NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

SOUTH BARROW WELL NO. 20

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: Gordon W. Legg

For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
MARCH 1983

TABLE OF CONTENTS

	Page
GEOLOGIC SUMMARY	
Introduction	1
Pre-Drilling Prognosis	1
Post-Drilling Summary	1
Location Map (Figure 1)	3
Certificate of Surveyor (Figure 2)	4
Structure, Top of Lower Barrow sandstone (Figure 3)	5
WELLSITE GEOLOGIST'S REPORT	
Introduction	6
Stratigraphy	
Wireline Log Tops	6
Cretaceous	
Torok Formation	7
"Pebble Shale"	7
Jurassic	
Kingak Formation	8
Upper Barrow sandstone	8
Lower Barrow sandstone	8
Triassic	
Undifferentiated	9
Sag River Sandstone	9
Pre-Mississippian	
Argillite	10
Hydrocarbon Shows and Tests	10
Conclusions	11
LIST OF FIGURES	
Figure 1 - Location Map	3
Figure 2 - Certificate of Surveyor	4
Figure 3 - Structure, Top of Lower Barrow sandstone	5
PERTINENT DATA AND APPENDICES	
Appendix	
A. Summary of Pertinent Data	A-1-2
B. Drill Cuttings and Core Descriptions	B-1-6

PERTINENT DATA AND APPENDICES (Continued)

C.	Drill Stem Test Report	C-1
D.	Summary of Testing Procedures - Barrow sands	D-1-3
	Summary of Testing Procedures - "Pebble Shale" sands .	D-4-9
E.	Logging Reports	E-1-2
F.	Log Analysis Report of May 5, 1980	F-1
G.	Water Analysis Report	G-1-4
H.	Gas Analysis Report	H-1-3
I.	Crude Oil Analysis Report	I-1-2
J.	Core Analysis Report	J-1-3

COMPOSITE LITHOLOGY LOG (In Pocket)

GEOLOGIC SUMMARY

INTRODUCTION

The South Barrow No. 20 well is located in the NE 1/4 of protracted Section 26, T22N, R17W, Umiat Meridian, North Slope Borough, Alaska. The surveyor's plat locates the well 1980' FNL and 1600' FEL of the section (see Figures 1 and 2). The well was drilled in early 1980 in order to further delineate and develop the East Barrow Gas Field, with the Lower Barrow sandstone as the primary objective. Secondary objectives were to test the productive potential of the Upper Barrow sandstone, Sag River Sandstone, and to evaluate, if possible, several thin "Pebble Shale" sandstones which appeared to contain hydrocarbons.

South Barrow No. 20 was spudded on April 7, 1980 and completed on May 10, 1980 as a reported shut-in oil well in two sandstones of the "Pebble Shale", although test results and duration certainly do not necessarily justify the "oil-well" designation.

In each of the South Barrow wells drilled after No. 13, an inhibitive mud system, containing calcium chloride, was used below the intermediate casing (commonly 9-5/8" to about 1,500 feet). This was done to minimize damage to potential reservoirs caused by swelling clays, which are present in the Barrow sandstones and the Sag River Sandstone (determined by water-susceptibility tests on cores from the South Barrow Nos. 12 and 13). The high concentrations of calcium chloride used below the intermediate casing necessitated running a dual laterolog, as the high calcium and chloride ion concentration in the mud adversely affects the measurement of conductivity by the dual induction log. The dual induction log was run in the upper part of each well where fresh-water mud was used.

PRE-DRILLING PROGNOSIS

The South Barrow No. 20 was intended as a development gas well in the Lower Barrow sandstone. The sandstone was expected to be similar to that penetrated in the South Barrow No. 12. Approximately 20-30' of porous sandstone was anticipated. Secondary objectives of the well were the Upper Barrow sandstone and the Sag River Sandstone. Additionally, evaluation of several thin sandstones of the "Pebble Shale", if developed as in the No. 12 well, was planned if conditions appeared favorable.

POST-DRILLING SUMMARY

The principal objective of South Barrow No. 20, the Lower Barrow sandstone, had 20 feet of clean, porous sandstone developed. This was consistent with the predicted 20-30 feet. Since the sandstone had good shows, was well situated structurally, and had good porosity, there was every reason to expect better-than-average gas production from the Lower Barrow. Although the well achieved a maximum of 1.3 MMCFGPD and one barrel of water per minute on Production Test No. 2, electric log

computation and sample analysis indicated that production should have been better. It has been concluded that the sandstone was damaged by cement entry when the 7" casing was cemented.

The Sag River Sandstone, although bleeding oil from cores, was much too tight, as demonstrated both from core and log analysis, to yield significant amounts of fluid. This conclusion was proved by the negative results of a drill-stem test of the sandstone.

Finally, the recovery of gas-cut oil and mud from two sandstones in the "Pebble Shale", has led to South Barrow No. 20 being officially termed a shut-in oil well, although the amount of oil recovered, plus associated temperature and production problems, casts considerable doubt on the well's classification as an "oil well".

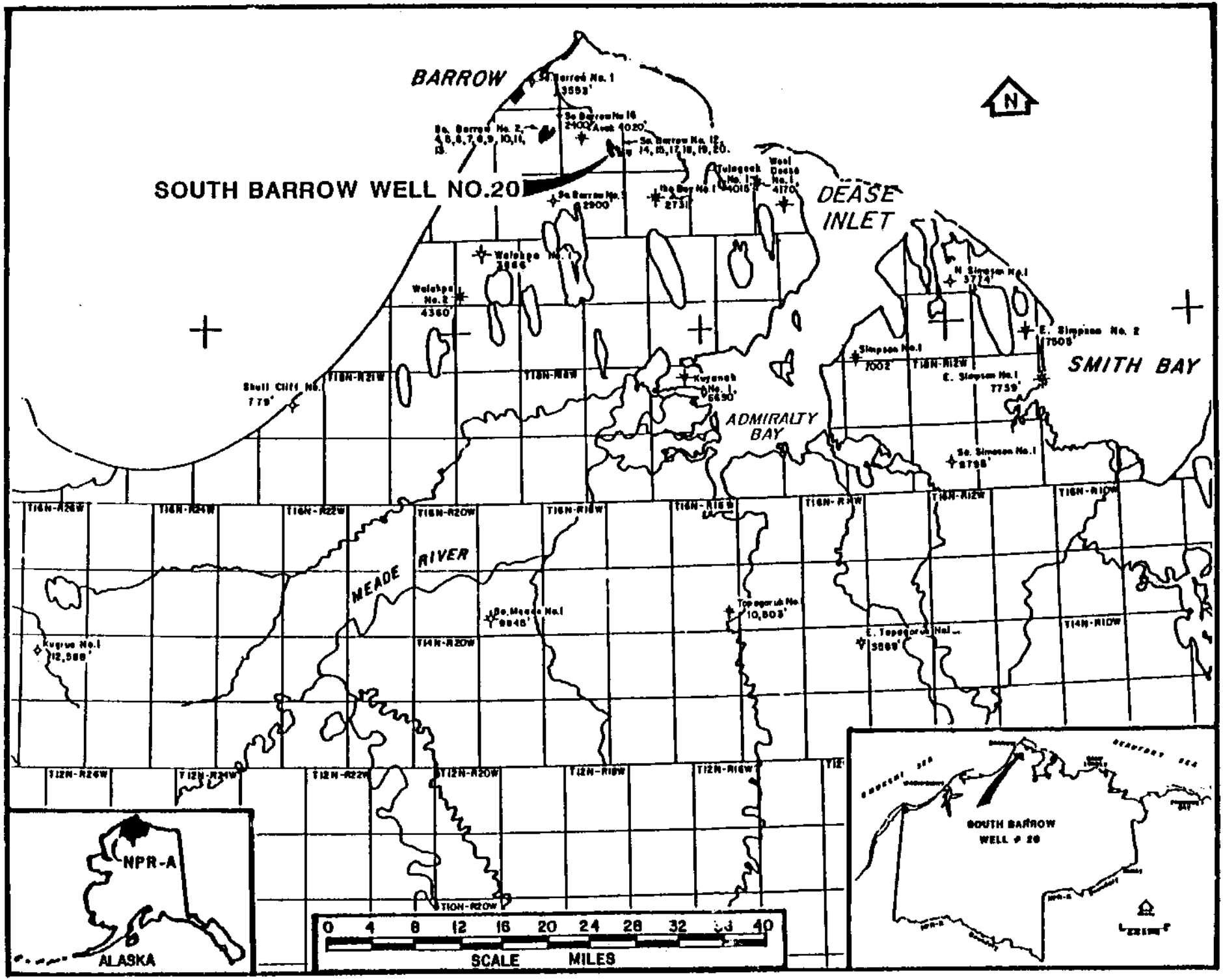
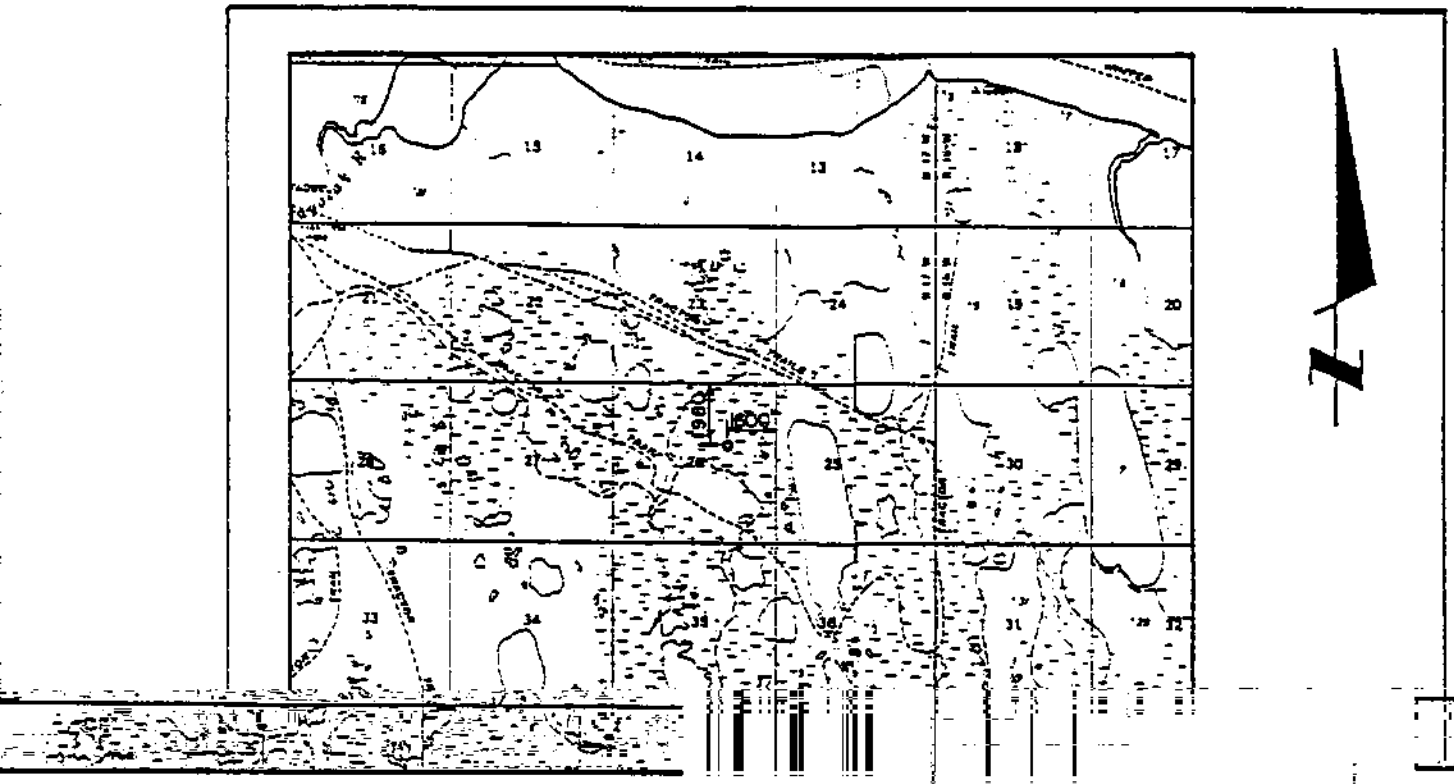


FIGURE 1 - LOCATION MAP - SOUTH BARROW WELL NO. 20



N MILES

BARROW GAS WELL No. 20
LAT. = 71°13'57.02"
LONG. = 156°20'11.98"
Y = 6,303,300.91
X = 696,001.93
ZONE 6

CATE OF SURVEYOR

fy that I am properly registered
o practice land surveying in the
a and that this plat represents
vey made by me or under my super-
at all dimensions and other details

AS STAKED

BARROW GAS WELL No. 20

LOCATED IN

NE 1/4 PROTRACTED SEC. 26, T22N, R17W, UMIAT MERIDIAN, AK.

