NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

NORTH KALIKPIK TEST WELL NO. 1

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: Gordon W. Legg
Edited by: R. G. Brockway

For the

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

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INTRODUCTION

The North Kalikpik Test Well No. 1 is located in the SW 1/4, 2766' FNL and 2593' FWL, of protracted Section 3, T13N, R2W, Umiat Meridian, National Petroleum Reserve in Alaska (see Figures 1 and 2).

The well was spudded on February 27, 1978 and plugged and abandoned as a dry hole after reaching a total depth of 7,395 feet (driller). The date of abandonment and subsequent rig release was April 14, 1978.

No shows of any significance were encountered in drilling the well and no potential reservoir rocks were present within the drilled section.

PRE-DRILLING PROGNOSIS

The objective of the North Kalikpik Test Well No. 1 was, what was believed to be, erosional remnants of Kuparuk River sandstone which, according to the seismic interpretations, had been deposited as a series of north-south channels (see Figure 3). The hypothesis supposed the channels to have formed as a result of either (1) normal ocean circulation or (2) from storms and/or erosion during regional tilting. The unconformity at the base of the Cretaceous would have then resulted in "Pebble Shale" being deposited in the intervening channels, thus putting the rich source beds of the "Pebble Shale" in both lateral and superposed contact with Kuparuk River sandstone. The test was entirely stratigraphic in nature, but was located on a large regional east-west structural trend mapped at the basal Cretaceous level (see Figure 3).

The seismic interpretations were evolved from what was termed "good to excellent" data and were based primarily upon reflection amplitude lateral changes, creating apparent "bright spot" contrasts and velocity sags (see Figure 4). The seismic interpretations anticipated at least 100 feet of gas charged sandstone within the Kuparuk River section.

POST-DRILLING ANALYSIS

The North Kalikpik Test Well was drilled to a measured total depth of 7,395 feet (driller). At this depth, 258 feet of the Jurassic Kingak Formation had been penetrated, which is stratigraphically below the Cretaceous Kuparuk River sandstone. No sandstone bodies were encountered in the continuous coring which was done above and through the "Pebble Shale"/Kingak contact. Electric logs also confirmed that there was no sandstone development of any kind in the basal "Pebble Shale" or in the underlying 258 feet of penetrated Kingak.

A "Post-Drilling Analysis" prepared by Tetra Tech concluded that the velocity anomalies which were present on the seismic records near the well location were caused, not by gas-charged sandstones near the base of the "Pebble Shale", but by gas-charged shales within the "Pebble Shale" unit.

This analysis does not appear to be substantially supported by data obtained in drilling the well, although some shale cores did bleed fine gas bubbles from factures.

