NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

IKPIKPUK TEST WELL NO. 1

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: R. G. Brockway

For the

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

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INTRODUCTION

The Ikpikpuk Test Well No. 1 is located in the NW 1/4, protracted Section 25, T13N, R10W, Umiat Meridian, Alaska, on the National Petroleum Reserve in Alaska. The wellsite is approximately 10 miles southwest of Teshekpuk Lake and 80 miles southeast of Barrow, Alaska (see Figures 1 and 2). Drilling began on November 28, 1978, and was completed on February 13, 1980 of the second season of drilling, at a total depth of 15,481 feet. The well was suspended on April 17, 1979 for the summer, with well operations again resuming on December 25, 1979; actual drilling began on January 7, 1980. The rig was released on February 28, 1980. A suite of geologic formations was drilled which began with the Late Cretaceous Nanushuk Group and ended with the Mississippian Endicott Group (Kekiktuk Formation).

Hydrocarbon shows were minor and predominantly limited to the Lower Cretaceous sandstones. Two of these zones (7446-7472' and 6877-6923') were tested, with each recovering some gas too small to measure (see Appendix E).

The well bottomed in metamorphosed sediments thought to be quartzite of the Kekiktuk Formation. Dr. H. E. Enlows, Oregon State University, has described core chips from this zone as a metasediment consisting of quartz clasts in a matrix of Wilkeite (see Appendix I).

Sixteen conventional cores were cut, 99 sidewall cores were shot (55 recovered) and two drill-stem tests were performed on the Ikpikpuk Test Well No. 1.

PRE-DRILLING PROGNOSIS

The Ikpikpuk Test Well No. 1 was programmed to test a seismically interpreted structural/fault closure (Figure 3) and to provide stratigraphic information for the deeper portion of the Ikpikpuk basin. This closure was thought to extend from the Triassic through Pre-Devonian strata.

Objectives to be drilled in this well were the Cretaceous, Jurassic, Permian-Triassic, Permian and Mississippian sandstones and the Permian-Mississippian Lisburne Group limestones.

Of the Cretaceous sandstones, the Nanushuk Group was expected to have approximately 500 feet and the Torok Formation a few isolated beds with reservoir potential. Any trapping mechanism would be stratigraphic in nature. An estimated 20 feet of sandstone of Jurassic age, which is present in the Topagoruk No. 1 and South Simpson No. 1, was the next probable reservoir strata.

The Ivishak Formation of Permian-Triassic age was expected to have 110 feet of sandstones, however, the porosities would probably be low. The Lisburne Group was thought to contain 1,200 to 1,800 feet of limestone and some dolomite with interbedded shale and possibly some sandstone.

Approximately 150 to 250 feet of reservoir strata, with porosities up to 11%, could be present.

A possible 100 feet of porous sands, within the approximate 1,500 feet of Endicott Group, were expected.

Hydrocarbons that could be present, based on maturation studies and previous geochemical analysis in the area, were oil and gas from the Cretaceous sandstones and Lisburne limestones and gas from the Jurassic sandstone, Ivishak Formation and Endicott Group.

POST-DRILLING SUMMARY

The Ikpikpuk Test Well No. 1 was drilled to a total depth of 15,481 feet through a suite of formations that began with the Upper Cretaceous Nanushuk Group and ended in the Mississippian Endicott Group (Kekiktuk Formation).

Hydrocarbon shows in the Nanushuk Group were limited to very minor methane gas kicks (maximum 125 units) which appear to be associated with thin coal beds.

It was not until the lower Torok sandstones below 6,800 feet that any appreciable shows were encountered. At 6,925 feet (mud log), a gas show of 1,210 units was recorded from a sandstone-shale unit (6872-6922') that had a good gassy odor and bright yellow fluorescence. A drill-stem test was undertaken, after completion of drilling, through perforations 6877-6923' which recovered gas too small to measure (see Drill-Stem Test No. 2, Appendix E). Electrical log computations through the interval 6876-6922' indicated 11.5% porosity and a 100% water saturation. The shows in this sandstone unit were the best encountered in Ikpikpuk Test Well No. 1.

The first definite discernible top, which was the "Pebble Shale", was encountered at 7,237 feet, which was 137 feet lower than prognosed.

A sandstone, originally thought to be Jurassic in age, was encountered at 7,436 feet. This 42 foot sandstone has now been dated as Lower Cretaceous in age through biostratigraphic data by Anderson, Warren & Associates, Inc.

This Late Cretaceous (Neocomian) age has been extended through the sediments below the sandstone to a depth of 8,100 feet (see Appendix J). The interval 7436-8125' has been called the Kuparuk Formation in this report with the sandstone known as the Kuparuk sand or "Pebble Shale" sand by some. A small gas reading (125 units) and a very slow cut were recorded from the Kuparuk sand. Electric log analysis showed the sandstone to have 13% porosity with a 90% water saturation (Appendix D). Even though a high water saturation was calculated, a drill-stem test (No. 1) was performed through perforations over the interval 7446-7472'. Recovery from the test was gas too small to measure plus 1,338 feet of slightly gas-cut rat-hole mud (Appendix E).

Hydrocarbon shows through the Jurassic and Triassic age sediments were nil to very minimal and not considered worth testing.

The top of the Sadlerochit Group, which was predicted seismically at 9,330 feet, was encountered at 10,542 feet. No hydrocarbon shows were observed. Porosities appeared to be fair in the Ivishak Formation, as exhibited by Cores No. 8 (10,619-10,649') and No. 9 (10,815-10,842') with a maximum of 19.4%, but permeability was generally less than 1.0 millidarcy (Appendix H).

At the top of the Lisburne Group, encountered at 11,446 feet, is a 227 foot transition zone very similar to that found in the No. 1 Inigok, NW 1/4, protracted Section 34, T8N, R5W, U.M. The massive limestones begin at 11,673 feet. Three units comprise the massive limestone section of the Lisburne Group: an "Upper Limy Unit", a Dolomite Unit, and a "Lower Limy Unit". Of the three units, only the Dolomite Unit had any porosity above 3% and that reached a maximum of 6% (13,784-13,788') from electrical log computations. A dull yellow fluorescence and slow yellow cut fluorescence was reported from 13,785-13,890'. All other samples were barren of shows.

At 14,840 feet, a zone of red siltstones, sandstones and shales was penetrated. This has been called the top of the Endicott Group and these red beds, which extend downward to 15,305 feet, may be the Itkilyariak Formation equivalent. Below 15,305 feet are sediments believed to be the Kekiktuk Formation. These sediments have been identified as a metamorphosed quartz breccia. Dr. H. E. Enlows, Oregon State University, has called samples from a core at 15,421 feet as being metasediments having a cataclastic texture. They consist of quartz clasts in a Wilkeite groundmass (Appendix I). The well bottomed in this type rock.

After evaluation of all available information, it was deemed that this hole was dry and it was plugged and abandoned.

If the structural/fault closure does exist in this well, then it appears that any trapped hydrocarbons, if there ever were any, have either migrated or been flushed out. It is uncertain if the closure exists. The predicted top of the Lisburne Group and the actual top were only 14 feet apart, but a predicted top of 15,020 feet for the Pre-Devonian Argillite was probably from the reflections from the red sandstones of the Endicott Group topped at 14,840 feet. It appears that the Argillite was not penetrated in this well.

Possibly by moving updip in a northerly direction, some type of stratigraphic traps could be encountered which might contain hydrocarbons although a correlation with the No. 1 E. Teshekpuk, which is approximately 600 feet higher on the top of the Sadlerochit Group, indicates otherwise. Only slight shows of gas were recorded in the No. 1 E. Teshekpuk, which is some 36 miles northeast of the Ikpikpuk Test Well No. 1.

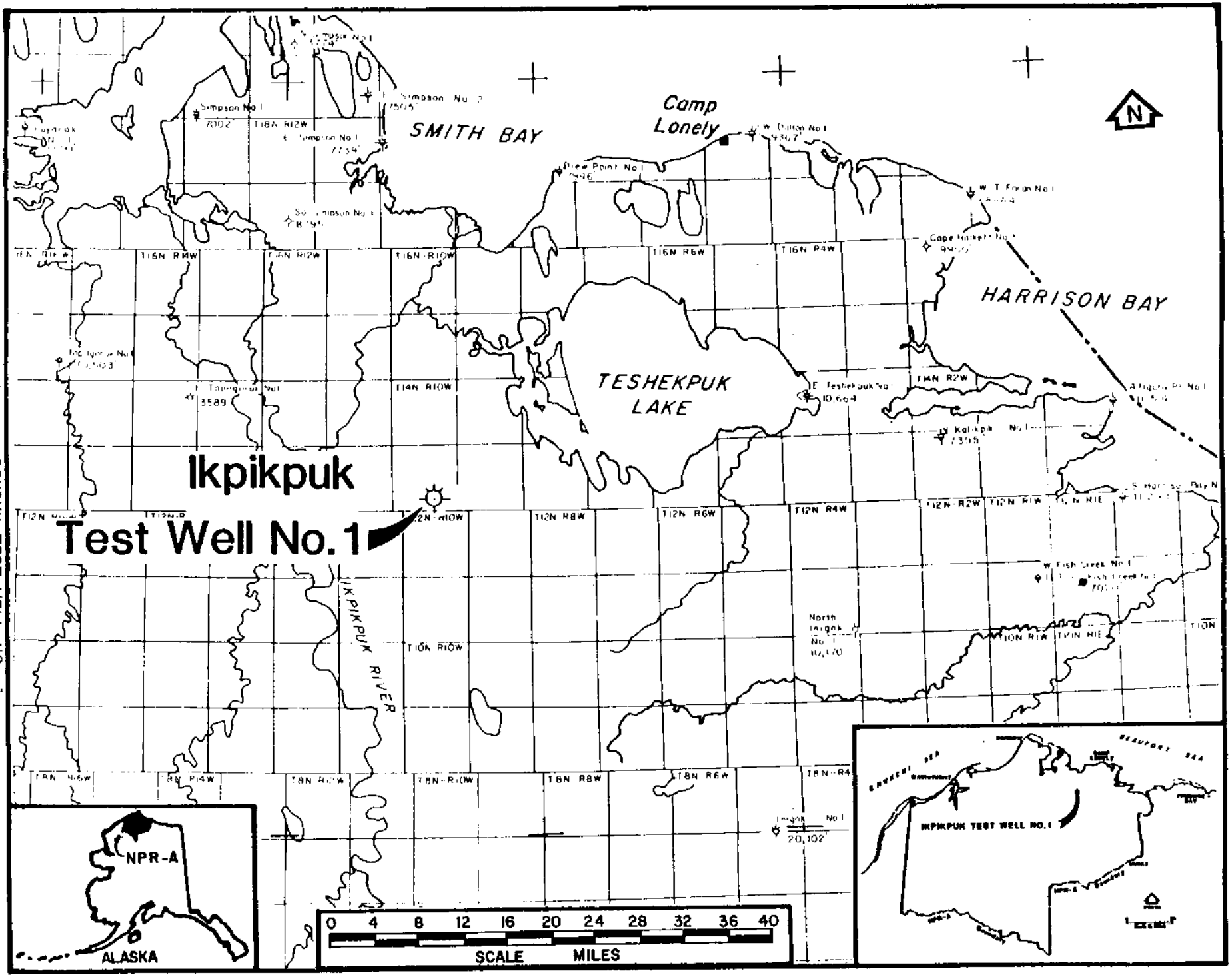
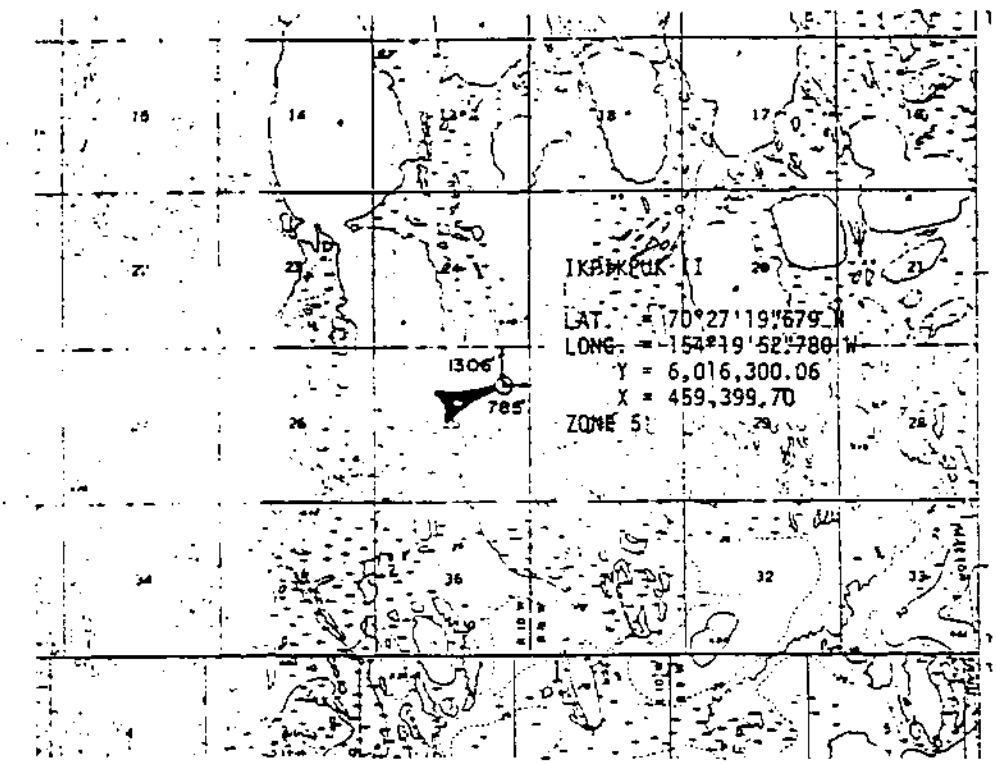


FIGURE 1 - LOCATION MAP - IKPIKPUK TEST WELL NO. 1



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.

August 17, 1977

0 1/2 1 2
SCALE IN MILES

AS STAKED
IKPIKPUK I
LOCATED IN
NE1/4 PROTRACTED SEC. 25 T13 N, R10 W, UMIAT MERIDIAN, AK

Surveyed for
HUSKY OIL
N.P.R. OPERATIONS INC.

Surveyed by
Bell, Herring and Associates
ENGINEERS AND LAND SURVEYORS
801 West Fireweed, Suite 102
ANCHORAGE, ALASKA 99503

FIGURE 2
Surveyor's Plat
Ikpikpuk Test Well No. 1

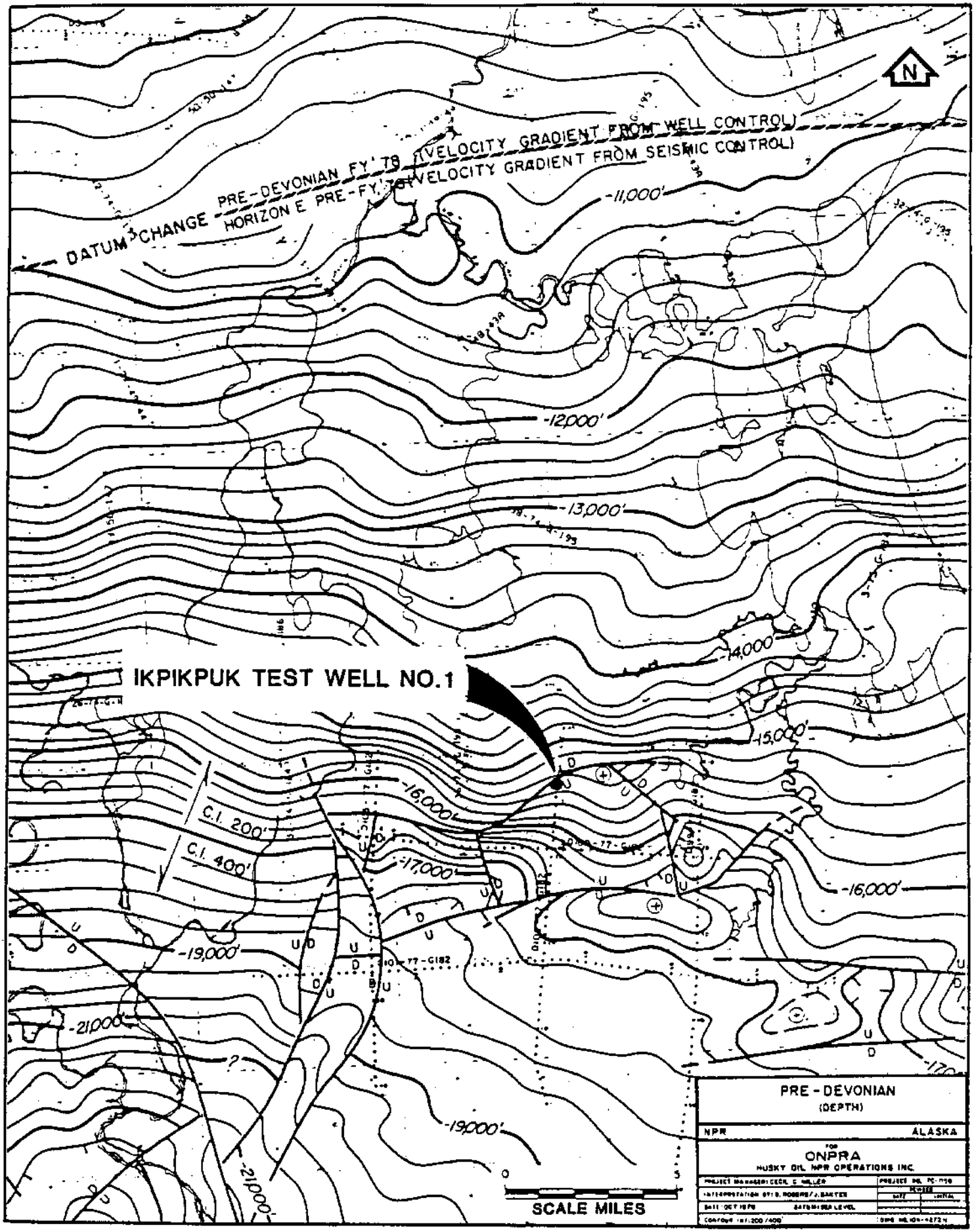


FIGURE 3 - STRUCTURE, TOP OF PRE-DEVONIAN - IKPIKPUK TEST WELL NO. 1

WELLSITE GEOLOGIST'S REPORT
BY
RICHARD V. NELSON

SUMMARY

The Ikpikpuk Test Well No. 1 was drilled over the course of two drilling seasons, 1978-1979 and 1979-1980. It spudded November 28, 1978, and was suspended for the summer on April 17, 1979, after setting a liner to a depth of 14,208 feet. The section at that point had been drilled into the "Lower Limy Unit" of the Lisburne. Drilling resumed January 7, 1980. The well penetrated an additional 630 feet of the Lisburne before entering the Endicott Group and reached a total depth of 15,481 feet in metasediments.

This well was programmed as a deep test of a basement fault closure (Figure 3) and to gain stratigraphic data for the Ikpikpuk Basin. Reservoir quality formations were expected in the Nanushuk Group, Simpson sand (within the Kingak Formation) and possibly the Ivishak Formation. No structural traps were postulated in these horizons. The Lisburne and Endicott sections might also contain reservoir quality units involved with the faulted closure.

Only minor shows of oil or gas were encountered while drilling and all porous intervals on the electric logs were interpreted as having high water saturations. Drill stem tests were run on the two best zones and both recovered gas at a rate too small to measure. The well does however provide valuable stratigraphic information.

STRATIGRAPHY

WIRELINE TOPS

	Below Kelly Bushing	Subsea KB 52'
CRETACEOUS		
Nanushuk Group (undifferentiated)	Samples start at 100'	
Torok Formation	3,750'	-3,698'
"Pebble Shale"	7,237'	-7,185'
Kuparuk Formation	7,436'	-7,384'
JURASSIC		
Kingak Formation	8,125'	-8,073'
TRIASSIC		
Sag River Sandstone	9,844'	-9,792'
Shublik Formation	9,917'	-9,865'

TRIASSIC-PERMIAN		
Sadlerochit Group		
Ivishak Formation	10,542'	-10,490'
Kavik Shale Member	11,098'	-11,046'
Echooka Formation	11,290'	-11,238'
PERMIAN-MISSISSIPPIAN		
Lisburne Group		
Transition Zone	11,446'	-11,394'
Upper Limy Unit	11,673'	-11,621'
Dolomite Unit	13,760'	-13,708'
Lower Limy Unit	14,010'	-13,958'
Endicott Group	14,840'	-14,788'
TOTAL DEPTH	15,481'	-15,429'

CRETACEOUS

Nanushuk Group (undifferentiated): 100-3750'

Samples collected from the base of the conductor casing (100') to a depth of 160' contained foraminifera which indicated a Late Cretaceous Cenomanian age [Anderson, Warren & Associates, Inc. (AWA)] Zone F-8. Palynology data dates the interval 100' to 550' as Cenomanian, AWA P-M16. Below 550' to a depth of 3440' an age of Middle to Late Albian (Early Cretaceous) AWA P-M17 has been assigned. Paleontology samples were very sparse in the interval 160-740' but has been given an age of Albian to Cenomanian (AWA F-8 to F-9) Early to Late Cretaceous, 740' to 3485' were in the AWA F-9 zone, Middle to Late Albian.

Lithologies consisted of extremely soft gray, silty clays; gray, argillaceous and carbonaceous siltstones and light gray, very fine to fine and occasionally coarse grained, carbonaceous sideritic to siliceous sandstones. Minor thin coals and siderite beds or concretions were observed. Deposition of these sediments was in a marginal marine to outer neritic environment and probably laid down in alternating transgressive and regressive cycles.

Sandstones occupy approximately 20% of the Nanushuk Group and are predominantly located in the upper 1300'. Maximum thickness of the sandstone units is 60'.

Minor methane gas shows were recorded while drilling, most appeared to be associated with coal beds. One core (No. 1, 2930-2960') was cut recovering 30' of siltstone and claystone.