SURVEYED FOR

HUSKY OIL

N. P. R. OPERATIONS, INC.

TECTONICS INC.

P.O. BOX 4-2256, ANCHORAGE, AK 99509

0 1/2 1

SCALE I

CERTIFI

I hereby certi
and licensed t
State of Alask
a location sur
vision, and th
are correct.

STATE OF ALA
49TH

RTIFICATE OF SURVEYOR - SOUTH BARROW WELL NO. 20

FIGURE 2 - CE

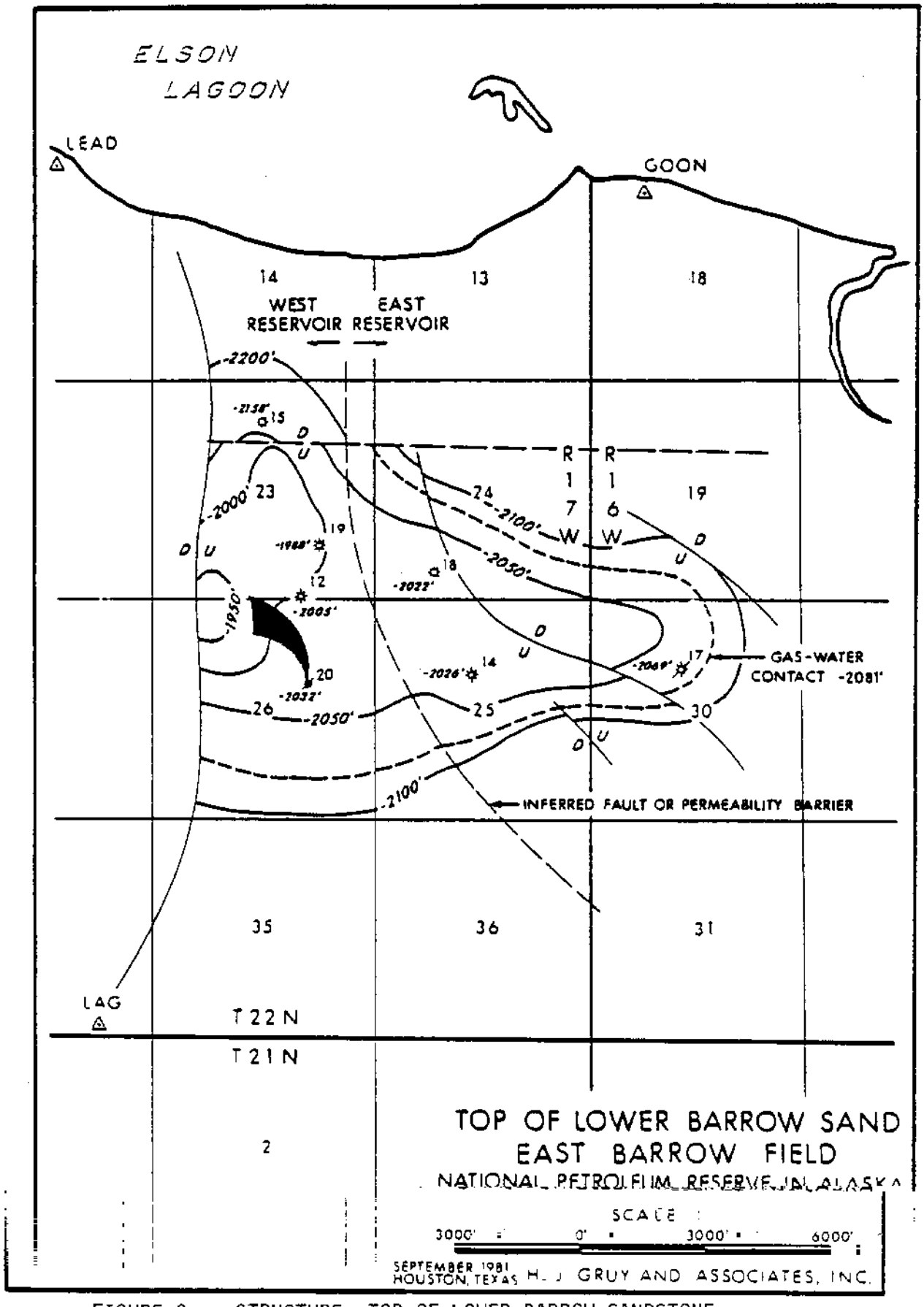


FIGURE 3 - STRUCTURE, TOP OF LOWER BARROW SANDSTONE

WELLSITE GEOLOGIST'S REPORT
ORIGINAL REPORT BY: RICHARD V. NELSON, JR.
REVISED BY: GORDON W. LEGG

INTRODUCTION

The South Barrow No. 20 well was drilled in early 1980 in order to further delineate and develop the East Barrow Gas Field. A location to the south of South Barrow No. 12 had been chosen to test the hypothesis that the Lower Barrow sandstone would improve in reservoir quality in a southward direction. Additionally, South Barrow No. 20 was to further evaluate the potential of the Upper Barrow sandstone and investigate the possible oil potential of the Sag River Sandstone. Testing was anticipated for several thin sandstones in the "Pebble Shale", which had contained good shows in previous wells and appeared to be hydrocarbon-bearing from log analysis.

The major objective, a producible gas well, was not realized because the Lower Barrow sandstone was apparently irreversibly damaged during the cementing of the seven inch casing at 2127'. Two production tests were performed through perforations of the Upper and Lower Barrow sandstones with a maximum recovery of 1.3 MMCFGPD and one barrel of water per minute (page 11 and Appendix D). Other objectives fulfilled were the coring and testing of the Sag River Sandstone (12 MCFGPD and slightly gas-cut mud with trace of oil) and testing two sandstones in the "Pebble Shale" with a recovery of gas-cut oil and mud.

STRATIGRAPHY

WIRELINE LOG TOPS

	Drilled Depth (BKB)	Subsea KB 30 Feet
CRETACEOUS		
Torok Formation	100' samples start	-70'
"Pebble Shale"	1313'	-1283'
JURASSIC		
Kingak Formation	1733'	-1703'
Upper Barrow sandstone	1980'	-1950'
Lower Barrow sandstone	2062'	-2032'
TRIASSIC		
Undifferentiated	2130'	-2100'
Sag River Sandstone	2240'	-2210'
PRE-MISSISSIPPIAN		
Argillite	2314'	-2284'

Torok Formation (300-1313')

g the Torok Formation in South Barrow Well No. 20 are
ystones, which are typically soft, silty and occasionally
e thin siltstones and sandstones, with the sandstones
above a depth of 750'. The sandstones are light gray,
ne grained, silty and argillaceous, and frequently
e siltstones are gray, very argillaceous, typically sandy,
A few very thin beds of coal are present from 750' to
re traces of pyrite and shell fragments.

visible shows in the samples, and only a few slight
chromatograph gas readings, mostly in the interval

313-1733'

e "Pebble Shale" is easily distinguishable from the
by the presence of well rounded, frosted to polished
ich are "floating" in the shale matrix. The shale is very
in the upper part, and it is also silty, finely micaceous
grades downward to a dark gray, carbonaceous, silty
mewhat less organic than the upper section. The upper
le Shale", about 60', is also quite distinctive because of
e in the gamma-ray response.

1500', the "Pebble Shale" becomes very silty to sandy.
e two relatively clean sandstones, which contained good,
ng, and also registered fair gas shows on the
The first sandstone, from 1564' to 1573' (DLL), is
g "salt and pepper", gray and brown stained, fine to
with scattered coarse grains and having fluorescence and
sandstone, from 1625' to 1636' (DLL), is described as
epper" gray, with brown stain, very fine to fine grained,
rse grains and friable, also with fluorescence and cut.
were production tested after the well had reached total
sion under "Hydrocarbon Shows and Tests"; also, test
0).

rt of the "Pebble Shale" (approximately 100' thick) is
stone, which is medium gray to brown, argillaceous,
calcareous, with coarse grains and granules of quartz
This 100' unit contains a "basal" sandstone, about 12'
"salt and pepper" gray, slightly conglomeratic,
slightly "dirtier" than the sandstones above. There was
llow fluorescence and milky-yellow cut fluorescence.

Torok Formation

Rocks representing
almost entirely cla
sandy. There are
generally absent
very fine to fi
carbonaceous. Th
and carbonaceous.
950'. There are ra

There were no
increases in the
1230-1300'.

"Pebble Shale": 1

Lithologically, th
overlying Torok
quartz grains, wh
dark gray to black
and organic, but
shale, which is so
part of the "Pebb
the strong increas

Below a depth of
In this section ar
visual oil staini
chromatograph.
described as bein
medium grained,
cut. The second
being "salt and p
with scattered coa
Both sandstones
depth (see discus
data in Appendix

The lowermost pa
predominantly silt
partly sandy and
and dark chert.
thick, which is
argillaceous, and
a reported good ye

JURASSIC

Kingak Formation: 1733-2130'

The upper 250' of the Kingak Formation is composed of shale, which is light to dark gray and gray-brown, soft to firm, and is considerably less silty than the overlying "Pebble Shale". The shale is frequently carbonaceous, and is bentonitic in part. At 1980', the shale grades downward into a sandy facies, which is represented by the Upper and Lower Barrow sandstones. From the bottom of the Lower Barrow sandstone at 2082' to the Triassic top at 2130', the Kingak Formation is represented by interbedded siltstone and shale. These rocks are medium gray-brown, partially micaceous and carbonaceous, sandy, and pyritic.

Upper Barrow sandstone: 1980-2043'

The Upper Barrow sandstone is light gray, very fine grained, moderately clay-filled, slightly calcareous, silty, glauconitic and friable to hard. The rock has poor porosity, some brown staining, gold fluorescence, and bright milky-white cut fluorescence. Electrical-log characteristics indicate the zone is shaly and tight, although a 1,600-1,900-unit gas reading was recorded in the interval 2025-2060' on the mud log. Neither conventional nor sidewall cores were taken in the Upper Barrow sandstone.