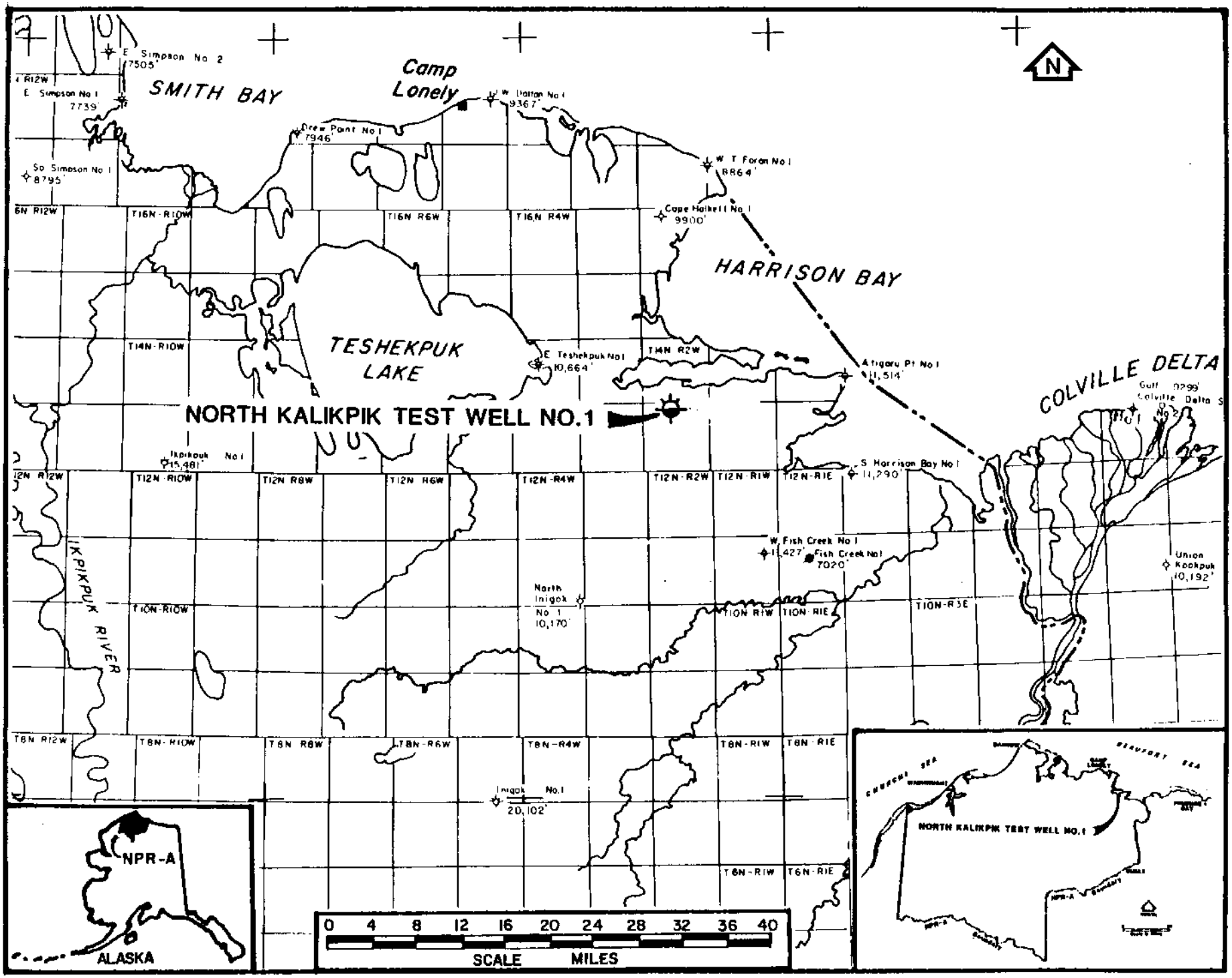