Torok Formation: 3750-7237'

The Nanushuk-Torok contact is gradational and indefinite in this (and other) wells. For continuity with other wells in the area, the contact has been placed at the base of the sandstone interval of the Nanushuk Group at 3750'. The base of the formation is placed at the marked change to the

distinctive dark shale of the "Pebble Shale" at 7237'. Foraminifera found in the samples from this interval were identified as being in the zone AWA F-10 (Early Albian to Late Aptian) from 3485' to 5180' and AWA Zone F-11 (Aptian) from 5180' to 7240'. Based on spores the interval from 3440' to 7360' was classified as AWA P-M18 (Early Albian to Aptian).

From 3750' to 6000', the lithology is dark gray, micaceous shale with pyrite inclusions, minor carbonaceous material and thin beds and laminations of siltstone and sandstone. The lower part of the Torok, from 6000' to 7237', becomes gray-brown, fissile and medium to dark gray, firm shales with interbedded sandstones and siltstones. The sandstones are "dirty". Using a cut-off of 60 API gamma ray units, there is a net of about 170 feet of sandstone in the interval.

Sandstones between 6000' and 6675' are very fine to medium grained, carbonaceous, silty and shaly with no shows of oil or gas.

Between 6675' and 6820', the sandstones are light gray, fine to medium grained, quartzose, poorly sorted, subrounded and subangular and most are clay filled. Fair SP Log character is developed in the sands. No visible hydrocarbon indications were observed. Gas in the drilling mud increased to 104 units at 6820' with a chromatographic breakdown of 17,300 ppm C_1 and 550 ppm C_2.

The interval from 6872' to 6922' consists of light gray very fine grained quartz sandstone with varying amounts of clay filling. Good gassy odor and bright yellow fluorescence were noted throughout the interval though there was no visible staining. Maximum gas recorded was 1,210 units consisting of 22,000 ppm C_1, 1,500 ppm C_2, 4,000 ppm C_3, 1,020 ppm C_4 and 81 ppm C_5. Drill-Stem Test No. 2 tested perforations from 6877' to 6923' and indicated generally tight formation characteristics with gas flow at a rate too low to measure (see Appendix E). As this was the best zone in the Torok, based on both observations while drilling and electric log analysis, no other tests were run in the Torok Formation.

From 6922' to 7237' interbedded sandstone and gray-brown shales occur. The sandstones are light gray to gray, very fine to fine grained with soft clay as a matrix material. No visible oil staining was noted although a bright yellow-white fluorescence was observed on fresh breaks. Maximum gas recorded was 91 units.

Three cores were taken in the Torok Formation, Core No. 2 (3784-3812'), Core No. 3 (5690-5700') and Core No. 4 (7132-7143'). Cores Nos. 2 and 3 recovered dark gray shale while Core No. 4 had interbedded shale and sandstone.

"Pebble Shale": 7237-7436'

The "Pebble Shale" was picked at 7237', the top of a highly radioactive zone that characteristically goes off scale on the gamma ray logs. Lithologically, the "Pebble Shale" consists of very dark gray to black

micaceous, splintery shales having a slight brown cast with floating well rounded, frosted to polished quartz grains and rare pebbles. Occasional thin shaly tight sandstone stringers occur.

The maximum hydrocarbon indications was a 120 unit gas kick from the shale section at 7280'. Component breakdown was 22,000 ppm C_1, 1,200 ppm C_2, 780 ppm C_3 and 170 ppm C_4.

Paleontology data by Anderson, Warren & Associates has dated the interval 7240-7480' as Early Cretaceous (Neocomian AWA F-12 to F-13).

Core No. 5 (7368-7378') recovered 9 feet of very dark gray shale with scattered sand grains and pebbles.

Kuparuk Formation: 7436-8125'

The Kuparuk Formation with a 42' sandstone (7436-7478') at the top was penetrated at 7436' below kelly bushing. This sandstone (Kuparuk sand) is often called the "Pebble Shale" sand because of its proximity to the basal part of the "Pebble Shale". Paleontology data through this sand (7420-7480') is indeterminate but below 7480' to 8100' an Early Cretaceous (Neocomian AWA F-13 to F-14) age has been established (see Appendix J). Palynology reports the upper part of the sandstone as being Neocomian AWA P-M19 (7436-7450') while the lower portion of the sandstone and the underlying shales, siltstone and sandstones to a depth of 7840' has been given an Early Cretaceous (Neocomian AWA P-M20) age.

This transgressive marine sandstone is white to light brown, very fine grained, subangular to angular, slightly friable and silty and contains rare glauconite. Hydrocarbon shows were limited to a 125 unit gas kick and a very slow cut from the samples. Electric log computations established an average porosity of 13% with very high water saturations (Appendix D). A drill-stem test (No. 1) over the interval 7446-7472' was undertaken and recovered gas too small to measure plus 1338' of slightly gas-cut rat-hole mud (Appendix E).

Below the Kuparuk sand to a depth of 8125', are Early Cretaceous dark gray to dark brown micaceous marine shales with floating sand grains. Minor amounts of siltstone and sandstone were observed in the samples.

A core (No. 6) was cut from 7491-7501' which recovered 10 feet of dark gray-brown, micaceous, noncalcareous shale with scattered shell fragments and rare pyrite.

JURASSIC

Kingak Formation: 8125-9844'

The top of the Kingak Formation has been picked at 8125' on the top of a zone with gray, very glauconitic sandstone lenses. A sandy interval such

as this is quite typical of the top of the Kingak throughout portions of the North Slope. Biostratigraphic information has established a Late Jurassic (Kimmeridgian to Tithonian) age beginning at depths of 8100' (paleontology AWA F-15 to F-16, Appendix J) and 7840' (palynology AWA P-M21). Paleontology zones AWA F-16 to F-18 (Late to Early Jurassic) were present in the interval 8190-9600'. A similar fauna (AWA F-18) with an incomplete Triassic (AWA F-19) assemblage is present from 9600-10,110'. Palynology gives the intervals 7840-8290' a Kimmeridgian to Tithonian age (AWA P-M21), 8290-9100' an Oxfordian (AWA P-M22) and 9100-9730' an Early to Middle Jurassic (AWA P-M23) age. Below 9730' to a depth of 10,740' ages are indeterminate.

Dark gray-brown, dark brown and occasionally dark gray shales comprise the Kingak Formation to a depth of 9037'. These shales are micaceous, fissile to splintery, contain rare pyrite, floating sand grains and siderite concretions and have minor siltstone and sandstone stringers.

The interval 9037' to 9105' is a medium to light gray, very fine grained silty sandstone [Simpson sandstone(?)] with rare glauconite and pyrite. Thin interbedded dark brown shales and brown siltstones were also observed in the zone. Samples and mechanical logs indicate the sandstone to be shaly with low permeability.

This sandstone appears(?) to be approximately equivalent to the thick porous, massive sandstones (Simpson sandstone) found in the No. 1 Kugrua, NW 1/4, Section 8, T14N, R6E, U.M. at a depth of 8713' and at 7858' in the No. 1 South Meade, NW 1/4, Section 31, T15N, R19W, U.M.

Marine shales occupy the interval below the Simpson sand to a depth of 9626'. These shales are dark gray, black and gray-brown, partly silty and sandy with rare glauconite and floating quartz grains and thin stringers of siltstone.

At 9626', another sandstone was encountered. The 46' low porosity (3-6% mechanical logs) sandstone is medium gray-brown to dark gray, very fine grained, silty, slightly argillaceous, subangular and well sorted. A very slight cut was obtained from the samples and a 120 unit gas kick recorded in this sand.

The interval 9672' to 9844' is composed of dark gray to dark gray-brown, slightly micaceous, fissile to splintery, pyritic and slightly fossiliferous shales.

No cores were taken from the Kingak Formation.

TRIASSIC

Sag River Sandstone: 9844-9917'

The Sag River Sandstone is composed of two units in the No. 1 Ikpikpuk well. The upper unit is composed of a dark gray-brown, very fine

grained, silty subangular sandstone which is well sorted, hard, slightly siliceous to slightly calcareous and has rare glauconite. The lower unit is a siltstone-sandstone-shale sequence.

The base of the Sag River and top of the Shublik Formation boundary is only a tentative pick on a break in the gamma ray log. Biostratigraphic data is uninformative in that palynology is indefinite while paleontology is listed as Triassic to Early Jurassic (AWA F-18 to F-19) with an incomplete AWA F-19 assemblage in the interval 9600-10,110'.

The character of the Sag River Sandstone is not that of the barrier bar and beach complex that is found in wells to the north and west of this well; i.e., East Teshekpuk No. 1, Section 16, T14N, R4W, U.M., South Simpson No. 1, Section 11, T17N, R12W, U.M. and Kugrua No. 1, NW 1/4, Section 8, T14N, R26W, U.M. The Sag River deposited at Ikpikpuk is interpreted to have been in a near-shore marine environment.

No hydrocarbon shows were observed.

Shublik Formation: 9917-10,542'

As mentioned previously, the top of the Shublik Formation is only a tentative pick; i.e., picked on gamma ray break. The Shublik is composed of three units in this well: an upper marine (9917-10,265') siltstone, sandstone and shale unit, in which the siltstones and sandstones are medium to light gray, hard, siliceous to calcareous with rare glauconite and common pelecypods and crinoids), a middle unit (10,265-10,370') of thin dark gray and tan fossiliferous limestone beds with black phosphate pellets and a lower unit (10,370-10,542') composed of brown to light gray sandstones, gray-brown siltstones, and brown to dark gray shales.

Foraminifera determinations by Anderson, Warren & Associates, Inc. have given the interval 10,110-10,570' a Triassic age (AWA Zones F-19 to F-20). Palynology is still indeterminate to a depth of 10,740'.

Core No. 7 (10,270-10,300') recovered 25 feet of dark gray, hard, calcareous shales with Monotis, sp. and Halobia, sp. shells and 5 feet of dark gray limestone with the same type fossils.

No significant oil or gas indications were observed.

TRIASSIC-PERMIAN

Sadlerochit Group

Ivishak Formation: 10,542-11,098'

The top of the Ivishak Formation has been picked at 10,542' on the top of a light gray, very fine to fine grained, poorly sorted subrounded sandstone which has clear and white quartz grains and is hard and tight. Possibly the top could be picked at 10,444' but the presence of phosphate

pellets (which are typical of Shublik Formation) in the sandy zones between 10,444' and 10,540' indicates this interval should be in the Shublik Formation. The sandstone interval (10,542-10,602') is interbedded with brown-gray flaky shale and gray-brown firm siltstones to a depth of 10,602' and is interpreted to be pro-delta to near-shore marine.

From 10,602' to 10,732' a clean bioturbated quartz sand is developed which is thought to represent deposition in a pro-grading delta. The lithology is quartz sandstone, fine to medium grained at the top decreasing in grain size to very fine grained at 10,620', and consists of white to clear well compacted quartz grains, in part siliceous, subrounded to rounded, well sorted, commonly bioturbated; with thin horizontal shale partings and rare siliceous nodules or clasts. The best electrical log porosity was calculated between 10,610' and 10,670', averaging 15% and is water saturated. Core No. 8 (10,619-10,649') recovered 30 feet of white to light gray quartz sandstone, partly quartzitic, subangular to subrounded, becoming slightly argillaceous in the lower 16 feet. Porosities averaged 13% but permeability was generally less than 1.0 millidarcy (Appendix H).

Approximately 200 barrels of mud were lost to the formation at 10,651'.

From 10,732' to 11,098' deposition is interpreted to be continental to marginal marine and is characterized by red to pink silty shales and siltstones interbedded with carbonaceous sandstone beds representing probable bar or distributary channel deposits. Two major sandstone units are present in this interval. The first, 10,810-10,847', consists of light gray, very fine to fine grained, siliceous sandstone that is, in part, fine to medium grained, pebbly, and has thin shaly partings and shale clasts. The second unit from 10,948' to 11,001' consists of sandstone which is red and reddish-gray, fine to very fine grained, slightly friable, subrounded to subangular, with clear to white, orange and pink quartz grains. It is carbonaceous and in part siliceous. Maximum mechanical log porosity developed in these two sands is 14% with a calculated high water saturation. A loss of 400 barrels of mud occurred at 11,001' but may have gone into the zone at 10,651'.

A core cut from 10,815-10,842' (No. 9) had porosities varying from 5.4% to 14.4% from a light gray sandstone, but again permeability was predominantly below 1.0 millidarcy (Appendix H). Hydrocarbon shows were nil throughout the formation.

The interval from 10,570' to 11,380' was dated as Permo-Triassic (AWA F-20) based on foraminifera. Palynology data within the interval 10,740' to 11,830' indicates it is probably undifferentiated Permian to Triassic.

Kavik Shale Member: 11,098-11,290'

The Kavik Shale member of the Ivishak Formation was topped at 11,098' and represents a change back to marine depositional conditions. Lithology of the Kavik is dark gray brittle shale with thin siltstone stringers and rare carbonized plant fragments as exhibited in Core No. 10 (11,108-11,135').

Echooka Formation: 11,290-11,446'

Penetrated at 11,290', the Echooka Formation is thought to have been deposited as a northward transgressive deposit in a marine to non-marine environment. Lithology is a dark green, shaly, siliceous, glauconitic, very fine grained, subangular quartz sandstone with interbedded gray siltstone and dark gray-green, dark gray and red mottled shales. A 56' interval at the base is composed of dark gray shale and dark gray-green siltstone.

No significant reservoir rock was encountered in th Echooka Formation. The best porosity indicated on the neutron porosity log is only 6% between 11,321' and 11,334'.

Maximum gas in the mud while drilling the Echooka was only 35 units, which occurred at about 11,325'.

PERMIAN-MISSISSIPPIAN

Lisburne Group

Transition Zone: 11,446-11,673'

Below the base of the Echooka at 11,446' and above the top of the massive limestone of the Lisburne Group at 11,673' is a section called herein the "Lisburne Transitional Zone". This shallow marine carbonate-clastic depositional regime penetrated at Ikpikpuk is very similar to that found in the Inigok No. 1, NW 1/4, Section 34, T8N, R5W, U.M. This section is composed of interbedded gray, tan, gray-brown limestones; dark gray, silty, calcareous, micaceous shale and dark gray siltstone, all with rare fossils. Foraminifera from the interval from 11,380' to 11,620' indicate an Early Permian zone F-20 age as established by Anderson, Warren & Associates, Inc.

Upper Limy Unit: 11,673-13,760'

The carbonate sediments of the Upper Limy Unit were deposited on a shallow marine shelf with occasional shale and siltstone beds. These carbonates are primarily clean bioclastic and allochemical limestones composed of crinoids, bryozoans, foraminifera, brachiopods, spines, oolites and pellets with sparry calcite and occasionally micrite cement. They are generally recrystallized to the point that fossil grains are indistinct to ghostly. The rare occurrence of dolomite and lack of evaporites, in addition to the recrystallized tight limestone points to an environment of carbonate deposition in unrestricted marine waters. Below 12,900', there is an increase in clastic sediments as evidenced by the number of siltstones and occasional sandstones present.

Samples from 11,620' to 11,830' contain foraminifera indicative of AWA zone F-21 (Early Permian). The interval 11,830-12,480' is indicated to be no older than Mamet's zone 21 but may be as young as zone 24. The interval 12,480' to 12,930' is Middle to Lower Pennsylvanian (Mamet's zone 21). A

pick of Mamet's zone 20 is made at 12,930' (Lower Pennsylvanian). The section from 13,450' to 13,760' is thought to be Mamet's zones 18 to 19, which are upper Mississippian (Chester).

Hydrocarbon shows consisted of a maximum 335 unit gas reading at 11,839' in a zone which contained no potential reservoirs.

Two conventional cores (No. 11, 11,718-11,733' and No. 12, 12,743-12,753') were taken in the Upper Limy Unit. Both recovered limestone with occasional shale and siltstone stringers.

Dolomite Unit: 13,760-14,010'

The top of the dolomite unit was placed at 13,760'. This unit consists of basically the same type of limestone encountered above but with thin beds of dolomite. One exception is an 80' dolomite bed with interbedded siltstones at 13,780' to 13,860'. No evaporites occur within the unit and as such it is thought to represent a period of carbonate deposition in which the waters were somewhat restricted. Slight pinpoint to small vugular porosity occurs in the dolomite but no effective permeability exists. The maximum log porosity developed in the dolomite unit was 6% from 13,784-13,788'.

A dull yellow fluorescence and slow yellow cut was observed in the 13,785-13,790' sample which may have been contamination from the mud additives. No cores were taken.

Fossil representation is poor in this interval but could be indicative of Mamet's 17 to 18 zones (Mississippian, Chester).

Lower Limy Unit: 14,010-14,840'

Based on the change to lime packstone and on paleontological evidence, probable Mamet's zones 14 to 16 (Meramecian), the section from 14,010' to 14,840' is thought to represent the Lower Limy unit of the Lisburne. Down to 14,460', carbonates dominate with interbedded medium to dark gray limestone and medium gray, finely crystalline dolomite. Considerable secondary silicification has occurred through this part of the Lisburne. From 14,460' downward, the section contained far more detrital material with dark gray argillaceous siltstones and occasional sandstones interbedded with fine limestones and dolomites.

Probable depositional environment was that of a shallow, low energy shelf. These do not normally produce carbonates with good primary porosity. Post-depositional changes, including considerable silicification, have limited secondary porosity.

No coring was undertaken in this unit.

The Lisburne Group carbonates were tight throughout with log porosities in the general range of 0-3% with 6% being the high (Dolomite Unit). Hydrocarbon shows were almost non-existent with the best being the aforementioned 335 unit gas kick at 11,839'.

Endicott Group: 14,840-15,481'

The section from 14,840' to 15,305' was marked by interbedded red sandstones, argillaceous red siltstones, and red shales. General lithology suggests that this is probably the Itkilyariak Formation. Core No. 13 (14,971-14,986') recovered 10.5 feet of red sandstone and 4.5 feet of red shale.

Dark carbonaceous shales, coal and quartzites below 15,305' indicates a probable Kekiktuk Formation. Below 15,320', the sediments consist of cataclastic metasediments.

Thin section petrography and x-ray diffraction analysis of samples from Core No. 14 (15,421-15,424') were performed by Dr. H. E. Enlows at Oregon State University (Appendix I). They were described as having a "cataclastic texture" consisting of quartz clasts and a fine groundmass of Wilkeite, a somewhat uncommon metamorphic mineral first identified in contact metamorphics in California where it is associated with diopside, garnet, and other metamorphic minerals. Dr. Enlow suggests that the rock is the result of dynamic metamorphism.

The presence of coal in the samples below 15,320' indicates that they are still from the Kekiktuk Formation. Anderson, Warren & Associates indicate the interval 14,850-15,200' is of Late Mississippian age (Mamet's zones 14 to 16) and 15,200-15,481' is probable Mississippian.

No shows of gas or oil were observed while drilling. Electrical logs confirmed the lack of hydrocarbons as well as the absence of reservoirs.

Two other cores in addition to Core No. 14 were attempted. Core No. 15 (15,461-15,462') had no recovery. Core No. 16 (15,462.7-15,469.2') recovered 4 feet of highly fractured quartzite.

TESTING

At the completion of the drilling and logging of the Ikpikpuk No. 1 test well, the hole was plugged back in stages and two drill stem tests were run as a final check of the only two zones with any hydrocarbon potential.

Drill-Stem Test No. 1 was through perforations from 7446' to 7472'. Recovery was gas at rates too small to measure and 1338' of slightly gas-cut rat-hole mud (Appendix E).

Drill-Stem Test No. 2 was through perforations from 6877' to 6923'. Gas did not reach the surface until 50 minutes into the final flow period and the flow was at a rate too small to measure. Also recovered was 935 feet of gas-cut mud and formation water (Appendix E).

STRUCTURE

Dipmeter data indicate low formation dips at the No. 1 Ikpikpuk. Dips average 2-4° to a depth of 14,800' with the exception of some of the

sandstones which have dips somewhat higher but this is probably due to intraformation bedding. Below 14,800', the average increases to 6-8°.

Some changes in direction of dip were observed on the dipmeter logs. The intervals 2620-3300' and 3750-5320' have a general northeast direction of dip while the interval 3300-3750' is to the southeast and 5320-7500' is to the northwest. Below 7500' to a depth of 15,238', the dip is in a southwest direction.

CONCLUSIONS

The subject well tested the stratigraphic possibilities of the Cretaceous to Triassic rocks. No significant oil, gas, or coal deposits occurred in these rocks. While some of the sandstone deposits gave gas indications, they appeared to be discontinuous (small limited reservoirs), and commonly had soft clay in the matrix. Two of the better sandstones were tested and both recovered gas too small to measure (see composite log and Appendix E).

The hydrocarbon potential of the sequence of rocks from the Sag River Sandstone through the Lisburne Group was observed and calculated. The sandstones of the Sag River and Sadlerochit Group are generally of low porosity, are calculated to be water wet and have no hydrocarbon shows. The Lisburne carbonates are very tight (0-3% porosity), and display only scattered very slight hydrocarbon shows.

Mississippian sandstones of the Endicott Group are all tight and void of hydrocarbons.

It was concluded that, after full evaluation of all information available, this well was a dry hole and consequently plugged and abandoned.