Separating the Upper Barrow from the Lower Barrow sandstone is a 19' section of Kingak sandstone, similar to the Upper Barrow, which grades to siltstone. Although not noted in the samples of this well, there is usually a thin 1-2' shale capping the Lower Barrow sandstone. This shale can be picked on the drilling-time logs and is indicated on the gamma-ray log of this well at 2060-2062' (DLL).

Lower Barrow sandstone: 2062-2082'

The Lower Barrow sandstone, the principal producing zone in the East Barrow Gas Field, was encountered in the interval from 2062-2082' (DLL). The sandstone is medium gray to brown, very fine to fine grained, and friable. This sandstone is relatively cleaner than that in the Upper Barrow. Glauconite pellets and shell fragments are scattered in the sandstone. The rock has fair porosity, dull fluorescence, and bright yellow cut fluorescence. The sandstone registered a gas show of 1,800 units when the section was penetrated. No sidewall cores or conventional cores were taken in the interval.

Log calculations by Armour Kane give an average porosity of 24% and a water saturation of 36% for the interval 2068-2074'. No drill-stem test was taken in this interval, but a later production test, co-mingled with the Upper Barrow sandstone, recovered gas at a final rate of 1.3 MMCFPD. Details of this test and other tests are discussed under "Hydrocarbon Shows and Tests".

TRIASSIC

Undifferentiated: 2130-2240'

Triassic rocks were first penetrated at a depth of 2130'. This depth was obtained from log correlations with South Barrow No. 14 well, where paleontological determinations were available. No paleontological analysis was performed on South Barrow No. 20. The portion of the Triassic above the Sag River Sandstone (2130-2240'), consists of medium to dark gray shale and some argillaceous siltstone. The shale and siltstone are firm, slightly carbonaceous, and have scattered concentrations of dark to medium green glauconite(?) pellets.

Sag River Sandstone: 2240-2314'

The Sag River Sandstone consists of white to tan, very fine grained, hard, glauconitic sandstone in the uppermost part. Porosity at the top is very low. It grades downward to fine grained, friable sandstone with dark brown stain (dead oil), dull orange fluorescence, and immediate bright yellow cut.

At a depth of 2247', a coring program was initiated, resulting in three cores being obtained at 2247-2269' (cut 22', recovered 20.6'); 2269-2299' (cut 15', recovered 14.9'); and 2299-2314' (cut 30', recovered 29'). All three cores contained Sag River Sandstone, with Core No. 3 additionally penetrating about 0.2' of argillite basement.

A generalized core description for each core is as follows:

Core No. 1 — Sandstone: medium gray to green, glauconitic, calcareous, clay-filled; tight, bleeding dark brown heavy oil, strong odor.

Core No. 2 — Sandstone: medium grained, with occasional coarse grained and shelly zones, glauconitic, calcareous; tight, bleeding dark brown heavy oil throughout, strong odor, dull gold fluorescence, bright greenish-yellow cut fluorescence.

Core No. 3 — Sandstone: medium brown to green, very fine grained, some coarse grained, glauconitic, hard, very calcareous; shells and fragments common; tight, bleeding heavy brown oil from pores and fractures; bottom 0.2' is argillite, bright green at contact, then dark gray, hard, micromicaceous; dips of approximately 45°.

The interval from 2127-2314' was drill-stem tested, with a recovery of gas-to-surface after one hour of the first flow period at a rate too small to measure. Flow rate stabilized at 12 MCFGPD in second flow period. Recovery in the drill pipe was 2.6 barrels of slightly gas-cut mud with a trace of oil at the top of the testing tool. The disappointing recovery, plus the poor formation pressures, confirmed that the Sag River Sandstone is too tight to be a potential reservoir at this location.

PRE-MISSISSIPPIAN

Argillite: 2314-2356'

The interval from 2314' to the total depth of 2356' is composed of dark gray, micromicaceous, pyritic, hard argillite with some quartz veins. A description of the top of the argillite section was given above in Core No. 3.

HYDROCARBON SHOWS AND TESTS

The first shows of any significance occurred in several thin sandstones in the "Pebble Shale". The first of these sandstones at 1564-1573' had a gas reading of 300 units and contained brown oil stain with a gold fluorescence and yielded a milky-yellow cut. The porosity calculated by the log analyst, Armour Kane, was an average of 17%, and the water saturation was 27%. The second sandstone, at 1625-1636', had a gas reading of 250 units, appeared to be friable and porous in the samples, and had brown oil stain, gold fluorescence and milky-yellow cut. Calculated porosity and water saturation was 21% and 12.5%, respectively. Another sandstone, 1704-1710', had a 260-unit gas reading and contained good fluorescence and cut. Sample observation and electric-log analysis indicate that the sandstone is shaly and tight.

A production test (Test No. 3) with a perforated interval of 1556-1574' and 1629-1639' in the 7" casing, was conducted after drilling was terminated. This test recovered a total of 21 barrels of fluid (see Appendix D for Production Test No. 3 and Summary of Testing Procedures, "Pebble Shale" sands). This fluid was reported as gas-cut oil and mud, without any stated ratio of oil/mud. In the Production Test No. 3 write-up, conclusion No. 1 states that: "The reservoir produced mainly water and oil, not gas." Under the "Discussion" in this report, the engineer predicts that by pumping, the well might be capable of producing 20-25 BOPD, with that rate being attained only in the earliest portion of the well's productive life, and then declining as the high viscosity of the fluid would act as a brake on the reservoir pressure beyond the wellbore.

Shows were encountered in both the Upper Barrow sandstone (1980-2043') and in the Lower Barrow sandstone (2062-2082'). The Upper Barrow registered 1,900 units of gas, and the Lower Barrow registered 1,800 units of gas. Both sandstones showed good visual staining, fluorescence and cut. The Upper Barrow sandstone is very shaly, both in the samples and from an examination of the gamma-ray log. Log calculations showed a density porosity of 15-16% and a water saturation of 40-45%. The Lower Barrow sandstone was quite clean. The calculated porosity was 24% with a calculated water saturation of 36%. The reservoir quality of the sandstone should have been very good, based on sample analysis and interpretation of all electric-log parameters.

A problem developed when the discovery was made that cement from the cementing operation on the 7" casing had apparently not risen above the Lower Barrow sandstone. The inescapable conclusion is that the Lower

Barrow was severely damaged by cement being squeezed into the zone. This is the most likely explanation for the later poor productive performance from what should have been a very good gas-producing sandstone.

Two production tests were conducted after drilling was completed by perforating both the Upper and Lower Barrow sandstones. These zones were tested together, instead of as separate units, when it was discovered there was no cement behind the casing above the Lower Barrow sandstone. A block squeeze was performed above the Upper Barrow sandstone by perforating the casing from 1950-1951' and injecting cement. Since only 19 feet separated the Upper and Lower Barrow sandstones, a decision was made not to block squeeze for isolation of the two sandstones and risk further formation damage.

Production Test No. 1 (1994-2046' and 2064-2082') was unsuccessful when the well was unable to unload the calcium-chloride mud from the hole. The test was aborted, and the interval was reperforated for Production Test No. 2 (1994-2046' and 2064-2079'). This test achieved a maximum rate of 1.3 MMCFGPD with 1 barrel of water/minute on a 1.5" choke and a flowing tubing pressure of 30 psi after being acidized (see Appendix D for details).

The lowermost zone of show in the South Barrow No. 20 was in the Sag River Sandstone, which was encountered at 2240'. The Sag River Sandstone was continuously cored from 7 feet below its top through the base of the interval at 2314'. The cores were stained with dark brown heavy oil, and were bleeding oil throughout, indicating that the sandstone was tight. No increase in gas was noted from the mudlog. The sandstone was shaly and well cemented with calcite. Log calculated porosities ranged from 4-16%. Drill-Stem Test No. 1, conducted from the base of the 7" casing at 2127' to 2314' (total depth at time of testing), confirmed the tight, non-productive nature of the Sag River Sandstone, by getting gas to the surface after one hour into the first flow period. The gas flow was at a rate too small to measure. Flow rate stabilized at 12 MCFGPD with 17 psi FP in final flow period. Recovery of fluid in the drill-pipe was 2.6 barrels of slightly gas-cut mud, with a trace of oil.

CONCLUSIONS

The South Barrow No. 20 failed to achieve its major objective, when the Lower Barrow sandstone was apparently severely damaged by the cementing job on the 7" casing. The production test of both the shaly, tight Upper Barrow and the damaged Lower Barrow (co-mingled), failed to yield gas at a production rate and pressure high enough to put the well into production.

A secondary objective, coring and testing the Sag River Sandstone for its potential as a hydrocarbon producer, was achieved, but yielded negative results, since the zone was too tight to give up significant amounts of fluid.

Finally, the secondary objective of evaluating the productive potential of the "Pebble Shale" sandstones was achieved by obtaining a small amount of gas-cut oil and mud (estimated at 21 barrels) on a production test. The necessity of having to successively "gas-lift" the fluid from these sandstones by injecting gas from South Barrow No. 19, the low pour point of the oil (-49°F), and the low temperatures (39.4°F at 1635'), places a great deal of doubt on whether or not South Barrow No. 20 can be justifiably termed an "oil-well".

PERTINENT DATA AND APPENDICES

Appendix

A.	Summary of Pertinent Data	A-1-2
B.	Drill Cuttings and Core Descriptions	B-1-6
C.	Drill Stem Test Report	C-1
D.	Summary of Testing Procedures - Barrow sands	D-1-3
	Summary of Testing Procedures - "Pebble Shale" sands .	D-4-9
E.	Logging Reports	E-1-2
F.	Log Analysis Report of May 5, 1980	F-1
G.	Water Analysis Report	G-1-4
H.	Gas Analysis Report	H-1-3
I.	Crude Oil Analysis Report	I-1-2
J.	Core Analysis Report	J-1-3

SUMMARY OF PERTINENT DATA *

WELL NAME:	South Barrow Well No. 20
API NO.:	50-023-20015
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	1980' FNL, 1600' FEL, NE 1/4, protracted Section 26, T22N, R17W, Umiat Meridian, North Slope Borough, Alaska
COORDINATES:	Latitude: 71°13'57.02"N Longitude: 156°20'11.98"W X = 696,001.93 Y = 6,303,300.91 Zone 6
ELEVATION:	30' Kelly Bushing, 12' Pad, 7' Ground
DATE SPUDDED:	April 7, 1980
TOTAL DEPTH:	2356' (driller) 2348' (Schlumberger)
PLUGGED BACK TOTAL DEPTH:	1749'
DATE REACHED TOTAL DEPTH:	April 22, 1980
RIG RELEASED:	May 10, 1980
STATUS:	Shut-in oil well
CASING RECORD:	13-3/8" @ 100' 9-5/8" @ 1490' 7" @ 2127'

LOGGING RECORD:

DIL/SFL/GR/SP	105-1492'
DLL/SFL/GR/SP/CAL	1500-2130'
DLL/SFL/GR/SP	2117-2334'
BHC/GR	105-1492'
	1500-2130'
	2117-2343'
CNL/FDC/GR/CAL	1485-2131'
	2117-2347'
CBL/VDL	1100-2120'
Temp. Log	200-1739'

LOGGING RECORD: (Continued)

Saraband	1500-2112'
	2125-2333'
Mudlog	110-2356'
Geologist's Lithology Log	110-2356'

SIDEWALL CORES: None taken.

