NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

U. S. NAVY

SOUTH BARROW WELL NO. 13

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

For the

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

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GEOLOGIC SUMMARY

INTRODUCTION

The South Barrow Well No. 13, 552' FSL and 807' FWL, protracted Section 14, T22N, R18W, Umiat Meridian, is located in the South Barrow Gas Field, approximately four miles southeast of Barrow, Alaska.

Drilling below conductor casing at 74' began on December 17, 1976 and terminated at a depth of 2534' on January 1, 1977. A suite of lithologies from Lower Cretaceous (Torok) to Pre-Mississippian (argillite) were penetrated.

After attempting flow tests, the rig was released on January 16, 1977.

PRE-DRILLING PROGNOSIS

The primary objectives of South Barrow Well No. 13 were the lower Jurassic Barrow sandstones. A possible secondary objective was the Lower Unconformity sandstone at the base of the "Pebble Shale". The Barrow sandstones were predicted to be encountered at a subsea depth of -2195' and the argillite at -2320'.

POST-DRILLING SUMMARY

The South Barrow Well No. 13 was drilled through the Torok Formation and "Pebble Shale" to a depth of 2159' where two continuous cores (2159-2219') were taken in an effort to cut the Lower Cretaceous-Jurassic unconformity. The contact was not observed in either core. The unconformity was encountered at 2240' (-2200' subsea). At the South Barrow Well No. 11, located approximately 3000' to the northeast, it was at -2160' subsea.

An additional 25' of section not present at the top of the Kingak Formation in South Barrow Well No. 11 was noted in No. 13.

The Barrow sandstones were encountered at 2296' with 52' of the Upper Barrow being cored. Fair to good hydrocarbon shows were observed in the upper 34', then became spotty to nil downward. Porosities varied from 4.2 to 19.6%, but permeabilities were generally very low. Susceptibility tests were performed on Core No. 4 (2318-2348') and the clays in the sandstone matrix were found to be highly susceptible to damage from contact with fresh water (Appendix E).

The Lower Barrow sandstone was not cored, but an 18' sandstone (2363-2381') had porosities of 16-18% and water saturations of 66-75%. Hydrocarbon shows were limited to spotty dull yellow fluorescence.

The Triassic Shublik Formation, 61' thick (not predicted in prognosis), was encountered overlying the argillite which was penetrated at 2472'.

Flow tests through perforations at 2358-2368', 2330-2345', 2315-2330', and 2224-2234' were attempted with negative results (see testing information).

The well was suspended.

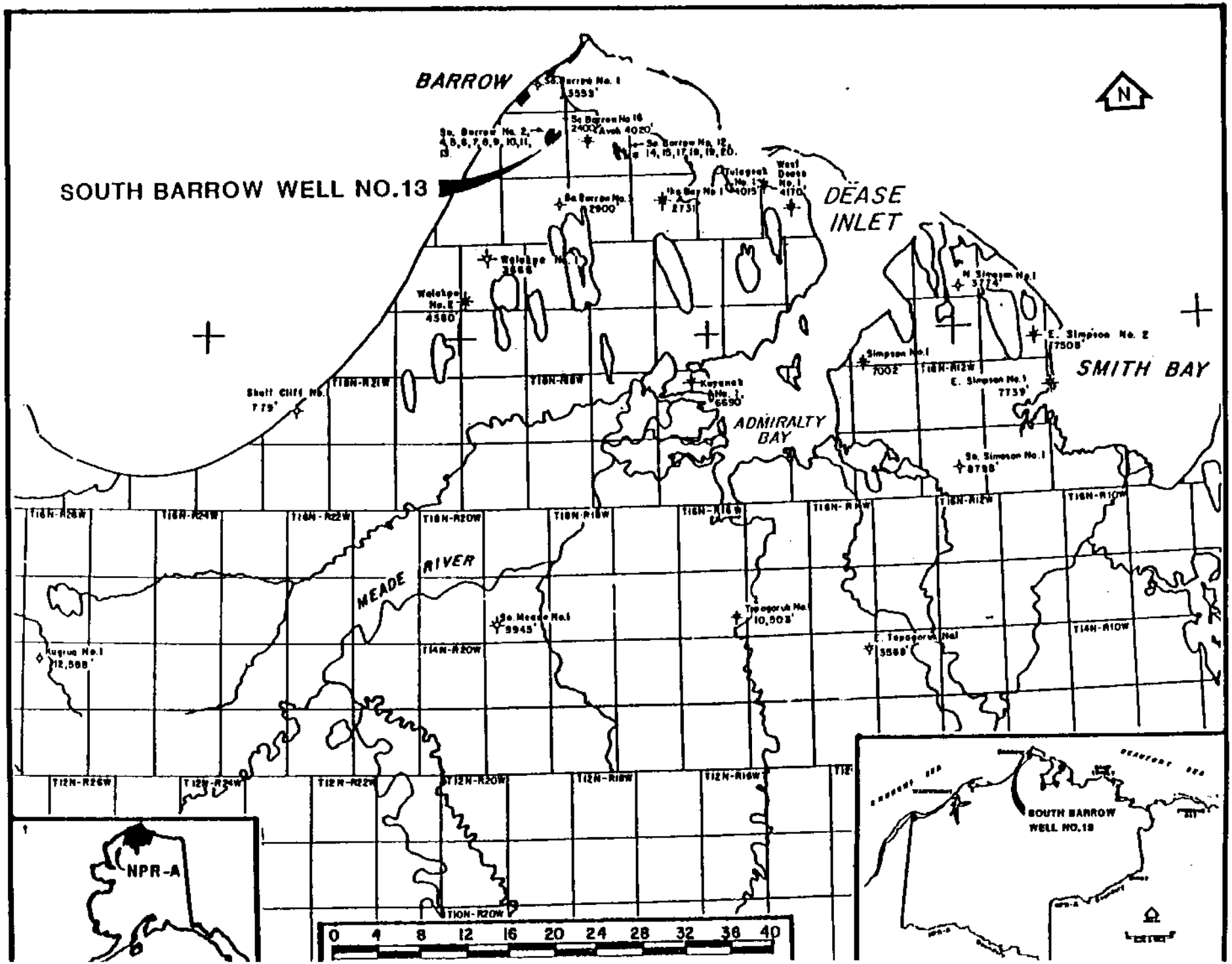
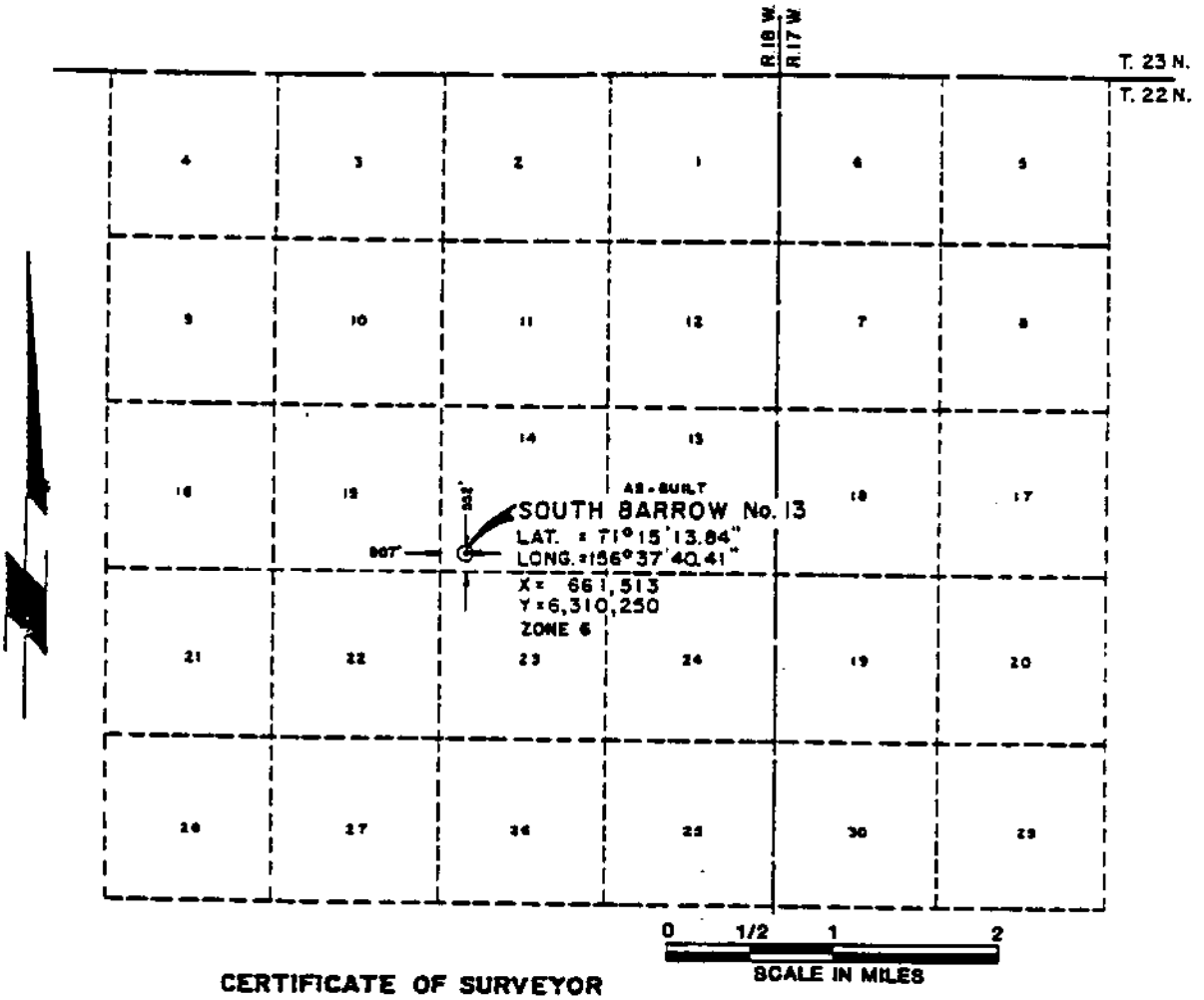