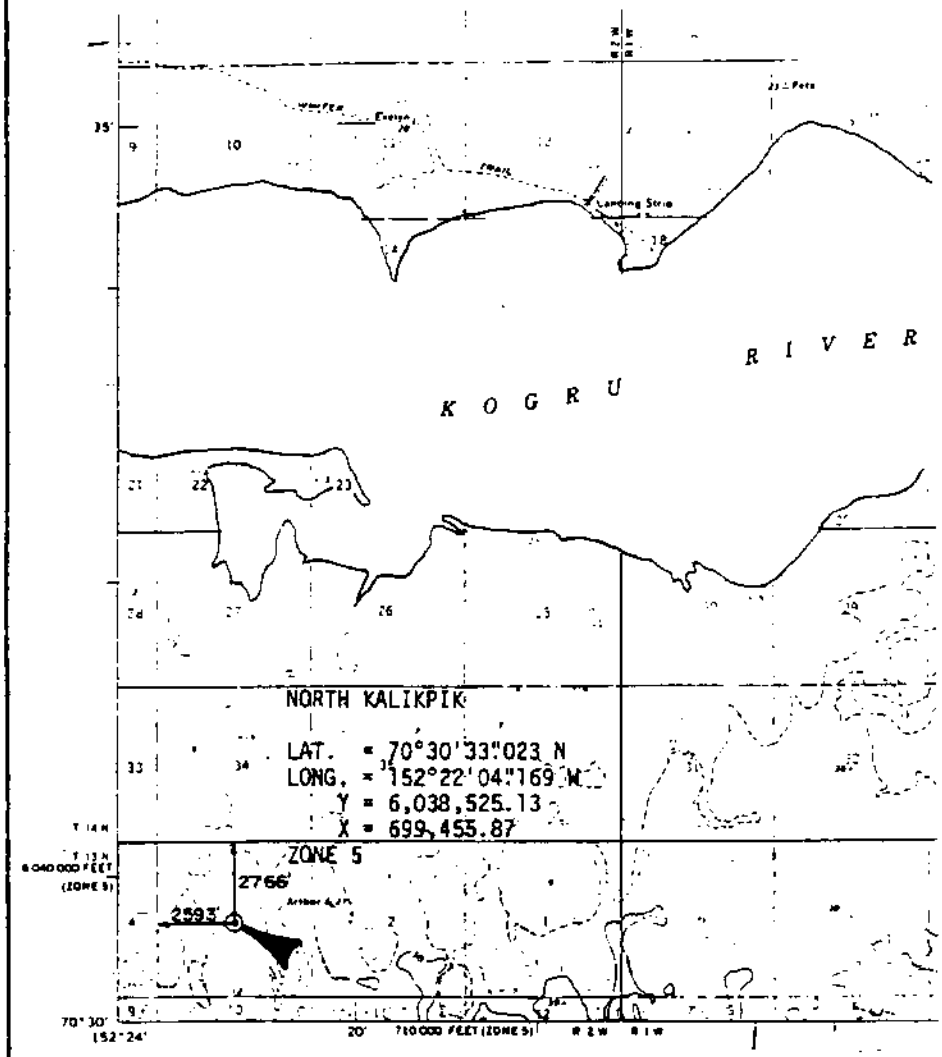