CONVENTIONAL CORES:

No.	Interval	Recovery	Rock Unit
1	2247-2269'	20.2'	Sag River Sandstone
2	2269-2299'	29.0'	Sag River Sandstone
3	2299-2314'	14.9'	Sag River Sandstone Argillite

DRILL STEM TESTS: DST No. 1, 2127-2314' (see Appendix C for details)

PRODUCTION TESTS: Production Test No. 1; Perf. 1994-2046' & 2064-2082' (see Appendix D for details)
Production Test No. 2; Perf. 1994-2046' & 2064-2079' (see Appendix D for details)
Production Test No. 3; Perf. 1556-1574' & 1629-1639' (see Appendix D for details)

WELLSITE GEOLOGIST: Richard V. Nelson, Jr.

LOG ANALYST: Armour Kane

DRILLING CONTRACTOR: Brinkerhoff Signal, Inc., Rig No. 31

MUDLOGGERS: The Analysts

BIOSTRATIGRAPHIC ANALYSIS: None

Copies and/or reproducibles of all geologic data are available from:

National Oceanic and Atmospheric Administration
EDIS/NGSDC (D62)
325 Broadway
Boulder, CO 80303

SOUTH BARROW WELL NO. 20
DRILL CUTTINGS & CORE DESCRIPTIONS
BY
RICHARD V. NELSON, JR. - 0-2356'

DEPTH DRILLED (FEET - BELOW KELLY BUSHING)	
0 - 100	No recovery.
100 - 230	Claystone: light to medium gray, slightly silty, very water susceptible in lower part of interval; occasional thin stringers of Sandstone: gray, dirty; occasional Siltstone: light gray-brown, trace of tarry, dead oil from sandstone, trace of coal, occasional shell fragments, trace of pyrite.
230 - 430	Claystone: medium gray, slightly silty, soft, water susceptible in drilling mud; occasional Siltstone: medium gray, soft to firm.
430 - 620	Claystone: medium gray, soft, water susceptible, slightly silty, with traces of Siltstone: medium to light gray, soft to occasionally hard, calcareous cement; traces of Sandstone: fine to very fine grained, subangular to angular, loose to cemented with calcite; trace of coal, pyrite and shell fragments.
620 - 740	Claystone: medium gray, soft, silty, with minor Siltstone and Sandstone: as above.
740 - 750	Coal: low grade, black, pyritic.
750 - 840	Sandstone: light gray, very fine to fine grained, dirty, thin beds, with Siltstone: medium gray, argillaceous; Claystone: medium gray to brown, soft.
840 - 950	Sandstone, Siltstone and Claystone: as above, with thin beds of coal.
950 - 1110	Sandstone, Siltstone and Claystone: as above.
1110 - 1160	Claystone: medium to light gray, soft, plastic, water susceptible; Shale: medium gray and brown, soft, slightly silty, carbonaceous, with traces of pyrite, coal and shell fragments.
1160 - 1340	Sandstone: medium to light gray, "salt and pepper", fine grained, occasionally well cemented; occasional blebs of dead, black, tarry material, probably as thin beds in shale and minor argillaceous siltstone.

1340 - 1500	Shale: very dark gray, slightly silty, slightly micaceous, firm, with scattered well rounded quartz grains; occasional thin siltstone; trace of pyrite, occasional shell fragments.
1500 - 1530	Contaminated samples with cement; Shale: dark gray, carbonaceous, slightly silty, with minor fine grained sandstone.
1530 - 1570	Siltstone: medium gray-brown, argillaceous, carbonaceous, soft to firm with minor shale and claystone; trace of well rounded quartz and chert grains.
1570 - 1580	Sandstone: "salt and pepper", gray to brown stain, fine to medium grained, with large well rounded quartz and chert grains and granules, brown stain, good yellow fluorescence, milky-gold cut fluorescence with 290 units of gas.
1580 - 1630	Siltstone: medium gray-brown, argillaceous, sandy, carbonaceous and occasionally micaceous; scattered well rounded quartz and chert grains; occasional trace of fine grained sand, with minor thin limestone and dolomitic ironstone (possible concretions).
1630 - 1640	Sandstone: "salt and pepper", gray, and medium green, friable, brown stain with fluorescence, as above, at 1570'.
1640 - 1700	Siltstone: as above, with minor light gray-green, waxy bentonitic claystone; trace of fine grained sandstone; abundant well rounded quartz and chert grains.
1700 - 1740	Siltstone: as above, with marked increase in quartz and chert grains, and chert fragments.
1740 - 1770	Shale: dark gray, argillaceous, rare carbonaceous, grading to argillaceous siltstone; occasional thin beds of medium to coarse grained sandstones.
1770 - 1990	Shale and Claystone: light to medium gray-brown, occasionally silty, soft to firm, with minor Shale: dark gray, carbonaceous, trace of fine to coarse loose sand; no odor, stain, cut or fluorescence.
1990 - 2040	Sandstone: light to medium gray, very fine grained, trace of glauconite, clay filled, hard, to occasionally friable, nil to poor porosity, no visible stain, fair gold fluorescence, milky cut fluorescence.
2040 - 2050	Sandstone: as above, with slight increase in porosity; show also slightly better than above, with 1,900-2,000 units of gas.

2050 - 2060	Sandstone: as above, becoming very silty, grades to siltstone.
2060 - 2090	Sandstone: light to medium gray, fine grained, friable, fairly clean, fair porosity, no visible stain, fair yellow-gold sample fluorescence, good milky cut fluorescence; becomes tight and silty at base.
2090 - 2140	Siltstone and Shale: interbedded; medium gray-brown, occasionally micaceous and carbonaceous, sandy, pyritic, occasional shell fragments.
2140 - 2160	Shale: as previously reported, sample highly contaminated with cement.
2160 - 2242	Shale: medium gray, soft, slightly silty, carbonaceous and micaceous, occasional dark gray and medium green pellets.
2242 - 2247	Sandstone: white to tan, very fine grained, hard, with glauconitic pellets, no porosity at top; grades to fine grained sandstone, friable, with dark brown stain (dead oil), dull orange initial sample fluorescence, immediate bright yellow cut fluorescence.
2247 - 2269	Core No. 1: Cut 22', Recovered 20.2'

2247.0-2249.5' (2.5')	Sandstone: very fine grained, moderately argillaceous, hard, tight, grading occasionally to siltstone; poorly sorted, bleeding dark brown, heavy oil, poor initial fluorescence.
2249.5-2250.8' (1.3')	Siltstone: medium gray, argillaceous, sandy, tight, firm, clayey, finely cross-laminated.
2250.8-2253.7' (2.9')	Sandstone: medium gray to green, very fine grained, clay-filled, low porosity, glauconitic, lightly calcareous, strong odor, bleeding dark brown oil, very dull gold fluorescence, bright yellow-green cut fluorescence.
2253.7-2256.0' (2.3')	Sandstone: becoming green, very glauconitic, with shell material common, some chert and quartz granules.
2256.0-2257.4' (1.4')	Sandstone: as above, becoming medium grained, glauconitic, shell fragments, with occasional irregular shale and siltstone laminations.

	2257.4-2259.0' (1.6')	Sandstone: green, very fine grained, cleaner.
	2259.0-2260.6' (1.6')	Sandstone: green, very fine grained, glauconitic, poor porosity, clay-filled, with minor laminations of siltstone and shale; shell material common.
	2260.6-2261.8' (1.2')	Sandstone: as above, with strong odor, and bleeding heavy oil.
	2261.8-2263.5' (1.7')	Sandstone: as above, becoming very calcareous, firm to hard.
	2263.5-2266.9' (3.4')	Sandstone: as above, but becoming coarser grained, with shells and siliceous granules, very glauconitic.
	2266.9-2267.2' (0.3')	Sandstone: very calcareous, more pelletal, hard.
	2267.2-2269.0' (1.8')	No recovery.
2269 - 2299	Core No. 2: Cut 30', Recovered 29'	
	2269.0-2269.7' (0.7')	Sandstone: medium gray, very fine grained, slightly calcareous, hard, tight, bleeding heavy oil.
	2269.7-2271.9' (2.2')	Sandstone: medium gray to brown to green, very fine to fine grained, with granules and shell hash, hard, with irregular shale laminations; thinly interbedded with very fine grained sandstone and laminations of medium gray-brown shale; hard to occasionally friable in shelly portions, bleeding heavy oil.
	2271.9-2273.3' (1.4')	Sandstone: medium gray to brown, hard, very fine grained, lightly calcareous, moderately argillaceous.
	2273.3-2274.5' (1.2')	Sandstone: generally saturated with heavy oil, and with very dull fluorescence, bright greenish-yellow cut fluorescence.
	2274.5-2276.0' (1.5')	Sandstone: slightly argillaceous, fair porosity, strong odor, bleeding heavy oil.

	2276.0-2278.7' (2.7')	Sandstone: very fine grained, slightly argillaceous, slightly calcareous, hard, with irregular shale laminations.
	2278.7-2284.7' (6.0')	Sandstone: medium gray-brown, fine grained, slightly argillaceous, with shale laminations, glauconitic, slightly calcareous, occasional shell fragments.
	2284.7-2293.0' (8.3')	Sandstone: slightly finer grained and more silty, tight, bleeding heavy oil from pores and fractures.
	2293.0-2298.0' (5.0')	Sandstone: as above, very fine grained.
	2298.0-2299.0' (1.0')	No recovery.
2299 - 2314	Core No. 3: Cut 15', Recovered 14.9'	
	2299.0-2299.5' (0.5')	Sandstone: green to brown, coarse, abundant shell fragments, calcareous, bleeding heavy oil, dull fluorescence.
	2299.5-2302.8' (3.3')	Sandstone: medium gray-brown to green, very fine grained, with laminations of fine grained; lightly calcareous, moderately to slightly argillaceous.
	2302.8-2304.1' (1.3')	Sandstone: hard, cemented zone, abundant brachiopods, lower porosity, but saturated with heavy oil.
	2304.1-2306.0' (1.9')	Sandstone: as above, but with strong oil odor; bleeding dark brown, heavy oil, very dead, initial fluorescence.
	2306.0-2307.9' (1.9')	Sandstone: medium brown to green, very fine grained, hard, very calcareous, shells and fragments common, bleeding heavy, brown oil from pores and fractures.
	2307.9-2308.5' (0.6')	Sandstone: coarse sand grains and granules, hard, well cemented, calcareous, tight.
	2308.5-2310.1' (1.6')	Sandstone: medium gray, very fine grained, calcareous cement, slightly argillaceous, tight.

	2310.1-2313.0' (2.9')	Sandstone: occasional laminations of coarse grained sand and shell fragments.
	2313.0-2313.7' (0.7')	Shell hash and small pebbles, bleeding heavy oil.
	2313.7-2313.9' (0.2')	Argillite: 1/2" of bright green at contact, then balance is dark gray, hard, micromicaceous; dips of approximately 45°.
	2313.9-2314.0' (0.1')	No recovery.
2314 - 2350	Argillite: dark gray, micromicaceous, hard, occasional quartz veins, pyritic.	
2350 - 2356	Argillite: as above.	
2356	Total Depth.	