FIGURE 1 - LOCATION MAP - SOUTH BARROW WELL NO. 13



CERTIFICATE OF SURVEYOR

I hereby certify that I am properly registered and licensed to practice land surveying in the State of Alaska and that this plat represents a location survey made by me or under my supervision, and that all dimensions and other details are correct.

4-3-77
Date

SURVEYOR

AS-BUILT

SOUTH BARROW No. 13

Located in
SW V4 PROTRACTED SEC. 4, T 22 N., R 16W., U.M., ALASKA

Surveyed for
HUSKY OIL
N.P.R. OPERATIONS

Surveyed by
F. M. LINDSEY & ASSOC.
LAND & HYDROGRAPHIC SURVEYORS
2502 West Northern Lights Boulevard Box 4-081
Anchorage Alaska

FIGURE 2 - CERTIFICATE OF SURVEYOR - SOUTH BARROW WELL NO. 13

WELLSITE GEOLOGIST'S REPORT
BY: RONALD G. BROCKWAY

INTRODUCTION

Drilling below conductor casing began on December 17, 1976, on South Barrow No. 13 proposed gas well. The well was drilled to a depth of 1,166 feet on December 21, 1976, at which time 10-3/4" casing was set at a depth of 1,157 feet. Drilling rates from 74 feet (base of conductor casing) to 1,166 feet varied from 0.4 min. to 2.5 min. per foot.

Drilling resumed December 24, after allowing the cement to set on the casing and the well was drilled to a depth of 2,159 feet on December 25, 1976, at an average rate of 0.8 min. to 1.5 min. per foot. At this point two 30-foot cores were taken in an effort to core the Lower Cretaceous-Jurassic unconformity. These cores, 2159-2219', were predominantly dark shale and did not cut the unconformity. A sand, black shale, and dark chert-pebble conglomerate comprised the last foot of core recovered (2218-2219'). The conglomerate could possibly be an erosional remnant near the top of the unconformity.

At 2,230 feet, a conglomeratic sandstone was encountered which was correlated to the Unconformity sandstone in South Barrow No. 11. At this point, it was discovered that South Barrow Well No. 13 was about 40 feet structurally lower than No. 11 at the base of the sandstone.

Two cores (Nos. 3 and 4) were taken December 29 and 30, 1976, from 2288-2348' to recover the porous zones of the Barrow gas sands. These cores were predominantly "dirty" sandstones with interbedded siltstones and shales. Occasional zones exhibited good porosity, up to 20% (estimated). Oil staining was observed throughout both cores, but became very poor in the lower portion of Core No. 4.

The well was then drilled December 30, 1976, with a rotary bit from 2348' to 2410'. Drilling rates averaged 3.5 min. per foot, except for the last five feet which averaged 6 min. per foot. At this point a 15-foot core (2410-2425') was taken to recover the argillite, which was postulated to be at this point. Some argillite chips were encountered in the ditch samples. Core recovery showed only shaly sandstone and siltstone, partly calcareous.

Electrical logs were run (December 31 and January 1) at this point to ascertain the correlations and porosities of the well and it was discovered that the well was still in what was then thought to be Lower Barrow sand. An added stratigraphic section, not present in South Barrow No. 11, was discovered immediately below the Unconformity sand at 2230'. This section was about 25 feet thick, which then put the well about 65 feet structurally lower than predicted by the prognosis.

At this time, it was decided to continue drilling the well with a conventional bit into the argillite. Black and very dark gray sedimentary rocks were observed in the 2475-2480' sample. These rocks were very soft and considered a claystone, probably weathered argillite, and drilled at an average rate of 2.5 min. per foot to 2510'. Drilling rates increased to approximately 4.0 min. per foot, and samples indicated the argillite becoming more siliceous and hard. Core No. 6 was cut from 2522-2534' in the argillite; recovery was only three feet.

Drilling was suspended at 2534' on January 1, 1977. Final electrical logs and sidewall coring were performed January 1 and 2.

No drill-stem tests were undertaken while drilling. Two flow tests were attempted after completion of drilling with negative results.

Six conventional cores were cut, and 24 sidewall cores (17 recovered) were shot.

The well was suspended.

STRATIGRAPHY

WIRELINE TOPS

	Feet below Kelly Bushing	Subsea (KB 40')
CRETACEOUS		
Torok Formation	200' samples start	-160'
"Pebble Shale"	1740'	-1700'
JURASSIC		
Kingak Formation	2240'	-2200'
Upper Barrow sandstone	2296'	-2256'
Lower Barrow sandstone	2363'	-2323'
TRIASSIC		
Shublik Formation	2411'	-2371'
INDETERMINATE		
Argillite	2472'	-2432'
TOTAL DEPTH	2534'	-2494'

NOTE: A discrepancy has been noted between the 2" DIL and 5" DIL logs. At depth of 1550', both logs are the same. At the base of the Unconformity sand (2240' 2" DIL) there is a 6' difference with the 5" (2234'). The Gamma Ray from the FDC/CNL log matches closely with the 5" DIL log.

Tops in this report are picked to correlate with 2" composite log.

CRETACEOUS

Torok Formation: 200-1740'

The rocks of the Torok Formation were quite soft and had a tendency to disperse in the drilling mud. Therefore the described samples may not be entirely representative of the formation. At the same time, there were problems with the flow line freezing. Light gray, sandy, silty claystones are the main lithology of the Torok. Some thin-bedded light gray, very fine grained sandstones and siltstones were observed.

Coal chips, pyrite inclusions, chert pebbles, limestone nodules and fossil fragments were scattered throughout.

The interval 200-1740' has been given an Aptian to Albian age by Anderson, Warren & Associates, Inc.

Hydrocarbon shows were very minor in the Torok Formation. A very slight show of gas was noted at 1450' where a peak of 80 units, 50 units over background, was recorded.

"Pebble Shale": 1740-2240'

At 1740', there was a very distinct change in lithology. A dark gray, fissile, carbonaceous shale with "floating" rounded quartz grains was penetrated. This change was supported by a high gamma-ray reading on the Gamma-Ray log and also by biostratigraphic data. Thin scattered sandstone beds were present to approximately 2000' where they became more numerous. A thin sandstone at 2010-2020' had a gas peak of 120 units and displayed a fair fluorescence and cut. Minor shows were recorded to 2065'.

Starting at 2159', Cores Nos. 1 and 2 were cut (2159-2189', 2189-2219') with 57 feet recovered. Dark brownish-gray shale with some dark gray and dark brown shale and "floating" quartz grains was the predominate lithology. Some brown siltstone and sandstone beds, some with hydrocarbon shows, were present in the upper core.

Both cores exhibited fracturing with slickensides common. Free oil was noted in fractures at 2177.4' to 2180'. One foot of conglomerate with a black shale matrix was recovered from the bottom of Core No. 2. This may be part of a transitional zone leading to the basal conglomeratic sandstone which was encountered at 2230'.

The conglomeratic sandstone (Lower Unconformity sandstone, 2230-2240') is light gray, "salt and pepper", subrounded to subangular, and it contains pebbles of light and dark chert. An estimated 15-20% porosity (Density log shows a maximum of 22%) was observed with slight hydrocarbon staining and a trace of gas recorded.

