NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

KUGRUA TEST WELL NO. 1

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

For the

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

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GEOLOGIC SUMMARY

INTRODUCTION

The Kugrua Test Well No. 1 is located in the NW 1/4 of protracted Section 8, T14N, R26W, Umiat Meridian (see Figures 1 and 2). The well location is in the northwestern portion of the National Petroleum Reserve in Alaska, a relatively unknown area from a subsurface geological standpoint. Drilling of the well commenced on February 12, 1978. Drilling was completed on May 21, 1978, and the rig was released on May 29, 1978 after the well was plugged and abandoned. Total depth was 12,588 feet.

No oil shows were encountered in drilling the well. Gas shows were common in rocks of the Nanushuk Group (frequently associated with coal beds or carbonaceous zones above the Torok Formation). Numerous gas shows were also encountered in the Torok Formation; a sandstone from 6410' to 6445', recorded a total gas reading of 928 units. The drilling mud weight was cut from 10.6 to 10.4 pounds/gallon. A gas show of 750 units was recorded in the Kuparuk River Sandstone equivalent, and gas shows associated with geo-pressured conditions were encountered throughout the Kingak Formation. Shows diminished and became insignificant below the 9-5/8" casing at 8704'. None of the observed gas shows occurred in rocks of reservoir quality, so further evaluation was deemed unnecessary.

PRE-DRILLING PROGNOSIS

The Kugrua Test Well No. 1 was drilled in order to test a large structural/stratigraphic closure interpreted as being formed by basal sedimentary strata onlapping the basement high to the north and by the change in structural strike between the pre-Devonian (basement) and the Lisburne Group. Possible reefing in carbonates of the Lisburne or in Devonian rocks was also suspected. An additional reason for drilling the prospect was to gather subsurface geological information in a poorly known area of the National Petroleum Reserve in Alaska.

POST-DRILLING SUMMARY

The Kugrua Test Well No. 1 was drilled to a total depth of 12,588 feet and bottomed in rocks of the Lisburne Group. The well did not completely fulfill its objective because the identified structural/stratigraphic closure was believed to have been formed on the basal sediments immediately overlying the basement, and since the drilling rig was unable to drill deep enough to test the expected section because of the termination of the drilling season. The objective was deeper than had been anticipated, helping to create the time-constraint. The seismic anomaly within the Lisburne Group which had been identified as possible reefing was apparently generated by some other phenomenon, possibly a facies change (some clastics were present within the Lisburne carbonates).

The drilling of Kugrua showed the presence of a thick, mid-Jurassic sandstone. The sandstone had a gross thickness of 117 feet, and had encouraging porosity values (average of 13.4%). The sandstone, if encountered at some other location on a closed structure, and possessing somewhat better porosity, could well become a hydrocarbon reservoir.

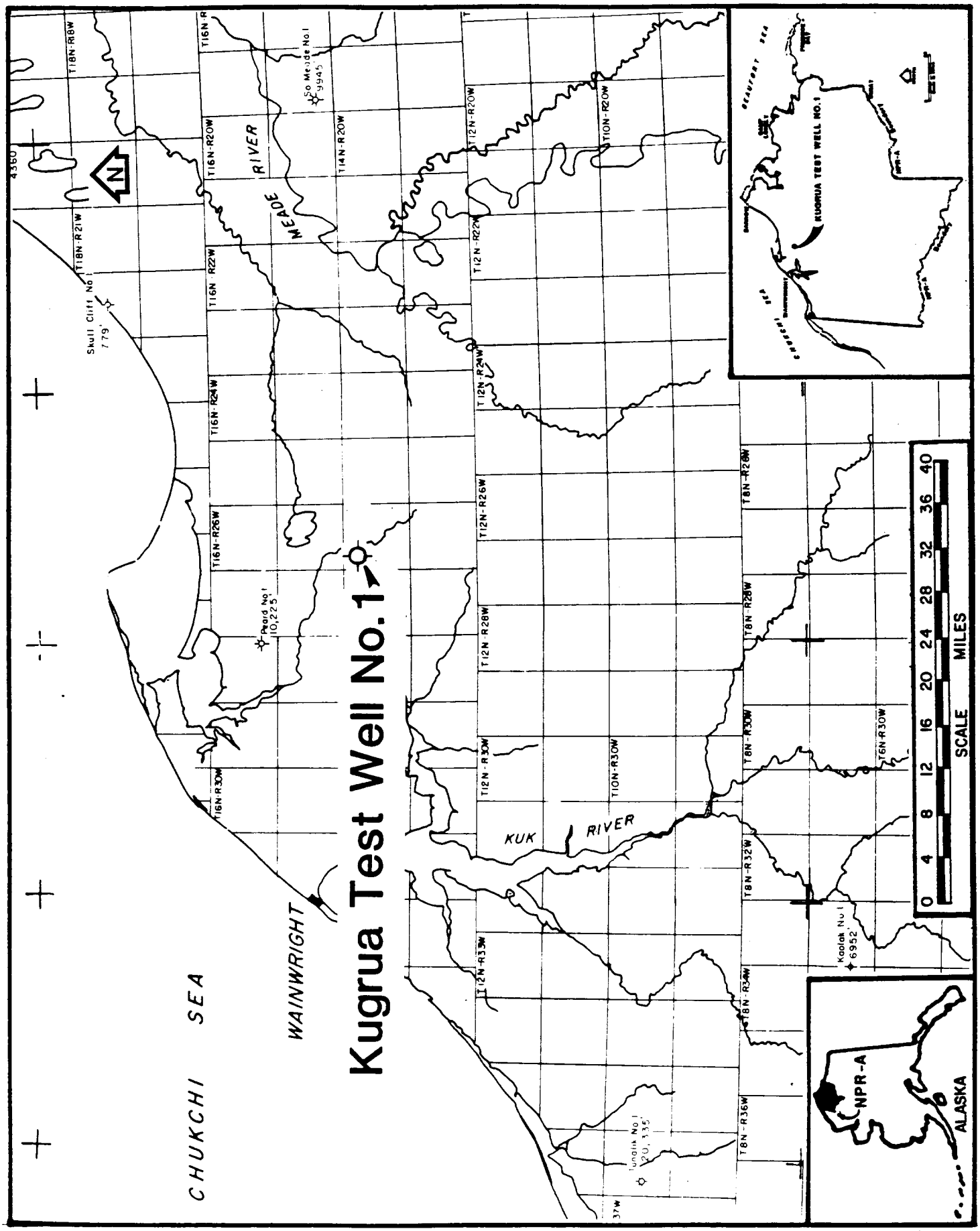
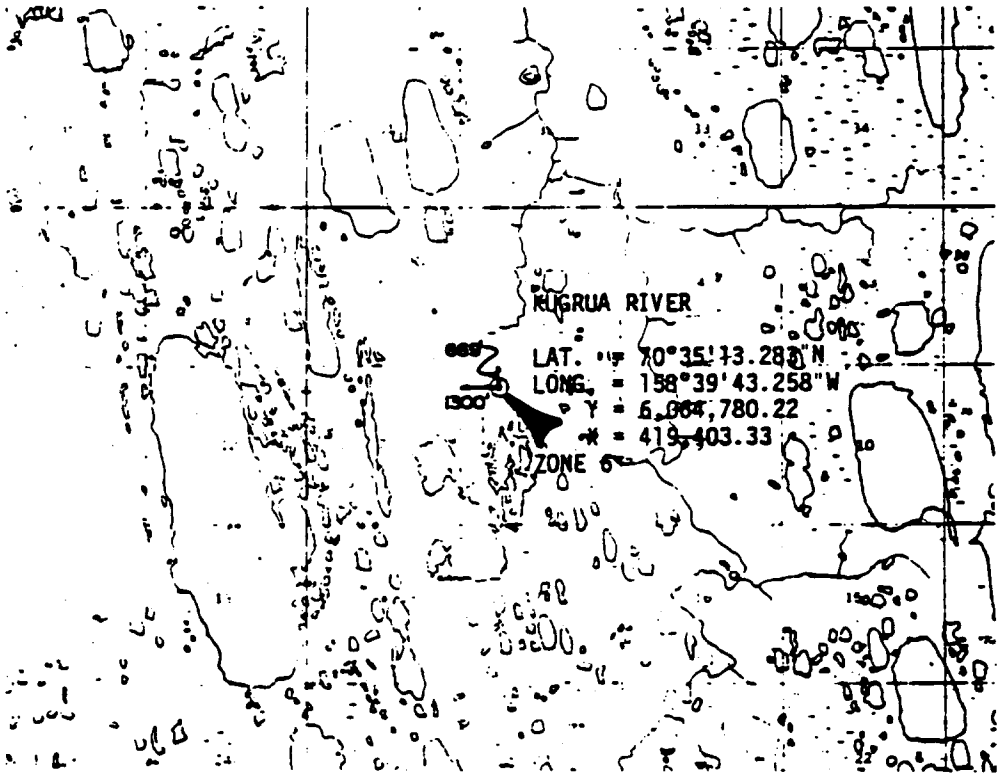


