NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

PEARD TEST WELL NO. 1

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: Geology Department

For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
SEPTEMBER, 1982

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INTRODUCTION

The Peard Test Well No. 1 is located in the northwestern part of the National Petroleum Reserve in Alaska in the NW 1/4 of protracted Section 25, Township 16 North, Range 28 West, Umiat Meridian, approximately 65 miles southwest of the community of Barrow, Alaska (see Figures 1 and 2). Drilling of the well commenced on January 26, 1979. Drilling operations were completed by April 9, 1979. The well was plugged and abandoned, and the rig was released on April 13, 1979, after drilling to a total measured depth below kelly bushing (BKB) of 10,225 feet. Indications of hydrocarbons were limited to minor shows of gas within the Lower Cretaceous sandstones and a very poor show of gas within the Permian Echooka Formation. None of the hydrocarbon shows were considered to warrant any additional evaluation and therefore were not tested.

PRE-DRILLING PROGNOSIS

The objectives of drilling the Peard well were to test the seismic anomalies observed within the Cretaceous and Jurassic rocks and to test a potential large stratigraphic trap expected within the Carboniferous rocks of the Lisburne Group (or equivalents). The well was forecast to penetrate the top of the Pre-Devonian "Argillite" rocks at 9,900 feet drill depth.

The seismic anomalies within the Lower Cretaceous and Jurassic rocks were interpreted as representing possible porous sandstone development and/or hydrocarbon saturated reservoir intervals within the Torok, "Pebble Shale", and Simpson sand. Seismic interpretations suggested a correlation existed between gas shows within equivalent intervals in the Kugrua No. 1 well and the anomalous seismic events in the Peard area. Isopach maps of these intervals also suggested a thickening of the Lower Cretaceous and Jurassic sandstones in the area.

The well was also located near the interpreted updip pinchout of the Lisburne Group carbonates or equivalent clastics. Figure 3 illustrates the interpreted structure and limit of the Carboniferous in the Peard area.

All potential reservoir intervals were considered principally gas prone as based on maturation studies and previous geochemical analysis in the area.

POST-DRILLING SUMMARY

The well was drilled to a total measured depth of 10,225 feet (BKB) into the "Argillite basement" rocks. These rocks, presumably Pre-Devonian in age, were first encountered at 9,638 feet or about 260 feet structurally higher than initially forecast.

Drilling of the well confirmed the presence of several low potential reservoir sandstones within Lower Cretaceous and Jurassic rocks, but none of these contained any significant amounts of hydrocarbon. Both the

"Pebble Shale" sandstone and the Simpson sandstone were present and exhibited intervals of porosity, but both were water wet. Of the remaining Cretaceous-Jurassic strata, only two intervals within the Torok Formation exhibited any indication of hydrocarbons. These two intervals were restricted to gas shows from thin silty low permeability sands at approximately 4,250 feet and 6,170 feet.

The deeper Carboniferous objectives (Lisburne Group or equivalents) were completely absent at the location. A portion of the Permian Echooka Formation did exhibit reservoir potential accompanied by poor shows of gas, but the entire unit was water saturated. Maximum porosity in the Echooka was developed in the upper part and in the lower 40 feet of the unit directly overlying the "Argillite basement". Permeabilities, as measured from a core at the top of the Echooka, were less than 2.5 millidarcies and averaged less than 1.0 millidarcy (see Appendix E-1).

Drilling of the well considerably restricted the potential areal extent of a stratigraphic trap within the Lisburne or equivalent rocks to the area between the Peard well and the Kugrua Test Well No. 1 (located approximately 12 miles to the southeast). The lack of significant hydrocarbons within the basal part of the Echooka Formation may greatly diminish the chances of hydrocarbons being present in these horizons. The Echooka Formation still is worthy of further exploration if a trapping mechanism can be found, combined with more favorable reservoir characteristics (permeability development).

6

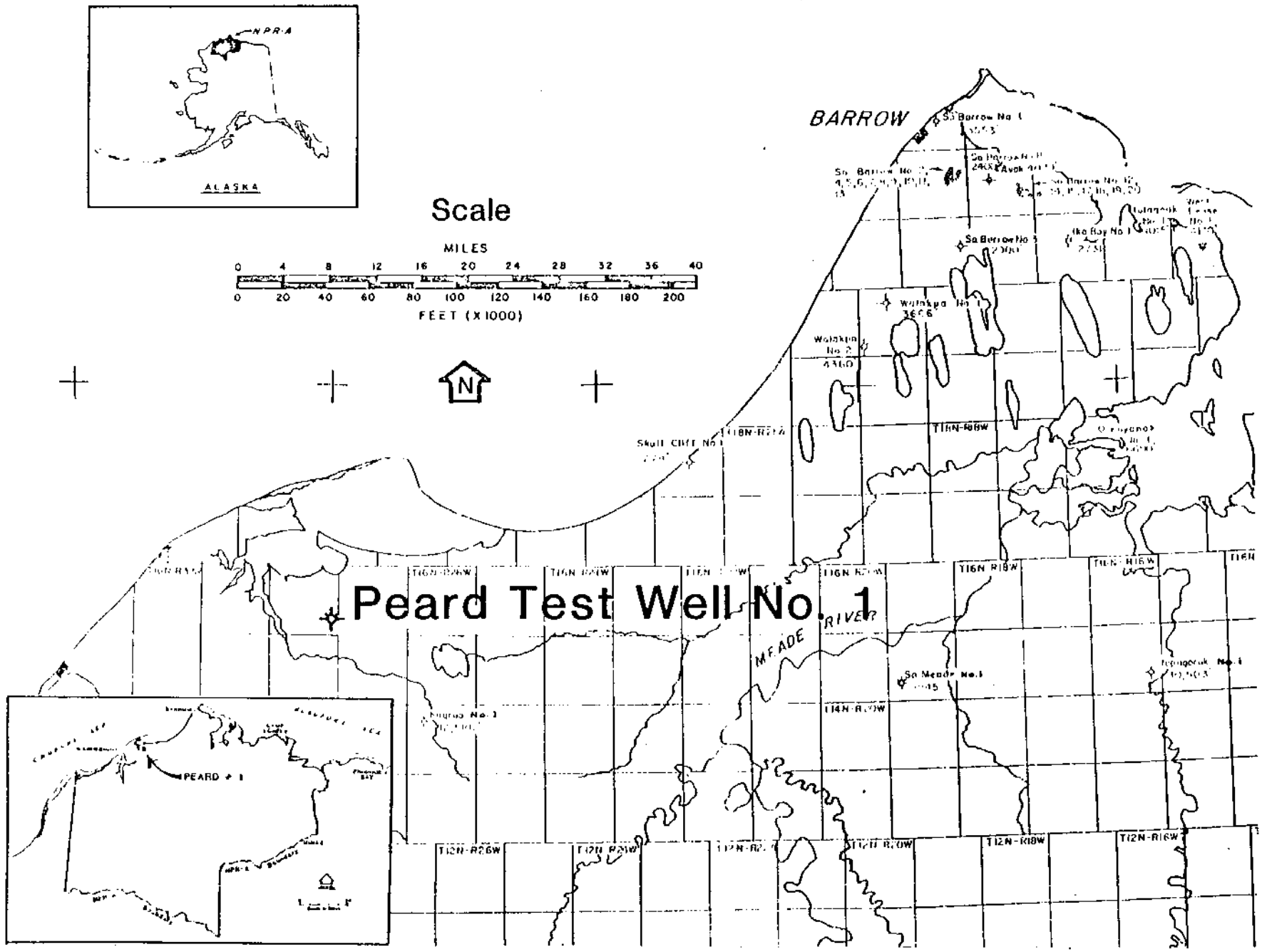
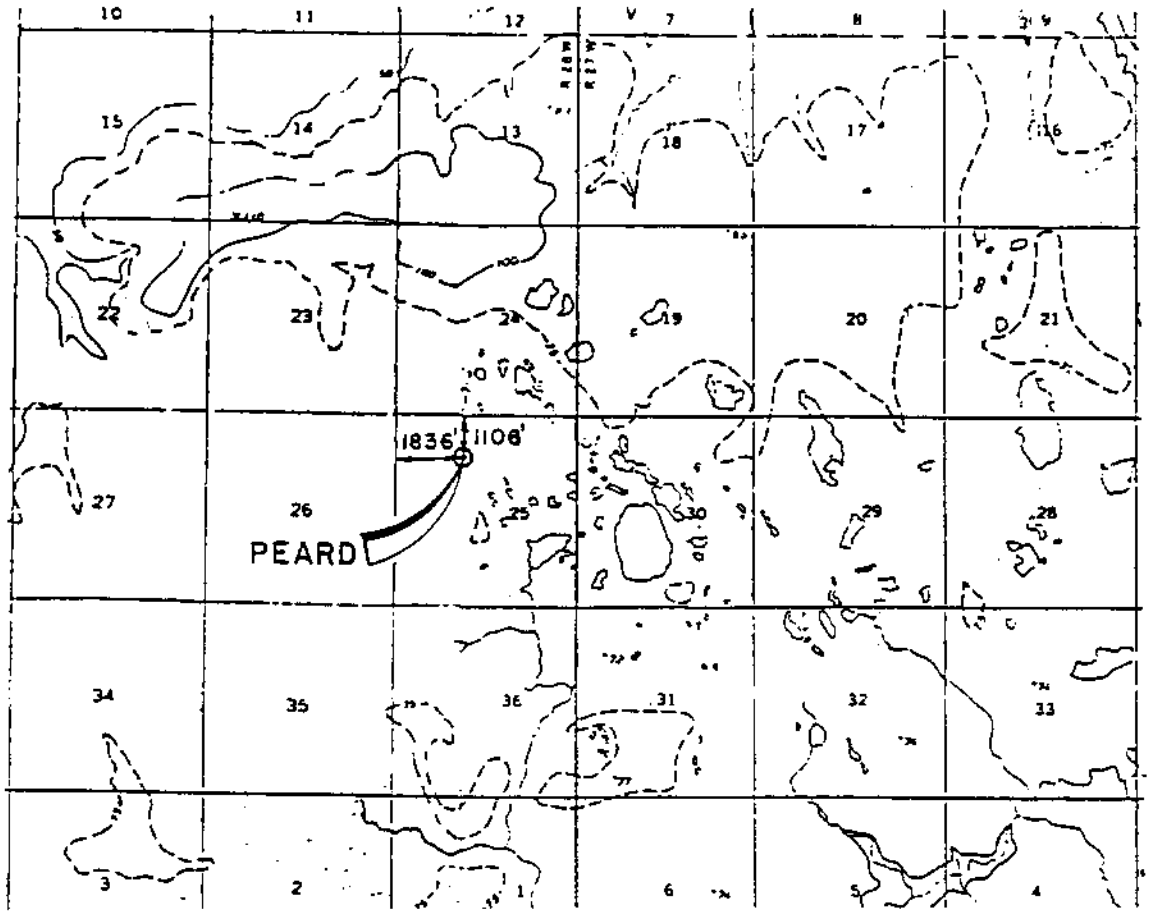


FIGURE 1 - LOCATION MAP - PEARD TEST WELL NO. 1



PEARD 3-79

LAT. = 70° 42' 56.321"
LONG. = 159° 00' 02.518"
Y = 6,112,416.92
X = 378,949.07
ZONE 6

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.