Biostratigraphic determinations by Anderson, Warren & Associates, Inc. have placed the interval 1740' to 2080' as probable Early Cretaceous (Neocomian) and 2080-2220' as Late Jurassic-Early Cretaceous (Neocomian) by microfauna. The interval 1710-2411' was indicated as probably Neocomian by palynology.

JURASSIC

Kingak Formation: 2240-2411'

The Kingak Formation includes the Upper and Lower Barrow sandstones as intervals in the lower, sandy facies of the Kingak. The top of the section is composed of gray-brown shales, with siltstones and minor sandstones. The Kingak section below the Lower Barrow sandstone is a sequence of sandstone and shale in which the shales are a dark gray-brown. The main sandstone body (Upper Barrow) begins at 2296' in Core No. 3 (2288-2318'). After correlation with South Barrow No. 11, it was found that an additional 25' of extra section is present at the top of the Kingak in South Barrow No. 13, compared to South Barrow No. 11.

Upper Barrow sandstone: 2296-2353'

The Upper Barrow sandstones have been picked at 2296', where the main sandstone body starts in Core No. 3. Cores Nos. 3 and 4 (2288-2348'), recovered 60 feet, of which 52 feet was brownish-gray to light gray, very fine grained glauconitic sandstones with siltstone interbeds. Good hydrocarbon shows were present to a depth of 2330'; below this point they become spotty to slight. Fracturing was observed in both cores.

Core analysis of samples from Cores Nos. 3 and 4 showed porosities ranging from 4.2 to 19.6%. Permeabilities varied from 0.0 to 114 millidarcies with most below 5.0. Water saturations from the core analysis were generally over 60% (Appendix D).

Lower Barrow sandstone: 2363-2382'

The Lower Barrow sandstone has been picked at the top of an 18' sandstone that is light gray, very fine grained and contains siderite and calcite streaks. Porosities through this sand were 16-18% as shown on the density porosity log with water saturations of 66 to 78% (Appendix C). Hydrocarbon shows were limited to a dull yellow spotty fluorescence.

Paleontological data has placed the interval 2220-2411' into an Early to Middle Jurassic age.

TRIASSIC

Shublik Formation: 2411-2472'

Sandstone is the main lithology of the Shublik Formation. The sandstone is light gray to light brown, very fine grained, partly calcareous, and

commonly fossiliferous. The formation also includes some interbedded shale and siltstone. The sandstones are shaly, have generally poor porosity and contain no shows.

Core No. 5 (2410-2425') apparently cut the contact between the Jurassic and Triassic rocks. Anderson, Warren & Associates, Inc. place the microfaunal time line at 2411'. This contact was not observed in the core, but it may be at the top of the shale, with fossils described at 2412.5-2414.5' (Appendix B).

INDETERMINATE

Argillite: 2472-2534'

The argillite was penetrated at 2472' (E-log pick), and the upper 25' was a very dark gray to black, carbonaceous claystone. Below this was black argillite, showing low-grade metamorphism and quartz-filled fractures.

Core No. 6 (2522-2534') recovered 3' of black argillite with quartz veins and pyrite inclusions. Traces of gas bubbles were noted in the core. Chromatograph readings rose to 80-90 units.

Anderson, Warren & Associates, Inc. pick the base of the Triassic at 2460'.

ZONES OF HYDROCARBON SHOWS

1400-1480'	Slight gas show.
1810-1820'	Slight gas show.
2000-2100'	Slight gas show, spotty fluorescence, fair cut.
2230-2240'	Oil stain, good fluorescence, good cut, gas show 80 units.
2270-2300'	Spotty fluorescence, fair cut.
2300-2350'	Good fluorescence, bright yellow, good cut, bright milky yellow, becoming dull yellow 2330-2340', dull yellow cut.
2364-2385'	Spotty fluorescence, dull yellow, very faint, slight dull yellow cut.
2475-2534'	Slight gas show, up to 90 units. Core No. 6 exhibited trace of gas bubbles after being washed.

TESTING

No drill-stem tests were performed on this well while drilling. After completion of drilling, an attempt was made to flow test the well through perforations at 2358-2368', 2330-2345', 2315-2330', and 2224-2234'.

Negative results were obtained even after being "rocked" with gas from South Barrow No. 10.

The well was reperforated at 2383-2387', 2356.5-2376.5', 2315.5-2345.5' and 2224.5-2234.5'. Again the well was "rocked" with gas and recovered a very slight flow. The well was then suspended.

In an effort to ascertain why the well did not produce, samples were taken from Core No. 4, over the interval 2318-2344', for analysis of susceptibility to liquids. It was found that the clays in the sandstone matrix were of the swelling type and very highly susceptible to fresh water; a fresh-water mud was used to drill the well. It was also noted that a diesel-based mud would have the least effect on the swelling clays (Appendix E).

NOTE: This well was flow tested again on July 20, 1978 at a calculated A.O.F. of 360 MCFPD. This improvement in gas flow indicates that, to some extent, the reservoir sandstones are "self healing", probably due to dehydration of the interstitial clay minerals by methane (Drilling History, ibid, Appendix II, pages 2-5).

CONCLUSIONS

1. With South Barrow Well No. 13 being 65 feet structurally lower at the top of the Upper Barrow sand than originally predicted, the closing structure of the South Barrow Gas Field becomes much smaller and is confined mostly to Section 14. Possibly another structure may be present to the south in Section 23 with South Barrow No. 13 being located in the saddle between.

2. The Upper Barrow sand appears to be the best source for gas production. Although the sandstone is shaly and has shale banding and laminations, some thin zones have porosity up to 20%. The upper portion (2296-2340') of the unit exhibited good to spotty bright blue-yellow fluorescence and cut, indicating that the hydrocarbons present are of high viscosity.

3. Below 2340', fluorescence becomes spotty to nil and a very faint, very dull yellow. These sands appear to be flushed and water-wet and that production should be limited to those sands above 2340'. Electric-log computations show a high water saturation for the Lower Barrow sandstone at 2363-2381'.

4. Some gas was encountered at the top of the argillite with some kicks as high as 90 units on the chromatograph.

PERTINENT DATA AND APPENDICES

SUMMARY OF PERTINENT DATA *

WELL NAME:	South Barrow Well No. 13
API NO.:	50-023-20008
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	552' FSL, 807' FWL protracted Section 14, T22N, R18W, Umiat Meridian, Alaska.
COORDINATES:	Latitude: 71°15'13.84"N Longitude: 156°37'40.41"W X = 661,513 Y = 6,310,250 Zone 6
ELEVATION:	40' KB, 22' Ground, 26' Pad
DATE SPUDDED:	December 17, 1976
TOTAL DEPTH:	2,534 feet
DATE REACHED TOTAL DEPTH:	January 1, 1977
RIG RELEASED:	January 16, 1977
STATUS:	Suspended January 17, 1977
CASING:	20" @ 74' 10-3/4" @ 1157' 7" - surface to 2514'

LOGGING RECORD:

DIL/SP	75-1093'
	1157-2422'
	1157-2527'
BHCS/GR/Caliper	75-1080'
	1157-2419'
	1157-2523'
FDC/CNL/GR/Caliper	1157-2427'
	1157-2534'
FDC/GR/Caliper	1157-2427'
	1157-2534'
HDT Dipmeter	1157-2534'
CBL/VDL/GR	50-2464'
CCL	2224-2387'
Mudlog	200-2534'

LOGGING RECORD: (Continued)

Computed Logs	
Dipmeter Arrow Plot	1165-2458'
Saraband	1160-2504'

SIDEWALL CORES: Shot 24, recovered 17.

CONVENTIONAL CORES:

No.	Depth	Recovered	Formation
1	2159-2189'	30'	"Pebble Shale"
2	2189-2219'	27'	"Pebble Shale"
3	2288-2318'	30'	Upper Barrow
4	2318-2348'	30'	Upper Barrow
5	2410-2425'	15'	Shublik
6	2522-2534'	3'	Argillite

WELLSITE GEOLOGIST: R. G. Brockway

WELL LOG ANALYST: Armour Kane

CONTRACTOR: Husky Oil NPR Operations, Inc.

MUD LOGGERS: Petro-Tec

BIOSTRATIGRAPHIC ANALYSIS: Anderson, Warren & Associates, Inc.