FIGURE 1 - LOCATION MAP - NORTH KALIKPIK TEST WELL NO. 1



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

STATE OF ALASKA
49TH
JOHN M. HERRING
No. 953-S
REGISTERED PROFESSIONAL LAND SURVEYOR

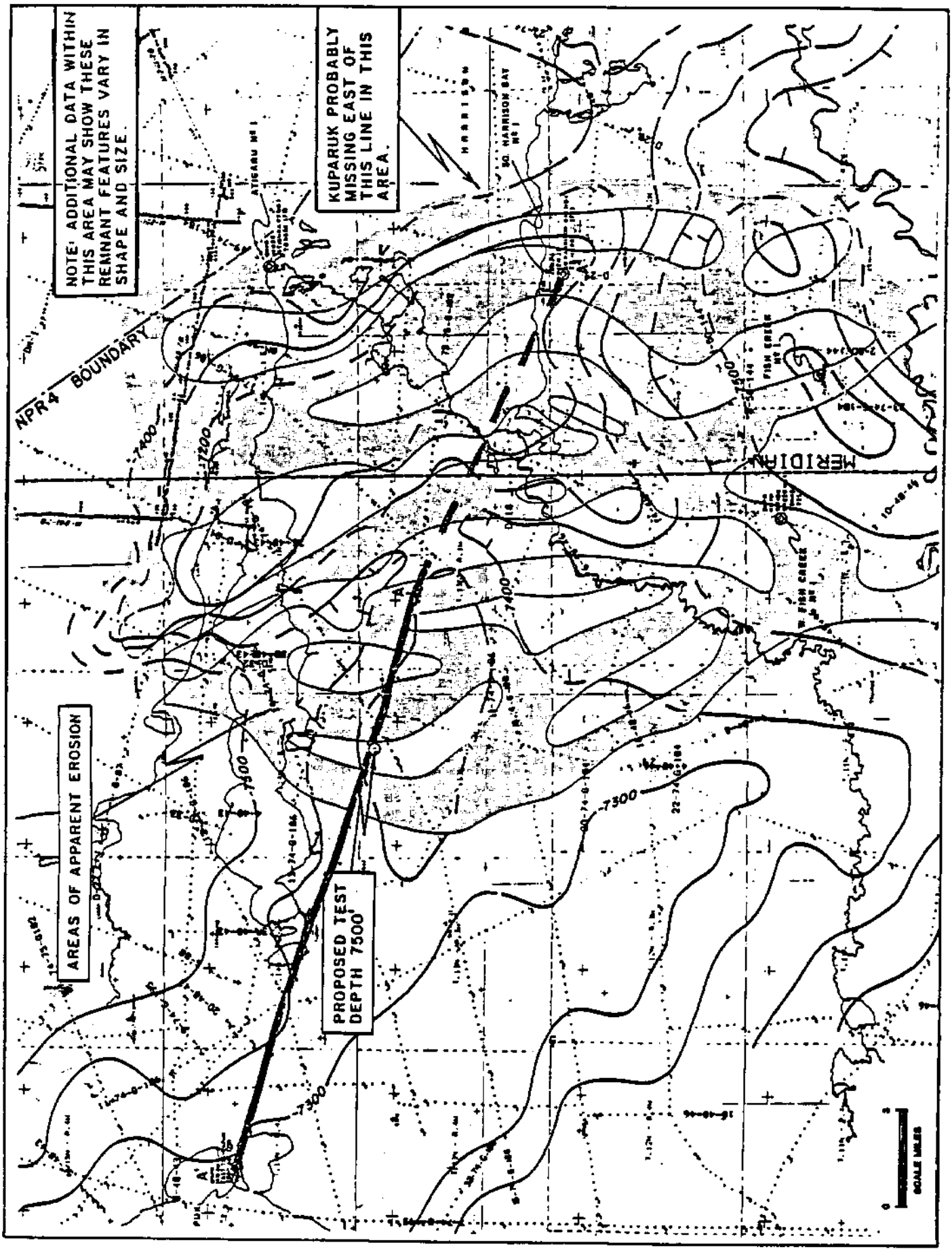
0 1/2 1 2
SCALE IN MILES

AS STAKED
NORTH KALIKPIK
LOCATED IN
1/4 PROTRACTED SEC. 3 T13N, R2W UMIAT MERIDIAN, AK

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

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

FIGURE 2 - SURVEYOR'S PLAT - NORTH KALIKPIK TEST WELL NO. 1



PRE-DRILLING INTERPRETATION

FIGURE 3 - PRE-DRILLING MAP INTERPRETATION - NORTH KALIKPIK TEST WELL NO. 1
(From Tetra Tech "Post-Drilling Analysis" dated October 1978)