PERTINENT DATA AND APPENDICES

SUMMARY OF PERTINENT DATA*

WELL NAME:	Ikpikpuk Test Well No. 1
API NO.:	50-279-20004
OPERATOR:	Husky Oil NPR Operations, Inc.
CONTRACTOR:	Parco, Inc., Rig 96
LOCATION:	1306' FNL, 785' FEL NE 1/4, protracted Section 25, T13N, R10W Umiat Meridian, Alaska
COORDINATES:	Latitude: 70°27'19.679" North Longitude: 154°19'52.780" West X = 459,399.70, Y = 6,016,300.06 Zone 5
ELEVATION:	52' Kelly Bushing (KB), 32' Pad
CASING:	30" @ 100' 20" @ 521' 13-3/8" @ 2603' 9-5/8" @ 9873' 7" liner from 9528' to 14,208'
DATE SPUDDED:	November 28, 1978
DATE SUSPENDED:	April 17, 1979
DATE WELL OPERATIONS RESUMED:	December 25, 1979, Drilling January 7, 1980
DATE REACHED FINAL TOTAL DEPTH:	February 13, 1980
FINAL TOTAL DEPTH:	15,481 feet (driller)
DATE RIG RELEASED:	February 28, 1980
LOGGING RECORD:	
DIL/GR/SP	101-15,389'
BHCS/GR/TTI	102-15,294'
FDC/GR/Cal/RR	100-15,400'
CNL/FDC/GR	100-15,400'
HDT-Dipmeter	2,603-15,400' (3 runs)
Temperature	100-15,435' (Run 1 before logging) Surface-15,405' (Run 2 after logging)

CBL	2,100- 7,522'
Mud Log	100-15,481'
Auto Calcimeter Plot	10,100-15,285'
Dc Exponent	500-15,481'
Drilling Data Pressure Log	600-15,481'
Pressure Analysis Log	10,000-15,480'
Velocity Survey (Birdwell)	100-15,481'
Computed Logs:	
Dipmeter Arrow Plot	2,622-15,400'
Geogram	198-15,378'

SIDEWALL CORES:

Run 1	5450-9890' (shot 69, recovered 42)
Run 2	9918-11,487' (shot 30, recovered 13)

CONVENTIONAL CORES:

No.	Interval	Recovery	Formation
1	2,930- 2,960'	30.0'	Nanushuk Group
2	3,784- 3,812'	28.0'	Torok
3	5,690- 5,700'	10.0'	Torok
4	7,132- 7,143'	11.0'	Torok
5	7,368- 7,378'	9.0'	"Pebble Shale"
6	7,491- 7,501'	10.0'	Kuparuk
7	10,270-10,300'	30.0'	Shublik
8	10,619-10,649'	30.0'	Ivishak
9	10,815-10,842'	27.0'	Ivishak
10	11,108-11,135'	27.0'	Kavik Member
11	11,718-11,733'	15.0'	Lisburne
12	12,743-12,753'	10.0'	Lisburne
13	14,971-14,986'	15.0'	Endicott Group
14	15,421-15,424'	1.1'	Endicott Group
15	15,461-15,462'	0.0'	Endicott Group
16	15,462.7-15,469.2'	4.0'	Endicott Group

CORE ANALYSIS: (Core Laboratories, Inc.)

Core No.	Interval	Spl. No.
4	7,135- 7,142'	1- 6
8	10,619-10,649'	1-16
9	10,815-10,841'	17-30
Sidewall	7,466	1
Sidewall	12,994'	

NOTE: Coregraph available.

HYDROCARBON SHOWS:	6920-7020', bright yellow fluorescence, 1,210 units gas @ 6923' 7436-7445', very slow cut, 140 units gas @ 7440' 11,705-11,710', 850 units gas, no fluorescence, cut or show.
DRILL-STEM TESTS:	
No. 1	7446-7472' (perforations), recovered gas and gas cut rat hole mud.
No. 2	6877-6923' (perforations), recovered gas and gas cut drilling fluid and formation fluid.
FLUID & SPECIAL ANALYSIS:	
Gas Analysis Report (DST 1 & 2)	Chemical & Geological Laboratories, Inc.
Analytical Report (DST 2)	Chemical & Geological Laboratories, Inc.
Water Analysis Report (DST 1 & 2)	Chemial & Geological Laboratories, Inc.
WELL STATUS:	Dry and abandoned
WELLSITE GEOLOGISTS:	D. Young J. Greene R. Nelson
LOG ANALYST:	Armour Kane
DRILLING CONTRACTOR:	Parco, Inc., Rig 96
MUD LOGGERS:	Exploration Logging
BIOSTRATIGRAPHIC STUDIES:	Anderson, Warren & Associates, Inc.

ADDITIONAL GEOLOGIC DATA:

Sedimentary Petrology Analysis, dated February 16, 1980, Harold E. Enlows, Oregon State University.

Final Foraminifera Report, dated June 7, 1979, Anderson, Warren & Associates, Inc.

Final Palynology Report, dated June 7, 1979, Anderson, Warren & Associates, Inc.

Addendum to Foraminifera Report, dated March 26, 1980, Anderson, Warren & Associates, Inc.

Addendum to Palynology Report, dated March 26, 1980, Anderson, Warren & Associates, Inc.

End of Well Report (November 1978-April 1979), Exploration Logging, 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

IKPIKPUK TEST WELL NO. 1
DRILL CUTTINGS AND CORE DESCRIPTIONS
BY

D. YOUNG	-	100- 7,132'
		9,913-11,205'
		13,930-14,210'
J. GREENE	-	7,132- 9,913'
		11,205-13,930'
R. NELSON	-	14,210-15,481'

NOTE: Sample descriptions written before electrical surveys taken. Depths may or may not conform with final correlation of samples and mechanical control.

DRILLED DEPTH (FEET BELOW KELLY BUSHING)	
0 - 100	No samples recovered.
100 - 160	Claystone: light gray, soft interbedded, with Siltstone: gray, tan, firm; trace of gypsum.
160 - 220	Sandstone: light gray, fine to very fine grained, hard, tight, argillaceous, grading to gray, sandy siltstone.
220 - 250	Siltstone: medium gray, firm, pyritic; trace of coal.
250 - 280	Lignite: brown, fissile, splintery, interbedded with Coal and Claystone: light gray, white, possibly kaolin.
280 - 310	Sandstone: light gray, fine to medium grained, well sorted, subrounded, hard, tight, carbonaceous, pyritic, slightly glauconitic.
310 - 320	Coal: black, hard, subconchoidal, subbituminous.
320 - 340	Shale: tan, hard, blocky.
340 - 460	Coal interbedded with tan, hard shale.
460 - 530	Sandstone: light gray, fine grained, highly argillaceous, noncalcareous, tight, no stain, odor, fluorescence or cut.
530 - 550	Coal.
550 - 590	Sandstone: light gray, medium to coarse grained, poor to well consolidated, argillaceous, carbonaceous in part, grades to Quartzite: light brown, very hard, vitreous, interbedded with Siltstone: tan, light gray, firm.

590 -	605	Siderite: light brown, hard, argillaceous.
605 -	620	Coal.
620 -	665	Siltstone: light gray, medium hard to hard, interbedded with Siderite: brown to tan, very hard with calcite filled fractures.
665 -	770	Sandstone: light gray, very fine to fine grained, medium hard, friable, common fine grained, loose, well rounded quartz grains, interbedded with light gray, hard, siltstone, rare Inoceramus prisms.
770 -	785	Siltstone: tan, light to medium gray, hard in part, sandy.
785 -	815	Coal interbedded with siltstone.
815 -	875	Siltstone: light gray, medium gray, hard in part, sandy, interbedded with Claystone: hard, slightly silty; trace of white chalk, possibly kaolinite.
875 -	950	Sandstone: light gray, tan, fine to medium grained, medium hard, poorly sorted, subrounded, argillaceous, pyritic, carbonaceous, dull gold fluorescence; no oil stain or cut; sandstone becomes well sorted, friable with fossil wood at 920'.
950 -	1080	Shale: light gray, medium gray, slightly silty, slightly calcareous, in part micromicaceous.
1080 -	1130	Coal: black, subbituminous, interbedded with Shale: buff, slightly silty, medium hard.
1130 -	1180	Shale: buff, slightly silty, medium hard, interbedded with Shale: dark brown, soft, fissile, micaceous and coal.
1180 -	1280	Sandstone: light gray, tan, medium to fine grained, well rounded, well sorted, firm, becoming hard, tight, argillaceous, pyritic, carbonaceous, very slightly calcareous with dull gold to yellow sample fluorescence with slow, white cut fluorescence; no stain, no odor.
1280 -	1350	Claystone: medium gray, brown-gray, soft with coal stringers.
1350 -	1420	Siltstone: medium gray, medium hard, interbedded with Shale: gray, hard, micromicaceous.
1420 -	1570	NOTE: Sample quality and quantity very poor from 1300-1945'; interbedded Claystone: buff, gray, hard, soft, occasionally grades to siltstone.

1570 - 1600	Sandstone: light gray, fine grained, medium hard, carbonaceous, highly argillaceous.
1600 - 1650	Claystone: drilling and log interpretation.
1650 - 1680	Sandstone: light gray, fine grained, medium hard, carbonaceous, highly argillaceous.
1680 - 1785	Claystone: light gray, soft with stringers of Sandstone: as above; common shell fragments, cones and Inoceramus prisms.
1785 - 1820	Sandstone: light gray, fine grained, medium hard, friable, argillaceous, carbonaceous, common pyrite in 5-10 mm chunks.
1820 - 1965	Interbedded Claystone: brown, soft, gummy; Siltstone: medium gray, firm; Sandstone: as above.
1965 - 2005	Siltstone: medium gray, firm, micromicaceous, sample quality, good to fair.
2005 - 2025	Claystone: brown, soft, gummy.
2025 - 2370	Siltstone: medium gray, firm, micromicaceous, commonly pyritic, thin claystone stringers occur throughout this interval.
2370 - 2400	Sandstone: light gray, fine grained, medium hard, pyritic, carbonaceous, white, clear, green quartz, well rounded, well sorted, dull yellow fluorescence, no visible stain, no cut.
2400 - 2460	Claystone: light gray, soft, grades in part to siltstone.
2460 - 2580	Interbedded Claystone: as above; Siltstone: dark gray to light gray, and Sandstone: light gray, fine grained, friable, highly argillaceous.
2580 - 2620	Sandstone: light gray, fine grained, medium hard, friable, argillaceous, carbonaceous, very slightly calcareous, common pyrite, common chert fragments, sharp, white to light gray translucent; interbedded with Claystone: light gray, soft; rare Inoceramus prisms.
2620 - 2875	Claystone: light gray, soft, gummy, micromicaceous, grading in part to siltstone and with thin sandstone stringers.
2875 - 2925	Sandstone: light gray, very fine to fine grained, firm, argillaceous with dull orange fluorescence and very slight yellow cut fluorescence, no visible stain or porosity; interbedded with Claystone: gray-brown, soft, gummy.

2925 - 2930 Siltstone: light gray, firm, micromicaceous.

2930 - 2960 Core No. 1: Cut 30', Recovered 30'

2930.0-2960.0' (30.0') Claystone: medium gray, firm, silty, with thin siltstone laminations and horizontal bedding.

2960 - 3100 Claystone: light gray, silty, micromicaceous, interlaminated with Siltstone: light gray, firm, micromicaceous, carbonaceous, rarely pyritic and with a trace of brown, hard, sandy shale.

3100 - 3150 Coal stringer, black, hard, highly pyritic.

3150 - 3265 Siltstone: light gray, firm, micromicaceous, carbonaceous, interbedded with Claystone: light gray, silty, micromicaceous.

3265 - 3350 Sandstone: very fine grained, light gray, firm, highly argillaceous, carbonaceous.

3350 - 3400 Claystone: medium gray, gray-brown, soft, gummy, nonsilty.

3400 - 3580 Siltstone: light gray, firm, carbonaceous, micromicaceous, interbedded with Claystone: light gray, medium gray, soft micaceous.

3580 - 3730 Sandstone: light gray, very fine grained, argillaceous, highly carbonaceous, micromicaceous, slightly calcareous with finely disseminated pyrite, dull orange fluorescence, very slight yellow cut fluorescence, no stain, interbedded with Siltstone: light gray, firm, slightly calcareous, and Claystone: light gray, gray-brown, soft, micaceous.

3730 - 3784 Sandstone: light gray, fine to very fine grained, white clear quartz, well sorted, well rounded, friable, clay filled in part, clean, no visible stain or porosity, dull orange fluorescence, very slight yellow cut fluorescence, 45 units gas kick at 3740'.

3784 - 3812 Core No. 2: Cut 28', Recovered 28'

3784.0-3786.0' (2.0') Shale: dark gray, hard, micromicaceous, nonsilty, noncalcareous, massive, brittle, no bedding.

3786.0-3807.0' (21.0') Shale: dark gray, hard to moderately hard, subfissile, micromicaceous, with bedding dips and partings of 10°-15°.

3807.0-3812.0' (5.0')	Shale: as above, increasingly hard with near horizontal bedding.
3812 - 4040	Shale: dark gray, medium gray, firm, micromicaceous, occasionally becoming silty with siltstone stringers.
4040 - 4110	Shale: as above, with very coarse grained, clear, nonfrosted, subrounded to well rounded quartz floaters.
4110 - 4350	Shale: medium gray, firm, micromicaceous, finely, disseminated, carbonaceous, interbedded with Siltstone: light gray, carbonaceous.
4350 - 4425	Sandstone: light gray, fine to very fine grained, clay filled, friable, dull orange fluorescence with slow yellow cut fluorescence.
4425 - 4530	Sandstone: light gray, fine to very fine grained, argillaceous, carbonaceous, white clear quartz, well rounded.
4530 - 4650	Shale: medium gray, firm, in part silty, interbedded with Siltstone: light gray, medium gray, firm, carbonaceous, micromicaceous.
4650 - 4720	Sandstone: light gray, very fine grained, argillaceous, friable, firm, carbonaceous; no stain, odor, cut or fluorescence.
4720 - 4870	Shale: medium gray, dark gray, firm, micromicaceous, becoming splintery with thin siltstone stringers.
4870 - 4950	Sandstone: light gray, medium gray, very fine grained, highly argillaceous, friable, grading to siltstone in part; no stain, odor, cut or fluorescence.
4950 - 5085	Siltstone: light gray, medium gray, firm, carbonaceous, in part grading to very fine grained, argillaceous, sandstone interbedded with Shale: dark gray, firm, micromicaceous.
5085 - 5120	Sandstone: light gray, very fine grained, firm, argillaceous, carbonaceous.
5120 - 5150	Shale: medium gray, dark gray, firm, micromicaceous.
5150 - 5200	Siltstone: light gray, firm, carbonaceous with pyrite nodules.
5200 - 5220	Shale: medium gray, firm, silty, micromicaceous with finely disseminated, carbonaceous and with occasional thin, siltstone stringers.

5220 - 5240	Shale: light gray, soft, micromicaceous.
5240 - 5300	Shale: medium gray, dark gray, firm, subfissile, micromicaceous.
5300 - 5360	Shale: dark gray, firm, subfissile, micromicaceous, with disseminated, carbonaceous and occasional thin siltstone stringers.
5360 - 5390	Sandstone: light gray, fine grained, clay filled, carbonaceous, friable; no stain, no cut, no fluorescence.
5390 - 5480	Shale: medium gray, dark gray, subfissile, firm, micromicaceous with thin stringers of Sandstone: as above, which in part grade to siltstone.
5480 - 5540	Sandstone: light gray, fine to very fine grained, clay filled, friable, in part grading to siltstone; no stain, no cut, no fluorescence.
5540 - 5570	Shale: medium gray, dark gray, firm, micromicaceous, carbonaceous, in part silty.
5570 - 5600	Sandstone: light gray, very fine grained, clay filled, carbonaceous, clear white, medium to well sorted, noncalcareous; no stain, no cut, no fluorescence.
5600 - 5690	Shale: dark gray, firm, micromicaceous, in part silty, in part subfissile.
5690 - 5700	Core No. 3: Cut 10', Recovered 10'
	5690.0-5700.0' (10.0') Shale: dark gray, hard, brittle, micromicaceous, subconchoidal, horizontal to subhorizontal partings with occasional thin, medium gray partings, laminations and pods of siltstone bedding dips of 0°-10° are present.
5700 - 5850	Shale: dark gray, medium gray, firm, micromicaceous with occasional thin, medium gray siltstone and sandstone stringers.
5850 - 5870	Siltstone: medium gray, firm, in part grading to fine grained, highly argillaceous sandstone.
5870 - 6000	Shale: medium gray, dark gray, firm, in part silty with thin siltstone laminations.
6000 - 6080	Siltstone: light gray, firm, carbonaceous, interbedded with Shale: as above.

6080 - 6100	Sandstone: light gray, very fine grained, white clear quartz, poorly sorted, argillaceous, highly carbonaceous, firm, friable; no stain, no cut, no fluorescence.
6100 - 6200	Shale: dark gray, firm, micromicaceous, in part silty, splintery with occasional siltstone stringers.
6200 - 6210	Sandstone: light gray, very fine grained, fine to medium grained, firm, white clear quartz, subangular, poorly sorted, carbonaceous, clay filled; no stain, no cut, no fluorescence.
6210 - 6230	Shale: dark gray, firm, silty.
6230 - 6240	Sandstone: very fine to fine grained, light gray, firm, friable, argillaceous, carbonaceous, slightly calcareous.
6240 - 6280	Sandstone: fine to medium to coarse grained, light gray, firm, friable, poorly sorted, subangular, subrounded, white clear quartz, in part with white clay filled matrix, low porosity; no stain, odor, cut, or fluorescence.
6280 - 6300	Shale: gray-brown, medium gray, highly micaceous, fissile.
6300 - 6320	Shale: medium gray, dark gray, firm, micromicaceous, splintery.
6320 - 6330	Sandstone: light gray, firm, fine to medium grained, poorly sorted, white, clay filled matrix, rare pyrite nodules, trace of pyritized fossil wood; no stain, cut or fluorescence.
6330 - 6350	Shale: brown, gray-brown, highly fissile, highly micaceous, probable high gamma ray shale.
6350 - 6370	Dolomite: brown, hard, microcrystalline.
6370 - 6430	Shale: medium gray, dark gray, firm, micromicaceous, finely disseminated carbon, noncalcareous, nonsilty, flaky, splintery.
6430 - 6440	Sandstone: light gray, fine to medium grained, argillaceous, carbonaceous.
6440 - 6500	Shale: as at 6370', in part silty with thin siltstone stringers.
6500 - 6530	Sandstone: as above, in part with white, clay filled matrix, rare, very coarse grained, subrounded, nonfrosted quartz floaters, slightly calcareous; no stain, no cut, no fluorescence.

6530 - 6540	Sandstone: light gray, medium gray, fine to medium grained, highly argillaceous, clear, white, rarely light green quartz, poorly sorted; no stain, odor, cut or fluorescence.
6540 - 6630	Shale: dark gray, medium gray, firm, micromicaceous, splintery.
6630 - 6660	Siltstone: medium gray, firm, highly argillaceous.
6660 - 6730	Shale: as at 6540', with occasional siltstone stringers.
6730 - 6740	Sandstone: light gray, white, fine to medium grained, in part white, clay filled matrix, clear, white, rare pink and light green grains, subrounded, fairly well sorted, carbonaceous, friable, 5% porosity; no stain, cut or fluorescence.
6740 - 6770	Shale: brown, firm, fissile, highly micaceous, 10% sample.
6770 - 6880	Sandstone: as at 6730', interbedded with siltstone and shale:
6880 - 6927	Shale: dark gray, medium gray, firm, interbedded with Siltstone: medium gray, hard, gassy, geopressured.
6927 - 7020	Sandstone: light gray, very fine grained, well sorted, highly argillaceous, hard in part with swelling clay in matrix, gassy odor or fresh breaks, bright yellow-white sample fluorescence, yellow-white crush cut fluorescence, no stain, no visible porosity.
7020 - 7050	Sand: light gray, tan, very fine to fine to medium grained, slightly argillaceous, friable, poorly sorted, subrounded, poorly cemented, rare, subangular pebbles, varicolored white, clear, pink, orange, black; nil to 5% porosity fluorescence and cut as at 6927'; no stain.
7050 - 7070	Shale: gray-brown, fissile, abundant mineral biotite.
7070 - 7120	Sandstone: light gray, tan, very fine grained, firm, moderately sorted argillaceous clay in matrix, yellow-white fluorescence and crush cut; traces of tan-brown siderite and white-gray calcareous shale in part, with very small microfossils or oolites.
7120 - 7132	Shale: medium gray, dark gray, firm to soft, micromicaceous.

7132 - 7143 Core No. 4: Cut 11', Recovered 11'

7132.0-7139.0' (7.0') Shale: dark gray to very dark gray, micromicaceous, noncalcareous, slightly conchoidal fracture, scattered carbonaceous, silty, sandy streaks, part with irregular bedding.

7139.0-7143.0' (4.0') Sandstone: light gray, very fine grained slightly salt and pepper, angular to subangular, well sorted, noncalcareous, silty, streak of Shale: as above, very slightly porous, no cut.

7143 - 7170 Shale: very dark gray, micromicaceous, rare Inoceramus prisms, partly silty, trace carbonaceous material with interbedded Sandstone: light gray to gray, very fine grained, slightly friable, slightly porous, salt and pepper, silty matrix, angular, well sorted, part medium sorted, rare, very slight cut, trace Sandstone: gray with white clay grains, trace Shale: brown, soft, silty.

7170 - 7200 Shale: dark gray, micromicaceous, slightly splintery; Shale: brown, soft, silty; Sandstone: light gray to gray, very fine grained, slightly friable, slightly porous, salt and pepper, silty matrix, angular, medium sorted, very slightly cut 7170-7175'.

7200 - 7220 Shale: medium to dark gray-brown, soft, silty; Shale: dark gray, splintery, minor sandstone at 7170-7200'.

7220 - 7240 Shale: dark gray-brown cast, soft, part silty, minor sandstone as at 7170-7200'.

7240 - 7280 Shale: dark gray, slight brown cast, micromicaceous, part splintery, trace siderite and pyrite, very rare floating rounded sand grains, medium size, very light orange, very slightly frosted, minor Sandstone: light gray, salt and pepper, silty, slightly friable, trace cut or mud contamination.

7280 - 7290 Shale: medium to dark gray, part brown cast, micromicaceous, trace floating sand grains, very light orange, medium to coarse grained; trace bentonitic Shale: light green, cream.

7290 - 7300 Shale: medium to dark gray, part brown cast, micromicaceous, increase floating sand; trace Sandstone: light gray, trace dark grains, friable, slightly porous, noncalcareous, trace bentonitic Shale: cream, green.

7300 - 7368 Shale: dark gray-brown, soft, trace floating sand grains, trace pyrite, trace bentonitic Shale: cream, trace

Sandstone: light gray, slightly salt and pepper, friable, rare cut blue-yellow; floating sand grains, medium coarse grain size, very slightly frosted, faint orange color in part.