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

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

SOUTH BARROW WELL NO. 13
DRILL CUTTINGS AND CORE DESCRIPTIONS
BY
RONALD G. BROCKWAY

DRILLED DEPTH (FEET BELOW KELLY BUSHING)	
0- 200	No samples caught.
200- 240	Claystone: light gray, silty, sandy, carbonaceous flakes, trace of pyrite inclusions, rare quartz and chert pebbles, very slightly calcareous.
240- 250	Claystone: as above, but with rare bentonite inclusions.
250- 260	Sandstone: light to medium gray, subangular, medium sorting, silty, soft to friable, occasional pebbles.
260- 300	Claystone: light gray, silty, slightly sandy, carbonaceous flakes, disseminated pyrite and inclusions (less than 1%), rare fossil fragments, dark chert granules and pebbles, calcareous inclusions, trace of bentonite.
300- 350	Claystone: as above, but with sandstone inclusions, very fine grained, subangular, calcareous, rare glauconite, tight.
350- 380	Claystone: as above, but with thin calcareous siltstone stringers.
380- 400	Claystone: as above, but with thin calcareous siltstone stringers and very finely carbonaceous.
400- 420	No samples recovered.
420- 450	Claystone: light gray, silty, soft, rare chert granules, trace of shell fragments, with Siltstone: light gray, and Sandstone: light gray, subangular, very fine grained, tight, rare shell fragments, pyritic.
450- 480	No samples recovered.
480- 490	Claystone: light gray, silty, sandy, trace of shell fragments, rare pyrite, scattered calcareous inclusions; Sandstone stringers: light gray, fine grained, predominantly loose, subangular, medium sorting.
490- 500	No samples recovered.

500- 520	Claystone: light gray, silty, sandy with thin Sandstone stringers: light gray, fine grained, subangular and with shell fragments and foraminifera.
520- 530	Siltstone: light gray, calcareous, limestone nodules, pyrite inclusions, claystone laminae, scattered chert pebbles.
530- 550	No samples recovered.
550- 590	Claystone: light gray, silty, calcareous stringers, carbonaceous, shell fragments, very argillaceous limestone inclusions, a few marlstone stringers, rare chert pebbles and calcareous siltstone stringers.
590- 610	Claystone: as above with Sandstone laminations: very fine grained, bentonitic, tight, trace of pyrite.
610- 620	Siltstone: medium to light gray, clayey, calcareous, carbonaceous, shell fragments.
620- 680	Claystone: light gray, silty, slightly calcareous, rare coal chips, pyrite and light gray limestone inclusions, rare quartz granules, thin siltstone and sandstone partings and light gray marlstone stringers.
680- 700	Siltstone: light gray, with Sandstone stringers: subangular, very fine grained, calcareous, rare medium, rounded quartz grains, and Sandstone: light gray, subangular, fine grained, poorly sorted, very silty and argillaceous.
700- 730	Claystone: light gray, silty, siltstone and sandstone inclusions, limestone nodules, very argillaceous and chert granules, coal chips and shell fragments.
730- 750	Siltstone: light gray, sandy, pyritic, partly calcareous, very argillaceous limestone nodules, chert granules, coal chips and shell fragments.
750- 800	Claystone: light gray, silty, trace of coal chips, dark chert granules and shell fragments, very argillaceous limestone nodules, sandstone and siltstone inclusions, trace of pyrite.
800- 840	Claystone: light gray, silty; Sandstone laminae: very fine grained, light gray, calcareous, tight; Siltstone laminae: calcareous, sandstone and siltstone nodules.

840- 910	Claystone: light gray, silty, trace of loose sand, pyrite inclusions up to five millimeters; foraminifera and shell fragments, very argillaceous limy nodules, rare coal chips.
910- 920	No samples recovered.
920- 950	Claystone: light gray, silty, sandstone and siltstone laminae, shell fragments; Sandstone: very fine grained, subangular, medium sorting, slightly carbonaceous, pyritic.
950- 960	Sandstone: light gray, very fine grained, subangular, medium sorting, pyritic, calcareous, friable, fair porosity.
960- 990	Claystone: light gray, silty, pyrite inclusions, shell fragments; interbedded Siltstone: gray, clayey, and Sandstone: light gray, very fine grained, subangular, scattered chert pebbles, calcareous, argillaceous limestone nodules and glauconite granules.
990-1030	No samples recovered.
1030-1040	Claystone: light to medium gray, silty with thin Siltstone and Sandstone laminae: calcareous, argillaceous.
1040-1080	Claystone: medium to dark gray, carbonaceous, trace of shale, occasional coal chips, pyrite inclusions; Sandstone and Siltstone laminae: light gray, slight oil stain, trace of tan limestone with oil stain, shell fragments.
1080-1100	Sandstone: light gray, subangular, fine grained, poorly sorted, carbonaceous, clayey, with Claystone: light to medium gray, medium hard, pyritic.
1100-1130	Sandstone: light gray, fine grained, subangular, poorly sorted, pyritic, calcareous, glauconitic, with Siltstone: gray, hard, calcareous and Claystone: light gray, silty, sandstone and siltstone laminae, shell fragments and coal chips.
1130-1160	Sandstone: light gray, fine grained, subangular, medium sorting, calcareous, pyritic, clayey, coal chips, siltstone and claystone laminae, scattered quartz granules.
1160-1240	Very poor samples; mostly cement and rust flakes from casing, rare claystone, siltstone and sandstone chips.
1240-1300	Claystone: light to medium gray, silty, some siltstone laminae, slightly carbonaceous, partly pyritic.

1300-1320	Claystone: light to medium gray, silty, soft, with siltstone laminae and rare chert pebbles.
1320-1340	No samples recovered.
1340-1370	Claystone: gray, silty, soft, slightly carbonaceous with Siltstone laminations: gray, slightly carbonaceous.
1370-1440	Claystone: light to medium gray, soft, silty with interbedded Siltstone: gray to gray-brown, clayey, soft.
1440-1460	Sandstone: light gray, very fine grained, subangular, medium sorted, calcareous, poor to fair porosity with interlaminated claystone and siltstone.
1460-1500	Claystone: gray and light gray, silty, soft with a few sandstone and siltstone laminae.
1500-1540	Claystone: medium and light gray, silty, slightly carbonaceous, siltstone and sandstone laminae, scattered chert pebbles.
1540-1550	No samples recovered.
1550-1590	Siltstone: medium to light gray, clayey, coal chips, with Claystone: light gray, silty, shell fragments and sandstone inclusions, with interbedded Siltstone: light gray, micaceous.
1590-1600	Sandstone: light gray, very fine grained, subangular with Siltstone: light gray, micaceous, and Claystone: light gray, glauconite pellets.
1600-1630	Siltstone: light gray, clayey to sandy, carbonaceous, with Claystone: light gray, rare chert pebbles and glauconite pellets.
1630-1660	Claystone: light gray to gray, silty, soft, occasional shell fragments, with Siltstone stringers: light gray, soft.
1660-1720	Siltstone: light gray, slightly sandy, soft, scattered coal chips, with Claystone: light gray, silty, micaceous, some shell fragments.
1720-1730	Siltstone: gray, clayey, soft, rare glauconite pellets.
1730-1740	Claystone: gray, silty, moderately soft, altered fossil fragments and coal chips.

1740-1810	Shale: dark gray, fissile, carbonacous, micromicaceous, rounded frosted quartz grains, fine to coarse, coal stringers at top, thin sandstone partings.
1810-1830	Sand: loose, very fine to medium grained, subrounded to rounded, partly frosted, pyritic, shale and siltstone laminae, and Shale: dark gray, as above, with Claystone: gray, micaceous with sandstone laminae.
1830-1870	Shale: dark gray, carbonaceous, micromicaceous, pyritic, sandstone and siltstone laminae, rounded frosted quartz grains.
1870-1890	Sand: predominately loose, rounded to subrounded, fine to coarse grained, rare calcareous streaks, with Shale: dark gray, carbonaceous, sandstone and siltstone laminations, rounded frosted quartz grains.
1890-1900	Sandstone: gray, predominantly loose, fine to medium grained, clayey, silty, calcareous streaks.
1900-1930	Siltstone: gray, slightly sandy, slightly carbonaceous, interbedded with Shale: dark gray, carbonaceous, pyritic, rounded frosted quartz grains.
1930-1950	Sandstone: light to medium gray, very fine to fine grained, calcareous, silty, pyritic, moderately hard.
1950-1970	Shale: dark gray, silty, carbonaceous, frosted quartz grains; Sandstone stringers: light gray, very fine grained, subangular, medium sorted.
1970-2000	Sandstone: gray, subrounded, medium sorting, fine to medium grained, pyritic, scattered coarse grains, with Shale: dark gray, carbonaceous, micaceous, inclusions of quartz grains, siltstone and sandstone stringers, pyritic, rounded frosted quartz grains.
2000-2030	Sandstone: light gray, fine to medium grained, subrounded, poorly sorted, silty, argillaceous, friable, fair porosity, fair cut, some gas, with Shale: dark gray, micaceous, pyritic, sandstone laminae, rounded quartz grains.
2030-2040	Sandstone: gray, very fine to fine grained, subrounded, medium sorted, silty.
2040-2050	Shale: dark gray, carbonaceous, pyritic, slightly silty, partly fissile with frosted quartz grains.