July 16, 1978

STATE OF ALASKA
JOHN L. HERRING
No. 953-S
REGISTERED PROFESSIONAL LAND SURVEYOR

SCALE: 1" = 1 MILE

AS STAKED

PEARD 3-79

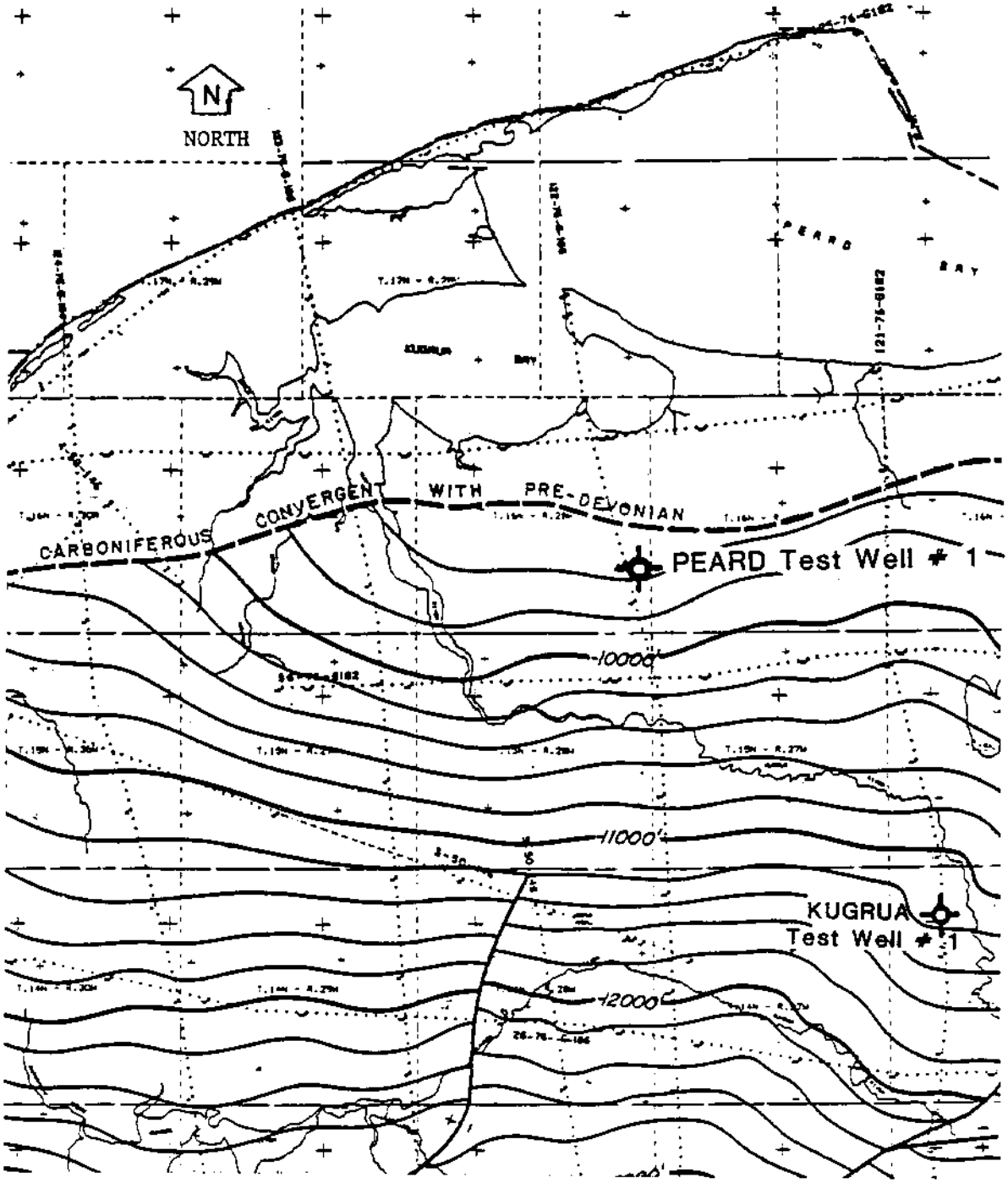
NW 1/4 PROTRACTED SEC. 25, T 16 N, R 28 W, UMIAT MER

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
Peard Test Well No. 1



STRUCTURAL CONTOUR
TOP of CARBONIFEROUS

Contour Interval : 200'
Scale : 1:250,000

FIGURE 3

ILLUSTRATES PRE-DRILLING INTERPRETATION OF CARBONIFEROUS HORIZON.

WELLSITE GEOLOGIST'S REPORT
BY
R. A. WERMEYER

SUMMARY

Peard Test Well No. 1 spudded January 26, 1979, after cementing 20" conductor pipe at 88 feet (109 feet wireline depth).

The first objective, the Torok Formation, was encountered at 3115' which was 885' high to the prognosed top. Several gas shows were recorded within the formation. The most significant show was 2,600 units from a sand at 5810'; other shows were at 4250', 4350' and 6175'. However, no oil shows were observed in the cuttings.

The "Pebble Shale" unit was encountered at 6195', 245' lower than prognosed. The Kuparuk sand equivalent was water wet.

The Kingak Formation was found at 6725', 286' low to prognosis. Some overpressuring occurred within the Kingak, but no difficulties were encountered due to the geopressures.

A small gas show of 250 units was recorded in the Simpson sand of the Kingak at 7822', but no shows were found in the cuttings.

The Sag River Sandstone was reached at 8411'; it was 211' low to prognosis and water wet. Gross thickness of the porous interval of the Sag River was 90' at this location compared to the nearby Kugrua well which had 114' of sand.

The top of the Shublik Formation was picked at a depth of 8530', 155' low to prognosis. The 8530' top coincides with the top of the Triassic determined by paleontological analysis. Thickness of the Shublik was forecast to be 250' and was found to be 187' at this location, about 150' thinner than in the Kugrua No. 1 well.

The Ivishak Formation (upper part of the Sadlerochit Group) was prognosed at 8625'. The top of the formation was penetrated at 8741', only 116' lower than anticipated. The sands within the Ivishak were not well developed and only minor gas shows were recorded with no oil staining in the cuttings.

The Echooka Formation, the basal formation of the Sadlerochit Group, was encountered at 9470' and was a well developed sand at this location. Thickness of the Echooka was 168', comparable to the thickness in the Kugrua No. 1 well. In composition, the Echooka sand at Peard is visibly quite different from the equivalent redbed sequence and conglomerates at Kugrua. The Echooka unconformably overlies the "argillite" basement in the Peard well.

The Lisburne Group was prognosed to be 365' thick at Peard Bay, a thinning of at least 1000' from the Kugrua No. 1 well approximately 12 miles away. The Lisburne, however, was absent at the Peard location. The "Argillite" was encountered at 9638' or 262' high to prognosis.

WIRELINE LOG TOPS

	Drilled Depth (BKB)	Subsea Depth
LOWER CRETACEOUS		
Nanushuk Group		
Nanushuk (nonmarine)	Surface	
Nanushuk (marine)	1470'	(-1367')
Torok Formation	3115'	(-3012')
"Pebble Shale"	6195'	(-6092')
Kuparuk sand Equivalent	6525'	(-6423')
JURASSIC		
Kingak Formation	6725'	(-6622')
Simpson sand	7822'	(-7719')
LOWER JURASSIC/UPPER TRIASSIC		
Sag River Sandstone	8411'	(-8308')
UPPER TO MIDDLE TRIASSIC		
Shublik Formation	8530'	(-8427')
LOWER TRIASSIC and PERMIAN		
Sadlerochit Group	8741'	(-8638')
Ivishak Formation	8741'	(-8638')
Kavik Shale	9358'	(-9255')
Echooka Formation	9470'	(-9367')
PENNSYLVANIAN TO MISSISSIPPIAN		
Lisburne Group	Missing	
PRE-DEVONIAN		
"Argillite"	9638'	(-9535')
TOTAL DEPTH	10,225'	(-10,122')

STRATIGRAPHY

EARLY CRETACEOUS

Nanushuk Group: 0-3115'

Nonmarine Nanushuk

In the Peard No. 1, the nonmarine Nanushuk occurs from the surface to approximately 1470'. The upper Nanushuk consists of predominantly gray and gray-brown, very soft clay or claystone with interbedded light-gray to gray-brown sandstone and siltstone and thin beds of coal.

The upper 1015' of the interval is predominantly clay: light-gray and gray-brown, very soft, sticky, locally grading to claystone, which is slightly calcareous and silty. Interbedded with the clay are sandstones, light gray, very fine to medium grained, translucent quartz with salt and pepper appearance. The sands grade in part to light gray and gray-brown siltstones, variable soft to firm, slightly calcareous in part with salt and pepper appearance. The sands reach a maximum individual thickness of 35'. Thin stringers of black, hard, glossy coal in beds of maximum of 7' are present and account for approximately 5% of this total interval.

The lower part of the nonmarine Nanushuk from 1015' to its base at 1470' consists predominantly of sands 10' to 45' thick with interbeds of clay and siltstone generally as described in the first 1000'. Coal is not present in this interval.

Good spontaneous potential development was recorded on the log across the sands greater than 10' thick throughout the interval. However, the sonic log suggests that the sands above 1000' have better potential reservoir qualities probably due to less clay in the pore space.

Methane gas occurred in the nonmarine Nanushuk above 1000', primarily associated with the coal beds. However, a sand in the interval 1105' to 1211' recorded ditch gas of 480 total units, primarily methane.

Anderson, Warren & Associates' Biostratigraphic Report indicates no foraminifera above 450'. From 450' to 1470', the sediments were dated Early Cretaceous (Middle to Late Albian). Palynology dates the nonmarine Nanushuk as Aptian-Albian undifferentiated (see reference in Appendices).

Marine Nanushuk

The predominantly marine sediments of the Nanushuk Group occur in the interval 1470' to 3115'. Within this interval, the sediments represent deposition from a transitional environment at the top into a marine environment.

The upper 1280' of the marine Nanushuk consist of interbedded sands, siltstones, clays and claystones. The sands are light to medium gray, fine to medium grained, clear to translucent quartz grains, generally friable, calcareous and occasionally having carbonaceous inclusions. The sands vary in thickness rarely to 45' and are interbedded with thin siltstone stringers. The clays are generally gray to gray-brown, soft, sticky, occasionally firm, with carbonaceous inclusions and locally carbonaceous laminae. Thin siltstone stringers are gray or gray-brown, soft and friable, calcareous and frequently grade to a very fine grained sandstone.

The lithology of the sediments in the interval 2750' to 3115' is generally the same as the upper 1280' except that the sands are very argillaceous and very thinly bedded. The clays are better compacted becoming claystone grading to shale. A basal sandstone; 77' thick, consists of clear to light gray, very fine quartz grains, very argillaceous and calcareous, friable with abundant thin stringers of siltstone.

Conventional core No. 1 was cut at 3034.5' to 3065' and consisted of interbedded and interlaminated siltstones, sandstones and shales. Anderson, Warren & Associates dates the core as Early Cretaceous, Aptian-Albian.

Anderson, Warren & Associates' Biostratigraphic Report dates the interval 1470' to 2610' as Early Cretaceous (Middle to Late Albian) F-9 and the interval 2610' to 3115' as Early Cretaceous (Aptian to Early Albian) F-10. Palynology indicates a date of Aptian-Albian undifferentiated.

Minor methane gas shows were recorded throughout the marine Nanushuk. Maximum reading of 440 units total gas was recorded at 2190'; the gas was primarily methane (C_1) with minor amounts of heavier components.

Torok Formation: 3115-6195'

The top of the Torok Formation was pentrated at 3115' and the base at 6195' for a total interval of 3080'. This compares to 3070' found in the nearby Kugrua No. 1 well. The South Meade No. 1 well had in excess of 3400' of Torok. At the Topagoruk No. 1 well, the Torok Formation was slightly thinner than in the South Meade No. 1 well.

From 3115' to 5350', the lithology of the upper Torok is essentially interbedded and interlaminated shale and siltstone. A few thin sandstone stringers interrupt this sequence. The shale is generally gray-brown to brownish-gray, well compacted, fissile, micaceous and contains some carbonaceous material. The sandstone stringers are clear to light gray, fine to medium grained, subangular quartz grains with a salt and pepper appearance due to carbonaceous inclusions. The sands are also moderately calcareous.

Minor gas shows were recorded throughout the upper Torok with a maximum ditch-gas reading of 1250 units from a thin sand at 4228' to 4260'. The gas analyzed as C_1: 250,000 ppm, C_2: 20,000 ppm, and C_3: 2,000 ppm.

From 5350' to 6195', sandstones become a more prominent percentage of the lithology. The sands are clear to light gray becoming light gray-brown in the basal part of this interval, generally fine to medium grained, with disseminated mica and micaceous partings, carbonaceous and slightly calcareous. Interbedded shale and siltstone stringers are common. The second major lithology found in this interval is medium- to dark-gray, well compacted micaceous shales with occasional carbonaceous matter. Interbedded with the shales are gray-brown to brownish-gray argillaceous siltstones.

Four conventional cores were taken in the Torok Formation. Anderson, Warren & Associates' Biostratigraphic Report dates both Cores No. 2 and No. 3 (4278-4294' and 5409-5421', respectively) as Early Cretaceous, Aptian (F-11) age by foraminifera. Core No. 4 (5906-5916.4') and Core No. 5 (6119-6129.4') as age indeterminate but were dated by enclosing ditch samples also as F-11. Palynology dates the four cores as Early Cretaceous, Aptian-Albian (P-M19 to P-M17).

Slickensides were noted in Core No. 2 in the interval 4287.6-4292', dipping 5° and 45°. This may represent faulting in post-Aptian time. A close analysis of bedding or laminae across the slickensides may indicate a discordance in the strata and syndepositional faulting. The dipmeter also shows an abrupt change in direction and degree of dip at the same depth.

Numerous ditch-gas shows were recorded throughout the Torok Formation varying from 100 to 2,600 units. A number of the shows were directly associated with sandstone beds. No oil shows were observed in the cuttings. The maximum gas recording was 2600 units from a sand in the interval 5750-5863' with analysis of the gas components indicating C_1: 500,000 ppm, C_2: 26,000 ppm, C_3: 3,000 ppm, and C_4: 100 ppm.