FIGURE 1 - LOCATION MAP - KUGRUA TEST WELL NO. 1



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

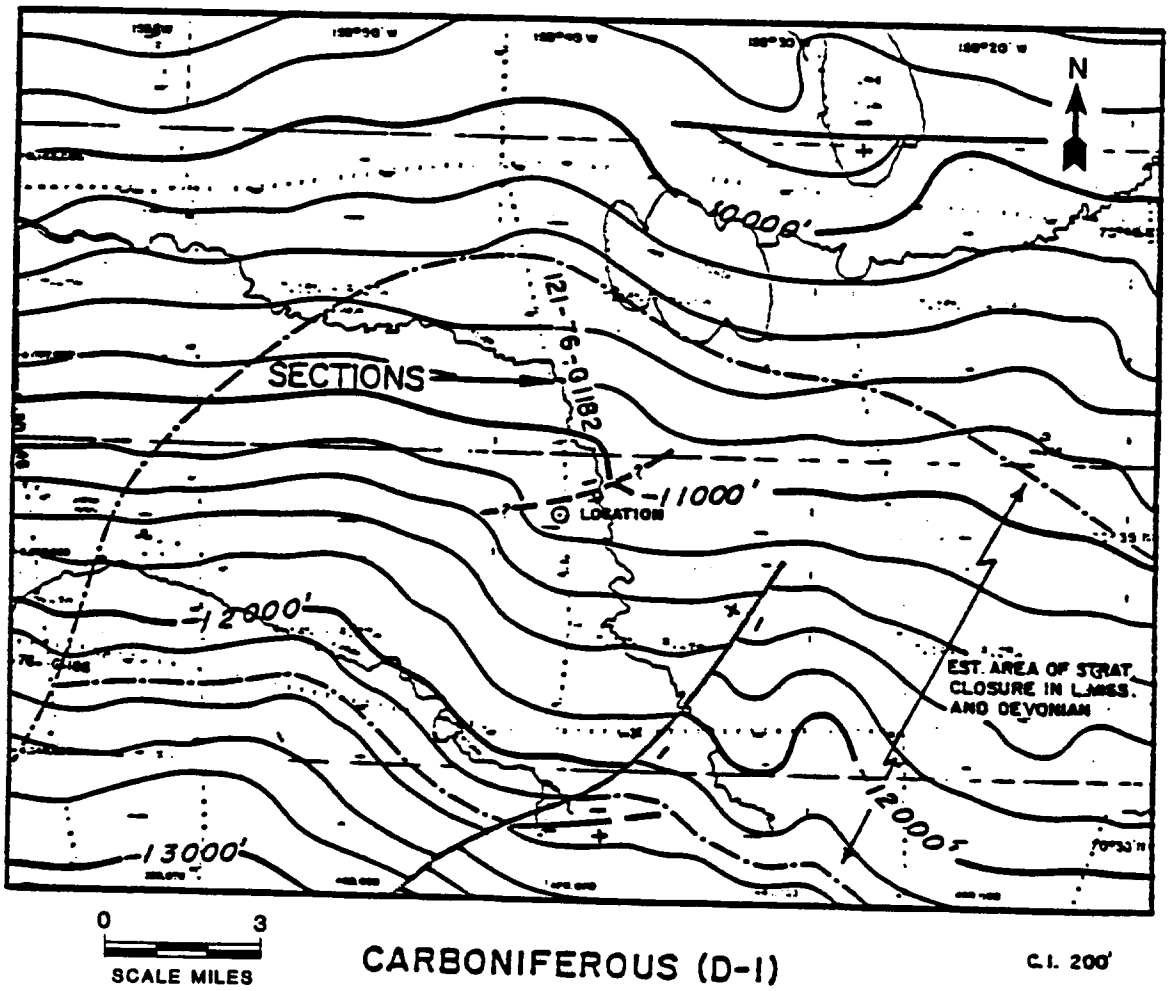
0 1/2 1 2
SCALE IN MILES

AS STAKED
KUGRUA RIVER
LOCATED IN
NW1/4 PROTRACTED SEC. 6 T14 N,R26W, 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 - CERTIFICATE OF SURVEYOR - KUGRUA TEST WELL NO. 1



TOP LISBURNE GROUP

FIGURE 3 - Structure, Top of Lisburne Group - KUGRUA TEST WELL NO. 1

(Source of Map from Tetra Tech Seismic Interpretation)

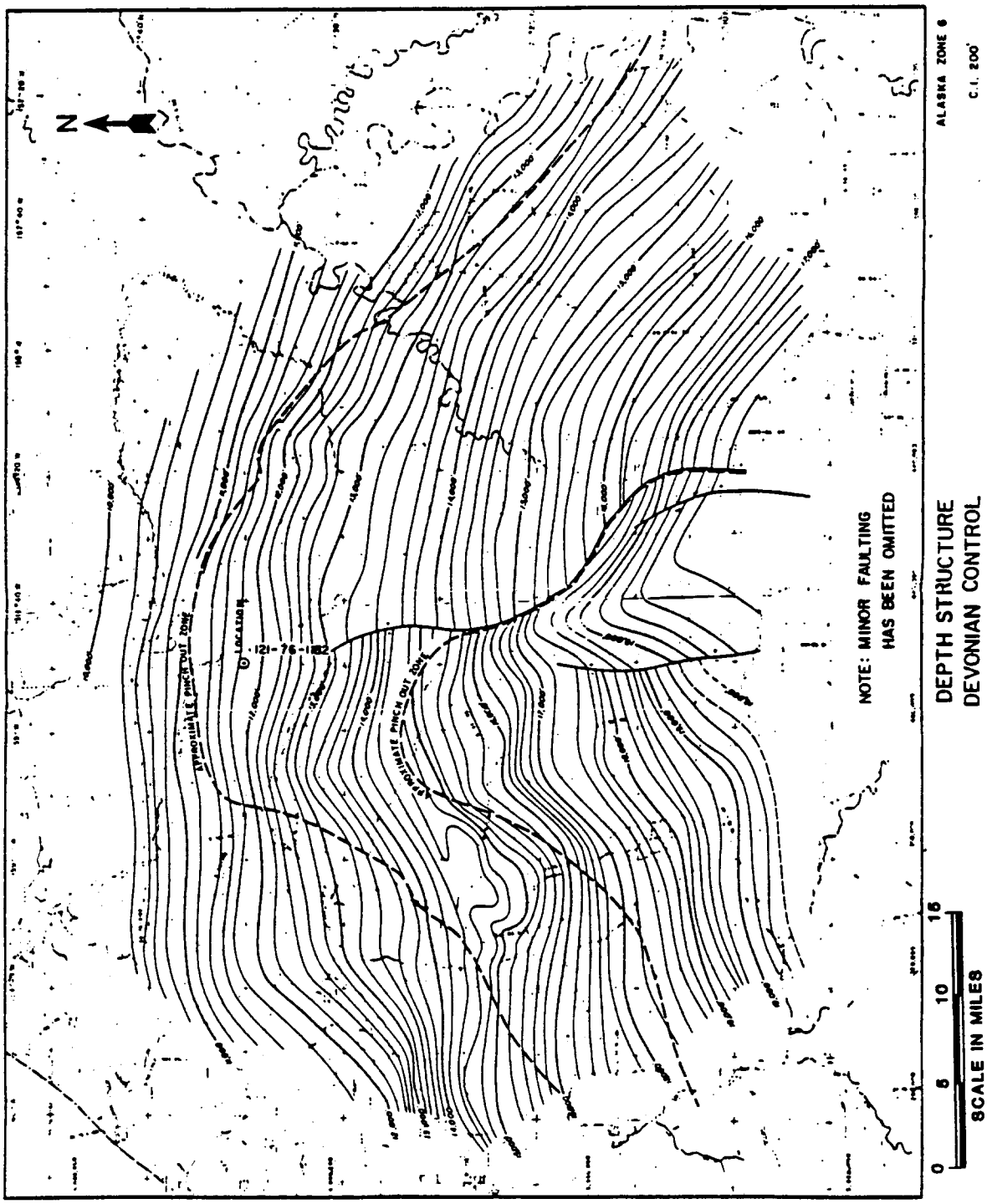


FIGURE 4 - Depth Structure, Devonian Control - KUGRUA TEST WELL NO. 1
(Source of Map from Tetra Tech Seismic Interpretation)

WELLSITE GEOLOGIST'S REPORT
BY
WILLIAM D. FENEX
AND
ARLEN EHM

SUMMARY

The Husky Oil, USGS/NPRA Kugrua Test Well No. 1 was drilled to test a seismically interpreted stratigraphic anomaly within the Carboniferous Lisburne Group. No structural closure is present on any horizon and only southward regional dip with minor nosing is indicated from seismic work within the prospective area. This anomaly appears to be a wedge of sediments in the upper part of the Lisburne Group which onlap the pre-existing basement "highs".

STRATIGRAPHY

WIRELINE LOG TOPS

	DRILLED DEPTH (FEET BELOW KELLY BUSHING)	SUBSEA (K.B. 85')
CRETACEOUS		
Nanushuk Group		
Corwin Formation	Surface	
Grandstand Formation	1,420'	-1,335'
LOWER CRETACEOUS		
Torok Formation	3,820'	-3,735'
EARLY CRETACEOUS		
"Pebble Shale"	6,890'	-6,805'
Kuparuk River Sandstone equivalent	7,205'	-7,220'
JURASSIC		
Kingak Formation	7,304'	-7,219'
Sag River Sandstone	9,516'	-9,431'
TRIASSIC		
Shublik Formation	9,630'	-9,545'
TRIASSIC-PERMIAN		
Sadlerochit Group		
Ivishak Formation	9,965'	-9,889'
Kavik Shale Member	10,820'	-10,735'
Echooka Formation	10,989'	-10,904'
PERMIAN - MISSISSIPPIAN		
Lisburne Group	11,160'	-11,075'
TOTAL DEPTH	12,588'	-12,503'

CRETACEOUS

Nanushuk Group

Corwin Formation: Surface-1420'

The nonmarine Corwin Formation, which was deposited in a delta plain environment, occurs from the surface to about 1420'. This interval consists predominantly of gray claystone with interbedded coal, sandstone, and siltstone. The sandstones are light gray in color and are composed of fine to medium quartz grains with rare large grains, some pyrite nodules, and scattered carbonaceous inclusions. The siltstones are medium gray and contain abundant carbonaceous material. The siltstones grade to sandstone in part.

The interval from 735' to 930' is predominantly sandstone with thin interbedded claystone and siltstone zones. The composition of each of these rock types is essentially as noted above, although a marked improvement in reservoir characteristics occurs in the sandstones. Good spontaneous-potential development (30-50 millivolts) was measured on the DIL log.

Below 930' and continuing to 1420', the Corwin is predominantly siltstone, claystone, and sandstone with rare, thin coal beds. Rock types are essentially the same as the preceding with the exception of a marked decrease in sandstone porosities. Abundant carbonaceous laminations and inclusions occur within the siltstone and sandstone.

Oil and Gas Shows

Methane gas shows associated with the coal beds occurred throughout the Corwin Formation.

Grandstand Formation

At about 1420', the Corwin grades into the Grandstand, with the occurrence of marginal marine deposition. The lithology of this interval is claystone, interbedded with siltstone and sandstone, and containing fossil debris such as *Inoceramus* prisms. Two fairly thick tongues of sandstone with minor interbedded siltstone, claystone, and coal occur near the top of the Grandstand; the first of these is from 1515' to 1572' and the second from 1697' to 1955'. The sandstone is gray in color and consists of fine to medium quartz grains, loosely cemented, with abundant carbonaceous material. Porosity and permeability are largely inhibited by clay in the matrix.

From 1955' to 3736', the predominant lithology is gray claystone that grades partly into thinly bedded gray siltstone containing abundant carbonaceous material and some finely disseminated mica. Scattered thin beds of siltstone that grade into fine grained sandstone occur throughout this interval.

The Grandstand Formation from 1955' to 3736' was deposited on a broad, shallow marine shelf, the source area of which was apparently to the south and southwest.

A thick sandstone unit deposited during a northward progradation of the shoreline occurs from 3736' to 3820'. Lithologically, this sandstone is composed of very fine to fine, subangular, clear quartz grains with black, ferromagnesian minerals scattered throughout. Some clay filling occurs throughout this interval.

The base of this unit is selected as the contact between the Grandstand Formation and the Torok Formation. An aggregate thickness of 2420' of Grandstand Formation is present in the Kugrua Test Well No. 1.