2050-2060	Sandstone: light to medium gray, subangular to subrounded, poorly sorted with scattered very coarse grains and granules.
2060-2070	Shale: dark gray, silty, carbonaceous, rounded quartz grains, occasional limestone nodules.
2070-2080	Sandstone: gray, subrounded, medium sorted, fine to medium grained, pyritic, silty.
2080-2090	Shale: dark gray, carbonaceous, pyritic, micaceous, frosted quartz grains, siltstone laminae.
2090-2100	Sandstone: light gray, fine to medium grained, subangular to subrounded, calcareous, silty, slight visible staining.
2100-2110	Sand: loose, fine grained with scattered medium grains, subrounded, probably silty and clayey, with Shale: dark gray.
2110-2120	No samples recovered.
2120-2159	Shale and Claystone: dark gray, slightly silty, carbonaceous, coarse rounded quartz grains, sandstone laminae, with Sandstone: light gray, "salt and pepper", fine grained, medium sorted, subangular to subrounded, siliceous, fair porosity, and Shale: dark gray, carbonaceous, pyritic, limestone and siderite nodules, sandstone stringers.
2159-2189	Core No. 1 - Cut 30', Recovered 30'

2159.0-2162.0' (3.0')	Shale: dark gray-brown, micaceous, carbonaceous, scattered floating rounded quartz grains, slightly silty, pyrite inclusions and thin streaks, streaks appear to be replacing fossils, slight odor, no cut, apparent bedding dip 15°, random fractures, slickensides.
2162.0-2163.3' (1.3')	Siltstone: dark gray-brown, very shaly, slightly micaceous, carbonaceous, rare rounded sand grains, scattered glauconitic pellets, rare fossils replaced with pyrite, random fractures, slight odor.
2163.3-2166.0' (2.7')	Shale: dark brown, silty, floating red sand grains, pyrite inclusions, carbonaceous, micaceous, highly fractured, random, partly soft and mushy, 2165-2166', approximate dip 20°.

2166.0-2171.0' (5.0')	Shale: dark gray-brown, carbonaceous, micaceous, pyrite inclusions and streaks, 2" sandstone at 2168', light gray, very fine grained, subangular to subrounded, oil stain, becomes silty at 2169', 85° fracture, with slickensides, dip 15°.
2171.0-2172.0' (1.0')	Shale: dark brown, micaceous, carbonaceous, pyrite inclusions, altered fossils(?), rare chert granules, up to 2 mm, slightly silty, scattered round sand grains, random fractures, slickensides.
2172.0-2175.0' (3.0')	Shale: dark brown, micaceous, carbonaceous, silty, pyrite inclusions, some glauconite pellets, disseminated pyrite, scattered round quartz and dark chert grains, fractures 45°-85°, slickensides.
2175.0-2176.0' (1.0')	Siltstone: dark brown, very shaly, pyrite inclusions, round quartz and chert grains, scattered glauconite pellets, highly fractured and brecciated.
2176.0-2177.0' (1.0')	Shale: dark brown, carbonaceous, micaceous, slightly silty, rare round quartz grains, fractures with slickensides.
2177.0-2177.4' (0.4')	Sandstone: light brown, fine grained, subangular to subrounded, medium sorted, black shale grains, silty, argillaceous, soft, 3% porosity, oil stain, petroleum odor, very good very light yellow-blue cut.
2177.4-2180.0' (2.6')	Shale: dark gray-brown, silty, very large cast from chert(?) pebble, thin sandy band 2177.4-2177.8', spotted dull yellow fluorescence, fair cut, vertical fracture with free hydrocarbons 2177.4-2178.0'.
2180.0-2181.0' (1.0')	Siltstone: dark brown, shaly, micaceous, pyrite inclusions, scattered round quartz grains, dark chert granules and pebbles up to 1/2", appears stained, no fluorescence, very slight cut, 85° fracture.

2181.0-2181.5' (0.5')	Shale: dark brown, silty, micaceous, carbonaceous, pyrite inclusions, rare round sand grains, a few dark chert granules, appears slightly stained, very slight cut, fractures with slickensides.
2181.5-2182.0' (0.5')	Siltstone: dark brown, very shaly, round quartz and chert granules 5%, pyrite inclusions, vertical fractures, stain as above.
2182.0-2183.0' (1.0')	Shale: dark brown, silty, round chert and quartz grains, 1-2%, chert granules, light gray, calcareous, fine grained sandstone inclusions at 2182.8', rare glauconite, partly pyritic cement, fractures 65° to vertical.
2183.0-2184.5' (1.5')	Siltstone: dark brown, sandy, 25%, slightly conglomeratic, round chert pebbles, shaly, micaceous, pyrite inclusions, 70° fractures, bedding dip 20°.
2184.5-2185.0' (0.5')	Sandstone: dark brown, slightly conglomeratic, dark chert granules, subrounded, poorly sorted, very fine to coarse grained, very silty, argillaceous, rare white calcite granules, one large calcareous, very pyritic, very fine grained, oval sandstone pebble (2-1/2"), fractures.
2185.0-2186.0' (1.0')	Siltstone: dark brown, sandy, 20%, shaly, micaceous, scattered chert granules, random fractures.
2186.0-2188.4' (2.4')	Shale: dark brown, micaceous, slightly pyritic, sandy inclusions, fractured, becoming partly shiny and smooth.
2188.4-2189.0' (0.6')	Shale: dark brown, smooth, partly fragmented, fish(?) fragments, slightly carbonaceous, tabular, bedding dip horizontal to 5%, slickensides.
2189-2219	Core No. 2 - Cut 30', Recovered 27'
2189.0-2190.5' (1.5')	Shale: gray-brown, soft, flaky, micromicaceous, highly fractured, random, abundant slickensides, some pyrite inclusions.

2190.5-2191.8' (1.3')	Shale: brown-gray, micaceous, slightly silty, pyrite inclusion, rare fossil fragments, fish(?), highly fractured, random.
2191.8-2192.6' (0.8')	Shale: dark gray, partly brown, slightly micaceous, thin pyritic stringers along bedding plane, dip 25%, fissile fragments, becomes flaky at 2192.6', highly fractured, random, abundant slickensides.
2192.6-2194.0' (1.4')	Shale: brown, micaceous, flaky, pyrite inclusions, highly fractured, random, slickensides.
2194.0-2196.0' (2.0')	Shale: dark gray-brown, micaceous, pyrite inclusions, appears to be fossil replacement, trace fish fragments at 2196', highly fractured, slickensides.
2196.0-2200.0' (4.0')	Shale: dark gray, pyrite inclusions, brecciated, highly fractured, slickensides questionable bedding plane at 75°.
2200.0-2209.0' (9.0')	Shale: dark brown-gray, micromicaceous, occasional round floating quartz and chert grains, fine to very coarse, pyrite inclusions, carbonaceous, very slightly silty, brecciated, slickensides, Gastropod at 2204-2205'.
2209.0-2210.0' (1.0')	Shale: dark brown-gray, slightly silty, slightly micromicaceous, rare brown nodules, slightly calcareous, siderite(?), pyrite inclusions, highly fractured and brecciated.
2210.0-2213.0' (3.0')	Shale: dark gray, slightly brown, scattered pyrite inclusions, highly brecciated, abundant slickensides.
2213.0-2214.0' (1.0')	Shale: dark gray, slightly brown, scattered floating quartz grains, pyrite inclusions, highly shattered and pulverized.