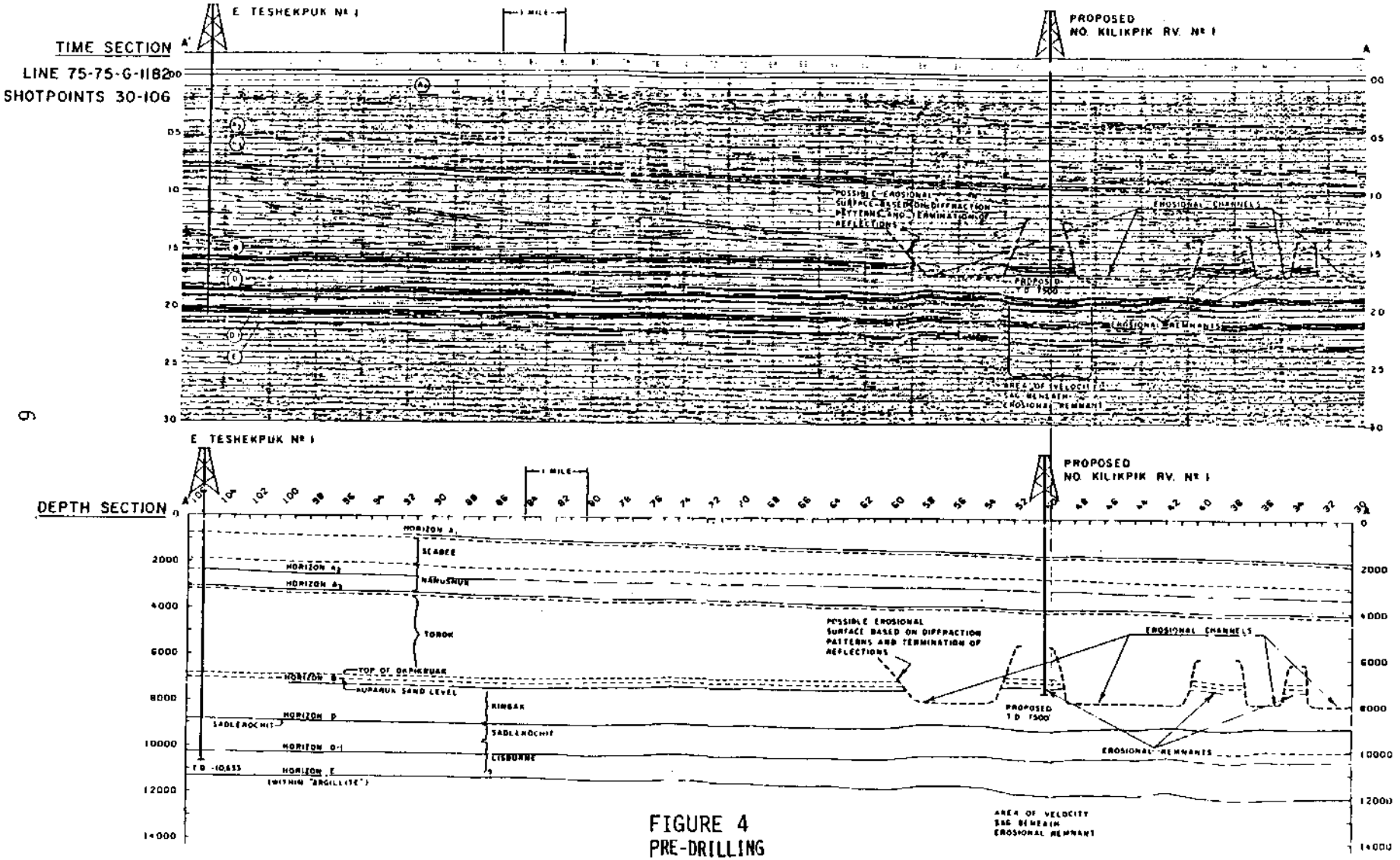


FIGURE 4
PRE-DRILLING
SEISMIC CROSS-SECTION INTERPRETATION

(From Tetra Tech "Post-Drilling Analysis" dated October 1978)

WELLSITE GEOLOGIST'S REPORT
BY: ARLEN EHM
EDITED BY: GORDON W. LEGG

SUMMARY

The North Kalikpik Test Well No. 1 was drilled in early 1978 as one of several tests designed to test a particular prospective area or concept, and to provide geologic (primarily stratigraphic) information. This test was designed primarily to investigate a prospective area based on an interpretation of the seismic surveys conducted in the area. It was located 2766' FNL, 2593' FWL, of protracted Section 3, T13N, R2W, Umiat Meridian, approximately 10 miles inland from Harrison Bay, and two miles south of the Kogru River. North Kalikpik Test Well No. 1 is somewhat centrally located in an area that includes six exploratory wells located within a radius of 25 miles.

The primary objective of this test was the zone interpreted to be the Cretaceous Kuparuk River sandstone, which was encountered in the East Teshekpuk Test Well No. 1 to the west, and which was interpreted to be present on the seismic records within the immediate area of the North Kalikpik well. Three previously drilled wells located east and southeast of this test did not reveal the Kuparuk River sandstone to be present. These tests are the Atigaru Point No. 1, the South Harrison Bay No. 1, and the West Fish Creek Test Well No. 1 (Figure 1).

A velocity anomaly appears to be present on the seismic records in the area, which was interpreted to indicate channel erosion of the Kuparuk River sandstones. An alternate interpretation was that the sandstone stringer penetrated in the East Teshekpuk No. 1 did not represent depositional continuity with the areas of Kuparuk River sandstone deposition east of the National Petroleum Reserve in Alaska, and that the velocity anomaly was due to gas saturated lenticular sandstones in the lower part of the "Pebble Shale".

The North Kalikpik Test Well No. 1 was drilled to a depth of 7395', penetrating the entire Cretaceous section and 258' of Jurassic age rocks. The objective (Kuparuk River sandstone) was not present in this test, nor were there any indications of oil anywhere in the test well. Minor quantities of gas were logged while drilling, but reservoir rocks were absent, and the electric logs did not indicate any possible zones of interest.

The velocity anomaly appears to have been due to causes other than an erosional remnant of the Kuparuk River sandstone. It is possible that the anomaly is due to a velocity contrast at the unconformable contact of the Cretaceous "Pebble Shale" with the shales of the Jurassic Kingak Formation below.

WIRELINE LOG TOPS

	Drilled Depth	Subsea Depth K.B. 40'
CRETACEOUS		
(Undifferentiated)	80'	-40'
Torok Formation	4265'	-4225'
"Pebble Shale"	6896'	-6856'
Kuparuk River sandstone	Missing	
JURASSIC		
Kingak Formation	7137'	-7108'
TOTAL DEPTH	7395'	-7345'

STRATIGRAPHY

CRETACEOUS

Undifferentiated: 80-4265'

It is possible that the upper few tens of feet of sediments in this test may have been of other than Cretaceous age. However, the first sample was collected at 80', where the sediments were Late Cretaceous in age.