Oil and Gas Shows

The sandstone from 3736' to 3820' carried shows of gas with a maximum reading of 1,072 units of total gas. Quantitative values of the various gas components were recorded as follows:

C_1	200,000 ppm+
C_2	60,000 ppm+
C_3	1,800 ppm
C_4	Trace

No shows of oil and no surface indications of gas were noted in this interval.

LOWER CRETACEOUS

Torok Formation: 3820-6890'

The top of the Torok occurs at 3820' and is selected on the top of the thick shale and claystone interval which continues to 6125'. This top is not supported by paleontological data (Torok was picked at 4110' by Anderson, Warren & Associates, Inc.), but is compatible with regional correlations, both surface and subsurface. An excellent correlation can be made with the U. S. Navy, Topagoruk Test Well No. 1 (25 - 15N - 16W), 65 miles to the east. The top of the massive shale unit occurred at 3428' in that well and is overlain by a thick sandstone unit. Lithologically, the Torok from the top to 6125' is predominantly dark gray-brown shale with finely disseminated mica, occasional carbonaceous and pyrite inclusions, and some silty zones which grade to siltstone in part. Some thin gray sandstone beds occur within this interval, each of which carry minor amounts of gas. These sands are composed of fine quartz grains in calcite cement. Some carbonaceous laminations occur within this sand and some clay filling is present.

From 6125' to 6890', the Torok interval contains a greater number of sandstone beds which are lithologically similar to those above, but have much better reservoir development. Calculated porosities from log analysis are from 9% to 10.5%. Water-saturation calculations indicate these sands are water bearing.

Oil and Gas Shows

The thin sandstone beds in the upper portion of the Torok contain minor amounts of gas which were measured from 208 units to as high as 1,984 units of total gas. Chromotograph measurements vary from 190,000 ppm to 350,000 ppm C_1, 12,000 ppm to 40,000 ppm C_2, 500 ppm to 2,000 ppm C_3 and traces of C_4.

The sandstones in the interval from 6125' to 6890' exhibit much better porosity and permeability than those in the upper unit with an accompanying increase in quality and quantity of show. The sand from 6125' to 6135' had abundant tar interspersed throughout with a total gas reading of 1,920 units and chromatograph readings of 220,000 ppm C_1, 25,000 ppm C_2, 5,500 ppm C_3, and 220 ppm C_4. Gas bubbles were present at the surface in the bell nipple and at the flow line and the mud weight was cut from 10.1 ppg to 9.8 ppg. Two sandstone zones, 6235' to 6258' and 6273' to 6285', had total gas readings of 960 units and 1,120 units, respectively. Quantitative measurements were 170,000 ppm C_1, 26,000 ppm C_2, 5,000 ppm C_3, in the upper sand, and 160,000 ppm C_1, 80,000 ppm C_2, and 10,000 ppm C_3, in the lower sand. No show was observed in the samples, nor was there any surface indication of gas. A sandstone from 6410' to 6445' had total gas readings of 928 units and quantitative measurements of 210,000 ppm C_1, 78,000 ppm C_2, and 550 ppm C_3. No show was observed in the samples, but the mud was cut from 10.6 ppg to 10.4 ppg.

EARLY CRETACEOUS

"Pebble Shale": 6890-7205'

The "Pebble Shale", which unconformably underlies the Torok Formation, occurs at 6890' and continues to 7205'. The "Pebble Shale" is a black, fissile, smooth to silty, calcareous shale and it contains floating, fine-to-medium sized, rounded quartz grains, some finely disseminated mica, and scattered pyrite nodules. The "Pebble Shale", which was deposited in a marine environment, is geopressured in this area and is subject to sloughing. The large volume of cuttings brought to the surface occur as large splinters and shards with a conchoidal fracture.

A conventional core was cut from 7197' to 7202', and 5' of shale was recovered. This shale is as described above and contained shell fragments (Inoceramus), occasional large black rounded chert fragments, and some pyrite nodules.

Three hundred fifteen feet of "Pebble Shale" was measured in the Kugrua Test Well No. 1.

Kuparuk River Sandstone equivalent: 7205-7304'

At 7205', directly below the "Pebble Shale" is the marine Kuparuk River Sandstone equivalent which represents the basal sand deposited during the Neocomian transgression. This sandstone is composed of fine, subrounded to subangular quartz grains in a generally siliceous, but moderately friable matrix. Abundant bright green glauconite pellets are scattered throughout this sand. Towards the base, this sand grades to shaly siltstone. Porosity is generally very poor to nil. The base of the Kuparuk River Sandstone equivalent was picked at 7304' for an aggregate thickness of 99'.

Oil and Gas Shows

Seven hundred fifty units of total gas were recorded on the gas analyzer from 7205' to 7235', but no other show was noted in this sand.

JURASSIC

Kingak Formation: 7304-9516'

The Kingak Formation, which was deposited in a marine environment, unconformably underlies the Kuparuk River Sandstone equivalent. The Kingak interval from its top at 7304' to 7475' consists of black shale, fissile, silty in part, calcareous and contains finely disseminated mica, pyrite nodules and floating quartz grains. Some thin beds of gray siltstone are interbedded with the shale. Some overpressuring occurs in the lower part of this interval.

From 7475' to 7650', a gradual increase in siltstone and sandstone content occurs, which probably represents a "stillstand" during the Kingak transgression. The siltstones are tan in color and contain black ferromagnesian minerals, finely disseminated mica and carbonaceous laminations and inclusions. The siltstones grade to very fine grained sandstone from 7508' to 7533'. One hundred ninety units of gas were recorded from this interval. The calculated porosity of this sandstone, from the density log, was 9.5%.

The deposition of black shale, which occurs at 7650', signals a return to deeper marine conditions. This black shale sequence contains numerous thin glauconitic siltstone beds and grades to claystone in part. From 8400' to 8610', numerous brown calcareous ironstone (siderite) concretions occur; pyrite nodules are also common throughout this interval.

The Kingak shale is geopressured throughout the interval from 7650' to 8610', and the inherent drilling problems associated with overpressuring occurred. Pore pressure did not reach the postulated 15.4 ppg derived from seismic interpretation, but it would have been impossible to have increased the mud weight beyond the 12.1 ppg which was used because of lost-circulation problems previously encountered.

Thin sandy siltstone zones interbedded with shale are abundant in the interval from 8610' to 8713'. These siltstones are representative of near-shore deposits and are dark gray in color, argillaceous, and contain finely disseminated mica, carbonaceous laminations and glauconite pellets.

A thick, somewhat porous sandstone unit occurs from 8713' to 8830' and was probably deposited as a barrier bar-beach complex formed during a southward progradation of the shoreline. This sandstone is very light gray, and is composed of fine to very fine quartz grains and rare minute ferromagnesian minerals. It contains bright green glauconite pellets, some finely disseminated mica, rare pyrite inclusions, and carbonaceous laminations. Porosity calculated from the density log through this interval averages 13.4%, but the white clay matrix would considerably reduce the effective porosity.

Three thousand two hundred barrels of mud were lost in the top of this sandstone. Because of the overpressured conditions and attendant problems encountered in the overlying shale, the decision was made to set a 9-5/8" string of intermediate casing through this troublesome interval. The casing shoe was set into a resistive, silty-sandy zone at 8704' K.B. The shoe was drilled out with 11.8 ppg mud, and the remainder of the sand zone was drilled with full returns.

A gradation to tight, very fine grained sandstone and siltstone with interbedded shale occurs at 8830' and continues to 8897'. These silty sand zones are dark gray-brown in color, very argillaceous, hard, blocky, and contain rare glauconite pellets.

This thick, relatively porous sandstone marks the base of the Late Jurassic. Paleo data indicates that the top of Middle Jurassic rocks (AWA F-17) occurs at 8890'.

From 8897' and continuing to 9334', deeper marine black shale deposits occur. This shale is overpressured at the top and is subject to sloughing. This shale contains finely disseminated mica, pyrite inclusions and occasional carbonaceous material. Dark gray, micaceous siltstones occur as thin interbeds through this interval.

Near shore marine deposits of sandy oolitic dolomite and oolitic sandstone interbedded with siltstone and shale occur from 9334' to 9516'. This complex lithologic sequence is very low in porosity, and contains no potential reservoir beds.

<u>Sag River Sandstone</u>: 9516-9630'

The Sag River Sandstone, which was deposited as a barrier bar-beach complex during the initial transgression of Early Jurassic seas, is composed of very fine to fine to occasional medium, subrounded quartz grains which are generally well cemented with calcite. White clay locally comprises the matrix. Rare, bright green glauconite and ferromagnesian minerals are scattered throughout. The density-log porosity through the interval 9519-9620' varies from 8% to 14%.

The top of the Sag River Sandstone is at 9516', and the base is at 9630'. The thickness of the formation is 114'.

Three hundred barrels of mud were lost into the Sag River at 9526', and a gradual loss of 650 barrels occurred from 9526' to 9625'. Another 500 barrels of mud were lost, probably into the Sag River, while drilling from 9680' to 9700'.

Oil and Gas Shows

No shows of oil or gas were encountered in the Sag River sand.

TRIASSIC

Shublik Formation: 9630-9965'

The near-shore marine deposits of the Shublik Formation occur at 9630' and unconformably underlie the Sag River Sandstone. These deposits are composed of interbedded dark gray-brown siltstone, which is argillaceous, and with finely disseminated mica and rare glauconite; and light gray limestone, which is dolomitic, chalky, and with black phosphate pellets and rare glauconite. Thin beds of gray shale with abundant finely disseminated mica occur throughout. From 9905' to the base of the Shublik at 9960', lithologies are largely limestone, mottled tan to gray-brown, pelletal (black phosphate pellets), very fossiliferous (pelecypods) in part, occasionally oolitic, with traces of siltstone, as above.

The Shublik Formation did not contain any potential reservoir rocks at the Kugrua location, because of the generally non-porous nature of the sequence.

Oil and Gas Shows

No shows were encountered in the Shublik in this well.

TRIASSIC-PERMIAN

Sadlerochit Group

Ivishak Formation: 9965-10,820'

The Ivishak sandstone is composed of grains which are very fine grained to silt-size. The sandstone is gray, calcareous, with rare, pale green glauconite pellets and finely disseminated mica. Interbedded with this sandstone are thin beds of dark gray siltstone and shale, both of which contain finely disseminated mica and occasional pyrite inclusions. This pro-delta sequence prevails to 10,375', where a thin tongue of chert conglomerate of the pro-grading delta front occurs. At 10,415', a return to pro-delta conditions occurs with accompanying deposition of thinly interbedded sandstones, siltstones and shales. A conventional core was cut from 10,480' to 10,504'; the rock consisted of thinly interbedded gray siltstone and black shale with finely disseminated mica, pyritized worm tubes and nodules, and abundant carbonaceous inclusions.