PRELIMINARY

HUSKY

HUSKY OIL NPR OPERATIONS
U.S. GEOLOGICAL SURVEY/ONPRA

DRILL STEM TEST REPORT FORM

WELL NAME BARROW #20 DST. NO. 1 DATE 4/20-21, 1980

Formation Tested SAG RIVER
Test Interval 2127-2314'
Total Depth 2314'
Choke Size: Surface 1/8" - open Bottom Hole 1/2"

Hole Size 5 5/8"
Drill Collar Length 322' I.D. 2 1/4"
Drill Pipe Length 1750' I.D. 2.76"
Packer Depth(s) 2117 Ft.
Depth Tester Valve 2095' Ft.
Cushion Type none Amount

TEST DATA

Tool open at 1210 hrs, 4-20-80 hrs.
Initial flow period 120 min.
Initial shut-in period 240 min.
Final flow period 480 min.
Final shut-in period 900 min.
Unseated packer at 1710 hrs. 4-21-80 hrs.

RESISTIVITY CHLORIDE DATA

	Resistivity		Chloride Content
Recovery Water	@ °F.		ppm
Recovery Mud	@ °F.		ppm
Recovery Mud Filtrate	@ °F.	41000	ppm
Mud Pit Sample	@ °F.		ppm
Mud Pit Sample Filtrate	@ °F.	41000	ppm
Mud Weight 9.9	vis	38	cp

Description of initial flow period Opened with strong blow decreasing to weak blow in 20 min, GTS TSTM in 1 hr.

Description of final flow period Opened w/strong blow decreased to mod blow after 20 min, well started surging, increased to mod blow in 2 hrs 10 min, increased to strong blow in 5 hrs w/SFP 15 psi; removed choke for 1 hr 40 min; reinstalled 1/8" choke w/9 lbs SFP increasing to 15 lbs at which time measured final stabilized rate at flow line was 12 MCFPD w/17 psi FTP

PRESSURE DATA

		Gauge No. 7702	Gauge No. 685	Gauge No. 352	Gauge No. 134
TEMPERATURE		Depth 2098 ft.	Depth 2102 ft.	Depth 2135 ft.	Depth 2139 ft.
		48 Hour Clock	48 Hour Clock	48 Hour Clock	48 Hour Clock
Est.	°F	Blanked Off No	Blanked Off No	Blanked Off Yes	Blanked Off Yes

Actual °F		Pressures Field	Pressures Office	Pressures Field	Pressures Office	Pressures Field	Pressures Office	Pressures Field	Pressures Office
Initial Hydrostatic		1149						1163	
First Period FLOW	Initial	68						88	
	Final	170						181	
	Closed In	902		CLOCK FAILED		NOT REPORTED		909	
Second Period FLOW	Initial	199						206	
	Final	276						289	
	Closed In	960						958	
Third Period FLOW	Initial								
	Final								
	Closed In								
Final Hydrostatic		1149						1163	

RECOVERY DATA

Cushion	Type	Amount	Depth Back Pres. Valve	Surface Choke	Bottom Choke
Recovered 2.6		[redacted] Feet bbl of	al gas cut mud, w/tr of oil at top of tool		
Recovered		Feet bbl of			
Recovered		Feet bbl of			
Recovered		Feet bbl of			

Flow Through Tester Valve

Remarks Chromatograph analysis indicates produced gas essentially 100% C_1 (methane)

RICH NELSON
Prepared by

C-1

11/78

SUMMARY OF TESTING PROCEDURES

PRODUCTION TEST NO. 1
Barrow sands

April 26, 1980

Perforated 7" casing at 4 shots per foot.

Lower Barrow sands - 2064-2082' (18 feet)
Upper Barrow sands - 1994-2046' (52 feet)

Mud in hole while perforating was 10.8 ppg $CaCl_2$ mud. No gain or loss of mud volume occurred during perforating.

Ran 2-7/8", 6.5# tubing to 2083' KB. Injection lines at 1900' and 1200'.

April 27, 1980

Reverse circulated and displaced mud to 9.2 ppg $CaCl_2$ mud. Rocked well with 2,000 psi of nitrogen with no flow.

Filled hole and pumped 5 barrels of $CaCl_2$ solution into well:

600 psi - Maximum
500 psi at 3 BPM
400 psi - Initial shut-in pressure in 1 minute

Rocked well with nitrogen, no flow. Rocked well again; started unloading. Some liquids flowed but not a total flow, so test aborted.

April 28, 1980

Cleaned up well.

Killed well with 9.2 ppg $CaCl_2$ water.

Pulled out of hole with tubing.

PRODUCTION TEST NO. 2
Barrow sands

April 29, 1980

Reperforated Upper and Lower Barrow sands except for the bottom 3 feet of the Lower Barrow sand due to fill. Perforations at 4 shots per foot.

April 30, 1980

Ran in hole with tubing; nippled up and tested tree. Laid gas line from Barrow 19 to Barrow 20.

Circulated 300 gallons of 15% HCL into the tail of the tubing. Squeezed acid into formation with pressure building to 400 psi. Backed off pump to 350 psi. Pumped remainder of acid with a minimum pressure of 345 psi and a final pressure of 360 psi.

Opened well to flow. Unloaded well, using Barrow Well No. 19. Rocked well to get flowing.

May 1, 1980

Well started flowing at 5:45 a.m., producing through the annulus.

Pressure declined during the test, without stabilizing.

11:45	3/32" choke	425 psi - 450 psi (Flow Prover)
12:35	1/8" choke	450 psi and dropping

ABORTED TESTING AS PLANNED

Opened well to atmosphere to test for AOF

30 psig (casing) - 35 psig (tubing)

19 psi flowing pressure on 1-1/2" choke

1.31 MMCFPD - FINAL FLOW

23:30 Shut well in to run Hewlett-Packard recorder. Ice plug in wellbore. Pumped alcohol down well to clear the ice plug and ran in hole with Hewlett-Packard to 2045'.

May 2, 1980

Ran pressure buildup with BHT 34.7°F at shut-in time, 37.2°F at 6:00 p.m. BHP at 6:00 p.m. was 734 psi, surface pressure 625 psi.

Pulled tubing and ran in hole with RTTS to 1965'. Test squeezed perfs to 1,000 psi with pressure holding.

Tested for communication at 2058', 300 psi held with tubing open. Circulate in acid.

Squeezed acid into Lower Barrow with 300 psi and 1/3 BPM, 400 psi at 2 BPM with displacing fluid communicated.

May 3, 1980

2:35 a.m. - Open tubing to flow
2:42 a.m. - Acid to surface

The well flowed for 30 minutes and was then killed with 9.2 ppg $CaCl_2$ mud.

The Xmas tree was nippled up again and the well rocked to flow with gas from Well 19.

Tubing plugged: Unplugged tubing and had well flowing at 21:30. At 23:30, Well No. 19 was shut in and Well No. 20 flowed on its own.

Flowed well at a rate of 1.3 MMCFD at a tubing pressure of 30 psig with 1 BPM of 8.8 ppg water production.

The well was shut in after two hours of flow and began 4 point flow test.

Four-point test run at 1/16" (40 MCFPD), 3/32" (100 MCFPD), 1/8" (100 MCFPD), 3/16" (liquids surfaced) chokes.

After the four-point test, the well was shut in at 6:00 p.m. and the Hewlett-Packard recorder run to bottom for pressure buildup. Initial BHP 519 psi, Final BHP 825 psi.

Pulled Hewlett-Packard; killed well.

SUMMARY OF TESTING PROCEDURES

PRODUCTION TEST NO. 3
"Pebble Shale" sands - 1556-1574' and 1629-1639'

May 7, 1980

Hours

1715 Unloaded Well 20 with gas from Well No. 19. Injected down the annulus and displaced $CaCl_2$ water up the tubing to flare pit.

1815 Well fully unloaded with gas to surface. Momentarily shut in well to install 3/16" choke in flow prover.

1826 After surface flowing pressure dropped 120 psi within eleven minutes, closed in to inject methanol down the tubing.

1926 Produced through 1/8" choke up the annulus. Injector lines wouldn't pump methanol with 3,000 psi applied.

2037 Pressure constantly declined. Installed 1/16" choke to slow the decline.

2100 Closed well in. Pumped one barrel methanol down annulus. Began to produce through tubing.

2130 Tubing pressure dropped to 170 psig. Liquid began rising in tubing.

2145 Closed well in. Opened choke to 1-1/2" orifice plate and injected gas from Well No. 19 down the annulus to lift fluid out of the wellbore to the surface. Estimated four barrels of fluid.

2215 Opened well on 1/16" orifice. Ran Hewlett-Packard pressure recorders down hole to lower perforated zone at 1635'.

2230 Fluid began rising in tubing; wellbore pressure declined.

May 8, 1980

0100 Closed well in with Hewlett-Packard recorder in hole. Bottom-hole pressure at 270 psi; temperature at 39.4°F.

0900 Bottom-hole pressure increased to 405.2 psig.

0915 Opened well to flow on 1/16" choke.

0945 Surface flowing pressure decreased from 50 psig to 0 psig.

1000 Changed choke to 1-1/2" and lifted fluid out of tubing with gas from Well No. 19. Recovered seven barrels gas-cut oil with mud.

1010 Changed choke to 1/16".

1200 Pressure declined again; opened to 1/8" choke.

1300 Began to lift fluids out of well with Well No. 19. Recovered six barrels of oil- and gas-cut mud.

1400 Opened well to atmosphere. Bottom-hole pressure dropped from 436 to 110 with the blowing down of Well 19 gas and the inflow of fluids.

2235 BHP leveled out at 192.5 psi. Lifted fluid through tubing with approximately four barrels of gas-cut oil and mud. Temperature surveyed out of hole.

PRODUCTION TEST NO. 3
Pressure - Temperature Record
"Pebble Shale" sands (1556-1574', 1629-1639')

Time	Tubing Pressure	Casing Pressure	Prover Pressure	Temp. °F	Orifice 64ths	Remarks
5/7/80						
1715						Unloading well.
1815						Gas to surface.
1816	600	600	550		12	
1826	500	500	430		12	
Cl	500	500			12	Closed. Injected methanol.
1926	500	500			12	
1930	480	480	470	28	8	
1945	475	400	400	29	4	
2000	400	335	335	28	4	
Cl	400	350				
2037			375		4	
2045	400	330	330	29	4	
2100	400	310	320	21	4	
Cl	400	310			4	Closed. Changed to tubing production.
2115					4	Closed.
2130	170	300	140	20	4	Slug of liquid in tubing.
2145	80	300	50	20		Closed.
2215					4	Open. Gas lift with Well No. 19.
2230					4	
2245	400	420	345	-10	4	
2300	-	360	270	-12	4	
2315	-	330	220	-14	4	
2330	-	300	170	-14	4	
2345	-	290	140	-14	4	
2400	-	275	110	-12	4	
5/8/80						
0015	-	250	90	-8	4	
0030	-	240	70	-8	4	
0045	-	240	60	-8	4	Closed in. BHT = 39.4 at 1635'. Pressure BH = 270 psi.

0900	-	350				
0915	-				4	Open well.
0920	-	340	50	12	4	
0930	-	340	10	14	4	
0945	-	340	0	22	4	
1000	-				96	Gas lift with Well No. 19.
1010		460			4	Shut off Well No. 19
1015		450	260	17	4	
1030		450	230	4	4	
1045		440	220	0	4	
1100		440	210	0	4	
1115		430	200	0	4	
1130		430	190	2	4	
1145		420	180	2	4	
1200		410	170	2	4	
1205						Changed choke sizes.
1210		400	150	3	8	
1215		390	160	0	8	
1230		360	125	0	8	
1245		350	105	-1	8	
1300		340	85	-1	8	

PRODUCTION TEST NO. 3
"Pebble Shale" sands

CONCLUSIONS

1. The reservoir produced mainly water and oil, not gas.

2. Temperatures of the producing zones, 1556-1574' and 1629-1639', were approximately 40°F.

3. Initial reservoir pressure (P_t) was at least 436 psia.

4. There was fluid influx into the wellbore and redistribution of these fluids within the wellbore.

5. The well would produce at a maximum rate of approximately 20-25 BOPD.

DISCUSSION

A standard flow after flow production test was attempted as suggested by H. J. Gruy and Associates. This test was impossible to carry out as planned due to rapid decline in pressure and flow rates.