It is of interest to note that highly radioactive shale is present within the above sand specifically in the interval 5810-5841' can be correlated with a high radioactivity zone in the Kugrua No. 1well at 6450-6478'. This highly radioactive zone does not appear in the South Meade No. 1 well.

"Pebble Shale", upper part: 6195-6525'

The top of the "Pebble Shale" occurs at 6195' in the Peard No. 1 well and is recognizable on the gamma-ray log by high radioactivity which is also readily seen in the nearby Kugrua No. 1 and South Meade No. 1 wells.

The interval from the top of the "Pebble Shale" to the top of the Kuparuk sand equivalent is 330' in Peard No. 1, 315' in Kugrua No. 1, and only 242' in South Meade No. 1.

The upper part of the "Pebble Shale" is a dark-gray to black, well compacted, hard, fissile shale primarily recognized by inclusions of

fine to medium, frosted, generally well rounded quartz grains, rarely with coarse to very coarse, well rounded, black chert grains, pyrite nodules, pyritized worm tubes and rare very coarse mica flakes and carbonaceous material. The quartz and chert grains are the most diagnostic feature of this shale.

A conventional core (No. 6) was cut in this formation from 6403-6413' with a recovery of 8'. The lithology was as described above.

The top 45' of the "Pebble Shale" is dated by foraminifera as Early Cretaceous (probably Aptian) F-11 with the interval 6240' to top of the Kuparuk sand at 6525' as Neocomian, F-12 to F-13. Palynology places the top of Neocomian at 6210'. Core No. 6 (6403-6413') is dated Neocomian by both foraminifera and palynology.

The "Pebble Shale" was slightly geopressured, but presented no problems to drilling this formation. Maximum gas recorded was 420 units at 6380'. Chromatograph analysis of this gas was as follows: C_1: 80,000 ppm, C_2: 7,200 ppm, C_3: 3,000 ppm, C_4: 400 ppm, and C_5: 1,000 ppm.

Kuparuk sand equivalent: 6525-6562'

The Kuparuk sand equivalent, stratigraphically the middle "member" of the "Pebble Shale" was reached at 6525' in Peard No. 1. Thickness of this sand is 37' in Peard No. 1. In the Kugrua No. 1 well this sand is 99' thick, and in the South Meade No. 1 it is 14' thick.

The composition of the marine Kuparuk sand is clear to light gray, fine grained, subangular quartz grains, moderately cemented with calcite. Rare, very fine, bright green glauconite was present in the upper part of this sand and increased in the basal portion of the unit.

The age of the Kuparuk sand is Neocomian. The environment of deposition has been interpreted as middle neritic to upper bathyal by AW&A.

"Pebble Shale", lower part: 6562-6725'

Reviewing the lithology in Peard No. 1 from 6586-6720' (6725' by electric log), the diagnostic feature of the "Pebble Shale", i.e., well rounded quartz and black chert grains, are still present in this interval. Note that the 6725' base of the unit is also the top of a transition zone overlying a Kingak sandstone. It also coincides with the depth of 6720' in the Biostratigraphic Report for base of Neocomian.

It is the author's opinion that this interval probably represents the basal shale member of the "Pebble Shale". The shales below the sand at approximately 6750' in the Peard well fail to carry the floating quartz and chert grains and also become dark gray-brown or no longer the dark gray to black of the "Pebble Shale". The dipmeter log suggests an unconformity could be present at 6725'.

Based on the lithology in the interval below the base of the Kuparuk sands to 6725', this depth in the Peard No. 1 was correlated through the Kugrua No. 1 and South Meade No. 1 wells, as the base of the "Pebble Shale". This also represents the top of the Kingak Formation.

Electrical-log correlations indicate that the "Pebble Shale" in the Topagoruk No. 1 well is equivalent to the upper "Pebble Shale" in the Peard well. The lower part of the "Pebble Shale" is absent by nondeposition, having pinched out west of the Topagoruk well, and the upper "Pebble Shale" disconformably overlaps the Kingak Formation in the Topagoruk No. 1 well. The author, however, has not personally reviewed the cuttings for this equivalent interval in Kugrua No. 1 and South Meade No. 1 wells.

Based on foraminifera, the interval 6240-6720' is Early Cretaceous (Neocomian) in age and is assigned to AWA Zones F-12 to F-13. Palynology places the probable base of the Neocomian as low as 7243'.

JURASSIC

Kingak Formation, upper part: 6725-7822'

The top of the Kingak Formation is selected at 6725' in Peard No. 1 well. The Kingak Formation is here informally subdivided into an upper shale member and a lower shale member by the intervening Simpson sand. The top of the Sag River transition zone is here used as the base of the Kingak.

The lithology in the upper Kingak is generally a dark gray-brown, well compacted, micaceous, pyritic shale, with interbedded brown to gray-brown, slightly siliceous, micaceous and carbonaceous siltstone. Siderite nodules and floating sand grains are present throughout this interval. Very thin bentonite stringers are present below 7150'. Glauconite is found in thin sandstone stringers below 7350'.

The upper shale member of the Kingak includes in the lower part a transition zone that grades into the Simpson sand. Rocks above the transition zone (top at 7735') are 1010' thick in the Peard No. 1 well, 1103' in Kugrua No. 1 well, 870' in South Meade No. 1 well, and 1281' in the Topagoruk No. 1 well. The above interpretations indicate a slight thickening from the Peard high to the southeast toward Kugrua, thinning over the Meade Arch and reaching its greatest thickness locally in the Topagoruk area. The thinning across Meade Arch indicates greater beveling of the Jurassic sediments there than in the other wells in the section and probably accounts for the lack of Jurassic sand at the top of the Kingak Formation in the wells other than the Peard No. 1.

The age of the upper part of the Kingak is Late Jurassic to Early Cretaceous (Kimmeridgian to Valanginian) to 7243'; below 7243' the age is Late Jurassic (Oxfordian) F-16.

Dipmeter indicates low dips with no consistent directional pattern through this interval. The upper Kingak was geopressured, but created no problems in drilling.

Simpson sand: 7822-7950'

The Simpson sand was discovered in the Topagoruk No. 1 well. The top of the transition facies of this sand was encountered at 7735' in the Peard No. 1 well and the top of the porous sand at 7822'. The interval from the top of the transitional facies to the top of the lower Kingak is 215' in Peard No. 1, 282' in Kugrua No. 1, 213' in South Meade No. 1, and 295' in Topagoruk No. 1. This indicates a thickening southeast to the Kugrua well and an easterly thinning over the Meade Arch. Gross porous sand is 91', 119', 88', and 64' thick, respectively, in the above wells.

The porous sandstone is brown to gray-brown, fine to very fine grained, argillaceous, silty and in part siliceous. Glauconite is abundant and partly altered to clay. Siderite is common and occasionally forms thin stringers. Carbonaceous material and phosphatic pellets are occasionally present. Interbedded dark brown-gray siltstones and dark gray-brown to dark gray shales interrupt the sand sequence and constitute the basal 37' of this unit.

A conventional core (No. 7) was cut in the Simpson sand from 7837-7868.5'. The description of the core is as detailed above. Core analysis was run on every third foot. Porosity averaged 16.4% with a minimum of 8.4% and a maximum of 25.4%. Permeability averaged 0.11 millidarcies. Grain density was higher than normal for sand due, apparently, to siderite inclusions.

The dipmeter recorded southwest dips of 2° to 6° with southerly dips of 2° in the basal 40' of the sand.

The age of the Simpson sand is mostly Late Jurassic (Oxfordian) F-16.

A 250-unit gas kick was recorded upon penetrating into the Simpson sand. Chromatograph analysis showed C_1: 49,000 ppm, C_2: 3,000 ppm, C_3: 1,000 ppm, and C_4: 400 ppm. No oil shows were observed in the cuttings.

Kingak Formation, lower part: 7950-8225'

The top of the lower part of the Kingak is picked at 7950' from the electrical log, and the base is picked at 8225'. This part of the Kingak is 275' thick in the Peard No. 1 well, 443' in the Kugrua No. 1 well, 463' in the South Meade No. 1 well, and 396' in the Topagoruk No. 1 well. Regionally the unit thickens off the Peard high through Kugrua No. 1 and eastward across the Meade Arch. The interval then thins slightly eastward towards the Topagoruk No. 1 well.

The lower part of the Kingak is predominantly a dark gray-brown to dark-gray micaceous shale. Pyrite inclusions and occasional stringers of glauconite also occur. The shale is interbedded with brownish-gray to dark-gray micaceous partly glauconitic siltstones and scattered stringers of light-gray to greenish-gray very fine grained argillaceous sandstone. The sandstone stringers may be glauconitic and slightly carbonaceous.

Foraminifera date these sediments as Early to Middle Jurassic (F-17 to F-18). Age dating by palynology is indeterminate.

Minor quantities of methane gas were recorded from this interval.

Sag River Sandstone and Sag River transition zone: 8225-8530'

A transition zone overlying the porous Sag River sands occurs at 8225' in Peard No. 1. The lithology of this transition is interbedded shale, sandstone and siltstone. The shales and siltstones are as described for the lower part of the Kingak. Sandstones constitute approximately 30% of the transition zone. The sands are buff becoming light gray to gray-brown, very fine grained, silty, argillaceous, micaceous and glauconitic. Siderite and chert are found between 8330' and 8360'.

The uppermost rock unit of the Sag River transition at 8225-8275' consists of sandstone that is light buff to very light gray, very fine to fine grained, glauconitic and argillaceous. This sandstone appears to constitute a barrier-bar terminated by further transgression of the Early Jurassic seas and buried by deposition of the overlying deeper marine lower Kingak sediments.

Underlying this interval down to the top of the "main" Sag River sandstones at approximately 8430' are interbedded sands, siltstones and shales as first described above.

Conventional Core No. 8 (8275-8289.5') consisted of interbedded and interlaminated very fine grained, silty, micaceous, glauconitic sandstone and micaceous and carbonaceous siltstone.

The rocks between 8225' and 8280' and the overlying lower part of the Kingak are dated as Early to Middle Jurassic, F-17 to F-18. Strata from 8280' to 8410' are Triassic to Early Jurassic, F-18 to F-19.

The top of the porous Sag River sandstone was encountered at approximately 8430' in the Peard No. 1 well.

The sandstone of the Sag River is light gray-brown becoming brown, very fine grained, calcareous with carbonaceous inclusions, clayey with glauconite, which is in part altered. Locally fossil fragments are present, and thin interbeds of gray-brown to dark brown siltstone with carbonaceous and glauconitic inclusions are present.

Paleontology data dates the Sag River Sandstone as Triassic to Early Jurassic, F-18 to F-19.

A conventional core (No. 9) was cut at 8451-8481'. Lithology is as described above.

The Sag River Sandstone had a 200-unit gas show. No oil shows were observed in cuttings, but the core appeared partly stained and exhibited a very slight yellow residue after a chloroethane cut.

Lost circulation occurred at 8441' with a total loss of 250 barrels of mud.

TRIASSIC

Shublik Formation: 8530-8741'

The Shublik Formation consists of gray-brown to brown calcareous siltstone, in part argillaceous and fossiliferous to 8595', with interbeds of dark-brown to dark-gray micaceous and calcareous shales, and light-brown to gray-brown very fine grained calcareous sandstones, with rare fossil fragments, mica, and stringers of glauconite. Buff to light-brown sandy limestone stringers occur in the top 30'. From 8595' to the base of the Shublik at 8741', the siltstones become dark gray to black with some gray-brown. Phosphate pellets are present below 8630'. Light-gray chalky limestone stringers with fossil fragments and black phosphate pellets are interbedded with the siltstones and shales below 8655'. Rare gray chert and rare loose very coarse clear quartz grains are present.

The Shublik Formation in the Peard No. 1 well is 211' thick. The top of the Shublik is taken at the top of the increase in radioactivity on the gamma-ray log at 8530-8534'. The Kugrua No. 1 encountered 335' of Shublik, the South Meade No. 1 had 287', and the Topagoruk No. 1 had 397' of Shublik.

High radioactivity recorded on the gamma-ray log below 8655' in Peard No. 1 is probably due to high concentrations of phosphate pellets. This zone can be readily correlated into the Kugrua No. 1 and South Meade No. 1.

The Shublik is dated from foraminifera as Triassic in age, F-19. Palynology dating indicated a probable Triassic age.

Minor methane gas shows to 200 units were recorded in the interval. No oil shows were observed in the cuttings.

TRIASSIC-PERMIAN

Sadlerochit Group: 8741-9638'

Ivishak Formation: 8741-9358'

The Ivishak Formation was picked at 8741' with the base at 9358'. Total thickness is 617'. The Kugrua No. 1 well penetrated 1024' of Ivishak, the South Meade No. 1 had 347', and Topagoruk No. 1 drilled 780'.