Kavik Shale Member: 10,820-10,989'

The Kavik Shale Member of the Ivishak Formation consists of an interbedded sequence of shales and siltstones with occasional shaly sandstones. The shales are very dark gray to brown, silty and micaceous; the siltstones are generally light to dark gray, argillaceous, siliceous to quartzitic, micaceous and with sandstone partings; the sandstone, probably occurring mostly as thin laminae and interbeds, is very light gray to buff, silty, siliceous and argillaceous.

Echooka Formation: 10,989-11,160'

The top of the Echooka Formation was encountered at 10,989'. The upper part of the Echooka is interbedded brick-red claystone and sandy siltstone with some gray chert pebbles and a trace of red jasper. This sequence continues to 11,112' where it becomes red to gray conglomerate composed of red, gray, and black chert pebbles interbedded with claystone and sandstone. The Echooka Formation represents the basal sediments deposited on the eroded Lisburne surface during the initial northward transgression of shallow Permian seas. A conventional core was cut in the Echooka from 11,030' to 11,033'. This core consisted of medium gray claystone and dark gray-green sandstone which grades downward into silty sandstone and brick-red claystone.

No dip was observed in the cores of the Echooka or the Ivishak. Reservoir quality sandstones are not present in either the Ivishak or Echooka Formations. Porosities are very low, generally in the 3% to 6% range. Aggregate thickness of the Sadlerochit Group is 1,195'.

Oil and Gas Shows

No shows were observed in rocks of the Sadlerochit Group.

PERMIAN-MISSISSIPPIAN

Lisburne Group (undifferentiated): 11,160-12,588' (total depth)

Underlying the Sadlerochit Group unconformably are the shallow-marine shelf carbonates and thin intermittent clastic zones of both sandstone and red shale of the Lisburne Group. The Lisburne occurs at 11,160' and continues to total depth at 12,588'. The carbonate deposits are largely limestone, composed of allochemical and biogenic constituents such as crinoids, bryozoans, oolites, pellets, and intraclasts which are cemented with spar calcite or calcilutitic lime mud.

From the top at 11,160' and continuing to 11,990', the Lisburne is composed of gray-brown to tan limestone that contains abundant fossiliferous material, occasional oolites and black phosphate pellets, rare pyrite and chert nodules in a spar calcite matrix.

The rock is essentially non-porous. Thin beds of light gray, medium to coarse grained sandstone are interbedded with the limestone from 11,195' to 11,300' and from 11,410' to 11,425' and from 11,504' to 11,530'.

From 11,530' to 11,986', lithologies are composed largely of fossiliferous limestones, as previously described, with thin beds of gray, fissile shale, containing some carbonaceous material. Some glauconite and phosphate pellets and chert nodules occur throughout this interval. No visible porosity was observed in this part of the Lisburne.

Beginning at 11,986', abundant thin beds of gray sandstone, red shale, and siltstones occur as thin interbeds within the limestone. These thin sands and red shale and siltstone interbeds continue to 12,402'.

From 12,402' to total depth of 12,588', the section is composed of fossiliferous limestone, as above, with abundant chert nodules and pellets.

The Lisburne Group in the Kugrua area was deposited in a near-shore marine environment in which a suite of mixed carbonate-clastic rocks occur interbedded throughout the section. No porosity development of significance occurred within the penetrated Lisburne section. This lack of porosity is considered to be due to the fact that this immediate area was within the totally marine realm and had no intimate association with the intertidal-supratidal or sebkha environments in which dolomite deposition with its associated intercrystalline porosity occurs. This does not preclude the possibility of the sebkha, with its associated dolomite porosity, occurring near the Kugrua area, probably to the north.

Oil and Gas Shows

There were no observed hydrocarbon shows in rocks of the Lisburne Group.

CONCLUSIONS

Although the Kugrua Test Well No. 1 was still in the Lisburne Group at total depth, it is felt that enough of the section was penetrated to test the concept of stratigraphic onlap. The well also provided valuable stratigraphic information for future evaluation within the northwestern part of the National Petroleum Reserve. The lack of porosity development within the Lisburne at this location is discouraging, but does not preclude the possibility of porosity occurring nearby. Because of the proximity of this type of depositional environment to the shoreline, it is possible that a transition to sebkha conditions with their associated dolomites could occur within a short distance.

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E. Listing of Other Available Geological Data and
Source of Other Geological and Well Data E-1

SUMMARY PERTINENT DATA, OPERATIONS & ANALYSIS*

WELL NAME:	Kugrua Test Well No. 1
API NO.:	50-133-20002
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	669' FNL, 1300' FWL (NW 1/4) protracted Section 8, T14N, R26W Umiat Meridian North Slope Borough, Alaska
COORDINATES:	Latitude: 70°35'13.283" North Longitude: 158°39'43.258" West X = 419,403.33; Y = 6,064,780.22 Zone 6
ELEVATION:	85' Kelly bushing (KB); 65' Ground
CASING:	30" @ 80' 20" @ 496' 13-3/8" @ 2611' 9-5/8" @ 8704'
DATE SPUDDED:	February 12, 1978
TOTAL DEPTH:	12,588 feet (driller) 12,594 feet (Schlumberger)
DATE REACHED TOTAL DEPTH:	May 21, 1978
DATE RIG RELEASED:	May 29, 1978

LOGGING RECORD:

DIL/SP	493-12,594'
BHC/GR	493- 2,624'
	8,697-12,582'
BHC/GR/CAL	2,608- 8,699'
CNL/FDC/GR/CAL	2,616-12,588'
HDT Dipmeter	2,609- 8,702'
	11,068-12,592'
Saraband	2,611-10,170'
	10,170-12,556'
Mudlog	92-12,588'
Birdwell Velocity Survey	1,000-12,366'
Geogram	2,715-12,439'

SIDEWALL CORES:	Run No. 1 - 45 shot, 39 recovered** Run No. 2 - 45 shot, 39 recovered.

CONVENTIONAL CORES:

No.	Interval	Recovery	Rock Unit
1	7,197- 7,202'	5.0'	"Pebble Shale"
2	10,480-10,504'	24.0'	Sadlerochit Group
3	11,030-11,033	3.0'	Sadlerochit Group

STATUS: Plugged and abandoned

DRILLING FOREMEN: John Williams
Bob Ramsey

WELLSITE GEOLOGISTS: Arlen Ehm
Dave Fenex

WELL LOG ANALYST: Armour Kane

DRILLING CONTRACTOR: Parco, Inc., Rig 95

MUDLOGGERS: Borst and Giddens

BIOSTRATIGRAPHIC ANALYSIS: Anderson, Warren & Associates, Inc.

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

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

** Sidewall cores were utilized for various analyses including: lithology, paleontological, and geochemical.

KUGRUA TEST WELL NO. 1
DRILL CUTTINGS AND CORE DESCRIPTIONS

Arlen Ehm	-	115- 6,614'
		10,650-11,250'
Dave Fenex	-	6,614-10,650'
		11,250-12,588'

DRILLED DEPTH (FEET BELOW KELLY BUSHING)	
0- 115	No recovery.
115- 700	Claystone: light cream to medium gray, indurated to soft, sticky, and interbedded sandstone, siltstone and coal; sandstone is buff to light gray, fine to medium grained, slightly friable to hard; siltstone is brown to light gray, argillaceous and hard; coal is low grade subbituminous and is associated with methane gas; clay is present in beds and as underclay; continental deposits are represented, as in the Corwin Formation. NOTE: Lithology in the above interval is highly interpretive because of large hole size (17-1/2"), and the rapid drilling rate.
700- 760	Sandstone: light to medium gray, subangular, firm to friable, very argillaceous, micaceous with Siltstone: medium brown to medium gray, argillaceous, and with Claystone: buff, silty in part.
760- 1000	Sandstone, Siltstone and Claystone: as above, but with increasing amounts of claystone toward bottom of interval.
1000- 1030	Sandstone: medium gray, fine to very fine grained, subangular quartz and carbonaceous fragments, abundant clay filling in pores; Siltstone: dark gray, hard; Claystone: light tan, hard, carbonaceous laminations; trace of pyrite and well rounded, frosted quartz grains.
1030- 1060	Sandstone: as above, with some intergranular porosity; Siltstone: as above, highly carbonaceous; some translucent quartz grains; Claystone: as above and with traces of well rounded quartz grains.
1060-1090	Sandstone, Siltstone and Claystone: as above with some Siltstone: very argillaceous; trace of rose quartz.
1090- 1240	Sandstone: as above with Claystone: buff, hard, and with Claystone: light cream, hard, with well rounded, frosted, floating quartz grains and with Siltstone: as above, but with abundant carbonaceous laminations.

1240- 1270	Sandstone: light to medium gray, predominantly fine grained, argillaceous; Sandstone: green to medium gray to dark gray, highly carbonaceous and interbedded with coal; Claystone: buff, hard; trace of pyrite and trace of well rounded frosted quartz grains.
1270- 1300	Sandstone, Siltstone and Claystone: as above with sandstone becoming less friable in part; pyrite disseminated in claystone, and occurring as nodules.
1300- 1330	Sandstone: as above, but less friable; Siltstone, with abundant carbonaceous laminations; Claystone: as above, and with some Claystone: gray, soft and sticky.
1330- 1420	Sandstone, Siltstone and Claystone: as above, but sandstone becoming more friable and more clay-filled.
1420- 1450	Sandstone, Siltstone and Claystone: as above, but with a trace of coal.
1450- 1540	Sandstone: medium brown to medium gray, some very fine grained, poorly sorted, firm to hard; Siltstone: medium brown to medium gray, hard; Claystone: buff to light brown and reddish-brown, some light cream with well rounded, frosted, floating quartz grains.
1540- 1570	Sandstone, Siltstone and Claystone: as above, with some spherical pyrite concretions; some Inoceramus prisms.
1570- 1600	Sandstone, Siltstone and Claystone: as above, but no longer containing pyrite or Inoceramus.
1600- 1630	Sandstone, Siltstone and Claystone: as above, with claystone becoming laminated in part.
1630- 1690	Sandstone, Siltstone and Claystone: as above, but with siltstone containing abundant carbonaceous laminations.
1690- 1720	Sandstone: medium brown to medium gray, poorly sorted, subangular quartz and rounded carbonaceous fragments, soft to friable, calcareous cement; Siltstone: medium gray, carbonaceous in part, hard; Claystone: buff and red, firm, some gray, sticky; trace of pyrite.
1720- 1750	Sandstone, Siltstone and Claystone: as above, with the sandstone becoming moderately calcareous.
1750- 1780	Sandstone, Siltstone and Claystone: as above with sandstone becoming friable in part.

