the formation water is unknown. Assuming an Rw of 0.075Ωm at 25^{O}C resulted in average water saturations of 20 percent.

The low porosities encountered make it unlikely that this formation would ever be productive at this location.

Saline River

A massive 475m thick salt bed, with several shale layers contained within it, the Saline River likely influences the formation water salinities in the underlying formations. The logs do indicate a few porous intervals within the salt and shales, but these are most likely either salt-filled, or artifacts of washouts or shoulder-bed effects.

Mount Cap

There are four thin carbonates within the Mount Cap shale, beginning at 1533m. The first is thin, dolomitic and less than 5 percent porosity. The last three are dolomitic limestones with porosities reaching 7 percent. The best potential of these three is the 2m interval from 1549m to 1551m. Water saturations in this interval are as low as 20 percent. Based upon the responses of the neutron and density logs, it appears that these carbonates are oil bearing.

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

Mount Clark Sands

This formation is a series of thin sands, each approximately 2m thick. Porosity in these sands ranges between 8 and 15 percent. All of these sands are at 50 percent water saturation, except the lowest sand. There the water saturations drop to 30 percent. It was noticed also that the log response of this lower sand is different than the upper sands. One possibility is that the lower sand has a detrital dolomite component. The lower water saturations might be indicative of a courser grain size, compared to the upper sands.

The water saturations calculated would indicate hydrocarbons in these sands. Correcting the neutron log to a sandstone matrix, and plotting these logs on compatible sandstone scales, resulted in the neutron and density logs tracking through the clean sands. This would indicate that the hydrocarbon is likely oil.

The cement bond log indicated that there was a relatively good bond above the Mount Clark sands, and intervals of good bonding below. In addition, an external packer was set on the outside of the casing at 1911.45m. It would seem unlikely that the water tested could be coming behind casing from the Proterozoic Dolomite.

There was a report that a heavy oil or tar was observed on the cups after testing. It has not yet been determined whether this was pipe dope, or formation fluid.

Proterozoic Dolomite

This dolomite has an average of 5 percent porosity, most of which appears to be vuggy porosity. On an openhole test, only water was recovered. This is consistent with the log interpretation, where an 'm' of 2.5 was used to correct for the vuggy nature of the rock. The resulting water saturations were at, or near 100 percent.

I have enclosed: a well summary sheet, an analysis summary, an analysis plot, and a composite plot of the data. Thank you for this opportunity to be of service to you. I would be glad to answer any further questions you might have.

Sincerely,
OAKROCK Ltd.

K Heslop

Kenneth Heslop, P.Eng.

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

Table #3: Mount Cap Net Pay Summary

Cut-Off Values		Average Values		Net Pay Thickness		
Sw (%)	PhiE (%)	Sw (%)	PhiE (%)	h (m)	Phih (m)	Hch (m)
20.0	3.00	15.5	6.5	0.63	0.04	0.03
20.0	4.00	15.5	6.5	0.63	0.04	0.03
20.0	5.00	15.5	6.5	0.63	0.04	0.03
20.0	6.00	14.8	6.7	0.50	0.03	0.03
30.0	3.00	21.7	6.4	2.00	0.13	0.10
30.0	4.00	21.7	6.4	2.00	0.13	0.10
30.0	5.00	21.5	6.7	1.75	0.12	0.09
30.0	6.00	21.6	7.0	1.38	0.10	0.08
40.0	3.00	24.7	6.3	2.75	0.17	0.13
40.0	4.00	24.4	6.4	2.63	0.17	0.13
40.0	5.00	24.1	6.7	2.25	0.15	0.12
40.0	6.00	24.0	7.1	1.75	0.12	0.09

Dr. Peter Goetz,
Ranger Oil Limited

Re: Petrophysical Analysis of Nota Creek, N.W.T.

May 1, 1998

Table #4: Mount Clark Net Pay Summary

Cut-Off Values		Average Values		Net Pay Thickness		
Sw (%)	PhiE (%)	Sw (%)	PhiE (%)	h (m)	Phih (m)	Hch (m)
40.0	4.00	35.8	9.4	1.13	0.11	0.07
40.0	6.00	35.8	9.4	1.13	0.11	0.07
40.0	8.00	35.1	10.1	0.88	0.09	0.06
40.0	10.00	35.0	10.6	0.63	0.07	0.04
60.0	4.00	48.6	9.1	3.50	0.32	0.16
60.0	6.00	48.6	9.6	3.13	0.30	0.15
60.0	8.00	49.9	10.7	2.25	0.24	0.12
60.0	10.00	49.0	11.9	1.38	0.16	0.08
100.0	4.00	58.9	9.3	7.88	0.73	0.30
100.0	6.00	58.8	9.7	7.13	0.69	0.29
100.0	8.00	59.5	10.8	5.13	0.56	0.22
100.0	10.00	58.7	12.1	3.13	0.38	0.16

RANGER NOTA CREEK
C-17-65-10-126

COMPANY: RANGER OIL LIMITED FIELD: NOTA CREEK PROV: N.W.T.
Data Top: 170 Base: 1935 Data Increment: 0.1250 Metres
KB: 172.2200 Ground Level: 168.2200