7368 - 7378 Core No. 5: Cut 10', Recovered 9'

7368.0-7377.0' (9.0') Shale: very dark gray with brown cast, moderately soft, slightly micaceous; pyritic fossil remains, rare scattered rounded sand grains, fine to coarse, very rare pebble rounded with clay film, very slightly frosted to polished in part light orange.

7377.0-7378.0' (1.0') No recovery.

7378 - 7420 Shale: very dark gray with slight brown cast, slightly micaceous, pyritic fossils, rare very light orange floating sand grains, rounded, medium grained, part with clay film; trace Shale: light gray, clayey, bentonitic, trace silty shale; rare Bentonite: light green, rare pebble gray, subrounded chert(?).

7420 - 7428 Shale: very dark gray with slight brown cast, slightly micaceous, pyritic fossils, rare very light orange, floating sand grains, rounded, medium grained, part with clay film; trace Sandstone: gray, tight.

7428 - 7465 Sandstone: white, light brown, very fine grained, angular, subangular, slightly friable, rare glauconite, slightly silty, very slight cut; Shale: very dark gray with slight brown cast, slightly micaceous, pyritic fossils.

7465 - 7491 Shale: very dark gray, splintery; Shale: dark brown, moderately soft becoming brown, reddish at base of unit; interbedded Sandstone: light gray, white, very fine grained, silty, glauconitic, very slightly friable, subangular, well sorted, and Siltstone: gray-brown, trace siliceous.

7491 - 7501 Core No. 6: Cut 10', Recovered 10'

7491.0-7501.0' (10.0') Shale: dark gray-brown, micaceous, brown streak, noncalcareous, rare shell fragments, pelecypod, trace pyrite, slight uneven break.

7501 - 7530 Shale: very dark gray, very dark gray-brown, brown streak, micaceous, trace pyrite, part soft, part breaks very easily; rare sandstone and siltstone, very rare floating rounded sand grains.

7530 - 7560	Shale: very dark brown, part soft, part breaks easy, brown streak, pyrite, floating sand grains, trace Siltstone: dark gray-brown, friable, argillaceous.
7560 - 7640	Shale: dark brown, micaceous, part silty, pyrite, rare floating sand grains, rounded.
7640 - 7690	Shale: medium, dark brown, slightly fissile, micaceous, pyrite, moderately soft.
7690 - 7720	Shale: medium, dark brown, slightly fissile, micaceous, part silty, sandy, pyrite, little light brown clay, shale soft.
7720 - 7760	Shale: medium, dark brown, slightly fissile, micaceous, pyrite, brown streak.
7760 - 7830	Shale: medium, dark brown, slightly fissile, micaceous, trace pyrite, trace floating sand grains, trace siderite.
7830 - 7890	Shale: dark brown, fissile, micaceous, rare pyrite, rare floating sand grains, trace siderite.
7890 - 7938	Shale: very dark gray-brown, fissile, part splintery, rare floating sand grains, pyrite, siderite.
7938 - 8020	Shale: medium, dark gray-brown cast, micaceous, fissile, pyrite, floating sand grains, rounded, very light orange, rare shell fragment.
8020 - 8090	Shale: medium, dark gray, part dark brown, fissile, micaceous, pyritic, rare floating sand grains, rare siderite, very rare chert gray opaque, shale becoming splintery, trace Clay: cream, siliceous.
8090 - 8120	Shale: medium gray, dark gray, trace brown, fissile, splintery, rare coarse glauconite, very rare pyrite floating sand.
8120 - 8190	Shale: medium and dark gray, dark brown, fissile, splintery, rare pyrite, floating sand grains, glauconite, interbedded thin lenses, Sandstone: gray, very fine grained, subangular, silty, shaly, very glauconitic.
8190 - 8210	Shale: dark gray-brown cast, splintery, rare pyrite, floating sand grains, very rare glauconite, trace Sandstone: gray-green, tight, glauconitic.
8210 - 8290	Shale: dark gray-brown cast, splintery, rare pyritized fossils, floating sand grains, rare glauconite, rare shell fragment; trace Siltstone: gray, medium gray, glauconitic.

8290 - 8370 Shale: dark gray-brown cast, part splintery, pyritized fossils, floating sand grains, very light orange, fine to coarse grained, very rare glauconite, trace Siltstone: gray, glauconitic, pyritic.

8370 - 8470 Shale: dark gray-brown, brown streak, part splintery, pyritic, rare glauconite, rare imbedded floating sand, rare pyritized fossils; rare Siltstone: gray, glauconitic to medium dark gray, argillaceous.

8470 - 8530 Shale: dark brown, brown streak, dark gray, splintery pyrite, pyritized fossils, glauconitic, very rare floating sand, part nonglauconitic; very rare Siltstone: gray, very slightly salt and pepper.

8530 - 8590 Shale: dark brown, brown streak, trace soft, pyritized fossils, common, very rare glauconite, very rare siderite, very rare imbedded floating sand; very rare Siltstone: gray, glauconitic.

8590 - 8650 Shale: dark brown, brown streak, trace silty, trace sandy, rare pyrite, pyritized fossils, glauconite, floating sand grains, very rare Sandstone: light gray, silty, very fine grained with light green glauconite, very rare Siltstone: gray, sandy.

8650 - 8760 Shale: dark brown, brown streak, trace silty, sandy, rare pyrite, pyritic fossils, glauconite, and floating sand grains, very rare Sandstone: light gray, silty, very fine grained, with light green glauconite, very rare Siltstone: gray, sandy.

8760 - 8800 Shale: dark brown, brown streak, part silty, pyrite, pyritized fossils, floating sand grains, trace siderite; Siltstone: dark brown, shaly.

8800 - 8880 Shale: dark brown, brown streak, part silty, rare glauconite, fine to coarse grained, pyrite, pyritized fossils, siderite and floating sand grains, trace Siltstone: gray, trace carbonaceous, trace sandy glauconitic, very rare Sandstone: light gray, very fine grained, silty, very rare glauconite, slightly salt and pepper, angular, well sorted.

8880 - 8950 Shale: very dark gray-brown, brown streak, trace splintery to fissile and splintery, rare pyrite, pyritized fossils, very rare floating sand and glauconite.

8950 - 9010 Shale: as above; trace Sandstone: light gray, very fine grained, silty, slightly salt and pepper, rare carbonaceous, angular, well sorted, shaly partings. This sandstone between 8950-8960'.

9010 - 9020	Shale: dark brown, soft, silty, trace Shale: brown, gray, soft, clayey, pyritic fossils; rare Sandstone: gray-brown, very fine grained, silty, argillaceous, soft, friable, slightly porous; no stain, odor, cut, or fluorescence; Siltstone: medium brown, soft, clayey, sandy.
9020 - 9080	Sandstone: gray, very fine grained, silty, angular, well sorted, slightly porous, very slightly micaceous, trace pyrite, very slight cut to no cut; Siltstone: medium brown, soft, clayey, sandy.
9080 - 9140	Sandstone: light gray to gray, very fine grained, silty, slightly friable, slightly micaceous, rare light green glauconite, trace shaly streak; Siltstone: gray, gray-brown, slightly micaceous, trace shaly.
9140 - 9290	Shale: very dark gray, black, part brown streak, part splintery, rare pyrite and pyritized fossils, trace Shale: medium to dark gray, moderately soft, splintery, interbedded Siltstone: medium gray, friable and trace Sandstone: gray-brown, very fine grained, silty, slightly friable, very rare glauconite, rare floating sand grains.
9290 - 9360	Shale: very dark gray, brown, trace black, part brown streak, rare splintery, very rare floating sand and glauconite, rare pyrite, trace Siltstone: gray, medium gray, argillaceous, moderately soft, very slightly calcareous, trace at 9350' Sandstone: light gray, very fine grained, silty, very slightly calcareous, slightly salt and pepper, subangular, well sorted, tight to very slightly porous.
9360 - 9400	Shale: dark gray-brown, brown streak, slightly micaceous, very rare pyrite, floating sand grains, and glauconite, trace Siltstone: brown, medium brown, slightly micaceous, argillaceous.
9400 - 9470	Shale: medium gray, brown cast, micaceous, brown streak, rare pyrite and glauconite, very rare floating sand, Shale: part very dark gray-brown, part silty; Siltstone: gray-brown, moderately soft, slightly micaceous, pyritic.
9470 - 9613	Shale: very dark gray-brown, medium gray, micaceous, brown streak, trace silty, rare pyrite, pyritized fossils, very rare floating sand, very rare glauconite, very rare siderite, brown calcareous; Siltstone: dark brown, moderately soft, slightly sandy; Sandstone at 9498-9501': light gray, very fine grained, silty, subangular, well sorted, slightly salt and pepper, very slightly calcareous; no stain, odor, cut, or fluorescence.

9613 - 9622	Sandstone: medium gray-brown, very fine grained, silty, slightly argillaceous, subangular, well sorted, slightly friable, very slightly porous, very slight cut fluorescence.
9622 - 9643	Sandstone: medium to dark gray, very fine grained, very silty, slightly argillaceous, rare slightly calcareous, rare siliceous, slightly friable to tight, very slightly porous, very slight cut fluorescence; trace Siltstone: medium to dark gray-brown, part tight, slightly calcareous; trace Shale: very dark gray, part with brown streak.
9643 - 9670	Shale: very dark gray, part with brown streak, trace pyrite, little interbedded Sandstone: as above.
9670 - 9740	Shale: dark gray-brown, trace black, brown streak, trace pyrite, pyritized fossils, very rare floating sand grains, shale becoming partly fissile, splintery, trace Sandstone: dark gray, very fine grained, tight.
9740 - 9810	Shale: medium and dark gray, slightly micaceous, part fissile, pyrite and pyritic fossils, very rare floating sands to none, in part silty.
9810 - 9842	Shale: dark gray, slightly micaceous, part splintery, part silty and sandy, pyrite and pyritized fossils, very rare floating sand grains; Siltstone: gray, medium gray, tight, slightly siliceous, trace slightly calcareous, trace Sandstone: gray, dark gray-brown, very fine grained, silty argillaceous, tight trace friable.
9842 - 9913	Sandstone: medium gray to dark gray-brown, very fine grained, silty, argillaceous, tight, trace siliceous, slightly calcareous, trace Shale: very dark gray with brown cast, slightly fissile and splintery, trace pyrite, sandstone in part grading to siltstone.
9913 - 9920	Sandstone: light gray, white, very fine grained, firm, friable, in part siliceous with rare glauconite.
9920 - 9960	Siltstone: medium gray, firm to hard becoming slightly calcareous with thin stringers of Shale: brown-gray, soft, platy, micromicaceous.
9960 - 9980	Siltstone: as above, grading in part to Sandstone: light gray, medium gray, argillaceous, pyritic, poorly sorted with rare quartz and chert fragments.
9980 -10,050	Siltstone: medium gray, light gray, hard to firm, siliceous, slightly calcareous, slightly sandy with rare glauconite.

10,050-10,170 Siltstone: medium gray, light gray, firm, occasionally grades to argillaceous, sandstone becomes increasingly calcareous with 7% at 10,080', 10% at 10,100', 16% at 10,140'.

10,170-10,220 Shale: black, becoming dark gray at 10,190', firm, silty, slightly calcareous, in part splintery with fairly common crinoid columnals.

10,220-10,270 Shale: brown-gray, dark gray, firm, calcareous, micromicaceous, in part silty with brown fossil fragments and crenulated casts of probable Monotis sp. and/or Halobia sp., thin beds of Limestone: light gray-brown, highly fossiliferous occurs at 10,240' and 10,260', probable Monotis sp.

10,270-10,300 Core No. 7: Cut 30', Recovered 30'

10,270.0-10,285.0' (15.0')	Shale: dark gray, hard, brittle, calcareous with common whole shells and shell impressions and poorly developed near horizontal bedding.
10,285.0-10,285.2' (0.2')	Pebbles, small to large (2.5" x 1"), tan, black, subrounded, occur in a shale matrix.
10,285.2-10,285.4' (0.2')	Large subhorizontal, partially open fracture.
10,285.4-10,285.8' (0.4')	Limestone: dark gray, argillaceous, with thin bed of light gray concentrated whole Monotis sp. shells.
10,285.8-10,293.4' (7.6')	Shale: dark gray, hard, brittle, highly calcareous, in part grading to dark gray, argillaceous, limestone and with light gray bands of biohermal limestone.
10,293.4-10,293.6' (0.2')	Shale: as above with large carbonized wood fragments (3" x 1") in horizontal attitude.
10,293.6-10,300.0' (6.4')	Limestone: dark gray, biohermal, interbedded with dark gray, calcareous, fossiliferous shale with near horizontal bedding.

10,300-10,305 Shale: as above.

10,305-10,320 Limestone: tan-brown, hard, fossiliferous, biocalcarenite, very common black phosphate pellets, pyrite replacement of calcite and crinoids, nil porosity, no shows.

10,320-10,335 Sandstone: brown, very fine grained, highly argillaceous, silty, firm phosphate pellets, grades in part to sandy biocalcarenite.

10,335-10,360 Shale: gray-brown, dark gray, firm, becoming noncalcareous, interbedded with Siltstone: medium gray, firm, slightly calcareous, and Limestone: brown-tan, firm, argillaceous, phosphatic, glauconitic.

10,360-10,390 Sandstone: brown, very fine grained, silty, firm, argillaceous, tight, no shows.

10,390-10,440 Shale: brown, brown-gray, firm, silty, noncalcareous, with finely disseminated and chunk pyrite.

10,440-10,470 Sandstone: light gray to tan, very fine grained, in part grading to very poorly sorted fine to medium to coarse grained subangular to subrounded and with small pebbles of chert and quartz, no visible porosity or shows noted.

10,470-10,525 Sandstone: buff to light gray, very fine grained, firm, hard, dolomite cemented, in part siliceous and grading to gray-brown, firm siltstone, interbedded with Shale: brown-gray, firm, splintery.

10,525-10,540 Shale: dark gray, gray-brown, firm, flaky, interbedded with Sandstone: as above, no porosity, no shows.

10,540-10,560 Sandstone: light gray, very fine to fine grained, poorly sorted, subrounded, clear, white quartz, hard, tight, no porosity, interbedded with Shale: gray-brown, flaky, and Siltstone: brown-gray, hard, firm.

10,560-10,600 Sandstone: tan to light gray, very fine grained, in part medium grained, poorly sorted with small chert and quartz pebbles, hard, siliceous, no porosity, no shows, slight gas increase, 6 units to 22 units at 10,590'.

10,600-10,619 Sandstone: buff to white, fine to medium grained, hard, clean, subrounded, rounded white, clear quartz, well compacted, slight intergranular porosity, 5-10%, very slight yellow cut fluorescence; no odor, no visible stain.

10,619-10,649 <u>Core No. 8: Cut 30', Recovered 30'</u>

10,619.0-10,633.0' (14.0') Sandstone: white to light gray, fine to very fine grained, clean, clear, white, well sorted subangular to subrounded quartz, hard, well compacted with few thin shale partings dipping 0°-15°, poorly developed, nonmineralized closed

vertical fractures, slight intergranular porosity, 5-10%, no stain, odor, cut, very slight yellow cut fluorescence, possibly contamination.

10,633.0-10,645.4' (12.4') Sandstone: light gray to white, fine to very fine grained, slightly argillaceous, hard, very hard, in part grading to quartz, overgrowth quartzite, common bioturbation with thin horizontal shale partings and siliceous shale nodules tight, 5% porosity; no shows.

10,645.4-10,649.0' (3.6') Sandstone: as at 10,619' to 10,633', in part, very hard, grading to quartzite.

10,649-10,730 Sandstone: white, very fine to fine grained, occasionally medium to coarse grained, poor to well sorted, becomes very hard, siliceous, quartzitic with occasional thin gray shale and siltstone stringers.

10,730-10,765 Shale: pink to red, red-brown, light gray, silty, interbedded with Sandstone: white to light gray, light green-gray, pink to red, very fine to fine grained, argillaceous, varicolored grains, pink, orange, green, gray, clear, black.

10,765-10,785 Sandstone: white, light gray-green, fine to very fine grained, well sorted, well rounded, tight, some pink grains, thin red shale stringer.

10,785-10,805 Shale: red, silty, firm, in part brown-gray shale interbedded with Sandstone: light gray, very fine to fine grained, hard, slightly argillaceous, siliceous.

10,805-10,810 Siltstone: red-brown, hard, grades to Shale: pink-red, firm.

10,810-10,815 Sandstone: white to light gray, very fine to fine to medium grained, poorly sorted, well rounded, clean, firm, hard, slightly friable, clear, white quartz; no stain, odor, cut, or fluorescence.

10,815-10,842 Core No. 9: Cut 27', Recovered 27'

10,815.0-10,821.0' (6.0') Sandstone: light gray, very fine to fine grained, hard, clear, white quartz, slightly siliceous with thin shale streaks, random 15°-20° dips, closed, discontinuous vertical fractures, 5% porosity, no shows.

10,821.0-10,828.4' (7.4')	Sandstone: light gray, fine to medium grained, poorly sorted, argillaceous, subangular, subrounded, increasingly coarse with small pebbles, white, clear, pink, tan, black, hard, tight with thin shale partings, 15°-20° dips, few scattered shale pods, black, medium gray, hard.
10,828.4-10,829.8' (1.4')	Sandstone: as at 10,815' to 10,821', increasingly hard quartzite.
10,829.8-10,842.0' (12.2')	Sandstone: light gray, fine grained, slightly argillaceous, hard, very hard, siliceous, tight, with common Shale clasts: medium gray, brown, up to 1" x 1" near horizontal bedding, thin hard dark gray shale partings, salt and pepper, carbonaceous grains, closed discontinuous vertical fractures; no shows.
10,842-10,870	Sandstone: white to light gray, very fine to fine grained, white, clear quartz, well sorted, subrounded, clean, hard, siliceous, trace carbonaceous; no shows.
10,870-10,880	Sandstone: light green to gray, very fine grained, silty, slightly argillaceous, hard, interbedded with red-brown, silty, shale and dark gray shale.
10,880-10,890	Shale: red to pink, silty, flaky, Shale: dark brown-gray, very hard, splintery, red shale grades in part to red-pink siltstone.
10,890-10,925	Sandstone: white to light gray, very fine to fine grained, well sorted, subrounded, clear, white, rarely pink quartz, hard, in part very hard quartzite, interbedded with thin stringers of red-brown and gray shale.
10,925-10,960	Sandstone: as at 10,890', with fairly common orange and black, rarely pink grains, interbedded with thin red-brown and gray-brown shale and red-brown, medium gray micaceous, carbonaceous, siltstone.
10,960-11,000	Sandstone: red, fine to very fine grained, moderately hard, slightly friable, argillaceous, micromicaceous, clear, white, rarely green (not glauconite) and orange quartz grains, subangular, occasionally angular chert and quartz grains with thin shale beds, dark gray, micromicaceous, pyritic, hard, blocky; no shows.

11,000-11,045 Sandstone: light gray, reddish cast, very fine to fine grained, becoming silty, becoming commonly carbonaceous, hard to very hard siliceous cement, blocky, minor shale and white to pink clay alteration.

11,045-11,080 Sandstone: as above, becomes light gray with thin shale stringers, brown to gray, light gray to pink.

11,080-11,100 Siltstone: medium gray, hard, gradational with light gray, silty sandstone and interbedded with Shale: medium gray, firm, slightly silty.

11,100-11,108 Shale: light gray, medium gray, micromicaceous, flaky, splintery.

11,108-11,135 Core No. 10: Cut 27', Recovered 27'

11,108.0-11,135.0' (27.0') Kavik Shale Member. Lithology: Shale: dark gray, very hard, brittle, with thin stringers and lenses of medium gray, silty shale, noncalcareous, rare carbonized plant fragments on shale partings; low angle dips of 10°-15°, decrease below 11,120' to 0°-5°; no hydrocarbon indications observed.

11,135-11,160 Shale: dark gray, medium gray, dark brown-gray, hard, firm, flaky, micromicaceous, trace of pelecypods.

11,160-11,205 Shale: medium gray, silty, in part grading to carbonaceous, siltstone occasionally becomes dark gray, dark brown-gray, rare chunk pyrite, rare nondescriptive fossils.

11,205-11,240 Shale: medium, dark gray, micromicaceous, rare pyrite, rare fossil impressions; Siltstone: gray, medium gray, micaceous, trace carbonaceous, trace gray-green, hard.

11,240-11,296 Shale: medium, dark gray, micromicaceous, rare pyrite, rare fossil impressions; interbedded Siltstone: gray, gray-green, hard, micaceous, trace carbonaceous, and Sandstone: pink, white, fine grained, angular, slightly friable, part siliceous, trace varicolored grains, trace white grains.

11,296-11,380 Sandstone: very dark gray-green, gray, fine grained to very fine grained glauconitic, siliceous, part shaly, little light green, very fine grained, silty; interbedded Siltstone: gray, hard, tight, very slightly salt and pepper, sandy, part dolomitic, and Shale: very dark brown, soft, part siliceous, part silty to dark gray; trace Shale: red, rusty, iron stained.

11,380-11,458 Shale: dark gray-green, dark gray, part fissile, rare glauconite; trace Shale: red-maroon mottled, trace black grains, part dolomitic; interbedded Siltstone: dark green-gray, shaly, part dolomitic, trace siliceous, trace Sandstone: white, very fine grained, siliceous; red to maroon shale in thin beds from 11,360' to 11,385'.

11,458-11,495 Siltstone: dark gray, dark brown-gray, calcareous, hard, slight conchoidal fracture, rare shell fragments, part dolomitic, trace pyrite; little Shale: dark green-gray, part silty, part splintery, rare silty limestone.

11,495-11,501 Limestone: cream to light gray, microcrystalline, silty, slightly micaceous.

11,501-11,640 Siltstone: dark gray, hard, calcareous, very rare brachiopod-like spine, small; Shale: dark gray, fine micaceous, part silty; Limestone, 11,537-11,541': medium, dark gray-brown microcrystalline, slightly silty; streaks Sandstone: white, fine grained, angular, very slightly friable to quartzitic; rare interbeds Limestone: medium and very dark gray, microcrystalline, silty at 11,579' to 11,580' and 11,624' to 11,627'.