1780- 1840	Sandstone: light gray, fine to medium grained, poorly sorted, subangular quartz, carbonaceous fragments; rare fragments of brown crystalline dolomite and medium gray chert; some intergranular porosity, but pores are clay-filled in part; highly calcareous, soft and friable; Siltstone: medium gray to brown-gray, argillaceous; Claystone: brown and red, hard.
1840- 1880	Sandstone: as above, but with some gold, spotty fluorescence, no cut, slow milky-white to yellow crushed cut; Siltstone and Claystone: as above.
1880- 1960	Sandstone, Siltstone and Claystone: as above, no shows, and with traces of biotite and coal.
1960- 2020	Sandstone, Siltstone and Claystone: as above, but sandstone becoming firm.
2020- 2080	Sandstone: light medium gray, fine to medium grained, friable, clay-filled, some yellow spotty fluorescence, milky-white, crushed cut; Siltstone: light medium gray, firm to friable, slightly calcareous, minor carbonaceous material; Claystone: medium brown to medium gray, firm to soft, silty.
2080- 2140	Sandstone, Siltstone: as above, but with an increase in claystone.
2140- 2200	Sandstone, Siltstone and Claystone: as above, but with an increase in sandstone.
2200- 2320	Sandstone, Siltstone and Claystone: as above, but sandstone becoming minor.
2320- 2400	Claystone: as above, with only minor amounts of sandstone and siltstone.
2400- 2500	Claystone and Siltstone: as above.
2500- 2560	Siltstone: light medium brown to medium gray, firm to hard, sandy in part, continuing abundant carbonaceous laminations; minor sandstone and Claystone: as above.
2560- 2604	Predominantly Siltstone: as above with a trace of sandstone.
2604- 2624	No samples (depth correction).
2624- 2640	Siltstone: medium gray, firm, finely laminated with carbonaceous material, very finely laminated with mica, some disseminated mica, shaly.

2640- 2780	Predominantly Siltstone: as above, interbedded with Claystone: gray, silty and sticky.
2780- 2820	Siltstone, interbedded with Claystone: as above, but with slight increase in claystone.
2820- 3070	Siltstone and Claystone: as above, but with further increase in claystone.
3070 3210	Siltstone and Claystone: as above with a trace of Sandstone: medium gray, very fine grained, friable, argillaceous, no oil show, cut or fluorescence.
3210- 3280	Siltstone and Claystone: as above, but becoming increasingly shaly, grading to shale; occasional broken quartz grains.
3280- 3320	Siltstone: as above, with some medium gray to brown-gray, very fine grained Sandstone: firm to friable, carbonaceous.
3320- 3350	Claystone: gray, sticky, silty, with some Claystone: brown, firm, silty and with siltstone and minor Sandstone: as above.
3350- 3440	Siltstone: medium gray to brown-gray, carbonaceous, micaceous along laminae and as disseminated fragments; interbedded with Shale: light medium gray to dark gray, very silty, mostly blocky to splintery, some fissile; minor Sandstone: medium gray to light medium gray, some medium brown, moderately sorted, subangular to subrounded, predominantly quartz, and with rare fragments containing abundant carbonaceous fragments; no show.
3440- 3490	Shale and Siltstone: as above with minor Sandstone: as above; marked decrease in claystone.
3490- 3560	Shale, Siltstone, and minor Sandstone: as above, with siltstone becoming more argillaceous and less micaceous.
3560- 3710	Shale and Siltstone with minor Sandstone: as above, but with shale becoming more fissile.
3710- 3770	Sandstone: medium gray, light medium gray and medium brown, very fine grained, moderately sorted, subangular to subrounded, some clay filling, predominantly quartz and rare fragments which are abundantly carbonaceous, moderately calcareous; interbedded Siltstone: medium gray to brown-gray, shaly, carbonaceous, micaceous along laminae and as disseminated fragments; interbedded Shale: light medium gray to dark gray, very silty,

	blocky to splintery fracture; minor Claystone: gray, sticky; increase in sandstone downward, but with no shows.
3770- 3810	Sandstone, siltstone, shale and Claystone: as above, but with an increase in sandstone.
3810- 3840	Sandstone, siltstone, shale and Claystone: as above, but with a decrease in sandstone and an increase in Claystone: gray, sticky, silty.
3840- 3900	Sandstone, siltstone, shale and Claystone: mostly as above, but with siltstone and shale becoming very finely micaceous.
3900- 4020	Sandstone, siltstone, shale and Claystone: as above, with a trace of pyrite.
4020- 4100	Sandstone, siltstone, shale and Claystone: as above; gas show on chromatograph, but no indications of show in samples.
4100- 4160	Sandstone, siltstone, shale and Claystone: as above, but increase in sandstone, no oil show, fluorescence or cut.
4160- 4270	Siltstone and Shale: as above, with minor sandstone and Claystone: as above.
4270- 4400	Sandstone: as above, no show, with siltstone, shale and Claystone: as above.
4400- 4550	Sandstone: as above, with shale and siltstone becoming gradational.
4550- 4760	Sandstone, shale and Siltstone: as above, with sandstone becoming slightly to moderately calcareous.
4760- 4840	Sandstone: light gray to medium gray, fine grained to very fine grained, poorly to moderately sorted, predominantly quartz grains, subangular to subrounded, some clay filling, slightly to moderately calcareous, minor carbonaceous material, moderate porosity, becoming better sorted downward; shaly siltstone, silty shale and Claystone: as above.
4840- 4930	Shale and Siltstone: gradational as above, very silty, abundantly micromicaceous with Sandstone: as above.
4930- 4990	Sandstone: light gray and medium gray, some medium brown, fine to very fine grained, dirty, some clay filling, firm to friable; shaly siltstone and silty Shale: as above, with occasional silty claystone; some Claystone: brown to medium gray, soft, some firm; no shows.

4990- 5090	Sandstone: light gray, fine grained, moderately to poorly sorted, clay-filled in part, very slightly calcareous to moderately calcareous, firm to friable, and with Sandstone: medium gray to medium brown, fine to very fine grained, very poorly sorted, dirty appearance, firm to friable, no shows with siltstone and Shale: as above.
5090- 5170	Sandstone, siltstone and Shale: as above, with some clear calcite fragments - probably fracture filling.
5170- 5250	Sandstone: light gray, very fine grained, moderately to poorly sorted, some clay filling, predominantly subangular quartz with some carbonaceous fragments, firm to friable, slightly to moderately calcareous, no shows, with siltstone and Shale: as above.
5250- 5270	Sandstone and Shale: as above, with Siltstone: as above, but very micaceous.
5270- 5320	Claystone: medium brown to medium gray, soft to firm, silty; some gray, sticky, silty claystone, and with sandstone, siltstone and Shale: as above.
5320- 5410	Sandstone: medium brown, fine to very fine grained, poorly sorted, dirty, very micaceous, slightly calcareous, carbonaceous; shale and Siltstone: gradational from silty shale to shaly Siltstone: medium brown to dark gray.
5410- 5520	Sandstone, siltstone and Shale: as above, with siltstone beginning to become slightly sandy.
5520- 5540	Sandstone: medium gray, fine grained, highly carbonaceous, very slightly calcareous, poorly sorted, firm, with Sandstone: medium brown, very fine grained, silty, very poorly sorted, friable, in part, with silty shale, shaly siltstone and sandy Siltstone: as above.
5540- 5690	Interbedded and alternating sequences of sandstone, siltstone and Shale: as above, with abundant carbonaceous laminae on sandstone surfaces; trace of <u>Inoceramus</u> prisms and pyrite 5660-5670'.
5690- 5835	Predominantly shale and Siltstone: as above, with Sandstone: as above, and with some calcite fragments - probably fracture filling.
5835- 5860	Sandstone: medium gray, fine grained, poorly to moderately sorted, slightly calcareous, firm, predominantly subangular to subrounded quartz grains, with Sandstone: medium brown, very fine grained, silty, very poorly sorted, firm, very slightly calcareous to noncalcareous, with no visible shows, but gas show in gas detectors.

5860- 5930	Predominantly shale and Siltstone: as above, with very minor Sandstone: as above.
5930- 6100	Interbedded, alternating sequences of Siltstone: medium gray to brown-gray, slightly calcareous, carbonaceous laminae, hard, with Siltstone: medium gray, sandy, slightly calcareous, carbonaceous, micaceous, hard, with Shale: medium gray and brown-gray, hard, micaceous, splintery, and with Sandstone: as above, but no shows.
6100- 6315	Predominantly Sandstone: medium gray, fine to medium grained, poorly to moderately sorted, clay-filled in part, very micaceous, calcareous, firm to hard, abundant tar, intermixed with sandstone grains, and with Sandstone: medium brown, fine grained, poorly sorted, dirty, slightly calcareous, predominantly quartz, abundant tar, trace of brown, dense limestone fragments, no visible shows, but gas shows with slight mud-cutting effect (10.1 ppg to 9.8 ppg) and with minor siltstone and Shale: as above.
6315- 6400	Siltstone, shale and minor Sandstone: as above, with Claystone: gray, soft, sticky, silty.
6400- 6470	Sandstone: light brown to medium brown, fine to medium grained, moderately sorted, predominantly subrounded quartz, abundant carbonaceous fragments, some clay filling, moderately to highly calcareous, firm to friable, slightly porous with some medium brown, very fine grained sandstone, no visible shows; mud gas-cut from 10.6 ppg to 10.4 ppg; minor amounts of siltstone and Shale: as above.
6470- 6490	Sandstone: as above, some light gray, fine grained, and with minor siltstone and Shale: as above.
6490- 6614	Predominantly shale and Siltstone: as above, with minor Sandstone: as above.
6614- 6635	Shale: dark gray to black, blocky, smooth to silty, firm, minutely micaceous, grades to siltstone, in part.
6635- 6665	Sandstone: gray, with some pink grains, medium to fine grained, subangular to subrounded, "salt and pepper", calcite cement with some white clay filling, minutely micaceous, fair sorting, firm to moderately friable, nil to very poor visible porosity, no odor, stain, cut, or fluorescence (240 units of gas).
6665- 6720	Interbedded Shale: as above, and Sandstone: as above, gray, becomes very fine grained, very argillaceous in

part, very well indurated, tight, and Siltstone: gray-brown, "salt and pepper", argillaceous, with some Sandstone: gray with pink grains, very fine grained, "salt and pepper", subrounded to subangular, fair to well sorted, calcite cement, well indurated, nil visible porosity; no odor, stain, cut, or fluorescence.

6720- 6730 Sandstone: gray to gray-brown, "salt and pepper", very fine grained, well sorted, subangular to subrounded, calcite cement, minutely micaceous, firm to moderately friable, nil to very poor visible porosity, no odor, stain, cut, or fluorescence (640 units of gas).

6730- 6760 Shale: dark gray, blocky, firm, minutely micaceous, silty, in part, with interbedded Sandstone: as above, silty.