Interval 80-1085'

From 100' to 1085' sediments of Late Cretaceous Senonian age were identified by Anderson, Warren & Associates, Inc. (AWA) as being in their F-6 zone. Because of operational problems connected with the mud logging, nearly half of this interval is not represented by samples. The sampled sediments are light gray, soft clay shales, minor light gray siltstone, and rare, light medium gray, fine to very fine grained quartz sand with some carbonaceous fragments. Shell fragments, pyritized worm borings, and white, coarsely crystalline calcite are common, and bentonite and coal fragments are present in trace amounts. The environment of deposition was oscillating middle neritic to upper bathyal and nonturbid.

Interval 1085-1320'

From approximately 1085' to 1320', the rocks are predominantly light gray, "salt and pepper" sandstones, grading from fine to coarse grained, subangular to subrounded, quartz and chert grains with occasional black carbonaceous grains, calcareous, well cemented, and nonporous. Traces of lignitic coal and buff, dolomitic mudstone are also present.

This interval is characterized by a large reduction in fauna, and no new occurrences are reported. The environment of deposition is interpreted to be nonmarine to marginal marine. It is probable that this interval represents a nonmarine to marginal marine intertongue of the Prince Creek Formation. According to the paleontologic interpretation, this interval is dated as Late Cretaceous Turonian to Coniacian (AWA F-5 to F-6 zones).

Interval 1320-2025'

Rocks in this interval (1320-2025') are composed of shale, which is light gray, silty, chunky, and micaceous, and sandstone, which is light medium gray, and fine to very fine grained. The sandstones are subangular, with quartz and chert grains, calcareous, well cemented, slightly sideritic, and nonporous. The shale is occasionally calcareous, and rarely waxy. Although portions of this interval were logged as limestone, it is probable that they are actually slightly calcareous mudstones.

The environment of deposition for these Late Cretaceous Turonian to Coniacian sediments (AWA F-6 zone) was inner to middle neritic.

Interval 2025-2395'

Sandstone, which is light gray to medium gray, fine to very fine grained, predominates from 2025' to 2395', along with minor medium dark gray, silty, micaceous, calcareous shale. Sandstones are subangular quartz and chert grains and carbonaceous fragments, glauconitic, well cemented, calcareous to very calcareous, nonporous, and slightly sideritic. Minor slightly calcareous mudstone is also present.

The paleontological report describes these sediments as bentonitic, organically rich, with frequent fishbone fragments, and identifies them as Late Cretaceous, Cenomanian to Turonian (AWA F-7 zone). They are probably open marine neritic sediments.

Interval 2395-4265'

Undifferentiated sediments of the Nanushuk Group are present from 2395' to 4265'. Although no distinction is made as to formation, they are discussed herein in terms of sediment type and depositional environment.

According to the paleontological report, the sediments from 2395' to 2570' are Early to Late Cretaceous, Albian to Cenomanian (AWA F-8 zone), probable inner to middle neritic sediments. As such, the environment of deposition was turbid for the fine grained, silty, poorly sorted sandstones and silty shales. The sandstones are light medium gray, subangular, with quartz, chert and carbonaceous grains, calcareous, weakly to moderately cemented, fairly porous to nonporous, with a slight show of gas and a very poor show of oil in the samples from 2510-2540'.

Below 2570', the faunal assemblage is indicative of the Verneuilinoides borealis faunal zone which is Early Cretaceous, Middle to Late Albian age (AWA F-9 zone). The environment of deposition was middle to outer neritic, with relatively clear, nonturbid waters.

The sediments down to 3290' are predominantly shale and siltstone with some mudstone, according to the wellsite geologist's lithology log. The shale is light medium gray, soft, chunky, silty, slightly calcareous, and fossiliferous, with pyritized worm tubes common. The dual induction-laterolog, however, indicates that as much as 50% of the section

from 2570' to 2900' and from 3180' to 3290' is sandstone. The sandstones might have been very fine grained and loosely consolidated, and thereby missed in the sample catching process. The DIL shows thick sand bodies from 3180' to 3450', which correlate, in part, with sandstones on the wellsite geologist's lithology log. The log described the sandstones as gray, very fine grained to silty, with quartz, chert and minor carbonaceous fragments, poorly sorted, very calcareous, poorly consolidated to well cemented, argillaceous, and very slightly porous to nonporous.