The lithology of the Ivishak Formation is a series of interbedded tight sandstones and siltstones with minor thin shales. This sequence is occasionally interrupted by more porous sandstone beds up to 10-20' thick.

The sandstones are light to medium gray, very fine grained, well cemented with silica, glauconitic, occasionally carbonaceous, and with common white "tripolite" grains. From 9020-9200', these sandstones become quartzitic locally grading to quartzite. Quartz overgrowths were observed in this

interval. Interbedded with these sandstones are dark gray carbonaceous and micaceous siltstones with a siliceous appearance. Locally the siltstones may be light gray or gray-brown. From 8741-8860' are thin interbeds of dark-gray finely micaceous and calcareous shales. From 9060-9358', the dark-gray shales grade to gray-brown splintery shales.

A conventional core (No. 10) was cut from 8977-9008'. The top 24' of the core was interbedded siltstones and shales as described above. The bottom 7' of the core was quartzitic sandstones grading to quartzite with quartz overgrowths, mica, carbonaceous and dark-gray glauconite. Foraminifera date the upper part of the Ivishak as Permo-Triassic, possibly F-20. Palynology indicates probable Triassic.

Maximum gas recorded in the Ivishak Formation was 220 units at 8722'. Chromatograph analysis of this show was: C_1: 34,000 ppm, C_2: 3,000 ppm, C_3: 1,000 ppm, C_4: 400 ppm. No oil shows were observed in cuttings.

Kavik Shale Member: 9358-9470'

The Kavik Shale Member of the Ivishak Formation was penetrated at 9358'. The Kavik is well compacted, fissile, micaceous, and carbonaceous, siliceous siltstones and dark gray-brown shales.

The thickness of the Kavik is 112' in the Peard No. 1 and 169' in Kugrua No. 1. Kavik is missing from the South Meade No. 1 due to either nondeposition or erosion. The Topagoruk No. 1 well had 283' of Kavik.

The age of the Kavik Shale Member is probably Permo-Triassic, F-20.

No gas or oil shows were recorded from the Kavik Member.

Echooka Formation: 9470-9638'

The Echooka Formation, basal member of the Sadlerochit Group, was encountered at 9470' and the base at 9638' for a total interval of 168'. The Kugrua No. 1 penetrated 171'. The Echooka was absent from both the South Meade No. 1 and Topagoruk No. 1 by either nondeposition or erosion (see cross-section Figure 4). The Echooka Formation rests unconformably on Pre-Lisburne "Argillite" in Peard No. 1 well.

Lithology of the Echooka from 9470-9490' is a pebble conglomerate, medium to dark gray, consisting of well rounded smoky, milky and rarely pale green chert fragments and pebbles and frosted smoky and milky quartz fragments and pebbles coated dark gray-black. From 9490-9638', the lithology is a medium- to light-gray fine grained calcareous sandstone. Locally the unit contains well rounded medium to coarse quartz and chert grains. "Tripolite" is abundant throughout as are well rounded fine black grains. Rare interbeds of medium gray-brown siltstone occur in the unit. Log porosity varies from 12-25%.

A conventional core (No. 11) was cut from 9490-9520'; lithology was as described above. Core analysis was run on every third foot. Porosity averaged 14.8% with a low of 10.1% and a maximum of 21%. Permeabilities were very low averaging 0.4 millidarcies. Grain densities were that of sand except where pyrite was present.

The Echooka encountered in the Kugrua No. 1 well was described as interbedded brick-red claystone and sandy siltstone with some gray chert pebbles. The bottom 48' at Kugrua is red to gray conglomerate of red, gray and black chert pebbles interbedded with claystone and sandstone.

No indigenous fauna was found in the Echooka. Anderson, Warren & Associates' Report gives a probable date of Permian, based solely on lithology, and notes that the environment of deposition is probably marginal marine to nonmarine.

Several gas shows were recorded in the Echooka. A 512-unit ditch gas show at 9559' analyzed C_1: 85,000 ppm, C_2: 4,500 ppm, C_3: 700 ppm, and C_4: trace. The mud was cut from 9.9 to 9.7 lbs./gal. No oil shows were observed in cuttings.

PENNSYLVANIAN-MISSISSIPPIAN

Lisburne Group

Lisburne was missing in Peard No. 1 well by either erosion, nondeposition, or faulting, or by a combination of faulting and erosion.

PRE-DEVONIAN

Argillite: 9638-10,225'

Immediately and unconformably underlying the Echooka Formation at 9638', in the Peard No. 1 well, is a sequence of submetamorphic dark gray-black shales and siltstones. This sequence was present to total depth at 10,225', an interval of 587'.

From 9638-10,000', the lithology is interbedded submetamorphic siltstone and shales, very dark gray, hard, metallic or graphitic sheen, schistose and micaceous. From 10,000-10,120', submetamorphic shale is light to medium gray, hard, siliceous in appearance, slightly dolomitic, and with rare interbeds of siltstone as described above. From 10,120-10,215', the rock is interbedded submetamorphic medium- to dark-gray siltstone and light- to dark-gray shale.

A terminal core (No. 12) was cut from 10,215-10,225', The core was described as argillite. Bedding was near vertical, and fracturing of 65° to 90° was present.

Intervals of fracturing were seen frequently throughout the "argillite" with the fractures filled by quartz or calcite. A highly fractured and mineralized zone occurred from 9930-10,000' where samples contained 5-20% milky white quartz and/or calcite.

A sidewall core was shot at 9957' in a zone of relatively low radioactivity. Lithology was argillite with a large vein of calcite penetrating the core.

Microfossils were not found in the argillite, and thus the age is indeterminate.

CONCLUSION

Although the primary objective, the Lisburne Group, was absent in the Peard No. 1, the area as a whole cannot be condemned. Establishment of the wedge-out or omission of the Lisburne carbonates would still permit a Carboniferous stratigraphic prospect in the Peard Bay area, probably to the south-southeast of the drilled location.

PERTINENT DATA/APPENDICES

Appendix

SUMMARY PERTINENT DATA, OPERATIONS & ANALYSIS*

WELL NAME:	Peard Test Well NO. 1
API NO.	50-301-20002
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	1106' FNL, 1836' FWL Protracted Section 25, T16N, R28W, Umiat Meridian North Slope Borough, Alaska
COORDINATES:	Latitude 70°42'56.321" North Longitude 159°00'02.518" West X = 378,949.07; Y = 6,112,416.92 Zone 6
ELEVATION:	103' Kelly Bushing (KB); 75' Pad
DATE SPUDDED:	January 26, 1979
TOTAL DEPTH:	10,225' Driller; 10,229' Schlumberger
DATE REACHED TOTAL DEPTH:	April 6, 1979
FORMATION AT TOTAL DEPTH:	"Argillite" (Pre-Devonian)
DATE RIG RELEASED:	April 13, 1979
CASING:	20" @ 88', 109' wireline 13-3/8" @ 2632' 9-5/8" @ 8600'

HYDROCARBON SHOWS:

Interval/Formation	Description
4236-4260'/Torok	1,250 units ditch gas, no stain, fluorescence or cut.
5810'/Torok	2,600 units ditch gas.
6156-6239'/Torok	320 units ditch gas, milky pale yellow sample fluorescence.
9550-9615'/Echooka	500 units ditch gas, no stain, fluorescence or cut.

STATUS: Plugged and abandoned.

Operations & Analysis Performed

LOGGING RECORD:

Open Hole:	DIL/GR/SP - 109-10,223' (3 runs) BHCS/GR/TTI - 109-10,226' (3 runs) CNL/FDC/GR/CAL - Porosity 2632-10,227' (2 runs) FDC/GR/CAL - 2632-10,227' (2 runs) HDT-Dipmeter - 2632-10,226' (2 runs) HRT-Temp (Run 1 before final logging) - 60-10,231' HRT-Temp (Run 2, after final logging) - 75-10,231' Velocity Survey - 0-10,102' Mud Log (B&G) - 109-10,225' D_c Exponent - 88-10,225' Mud Wt., Temp., Sh. Den. - 500-10,225' IDEL (The Analysts) - 130-10,225'
Computed Logs:	Computed Dipmeters - 2632-10,226' Strat. Dipmeter with polar plots - 6521-8508' Strat. Dipmeter with polar plots - 9201-9650' Geogram Survey - 0-10,102'

SIDEWALL CORES:

Run 1	4234-8600'; 80 shots (some sidewall cores double shot); recovered 79.
Run 2	8617-9957'; 45 shots; recovered 31.

CONVENTIONAL CORES:

No.	Interval	Recovery	Rock Unit
1	3034.5- 3065.0'	30.5'	Nanushuk
2	4278.0- 4294.0'	14.0'	Torok
3	5409.0- 5421.0'	12.0'	Torok
4	5906.0- 5916.4'	10.4'	Torok
5	6119.0- 6129.4'	10.4'	Torok
6	6403.0- 6413.0'	8.0'	"Pebble Shale"
7	7837.0- 7868.5'	31.5'	Simpson sand
8	8275.0- 8289.5'	9.8'	Sag River Transition
9	8451.0- 8481.0'	27.5	Sag River?
10	8977.0- 9008.0'	31.0'	Ivishak
11	9490.0- 9520.0'	30.0'	Echooka
12	10,215.0-10,225.0'	10.0'	"Argillite"

CORE ANALYSIS:

Date	Interval	Core No.	Sample Nos.
6-6-79	5409-5419'	3	1-8
4-12-79	7839-7866'	7	1-10
4-12-79	9490-9517'	11	11-20

TESTS (DRILL STEM & PRODUCTION): None.

FLUID ANALYSIS: None.

WELLSITE GEOLOGISTS: R. A. Wermeyer
R. G. Brockway

WELL LOG ANALYST: Armour Kane

DRILLING CONTRACTOR: Nabors Alaska Drilling, Inc.
Rig No. 17

MUD LOGGERS: Borst & Giddens Logging Service, Inc.
(The Analysts)

BIOSTRATIGRAPHIC ANALYSIS: Anderson, Warren & Associates, Inc.

SPECIAL STUDIES AND ANALYSIS: Interpretation of "Stratigraphic" Dipmeter for Interval: 6521-8508' by: J. B. Vohs, Schlumberger, dated May 21, 1979.

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

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

PEARD TEST WELL NO. 1
DRILL CUTTINGS AND CORE DESCRIPTIONS

BY

R. WERMEYER	-	90- 6830'
		8481-10,225'
R. BROCKWAY	-	6830- 8481'

DEPTH DRILLED (FEET BELOW KELLY BUSHING)	
0- 90	No samples.
90- 125	Claystone: gray-brown, very soft to soft, slightly silty, calcareous, sticky.
125- 130	Coal: black, glossy, hard.
130- 140	Claystone: as above.
140- 146	Coal: black, glossy, hard.
146- 160	Clay: gray-brown, very soft to firm, slightly silty, sticky, in part grades to claystone.
160- 171	Siltstone: light brownish-gray, very hard, slightly calcareous, argillaceous, some interbedded coal fragments.
171- 180	Coal: black, glossy, hard.
180- 195	No recovery (depth correction).
195- 209	Clay: gray-brown, very soft to firm, sticky.
209- 212	Coal: black, glossy, hard.
212- 228	Clay: gray to gray-brown, soft, silty, in part grades to claystone.
228- 235	Siltstone: light brown, hard to very hard, slightly calcareous, argillaceous.
235- 250	Coal: black, glossy, hard.
250- 260	Siltstone: gray to gray-brown, firm to hard, well cemented.
260- 263	Coal: black, glossy, hard.
263- 270	Mudstone: light brown to brown, firm to hard.

270- 300	Sandstone: gray, black, translucent, gray-brown, very fine to medium grained, hard, angular to subangular, argillaceous, very poorly sorted, very calcareous.
300- 330	Clay: gray, soft, sticky.
330- 334	Sand: as above.
334- 340	Coal: black, glossy, firm, blocky.
340- 350	Siltstone: gray-brown, friable, grades to Sandstone: tan to brown, very hard.
350- 360	Sand: gray, translucent, black, salt and pepper, friable to firm, subangular, poorly sorted, moderately argillaceous.
360- 368	Coal: black, firm, subfissile, blocky.
368- 383	Siltstone: as above, with interbedded Sand: light gray to gray, salt and pepper, friable, very fine grained, subangular, moderately argillaceous.
383- 385	Coal: as above.
385- 390	Siltstone: as above.
390- 394	Dolomite: tan, gray-brown, finely crystalline, soft to firm, very argillaceous.
394- 399	Sand: as above.
399- 403	Dolomite: as above.
403- 410	Sand: as above.
410- 423	Clay: gray, soft, sticky, silty.
423- 430	Clay: gray, soft, sticky, with interbedded Siltstone and Sand: as above.
430- 950	Clay: gray, gray-brown, soft, in part sandy, slightly calcareous, sticky, with interbedded Siltstone: tan, light brown, gray-brown, soft to hard, very calcareous and Sand: as above, and Coal: as above, and very locally Dolomite: tan, dark gray-black, firm to hard, amorphous, dense, argillaceous.