6760- 6805 Sandstone: gray-brown, "salt and pepper", fine to medium grained, poorly sorted, subangular to subrounded, very argillaceous, some white clay filling, some carbonaceous fragments, minutely micaceous, nil visible porosity, no odor, stain, cut, or fluorescence, with interbedded Shale: as above.

6805- 6825 Sandstone: as above, more soft and friable, very poor visible porosity, no odor, stain, cut, or fluorescence (624 units of gas).

6825- 6885 Interbedded Shale: black, blocky to platy, silty, minutely micaceous, moderately firm, and Sandstone: gray, "salt and pepper", very fine grained to silty, calcite cement, well indurated, nil visible porosity, grades to siltstone in part, no odor, stain, cut, or fluorescence.

6885- 7197 Shale: black, splintery, fissile, smooth, very slightly calcareous, moderately indurated, with occasional disseminated fine to medium grained quartz grains and occasional loose, clear, rounded quartz grains; pyritic in part, becomes platy to blocky, minutely micaceous, silty toward base; grades to claystone, in part.

7197- 7202 <u>Core No. 1, Cut 5', Recovered 5'</u>

7197.0-7202.0' (5.0') Shale: black, very silty, blocky, very well indurated, minutely micaceous, occasional pyrite inclusions, rare shell fragments, and oblique fractures.

7202- 7205 Shale: black, silty, minutely micaceous; pyrite: rare, large, black, subrounded chert pebbles: moderately indurated, blocky.

7205- 7236	Sandstone: tan, very fine grained, well sorted, subrounded to subangular, moderately friable to very well indurated, very slightly calcareous, but generally siliceous; rare, bright green glauconite pellets, nil to very poor visible porosity, no odor, stain, cut, or fluorescence (720 units of gas).
7236- 7310	Shale: black, blocky to platy, occasionally fissile, smooth to occasionally silty, minutely micaceous, in part, very well indurated, brittle, very pyritic, with thin interbedded Sandstone: as above, silty, in part, thin carbonaceous laminations.
7310- 7360	Shale: black, platy to blocky, generally smooth, firm, pyritic, with Siltstone: gray-brown, blocky, minutely micaceous, becomes very argillaceous in part, grades to Shale: silty.
7360- 7460	Shale: predominantly dark gray to black, platy, splintery, fissile, smooth, firm, with trace of Sandstone: tan to brown, very poor visible porosity.
7460- 7530	Shale: as above, becomes very clayey, with Siltstone: brown-tan, "salt and pepper", firm, minutely micaceous, carbonaceous laminations and rare pellets, very well indurated, brittle.
7530- 7545	Predominantly Siltstone: as above.
7545- 7570	Sandstone: tan, very fine grained, well sorted, subrounded to rounded, calcareous cement, very well indurated, nil visible porosity, no odor, stain, cut, or fluorescence (190 units of gas).
7570- 7590	Siltstone: tan, "salt and pepper", carbonaceous laminations, minutely micaceous, very hard and brittle, siliceous, blocky.
7590- 7750	Interbedded Siltstone: tan, as above, grades to Siltstone: dark brown, argillaceous matrix, carbonaceous laminations in part, with Shale: black, minutely micaceous, platy to blocky, firm, pyritic, and Claystone: dark gray-brown, minutely micaceous, soft, gummy.
7750- 7800	Predominantly Claystone and Shale: as above, with thin beds of Siltstone: dark brown, argillaceous.
7800- 7850	Claystone: dark gray-brown, minutely micaceous, pyritic.

7850- 7945	Interbedded Claystone: as above, with very thin beds of Siltstone: dark brown, as above, and Shale: as above.
7945- 8015	Claystone: as above, pyritic.
8015- 8055	Claystone: as above, with interbedded Shale and Siltstone: as above; abundant pyrite.
8055- 8160	Predominantly Claystone: as above, with traces of Siltstone: dark brown, argillaceous, as above; abundant pyrite nodules.
8160- 8210	Predominantly Shale: black, platy to blocky, moderately indurated, smooth, minutely micaceous, silty, in part; some fissile shale with pyrite inclusions.
8210- 8310	Interbedded Siltstone: dark brown, argillaceous, as above, and Shale: black, as above, with some Siltstone: light gray, "salt and pepper", hard, brittle, blocky, minutely micaceous, rare glauconite pellets, becomes sandy in part.
8310- 8340	No samples; lost circulation at 8341'; lost approximately 1,000 barrels of mud.
8340- 8375	Shale: medium gray, minutely micaceous, rare carbonaceous pellets, rough texture, silty, in part, well indurated, interbedded with Shale: dark gray-brown to black, blocky, smooth, very hard and brittle, pyrite inclusions, siliceous, and thin stringers of Siltstone: dark brown, argillaceous, sandy, minutely micaceous, some white clay filling, with 30 percent coarse, bright green glauconite pellets.
8375- 8525	Shale: medium gray, as above, and Shale: dark gray-brown, as above, with some interbedded Claystone: gray-brown, minutely micaceous, abundant pyrite, with thin stringers of Siltstone: dark brown, argillaceous, minutely micaceous, hard, brittle, blocky.
8525- 8595	Interbedded Siltstone: dark gray-brown, blocky, minutely micaceous, very well indurated, and Shale: as above, pyritic; trace of Sandstone: tan, very fine grained to silty, fair sorting, minutely micaceous, moderately indurated.
8595- 8677	Predominantly Siltstone: dark gray-brown, as above, grades to medium gray, less argillaceous, some carbonaceous laminations, very well indurated, blocky, with some interbedded Shale: as above, very pyritic.

8677- 8695	Sandstone: dark gray, very fine grained to silty, occasional fine grained, poorly sorted, very slightly calcareous, minutely micaceous, moderately well indurated, nil visible porosity; no odor, stain, cut, or fluorescence.
8695- 8712	Lost circulation at 8712' (approximately 3,200 barrels); no sample.
8712- 8775	Sandstone: very light gray-brown, "salt and pepper", blocky, very fine to fine grained, fair to well sorted, minutely micaceous, rare, bright green glauconite pellets, white clay filling, soft and friable to moderately indurated, nil to very poor porosity, no odor, stain, cut, or fluorescence; becomes very light gray with pink grains, fine grained, some carbonaceous laminations, pyrite inclusions, and increase in glauconite pellets toward base.
8775- 8785	Shale: dark gray, minutely micaceous, platy to blocky, firm.
8785- 8870	Sandstone: light gray, as above, occasional pyrite inclusions, carbonaceous laminations; some thin Shale: as above, grades to Sandstone: gray-brown, "salt and pepper", very fine grained to silty, some white clay filling, moderately indurated, occasional carbonaceous laminations, nil to very poor visible porosity; no odor, stain, cut, or fluorescence; some loose white clay (probable fracture filling), rare glauconite pellets, minutely micaceous, grades to siltstone.
8870- 8915	Siltstone: dark gray-brown, sandy, very argillaceous, rare glauconite pellets: blocky, hard, brittle, with Shale: as above.
8915- 8940	Shale: dark gray to black, splintery, finely disseminated mica: moderately indurated, pyrite inclusions, fissile.
8940- 8952	Sandstone: light to dark gray, very fine grained to silty, blocky, in part, very hard and brittle, siliceous cement, glassy appearance, rare glauconite pellets, carbonaceous laminations, nil visible porosity; no odor, stain, cut, or fluorescence.
8952- 9025	Shale: dark gray to black, as above.
9025- 9128	Siltstone: dark gray-brown, minutely micaceous, hard, brittle, very argillaceous, with interbedded Shale: as above.

9128- 9255	Shale: as above, becomes very pyritic.
9255- 9297	Siltstone: dark gray-brown, very argillaceous, blocky, hard, brittle, with interbedded Shale: as above, pyritic.
9297- 9322	Shale: dark gray, minutely micaceous, pyrite inclusions, fissile, splintery with conchoidal fracture.
9322- 9332	Siltstone: as above.
9332- 9365	Dolomite: dark brown, with light gray-green oolites: argillaceous, very finely crystalline, hard and brittle, blocky, some calcite-filled fractures, interbedded with Sandstone: medium gray-brown, with gray oolites (ringed with pyrite); Sandstone: very fine grained, well indurated, poorly sorted, subangular to subrounded, nil visible porosity; no odor, stain, cut, or fluorescence; Siltstone: as above.
9365- 9478	Predominantly Dolomite: oolitic, as above, interbedded with Siltstone and Sandstone: as above.
9478- 9510	Interbedded Shale: dark gray, minutely micaceous, pyritic, fissile, splintery, with Siltstone and Dolomite: as above.
9510- 9526	No samples; lost circulation at 9526'.
9526- 9630	Sandstone: light gray, very fine grained, subrounded to rounded, well sorted, moderately indurated, soft and friable in part, well cemented with calcite, rare to common, bright green glauconite pellets, rare "salt and pepper", nil to poor visible porosity; no odor, stain, cut, or fluorescence; becomes argillaceous in part, some white clay filling, in part, grades to silty toward base.
9630- 9662	Siltstone: dark gray-brown, argillaceous, hard, brittle, blocky, finely disseminated mica: siliceous, well cemented with calcite, and with interbedded Sandstone: light gray, glauconitic, as above; abundant loose, large, quartz grains; clear, angular (fracture filling?).
9662- 9710	Limestone: light gray, dolomitic, very finely crystalline, chalky and soft, in part, some black carbonaceous material, grades to dark gray, argillaceous, slightly silty, nil visible porosity, occasional vug (fossil mold?), nonconnected, with large angular quartz crystals: as above, with some Siltstone: as above.

9710- 9740	Siltstone: dark gray to black, very argillaceous, finely disseminated mica: hard and brittle, with Limestone: dark gray-brown, very finely crystalline, silty, dense, with quartz crystals: as above; rare green glauconite pellets and black shiny phosphate pellets; limestone becomes chalky, in part, soft to well indurated.
9740- 9755	Shale: medium gray, abundant finely disseminated mica: fissile, platy to blocky, silty, in part.
9755- 9780	Interbedded Limestone and Siltstone: as above.
9780- 9792	Shale: medium gray, as above.
9792- 9837	Interbedded Limestone: dark gray-brown, mottled, dolomitic, silty, finely crystalline, firm, abundant scattered, bright green glauconite pellets, grades to chalky, soft, in part, occasional black, shiny phosphate pellets, with Siltstone: as above.
9837- 9885	Shale: medium dark gray to black, smooth to silty, blocky, firm, finely disseminated mica, pyrite inclusions.
9885- 9985	Limestone: dark gray-brown, some tan, mottled, finely crystalline, glassy, hard, brittle, dense, grades to Limestone: gray-brown, finely pelletal (oolites?) with abundant large, black, shiny phosphate pellets, occasional megafossil, moderate to well indurated, laminar structure, in part, nil visible porosity, grades to very chalky and soft, pyritic; toward base, becomes tan in color, only rare phosphate pellets; interbedded with Siltstone: dark gray, blocky, finely disseminated, mica: well indurated, and Shale: as above.
9985-10,040	Sandstone: light gray, very fine grained, silty, fair sorted, subangular to subrounded, finely disseminated mica and pyrite, well cemented with calcite, rare pale green glauconite pellets; sandstone is firm to some soft and friable, clay filling, in part, nil to very poor visible porosity; no odor, stain, cut, or fluorescence; with interbedded Siltstone: dark gray, blocky, finely disseminated mica: hard and brittle, with Shale: medium to dark gray, blocky, pyrite inclusions.
10,040-10,105	Sandstone: light gray, very fine grained to silty, well sorted, subrounded, finely disseminated mica and pyrite, well cemented with dolomite; slightly argillaceous, moderately indurated, some loose white clay filling, nil to very poor visible porosity, some carbonaceous laminations; no odor, stain, cut, or fluorescence; with some interbedded Siltstone: as above, pyritic.