The remainder of the section from 3450' to 4265' is predominantly dark gray shale, soft, weakly indurated, micromicaceous, with abundant pyritized worm borings. Although the section from 3680' to 3810' was logged as dolomite (mudstone), Core No. 1 from 3810' to 3820' revealed the section to be the soft dark gray shale just described.

Torok Formation: 4265-6896'

Sediments from 4265' to 6896' are identified as the Torok Formation, with the upper limit being based primarily on paleontological evidence. The Nanushuk-Torok contact is gradational and indefinite in this (and other) wells. In this report the top of the Torok is placed at the first occurrence of a definite Aptian assemblage. There is, however, some lithologic evidence for placing the top of the Torok higher. The faunal assemblage down to 5180' indicates an inner to middle neritic depth, with fluctuating turbidity. These sediments are Early Cretaceous, Late Aptian to Early Albian (AWA F-10 zone).

Core No. 2, taken from 4994' to 5004', recovered a shale with cross-laminated sandstone. The shale is dark gray, firm, moderately well indurated, very thinly laminated, micromicaceous, and pyritic. Sedimentary structures observed include cut-and-fill cross-laminations, small scale ripple cross-laminations, and some possible bioturbation. The sandstone is light medium gray, fine to very fine grained, subangular to subrounded, poorly to moderately well sorted, predominantly quartz with some rock fragments, and slightly calcareous.

From 5180' to 6890', the environment of deposition, based on the paleontological report, is open marine, and possibly basal slope. These sediments are Early Cretaceous, Aptian in age (AWA F-11 zone). Sample examination down to 6490', revealed no appreciable difference in the sediments. Core No. 3, taken from 5871' to 5881', contains essentially the same lithology as Core No. 2, except that the sediments are more indurated, and display fewer sedimentary structures.

A slight increase in sandstone content occurs between 6490' and 6610', along with gas shows from the flowline. From 6610' to 6970', the lithology contains lesser amounts of sandstone. A few thin sandstone beds were logged between 6857' and 6887', with an observed "drilling break". The DIL showed no sands to be present in this interval and the 4 sidewall cores taken within this interval confirmed the absence of sandstone.

Caving of the hole apparently occurred, coincidentally, with an increased penetration rate. From 6770' to 6890', light greenish-gray tuff was observed in the samples.

"Pebble Shale": 6896-7137'

The top of the radioactive "Pebble Shale" is at 6896', based on the Gamma Ray Log. This is the "hot zone" of marked increase in radioactivity of the shales. It should be noted, however, that the paleontologic top for these Early Cretaceous Neocomian sediments (AWA F-12 to F-13 zones) is at 6970'. Additional support for placing the boundary at 6896' is an increase in interval transit time on the Sonic Log, the first occurrence of "greasy" and "waxy" organic shale, and the presence of free organic matter in the samples; however, rounded, frosted, floating quartz grains, usually indicative of the "Pebble Shale" were first observed at 6980'. Additional study is needed to resolve this conflict of faunal assemblage versus lithology and radioactivity.

A thin, poorly developed sandstone appears to be present on the DIL from 6920' to 6930', but its presence was not detected during sample examination. Maximum gas from the flowline was 1,357 units from this interval.

Continuous coring of the "Pebble Shale" began at 6992', in order to study its source rock potential. The coring continued into the Kingak Formation, with little change in lithology. Core No. 5 was composed of dark gray to black shale, very well indurated, very thinly laminated, blocky to slightly fissile, highly organic in part, with laminations of bitumen to 1 mm thick, and rare, brown shale, highly organic, bentonitic in part, with bright gold fluorescence and streaming pale yellow cut fluorescence.

Also present, were abundant laminations of greenish-gray tuff from 1 mm to 5 mm thick, one bentonite bed 1/2" thick, pyrite spheres, some soft, plastic, tarry residue with pale yellow cut fluorescence, and rare, rounded, frosted, floating quartz grains up to 0.5 mm. Throughout the drilling and coring operations, these quartz grains were very rarely observed in the field, although the paleontological report states that they range from common to abundant. This is due, primarily, to the method of sample preparation for paleontological examination.