Fluid flow into the wellbore was slow due to the high viscosities at low temperature.

The pressure buildup plot indicates that fluids entered the wellbore and redistributed within the fluid column.

If the only gas produced from South Barrow No. 20 was that which was injected from Well No. 19, a wellbore to formation pressure differential of 330 psi may have been created. This pressure difference was created by the pressure drawdown during flow, reducing the wellbore pressure to a minimum of 110 psi. In the case of buildup, as long as bottom hole pressure is less than formation pressure, fluid influx into the well after close in will continue. The bottom hole pressure increases due to phase redistribution and increase in the fluid column height.

The redistribution of fluids in the wellbore will cause distortion for true pressure buildup plots. As a result of this "after flow", the extrapolation of pressure buildup may be conservative to the tune of 100 psi.

A production rate of 20-25 BOPD could be achieved as seen by the test. If the well produced six barrels of liquids when the bottom hole pressure was reduced to 110 psia from 420 psia for 12 hours and 50 percent of the liquid was oil, that is six BOPD. With pumping reducing bottom hole pressure to 100 psia, the well would flow at a higher rate, boosting it to as high as 20 BOPD--maybe to 25 BOPD.

With the high viscosity of the fluids produced, maximum production would be achieved earliest in the well's production life. With time the high viscosity of the fluid would act as a brake on the reservoir pressure beyond the wellbore, decreasing flow rates.

Because of the multiphase production of this well, no other reservoir properties, such as permeability and skin effect, can be evaluated.

HUSKY OIL NPR OPERATIONS, INC.
U.S. GEOLOGICAL SURVEY/ONPRA

LOGGING REPORT

WELL NAME SOUTH BARROW NO. 20

Date April 8, 1980 Driller Depth 1500'

Elevation 30' Logger Depth 1498'

Logs Ran and Intervals

DIL/SFL/GR/SP - 1492-Surface;
BHCS/GR/TTI - 1492-105'

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content

Discussion:

Unconsolidated

Log Tops & Correlations:

"Pebble Shale" 1314' (?)

Additional Evaluation Plans:

No additional logs or tests

RICH NELSON
Wellsite Geologist

Log Analyst

12/77

HUSKY OIL NPR OPERATIONS, INC.
U.S. GEOLOGICAL SURVEY/ONPRA

LOGGING REPORT

WELL NAME SOUTH BARROW #20

Date April 23, 1980 Driller Depth 2356'

Elevation 30' KB Logger Depth 2356'

Logs Ran and Intervals

SP/GR/DLL	2118-2334' (add 8')
GR/CAL/CNL/FDC	2118-2339' (add 8')
GR/MLL	Failed to get out of casing - stopped at 2080'
GR/BHCS	2117-2343 (add 8')
CBL/CCL	1100-2120 (add 8')

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content (S_w)
* 1564-1573'	9	9	Ss	17%	27% Gas & Water
* 1625-1636	11	11	Ss	21%	12.5% Gas
NO ZONES OF INTEREST IN SAG RIVER SANDS. (SEE "DISCUSSION")					

*From previous log run.

Discussion:

Sag River Sands are of low porosity (4-16% averaging 12%+) and appear quite shaly and probably tight.

Log Tops & Correlations:

Upper Barrow Sand	1980')	from previous log run
Lower Barrow Sand	2062')	
Top Sag River Sand	2240'	Logs recorded 8' shallow
Top Argillite	2315'	These tops have been adjusted to true depth

Additional Evaluation Plans:

Test Barrow Sands.

Rich Nelson
Wellsite Geologist
Armour Kane
E-2 Log Analyst

12/77

Log Analysis

ARMOUR KANE

Well Log Analyst
18360-6 Cantara St.
Reseda, Ca. 91335
(213) 993-0586

Formation Evalu.

May 5, 1980

Mr. S. L. Hewitt
Husky Oil/NPR Operations, Inc.
2525 C Street
Anchorage, Ak 99503

Dear Mr. Hewitt:

[illegible] logging run at South Barrow [illegible]
0500 hours on April 14, 1980, and completed DLL,
about 1200 hours the same day to a total depth of
was good except for a sticky galvanometer on the
4 to 1924 but the interval was traced on from another
Upper Barrow Sand is not too well defined by the gamma
be about 1980. Top of the Lower Barrow Sand is 2062.

interest up the hole, one from 1564 to 1573 and the
1636 indicate gas saturation from the curve responses
where the two curves are moving in opposite directions.
on porosity is no doubt too high due to shale effects
onses definitely suggest gas. Here, again, the old
es and there are no wet zones for R_{wa} computations.
SP shows a positive deflection of some 8 MV, R_w should
0.127 and is probably 0.15. This figure was used in
th zones resulting in porosity of 17% and S_w of 27% in
porosity of 21% and S_w of 12-13% in the lower zone.
plot results indicate an invasion diameter of 20-23
s are shaly but are worthy of testing.

Barrow Sand an interval from 2068-74 appears gassy with
and S_w of 36% using the Rw of 0.15, while the Upper
te shaly, 40-45%, with an average density porosity of

Run
ing to total depth of 2356 was begun April 23 at 0900
DLL, CNL/FDC, BHC and CBL at 2100 hours the same day.
od except for some skipping and spiking on the BHC and
nable caliper on the CNL/FDC. All logs were recorded
pipe measurement, casing shoe and lithology log.

g River Sands was found at 2240 and Argillite at 2315.
s are of low porosity from 4% to 16% and appear quite
tight with little evidence of hydrocarbon saturation
disappointing formation test.

Very truly yours,

A. Kane

A. Kane

at approximately
CNL/FDC and BHC a
2130. Log quality
gamma ray from 17
log. Top of the
ray but appears t

Two zones of
other from 1625 t
of Neutron-Densit
The apparent neut
but the curve res
problem of R_w ari
However, since th
approximate R_{mf} o
computations of b
the upper sand an
Approximate cross-
inches. Both san

In the Lower
a porosity of 24%
Barrow appears qu
15-16%.

The third lo
hours and finishe
Log quality was g
a somewhat questi
8 feet shallow to

Top of the S
The Sag River San
shaly and probabl
which confirms th

F-1

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA,

P.O. BOX 4-1276
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3364

ANCHORAGE INDUSTRIAL
5633 B Street

WATER ANALYSIS REPORT

OPERATOR: Husky Oil Company
WELL NO.: South Barrow No. 20
FIELD: NPRA
COUNTY:
STATE: Alaska

DATE: May 20, 1980 LAB NO. 3629-2
LOCATION:
FORMATION: SAG RIVER
INTERVAL: DST No. 1
SAMPLE FROM: Top of Tools

REMARKS & CONCLUSIONS: Hydrocarbon Content, mg/l — 2100
Gross Chromatograph indicates hydrocarbons similar to Diesel Fuel.

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	495	21.53	Sulfate	480	9.98
Potassium	145	3.71	Chloride	46000	1297.20
Calcium	26288	1311.79	Carbonate	280	9.32
Magnesium	15	1.23	Bicarbonate	0	—
Iron	—	—	Hydroxide	370	21.76
Total Cations		1338.26	Total Anions		1338.26

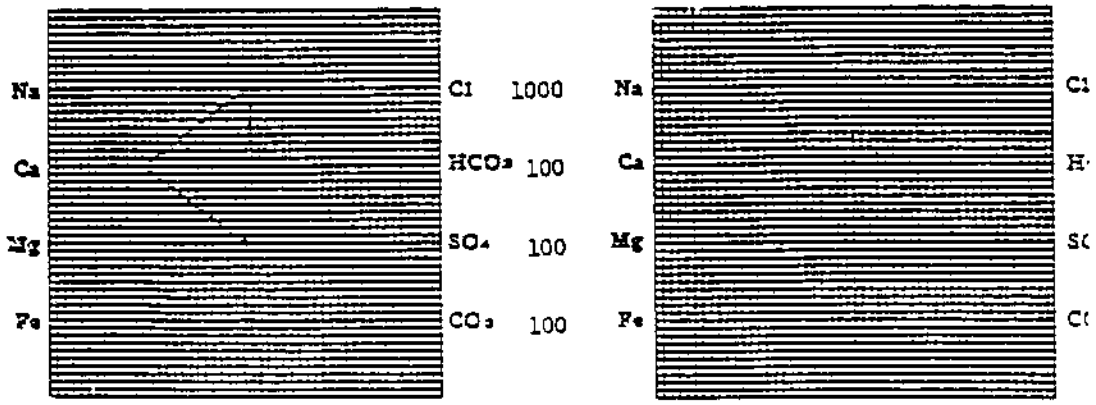
Total dissolved solids, mg/l: 74073
NaCl equivalent, mg/l: 72606
Observed pH: 10.9

Specific resistance @ 68°F.:
Observed: 0.11 ohm-meter
Calculated: 0.11 ohm-meter

WATER ANALYSIS PATTERN

Sample above described

Seal
MEQ per Unit



(No value in above graphs includes Na, K, and Li)
NOTE: Mg/l=MEQ/gram per liter Meq/l=MEQ/gram equivalents per liter
Sodium chloride equivalent by Dunlap & Hawthorne calculation from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

P.O. BOX 4-1276
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3364

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

WATER ANALYSIS REPORT

OPERATOR: Husky Oil Company
WELL NO.: South Barrow No. 20
FIELD: NPRA
COUNTY:
STATE: Alaska

DATE: May 20, 1980 LAB NO.: 3629-3
LOCATION:
FORMATION: SAG RIVER
INTERVAL: DST No. 1
SAMPLE FROM: Pit Sample

REMARKS & CONCLUSIONS:

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	215	9.35	Sulfate	27	0.56
Potassium	340	8.70	Chloride	100000	2820.00
Calcium	56233	2806.01	Carbonate	120	4.00
Magnesium	40	3.29	Bicarbonate	170	2.79
Iron	—	—	Hydroxide	0	—
Total Cations		2827.35	Total Anions		2827.35

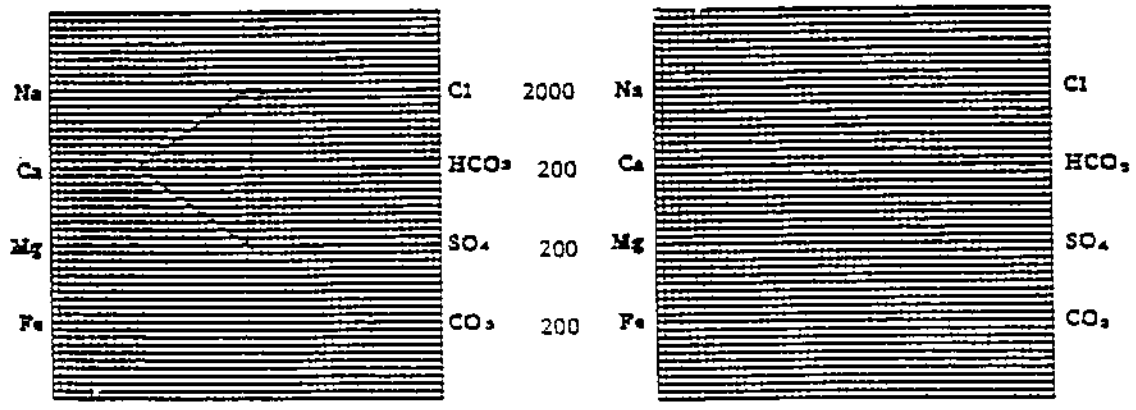
Total dissolved solids, mg/l: 157059
NaCl equivalent, mg/l: 154361
Observed pH: 9.1

Specific resistance @ 68°F.:
Observed: 0.06 ohm-meters
Calculated: 0.06 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value in above graphs includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Hammerstrom calculation from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC

P.O. BOX 4-1278
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3384

ANCHORAGE INDUSTRIAL CENTE
5633 B Street

WATER ANALYSIS REPORT

OPERATOR Husky Oil Company
WELL NO. South Barrow No. 20
FIELD NPRA
COUNTY
STATE Alaska

DATE May 20, 1980 LAB NO. 3629-4
LOCATION
FORMATION Barrow Sands
INTERVAL Production Test No. 1
SAMPLE FROM Flareline-Sample No. 1

REMARKS & CONCLUSIONS: Hydrocarbon Content, mg/l — 50
INSUFFICIENT SAMPLE FOR CHROMATOGRAPHIC ANALYSIS.