950- 1008	Clay and Claystone: gray, tan, soft to firm, some moderately compacted, in part sandy, interbedded with thin stringers of Sand: gray-brown, salt and pepper, fine to medium grained, subangular, moderately cemented with dolomite and occasional stringers of Siltstone: brown-gray, argillaceous, salt and pepper.
1008- 1054	Predominantly Sand: as above, and interbeds of Clay and Siltstone: as above.
1054- 1104	Predominantly Clay: gray-tan, silty, very soft, very finely sandy, with interbeds of Sand: as above.
1104- 1360	Predominantly Sand: light gray-brown, light gray, very fine to fine grained in part medium grained, poor to fair sorting, subangular to subrounded, friable, in part calcareous with local interbeds of clay and rare siltstone stringers, as above.
1360- 1475	Predominantly Clay: brown-gray, gray-tan, soft to very soft, occasionally firm, in part silty, very finely sandy, sticky, calcareous, grades to claystone, interbedded with occasional stringers of Siltstone: gray-brown, soft to hard, argillaceous.
1475- 1600	Predominantly Sand: gray, white, translucent, salt and pepper, friable to firm, very fine to medium grained, subangular to subrounded, poorly sorted, calcareous, interbedded with Clay: gray, gray-brown, soft, silty and sandy, and Siltstone: medium to dark gray, soft to firm, calcareous.
1600- 1761	Predominantly Sand: as above, but argillaceous, with interbeds of Clay: gray-brown, brown-gray, in part sandy, soft in part, grades to Claystone and Siltstone: as above.
1761- 1941	Predominantly Sand: clear, light gray, salt and pepper, medium grained, well sorted, subangular, friable, argillaceous, carbonaceous fragments, slightly calcareous, with interbedded Clay and Siltstone: as above, traces of Chert: tan, hard, some brown.
1941- 2012	Predominantly Clay: gray-brown, gray-tan, soft, very finely sandy, grades to claystone, interbedded with Siltstone: gray, gray-brown, friable, calcareous, some tan, firm.
2012- 2217	Predominantly Sandstone: light gray, some clear, some brown, fine to medium, poorly sorted, angular to subangular, firm to friable, calcareous, interbedded with Claystone: as above, with some tan, soft to firm, slightly silty, and Siltstone: as above,

occasionally some Chert: tan to orange, conchoidal fractures and rare pyrite.

2217- 2240 Predominantly Claystone: as above, with thin stringers of Sandstone: as above.

2240- 2313 Predominantly Sandstone: as above, interbedded with Claystone: as above, with microspecks of carbonaceous material and microlaminae of coal, and Siltstone: as above with very poor show, no visible stain, no fluorescence, slow yellow white fluorescent cut, no visible color, gas 10 units of methane.

2313- 2340 Predominantly Claystone: gray-brown, brown, soft to firm, silty, blocky, in part elongated, microspecks and microlaminae of carbonaceous material, some Claystone: tan, firm to hard, conchoidal fracture.

2340- 2370 No recovery (bypassing shakers).

2370- 2412 Predominantly Siltstone: as above, no show, interbedded with thin stringers of Sandstone: as above, and Claystone: as above.

2412- 2440 Predominantly Sandstone: clear, gray, unconsolidated to friable, very fine to fine grained, subrounded, poorly sorted, calcareous and some medium to dark gray, friable to firm, very fine to fine grained, moderately sorted, with interbeds of Siltstone and Claystone: as above.

2440- 2479 Predominantly Claystone: as above, with interbeds of Siltstone: as above.

2479- 2530 Predominantly Sandstone: as above, and interbeds of Siltstone and Claystone: as above.

2530- 2582 Interbedded Claystone and Siltstone: as above.

2582- 2640 Predominantly Sandstone: as above, interbedded with Siltstone: as above, and Claystone and Clay: gray-brown, very soft to slightly sticky.

2640- 3000 Predominantly Siltstone: brown, gray-brown, brown-gray, argillaceous, soft, speckled with very fine black carbonaceous(?) material locally grades to very fine sandstone, locally floating very coarse, rounded or fractured clear quartz grains, interbedded with Claystone/Shale: gray-brown, brown, locally in part very light gray, soft speckled with very fine black material, and Sandstone: light to medium gray, fine to very fine grained, angular, salt and pepper, slightly argillaceous, locally dolomitic to slightly

calcareous with very poor show at 2670-2700', 2760-2790', 2880-2910' and 2940-2970', very poor visible porosity, no visible stain, very rare yellow green fluorescence, yellow, slow streaming cut fluorescence.

3000- 3034.5 — No recovery (twisted off).

3034.5- 3065 — Core No. 1, Cut 30.5', Recovered 30.5'

3034.5-3065.0 (30.5') — Interbedded and interlaminated Siltstone, Sandstone and Claystone/Shale. Predominantly Siltstone: dark brownish-gray, argillaceous, noncalcareous, scattered mica, firm to hard, with shaly partings, blocky, with Sandstone: light to medium gray, very fine to fine grained, locally medium grained, angular to subangular, micaceous, possibly in part carbonaceous, fair to good sorting, and claystone, grading to Shale: dark gray-black, conchoidal fracture, in part color banded in grays, hard, interlaminations are horizontal to dips of 3° rarely 5° and are flat to irregular; bedding 15 millimeters, rarely to 2 centimeters thick.

3065- 3390 — Predominantly Siltstone: gray-brown, to medium to dark gray, soft, argillaceous, blocky, in part platy, micaceous, finely carbonaceous with interbeds and interlaminations of Claystone/Shale: gray-brown, soft, water soluble in part, slightly silty, platy, in part blocky, and Sandstone: light to medium gray, fine grained locally medium grained, subangular, moderately to well sorted, scattered mica and fine carbonaceous material, salt and pepper appearance, friable to firm, nil to poor visible porosity, no shows.

3390- 4080 — Interlaminated Siltstone, Claystone/Shale and Sandstone: as above, with increasing sandstone to 10%, as above.

4080- 4140 — Interbedded and interlaminated Siltstone, Claystone/Shale: as above, with Sandstone: as above, increasing to 60%.

4140- 4200 — Interlaminated Siltstone, Claystone/Shale and Sandstone: decreasing to 10%, as above.

4200- 4260 — Interbedded Sandstone, Siltstone and Claystone/Shale: as above.

4260- 4278	No recovery (did not circulate full bottoms up).
4278- 4294	Core No. 2, Cut 16', Recovered 14'
	4278.0-4292.0 (14.0') Shale: dark gray to black, very silty, possibly bentonitic, homogeneous, scattered carbonized wood fragments, micaceous, dips suggested by erosional coring features, very rare fossil fragments, very hard, dense; slickensides.
	4292.0-4294.0 (2.0') No recovery.
4294- 4320	Shale: dark brown-gray, very silty, fissile to platy, micaceous, dolomitic, soft.
4320- 4332	Sandstone: light gray to clear, fine to medium grain, rare coarse grains, subangular to subrounded, poorly sorted, speckled salt and pepper, well cemented, slightly calcareous, fair visible porosity, no show.
4332- 4374	Shale: as above, with local very thin laminae of Siltstone: dark brown-gray, argillaceous, soft to firm, micaceous.
4374- 4383	Sandstone: medium gray, medium grained, carbonaceous in part, in micaceous, as above, no show.
4383- 4402	Shale: as above.
4402- 4411	Sandstone: as above.
4411- 4440	Interbedded Shale and Sandstone: as above.
4440- 4475	Shale: dark brown-gray, as above, some smooth.
4475- 4488	Sandstone: light gray to clear, fine to medium grained, as above.
4488- 4530	Predominantly Sandstone: as above, some brown to gray, as above; and interbeds of Shale: as above.
4530- 4552	Interlaminated Shale: as above, and Siltstone: brown-gray, very argillaceous, soft to firm, micaceous.
4552- 4571	Sandstone: light gray to clear, some light brown-gray, fine grained, subangular, moderately well sorted, dolomitic to moderately calcareous, some

carbonaceous material, slightly salt and pepper, rare siderite crystals, fair visible porosity, no show.

4571- 4688 Interbedded sandstone, siltstone and shale; Sandstone: white to light gray, very fine to fine grained, moderately sorted, some calcite cement, slightly argillaceous, frosted quartz grains, fair porosity; Siltstone and Shale: as above.

4688- 4800 Interbedded and interlaminated Sandstone, Shale and Siltstone: as above.

4800- 4829 Interbedded siltstone and sandstone, Siltstone: as above, and Sandstone: light to medium gray, white, fine to medium grained, subangular, slightly calcareous, moderately cemented, friable to hard, fair visible porosity, no show.

4829- 4911 Siltstone: dark brown-gray, argillaceous, very finely sandy, dolomitic, with interbedded Shale: as above.

4911- 4968 Siltstone: dark brown, argillaceous, very fine grained, sand inclusions, soft to firm, dolomitic, possibly bentonitic, interbedded with Sandstone: as above.

4968- 5372 Sandstone: gray-brown, fine grained, well sorted, subangular, firm to hard, fair visible porosity, no show, interbedded with Shale: as above, some medium gray, soft to firm, dolomitic, smooth, and Siltstone: as above.

5372- 5388 Predominantly Sandstone: light gray to clear, some brown-gray, fine to medium grained, poorly sorted, very argillaceous, subangular to subrounded, speckled salt and pepper, poor porosity, no show; with laminae of Siltstone: as above.

5388- 5405 Predominantly Siltstone: generally as above, interbedded with Shale: as above.

5405- 5409 Strap line depth corrected to 5409'.

5409- 5421 Core No. 3, Cut 12', Recovered 12'

5409.0-5409.5 (0.5') Sandstone: light to medium gray, in part clear quartz grains, speckled salt and pepper, fine to medium grained, angular, fair sorting, micaceous, carbonaceous, dolomitic to slightly calcareous, well cemented, poor porosity, no show.

5409.5-5410.8 (1.3')	Shale: dark gray, hard, well compacted, fissile, conchoidal fracture, scattered carbonaceous material, finely micaceous, silty.
5410.8-5412.5 (1.7')	Predominantly Shale: as above, with blebs, irregular pods, and laminae of Sandstone: as above, in part convoluted, poor porosity, no show.
5412.5-5413.6 (1.1')	Sandstone: as above, no apparent shale inclusions, poor porosity, no show.
5413.6-5415.6 (2.0')	Predominantly Shale: as above, very finely micaceous with scattered very coarse micaceous flakes and blebs and irregular inclusions of Sandstone: as above, poor porosity, no show.
5415.6-5417.8 (2.2')	Predominantly Sandstone: as above, with very scattered blebs of shale and silty inclusions, poor porosity, no show.
5417.8-5419.6 (1.8')	Predominantly Shale: as above, with blebs and inclusions of Sandstone: as above, with poor porosity, no show.
5419.6-5420.5 (0.9')	Shale: as above, with interbedded sandstone.
5420.5-5420.7 (0.2')	Sandstone: as above, no show.
5420.7- 5421.0 (0.3')	Shale: as above.

5421- 5460 Predominantly Sandstone: light gray to clear, fine grained quartz, angular, well sorted, well cemented with dolomite and/or calcite, speckled salt and pepper, slightly micaceous, scattered carbonaceous material, poor to fair porosity, no show; with occasional interbed of Shale: dark brown-gray, firm, micaceous, silty, and Siltstone: dark brown-gray, firm, argillaceous, very finely sandy.

5460- 5520 Predominantly Sandstone: as above with interbeds of Shale and Siltstone: as above; sandstone probably consists of interbeds as well as blebs and irregular pods of sand in the shale and siltstone.