11,640-11,642 Limestone: cream, white, mottled brown, gray, very fossiliferous with indistinct fossils, shell fragments, spines(?), sparry calcite, rare chert, blue-gray.

11,642-11,704 Shale: very dark gray, part silty; Siltstone: medium, dark gray, calcareous; Limestone at 11,662' to 11,665' and 11,679' to 11,682, as above at 11,640' to 11,642'; limestone at 11,687' to 11,692', dark, resinous brown, microcrystalline with scattered indistinct fossils.

11,704-11,718 Limestone: cream, light brown, mottled brown, gray, fossiliferous with indistinct fossils, indistinct Crinoids, little soft chalky, pinpoint porosity, trace small vugs with druse, trace calcite and dolomite crystals, trace petroleum residue, no cut or fluorescence.

11,718-11,733 Core No. 11: Cut 15', Recovered 15'

11,718.0-11,729.0' (11.0') Limestone: dark resinous brown, fine crystalline, trace coarse crystalline, fossiliferous, crinoid, brachiopod, bryozoa, pelecypod, foraminifera, tubes, part argillaceous, calcite veining, trace small vugs with druse of calcite crystals; Shale: very dark gray, slightly micaceous, rare fossil fragments at 11,719'.

11,729.0-11,733.0' (4.0')	Limestone: medium brown, cryptocrystalline, scattered foraminifera or tubes, trace crinoid, brachiopod, bottom 3 inches vug with dolomite and quartz crystals, spotted good porosity; no odor, stain, cut, or fluorescence in core.
11,733-11,766	Limestone: medium brown-gray, mottled, brachiopod, foraminifera, interbedded Siltstone: dark gray, dark brown, calcareous; Shale: dark gray, micromicaceous.
11,766-11,770	Dolomite: gray, cryptocrystalline, slightly argillaceous.
11,770-11,774	Limestone: light gray, medium brown, part chalky, part soft, pinpoint porosity, part sandy, no shows.
11,774-11,800	Limestone: medium gray-brown, microcrystalline, trace crinoid, brachiopod, part very fine, sandy; little Shale: dark gray, and siltstone.
11,800-11,840	Limestone: cream, medium to dark brown, cryptocrystalline, trace crinoid to Limestone: cream, oolitic, tight to slightly porous, little cream, chalky, soft, indistinct oolitic, trace siliceous, little interbedded Siltstone: medium, dark gray-brown, sandy, calcareous breaks at 11,803' to 11,806' and 11,837' to 11,840'; no odor, stain, cut, or fluorescence.
11,840-11,865	Limestone: dark brown lithographic to slightly sandy, slightly oolitic, rare glauconite, scattered crinoid, brachiopod, stylolites, little light gray, chalky.
11,865-11,893	Limestone: medium brown, brown lithographic, rare stylolites, Chert: light gray, light brown, brown translucent; rare indistinct fossils, little slightly chalky.
11,893-11,927	Limestone: cream, light brown, slightly mottled, chalky, faint oolites, soft, trace chert faintly oolitic and fossiliferous.
11,927-11,940	Limestone: medium brown, lithographic, rare pyrite, stylolite and chert.
11,940-11,950	Limestone: light brown, brown mottled, tight, oolitic, becoming cream, chalky, soft, faintly oolitic, rare brachiopod, rare chert.
11,950-12,030	Limestone: gray-brown mottled, indistinct bioclastic, crinoid, brachiopod spines, trace Chert: light gray-brown translucent, interbedded Limestone: medium to dark brown, lithographic, part chalky.

12,030-12,046	Limestone: cream, light gray-brown mottled, chalk, part cryptocrystalline, trace crinoid, little Chert: light tan, light gray, translucent.
12,046-12,103	Limestone: medium gray to dark brown, lithographic, part splintery, part slightly conchoidal.
12,103-12,130	Limestone: light gray, chalky, sandy to dark gray mottled, siliceous, trace indistinct fossil, trace Chert: blue, dark gray to black, brown translucent, trace opaque; interbedded Limestone: medium brown, lithographic; rare glauconite.
12,130-12,158	Limestone: brown lithographic, trace chalky, rare pyrite, rare stylolite, trace slightly mottled, rare Chert: gray mottled translucent.
12,158-12,180	Limestone: light to medium brown mottled, faint pelletoid, rare indistinct oolites, part chalky, trace glauconite, trace Chert: light gray, translucent.
12,180-12,245	Limestone: cream to brown mottled, bioclastic, rare crinoid, interbedded Limestone: brown, lithographic; trace Dolomite: brown, sucrose; little Chert: light brown, light gray, translucent; Limestone 12,230' to 12,238': light brown, very fine oolitic, tight, part chalky.
12,245-12,345	Limestone: cream, mottled, medium gray, medium brown, pelletoid to bioclastic, part chalky, little Chert: light gray, mottled, brown translucent; trace Chert: white, opaque, little interbedded Limestone: brown, lithographic, rare faint oolite; 50% Chert: as above, mottled translucent from 12,290' to 12,300'.
12,345-12,364	Limestone: cream, light gray-brown, bioclastic, chalky, rare, fine pelletoid; Chert: blue, light gray, translucent; interbedded Limestone: light brown, brown, lithographic.
12,364-12,420	Limestone: light, medium to dark brown, lithographic, part chalky; interbedded Limestone: light brown, pelletoid, part bioclastic; Chert: light brown, translucent, trace opaque.
12,420-12,500	Limestone: dark brown, brown, lithographic; interbedded Limestone: cream, medium gray-brown, mottled, bioclastic, trace Siltstone: medium gray, trace green calcareous, little shaly; Chert: light gray, mottled, translucent to black sub-opaque.

12,500-12,540 Limestone: cream, brown-gray, mottled, bioclastic, trace pelletoid, part siliceous, rare stylolite, rare glauconite, little Chert: light brown, translucent; little Limestone: mottled, light and dark gray, black pelletoid, trace quartz vein; Chert: gray, subtranslucent, trace black opaque.

12,540-12,572 Limestone: gray, dark gray, mottled, trace black, pelletoid, bioclastic, trace Limestone: medium brown, lithographic; Chert: medium brown translucent; Siltstone interbedded: gray, green dolomitic.

12,572-12,590 Limestone: light gray, chalky, soft to gray-brown, cryptocrystalline.

12,590-12,620 Limestone: cream, brown, mottled, bioclastic, trace chalky, part silty, trace pelletoid, trace Chert: light gray, translucent; interbedded Siltstone: gray, slightly calcareous.

12,620-12,743 Limestone: white, cream, mottled brown to dark brown, bioclastic, trace pelletoid, trace crinoid, part silty, little Limestone: light gray, chalky to medium brown, lithographic; Chert: dark brown, rare black opaque and light gray, light brown translucent; trace Siltstone: brown-gray calcareous, and Shale: medium gray, micromicaceous.

12,743-12,753 Core No. 12: Cut 10', Recovered 10'

12,743.0-12,745.0' (2.0')	Limestone: very dark gray-brown, lithographic, conchoidal, little splintery, slightly argillaceous, trace siliceous; interbedded Limestone: very dark brown, crystalline bioclastic, crinoidal, scattered pelletoid, fractured.
12,745.0-12,749.0' (4.0')	Limestone: very dark gray-brown, fine, medium trace coarse crystalline, bioclastic, pelletoid, crinoidal, very slightly argillaceous, part fractured.
12,749.0-12,752.0' (3.0')	Limestone: very dark gray-brown, medium to very coarse, crystalline, bioclastic, crinoidal, slightly siliceous, rare glauconite, fractured.
12,752.0-12,753.0' (1.0')	Siltstone: dark gray, very slightly dolomitic, rare scattered crinoid.

12,753-12,870	Limestone: very dark gray-brown, light gray mottled, pelletoid, bioclastic crinoid, slightly argillaceous; Siltstone: light gray to gray, calcareous; Chert: light gray, with disseminated pyrite, opaque and light brown translucent; siltstone becoming light green, trace dark gray, part dolomitic; trace Shale: dark gray to black.
12,870-12,945	Limestone: light to very dark gray-brown, mottled, indistinct bioclastic, trace crinoid, bryozoa, little brown lithographic, trace chalky; interbedded Shale: dark gray, black micromicaceous, rare shell fragment; Sandstone: white, very fine grained, silty, subangular, well sorted, medium porosity, no show, sandstone from 12,895' to 12,905', little Siltstone: dark gray to light gray, tight, part calcareous.
12,945-12,960	Interbedded Limestone: cream, brown, mottled, indistinct, bioclastic, chalky, slightly silty and sandy, slightly dolomitic, trace crinoid, brachiopod spine; Siltstone: cream, light gray, soft, very calcareous, sandy.
12,960-12,992	Limestone: brown, mottled, bioclastic; interbedded Siltstone: medium, dark gray, siliceous, dolomitic, trace Shale: very dark gray, micromicaceous, trace splintery.
12,992-13,075	Limestone: light to dark gray-brown, mottled, part chalky, bioclastic, trace pelletoid, trace very dark gray, dark brown lithographic; Siltstone: light gray, gray, dark gray, tight, dolomitic, rare glauconite, trace Limestone: medium brown, lithographic.
13,075-13,091	Limestone: cream, white, fine crystalline, indistinct fossils, glauconitic, silty, little Limestone: medium to very dark gray-brown, lithographic; Siltstone: red, trace red shaly dolomitic at 13,083' to 13,091'.
13,091-13,130	Limestone: gray-brown, mottled, bioclastic, trace pelletoid, rare brachiopod spines, becoming very dark gray to black cryptocrystalline; trace Shale: very dark gray micromicaceous; trace Siltstone: medium, dark gray calcareous to dolomitic; trace Sandstone: gray, very fine grained, silty.
13,130-13,165	Interbedded Siltstone: dark green-gray, tight to friable, part sandy, part calcareous, part dolomitic; Limestone: brown, dark brown, lithographic; trace Shale: very dark gray, trace chert.
13,165-13,180	Limestone: white, light gray, medium gray, mottled, indistinct, bioclastic, fragmental, part soft, chalky, soft break 13,170' to 13,174'; Chert: light brown, mottled, translucent.

13,180-13,230	Interbedded Siltstone: gray, part red from 13,186' to 13,200', tight, dolomitic; Limestone: mottled, light to dark gray, brown bioclastic, trace brachiopod spine, trace chalky, trace brown, lithographic; trace Chert: light gray, brown and trace smoky, little light blue-gray translucent.
13,230-13,267	Limestone: mottled white, dark gray, chalky, bioclastic, little very dark gray-brown-black microcrystalline, trace crinoid, brachiopod spines, bryozoa.
13,267-13,285	Siltstone: light gray dolomitic to very fine sandy calcareous to dark gray dolomitic.
13,285-13,320	Limestone: medium, dark gray-brown, faintly mottled, bioclastic to very dark gray-brown, lithographic, argillaceous, part silty; trace Shale: dark gray, green; Chert: light gray, translucent, slightly mottled.
13,320-13,332	Limestone: mottled white, dark gray, indistinct, bioclastic, becoming very silty.
13,332-13,342	Chert: very light brown, translucent, with interbedded Limestone: as above, part chalky.
13,342-13,360	Siltstone: light gray, calcareous to light green-gray dolomitic and very fine, trace, glauconite.
13,360-13,430	Limestone: gray to dark gray, part brown, mottled, indistinct fossiliferous, siliceous, part silty; Chert: gray-brown, mottled, becoming predominantly Siltstone: light, medium, dark gray, brown, part siliceous, dolomitic, trace glauconite.
13,430-13,531	Limestone: dark brown, microcrystalline, trace silty to Limestone: white, cream, slightly mottled, bioclastic, part silty, trace glauconite; little Siltstone: green, dark gray, slightly dolomitic, trace siliceous to calcareous, little Chert: light gray, light brown, part mottled translucent.
13,531-13,550	Limestone: light gray, medium gray, cryptocrystalline with trace of bioclastic, granite stone interbedded with thin stringers of Siltstone: medium gray, dark gray and Shale: dark gray, noncalcareous.
13,550-13,570	Limestone: buff to tan, light gray, increasingly recrystallized.
13,570-13,575	Chert: light gray to white, mottled, translucent.

13,575-13,630	Limestone: buff to tan, light gray to buff, in part recrystallized, chalky, in part cryptocrystalline, trace nondescriptive fossils, pellet ghosts, interbedded with thin stringers of medium gray siltstone and Chert: light gray to white, brown, mottled.
13,630-13,685	Limestone: light gray to buff, partly recrystallized with rare fossil and pellet ghosts and with thin stringer of chert and siltstone.
13,685-13,720	Limestone: tan to buff, medium hard, increasingly recrystallized, slightly chalky, trace fossil and pellet ghosts, rare pelecypod fragment, occasional stringer of chert and siltstone.
13,720-13,725	Chert: white to clear, slightly mottled.
13,725-13,745	Limestone: tan to buff, light gray to buff, partly recrystallized, slightly chalky, tight, no stain, no cut, poorly preserved fossil fragments and pellets with thin beds of Siltstone: medium gray, firm, and Shale: dark gray, firm, slightly carbonaceous.
13,745-13,780	Limestone: buff to tan, tan to light gray, hard microcrystalline in part recrystallized with trace pelletal ghosts.
13,780-13,795	Dolomite: tan to buff, finely crystalline, sucrosic, few pinpoint vugs, slight visible porosity, approximately 5%, dull yellow fluorescence, slow yellow cut fluorescence, possible diesel and black magic contamination, no visible oil stain.
13,795-13,830	Limestone: medium gray, gray-brown, tan, hard, argillaceous, dolomitic, slightly siliceous, with thin beds of siltstone, shale and chert; no porosity; no shows.
13,830-13,860	Dolomite: medium gray, dark gray, hard, calcareous, argillaceous, cherty with stringers of siltstone and chert, white to clear spicular.
13,860-13,930	Limestone: light gray to tan, tan to buff, dolomitic, argillaceous, very hard microcrystalline, in part cherty, trace spicules, stylolitic, occasionally bioclastic with bryozoa, pelecypods, pelletal interbedded with thin stringers of Siltstone: medium gray, moderately hard, slightly calcareous.
13,930-13,940	Dolomite: buff, moderately hard, becoming dark gray, highly argillaceous, slightly calcareous, with thin stringers of medium gray, slightly dolomitic siltstone.

13,940-13,950	Limestone: tan to gray, buff, dolomitic, pelletal, grainstone, in part poorly preserved; no porosity; no shows.
13,950-13,965	Limestone: tan to buff, hard, microcrystalline, becomes cherty with white to clear, tan chert, in part banded as probable void filling in poorly preserved pelletal grainstone, minor thin stringers of siltstone and dark gray splintery shale, trace of glauconite.
13,965-13,990	Limestone: buff to light gray, medium hard, dolomitic, slightly cherty with thin stringers of Siltstone: medium gray, hard, and Shale: dark gray, hard, splintery; no porosity; no shows.
13,990-14,010	Limestone: light gray to tan, hard, slightly argillaceous, dolomitic, fossiliferous, with probable fusulinids, pelecypods, rarely pelletal, in part recrystallized, buff to tan, soft argillaceous, chalky with thin beds of medium gray, green-gray siltstone and dark gray shale.
14,010-14,028	Siltstone: medium gray, dark gray, firm, carbonaceous, micaceous, in part pyritic, same green-gray, hard.
14,028-14,040	Limestone: buff to light gray, medium hard, partly recrystallized, bioclastic, probable crinoids, and pelecypods, with thin beds of siltstone, and Chert: milky, light gray.
14,040-14,050	Dolomite: light gray, very hard, slightly siliceous.
14,050-14,055	Siltstone: green-gray, hard, medium gray, firm, interbedded with Limestone: light gray, green-gray, hard, siliceous.
14,055-14,115	Limestone: buff to light gray, medium hard, partly recrystallized, chalky, poorly preserved bioclastic, grainstone, rare crinoids, foraminifera, pelecypod, rare glauconite with thin stringers of Siltstone: medium gray, green-gray, and Chert: clear, milky, no visible porosity, no shows, limestone occasionally grades to dolomite.
14,115-14,145	Limestone: buff, medium hard, partly recrystallized, clean, poorly preserved bioclastic grainstone, crinoids, fossil and pelletal grains, few pyrite inclusions and with black mottling from 14,120' to 14,130' (possibly dead oil stain); no shows; no porosity.
14,145-14,210	Limestone: buff to light gray, medium hard, partly recrystallized, poorly preserved, biocalcarenite, slightly dolomitic with occasional streaks of black dead oil stain;

no shows; no visible porosity, rare crinoids, foraminifera and bryozoans, shell debris, occasional light gray chert fragments.

14,210-14,280 Limestone: medium to light gray, tan, calcarenite altered to micrite, firm to hard, interbedded with limy Mudstone: medium to dark gray, scattered fossil fragments, hard, occasionally siliceous, trace medium blue to black chert.

14,280-14,290 Limestone: medium to dark gray, predominantly a lime Mudstone: hard, siliceous in part, slightly argillaceous with scattered pelletal fragments and 5% blue to black chert.

14,290-14,300 Limestone: light gray, consists of mixed calcarenite, and lime Mudstone: as above, hard, siliceous, with 5% Chert: light to dark gray.

14,300-14,310 Limestone (lime mudstone): medium to light gray, hard, slightly dolomitic.

14,310-14,320 Dolomite: light to medium gray, very fine grained, sucrosic in part, calcareous matrix, with white, clear, coarse crystalline calcite as probable fracture fill, nil porosity; no odor, stain, cut, or fluorescence, with very minor gas increase.

14,320-14,370 Limestone (lime mudstone): interbedded medium to light gray to medium light gray-tan, hard, slightly dolomitic, occasional very fine dolomite crystals, occasional pelletal grains.

14,370-14,390 Limestone (lime mudstone): medium to light gray, hard, slightly dolomitic, occasional siliceous, scattered skeletal fragments.

14,390-14,410 Dolomite: medium to dark gray, very fine grained, microcrystalline, hard, calcareous, occasionally siliceous; trace Chert: blue-gray.

14,410-14,420 Limestone (lime mudstone): medium to dark gray, argillaceous, siliceous, very slightly dolomitic, hard, minor Chert.

14,420-14,460 Dolomite: light to medium gray, very fine to microcrystalline, compacted, rarely very finely sucrosic, calcareous, occasionally grading to medium gray dolomitic lime mudstone, shows varying amounts of silicification.

14,460-14,510 Siltstone: dark gray to black, argillaceous, grading to silty shale, calcareous to siliceous, hard, blocky fracture

to occasionally platy in shale portions; probably with interbeds of medium to dark gray, microcrystalline to very fine, argillaceous dolomite and lime mudstone.

14,510-14,550 Lime Mudstone: medium to occasionally dark gray, lightly dolomitic (occasionally very finely sucrosic) with thin zones of lime wackestone to packstone of poorly defined grains and pellets; darker portions are lightly argillaceous.

14,550-14,560 Dolomite: dark gray, calcareous to occasionally lime mudstone, argillaceous in parts, siliceous, hard.

14,560-14,580 Lime Mudstone: grading to Lime Wackestone: medium gray in least altered to occasionally dark gray where argillaceous, lighter gray where recrystallized to fine grained, parts are moderately siliceous with traces of chert.

14,580-14,650 Interbedded limestones, mostly lime Mudstone: as above, generally more siliceous, and clastics consisting of siltstone and shale gradational from one to the other, very dark gray to black, calcareous, hard, with thin, very hard "microconglomeratic" sandstone, consisting of very poorly sorted quartz grains up to coarse size, now recrystallized to clear quartz in a dark matrix of probably an argillaceous, lime mudstone which is now heavily silicified; traces of pyrite and black carbonaceous flakes are common.

14,650-14,660 Shale: slightly lighter silver gray, cleaner, and softer than those seen above.

14,660-14,680 Lime Mudstone: medium gray to brown, more recrystallized than above (microcrystalline to fine); traces pyrite, chert common.

14,680-14,690 Dolomite: medium gray to gray-brown, calcareous, grading to dolomitic lime mudstone, lightly to moderately siliceous, finely crystalline, hard.

14,690-14,700 Lime Mudstone: medium to dark gray, hard, argillaceous, grading to calcareous, argillaceous siltstone; moderately to heavily silicified.

14,700-14,710 Lime Mudstone: medium to light gray, almost blue-gray, very smooth textured microcrystalline; with very fine pyrite spheres and very finely disseminated pyrite, parts siliceous, scattered sand grains, oolites, pellets and shell fragments.

14,710-14,730 Lime mudstone to lime Wackestone: medium gray lime matrix with pellets, oolites, shell fragments and white quartz and chert grains; matrix mostly recrystallized to very fine, mostly gray with some fine cream colored matrix; with minor argillaceous streaks, scattered chert and siliceous patches.

14,730-14,760 Lime mudstone grading occasionally to lime packstone of matrix and grain composition as above with thin interbeds of chert conglomerate of hard cemented gray, green, red, orange and mossy chert sand to pebble, hard silicified matrix that was probably originally argillaceous lime mudstone; thin, light gray, salt and pepper sands composed of calcareously cemented quartz, chert and carbonate grains, with little or no porosity, and thin Siltstone: dark gray, argillaceous, calcareous to siliceous, and thin chert beds or beds of chert nodules.

14,760-14,810 Siltstone: dark gray to black, argillaceous, occasionally sandy, calcareous to siliceous, with interbeds of lime Mudstone: medium to dark gray, argillaceous to clean, mostly recrystallized to fine, grading occasionally to wackestones with shell grains, pellets and oolites; thin, hard Sandstone: as above, and abundant chert; pyrite showed a slight increase.

14,810-14,830 Siltstone grading to Sandstone: light gray, clean, very fine, calcite cemented with minor poor porosity.

14,830-14,845 Lime Mudstone to lime filled quartz and carbonate, Sandstone: light to medium gray, hard.

14,845-14,850 Redbeds: brick red to reddish-brown siltstone which grades occasionally to very fine grained red sandstone and red silty Shale: calcareous, argillaceous, hard; picking top Endicott on color change, though it may actually include some of clastic section above.