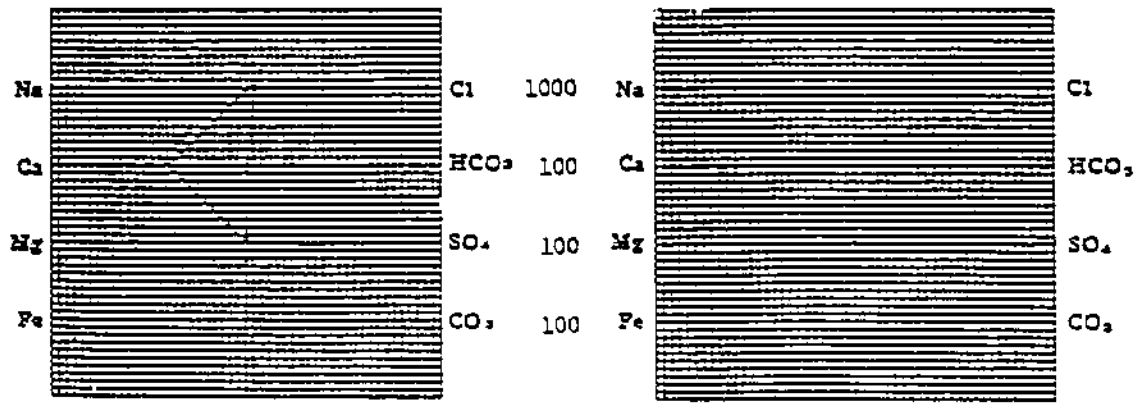
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	910	39.59	Sulfate	87	1.81
Potassium	90	2.30	Chloride	40000	1128.00
Calcium	21561	1075.91	Carbonate	0	—
Magnesium	180	14.80	Bicarbonate	170	2.79
Iron	-	—	Hydroxide	0	—
Total Cations		1132.60	Total Anions		1132.60

Total dissolved solids, mg/l 62913
NaCl equivalent, mg/l 61933
Observed pH 5.0

Specific resistance @ 68°F.:
Observed 0.12 ohm-meters
Calculated 0.13 ohm-meters

WATER ANALYSIS PATTERN

Sample above described



(No value in above graph includes Na, K, and Li)
NOTE: Mg/l = MEQgrams per liter Meq/l = MEQgrams equivalents per liter
Sodium chloride equivalent by Dunlop & Hawthorne calculation from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

P.O. BOX 4-1276 Anchorage, Alaska 99509 | TELEPHONE (907)-279-4014 274-3844 | ANCHORAGE INDUSTRIAL CENTER 5833 E. Street

WATER ANALYSIS REPORT

OPERATOR: Husky Oil Company
DATE: May 20, 1980
LAB NO.: 3629-5
WELL NO.: South Barrow No. 20
LOCATION:
FIELD: NPRA
FORMATION: Barrow Sands
COUNTY:
INTERVAL: Production Test No. 1
STATE: Alaska
SAMPLE FROM: Flareline-Sample No. 2

REMARKS & CONCLUSIONS: Hydrocarbon Content, mg/l — 31

INSUFFICIENT SAMPLE FOR CHROMATOGRAPHIC ANALYSIS

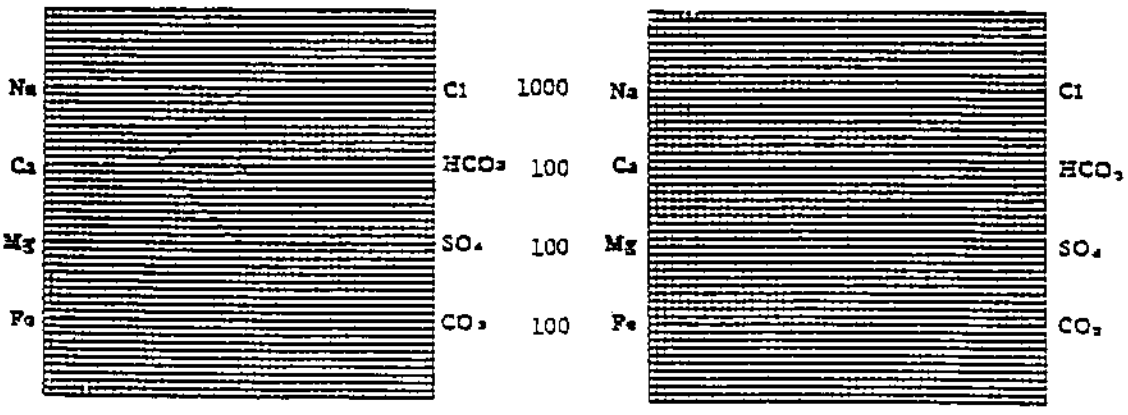
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	860	37.41	Sulfate	110	2.29
Potassium	85	2.18	Chloride	40000	1128.00
Calcium	21622	1078.93	Carbonate	0	—
Magnesium	175	14.39	Bicarbonate	160	2.62
Iron	—	—	Hydroxide	0	—
Total Cations		1132.91	Total Anions		1132.91

Total dissolved solids, mg/l: 62931
NaCl equivalent, mg/l: 61934
Observed pH: 4.9

Specific resistance @ 64°F.:
Observed: 0.13 ohm-meters
Calculated: 0.13 ohm-meters

WATER ANALYSIS PATTERN

Sample above described



(No value is above graph includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlop & Hawthorne calculation from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907) 279-4014
274-3384
ANCHORAGE INDUSTRIAL CENTER
5633 B Street

RECEIVED
MAY 22 1980
GEOLOGY DEPT.

GAS ANALYSIS REPORT

Company Husky Oil Company Date May 19, 1980 Lab No. 3710-1
Well No. South Barrow No. 20 Location
Field NPRA Formation Pebble Shale Sands
County Depth 1629-39
State Alaska Sampling Point Production Test No. 2
Line pressure ____ psig; Sample pressure ____ psig; Temperature ____ °F; Container number
Remarks Sample taken from Choke, 5-8-80

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	1.48	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	98.48	
Ethane	0.04	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE
GPM of pentanes & higher fraction		
Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis)		995
Specific gravity (calculated from analysis)		0.560
Specific gravity (measured)		0.560

Remarks:

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907)-279-4014
274-3384

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

RECEIVED
MAY 24 1980
GEOLOGY Dept.

GAS ANALYSIS REPORT

Company Husky Oil Company Date May 19, 1980 Lab No. 3712

Well No. South Barrow No. 20 Location

Field NPRA Formation Barrow Sands

County Depth 1994-2082

State Alaska Sampling Point Production Test No. 1

Line pressure ____ psig; Sample pressure ____ psig; Temperature ____ °F; Container number

Remarks

Casing head sample, 5-5-80

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	1.67	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	98.28	
Ethane	0.05	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) = 994

Specific gravity (calculated from analysis) = 0.561

Specific gravity (measured) = 0.560

Remarks:

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907) 279-4014
274-3384
ANCHORAGE INDUSTRIAL CENTER
5633 B Street

RECEIVED
MAY 24 1980
GEOLOGY DEPT.

GAS ANALYSIS REPORT

Company Husky Oil Company Date May 20, 1980 Lab No. 3629-1

Well No. South Barrow No. 20 Location

Field NPRA Formation Sag River Sand

County Depth

State Alaska Sampling Point DST No. 1

Line pressure ____ psig; Sample pressure ____ psig; Temperature ____ °F; Container number

Remarks Sample taken April 21, 1980 @ 0200 Hrs.

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	0.68	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	99.26	
Ethane	0.06	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) 1004

Specific gravity (calculated from analysis) 0.557

Specific gravity (measured) 0.555

Remarks:

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC

P.O. BOX 4-1278
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3364

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

CRUDE OIL ANALYSIS REPORT

Company: Husky Oil Company
Date: May 19, 1980 Lab. No. 3710-2
Well No.: South Barrow No. 20
Location:
Field: NPRA
Formation: Pebble Shale Sands
State: Alaska
Depth: 1629-39 Prod Test No. 2(Final Flow

GENERAL CHARACTERISTIC

Specific gravity @ 60/60 ° F	0.8460
A.P.I. gravity @ 60 ° F	35.8
Saybolt Universal Viscosity @ 70 ° F., seconds	I.S.
Saybolt Universal Viscosity @ 100 ° F., seconds	I.S.
B.s. and water, % by volume	97.8
Pour point, ° F	I.S.
Total sulphur, % by weight	0.29

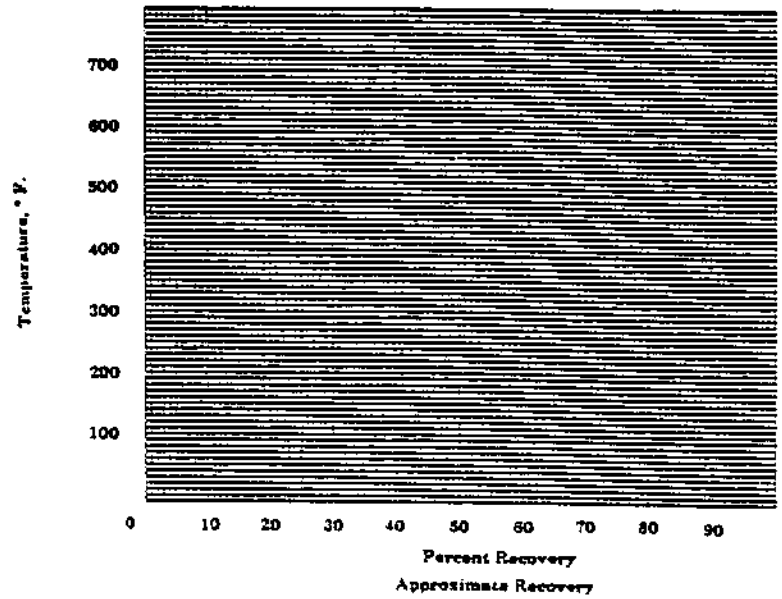
REMARKS: I.S. = INSUFFICIENT SAMPLE FOR ANALYSIS

ENGLER DISTILLATION

Recovery, %	Temperature, ° F.
IBP	
5	
10	INSUFFICIENT SAMPLE
15	
20	
25	
30	
35	
40	
45	
50	
55	
60	
65	
70	
75	
80	
85	
90	
96	
E.P.	