10,105-10,150 Interbedded Sandstone and Siltstone: as above, some carbonaceous laminations.

10,150-10,195 Sandstone: light to medium gray, very fine grained to fine grained, "salt and pepper", very slightly dolomitic, fair sorting, subangular to subrounded, scattered bright green glauconite pellets; soft and friable; in part, some white clay filling, remainder moderately cemented with dolomite and silica, becomes dark gray, with carbonaceous laminations and inclusions, some finely disseminated pyrite; sandstone is hard and brittle, nil to very poor visible porosity, no odor, stain, cut, or fluorescence, some minutely micaceous, interbedded with Siltstone: dark gray, sandy, rare glauconite, finely micaceous, dolomitic cement, rare, large gray and milky chert pebbles.

10,195-10,255 Interbedded Sandstone and Siltstone: as above.

10,255-10,285 Shale: dark gray to black, platy, finely micaceous, pyritic, with Siltstone: as above, and Sandstone: as above, white clay matrix, soft and friable, glauconitic.

10,285-10,360 Sandstone: light gray-tan, "salt and pepper", very fine grained to silty, fair sorting, rare, pale green glauconite pellets, finely disseminated pyrite, some carbonaceous laminations, hard and brittle, clayey, nil visible porosity; no odor, stain, cut, or fluorescence; becomes very hard and brittle toward base, glassy appearance due to quartz overgrowths; some Siltstone and Shale: as above.

10,360-10,415 Chert Conglomerate, composed of dark gray, black, and milky chert pebbles, subangular, in clear quartz matrix, with some shale, and Siltstone: as above.

10,415-10,435 Siltstone: light gray-tan, sandy, grades to Sandstone: hard, brittle, becomes dark gray, argillaceous, in part, pyrite inclusions, finely disseminated mica.

10,435-10,455 Sandstone: light gray-tan, "salt and pepper", very fine grained, fair sorting, subrounded to subangular, rare, pale green glauconite, carbonaceous laminations, clay-filled, in part, minutely micaceous, nil to very poor visible porosity; no odor, stain, cut, or fluorescence.

10,455-10,480 Siltstone and Shale: as above.

10,480-10,504 <u>Core No. 2, Cut 24', Recovered 24'</u>

10,480.0-10,482.3' (2.3') Siltstone: medium dark gray, argillaceous, finely disseminated mica, some finely disseminated carbon

	inclusions, hard and brittle, noncalcareous with thin laminations of Shale: dark gray-black, silty, fissile, vertical fractures.
10,482.3-10,484.5' (2.2')	Shale: dark gray-brown to black, silty, finely disseminated mica and carbonaceous inclusions, hard and brittle, with thin beds of Siltstone: as above; some pyritized worm burrows.
10,484.5-10,486.7' (2.2')	Siltstone: as above, with thin laminations of Shale: as above; vertical fractures.
10,486.7-10,493.0' (6.3')	Thinly bedded alternating zones of Siltstone and Shale: as above; with vertical fractures.
10,493.0-10,495.0' (2.0')	Predominantly Shale: as above, with thin, interbedded Siltstone: as above; oblique and vertical fracturing.
10,495.0-10,503.5' (8.5')	Predominantly Siltstone: as above, becomes argillaceous in part with thin interbeds of Shale: as above; vertical fractures.
10,503.5-10,504.0' (0.5')	Shale: as above, with pyritized worm burrows.

10,504-10,512	Shale: black, fissile, finely disseminated mica, with pyritized worm burrows, as above.
10,512-10,525	Siltstone: medium gray-brown, hard and brittle, as above.
10,525-10,557	Shale: black, as above, with interbedded Siltstone: as above.
10,557-10,572	Siltstone: as above.
10,572-10,580	Predominantly Shale: as above.
10,580-10,612	Interbedded Siltstone: as above, and Shale: as above.
10,612-10,642	Shale: as above.
10,642-10,648	Siltstone: as above.

10,648-10,730 Sandstone: light medium gray to light gray, very fine, fine and medium grained, with a trace of coarse grained; interbedded; moderately to well sorted, predominantly quartz with overgrowths, some dark hard mineral grains, and some tripolitic chert; hard to very slightly friable, slightly calcareous in part, slightly micromicaceous, slightly porous to nonporous; no odor, stain, cut, or fluorescence; interbedded Siltstone: moderate brown, micromicaceous, calcareous in part, hard to very hard, and interbedded Shale: medium gray to brownish-gray, silty, in part, micromicaceous; trace of brown, coarsely crystalline Limestone with possible fossils.

10,730-10,840 Sandstone and Siltstone: as above with increase in "chalky" or "marly" matrix, becoming laminated, and with disseminated pyrite and gray chert.

10,840-10,986 Siltstone and Sandstone: as above, becoming predominantly medium gray with some light gray and medium brown, predominantly fine to very fine grained, rare medium grained, moderately to well sorted, becoming hard to very hard, appears quartzitic, silica cement, noncalcareous, nonporous, and with Shale: as above.

10,986-11,005 Red beds; claystone, sandy siltstone, and silty Sandstone: brick red, very soft to firm, medium-sized grains of very angular black mineral, noncalcareous to slightly calcareous, micaceous, in part, some gray chert pebbles, trace of red chert.

11,005-11,030 Sandstone: medium gray and light gray to very light gray, some varicolored, fine to very fine grained, occasionally medium grained, clear quartz and white feldspar grains, subrounded to well rounded, well sorted, becoming moderately sorted downward, white to light gray micrite matrix, very highly calcareous, no apparent porosity; no odor, stain, cut, or fluorescence.

11,030-11,033 <u>Core No. 3, Cut 3', Recovered 3'</u>

11,030.0-11,033.0' (3.0') Claystone: medium gray, very hard, noncalcareous, vesicular or vuggy appearance; Sandstone: light gray to dark gray-green, fine to very fine grained, moderately sorted, silica cement, very hard, dolomitic, in part; red beds; silty sandstone and silty Claystone: brick-red and speckled reddish-black, very hard, noncalcareous, possibly hematitic.

11,033-11,115	Red beds; Sandstone: brick-red, light gray, medium gray, and minor dark gray-green, fine to very fine grained, some medium grained, predominantly subrounded to well rounded quartz and lithic fragments, some very angular black lithic fragments, occasional chert pebbles, predominantly highly calcareous; no odor, stain, cut, or fluorescence.
11,115-11,140	Red beds: as above, and Conglomerate: brick red and medium gray, with red, gray, and black, well rounded chert pebbles, greater than 4 mm in diameter, some appear coated, some appear quartzitic.
11,140-11,160	Red bed sequence, as above, without red sandstone and conglomerate.
11,160-11,200	Red bed sequence, as above, with minor conglomerate and white to light gray Limestone: firm to hard, argillaceous, silty, sucrosic appearance.
11,200-11,220	Limestone: as above, becoming dark gray, green and brown, becoming coarsely crystalline, fossiliferous, with minor Sandstone: as above.
11,220-11,240	Limestone: as above, becoming light gray and white, firm to hard, micritic matrix, argillaceous and silty, and Sandstone: as above, highly calcareous; limestone and sandstone are interbedded and gradational.
11,240-11,330	Limestone: biocalcarenitic, occasionally oolitic, dark gray, argillaceous, grades to light gray-tan, well cemented with calcite: medium to coarse grained, rare, black phosphate pellets, rare pyrite inclusions; moderate to very well indurated, dense, nil visible porosity, becomes pelletal with trace chert; light gray; occasional Limestone: dark gray-brown, medium crystalline, slightly pelletal, rare fossils, sandy, some spar cement, hard and dense, nil porosity.
11,330-11,345	Sandstone: light gray, "salt and pepper", medium grained, well sorted, subangular to subrounded, well cemented with calcite, nil visible porosity.
11,345-11,495	Limestone: calcarenitic, tan to cream, fine to medium grained, occasional black phosphate pellets, chalky and soft, in part, rare pyrite, generally well indurated, nil visible porosity, spar calcite cement, with interbedded Sandstone: as above.
11,495-11,620	Limestone: calcarenitic, calcilutitic, as above, tan to cream, mottled, grades to dark brown, argillaceous, very hard and brittle, spar calcite cement, nil visible porosity, becomes pelletal in part (phosphate).

11,620-11,705	Limestone: as above, with interbedded Shale: dark gray, smooth to silty, fissile, grades to light gray, with carbonaceous material.
11,705-11,825	Limestone: oolitic, calcarenitic, calcilutitic, tan to cream, spar calcite cement, stylolitic, pyrite inclusions, cherty, hard and brittle, nil visible porosity, grades to pelletal calcarenite with occasional black phosphate pellets, rare glauconite, loosely cemented; some Limestone: dark gray-brown, argillaceous.
11,825-11,890	Limestone: calcarenitic, calcilutitic, sandy, light gray-brown, fine quartz grains, "salt and pepper", moderately indurated, becomes coarse grained, in part, slightly argillaceous, grades to sandstone, in part, nil visible porosity, grades to pelletal Calcarenite: dark gray-brown, argillaceous, as above.
11,890-11,990	Limestone: calcilutitic, pelletal Calcarenite: cream to tan, spar calcite cement, hard and brittle, nil visible porosity, some glauconite pellets, clear to milky to black chert; trace of Mudstone: red, smooth, moderately indurated.
11,990-12,050	Sandstone: red, medium to coarse grained, poorly sorted, subangular, argillaceous, calcareous, glauconitic, nil visible porosity, with Mudstone: red, as above, with red and smoky chert; interbedded with Limestone: as above.
12,050-12,105	Sandstone: light gray to white, "salt and pepper", very fine grained to silty, well sorted, subrounded to subangular, well cemented with calcite; hard and brittle, nil visible porosity, with interbedded Limestone: as above, and thin beds of Mudstone: red, as above, and Siltstone: rose-red, sandy, argillaceous, moderately indurated, well cemented with calcite.
12,105-12,175	Limestone; Biocalcarenite: cream to tan, medium to coarse grained, well cemented with spar calcite, chalky, in part, rare glauconite pellets, becomes medium brown, subvitreous, with ochre and red pellets, nil visible porosity, with interbedded Sandstone: as above, green-gray, in part.
12,175-12,260	Limestone: calcilutitic, pelletal Calcarenite: white to cream, glauconitic, some black carbonaceous material, becomes chalky, in part, moderately indurated, nil visible porosity, becomes dark gray-brown, argillaceous, hard and brittle, subvitreous with ochre and red pellets, as above, nil porosity, with chert: tan, smoky, and green.