	2214.0-2215.0' (1.0')	Shale: very dark brown-gray, pyrite inclusions, becomes sandy, rounded grains, rounded chert granules and pebbles, highly polished, to 3/4", highly shattered and pulverized, fault gouge?
	2215.0-2215.8' (0.8')	Sand: loose sand, shale and pebbles, sand, subrounded, scattered black round chert pebbles, highly polished, large quartzite pebbles, gray, 1-1/2".
	2215.8-2216.0' (0.2')	Conglomerate: 3" chip, first chip out of core barrel. Sand, shale and dark chert pebbles, conglomeratic, very poorly sorted, sand granules very fine to very coarse, rounded to subrounded, dark shale matrix, chert pebbles rounded, polished, up to 15 mm (shale 40%, sand 30%, chert pebbles 30%). One white earthy inclusion, calcarous, possible caliche, pyritic inclusion.
	2216.0-2219.0' (3.0')	No recovery.
2219-2270	Sandstone: light gray, "salt and pepper", conglomeratic, subangular to subrounded, rounded pebbles, light and dark chert pebbles, slight stain and cut, 80 units of gas, fair porosity, with Shale: gray-brown and dark gray, micaceous, carbonaceous with sandstone and siltstone laminae, slight staining in the sandstone laminae.	
2270-2288	Sandstone: light gray, very fine grained to fine grained, slightly conglomeratic, slight staining, with Shale: as above.	
2288-2318	<u>Core No. 3: Cut 30'; Recovered 30'</u>	
	2288.0-2288.4' (0.4')	Shale: gray-brown, very slightly silty, micaceous, flaky in part, pyrite inclusions, fossil replacement?.
	2288.4-2288.8' (0.4')	Shale: gray-brown, micaceous, becoming sandy, 20%, sandstone inclusions.
	2288.8-2289.4' (0.6')	Siltstone: gray-brown, micaceous, shaly, slightly sandy, rare glauconite, pyrite inclusions, spotty light yellow fluorescence, very light yellow cut, becoming sandy, sandstone inclusions and glauconitic streaks last 0.3'.

2289.4-2291.5' (2.1')	Sandstone: light brown to light gray, very fine grained, subangular, medium sorted, silty, clayey, very glauconitic (30%), slightly pyritic, with shaly siltstone laminations, estimated porosity 3%, dull yellow spotty fluorescence, bright yellow cut.
2291.5-2293.5' (2.0')	Siltstone: brown-gray, micaceous, shaly, slightly glauconitic, sandstone partings and inclusions, spotty yellow fluorescence, slight cut in sandy portions.
2293.5-2294.0' (0.5')	Sandstone: brown-gray, very fine grained, subangular, silty, shaly, very glauconitic (20%), thin shale and siltstone banding, spotted yellow fluorescence, light yellow cut.
2294.0-2296.0' (2.0')	Siltstone: gray-brown, shaly, micaceous, glauconitic, pyritic inclusions, shale partings, sandstone inclusions, light brown, very glauconitic, medium yellow fluorescence, slight cut; 2195.2-2195.5', sandstone, very fine grained, subangular, medium sorted, very glauconitic, spotty bright yellow fluorescence and cut.
2296.0-2297.5' (1.5')	Sandstone: brown-gray, very fine grained, subangular to subrounded, medium sorted, glauconitic (15%), silty, shaly, micaceous, tight, spotty bright yellow fluorescence, light yellow cut, brown shale and siltstone laminations.
2297.5-2300.5' (3.0')	Sandstone: light brown-gray, very fine grained, subangular to subrounded, silty, argillaceous, slightly calcareous, tight, dull yellow to bright yellow fluorescence, banded, light yellow cut, estimated porosity 3%.
2300.5-2301.5' (1.0')	Siltstone: interlaminated, light brown-gray, shaly, light yellow fluorescence and cut, and Shale: gray-brown, micaceous, silty.
2301.5-2301.8' (0.3')	Sandstone: light gray, very fine grained, subangular to subrounded, medium sorted, glauconitic, silty,

	argillaceous, brown silty shale bands, yellow fluorescence, yellow cut, estimated porosity 3%.
2301.8-2303.0' (1.2')	Siltstone: gray-brown, micaceous, shaly, sandy inclusions (15%).
2303.0-2304.0' (1.0')	Sandstone: very fine grained, brown-gray, subangular, silty, shaly, tight, banded yellow fluorescence, yellow cut.
2304.0-2304.5' (0.5')	Sandstone: light gray, slightly brown, very fine to fine grained, subrounded to subangular, medium sorted, argillaceous, slightly silty, glauconitic (15%), trace mica, bright yellow fluorescence, bright yellow cut, estimated porosity 5%.
2304.5-2309.0' (4.5')	Sandstone: light gray to gray-brown, very fine grained, subangular, medium sorted, argillaceous, slightly calcareous, shale and siltstone bands, glauconite (20-30%), tight to porous, zones with estimated 15% porosity, average 7-8%.
2309.0-2310.5' (1.5')	Sandstone: brown-gray, very fine grained, subangular, medium sorted, very silty and shaly bands, tight, spotty yellow fluorescence, light yellow cut.
2310.5-2311.3' (0.8')	Siltstone: brown-gray, shaly, sandy streaks, sandstone laminations (30%), bright yellow fluorescence in sandstone, light yellow cut.
2311.3-2313.0' (1.7')	Sandstone: light brown, very fine grained, subangular, medium sorted, silty, shale bands, glauconitic, bright yellow fluorescence and cut.
2313.0-2314.0' (1.0')	Sandstone: light gray-brown, very fine grained, subangular, silty, argillaceous, glauconitic, siltstone and shale bands, bright yellow fluorescence, bright yellow cut, average porosity 3%, zones with 10% (estimated).

	2314.0-2316.0' (2.0')	Siltstone: gray-brown, sandy (25%), argillaceous, slightly carbonaceous, glauconitic, light yellow banded fluorescence, light yellow cut.
	2316.0-2318.0' (2.0')	Sandstone: light gray, slightly brown, very fine to fine grained, argillaceous, silty, glauconitic (30%), shale bands, partly hard and calcareous (2317-2318'), highly shattered, 5-10% porosity, bright yellow fluorescence and cut, petroleum odor.
		Fractures: 2288.0-2288.5' - 70° fairly tight 2289.0-2289.6' - 90° closed 2291.6-2292.3' - 90° & 65° fairly tight 2293.5-2295.5' - 80°-90° fairly tight 2296.5-2299.5' - 80°-90° tight 2300.8-2301.5' - 45°-90° tight 2304.0-2316.0' - 90°, random tight 2316.0-2318.0' - highly fractured and shattered.
2318-2348	Core No. 4 - Cut 30', Recovered 30'	
	2318.0-2319.0' (1.0')	Sandstone: light gray, very fine grained, subrounded, clayey, slightly silty, glauconitic, bright yellow fluorescence, good bright yellow cut, fair to good odor, very badly broken 2318-2318.75', shale partings and inclusions at 2319'.
	2319.0-2320.0' (1.0')	Sandstone: as above, becomes fine grained, soft, slight odor, bright yellow fluorescence and cut.
	2320.0-2321.5' (1.5')	Sandstone: light gray, very fine grained, shaly streaks, subrounded, clayey, glauconitic, slightly carbonaceous, slight odor, bright yellow fluoresence and cut, vertical fracture, 2321-2321.5' badly broken.
	2321.5-2322.0' (0.5')	Sandstone: light gray, very fine grained, subrounded, medium sorted, glauconitic, estimated porosity 20%, very good fluorescence and cut, bright yellow, vertical fractures, core breaks on horizontal plane.

2322.0-2324.75' (2.75')	Siltstone: gray-brown, very shaly, slightly sandy, glauconitic, slightly micaceous, shale inclusions and partings, random fractures, free hydrocarbon on fracture at 2323', 45°-90° fracture, pyrite inclusions and fossil replacement.
2324.75-2325.0' (0.25')	Shale: gray-brown, slightly micaceous, bedding planes horizontal.
2325.0-2326.1' (1.1')	Sandstone: light gray, very fine grained, subangular, clayey, glauconitic, silty, dull yellow gold fluorescence, light yellow cut, soft, friable, 15% porosity (estimated).
2326.1-2326.5' (0.4')	Siltstone: light brown, shaly, hard, sandy, calcareous, massive, hairline fracture.
2326.5-2326.8' (0.3')	Mudstone: light brown, very silty, slightly sandy, very slightly calcareous, rare glauconite.
2326.8-2327.2' (0.4')	Siltstone: light gray, very hard, very calcareous, argillaceous, slightly glauconitic, hairline fracture, one large fracture with calcite coating.
2327.2-2328.0' (0.8')	Sandstone: light gray, very fine grained, silty, clayey, subangular, slightly glauconitic, moderately hard.
2328.0-2330.5' (2.5')	Sandstone: light gray, very fine grained, subangular, medium sorted, glauconitic, carbonaceous flakes, friable, estimated 15% porosity, light yellow fluorescence and cut, highly fractured and shattered.
2330.5-2331.0' (0.5')	Siltstone: light to medium brown, shaly, slightly sandy, slightly banded, spotted fluorescence, slight cut, 45° fracture.
2331.0-2332.0' (1.0')	Shale: gray-brown, very silty, micaceous, slightly pyritic, slightly glauconitic, horizontal and 45° fractures.