Recovery, %
Residue, %
Loss, %

DISTILLATION GRAPH



300 EP gasoline, %
392 EP gasoline, %
500 EP distillate, %

CHEMICAL GEOLOGICAL LABORATORIES OF ALASKA, INC

P.O. BOX 4-1278
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3384

ANCHORAGE INDUSTRIAL CENTE
5633 B Street

CRUDE OIL ANALYSIS REPORT

Company: Husky Oil Company
Date: May 19, 1980 Lab. No. 3710-3
Well No.: South Barrow No. 20
Location:
Field: NPRA
Formation: Pebble Shale Sands
State: Alaska
Depth: 1629-39 Prod Test #2 (First Flow)

GENERAL CHARACTERISTIC

Specific gravity @ 60/60 ° F	0.8610
A.P.I. gravity @ 60 ° F	32.8
Saybolt Universal Viscosity @ 70 ° F., seconds	68.8
Saybolt Universal Viscosity @ 100 ° F., seconds	54.9
B.s. and water, % by volume	47.0
Pour point, ° F	-49
Total sulphur, % by weight	0.26

REMARKS: Water Specific Gravity @ 74 F- 1.321
All Analysis determined on clean oil phase.

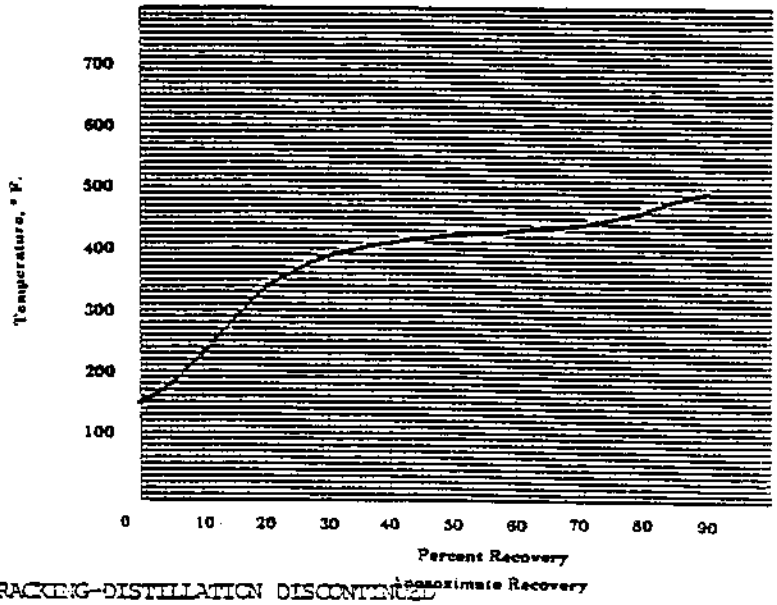
ENGLER DISTILLATION

Recovery, %	Temperature, ° F.
IBP	160
5	193
10	246
15	302
20	350
25	380
30	400
35	410
40	420
45	430
50	438
55	442
60	444
65	446
70	450
75	460
80	472
85	490
90	504 (*)
95	
E.P.	

(*) THERMAL CRACKING-DISTILLATION DISCONTINUED

Recovery, % 90.5
Residue, % 9.0
Loss, % 0.5

DISTILLATION GRAPH



300 EP gasoline, %
392 EP gasoline, %
500 EP distillate, %

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

USGS/HUSKY OIL COMPANY, OPR.
SOUTH BARROW #20
WILDCAT
NORTH SLOPE, ALASKA - NPRA

DATE : 23-APR-80
FORMATION :
DRLG. FLUID: WBM
LOCATION :

FILE NO : BP-3-589
ANALYSTS : WSP,TLS
LABORATORY: ANCHORAGE

CORE ANALYSIS RESULTS

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY (MD) MAXIMUM	90 DEG	VERTICAL	POR %	GRAIN DEN.	FLUID SATS. OIL	WTR	DESCRIPTION
1	2247.0	0.35	Core No. 1		12.4	0.00	12.3	65.2	ss;vfgr cly sl calc sid
2	2248.0	0.24			12.3	0.00	1.8	73.3	ss;vfgr cly sl calc
3	2249.0	0.14			12.0	0.00	0.9	78.5	same
4	2250.0	0.48			11.8	0.00	1.5	81.2	same
5	2251.0	21.			21.7	0.00	17.7	58.7	ss;vf-fgr cly sl calc
6	2252.0	13.			13.2	0.00	18.6	56.5	ss;f-mgr foss sid
7	2253.0	1.25			18.9	0.00	6.3	73.3	ss;f-cgr glauc foss
8	2254.0	1.99			11.8	0.00	1.6	84.3	ss;f-mgr foss sid
9	2255.0	27.			12.3	0.00	12.1	62.1	same
10	2256.0	4.40			15.5	0.00	9.1	63.9	ss;vf-fmgr cly calc
11	2257.0	26.			21.1	0.00	14.8	54.0	ss;f-mgr cly calc
12	2258.0	4.95			18.0	0.00	8.6	61.3	same
13	2259.0	5.96			18.5	0.00	8.5	63.7	same
14	2260.0	0.28			10.4	0.00	17.8	60.4	same;sid
15	2261.0	155.			22.6	0.00	17.8	46.7	ss;f-mgr calc
16	2262.0	192.			24.2	0.00	26.6	43.0	same
17	2263.0	7.36			11.2	0.00	14.4	50.4	ls glauc foss
18	2264.0	30.			22.0	0.00	15.6	63.5	ss;vf-mgr cly sl calc
19	2265.0	1.59			15.7	0.00	21.0	54.0	ss;f-mgr calc sid
20	2266.0	1.98			12.8	0.00	9.7	58.1	ls;glauc foss
21	2269.0	20.	Core No. 2		18.4	0.00	29.6	44.9	ss;vf-mgr calc sid
22	2270.0	0.82			13.5	0.00	28.4	44.6	same
23	2271.0	1.01			7.5	0.00	13.7	44.6	ls;glauc foss
24	2272.0	128.			21.6	0.00	35.0	38.0	ss;vf-fgr cly sl calc
25	2273.0	35.			19.6	0.00	29.8	44.2	same
26	2274.0	25.			19.5	0.00	23.2	55.6	same
27	2275.0	16.			18.6	0.00	19.1	53.7	same
28	2276.0	0.71			10.5	0.00	13.8	64.4	same;sid

These analyses, opinions or interpretations are based on observations and materials supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations, as to the productivity, proper operations, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

These analyses, opinions or interpretati
expressed represent the best judgment
representations, as to the productivity,

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Y, OPR. DATE : 23-APR-80
FORMATION :

FILE NO : BP-3-589
ANALYSTS : WSP,TLS

CORE ANALYSIS RESULTS

USGS/HUSKY OIL COMPA
SOUTH BARROW #20

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY (MD) MUM	90 DEG	VERTICAL	POR %	GRAIN DEN.	FLUID SATS. OIL	WTR	DESCRIPTION
		5.18			15.5	0.00	15.8	51.0	ss;vf-fgr cly sl calc
		1.			18.7	0.00	27.0	48.9	same
		4.86			14.4	0.00	20.5	50.6	same
		5.			19.4	0.00	18.5	56.5	same
		7.67			16.1	0.00	20.7	50.6	same
		5.			18.9	0.00	25.4	48.6	same
		7.32			16.3	0.00	23.6	46.1	same
		6.			19.8	0.00	21.2	52.9	same
		0.57			9.5	0.00	15.3	52.5	same;sid
		7.			21.1	0.00	23.4	51.0	ss;vf-fgr cly sl calc
		8.83			17.7	0.00	21.0	57.4	same
		7.01			15.8	0.00	20.9	61.1	same
		6.31			16.4	0.00	14.8	66.0	same
		4.			19.2	0.00	20.9	65.6	same
		6.19			14.6	0.00	15.3	53.6	same
		1.43			14.0	0.00	16.0	57.8	same
		0.19			7.0	0.00	11.0	58.3	ss;vf-fgr cly sid sl calc
		4.			18.9	0.00	17.3	60.7	ss;vf-fgr cly sl calc
		5.			18.7	0.00	29.6	37.0	ls;sdy foss
		4.			27.0	0.00	37.3	45.0	ss;f-mgr foss
		0.06			5.0	0.00	10.6	48.5	ls;slty lams
		4.			25.5	0.00	27.0	43.8	ss;f-mgr foss
		4.95			13.4	0.00	34.7	33.6	ss;vf-fgr cly sid foss
		2.			21.5	0.00	27.4	47.2	ss;f-mgr foss
		9.65			15.4	0.00	27.9	27.9	ss;vf-mgr cly foss
		3.45			15.9	0.00	6.7	66.8	ss;vf-mgr cly foss sid
		6.			21.5	0.00	23.9	53.5	ss;vf-mgr cly foss
		9.			24.4	0.00	28.2	37.9	ss;f-mgr foss
		0.14			5.5	0.00	5.8	46.6	ls;foss
		5.43			6.7	0.00	4.3	71.0	same;glauc

Core No. 3

SAMPLE NUMBER	DEPTH FEET	MAX
29	2277.0	
30	2278.0	
31	2279.0	
32	2280.0	
33	2281.0	
34	2282.0	
35	2283.0	
36	2284.0	
37	2285.0	
38	2286.0	
39	2287.0	
40	2288.0	
41	2289.0	
42	2290.0	
43	2291.0	
44	2292.0	
45	2293.0	
46	2294.0	
47	2295.0	
48	2296.0	69
49	2297.0	
50	2299.0	4
51	2300.0	
52	2301.0	5
53	2302.0	
54	2303.0	
55	2304.0	4
56	2305.0	44
57	2306.0	

...ons are based on observations and materials supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions ...of Core Laboratories, Inc. (all ... and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or ...proper operations, or profit ... of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

59

COMPANY, OPR. DATE : 23-APR-80
FORMATION :

FILE NO : RP-3-589
ANALYSTS : WSP,TLS

CORE ANALYSIS RESULTS

USGS/HUSKY OIL CO
SOUTH BARROW #20

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY (MD) MAXIMUM	90 DEG	VERTICAL	POR %	GRAIN DEN.	FLUID SATS. OIL	WTR	DESCRIPTION
		4.12			14.4				
		609.			23.9	0.00	7.6	53.9	ls;foss
		0.33			9.6	0.00	40.5	23.7	ss;f-msr foss
		50.			15.1	0.00	8.6	46.8	ls;foss
		35.			10.7	0.00	1.4	54.3	ls;foss glauc sdy *horiz. frac.*
		46.			4.8	0.00	24.5	37.4	ls;foss sid sdy *horiz. frac.*
						0.00	14.1	47.1	ls;foss *horiz. frac.*
59	2308.0								
60	2309.0								
61	2310.0								
62	2311.0								
63	2312.0								
64	2313.0								

erpretations are based on observations and materials supplied by the client to
dgment of Core Laboratories, Inc. (all errors and omissions excepted); both whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions
ctivity, proper operations, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.
Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or

These analyses, opinions or
expressed represent the best
representations as to the pr