12,260-12,305	Sandstone: white to light gray, fine grained, subrounded to subangular, well sorted, well cemented, with calcite, rare glauconite: pelletal, "salt and pepper", nil visible porosity; interbedded with Limestone: as above.
12,305-12,345	Limestone; pelletal Calcarenite: as above.
12,345-12,405	Sandstone: white, light gray, very fine grained to silty, well sorted, subrounded to subangular, white chalky matrix, poorly indurated, grades to moderately indurated, rare glauconite, trace pink chert, nil visible porosity; Mudstone: red, as above; lower 15' is Sandstone: green, very fine grained to fine grained, well sorted, subrounded to subangular, moderately indurated, composed of 40% chert grains; clear to red, translucent, nil visible porosity.
12,405-12,505	Limestone; Intrabiocalcarenite: coarse grained, with ochre, black, pink, red pellets, spar calcite cement, rare glauconite pellets, chalky in part, nil visible porosity; some Mudstone: red, as above.
12,505-12,540	Limestone: calcilutitic, Intrabiocalcarenite: very sandy, grades to Sandstone, in part: fine to medium grained, fair sorting, moderately well indurated, nil visible porosity.
12,540-12,588	Limestone; Intrabiocalcarenite: (abundant black phosphate pellets), calcilutitic, spar calcite cement, well indurated, nil visible porosity; last 8' composed of 50% Chert: black, clear, smoky.

Log Analysis

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

Formation Evaluation

April 14, 1978

Mr. Gordon W. Legg
Husky Oil/NPR Operations, Inc.
2525 C Street
Anchorage, Alaska 99503

Dear Mr. Legg:

Schlumberger began logging operations on Kugrua Test Well #1 at 2300 hours on April 5, 1978, and by 1700 hours on April 6 had completed Dual Induction Laterolog, Neutron-Density and Compensated Sonic. At that time a clean-out run was necessary due to sticky hole conditions and Schlumberger resumed logging at 0830 hours on April 7, completing dipmeter, Birdwell velocity survey and sidewall cores. Log quality was acceptable and 78 out of 90 sidewall cores were recovered. Of the 12 cores not recovered 10 were due to misfires. Rig time seems excessive although very few equipment failures occurred. The hole was badly washed out for hundreds of feet being beyond the reach of any of the calipers which means greater than twenty inches.

Correlative tops were: Pebble Shale 6890, Kuparuk River Sand 7201 and Kingak 7304. Best correlations were with the South Simpson and Fish Creek wells. No evidence of the top of the Torok could be found on the logs. A series of sands between 6100 and 6700 which indicated gas shows during drilling calculated wet and of low porosity (9%-11%) from log values and contained a high percentage of shale. A sand from 7555 to 7585 also calculated wet with a porosity in the order of 9.5% and is somewhat shaly. There are no intervals which would appear potentially productive. Water resistivities from Rw_a values appears to be .13 to .15 or in the 25,000 to 30,000 ppm range. You already have the detailed computations in your possession.

Very truly yours,

Armour Kane

Armour Kane

Log Analysis

COMPANY	WELL
HUSKY OIL/NPR OPERATIONS, INC.	KUGRUA TEST WELL #1
FIELD NORTH SLOPE	**COUNTY**
	STATE ALASKA

DEPTH	R_T	ϕ_D	ϕ_N	ΔT	ϕ_S	R_{w_e}	S_w						REMARKS
6105-10	18	9	24	80	18	.15	100						
6110-16	18	12	29	82	20	.28	73						
6236-50	14	10	29	79	17.5	.15	100						
6250-58	20	13	27	79	17.5	.38	63						
6274-84	15	10	24	79	17.5	.16	97						
6410-30	14	9	25	79	17.5	.14	100						VERY SHALY
6654-66	13	10	21	76	15	.15	100						
6666-74	17	10	20	75	14.5	.20	87						
7562-68	12	9.5	16.5	75	14.5	.13	100						
7570-80	13	9.5	16.5	75	14.5	.14	100						
	R_{w_e} MINIMUM IN TOROK SANDS = .15												
	R_{w_e} MINIMUM IN KINGAK SAND = .13												

Log Analysis

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

Formation Evaluation

May 26, 1978

Mr. Gordon W. Legg
Husky Oil/MPR Operations, Inc.
2525 C Street
Anchorage, Alaska 99503

Dear Mr. Legg:

Schlumberger began logging operations on Kugrua Test well #1 at 2330 hours on May 20, 1978, going in the hole with the Dual Induction-laterolog, went to bottom and began logging up. The tool stuck at 12,380 and was finally worked loose but the centralizers were pulled off and the log from there up was faulty. They came out, changed tools and panels and went back in, again without centralizersand logged a 600 foot interval twice with no repeatability and neither pass was satisfactory. These attempts were finished at 0600 hours on 5/21/78. A clean-out run was made and the 3rd DIL attempt began at 2130 on 5/21/78 using centralizers and was successfully completed at 2400 hours. The Neutron-Density was begun at 0100 hours 5/22/78, but due to engineer error of setting the wrong grain density on his panel the resulting density porosities were too high and the log had to be re-run and was completed at 0800 hours 5/22/78. Went in the hole with the Sonic Log at 0900 hours but the sonic caliper failed and the log was completed without caliper at 1145 on 5/22/78. The dipmeter was begun at 1300 hours and the tool was stuck at 11,078 and required a cut-and-thread fishing operation. Again, a sub-par performance by Schlumberger resulting in much lost rig time.

Formation tops from log correlations: Sag River Sand, 9516; Shublik, 9630; Sadlerochit, 9965; Echooka, 11,004 and Lisburne Lime, 11,160. The Sag River Sand had an average porosity of 10.8% and an average Sw of 79% based on Rw of 0.1 computed from the SP. Porosities in the Sadlerochit were quite low, in the 3% to 6% range. The Lisburne porosity was in the 0 - 3% range, precluding any possibility of production.

Very truly yours,

Armour Kane

Armour Kane

Log Analysis

COMPANY		WELL
HUSKY OIL/NPR OPERATIONS, INC.		KUGRUA TEST WELL #1
FIELD	COUNTY	STATE
NPRA #4	NORTH SLOPE	ALASKA

DEPTH	R_T	ϕ_D	ϕ_N	ΔT	ϕ_S	S_w							REMARKS
8920-88[illegible]	10	12	19	75	15	83							
9519-30	25	8	11	65	10	79	SAG RIVER						
9530-58	14	12	14	70	13	70		↓					
9566-80	15	9	13	63	9	90							
9580-160[illegible]	10	14	17	72	15	71							
9600 20	17	8	13	66	10.5	96							
	Av.	10.8%			Av.	79%							

S_w VALUES BASED ON R_w = 0.1 FROM SP

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

LOGGING REPORT

WELL NAME Kugura Test Well No. 1

Date 2/22/78 Driller Depth 2624'

Elevation 65 ft. GR 85 ft. KB Logger Depth 2624'

Logs Ran and Intervals

DIL 493' - 2624'
BHC/GR 493' - 2624'

Additional Logs to Run

None

Zones of Interest

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

Discussion:

Corwin Fm. Surface to 735'
Kukpowruk Fm. 735' to 2624'

Log Tops & Correlations:

Additional Evaluation Plans:

Arlen Ehm
Wellsite Geologist

Log Analyst

12/77

HUSKY

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

LOGGING REPORT

WELL NAME Kugrua Test Well #1

Date April 5-7, 1978 Driller Depth 8712'

Elevation 85 ft. K.B. Logger Depth 8702'

Logs Ran and Intervals

Dual Induction - Laterolog	2611 - TD
Neutron - Density	2611 - TD
Compensated Sonic	2611 - TD
Dipmeter	2611 - TD

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content	AV. SW%
6105-26	21	21	Shaly Sand	10.5	Water w/Gas	86
6236-58	22	22	Shaly Sand	11	Water w/Gas	88
6274-84	10	8	Shaly Sand	10	Water	97
6410-30	20	16	Vry Shly Sd	9	Water	100
6654-74	20	18	Shaly Sand	10	Water	99
7562-80	18	14	Shaly Sand	9.5	Water	100

Discussion:

Note: Above Sw valves derived from RWA computation. Approximate salinity is 25,000-30,000 ppm.

Log Tops & Correlations:

	Kugura	S. Simpson	Fish Creek
"Pebble Shale"	6890	6363	7090
Kuparuk River Sand	7201	6525	7480
Kingak	7304	6700	7640

Top of Torok not apparent on logs.

Additional Evaluation Plans:

W. D. Fenex
Wellsite Geologist

A. Kane
Log Analyst

12/77

HUSKY

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

LOGGING REPORT

WELL NAME Kugrua Test Well #1

Date 5/20-22/78 Driller Depth 12,588'

Elevation 85 ft. K.B. Logger Depth 12,594'

Logs Run and Intervals

Dual Induction - Laterolog	8697 - 12,594'
Neutron - Density	8697 - 12,594'
Compensated Sonic	8697 - 12,590'
Dipmeter	

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
8720-8830	110	90	Shaly Sand	12%	Water
9519-9620	101	86	Shaly Sand	10.8%	Water

Discussion:

Sadlerochit Porosities very low: in the 3% to 6% range

Lisburne Porosity from 0 - 3%

Log Tops & Correlations:

	Kugrua	S. Harrison	Fish Creek
Sag River	9,516	8,900	9,242
Shublik	9,630	8,957	9,285
Sadlerochit	9,965	9,240	9,515
Echooka	11,004	10,230	10,462
Lisburne	11,160	10,270	10,496

Additional Evaluation Plans:

D. Fenex
Wellsite Geologist

A. Kane
Log Analyst

12/7

LISTING OF OTHER AVAILABLE GEOLOGICAL DATA

No record of Final Biostratigraphic Report, Foraminifera or Palynology.

SOURCE OF OTHER GEOLOGICAL AND WELL DATA

Copies and some reproducibles of information referenced in this report, which was generated as part of the USGS/NPRA exploration effort, can be obtained by contacting:

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