Run #	Run Depth (m)	Rmf	Rmf Temp. (°C)	Mud Weight (kg/m3)	Bit Size (mm)	Neutron Type	Matrix	Resist. Type	Service Co.	Logging Date
1	588.000	0.750	10.00	1320	311	CNL/TNPH	Lime	IND.	Schlumberger	10-FEB-98
2	1949.000	0.000		1240	222	CNL/TNPH	Lime	IND.	Schlumberger	10-FEB-98

Formation Tops and Tests

145.00		FM Top: Hume
207.00		FM Top: Headless
227.00		FM Top: Landry
256.00		FM Top: Arnika
293.50	295.50	PERF
303.00	306.00	PERF
315.00		FM Top: Bear Rock
565.00		FM Top: Franklin Mountain
588.00		FM Top: Casing Shoe
907.50		FM Top: Saline River
1382.50		FM Top: Mount Cap
1879.00		FM Top: Mount Clark
1894.50	1898.00	PERF
1900.50	1908.00	PERF
1928.50		FM Top: Proterozoic Dolomite

Log Curves

0	Acoustic	170.00	1935.00
1	Neutron - (LS)	170.00	1935.00
2	Bulk Density	170.00	1935.00
3	PE	170.00	1935.00
4	Caliper	170.00	1935.00
5	Gamma Ray	170.00	1935.00
6	S.P.	170.00	585.00
7	Deep Resistivity	170.00	1935.00
8	Medium Resistivity	170.00	1935.00
9	Shallow Resistivity	170.00	585.00

C-17-65-10-126

RANGER NOTA CREEK
C-17-65-10-126

Analysis Parameters

Interval Top	170	585	850	1420	1879	1906
Interval Base	585	850	1420	1879	1906	1935
Lithology	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone
Porosity Method	N/D X	N/D X	N/D X	N/D X	SS-N/D	N/D X
Vshale Method	Linear	Linear	Linear	Linear	Linear	Linear
Sw Method	Mod. Sim.	Mod. Sim.	Mod. Sim.	Mod. Sim.	Mod. Sim.	Mod. Sim.
Permeability Method	Heslop	Heslop	Heslop	Heslop	Heslop	Heslop
a	1.00	1.00	1.00	1.00	1.00	1.00
m	2.25	2.00	2.00	2.00	2.00	2.50
'm' Method	Constant	Constant	Constant	Constant	Constant	Constant
n	2.00	2.00	2.00	2.00	2.00	2.00
Rw @ 25C/77F	1.080	0.075	0.040	0.040	0.040	0.040
Formation Temp.	15.80	29.00	37.00	56.00	71.00	71.00
Temp. Gradient	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340
R Shale	12	90	90	10	5	5
R Clean	–	–	–	–	–	–
dT Shale	260	170	170	220	240	220
dT Clean	–	–	–	–	–	–
dT Matrix	–	–	–	–	–	–
dT Fluid	–	–	–	–	–	–
Rho Shale	2680	2780	2780	2700	2595	2680
Rho Grain	–	–	–	–	2650	–
Rho Carbonate	–	–	–	–	2870	–
Rho Clean	–	–	–	–	–	–
Rho Matrix	2710	2710	2710	2710	–	2710
Rho Clay	2850	2850	2850	2850	2850	2850
Rho Fluid	1000	1000	1000	1000	1000	1000
Phi Shale	17.00	7.00	7.00	15.00	10.00	19.00
Phi Clean	–	–	–	–	–	–
Phi Matrix	–	–	–	–	–	–
Phi Clay	29.00	29.00	29.00	29.00	29.00	29.00
Phi Fluid	100.00	100.00	100.00	100.00	100.00	100.00
PE Shale	–	–	–	–	–	–
PE Clean	–	–	–	–	–	–
Gamma Ray Shale	50	60	60	80	70	80
Gamma Ray Clean	25	20	20	35	20	25
SP Shale	–	–	–	–	–	–
SP Clean	–	–	–	–	–	–
Corrections Applie	XSND/BHC-N/BHC-D	XSND	XSND	XSND	MIX	XSND
SALT/COAL LIMITS:			SALT			
Acoustic	–	–	200	–	–	–
Neutron	–	–	-0.05	–	–	–
Density	–	–	2400	–	–	–
Gamma Ray	–	–	150	–	–	–
Resistivity	–	–	1	–	–	–

Correction Options:
HCC - Hydrocarbon Density Correction
INV - Invasion Correction
ACC - Acoustic Compaction Correction
XSND - Exclude Sands from Solution
MIX - Mixed Matrix Shaly Sand Solution
BIAS - Bias Porosity Towards Density
BHC-G - Gamma Ray Borehole Corrections
BHC-N - Neutron Borehole Corrections
BHC-D - Density Borehole Corrections

RANGER NOTA CREEK

C-17-65-10-126

Interpreted by: Kenneth Heslop, P.Eng
Multiple Models Used In This Interpretation
6 Interpretive Intervals Defined

OAKROCK Ltd. (403)935-4641

RANGER NOTA CREEK

C-17-65-10-126

Prepared by: Kenneth Heslop, P.Eng
LogX Data Plot

OAKROCK Ltd. (403)935-4641