14,850-14,880 Sandstone: light gray, salt and pepper, to lightly iron stained, very fine grained, tight with calcite and minor amounts of light gray clay filling pore spaces, some quartz grains recrystallized and clear, with minor amounts of light gray to green to red, calcareous siltstone, also tight and dirty.

14,880-14,940 Siltstone: red, argillaceous and grading to red shale, sandy siltstone, calcareous to siliceous, shales siliceous, chert formation is common throughout, occasionally sandy.

14,940-14,950 Sandstone: light gray to pink, tight, cherty.

14,950-14,971 Siltstone grading to Shale: red, calcareous to siliceous with chert common.

14,971-14,986 Core No. 13: Cut 15', Recovered 15'

14,971.0-14,975.5' (4.5')	Shale: red to reddish-brown, siliceous, occasionally silty with silt content increasing downward, cherty type small siliceous growths are common throughout; shale is hard and "rings" when struck with hammer; scattered graphite partings were observed; occasional quartz grains or crystals.
14,975.5-14,979.5' (4.0')	Very fine red sandstone grading to siltstone, argillaceous, calcareous, siliceous with clasts and/or segregations of cream to pink lime mudstone and chert; this section has an overall turbated appearance, but shows banding and exclusion which suggests secondary segregation, scattered coarse grains of clear quartz are common; argillaceous material shows concentration around lime and chert.
14,979.5-14,986.0' (6.5')	Sandstone: brick red, very fine to fine grained, tight with argillaceous, calcareous, silty filling, hard with compaction and grain recrystallization and overall silicification and with small cherty growths; fairly massively bedded with rare siltstone clasts or fillings, occasional irregular shale laminations and occasional poorly developed low angle crossbedding.

14,986-14,990 Sandstone: as above in lower part of core.

14,990-15,030 Interbedded Siltstone: red, argillaceous, grading to red Shale: hard, calcareous to siliceous, sandy with abundant chert forming in place, and Shale: red to reddish-brown, hard, siliceous with small cherty formations.

15,030-15,070 Interbedded Siltstone and Shale: as above, but with very thin zones of hard, tight, silty, argillaceous, very fine grained sandstones.

15,070-15,080 Conglomeratic Sandstone: red, dirty, very poorly sorted with calcareous, argillaceous matrix; silicification and chert formation are common; probably contains chert pebbles as well as secondary chert; contains micaceous metamorphic rock fragments, some milk in matrix material.

15,080-15,090 Interbedded light brown to dark red, very fine grained sandstone, less conglomeratic than interval just above; with siltstone grading to shale with less micaceous than just above.

15,090-15,095 Siltstone: brick red to occasionally maroon, hard, argillaceous, siliceous with abundant secondary chert, with occasional micaceous and grading to slightly silty, hard, siliceous shale.

15,095-15,110 Limestone: light brown to red, very finely crystalline to micritic, either as very thin beds or as segregations in red siltstone which is very cherty, sandy with occasional detrital micaceous.

15,110-15,140 Siltstone: brick red to brown grading to claystone and shale, occasionally maroon colored, chert formation is common, detrital micaceous is common, occasional thin zones are sandy and softer, with occasional gray to green shale.

15,140-15,195 Limestone: medium to dark gray, mottled, reworked and compacted with marbly look, with occasional zones of lime mudstone to wackestone with small pellets and grains; slightly pyritic, clear quartz grains are common throughout, interbedded with brick red to brown and maroon siltstone and shale and minor medium to dark gray shale, traces of graphite and pyrite.

15,195-15,210 Siltstone: red to brown, occasionally maroon, with pink to white mottling, sandy, scattered chert, detrital micaceous, scattered clear quartz grains, calcite filled fractures.

15,210-15,225 Sandstone: white to light tan, fine to medium grained, subrounded quartz sand in firm white clayey, possibly anhydrite matrix (can be broken down easily with a probe), parts conglomeratic with white to gray, red, yellow and green chert, noncalcareous.

15,225-15,265 Siltstone: red to brown with pink to white mottling, grading to silty claystone and shale; occasional zones of pink pellets, zones of sandy siltstone and claystone; detrital micaceous is common; occasional chert and quartz filled fractures; markedly noncalcareous (less than 1% total in sample) when compared to long sections of red siltstone seen above.

15,265-15,285 Anhydrite(?): firm, light to medium gray, slightly soluble, noncalcareous slightly silty, argillaceous and carbonaceous, interbedded with red and pink mottled

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70

Siltstone: as above, and medium to dark gray; Shale: carbonaceous, silty, slightly micromicaceous; traces of very hard, black pyritic coal.

15,285-15,300 Shale/Claystone: medium to dark gray, silty, carbonaceous, graphitic to argillitic texture, with minor thin coals and anhydritic layers.

15,300-15,315 Siltstone: medium to dark gray, argillaceous, grading to claystone, sandy, slightly argillitic texture, graphitic with thin beds of very hard, black, slightly pyritic coal and thin beds of light gray Sandstone: fine to medium grained, tight, recrystallized to occasional quartzite.

15,315-15,421 Quartzite: white to light gray, crystalline quartz with minor chert, slightly pyritic, with occasional clear, euhedral quartz crystals up to 1/8 inch in size; possibly with some thin zones of argillitic shale; hole sloughing badly so that trouble was encountered when making connections; samples corresponding to these times are coal to anhydrite to shale as seen above; large rock fragments from the junk basket run behind the drill bit were red and gray shale with minor coal, but no quartzite; sample percentages where drilling is steady near 100% quartz; traces of yellow mineral, possibly sphalerite, are common; with occasional medium to dark gray siliceous mudstone or argillaceous quartzite; 15,414' to 15,421' driller's depth correction on strap out for Core No. 14.

15,421-15,424 <u>Core No. 14: Cut 3', Recovered 1.1'</u>

15,421.0-15,422.1' (1.1') Top 1/3 light gray mottled quartz breccia or conglomerate with softer gray anhydrite(?) filling; quartz is completely altered; middle portion (with a contact, possibly bedding, at about 45°) is medium to dark gray siliceous mudstone or argillaceous quartzite, highly fractured with soft, very finely crystalline fracture filling; possibly anhydrite; bottom portion of the core is again quartz conglomerate or breccia with a matrix of the softer gray anhydritic material and the darker argillaceous as in the middle of the core.

15,422.1-15,424.0 (1.9') No recovery.

15,424-15,461 Quartzite: white to light gray, mottled, crystalline quartz with small, clear, euhedral crystals common, minor amounts of medium to dark gray, siliceous mudstone to argillitic shale; traces of anhydrite(?) may be from fracture filling or zones; most probably breaking down and not seen in samples; traces of yellow to orange mineral, possible sphalerite; traces of dark gray to silvery, pelletal rock that look like very finely amiguloidal basalt, possibly from above.

15,461-15,462 Core No. 15: Cut 1', Recovered 0'

15,461.0-15,462.0' (1.0') No recovery.

15,462-15,462.7 No sample recovered.

15,462.7-15,469.2 Core No. 16, Cut 6.5', Recovered 4.0'

15,462.7-15,466.7' (4.0') Quartzite: light gray, mottled, completely altered with no evidence of original texture, occasional argillaceous inclusions up to one inch; highly fractured to brecciated with minor amounts of soft gray fracture filling (anhydrite?); open fractures and vugs with clear quartz crystals are common.

15,466.7-15,469.2' (2.5') No recovery.

15,469.2-15,481 Quartzite: light gray, mottled, as above.

Log Analysis

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

Formation Evaluation

February 3, 1979

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

Dear Mr. Hewitt:

Logging operations were begun on Ikpikpuk Test Well #1 at 1330 hours on January 27, 1979 and DIL, FDC/CNL, BHC, dipmeter and velocity survey were completed about 0200 on January 30 after numerous equipment failures. CST shooting was begun the morning of January 30 but due to some gun problems and a bird-caged cable was still in progress when I left the well at 0900. Lost rig-time, excluding the CST trouble amounted to about 21 hours but the logs as obtained were of good quality.

Log tops identified were Pebble Shale at 7235, Kuparuk River sand at 7440 and Kingak at 7650 from log response and 7480 from geologists' lith log; however, I believe the 7650 point is the more valid. Top of the Sag River formation was tentatively picked at 9845 but this is not the Sag River sand. Correlations were good with the Teshepuk Lake and South Simpson wells.

A series of four sand stringers from 6876-6922 have an average porosity of 11.5% and Sw=100%. Two other sands, 7080-84 and 7140-46, indicate some gas content from the FDC/CNL response but are of 12% and 13% porosity respectively. The sand from 7440-76 averages 15% porosity and Sw about 90%. Sandstone from 9636-70 is of low porosity ranging from 3%-6% and hence of no interest.

Very truly yours,

Armour Kane

AK/ pab

February 3, 1979

LOG ANALYSIS

IKPIKPUK #1 - SURFACE HOLE

BY ARMOUR KANE

Rmf = 4.2 @ 85° SSP = 60 MV @ 700

$\frac{Rmf}{Rw}$ = 7 Rw = 0.6 = 8000 ppm

Rwa (680-710) = 0.44 = 10,000 ppm
Rwa (740) = 7.0
Sw = 25-30%
Ø = 35%±

A compaction correction to derive Ø's was assumed to be 1.5 based entirely on Δ T in the shales and may or may not be accurate, but it moves us in the right direction. Rw of 0.6 from SP and Rwa from ΔT vs Ro of 0.44 are not too vastly different and should have some validity. Using these figures Sw is 25-30%; however if the hydrocarbon is gas, it is hard to understand why Δ T in the wet sand is greater than in the gas (?) sand. It should be the other way around. The two sands exhibit about the same GR deflection, meaning the shale content is about the same. Perhaps the neutron on the next run will resolve the problem.

Log Analysis

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

Formation Evaluation

April 16, 1979

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

Dear Mr. Hewitt:

Schlumberger began logging operations on Ikpikpuk Test Well No. 1 at 0300 hours on April 8, 1979, and completed DIL. CNL/FDC, BHC, Dipmeter, Velocity Survey and Sidewall Cores the afternoon of April 9, 1979. Some lost rig time was incurred due to a failure of the medium induction curve from 11,100 feet to casing which was re-run over that interval. The CNL/FDC had to be re-run due to engineer error in setting a 2.65 grain density instead of 2.71 on the FDC. All logs as finally obtained were of good quality. Engineers were Mallary and Ludlam. 13 of 30 Sidewall Cores were recovered, the missed recoveries being due to the hard formation.

Log tops were: Sag River Sand 9845; base Sag river/Shublik 10,378; Sadlerochit 10,440; Kavik 11,096; Echooka 11,290; base Echooka 11,390; Lisburne Transition 11,420 and massive Lisburne 11,698. Considerable discussion was involved with Mr. Tailleur of the USGS, Geologist Dave Young and myself regarding these log tops but we came to general agreement on the above depths.

No zones of interest were found in the logs due to generally low porosities. The Lisburne is characterized by numerous siltstone and shale streaks and exhibits a porosity in the 1 - 3% range.

Very truly yours,

Armour Kane

Log Analysis

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

Formation Evaluation

February 23, 1980

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

Dear Mr. Hewitt:

At [redacted] Test Well No. 1 Schlumberger began logging at 1600 hours on February 13, 1980, and went in the hole with a temperature survey but the tool failed at 11,600 feet where the recorded temperature was 240°F. They pulled out, changed tools and re-entered the hole but the second tool failed at 12,900 feet. Temperature was 254°F. Dead Horse was called for replacement tools and while waiting for delivery Schlumberger went in with DIL tools but hit a bridge at 15,378, and while spudding damaged the gamma ray tool which was then inoperative. They recorded the resistivity curves up to casing but some strange anomalies led us to believe the log was not valid. The replacement temperature tools arrived and the log was completed at 0530 hours on February 14. Lost time at this point was 9.5 hours.

The second DIL was attempted and successfully completed at 0830 hours. The log was almost a perfect repeat of the first attempt although it was run with a completely different set of tools: sonde, cartridge, panels, etc., which leaves the strange anomalies unexplained. Resistivities are very high and the bottom-hole thermometer read 294°F. By 0600 hours February 15, BHC, CNL/FDC, HRD, Birdwell velocity survey and the second temperature log were completed with no further trouble except for a broken cable strand. All temperature readings indicated a stabilized temperature of 294° F.

No zones of interest were found due to very hard formation with a porosity range of 0 - 6% except in the shale intervals. Cross-plots indicate the formation is a mixture of limestone, dolomite and shale and the gamma ray records unusually high levels of radiation, approaching 200 API Units. A washout from 15,270-15,320 is in excess of 19" and must be very large since the bulk density very nearly approximates that of the mud. Top of the Quartzite is at 15,320 and is definitely confirmed by all logs.

Very truly yours,

G. Kane

Armour Kane

NOTE: Formation tops in this appendix were picked at the wellsite and may or may not agree with the final correlations reached after evaluation of available information.

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HUSKY

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

LOGGING REPORT

WELL NAME IKPIKPUK #1

Date 11/29/78 Driller Depth 535'

Elevation 52' KB est. Logger Depth 536'

Logs Ran and Intervals

DIL-SP-GR Run #1 101-530'

BHC-Sonic-GR Run #1 102-530'

Additional Logs to Run

Zones of Interest

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

Discussion:

Probable coal seam occurs at 265-275'; 294-298'; 320-332'; 356-365'; 380-386'; 408-419'; 432-440'.

Log Tops & Correlations:

Additional Evaluation Plans:

D. B. YOUNG
Wellsite Geologist

Log Analyst

12/77

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

LOGGING REPORT

WELL NAME IKPIKPUK TEST WELL NO. 1

Date January 27, 28, 29, 1979 Driller Depth 9913'

Elevation 52 K.B. Logger Depth 9910'

Logs Ran and Intervals

SP/GR/DIL	2603-9904'
GR/BHC	2603-9904'
HRD-Dipmeter	2603-9909'
GR/CAL/FDC/CNL	2606-9908'
CST-Sample Taker	Bottom Shot 9890'

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
6876-6922'	46	32	Sandstone	11.5%	Sw = 100%
7080-7084'	4	4	Sandstone	12%	Prob Gas
7140-7146'	6	6	Sandstone	13%	Prob Gas
7440-7476'	36	36	Sandstone	13%	Sw = 90%

Discussion:
Sandstone from 9636' to 9670' is of low (3-6%) porosity

Log Tops & Correlations:

	Ikpikpuk	Teshekpuk	So. Simpson
Pebble Shale	7235'	6850'	6340'
Kuparuk River	7440'	7110'	6523'
Kingak	(Log) 7650' (Lith) 7480'	7450'	6700'

Additional Evaluation Plans:

DAVE YOUNG
Wellsite Geologist

ARMOUR KANE
Log Analyst

12/77

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HUSKY

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

LOGGING REPORT

WELL NAME IKPIKPUK #1

Date April 8-9, 1979 Driller Depth 14,210'

Elevation 52' KB Logger Depth 14,205'

Logs Run and Intervals

GR/SP/DIL	9600-14,202'	CST SIDEWALL CORES: Top Shot	9918'
GR/CAL/CNL/FDC	9600-14,198'	Bottom Shot	11,487'
GR/CAL/BHC	9600-14,190'		
HRD Dipmeter	9867-14,205'		
Velocity Survey	2880-14,210'		

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
NO ZONES OF INTEREST					

Discussion:

Log Tops & Correlations:

Sag River Sand	9845'	Lisburne Transition	11,420
Base Sag/Shublik	10,378'	Massive Lisburne	11,698'
Sadlerochit	10,440'		
Kavik	11,096		
Echooka	11,290'		
Base Echooka	11,390'		

Additional Evaluation Plans:

DAVE YOUNG
Wellsite Geologist

ARMOUR KANE
Log Analyst

12/77

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

LOGGING REPORT

WELL NAME IKPIKPUK #1

Date Feb. 13-15, 1980 Driller Depth 15,481'

Elevation 52' KB Logger Depth 15,435 (Temp Log only)

Logs Run and Intervals

Temp Survey (2)	100-15,435'
GR/SP/DIL	14,194-15,395'
GR/BHCS	14,194-15,394'
GR/CAL/CNL/FDC	14,194-15,400'
HRD Dipmeter	14,194-15,400'
Birdwell Velocity Survey	Top 3750', Btm. 15,400'

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
NO ZONES OF INTEREST					
FORMATIONS VERY HARD AND OF LOW POROSITY: 0 TO A MAXIMUM OF 6%					
CROSS-PLOTS INDICATE MIXTURE OF LIMESTONE, DOLOMITE AND SHALE.					

Discussion:

Borehole washed out from 15,270-15,320 - Diameter exceeds 19". Hole is so large bulk density reads approximately mud density. No CST because of very hard formation.

Log Tops & Correlations:

Top of Quartzite 15,320'

Additional Exploration Plans:

RICH NELSON
Wellsite Geologist

ARMOUR KANE
Log Analyst

12/77

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HUSKY

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

DRILL STEM TEST REPORT FORM

WELL NAME IKPIKPUK #1 DST. NO. 1 DATE 2-21-81, 2-22-80

Formation Tested PEBBLE SHALE" SAND
Hole Size 9 5/8" csg.

Test Interval 7446-7472' (4 perfs/ft.)
Drill Collar Length ____ I.D. ____

Total Depth PBTD 7530'
Drill Pipe Length ____ I.D. ____

Choke Size: Surface 8/64" (1/8") Bottom Hole 7/8"
Packer Depth(s) ____ Ft.

Depth Tester Valve ____ Ft.

Cushion Type none Amount ____

TEST DATA

Tool open at 21:43 hrs. 2-21-80 xx
Initial flow period 30 min.
Initial shut-in period 2 1/2 hrs. xxx
Final flow period 5 hrs. xxx
Final shut-in period Shut in @ 0545 2-22-80
Unseated packer at ____ hrs.

RESISTIVITY/CHLORIDE DATA

	Resistivity		Chloride Content
Recovery Water	@	°F	See below ppm
Recovery Mud	@	°F.	ppm
Recovery Mud Filtrate	@	°F.	ppm
Mud Pit Sample	@	°F.	ppm
Mud Pit Sample Filtrate	@	°F.	ppm
Mud Weight	vis		cp

Description of initial flow period Immediate strong blow of air w/35 psi surface pressure after 30 mins on 1/8" needle valve at bubble hose.

Description of final flow period Strong blow gas throughout w/gas too small to measure on 1/8" choke; flowing surface pressures as follows: 0 psi when opened, 10 psi @ 3 min, 20 psi @ 7 min, 27 psi @ 11 min. 30 psi @ 20 min. 32 psi @ 37 min, 33.5 psi @ 1 hr, 34 psi @ 1 hr. 45 min, 38 psi @ 2 hrs. 45 min, 35 psi @ 3 hrs. 15 min, 34 psi @ 3 hrs. 45 min, 29 psi @ 5 hrs. when shut in.

PRESSURE DATA

TEMPERATURE	Gauge No. 1274 Depth: 7361 ft.	Gauge No. 2781 Depth: 7365 ft.	Gauge No. 1249 2137 Depth: 7397 7401 ft.	TIME
	12 Hour Clock	24 Hour Clock	24 12 Hour Clock	Tool A.M.
Est. °F.	Blanked Off No	Blanked Off No	Blanked Off Yes Yes	Opened P.M.
7406' Actual 154 °F.	Pressures	Pressures	Pressures	Opened A.M. Bypass P.M.

		Field	Office	Field	Office	Field	Office	Reported Minutes	Computed Minutes
Initial Hydrostatic		4011		4013		4039	4042		
First Period FLOW	Initial	121		105		121	106	—	—
	Final	242		224		255	251		
	Closed In	2557		2558		2570	2582		
Second Period FLOW	Initial	242		224		255	251	—	—
	Final	403		408		417	437		
	Closed In			2624		2651			
Third Period FLOW	Initial							—	—
	Final								
	Closed In								
Final Hydrostatic		4011		4026		4039	4056	—	—

RECOVERY DATA

	Type	Amount	Depth Back Pres. Valve	Surface Choke	Bottom Choke
Recovered 253.5/4.0		Feet/bbl of rat hole fluid			
Recovered 1084.5/19.75		Feet/bbl of drilling fluid and gas cut drilling fluid			
Recovered		Feet/bbl of			
Recovered		Feet/bbl of			

Recovered From Tester Valve

Remarks 1st fluid recovered in reverse out 800 ppm chlorides
Fluid from middle of reverse out 700-800 ppm chlorides

SAM HEWITT

HUSKY

HUSKY OIL NPR OPERATIONS, I
U.S. GEOLOGICAL SURVEY ONPRA

PRELIMINARY

DRILL STEM TEST REPORT FORM

WELL NAME IKPIKPUK #1 DST. NO. 2 DATE 2-27-80

Formation Tested TOROK

Test Interval 6877-6923'; 6893-6898', 6903-6910', 6917-6923'. 4 perfs/ft., 6877-6883',

Total Depth PBTD 6939'

Choke Size: Surface 1/8" Bottom Hole 7/8"

Hole Size 9 5/8" csg.

Drill Collar Length ____ I.D. ____

Drill Pipe Length ____ I.D. ____

Packer Depth(s) ____ Ft.

Depth Tester Valve ____ Ft.

Cushion Type None Amount -

TEST DATA

Tool open at 0326 hrs. 2-26-80 xx.
Initial flow period 30 min.
Initial shut-in period 1 hr. xxx
Final flow period 3 hrs. xxx.
Final shut-in period 6 hrs. 4 min. min.
Unseated packer at 1400 hrs. 2-26-80 hrs.

RESISTIVITY CHLORIDE DATA

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

Description of initial flow period Strong blow of air in 2 min. of initial flow, shut in after 30 mins.