5520- 5585	Predominantly Sandstone: as above, with interbeds and interlaminae of Shale: as above, and Siltstone: as above.
5585- 5625	Predominantly Sandstone: as above, in part with very fine laminae of carbonaceous material and some micaceous partings, interbedded with Shale: dark gray, silty, hard, well compacted, fissile, platy, slightly dolomitic, and Siltstone: dark gray, blocky, argillaceous, firm, slightly calcareous.
5625- 5670	Predominantly Sandstone: as above, with interbeds of Shale: brown-gray, some dark brown, moderately compacted, fissile, rare Clay/Claystone: medium gray, very soft, silty, and Siltstone: brown-gray, some medium gray, soft, clayey.
5670- 5805	Predominantly Sandstone: as above, occasionally tan, fine to medium grained, subangular, poorly sorted, micaceous, carbonaceous, salt and pepper, argillaceous, poor porosity; interbedded with shale and siltstone.
5805- 5830	Sandstone: light to medium gray, fine to medium grained, some coarse subangular to subrounded grains, poorly sorted, speckled salt and pepper, micaceous, poor porosity, no show; interbedded with Shale: dark gray, brown-gray, soft to firm, noncalcareous, and Siltstone: dark gray, argillaceous, very finely sandy.
5830- 5870	Predominantly Siltstone: dark gray, brown-gray, dolomitic, blocky, argillaceous, and Shale: dark gray, brown-gray, soft to firm, possibly bentonitic, in part fissile, silty, noncalcareous and occasional sandstone stringer, as above.
5870- 5895	Interbedded Sandstone: as above, and Shale: brown-gray, and medium to dark gray, soft to firm, fissile, silty, in part splintery, and Siltstone: brown-gray, to dark brown, argillaceous, blocky, soft to firm.
5895- 5906	No recovery (working stuck pipe).
5906- 5916.4	Core No. 4, Cut 10.4', Recovered 10.4'
5906.0-5914.4 (8.4')	Interlaminated Sandstone: as above, no shows, and Shale: as above.
5914.4-5914.6 (0.2')	Sandstone: as above, interlaminated with occasional shale stringers and pods.

5914.6-5916.4 (1.8') Interlaminated Sandstone: as above, no shows, and Shale: as above.

5916.4- 6054 Interbedded shale, siltstone, and sandstone; Shale: dark gray to dark gray-brown, soft, occasionally well compacted, in part silty, micaceous, and Siltstone: dark gray, gray-brown, brown-gray, argillaceous, in part very finely sandy, soft to firm; and Sandstone: light to medium gray, clear, locally frosted, fine to medium grained, subangular to subrounded, fair to moderately sorted, hard, moderately cemented with dolomite, rare to scattered carbonaceous material, poor porosity, no show.

6054- 6110 Predominantly Siltstone: as above, and Shale: as above.

6110- 6119 Shale: dark gray, very finely micaceous, soft to firm, moderately well compacted; and Siltstone and Sandstone: as above, with rare loose, clear, some frosted, milky, very coarse, some fractured, quartz grains, subrounded and rare orange to tan chert, hard, conchoidal fracture, rare pyrite nodules and rare carbonized wood, black, woody texture, soft to brittle.

6119- 6129.4 Core No. 5, Cut 10.4', Recovered 10.4'

6119.0-6129.4 (10.4') Siltstone: gray-brown, argillaceous, micromicaceous, rare very coarse biotite flakes, very hard, well compacted, rare to scattered carbonized wood having woody texture, brittle, scattered other carbonaceous grains, siltstone has conchoidal fracture in part, common horizontal parting planes; zones of irregular small sandstone lenses and pods at 6119.3' to 6119.6', 6122.5', 6125', and 6127.8' to 6128.2' exhibiting flow texture and structure; generally horizontal, but some may dip 15° to 30° with the lenses at 6127.8' to 6128.2' dipping about 45°.

6129.4- 6154 Siltstone: dark gray-brown, as above, and dark brown, argillaceous, fissile, in part conchoidal fracture, and some Clay: medium tan, very soft, slightly water soluble; with Sandstone: very light gray brown, fine to medium grained, subangular, clear quartz, slight salt and pepper, poorly sorted, friable to firm, calcareous, poor porosity, no show.

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6154- 6168	Sandstone: light gray to clear, fine to medium grained, subangular to subrounded, moderately sorted, salt and pepper, friable to firm, moderately cemented with dolomite, poor to fair porosity, no visible stain, yellow-green fluorescence, no visible cut, slow milky yellow crush cut fluorescence.
6168- 6195	Siltstone: as above, grades to Shale: medium to dark gray, very finely micaceous, firm, fissile in part, splintery.
6195- 6208	Sandstone: light gray-tan, fine to medium grained, subangular to subrounded, fair to moderately sorted, salt and pepper, firm to friable, moderately cemented with dolomite, poor to fair porosity, no visible stain, yellow green fluorescence, no visible cut, slow milky yellow crush cut fluorescence.
6208- 6230	Siltstone grading to Shale: as above.
6230- 6239	Sandstone: as above, show as above.
6239- 6248	Shale: medium to dark gray, very finely micaceous, firm, fissile in part, splintery.
6248- 6403	Shale: dark gray-black to black, soft, silty, very slightly calcareous, in part fissile, smooth, rare disseminated fine to medium, clear, occasionally frosted, quartz grains, some loose and very coarse, rounded to well rounded grains, rare pyrite clusters, micromicaceous; appears slightly over pressured.
6403- 6413	Core No. 6, Cut 10', Recovered 6'
	6403.0-6405.0 (2.0') No recovery.
	6405.0-6411.0 (6.0') Shale: black, smooth, horizontal parting planes, fissile, conchoidal fracture, pyrite nodules, pyritized fossil stems, well compacted, rare medium grained quartz, rare medium to coarse black chert.
	6411.0-6413.0 (2.0') No recovery.
6413- 6525	Shale: black, hard, well compacted, fissile, rare medium, occasionally very coarse quartz grains, rare very coarse black, well rounded chert.

6525- 6552	Sandstone: very light gray to clear, fine grained, subangular, moderately sorted, moderately cemented with calcite, rare very fine bright green, glauconite, poor to fair porosity, no show.
6552- 6592	Shale: black, as above.
6592- 6600	Sandstone: as above.
6600- 6628	Shale: as above.
6628- 6636	Siltstone: dark brown, argillaceous, firm, well compacted.
6636- 6750	Interbedded Shale and Siltstone: as above.
6750- 6794	Sandstone: light gray to light brown, locally tan, very fine grained to fine grained, very slightly friable, moderately sorted, subrounded, well cemented with dolomite, some carbonaceous laminae, slightly micaceous, very poor to nil porosity, no show, interbedded with Shale and Siltstone: as above, sandstone appears to be cemented with silica and dolomite.
6794- 6830	Interbedded Sandstone and Shale: as above, and Clay: light brown, very soft, silty, slightly sticky.
6830- 7050	Thin interbedded and interlaminated shale and siltstone with occasional sandstone; Shale: very dark gray to gray-brown, micaceous, pyrite inclusions, silty streaks, occasional siderite nodules, slightly fissile, rare scattered foraminifera; Siltstone: gray-brown, brown, mica, carbonaceous flakes, pyrite inclusions, slightly siliceous; Sandstone: very light gray, light tan, very fine to fine grained, subangular, silty, micaceous, siderite nodules, slightly siliceous, occasional streaks with slight porosity, estimated 5%.
7050- 7500	Shale: dark gray-brown, dark brown, brown, micromicaceous, fissile to slightly blocky, carbonaceous flakes, occasional siderite nodule and pyrite inclusions, occasional medium to coarse floating quartz grain; with interlaminated Siltstone: gray-brown, brown, shaly, very slightly calcareous, rare sandstone laminations, thin light buff, subwaxy, bentonitic clay streaks, 7190-7220', scattered fossil fragments.
7500- 7550	Shale: dark gray-brown, brownish-gray, fissile, partly flaky, trace micaceous, occasional round chert grain, floating quartz grains, streaks bentonitic clay, occasional siderite nodules and bands.

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7550- 7670	Shale: gray, gray-brown, smooth, soft, very fissile, papery to flaky, appears finely laminated, floating quartz grains, becomes very papery and glauconitic at 7570', trace brown, very fine grained sandstone with glauconite and siltstone at 7570-7580', bentonite streaks at 7600-7670'.
7670- 7715	Shale: dark brown, dark gray-brown, trace gray, fissile, occasional glauconite grain, pyrite inclusions, thin bentonite partings, trace altered fossils, thin sandstone stringers at 7680-7690'.
7715- 7831	Interbedded Siltstone: light brown-gray, partly dark brown, argillaceous, soft, friable, slightly micaceous, rare glauconite, partly shaly, trace with white clay, occasionally slightly sandy, trace carbonaceous flakes, and Shale: dark gray-brown, partly micaceous, occasional pyrite inclusions, fissile to firm, occasional streak with glauconite, sandstone laminations.
7831- 7837	Sand: loose, white and clear quartz grains, green glauconite grains, subangular to subrounded, fine to medium grains, small chips very fine grained, subrounded; Sandstone: clear to light brown, occasional trace dark gray and brown, friable.
7837- 7868.5	Core No. 7, Cut 31.5', Recovered 31.5'

7837.0-7838.0 (1.0')	Sandstone: brown, fine grained, subangular, clayey, silty, siliceous, very slightly calcareous, fine to coarse glauconite grains and pellets, partly altered to green-gray clay, no shows, no porosity, 80° fracture.
7838.0-7841.0 (3.0')	Sandstone: gray-brown, subangular, fine grained, shaly, noncalcareous, soft light gray-green to light green-gray glauconite pellets and matrix, occasional black grains, 20-30% glauconite; becomes finer at 7840' and silty at 7841', no shows, no porosity.
7841.0-7842.8 (1.8')	Sandstone: gray-brown, fine to very fine grained, 20% glauconite pellets, altered, shaly, partly with light gray-green glauconitic clay matrix, slightly silty, no shows.
7842.8-7844.0 (1.2')	Sandstone: brown, very fine to fine grained, subangular to subrounded, hard, tight, sideritic, siliceous, partly

	shaly, medium to coarse glauconite pellets; gray-green to light gray, partly altered; no shows, no visible porosity.
7844.0-7847.6 (3.6')	Sandstone: gray-brown, very fine to fine grained, subangular, very clayey, soft, shaly, silty; glauconite pellets, light gray to buff, altered; very slightly calcareous.
7847.6-7849.6 (2.0')	Siderite: brown, hard, sandy, silty, slightly siliceous; glauconite pellets, fine to very coarse, rounded; 30-50%; thin stringer of sideritic siltstone with glauconite as above.
7849.6-7860.0 (10.4')	Sandstone: gray-brown, to green-gray, partly mottled, very fine to fine grained, subangular, clayey, silty, 20-40% glauconite pellets, soft to firm, pellets altered to clay, appears slightly stained at 7850.9-7851.8'; no fluorescence, slight yellow cut.
7860.0-7863.0 (3.0')	Sandstone: gray-brown, very fine grained, subangular, shaly, clayey, silty, slightly glauconitic to streaks up to 35% glauconite, becomes very silty at base.
7863.0-7868.5 (5.5')	Siltstone: dark gray, sandy, hard, siliceous, dark brown to black pellets common, carbonaceous, phosphatic, becomes dark brown at 7866', occasional gray-green glauconite pellets; vertical fracture at 7864-7866'.
7868.5- 7870	Sandstone: light gray, gray, very fine grained, subangular, clayey, glauconitic, silty, altered glauconite pellets, soft, tight.
7870- 7886	Siltstone: dark gray-brown, gray, gray-brown, shaly, trace altered glauconite pellets, partly carbonaceous, partly sandy, with Shale: dark brown-gray, partly silty, trace glauconite, slightly micaceous, trace siderite, silty with altered glauconite pellets; and Sandstone: as above.
7886- 7920	Sandstone: very light gray, very fine grained, subangular to subrounded, white siliceous clay matrix, glauconitic, fair porosity, no show, and Sandstone:

light gray, gray-green, dark brown, partly sideritic, altered glauconite grains, very fine grained, angular, clayey, clay matrix appears to be alteration product.

7920- 7940 Sandstone: as above, with increasing Siltstone: dark gray-brown, partly shaly, carbonaceous, rare glauconite, and Shale: dark gray-brown, dark brown, partly fissile, glauconitic streaks, trace pyrite.

7940- 8080 Shale: dark gray-brown to very dark gray, fissile, pyrite inclusions, partly micromicaceous, occasional foraminifera, with thin interbedded sandstones and siltstones.

8080- 8160 Siltstone: dark gray-brown to brown-gray, shaly, slightly micaceous, occasional glauconite grain, pyrite inclusions, with thin interbedded shale, occasional foraminifera, siderite nodules.

8160- 8230 Shale: dark gray-brown to dark gray, partly very fissile, partly silty, micromicaceous, pyrite inclusions, occasional glauconitic streak, with thin interbedded Siltstone: becomes dark gray, brown, soft, fissile, partly flaky, streaks with medium and coarse glauconite pellets.

8230- 8275 Sandstone: very light gray, buff, subangular to subrounded, very fine grained, scattered glauconite grains, occasional dark grains, some chips appear to be sideritic, occasional streaks with white slightly altered grains, very slight to no porosity, no show.

8275- 8289.5 <u>Core No. 8, Cut 14.5', Recovered 9.8'</u>

8275.0-8276.0 (1.0') Sandstone: very fine grained subangular to subrounded, very silty, shaly, micaceous, scattered glauconite, slightly siliceous, slightly carbonaceous, tight, no show.