2332.0-2333.0' (1.0')	Siltstone: gray-brown, shaly, sandy, slightly micaceous and glauconitic, 45°-90° fracture, spotted dull gold fluorescence, slightly dull yellow cut.
2333.0-2333.5' (0.5')	Sandstone: light gray, very fine grained, subangular, medium sorted, glauconitic, clayey, soft, estimated 12% porosity, slight stain, no odor, very dull yellow fluorescence, very slight cut.
2333.5-2336.5' (3.0')	Sandstone: very fine grained, subangular, silty, clayey, light gray, shaly streak, very soft, 5-10% porosity (estimated), very dull yellow fluorescence, very slight cut, chips appear to be pulverized.
2336.5-2337.5' (1.0')	Siltstone: gray-brown, shale and sandstone bands, micaceous, rare glauconite, light yellow fluorescence, slight cut, highly shattered, blocky.
2337.5-2339.5' (2.0')	Sandstone: light brown-gray, very fine grained, subangular, medium sorted, clayey, silty, soft, shale bands, dull yellow fluorescence and cut, highly shattered and brecciated.
2339.5-2342.0' (2.5')	Sandstone: light brown, very fine to fine grained, subangular, medium sorted, glauconitic, shaly, soft, slightly silty, glauconitic, shale partings, very dull fluorescence and cut.
2342.0-2344.0' (2.0')	Sandstone: brown, very fine grained, subangular, medium sorted, shaly, very glauconitic, very slight fluorescence and cut, vertical fracture.
2344.0-2345.0' (1.0')	Sandstone: as above, becoming more shaly.
2345.0-2347.5' (2.5')	Sandstone: light to medium brown, very fine grained, subangular, medium sorting, glauconitic, argillaceous, silty, shaly bands, Foraminifera, shell fragments, Fe-st inclusions below 46, glauconite pellets, brown, hard, spicules common, calcareous, weathered.

	2347.5-2348.0' (0.5')	Sandstone: brown, very fine grained, subangular, tight, glauconitic, siderite inclusions, good odor when struck, spotted stain and fluorescence, bright yellow, slight cut, shattered.
2348-2370		Shale: dark gray, pyritic, micaceous, rounded quartz grains, with Siltstone: gray, glauconitic, occasional chert granules.
2370-2410		Sandstone: light gray, very fine grained, subangular, medium sorting, pyritic, siderite and calcite streaks, poor to fair porosity, shale partings and laminations.
2410-2425	Core No. 5: Cut 15'; Recovered 15'	
	2410.0-2412.5' (2.5')	Sandstone: light gray, fine grained, subangular, soft, very clayey with brown sandy shale laminations (40%), very slight odor, no show.
	2412.5-2414.5' (2.0')	Shale: gray-brown, silty, sandy (20%), a few sandstone partings, micaceous, pyrite inclusions and fossil replacement.
	2414.5-2415.3' (0.8')	Siltstone: brown, very shaly, sandy, very slightly calcareous, hard, rare pyrite inclusions and shale laminations.
	2415.3-2417.2' (1.9')	Sandstone: brown-gray, fine grained, subangular, rare glauconite, slightly silty, very shaly (40%), breaks at 45° angle, shale laminations.
	2417.2-2417.5' (0.3')	Sandstone: light gray, very shaly, pyrite fossil replacement and inclusions, abundant fossils, Monotis sp.(?), almost a coquina.
	2417.5-2419.0' (1.5')	Sandstone: light gray, fine grained, subrounded, quartzitic, clayey, shaly, shale laminations, pyritic, tight, fossiliferous, Monotis sp.? No show.
	2419.0-2422.75' (3.75')	Sandstone: light gray to brown, fine grained, subrounded, shaly, rare glauconite, banded, shale laminations (40%), slight odor, no show.

2422.75-2423.0' (0.25')	Sandstone: light gray, very fine grained, subangular to subrounded, medium sorted, very calcareous to limy, very hard, dense, with sandstone inclusions, cobble size, round, hard, brown.
2423.0-2425.0' (2.0')	Sandstone: brown, very fine to fine grained, very hard, dense, slightly calcareous, sideritic, shaly, possibly siliceous, shattered, calcite filling on large fracture faces with free hydrocarbons, good odor.

2425-2450 Sandstone: light brown, slightly conglomeratic with quartz, chert and argillaceous granules and pebbles, pyritic, coal chips, siderite streaks, trace of free calcite.

2450-2460 Siltstone: light tan and light gray, sideritic, sandy, pyritic.

2460-2470 Sandstone: light brown, very fine to fine grained, subrounded, sideritic, pyritic, poor porosity, trace of coal.

2470-2500 Claystone: very dark gray to black, very soft, pyritic, scattered coal chips, probably weathered zone of argillite; becoming siliceous, micas appear to be slightly oriented.

2500-2522 Argillite: black, very poor grade metamorphics, becoming moderately hard, occasional shiny surface, oriented micas, pyritic, clear quartz fracture filling.

2522-2534 Core No. 6 - Cut 12', Recovered 3'

2522.0-2525.0' (3.0')	Argillite: black, carbonaceous, moderately hard, slight sheen on foliate planes, pyrite inclusions, foliation appears vertical, bedding planes horizontal, pyrite inclusions and banding, hairline quartz veins, cut across foliation, rare calcite crystals with iron coating, crystalline quartz fill on some fracture planes.
2525.0-2534.0' (9.0')	No recovery.

Total Depth: 2,534 feet.

LOG ANALYSIS - SOUTH BARROW WELL NO. 13
by: Armour Kane

So. Barrow #13 , Run #1

	DEPTH ON RUN #2	R_T	ϕ_D	ϕ_N	S_w (R_w=.37)	S_w (R_w=.28)	GR	V_{SH}
1	1955 (53)	18	19	22	47	59	65	41
2	2012 (09)	20	15	33	-	-	-	-
3	2018 (15)	25	18	24	60	53	58	30
4	2145 (40)	14	15	22	97	84	63	37
5	2184 (78)	18	13	24	99	86	74	50
6	2232 (24)	18	12	21	100	100	50	16
7	2234 (29)	21	15	18	79	69	40	0
8	2236 (31)	22	22	19	53	46	42	03
9	2238 (33)	20	21	19	58	50	60	33
10	2322 (16)	16	13	23	100	100	70	50
11	2324 (18)	17	15	21	88	77	50	16
12	2326 (20)	18	15	21	86	74	55	25
13	2328 (22)	19	15	23	83	72	52	20
14	2330 (24)	20	17	23	72	62	60	33
15	2336 (30)	20	19	21.5	64	56	50	16
16	2342 (36)	20	18	21	68	59	48	13
17	2346 (40)	20	18	22	68	59	57	30
18	2348 (42)	18	19.5	21	66	57	51	30
19	2350 (44)	17	16	22	82	72	55	25
20	2352 (46)	18	19	22	67	59	52	20
21	2363 (57)	19	16	22	78	68	53	21
22	2364 (58)	20	17	18.5	72	62	55	25
23	2366 (60)	21	18	19	66	57		
24	2368 (62)	21	17	18	70	61		
25	2370 (64)	21	15	19	79	69		
26	2374 (68)	20	18	19	68	59	57	30
27	2379 (73)	18	17	19	75	66	50	16
28	2392 (86)	18	15	20	86	74	55	25
29								
30		Av.	16.6 %					
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

LOG ANALYSIS - SOUTH BARROW WELL NO. 13
by: Armour Kane

E-LOG ANALYSIS

BASED ON 1150% WATER RECOVERED FROM S. BARROW 2 & 4. R_w = .37 @ ASSUMED BHT = 60
GRUY APPARENTLY USED R_w = .27 ON COMPUTED LOG - WE GET R_w = .28 @ 2226 AND 2316

So. BARROW #13 RUN #2

		R_T	ϕ_D	ϕ_N	S_w (R_w=.37)	S_w (R_w=.28)	GR	V_{sh}
1	1952	18	19	22	67	59	61	35
2	2009	20	15	24	–	–	–	–
3	2015	24	18	24	62	54	58	30
4	2140	14	15	22	97	84	61	35
5	2178	18	14	29	92	80	75	58
6	2226	18	12	24	107	100	50	16
7	2228	21	15	18	79	69	42	03
8	2230	22	20	20	58	50	45	08
9	2232	22	22	22	53	46	60	33
10	2316	16	13	23	105	92	50	16
11	2318	18	15	22	86	74	50	16
12	2320	18	17	22	76	66	50	16
13	2322	19	16	23	78	68	55	25
14	2324	20	17	23	72	62	60	33
15	2336	20	17.5	21.5	68	59	45	08
16	2340	20	18	22	68	59	57	28
17	2342	18	19	22	67	59	57	28
18	2344	18	15	22	86	74	60	33
19	2346	18	16.5	22	78	68	55	25
20	2358	20	15	18	81	70	55	25
21	2360	20	16	18	76	66	60	33
22	2362	20	15	19	81	70		
23	2364	21	12	20	99	86		
24	2367	20	14	21	87	76	42	03
25	2370	20	14	19	87	76	45	08
26	2385	19	16	20	78	68	50	16
27								
28			Av. 15%					
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company HUSKY OIL — Formation — Page 1-A of 2
Well SOUTH BARROW #13 — Cores DC — File BP-3-420
Field SOUTH BARROW — Drilling Fluid WBM — Date Report 1/14/77
County ARCTIC SLOPE State ALASKA — Elevation — Analysts WSP, RP
Location — Remarks BOYLES POROSITY