Description of final flow period Instant strong blow when opened for final flow; gas to surface in 50 min., too small to measure; turned to burn line, 5 psi; FWHP on 1/8" choke at 2 hrs, 15 min.; 13 psi at 3 hrs. when shut in

PRESSURE DATA

TEMPERATURE	Gauge No. 1249 Depth: 6801' ft.		Gauge No. 2137 Depth: 6805' ft.		Gauge No. 2781 Depth: 6838' ft.		Gauge No. 1274 Depth: 6841 ft.	
	24 Hour Clock		24 Hour Clock		24 Hour Clock		24 Hour Clock	
Est. °F.	Blanked Off	No	Blanked Off	No	Blanked Off	Yes	Blanked Off	Yes
Actual 130 °C	Pressures		Pressures		Pressures		Pressures	
	Field	Office	Field	Office	Field	Office	Field	Office
Initial Hydrostatic	3755.5		3752.7		3748.1		3752.8	
First Period FLOW Initial	100.9		92.6		98.7		94.1	
First Period FLOW Final	107.6		105.9		105.3		107.6	
First Period Closed In	1097.4		1054.1		920.0		938.6	
Second Period FLOW Initial	67.3		119.1		105.3		107.6	
Second Period FLOW Final	134.5		145.6		157.9		174.8	
Second Period Closed In	2153.3		2173.7		2161.4		2177.6	
Third Period FLOW Initial								
Third Period FLOW Final								
Third Period Closed In								
Final Hydrostatic	3755.5		3779.0		3748.1		3752.8	

RECOVERY DATA

Cushion	Type	Amount	Depth Back Pres. Valve	Surface Choke	Bottom Choke	Flow From Tester Valve
Recovered 935'/16.6		Feet/bbl of	gas cut drilling fluid and formation fluid			
Recovered		Feet/bbl of	(max 2100 ppm chlorides)			
Recovered		Feet/bbl of				
Recovered		Feet/bbl of				

Remarks

SAM HEWITT/DAN LOWE

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907)-279-4014
274-3364

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

GAS ANALYSIS REPORT

Company Husky Oil Company Date February 26, 1980 Lab No. 3000

Well No. Ikpikpuk No. 1 Location

Field NPRA Formation

County Depth DST No. 1

State Alaska Sampling Point Test Tool

Line pressure ____ psig; Sample pressure 260 psig; Temperature ____ °F; Container number

Remarks

Sample taken from chamber of test tool

Component	Mole % or Volume %	Gallons per MCF
Oxygen	TRACE	
Nitrogen	7.48	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	90.68	
Ethane	1.79	
Propane & Higher	0.05	
Total	100.00	—

GPM of pentanes & higher fraction

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) = 949

Specific gravity (calculated from analysis) = 0.594

Specific gravity (measured) 0.595

Remarks:

F-1

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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GAS ANALYSIS REPORT

Company Husky Oil Company Date March 3, 1980 Lab No. 2984-1

Well No. Ikpikpuk No. 1 Location

Field NPRA Formation Torok

County Depth DST No. 2 (6877-93)

State Alaska Sampling Point Manifold

Line pressure ____ psig; Sample pressure 11.8 psig; Temperature ____ °F; Container number

Remarks

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	1.53	
Carbon dioxide	0.02	
Hydrogen sulfide	—	
Methane	98.44	
Ethane	0.01	
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.

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GAS ANALYSIS REPORT

Company Husky Oil Company Date March 3, 1980 Lab No. 2984-2

Well No. Ikpikpuk No. 1 Location

Field NPRA Formation

County Depth DST No. 1

State Alaska Sampling Point Manifold

Line pressure psig; Sample pressure psig; Temperature 30 °F; Container number

Remarks Sample No. 3 taken 2-22-80 @ 0530 Hrs. by D. Lowe

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	0.90	
Carbon dioxide	0.37	
Hydrogen sulfide	—	
Methane	98.73	
Ethane & Higher	TRACE	
Total	100.00	—

GPM of pentanes & higher fraction

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) .997

Specific gravity (calculated from analysis) 0.561

Specific gravity (measured) 0.560

Remarks:

99.

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GAS ANALYSIS REPORT

Company Husky Oil Company Date March 3, 1980 Lab No. 3022

Well No. Tkpikpuk No. 1 Location

Field NPRA Formation

County Depth DST No. 2

State Alaska Sampling Point Test Tool Chamber

Line pressure psig; Sample pressure 105 psig; Temperature °F; Container number

Remarks

Total Gas Volume @ 105 psig, milliliters 777

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	1.42	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	98.56	
Ethane	0.02	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) 996

Specific gravity (calculated from analysis) 0.560

Specific gravity (measured) 0.560

Remarks:

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

ANALYTICAL REPORT

From Husky Oil Company — Product Gas Cut Mud

Address Anchorage, Alaska — Date February 28, 1980

Other Pertinent Data

Analyzed by LMG — Date February 28, 1980 — Lab No. 3022

REPORT OF ANALYSIS
GAS CUT MUD
DST NO. 2
IKPIKPUK NO. 1
NPRA, ALASKA

Sample taken from test tool 2-28-80 @ 1430 Hrs.

SAMPLE	CHLORIDE, mg/l
Gas Cut Mud	600

REMARKS:

Recovered 70 milliliters of gas cut mud. 777 milliliters @ 105 psig Natural Gas.

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Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
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WATER ANALYSIS REPORT

OPERATOR: Husky Oil Company
WELL NO.: Ipikpuk No. 1
FIELD: NPRA
COUNTY:
STATE: Alaska

DATE: March 21, 1980 LAB NO. 2980-1
LOCATION:
FORMATION:
INTERVAL: DST No. 1 (2-22-80)
SAMPLE FROM: Mud Prior to Test

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3267	142.12	Sulfate	3125	65.00
Potassium	95	2.43	Chloride	400	11.28
Calcium	18	0.90	Carbonate	720	23.98
Magnesium	2	1.07	Bicarbonate	2760	45.26
Iron	-	-	Hydroxide	-	-
Total Cations		145.52	Total Anions		145.52

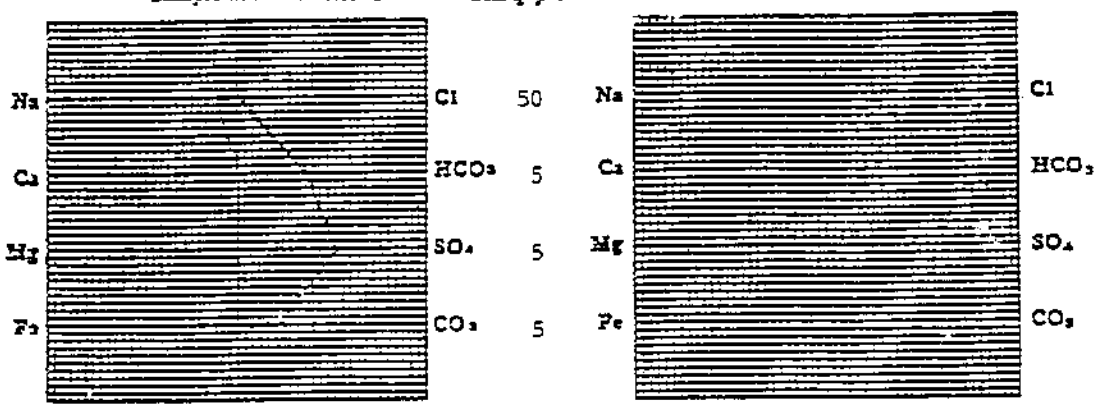
Total dissolved solids, mg/l: 8999
NaCl equivalent, mg/l: 6998
Observed pH: 9.8

Specific resistance @ 68°F.:
Observed: 1.01 ohm-meters
Calculated: 0.95 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Na value is above graph including Na, K, and Li)
NOTE: Mg/l = Milligrams per liter; meq/l = Milligram equivalents per liter
Sodium chloride equivalents by Dunlap & Henderson calculations from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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

TELEPHONE (907)-279-4014
274-3364

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5633 B Street

WATER ANALYSIS REPORT

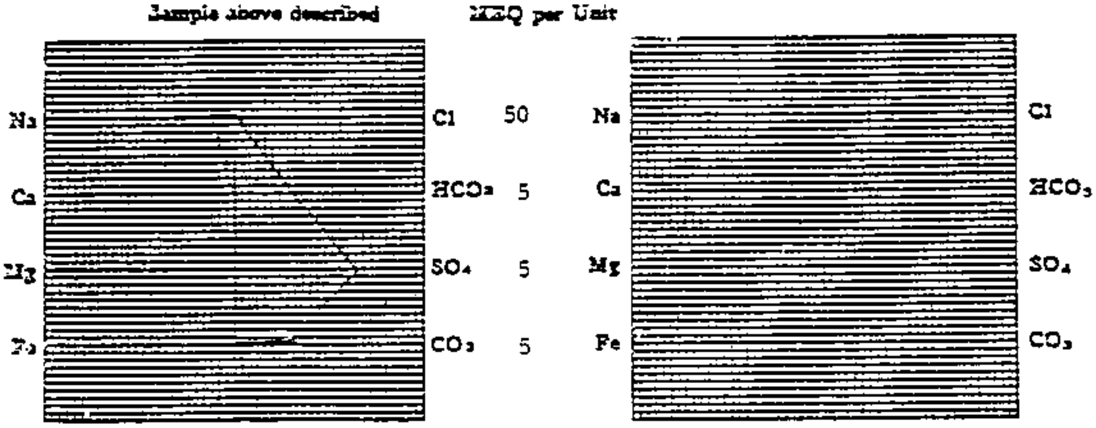
OPERATOR	Husky Oil Company	DATE	March 21, 1980 LAB NO. 2980-2
WELL NO.	Ikpikpuk No. 1	LOCATION	
FIELD	NPRA	FORMATION	
COUNTY		INTERVAL	DST No. 1 (2-22-80)
STATE	Alaska	SAMPLE FROM	First Fluid to Surface

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate
Oil & Grease, mg/l------169 (Appears to be pipe dope)

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3764	163.75	Sulfate	3830	79.66
Potassium	96	2.46	Chloride	500	14.10
Calcium	21	1.05	Carbonate	1080	35.96
Magnesium	1	0.08	Bicarbonate	2294	37.62
Iron	–	–	Hydroxide	–	–
Total Cations		167.34	Total Anions		167.34

Total dissolved solids, mg/l	10432	Specific resistance @ 68°F.:	
NaCl equivalent, mg/l	8076	Observed	0.84 ohm-meters
Observed pH	10.2	Calculated	0.82 ohm-meters

WATER ANALYSIS PATTERN



(Na 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 & 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. Toiktuk No. 1
FIELD NPRA
COUNTY
STATE Alaska

DATE March 21, 1980 LAB NO. 2980-3
LOCATION
FORMATION
INTERVAL DST No. 1 (2-22-80)
SAMPLE FROM Middle of Fluid

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	4583	199.38	Sulfate	3330	69.26
Potassium	98	2.51	Chloride	750	21.15
Calcium	175	8.73	Carbonate	3240	107.89
Magnesium	1	0.08	Bicarbonate	756	12.40
Iron	-	—	Hydroxide	-	—
Total Cations		210.70	Total Anions		210.70

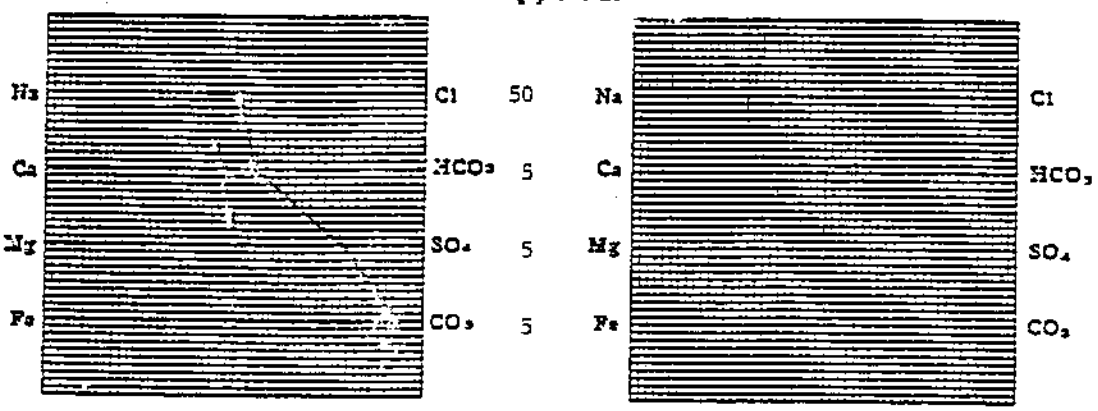
Total dissolved solids, mg/l 12553
NaCl equivalent, mg/l 11500
Observed pH 12.2

Specific resistance @ 68°F.:
Observed 0.62 ohm-meters
Calculated 0.58 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value to above groups includes Ba, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Hawthorne calculation from conductivity

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
DATE March 21, 1980 LAB NO. 2980-4
WELL NO. Ipikpuk No. 1
LOCATION
FIELD NPRA
FORMATION
COUNTY
INTERVAL DST No. 1 (2-22-80)
STATE Alaska
SAMPLE FROM Final Fluid

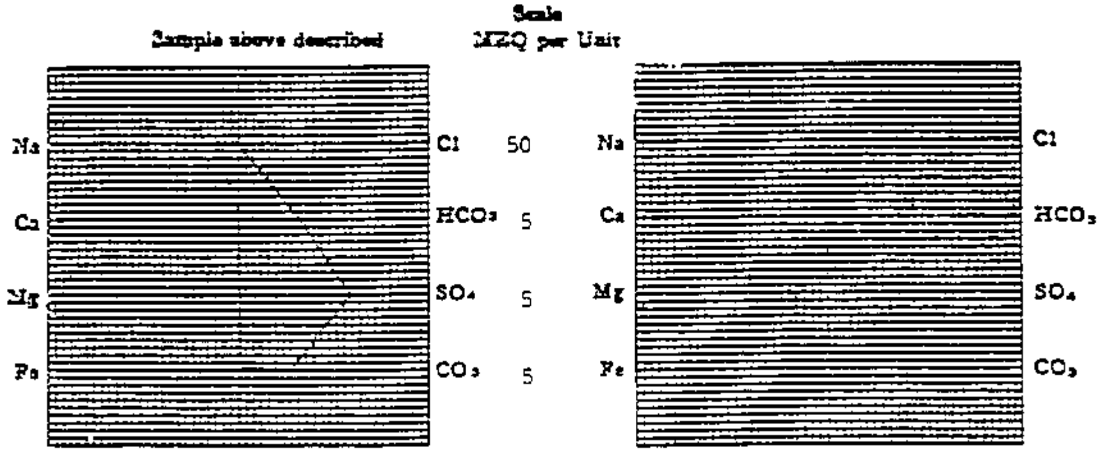
REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate
Chloride Content of gas cut mud from tool, mg/l------1500

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3363	146.29	Sulfate	3500	72.80
Potassium	97	2.48	Chloride	100	2.82
Calcium	12	0.60	Carbonate	1040	34.63
Magnesium	1	0.08	Bicarbonate	2390	39.20
Iron	–	–	Hydroxide	–	–
Total Cations		149.45	Total Anions		149.45

Total dissolved solids, mg/l 9300
NaCl equivalent, mg/l 7279
Observed pH 10.7

Specific resistance @ 68°F.:
Observed . . . . 0.99 ohm-meters
Calculated . . . . 0.90 ohm-meters

WATER ANALYSIS PATTERN



(Na value in above graph includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent = by Dunlap & Hawthorne calculation from components

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5633 B Street

WATER ANALYSIS REPORT

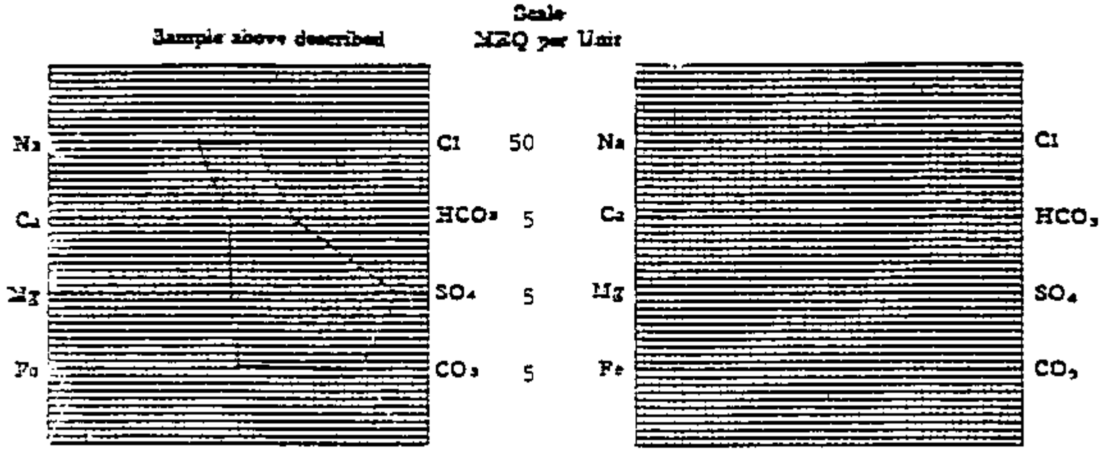
OPERATOR	Husky Oil Company	DATE	March 21, 1980 — LAB NO. 2983-2
WELL NO.	Ikpikpuk No. 1	LOCATION	
FIELD	NPRA	FORMATION	
COUNTY		INTERVAL	DST #2 (2-26-80)
STATE	Alaska	SAMPLE FROM	First Fluid to Surface

REMARKS & CONCLUSIONS: Mud, Quebracho filtrate.
Chloride content on background mud prior to test, mg/l——800
Oil & Grease, mg/l————69 (Appears to be Pipe Dope)

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	4994	217.23	Sulfate	5050	105.04
Potassium	102	2.61	Chloride	500	14.10
Calcium	165	8.23	Carbonate	2400	79.92
Magnesium	85	6.99	Bicarbonate	2195	36.00
Iron	—	—	Hydroxide	—	—
Total Cations		235.06	Total Anions		235.06

Total dissolved solids, mg/l	14387	Specific resistance @ 68°F.:	
NaCl equivalent, mg/l	12064	Observed	0.58 ohm-meters
Observed pH	11.2	Calculated	0.55 ohm-meters

WATER ANALYSIS PATTERN



(Na 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 & Hawthorne calculation from components

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WATER ANALYSIS REPORT

OPERATOR Husky Oil Company
WELL NO. Ikpikpuk No. 1
FIELD NPRA
COUNTY
STATE Alaska

DATE March 21, 1980 LAB NO. 2983-3
LOCATION
FORMATION
INTERVAL DST #2 (2-26-80)
SAMPLE FROM Middle of Fluid

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	5328	231.76	Sulfate	4800	99.84
Potassium	114	2.92	Chloride	520	14.66
Calcium	100	4.99	Carbonate	2200	73.26
Magnesium	1	0.08	Bicarbonate	3170	51.99
Iron	—	—	Hydroxide	—	—
Total Cations		239.75	Total Anions		239.75

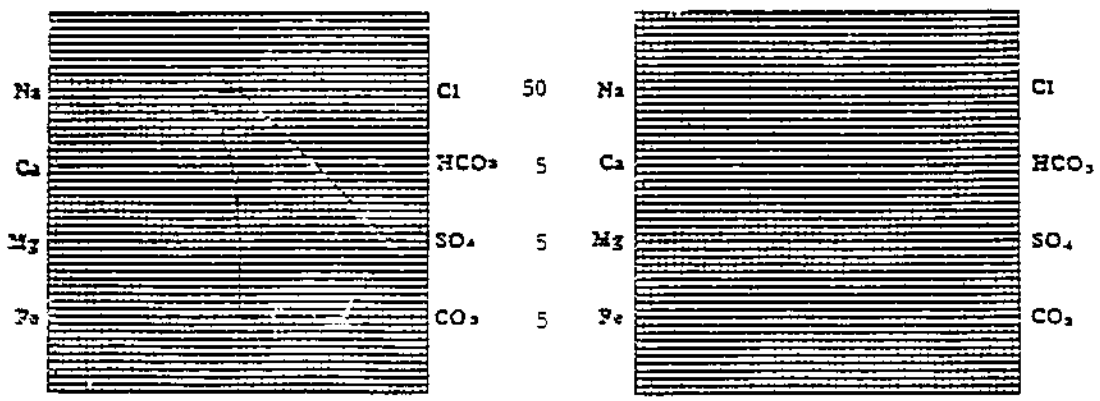
Total dissolved solids, mg/l 14638
NaCl equivalent, mg/l 12087
Observed pH 11.3

Specific resistance @ 68°F.:
Observed 0.55 ohm-meters
Calculated 0.55 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale MEQ per Unit



(Ba value is above graph between Na, K, and Li)
NOTE: Meq/l = Milligrams per liter Mg/l ÷ Milligram equivalent per liter
Sodium chloride concentration by Quantab & Hardness calculation from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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Anchorage, Alaska 99509

TELEPHONE (907)-279-4014
274-3364

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

WATER ANALYSIS REPORT

OPERATOR Husky Oil Company — DATE March 21, 1980 — LAB NO. 2983-4
WELL NO. Ikpikpuk No. 1 — LOCATION
FIELD NPRA — FORMATION
COUNTY — INTERVAL DST #2 (2-26-80)
STATE Alaska — SAMPLE FROM Final Fluid

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	5085	221.20	Sulfate	3600	74.88
Potassium	90	2.30	Chloride	520	14.66
Calcium	150	7.49	Carbonate	3600	119.88
Magnesium	5	0.41	Bicarbonate	1340	21.98
Iron	-	—	Hydroxide	-	—
Total Cations		231.40	Total Anions		231.40

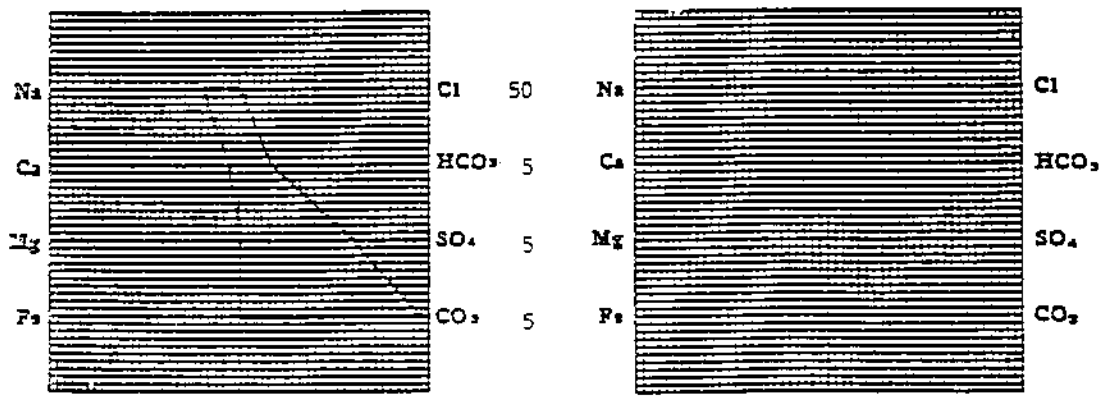
Total dissolved solids, mg/l — 13716
NaCl equivalent, mg/l — 12548
Observed pH — 11.2