8276.0-8277.0 (1.0') Siltstone: gray-brown, shaly, sandy, micaceous, slightly carbonaceous, occasional pyrite inclusion, with Sandstone: as above, banded, tight.

8277.0-8278.0 (1.0') Sandstone: as above, trace black shiny grains, appears to be coal or dead hydrocarbon residue, increasingly siliceous, no cut.

8278.0-8280.0 (2.0')	Siltstone: as above, shaly partings, finely banded, shattered zone at 8279', fossil cast at 8279-8280'.
8280.0-8282.0 (2.0')	Sandstone: light gray-brown, very fine grained, subangular to subrounded, siliceous, very silty, shaly, thin siltstone and shale banding, scattered glauconite, micaceous, tight, no show; vertical fracture 8280-8281.5'.
8282.0-8283.0 (1.0')	Siltstone: gray to brown, sandy, siliceous, with shale and sandstone bands.
8283.0-8284.8 (1.8')	Sandstone: as above, becomes brown, silty, fossil fragments, recrystallized to calcite, trace dark fossil, appears to be fine crinoid stems, rare pyrite, dark gray round pellets, possible foraminifera(?); random fractures with calcite fill; no shows; slickensides.
8284.5-8289.5 (4.7')	No recovery.
8289.5- 8370	Interbedded Sandstone: light gray to gray-brown, very fine grained, silty, shaly, slightly micaceous, occasional carbonaceous flake, tight to slightly porous, no show, occasional white altered grain, rare glauconite, and Siltstone: dark gray-brown, shaly, micaceous, occasional glauconite pellet, and Shale: dark gray-brown, dark gray, micaceous, fissile, pyrite inclusions, thin stringers light and medium brown siderite, occasionally with pellets, trace calcite filled fractures.
8370- 8380	Sandstone: very light gray to gray-brown, very fine grained, subangular, silty, clayey, slightly calcareous, occasional dark grain, rare glauconite, occasional white altered grain, with thin interbedded siltstone and shale.
8380- 8410	Thin interbedded Sandstone, Siltstone and Shale: as above.
8410- 8435	Sandstone: very light gray, buff, gray-brown, very fine grained, subangular, siliceous to calcareous to clayey, slightly salt and pepper, occasional fine grained streak, very slight to no porosity, no show, interbedded siltstone and shale.

8435- 8451	Predominantly lost circulation material, lost circulation at 8440'; trace Sandstone: very light gray, very fine grained, subangular, slightly calcareous, slightly siliceous, scattered glauconite, occasional dark grains; very poor show.
8451- 8481	Core No. 9, Cut 30', Recovered 27.5'

8451.0-8454.0 (3.0')	Sandstone: very fine grained, partly coarse sandy Siltstone: light brown-gray to dark brown, mottled, siliceous, very slightly calcareous, scattered glauconite grains and pellets, abundant carbonaceous and shaly plant casts, tight, no show, occasional fossil fragment, recrystallized to calcite.
8454.0-8459.0 (5.0')	Siltstone: gray-brown to dark brown, micaceous, shaly, scattered pyrite inclusions, shale laminations, carbonaceous, glauconite pellets, slightly altered, increasing sand downwards, vertical fracture 8457-8459', very slightly calcareous, trace fossil fragments.
8459.0-8460.0 (1.0')	Sandstone: very fine grained, hard, siliceous, abundant glauconite, green, altered to light gray and brown clay, appears partly stained, no cut, rare shale inclusions, vertical fracture.
8460.0-8462.0 (2.0')	Siltstone: gray-brown, hard, sandy, partly very calcareous, glauconite streaks altered to clay, vertical fracture.
8462.0-8469.0 (7.0')	Sandstone: light gray-brown to brown, mottled, very fine grained, silty, subangular, shaly inclusions, clayey, glauconitic, thin altered bands to scattered grains, scattered carbonaceous plant casts, appears slightly stained 8465-8467', no fluorescence, very slight yellow residual cut, vertical fracture.
8469.0-8471.0 (2.0')	Siltstone: gray-brown, sandy, siliceous, calcareous, argillaceous to shaly, scattered glauconite, scattered carbonaceous plant material, vertical fractures.

8471.0-8475.0 (4.0')	Sandstone: light gray-brown, light brown, very fine grained, subangular, silty, slightly calcareous, siliceous, scattered glauconite, carbonaceous plant casts; with interbedded Siltstone: brown, shaly, siliceous, slightly calcareous, vertical fracture, no show.
8475.0-8478.5 (3.5')	Sandstone: light brown and brown, very fine grained, subangular, calcareous, shaly inclusions, glauconitic, carbonaceous plant casts, pelecypod or brachiopod casts, occasional hairline fractures with calcite filling, becomes very sandy siltstone at base.
8478.5-8481.0 (2.5')	No recovery.
8481- 8590	Interbedded Sandstone: light gray, gray-brown, very fine grained, subangular, calcareous, slightly silty, clayey, glauconitic, no porosity, no show; with Siltstone: gray-brown to dark gray, calcareous, partly shaly, slightly calcareous; and Shale: dark gray-brown, dark gray, partly silty, slightly micaceous, fissile to slightly blocky becoming limy, occasional fossil fragment.
8590- 8652	Interbedded Siltstone: dark gray-black, blocky, firm, argillaceous, slightly calcareous, slightly fossiliferous, occasional phosphate pellets; and Shale: dark gray-black, blocky, firm to well compacted, occasional clear quartz grains, well rounded, very coarse.
8652- 8723	Interbedded Limestone: light gray, very argillaceous, common loose fossil fragments, very fine, round, phosphate pellets; and Siltstone: as above, and Clay: brown, soft, water soluble, silty.
8723- 8977	Interbedded Sandstone: light to medium gray, very fine grained, locally becoming fine grained, angular, moderately sorted, well cemented with calcite and silica, rare bright green to black glauconite, speckled salt and pepper, very poor to nil porosity, no show; and Siltstone: dark gray-black, firm, well compacted, siliceous; and some silty Clay: light to medium brown, very soft, water soluble, and Shale: dark gray-black, fissile, well compacted, silty, very finely micaceous, possibly carbonaceous.

8977- 9008 — Core No. 10, Cut 31', Recovered 31'

8977.0-9001.0 (24.0')	Interbedded and interlaminated shale and siltstone; Shale: dark brownish-black, very hard, silty, micromicaceous, conchoidal fracture, carbonaceous, rare microfossil casts; and Siltstone: dark brownish-black, hard, dense, argillaceous, micromicaceous, carbonaceous fragments, rare questionable silicified fecal pellets.
9001.0-9002.0 (1.0')	Sandstone: quartzitic, light gray, very fine grained, angular, moderately sorted, well cemented, with silica, very slightly dolomitic, suggestion of quartz overgrowths, very fine sparsely speckled salt and pepper, possibly dark greenish-black glauconite, very hard, micromicaceous, occasional black carbonaceous microzones, very dense, very poor to nil porosity, no show.
9002.0-9003.0 (1.0')	Interbedded and interlaminated Shale and Siltstone: as at 8977'.
9003.0-9008.0 (5.0')	Sandstone: quartzitic, grades to Quartzite: light gray, with common dark gray-black irregular to contorted very thin argillaceous laminae, very fine grained, well cemented with silica, recrystallized quartz, doubly terminated quartz at 9006.4', very hard, dense, nil visible porosity, no show.

9008- 9109 — Siltstone: light and dark gray, hard, well cemented with silica, in part carbonaceous.

9109- 9135 — Sandstone: quartzitic locally grades to Quartzite: light gray, fine grained, moderately sorted, well cemented with silica, hard, rare glauconite, nil porosity; and thin stringers of Dolomite: mottled light and dark gray, soft, argillaceous, chalky, nil porosity, no show.

9135- 9145 — Siltstone: dark gray-brown, hard, well compacted, slightly siliceous, argillaceous; grades to Shale: dark gray-brown, slightly micaceous, well compacted, silty.

9145- 9152 — Sandstone: as above.

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9152- 9270	Interbedded Sandstone: light gray to clear, very fine to fine grained, some medium grained, subangular, moderately sorted, well cemented with silica, slightly dolomitic, rare glauconite, poor to nil porosity, no show; and Shale: dark gray to dark gray-brown, fissile, well compacted, in part carbonaceous, micaceous, splintery; and Siltstone: light to medium gray, some dark gray-brown, in part sandy, siliceous, hard, in part micaceous.
9270- 9310	Interbedded Siltstone: dark gray, micaceous, firm to hard, in part silty, well compacted, with Sandstone and Shale: as above.
9310- 9350	Predominantly Siltstone: light to dark gray, locally medium gray, in part hard and siliceous, in part carbonaceous, well compacted; with Shale: as above; and Sandstone: light to medium gray, very fine to fine grained, angular, moderately sorted, very slightly dolomitic, firm, well cemented with silica, in part carbonaceous, poor to nil porosity, no show.
9350- 9400	Predominantly Siltstone: as above, rarely medium gray, very locally rare bright green glauconite; and increasing Shale: dark gray-brown to dark brown, fissile, splintery, hard, silty, micromicaceous, with decreasing Sandstone: as above, and medium gray-brown, fine grained, subangular, moderately sorted, argillaceous, rarely carbonaceous, firm, moderately well cemented with silica, in part micaceous, poor porosity, no show.
9400- 9469	Interbedded shale and siltstone; Shale: dark gray-brown to dark brown, locally some medium gray, firm, well compacted, fissile in part, splintery, micromicaceous, rarely carbonaceous; and Siltstone: gray-brown to dark gray-brown, argillaceous, in part very sandy, firm, blocky, in part carbonaceous.
9469- 9490	Pebble Conglomerate: medium to dark gray, in part stained black, fine to medium grained, subangular to subrounded, poorly sorted, in part very argillaceous, possible carbonaceous in part, calcareous, slightly siliceous, friable, scattered well rounded chert pebbles; smoky gray and black, and common to abundant coarse to very coarse, subrounded to round quartz grains, scattered gray, green, brown, chert fragments, rare questionable weathered igneous rock fragments, possible glauconite pellets; pebbles, chert fragments, and quartz grains increasing downward.

9490- 9520 Core No. 11, Cut 30', Recovered 30'

9490.0- 9499.0 (9.0')	Sandstone: medium gray, locally becoming dark gray, fine to medium grained, locally scattered coarse grained, subangular to subrounded, poorly to very poorly sorted, frosted, white clay filling, locally gray green clay filling, common weathered feldspar, micromicaceous, rare fine black mineral, finely disseminated pyrite, locally well rounded fine grained black chert, locally very coarse well rounded gray chert, calcareous, with rare shell casts in bottom foot, fair porosity, no show.
9499.0-9501.0 (2.0')	Sandstone: medium gray, as at 9490-9491' with rare very coarse smoky well rounded chert.
9501.0-9502.0 (1.0')	Sandstone: dark gray as 9490-9491', but very silty and argillaceous, poor porosity, no show.
9502.0-9517.0 (15.0')	Sandstone: light gray, fine grained, subangular, fair sorting, scattered weathered or altered feldspar, rare to scattered fine black grains, clay filling, calcareous, rare black glossy material coating grains and pore filling (possible gilsonite), micromicaceous, fair porosity, no show.
9517.0-9520.0 (3.0')	Sandstone: light gray, mottled very dark gray to black, very argillaceous, fine grained, subangular, fair sorting, shaly partings, scattered feldspar, rare black grains, in part calcareous, some contorted laminae, very poor porosity, no show.

9520- 9634 Sandstone: light gray to clear locally becoming medium gray, fine to very fine grained, angular to subrounded, poor to fair sorting, calcareous, scattered feldspar, rare black mineral, very rare, bright green glauconite, locally milky white chert grains and fragments, rare spots of black, glossy material coating grains and filling pores, friable, locally very rare shell fragments, fair porosity, no show.