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS			POROSITY PERCENT	GRAIN DENSITY	RESIDUAL SATURATION		REMARKS
		Horizontal Maximum	Horizontal 90°	Vertical			Oil % Pore	Total Water % Pore	
1	2289	0.02		0.02	4.2	2.81	3.7	72.6	ss,vfg,v [illegible]
2	2290	0.07		0.02	8.0	2.60	5.8	61.5	ss,vfg,v shly,slty
3	2291	0.04		0.02	7.4	2.61	1.0	73.6	ss,vfg,v shly,slty
4	2292	0.11		0.0	6.0	2.62	7.3	64.7	ss,vfg,v shly,slty
5	2293	0.04		0.0	6.5	2.62	5.4	64.5	ss,vfg,v shly,slty
6	2294	0.02		0.0	5.6	2.61	6.8	67.9	sh,sdy,slty
7	2295	0.02		0.0	7.7	2.61	5.4	68.8	ss,vfg,v shly,slty
8	2296	0.0		0.02	7.7	2.62	8.0	60.1	ss,vfg,v shly,slty
9	2297	0.02		0.02	7.3	2.62	7.1	71.2	ss,vfg,v shly,slty
10	2298	1.5		0.4	13.4	2.62	4.5	68.4	ss,vfg,shly,slty
11	2299	0.07		0.04	7.6	2.64	3.9	71.3	ss,vfg,v shly,slty
12	2300	0.8		6.8	12.5	2.62	4.2	63.2	ss,vfg,shly,slty
13	2301	0.02		0.2	7.1	2.62	6.4	69.8	ss,vfg,v shly,slty
14	2302	7.5		0.02	9.1	2.61	9.1	70.6	ss,vfg,v shly,slty
15	2303	0.1		0.04	8.8	2.62	7.6	65.6	ss,vfg,v shly,slty
16	2304	1.0		0.1	10.1	2.61	6.0	73.8	ss,vfg,shly,slty
17	2305	0.2		11	8.3	2.62	6.1	68.2	ss,vfg,v shly,slty
18	2306	8.9		2.1	12.9	2.62	5.6	64.4	ss,vfg,shly,slty
19	2307	29			11.9	2.61	5.8	62.2	ss,vfg,shly,slty
20	2308	11		0.8	11.3	2.62	5.7	63.5	ss,vfg,shly,slty
21	2309	0.4		0.4	11.4	2.63	7.2	67.0	ss,vfg,v shly,slty,
22	2310	0.1		0.3	10.3	2.61	4.6	62.8	same as above
23	2311	0.1		*10	9.5	2.62	6.2	63.4	same as above *SF
24	2312	0.02		0.6	8.1	2.63	7.1	62.5	same as above
25	2313	1.2		0.4	11.8	2.61	7.7	64.0	ss,vfg,shly,slty,
26	2314	1.3		0.02	11.2	2.62	9.4	61.2	same as above

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company HUSKY OIL — Formation — Page 2-A of 2
Well SOUTH BARROW #13 — Cores DC — File BP-3-420
Field SOUTH BARROW — Drilling Fluid WBM — Date Report 1/14/77
County ARCTIC SLOPE State ALASKA — Elevation — Analysts WSP, WL
Location — Remarks BOYLES POROSITY

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS			POROSITY PERCENT	GRAIN DENSITY	RESIDUAL SATURATION		REMARKS
		Horizontal Maximum	Horizontal 90°	Vertical			Oil % Pore	Total Water % Pore	
27	2315	24		0.1	11.1	2.62	6.6	53.7	ss,vfg,shly,slty,cly
28	2316	3.9		0.1	12.8	2.62	6.7	63.6	same as above
29	2318	114		51	14.8	2.62	8.0	65.2	ss,vfg,sl shly,slty, cly
30	2319	1.9		55	13.2	2.62	8.8	65.2	same as above
31	2320	10		0.2	14.4	2.61	10.6	57.6	same as above
32	2321	4.0		2.5	14.3	2.61	8.7	42.7	same as above
33	2324	0.1		1.3	7.0	2.65	3.7	52.4	ss,vfg,v shly,slty,
34	2325	35		3.6	19.6	2.64	7.8	53.6	ss,vfg,sl shly,slty
35	2326	1.6			13.1	2.95	12.9	66.7	ss,vfg,sid
36	2327	17		21	17.6	2.64	7.8	44.2	ss,vfg,sl shly,slty, cly
37	2328	14		16	15.9	2.65	8.1	47.5	same as above
38	2329	1.2		27	12.5	2.64	7.4	59.4	same as above
39	2334	1.0			16.2	2.63	3.8	66.1	same as above
40	2335	3.7			16.6	2.66	5.8	65.4	same as above
41	2336	0.7			9.9	2.63	5.0	57.9	ss,vfg,v shly,slty,
42	2337	3.6			13.9	2.63	4.7	68.9	ss,vfg,sl shly,slty cly
43	2338	22			16.7	2.63	6.1	62.9	same as above
44	2339	17			16.1	2.66	5.1	54.3	same as above
45	2340	15			12.8	2.62	3.3	63.7	same as above
46	2341	9.6			17.8	2.63	4.5	67.8	same as above
47	2342	52			16.5	2.63	4.8	61.6	same as above
48	2343	5.0			16.1	2.69	4.9	56.5	same as above
49	2344	0.2		0.2	9.9	2.62	4.7	54.1	same as above
50	2345	0.9		0.02	15.2	2.62	6.1	68.0	same as above
51	2346	0.2		0.1	8.4	2.64	5.0	63.4	same as above
52	2347	0.04		7.9	7.9	3.14	6.0	57.3	same as above

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.
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ANALYTICAL REPORT

From Husky Oil Company Product Core Samples
Address Anchorage, Alaska Date January 13, 1977
Other Pertinent Data

Analyzed by Ag Date January 19, 1977 Lab No. 5292

REPORT OF ANALYSIS
CLAY SWELLING SUSCEPTIBILITY
SOUTH BARROW NO. 13
NORTH SLOPE, ALASKA

Core samples from 2318-44 feet.

PROCEDURE:

Due to the low air permeability on all samples that did not contain fractured "K", all samples were pulverized and made into a homogeneous composite.

A 50 gram sample was placed in a cell and the permeability measured immediately after saturation of the sample with test fluid. Additional permeability measurements were made 15 minutes after saturation and results expressed in % flow reduction.

RESULTS:

FLUID	% FLOW REDUCTION
City of Anchorage Water(80 mg/l TDS)	82
Calcium Chloride- 1000 mg/l	46
Calcium Chloride- 5000 mg/l	40
Calcium Chloride- 10000 mg/l	33
Calcium Chloride- 20000 mg/l	29
Calcium Chloride-100000 mg/l	22
Sodium Chloride - 1000 mg/l	50
Sodium Chloride - 5000 mg/l	42
Sodium Chloride - 10000 mg/l	29
Sodium Chloride - 20000 mg/l	28
Sodium Chloride -100000 mg/l	21
Potassium Chloride- 10000 mg/l	30
Potassium Chloride- 20000 mg/l	29
Potassium Chloride-100000 mg/l	22

REMARKS & CONCLUSIONS:

Additional testing was performed utilizing Halliburton 15% HCl plus inhibitor and surfactant. After saturation with fresh water, 3 samples showed no improvement with Halliburton fluid.

Analysis on pulverized samples using Baroid diesel base mud showed very little invasion after subjected to 3 1/2 hours of testing.

Conclusions of the above analysis indicate that the formation tested contains a "clay" material that is very susceptible to fresh water. Fluids with a concentration of 20000 mg/l and higher have the least detrimental effect on these "clays". After the swelling has been completed it appears to be irreversible. All tests indicate drilling with a diesel based mud should prevent any additional damage caused by these swelling "clays".