Specific resistance @ 68°F.:
Observed — 0.54 ohm-meters
Calculated — 0.53 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value in above graphic because No. K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride contributed by Boron & Bicarbonate contained from components

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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5633 B Street

WATER ANALYSIS REPORT

OPERATOR	Husky Oil Company	DATE	March 21, 1980 LAB NO. 2983-5
WELL NO.	Ipikpuk No. 1	LOCATION	
FIELD	NPRA	FORMATION	
COUNTY		INTERVAL	DST #2 (2-26-80)
STATE	Alaska	SAMPLE FROM	Test Tool Sample

REMARKS & CONCLUSIONS: Mud, Quebracho Filtrate

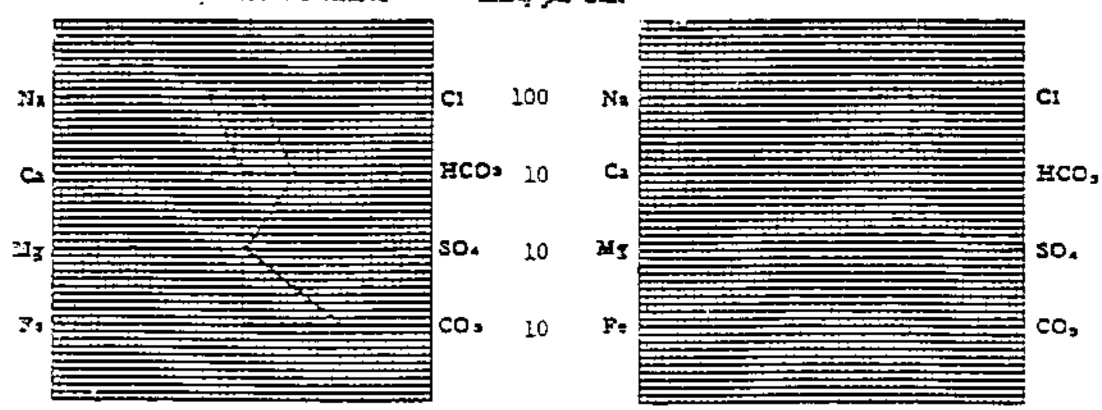
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	10068	437.97	Sulfate	130	2.70
Potassium	135	3.46	Chloride	8400	236.88
Calcium	26	1.30	Carbonate	4000	133.20
Magnesium	1	0.08	Bicarbonate	4270	70.03
Iron	–	—	Hydroxide	–	—
Total Cations		442.81	Total Anions		442.81

Total dissolved solids, mg/l	24881	Specific resistance @ 68°F.:	
NaCl equivalent, mg/l	24887	Observed	0.34 ohm-meters
Observed pH	10.9	Calculated	0.28 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Na value in above graph includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent = by Dunlap & Hawthorne calculation from components

119.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company USGS/HUSKY OIL COMPANY, OPR Formation ____ Page 1 of ____
Well IKPIKPUK #1 Cores DIAMOND File RP-3-531
Field WILDCAT Drilling Fluid WBM Date Report JUNE 6, 1979
County NORTH SLOPE State ALASKA Elevation ____ Analysts WSP
Location ____ Remarks PERM & BOYLES LAW 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	7135	0.8			4.8	2.70			sltst,sdy
2	7136	0.0			4.5	2.69			same
3	7139	0.1			11.3	2.69			ss,vfg,v slty
4	7140	0.1			8.4	2.69			same
5	7141	0.1			12.7	2.69			same
6	7142	0.0			12.9	2.69			same

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company USGS/HUSKY OIL COMPANY, OPR. Formation _____ Page 1 of 1
Well IKPIKPUK NO. 1 Core SIDEWALL File BP-3-506
Field WILDCAT Drilling Fluid WBM Date Report 2/11/79
County NORTH SLOPE State ALASKA Elevation _____ Analysts WSP
Location _____ Remarks BOYLES LAW 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	7466	37			20.5				SS,VFG,V CLY

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CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company USGS/HUSKY OIL COMPANY,OPR. Formation _____ Page 1 of _____
Well IKPIKPUK NO. 1 Cores DIAMOND File BP-3-510
Field WILDCAT Drilling Fluid WBM Date Report 3/5/79
County NORTH SLOPE State ALASKA Elevation _____ Analysts WSP,KR
Location _____ Remarks BOYLES LAW 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	10619	0.8			17.2	2.67			ss,vfg,slty
2	10621	4.6			17.4	2.68			same
3	10623	9.8			19.5	2.66			same
4	10625	5.6			18.7	2.69			same
5	10627	5.2			18.7	2.68			same
6	10629	5.3			19.4	2.66			same
7	10631	1.0			15.0	2.70			ss,vfg,sc pyr
8	10633	0.0			6.8	2.80			same
9	10635	0.0			6.0	2.70			ss,vfg,shly,sc pyr
10	10637	0.0			7.0	2.80			same
11	10639	0.4			8.7	2.72			same
12	10641	0.6			13.7	2.70			ss,vfg,slty
13	10643	0.0			8.0	2.82			ss,vfg, slty,shly,sc pyr
14	10645	0.0			4.2	2.86			same
15	10647	1.4			16.9	2.70			ss,vfg,slty
16	10649	0.8			13.8	2.67			same
17	10815	0.8			13.8	2.68			ss,vf-fg,slty
18	10817	5.3			11.4	2.68			same
19	10819	0.4			10.0	2.67			same
20	10821	1.0			8.9	2.74			same
21	10823	8.5			12.4	2.67			same
22	10825	0.1			6.5	2.67			same
23	10827	20			14.4	2.68			ss,vf-fg,slty
24	10829	4.2			10.4	2.67			same
25	10831	0.1			5.4	2.70			ss,vfg,slty
26	10833	0.2			5.9	2.68			same
27	10835	0.3			7.9	2.67			ss,vf-fg,slty
28	10837	0.3			6.5	2.69			ss,vf-fg,cly & sltst peb
29	10839	0.2			6.3	2.78			same,sc pyr
30	10841	0.3			8.0	2.67			ss,vfg,slty

CL-508

CORE LABORATORIES, INC. *Petroleum Reservoir Engineering*

COMPANY USGS/HUSKY OIL COMPANY, OPR FIELD WILDCAT FILE BP-3-510

WELL IKPIKPUK NO. 1 COUNTY NORTH SLOPE DATE 4/10/79

LOCATION _____ STATE ALASKA ELEV. _____

CORE-GAMMA CORRELATION

VERTICAL SCALE: 5" = 100'

CORE-GAMMA SURFACE LOG

PATENT APPLIED FOR

GAMMA RAY

RADIATION INCREASE →

COREGRAPH

TOTAL WATER ——

PERCENT TOTAL WATER

80 60 40 20

PERMEABILITY ——

MILLIDARCYS

100 50 10 5 1

POROSITY ——

PERCENT

20 10 0

OIL SATURATION - - - - -

PERCENT PORE SPACE

0 20 40 60 80

10619

10640

10815

10842

127.

Department of Geology Oregon State University Corvallis, Oregon 97331 (503) 754-2484

Feb. 16, 1980

REPORT ON THREE ROCK SAMPLES SUBMITTED BY:
Sam Hewitt, Husky Oil NPR Operations Inc. Received Feb. 8, 1980

Procedure.

The three samples, labeled Ikpikpuk #1, 15421.0', 15421.2' and 15421.3', were obviously three different samples from the same rock unit so the description below is a composite of the three. Petrographic and X-ray diffraction analyses were used to determine the texture and check the mineral content.

Macroscopic.

The rock appears to be a breccia consisting of light gray, angular quartz clasts of widely varying size (3 cm to a fraction of a millimeter in diameter) in a very light gray, finely crystalline matrix. Many small pyrite grains can be seen scattered through the finely crystalline matrix.

Microscopic.

The brecciated or "cataclastic" texture is readily visible microscopically and appears to be of tectonic origin, perhaps shearing during shallow metamorphism. The quartz clasts vary dramatically in size and practically all are markedly angular. Veinlets of the matrix material are at places found traversing the quartz clasts.

Quartz Clasts. The quartz clasts may be:
(1) Single crystal grains one millimeter or so in diameter, angular to subangular, suggesting, in some instances, broken rounds. Single crystal grains are rare.
(2) Polycrystalline grains, the various polycrystalline units joined in sutured contact. The crystalline units are often large, up to one millimeter across, and in some grains are elongate parallel to a common direction. This type quartz clast are the largest and form the majority of the clasts.
(3) Chert or fine polycrystalline grains.

Matrix. The matrix consists chiefly of a finely crystalline mass of a mineral identified by X-ray analysis as Wilkeite ($(Ca_5(P,S,Si)\ O_{12}\ (OH,Cl)_3)$), minor quartz as small anhedral grains and tiny pyrite crystals.

The matrix was generally featurless, but in a few instances darkened in certain areas to form "ghosts" of grains a millimeter or so in diameter or to form a "streaky" texture, perhaps generated by flow.

Point Count. Three thin sections were made, one from each sample, and a composite point count was made to obtain some idea of the mineral abundance. The result is given below.

Wilkeite	-	1329 points	68%
Quartz	-	610 "	31
Pyrite	-	11	0.6
Calcite	-	5	0.3
Muscovite	-	3	0.1
		1958	100.0

X-Ray Diffraction

A diffractometer run from 5 - 60 two theta was made on the matrix. Major peaks and the corresponding peaks for wilkeite and quartz are listed below.

Diffractometer Trace		Wilkeite		Quartz	
dA	Intensity	dA	Intensity	dA	Intensity
8.05	W	8.14	60		
4.25	W			4.26	35
3.86	W	3.85	10		
3.44	VS	3.45	70		
3.34	VS			3.34	100
3.16	S	3.18	10		
3.06	S	3.06	30		
2.79	VVS	2.80	100		
2.77	VS				
2.70	VS	2.70	90		
2.61	S	2.61	60		
2.51	M	2.51	20		
2.29	M				
2.24	S	2.24	80		
2.18	M				
2.06	M	2.06	10		
1.99	W	1.99	20		
1.93	VS	1.93	80		
1.88	M	1.88	30		
1.83	VS	1.83	80		
1.82	W			1.82	17
1.79	M	1.79	30		
1.78	M				
		1.76	50		
1.74	M	1.74	50		
1.72	S	1.72	50		
1.63	M	1.63	30		
1.60	VW	1.60	10		

Here reached 60 two theta and stopped the record.

The larger d spacing are often inaccurate so I discount the lack of precision in matching the 8.1Å Wilkeite peak while the extra peaks of the record I cannot account for. However, the accuracy of the rest makes the identification unmistakeable.

Wilkeite

This somewhat uncommon mineral was first identified along with diposide, vesuvianite (idocrase), garnet, crestmoreite and blue calcite in the contact metamorphic marble at Crestmore, Riverside County, California. Subsequent occurrance have been of a similar nature. It is an intermediate member of a series extending from apatite to ellestadite and contains only 20% P_2O_5 as against 41-42% P_2O_5 for apatite. The chemical composition is usually given as $Ca_5(P,S,Si)O_4(OH,CO_3)$.

ORIGIN OF THE ROCK

The cataclastic texture, presence of broken rounds of quartz grains, coarsely recrystallized masses of what appears to have been chert and the abundance of the phosphatic rich metamorphic mineral Wilkeite and minor muscovite appear to be the major pieces of evidence. I suggest a metasediment.

The original sediment must have been cherty, phosphatic and calcium rich and contained some minor interbedded sandstone. Shallow metamorphism including shear along with increased temperatures would produce the rock we see.

Harold E. Enlows
OPCS 104
State of Oregon Reg. G006

UNITED STATES GOVERNMENT

memorandum

DATE: February 4, 1981

REPLY TO ATTN OF: Roger J. Witmer, ONPRA

SUBJECT: Micropaleo stage/zonule revisions

TO: NPRA consociates

Revisions for 7 A.W.A. foraminiferal and 8 palynological reports were distributed on August 18, 1980 to everyone involved in NPRA projects. Recent conversations and phone calls have led me to believe that some of you may have misplaced these reports. Since then there have also been further revisions on the foraminiferal stage/zonules for Ikpikpuk #1 and Inigok #1 in regard to the Jurassic-Cretaceous boundary. As a result, I am forwarding an updated set so that you can make any necessary adjustments. If you have any questions, please give me a call.

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-111

Revisions for Anderson, Warren, and Associates FORAMINIFERA REPORTS of the following NPRA Test Wells: Cape Halkett 1, J. W. Dalton 1, Ikpikpuk 1, Inigok 1, Kugrua 1, S. Meade 1, and Peard 1

RE: USN - NPRA
Cape Halkett #1
Sec. 9, 15N/7W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

3346-4430' : Early Cretaceous (Middle to Late Albian) F-9.

4430-5680' : Early Cretaceous (Albian) F-10.

5680-6880' : Early Cretaceous (Late Aptian to Early Albian) F-10 to F-11.

6880-7320' : Early Cretaceous (Aptian) F-11.

7320-7510' : Early Cretaceous (Hauterivian to Barremian) F-12 to F-13.

7510-7630' : Indeterminate age. Sandstone.

7630-7960' : Late Triassic to Early Jurassic (F-18 to F-19). Sag River Ss.? at 7850 feet.

7960-8160' : Triassic (F-19).

8160-8830' : Permo-Triassic (F-20). Echooka Fm. lithology at 8790 feet.

8830-9020' : Middle Pennsylvanian (Mamet's Zone 21).

9025-9160' : Early Pennsylvanian (Mamet's Zone 20).

9160-9320' : Late Mississippian (Mamet's Zone 18 to Zone 19).

9320-9779' : Possible Late Mississippian. Endicott Group?

9779-9908' : Indeterminate age. Argillite.

RE: Husky/USGS - NPRA
J. W. Dalton #1
Sec. 14, 18N/5W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

8317-8560' : Probable Middle Pennsylvanian (Zone 21+).

8560-8980' : This interval remains Middle Pennsylvanian (Zone 21).

RE: Husky/USGS - NPRA
Ikpikpuk #1
Sec. 25, 12N/10W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

7480-8100': Change age to read: Early Cretaceous, Neocomian (Berriasian to Valanginian) F-13 to F-14.

8100-8190': Change age to read: Late Jurassic (Kimmeridgian to Tithonian) F-15 to F-16.

RE: Husky/USGS - NPRA
Inigok #1
Sec. 34, 8N/6W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

8060-8480': Change age to read: Early Cretaceous, Neocomian (Hauterivian to Barremian) F-12 to F-13.

9480-10280': Change age to read: Early Cretaceous, Neocomian (Berriasian to Valanginian) F-13 to F-14.

10280-11008': Change age to read: Late Jurassic (Kimmeridgian to Tithonian) F-15 to F-16.

RE: Husky/USGS - NPRA
Kugrua #1
Sec. 8, 14N/26W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

7220-7450' : Change age to read: Early Cretaceous (Hauterivian to Barremian) F-12 to F-13. This now means that strata from 6890 feet to 7450 feet are Early Cretaceous (Hauterivian to Barremian) F-12 to F-13.

7450-8020' : Change age to Early Cretaceous (Berriasian to Valanginian) F-13 to F-14. This means we are now suggesting that the Early Cretaceous is sitting directly on the Oxfordian (F-16) age strata in this well.

RE: Husky/USGS - NPRA
S. Meade #1
Sec. 31, 15N/19W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

6760-6970' : Change age to read: Early Cretaceous (Berriasian to Valanginian) F-13 to F-14. This means we feel that the Early Cretaceous is sitting directly on Oxfordian (F-16) age strata in this well.

RE: Husky/USGS - NPRA
Peard Bay #1
Sec. 35, 16N/2W, U.B.M.
North Slope, Alaska

FORAMINIFERA REPORT - REVISION

6720-7243'SW : Change age to Early Cretaceous (Berriasian to Valanginian) F-13 to F-14. This means that, like the Kugrua #1 and S. Meade #1 wells, we now feel that we are dealing with Early Cretaceous strata sitting directly on Oxfordian (F-16) age strata.

Interpreted by:

M. B. Hickey

ANDERSON, WARREN & ASSOCIATES, INC.

Richard E. Anderson

IKPIKPUK #1

GEOGRAM SURVEY

DEPTH REFERENCE:

KB IS 52 FEET ABOVE REFERENCE
NOTE: ALL DEPTH DATA, EXCEPT THAT FOR TVD CORRECTION, MUST BE SPECIFIED WITH RESPECT TO GEOGRAM REFERENCE INDICATED

GEOGRAM REFERENCE: [N] SUB SEA [ ] LOG DEPTHS

DIMENSIONS

HOLE DEVIATION:

TRUE VERTICAL DEPTH CORRECTION? [N] NO [ ] YES
IF "YES" SUBMIT (1) TABLE OF LOG DEPTH, HOLE DRIFT AND AZIMUTH OF DRIFT OF THE BOREHOLE, OR (2) LOG DEPTH VS. TVD DEPTH.

VERTICAL SCALE:

TOP DEPTH OF GEOGRAM IS: 198 FT.
TWO-WAY TRAVEL TIME AT TOP IS: .057 SEC.
BOTTOM DEPTH OF GEOGRAM IS: 14138 FT.

HORIZONTAL SCALE:

NUMBER OF TRACES IN GEOGRAM: 25

VELOCITY CHECK

INTERVAL VELOCITY CHECK-SHOT CORRECTION TO BE MADE? [N] YES [ ] NO
IF "YES" SUBMIT TABLE OF DEPTH VS. ONE-WAY TIME (SEE REVERSE SIDE)

SEISMIC LINE

AZIMUTH OF SEISMIC LINE (SEE REVERSE SIDE) 7 0-360°
DISTANCE FROM WELL TO SEISMIC LINE 0. FT.

WAVELET

RICKER: ZERO PHASE [ ] MIN. PHASE [ ] 17 HZ

GAIN CONTROL

RESTORE TRANSMISSION LOSSES? [N] NO [ ] YES 100 % (% RESTORATION)
(100% RESTORATION SIMULATES AMPLITUDE LOSSES OF SEISMIC SECTION)

STRUCTURAL ANALYSIS:

STRUCTURAL DIPS		
TOP DEPTH OF ZONE (AS PER GEO.REF-)	DIP 0-90°	AZIMUTH 0-360°

NOTE: IN THE EVENT OF PINCHOUTS, THE UPPER ZONE CONTROLS TRUNCATION OF LOWER ZONE(S).

INTERPRET DIPMETER AND ENTER DATA ON REVERSE SIDE.
MAXIMUM ENTRIES = 50

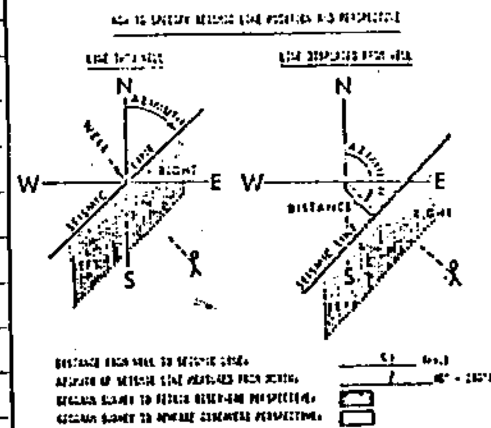
DISPLAY

DEFINE SCALES TO MATCH SEISMIC SECTION
HORIZONTAL SCALES: 150 FT./TRACE; 12 TRACES/INCH
VERTICAL SCALE: .2 SEC/INCH
POLARITY OF AMPLITUDE SHADING ON GEOGRAM: [N] POS. [ ] NEG.
SCHLUMBERGER LOGS WITH LINEAR TIME SCALE: (SEE REVERSE SIDE)

SWS- 7 N = NORMAL CHOICE

Fig. SI-1

TVD CORRECTION				VELOCITY CHECK SHOTS			STRUCTURAL DIPS		
MEASURED DEPTH	TVD DEPTH DRIFT	TVD DEPTH AZM.	+ or −	DEPTH'	2-WAY TIME		DEPTH'	DIP 0-90°	AZM. 0-360°
				[illegible]	[illegible]				
				[illegible]	[illegible]				
				698	[illegible]				
				[illegible]	[illegible]				
				[illegible]	[illegible]				
				1446	[illegible]				
				1948	[illegible]				
				[illegible]	[illegible]				
				5210	[illegible]				
				6650	[illegible]				
				[illegible]	[illegible]				
				7398	[illegible]				
				[illegible]	[illegible]				
				9578	[illegible]				
				9743	.9686				
				10326	[illegible]				
				11644	1.0565				
				[illegible]	[illegible]				
				14133	[illegible]				



WELL LOG DISPLAY (LINEAR TIME SCALE)

LOG	TRACK #			
CAL	1			
GR	2			
SP	3			
DIL	4			
SONIC	5			

Fig. SI-2

ADDITIONAL GEOLOGIC DATA

Sedimentary Petrology Analysis, dated February 16, 1980, Harold E. Enlows, Oregon State University.

Final Foraminifera Report, dated June 7, 1979, Anderson, Warren & Associates, Inc.

Final Palynology Report, dated June 7, 1979, Anderson, Warren & Associates, Inc.

Addendum to Foraminifera Report, dated March 26, 1980, Anderson, Warren & Associates, Inc.

Addendum to Palynology Report, dated March 26, 1980, Anderson, Warren & Associates, Inc.

End of Well Report (November 1978-April 1979), Exploration Logging, Inc.