9634- 9945	Interbedded siltstone and shale with minor sandstone; Siltstone: very dark gray, very hard, very micaceous, blocky, well compacted, sateen or metallic sheen in part, phillitic texture in part, locally thinly banded or laminated, very light and dark gray, medium and dark gray, locally fractures filled with quartz clear to translucent and milky white calcite becoming common to abundant at 9880-9890' and 9920-9945'; locally Shale: light medium gray, soft to firm, blocky, occasionally mottled light and medium gray, predominantly Shale: very dark gray, hard to very hard, well compacted, in part metallic sheen, and minor locally Sandstone: quartzitic, to quartzite, light gray to tan, or light brown, generally well cemented with silica, dense, hard, nil porosity, no show.
9945-10,030	Siltstone: very dark gray, hard to very hard, micaceous, occasional to common pieces with metallic sheen, and phillitic texture, suggestion of being very thinly laminated, rarely thinly laminated, medium and very dark gray, occasional pseudowaxy bedding, interbedded with Shale: very dark gray, hard, well compacted, dense, silty, rarely fine pyritic, occasional metallic sheen, and abundant Quartz: clear, translucent, milky white, smoky gray and some calcite as fracture fill occasionally grades clear, translucent to smoky gray to shale or siltstone, and Shale: light to medium gray, hard, some mottled, dense, siliceous appearance in part, rarely thinly banded.
10,030-10,160	Predominantly Shale: light gray in part medium gray, in part siliceous appearing, hard, in part firm, blocky, argillaceous, rarely slightly dolomitic, very rarely calcareous, occasionally pyritic, with interbeds of Siltstone: light to medium gray, in part less siliceous and hard, in part very argillaceous, slightly micaceous.
10,160-10,215	Predominantly Shale and Siltstone: light to medium gray as above, and Siltstone: dark gray, hard, in part very finely sandy, rare pseudo-sheen, rare phyllitic texture, very rarely pseudo-waxy laminae, rare quartz filling fractures, and some Shale: dark gray, hard, rare pseudo-sheen.
10,215-10,225	<u>Core No. 12, Cut 10', Recovered 10'</u>
10,215.0-10,225.0 (10.0')	Argillite: (metamorphic), very dark gray, very hard, very micaceous, locally pyritic, phyllitic texture, semimetallic sheen, in

	part wavy bedding (pseudo foliation), slickensided fractures, in part calcite coated and dipping 65-90°, bedding dips 70-80°.
10,225	Measured total drilled depth.

Log Analysis

ARMOUR KANE

Formation Evaluation

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

March 27, 1979

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

Dear Mr. Hewitt:

Logging operations on Peard Test Well No. 1 were begun by Schlumberger at 2000 hours on March 12, 1979, and Dual Induction, Neutron-Density, Sonic Log, Dipmeter, Birdwell velocity survey and sidewall samples were completed at 0700 on March 14, 1979. Log quality of all logs was very good as was depth control. Of 80 sidewall samples attempted 77 were recovered. No lost rig time due to equipment failure was experienced although some down time was incurred by the inadvertant closing of the rams on Schlumberger's sonic sonde. Engineers were Larry Nelson and Jeff Quinn.

Recognizable log tops were: Torok 3120 (this is a very tentative pick); Pebble Shale 6195; Kuparuk River sand 6530; Kingak 6590; Sag River sand 8432 and Shublik 8500. Correlation was quite good with the Kugrua well.

Quantitative analysis (see attached tabulation) of the Kuparuk River sand results in an average porosity of 16.5% and water saturation of 93% to 100%. Water saturation was computed using an Rw value of 0.14, a figure confirmed both from SP analysis and R_{wa} and thus may be used with confidence. The sand at 7828 has characteristics similar to those found in other wells, i.e. negative density porosities and neutron porosities in excess of 45%. This has been attributed to a high glauconite content and the possible presence of daphnite, a mineral of high density and high hydrogen index. Glauconite was found in abundance in ditch samples. The bottom 11 feet of the sand has a porosity of 6.5% and is 100% wet. The Sag River is tight and of low porosity but a 7 foot interval from 8444-51 indicates porosity of 10.5% and calculates wet using Rw of 0.3. There is a neutron-density "crossover" at 8480 which usually suggests the presence of gas; however, this is not confirmed by the sonic response which actually shows a decrease in apparent porosity rather than an increase expected in a gas sand.

There were no significant shows in the well.

Very truly yours,

Armour Kane

Armour Kane

Log Analysis

MARCH 27, 1979

COMPANY: HUSKY OIL/NPR OPERATIONS, INC. — WELL: PEARD TEST WELL #1

FIELD: NORTH SLOPE — COUNTY — STATE: ALASKA

DEPTH	R_T	ϕ_D	ϕ_N	ΔT	ϕ_S	S_w	REMARKS
6530-36	5	18	25	76	18	93	R_w FROM SP = 0.14; R_w = 0.14
6538-42	4.2	17	23	77	19	100	
6542-46	4.5	15	23	79	20	100	
7828-78	ϕ_D NEGATIVE, ϕ_N HIGH - GLAUCONITE & DAPHNITE						
7884-7900'	6.5	12	18	79	18	100	R_{we} = 0.15
		SAG RIVER					
8444-51	31	10.5	14	90	13	94	R_w FROM SP = 0.3; R_{we} = 0.35

Log Analysis

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

Formation Evaluation

March 28, 1979

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

Dear Mr. Hewitt:

Upon re-examination of the logs on the Peard Test Well No. 1 I find that I have made an error in porosity in the interval 8444-54 in my original report of March 27, 1979. The figures should have been ϕ_D = 14%, ϕ_N = 17% and ϕ_S = 16% resulting in a water saturation of 71% using Rw of 0.3 calculated from the SP. I must apologize for the error and can only attribute to lack of sleep while making calculations at the well site. Please correct my earlier report.

Very truly yours,

Armour Kane

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:

At Peard Test Well No. 1 Schlumberger began logging at 1500 hours on April 7, 1979, and successfully completed two Temperature Surveys, DIL/ CNL/FDC, BHC, Velocity Survey, Dipmeter and Sidewall Cores sometime on April 8, 1979. The writer was present only through the BHC, having been returned to the Ikpikpuk well to catch those logs so is unaware of the completion time of logging activity or of the sidewall recovery. Log quality was good and no lost rig time was experienced by Engineer Rathert.

Log tops were: Base Shublik 8740; definite top of Sadlerochit 8832; Echooka 9472 and Argillite 9638. Here, too, correlations were not precise but were generally agreed upon by the USGS, Geologist Wermeyer and myself.

The attached tabulation is a quantitative analysis of the Echooka sand, and since the FDC was adversely affected by the presence of glauconite and/or daphnite, the porosities used are from the Sonic Log which are probably optimistic due to the presence of shaliness. Water saturation was computed from Sonic Rw_a values and porosity compared to Rt values from the DIL and may also be on the optimistic side. Average porosity over 96 feet of the 166 feet of sand is 14.5% and water saturation averages 89%.

Very truly yours,

Armour Kane

Armour Kane

Log Analysis

April 16, 1979

COMPANY: HUSKY OIL/NPR OPERATIONS, INC. WELL: PEARD TEST WELL No 1

FIELD: NORTH SLOPE COUNTY: STATE: ALASKA

DEPTH	R_T	ϕ_D	ϕ_N	ΔT	ϕ_S	R_{wa}	S_{wa}	REMARKS
9489-94	4.5	—	26	83	21	.23	81	
9498-9502	9.5	—	28	75	15	.24	80	
9502-08	8	—	—	74	14	.17	94	
9508-16	7.5	13	21	84	21.5	.35	66	
9530-40	25	8	10	67	9	.21	85	
9540-50	21	8	10	67	9	.17	94	
9558-62	8	16	18	84	21.5	.42	60	
9566-70	10	10	15	75	15	.25	77	
9570-80	7.5	14	18	77	16	.22	83	
9582-84	14	9	12	67	9	.20	87	
9590-96	11	13	15	74	14	.25	77	
9610-20	5	17	22.5	80	18	.19	89	
9620-26	5	17	22	77	16	.15	100	
9628-34	6	18	23	82	20	.22	83	

NOTE: VALUES USED FOR S_w CALCULATIONS ARE SONIC POROSITIES AND SONIC R_{wa} — THESE MAY RESULT IN OPTIMISTIC S_w VALUES.

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

LOGGING REPORT

WELL NAME PEARD NO. 1

Date MARCH 12, 13, 1979 Driller Depth 8610'

Elevation 103.3 KB Logger Depth 8612'

Logs Ran and Intervals

GR/SP/DIL	2633-8606'
GR/CAL/CNL/FDC	2632-8610'
GR/CAL/BHC	2634-8601'
HRD Dipmeter	2632-8610'
CST Sidewall Samples	Top shot 4234', bottom shot 8600'

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Av. Porosity	Probable Fluid Content
6530-6546'	16	16	Sandstone	16.5	Water
7828-7878' *					
7889-7900'	11	11	Sandstone	12	Water
8430-8500'	70	7	Sandstone	10.5	Water

Discussion:

*This interval similar to those in South Meade and South Simpson; i.e., negative densit porosity and neutron porosity of 45% or greater, glauconite and daphnite? Most of Sag River Sand is of low porosity.

Log Tops & Correlations:

	PEARD	KUGRUA	
Torok	3120'	3820'	(Tentative in both wells)
Pebble Shale	6195'	6890'	
Kuparuk River Sand	6530'	7205'	
Kingak	6590'	7304'	
"2nd Ss"	6765'	7555'	
Sag River Sand	8432'	9516'	
Shublik	8500'	9630'	

Additional Evaluation Plans:

RON BROCKWAY & ARLEN EHM
Wellsite Geologist

ARMOUR KANE
Log Analyst

(51)

HUSKY

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

LOGGING REPORT

WELL NAME PEARD #1

Date April 7-8, 1979 Driller Depth 10,229'

Elevation 103.3 KB Logger Depth 10,227'

Logs Run and Intervals

Temperature Surveys (2)	50-10,229'	HRD Dipmeter	
GR/SP/DIL	8602-10,223'	CST-Sidewall Cores - Top Shot	8617'
GR/CAL/CNL/FDC	8602-10,227'	- Btm Shot	9957'
GR/CAL/BHC	8602-10,226'		
Velocity Survey	3115-10,225'		

Logs Not Run

Interval	Gross Thickness	Net Pay	Lithology	Av. Porosity *	Fluid Type
9472-9638'	166	96'	Sandstone	14.5%	Water

* Porosities are sonic derived density affected by glauconite; thus porosities are probably on the high side

Formation Correlations:

Base Shublik	8740'
Definite Top Sadlerochit	8832'
Echooka	9472'
Argillite	9638'

RAY WERMEYER

ARMOUR KANE

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company USGS/HUSKY OIL COMPANY, OPR Formation — Page 1 of 2
Well PEARD BAY NO. 1 Cores DIAMOND File BP-3-513
Field WILDCAT Drilling Fluid WBM Date Report 4/12/79
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	7839	0.5			25.4	2.74			ss,vfg,slty,sid
2	7842	0.4			24.0	2.76			ss,vfg,v slty,sid
3	7845	0.2			22.0	2.74			same
4	7848	0.0			10.8	2.95			sltst, sdy,sid
5	7851	0.0			8.4	3.15			sltst, sid
6	7854	0.0			15.4	2.74			sltst, sdy
7	7857	0.0			17.7	2.94			ss,vfg,slty,sid
8	7860	0.0			15.0	2.90			sltsc, sdy
9	7863	0.0			12.6	2.98			sltst, sid
10	7866	0.0			12.6	3.29			same,v slty
11	9490	0.1		0.1	15.3	2.74			ss,vfg,v slty
12	9493	0.0		0.0	10.5	3.25			sltst,sdy,pyr
13	9496	0.0		0.0	12.0	2.90			same
14	9499	0.0		0.0	11.6	3.01			ss,vfg,v slty,pyr
15	9502	2.3		1.7	19.1	2.68			ss,vfg,v slty
16	9505	1.5		0.8	21.0	2.66			same
17	9508	0.7		1.0	19.5	2.68			same
18	9511	0.3		0.3	17.2	2.68			same
19	9514	0.0		0.0	11.7	2.67			same
20	9517	0.0		0.0	10.1	2.69			same

* Core Gamma available
for both cored intervals.

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

Company USGS/HUSKY OIL COMPANY, OPR Formation _____ Page 2 of 2
Well PEARD #1 Cores DIAMOND File BP-3-533
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	5409	0.0			12.4	2.70			ss,vfg,slty,sl calc
2	5412	2.6			7.9	2.72			ss,vfg,slty,sl calc,sh incl
3	5413	0.1			12.4	2.70			ss,vfg,slty,sl calc
4	5414	0.4			11.0	2.70			ss,vfg,slty,sl calc,sh incl
5	5415	0.7			9.2	2.71			same
6	5416	0.7			12.1	2.70			ss,vfg,slty,sl calc
7	5417	0.3			12.9	2.69			same
8	5419	0.3			9.6	2.71			ss,vfg,slty,sl calc,sh incl

* Core Gamma not available for this interval.

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LISTING OF OTHER AVAILABLE GEOLOGICAL DATA

A. Final Micropaleontology Reports by Anderson, Warren & Associates, Inc.

1. Foraminifera Report, dated June 14, 1979.

    a. Revisions to above final report, dated August 18, 1980, and February 4, 1981.

2. Palynology Report, dated June 14, 1979.

    a. Revision to above report, dated August 18, 1980, and February 4, 1981.

B. Interpretation of "Stratigraphic" Dipmeter for Interval 6521-8508' by J. B. Vohs, Schlumberger, dated May 21, 1979, included two page written report plus direct interpretation on the arrow plots and polar plots.

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

Telephone: (303) 497-6376.