Everywhere throughout the "Pebble Shale" were worm borings and trails, which had been replaced primarily by marcasite and minor pyrite.

Beginning at 7058', thin beds of moderate brown claystone were occasionally present. These continued to the base of the interval, while tuff and bentonite ceased to be present.

The environment of deposition, indicated by the faunal assemblage in the "Pebble Shale" is middle neritic to upper bathyal, clear water. If the thin

laminations, identified as tuff, do represent ash falls, then there must have been reasonable proximity to volcanic activity throughout Neocomian and Early Aptian time.

JURASSIC

Kingak Formation: 7137-7395'

The top of the Kingak Formation was encountered at 7137'. The well was still drilling in the Kingak Formation at the time operations ceased at 7395'. Continuous coring was still underway through Core No. 16 at 7230'. At the time Core No. 9 was taken from 7136' to 7140', pelecypods and other megafossils were noted in the uppermost portion. Since there was no obvious discontinuity within the core, and no distinctive lithologic changes, the formational boundary was not detected. A change in the electrical and radioactivity logs occurs at 7148', which might appear to be the top of the Kingak. In view of all of the data, the top should more properly be called at 7137', where the first change in the logs occurs. When paleontologic confirmation of Jurassic fauna was confirmed, drilling operations were terminated, and a final core, No. 17, was taken from 7385' to 7390' (later revised to interval 7390-7395' due to a 5-foot wireline correction).

The Kingak Formation is medium to dark gray shale, very well indurated, thinly laminated to very thinly laminated, predominantly blocky, rarely subfissile, organic, contains pyritized worm trails and borings, pelecypods, ammonites, and ironstone concretions.

The Kingak Formation is Late Jurassic Oxfordian (AWA F-16 zone). The environment of deposition is middle neritic to upper bathyal.

STRUCTURE

With few exceptions, measured and observed structural dips are quite low. Measured structural attitudes were provided by the Schlumberger Four Arm High Resolution Dipmeter, while observed structural attitudes were provided by conventional cores. Other structural information is by inference from other sources.

Dipmeter data starts at 2628' within the Nanushuk Group. Within the sandstone and shale section from 2628' to 3450', the dips are 2°, or less, in a generally northeasterly direction. The actual bedding data are masked, however, by the apparent crossbeds with azimuths ranging clockwise, from northwest to south. From 3450' to 3660', dips range from 1° to 2° and are consistently to the northeast. From 3660' to 3870', dipmeter data are of poorer quality, although nothing on the suite of logs, or from sample examination, indicates a reason for this. A core taken from 3810' to 3820' reveals bedding which is perpendicular to the wellbore (flat-lying beds).

From 3870' to 4100', the dipmeter data are of better quality, with consistent east-northeast azimuths, but the magnitude of dip averages

between 6° and 8°. Dips average 2° down to 4130', where a probable fault exists. The dips then increase to 6°, then to 8° again, throughout the Nanushuk Group.

Dips within the Torok Formation are mostly erratic, but azimuths are in a general northeast direction down to 4440'. Here the quality improves considerably, assuming a nearly easterly azimuth, with dips diminishing in magnitude from 6° at 4440' to 3° at 4650'. No useable data are recorded until 5100', although a northeast azimuth is indicated. A core taken from 4994' to 5004' reveals abundant cross-bedding, slump structures and fractures, with the bedding planes dipping at a 15° angle to the wellbore. This is the probable cause of the random events which provide no useable data.

From 5100' to 5400', the dips range from 1° to 6°, but the azimuth is southwest. The dips from 5400' to 5600' are in a low enough range that they do not provide adequate azimuth data. From 5600' to 5650', dips suggest foreset beds dipping generally to the east, or a fault within the sediments at 5655'. Either interpretation is compatible with the geologic framework of the Torok Formation. Calcite fragments from fracture healing have been logged within this interval, strengthening the case for faulting.

Dips are generally less than 2° down to the base of the Torok at 6890', and are mostly of good quality except between 5910' and 5960', 6080' to 6095', 6190' to 6210' and 6410' to 6445'. Cores taken from 5871' to 5881' and from 6698' to 6708', revealed dips perpendicular to the wellbore. The core dips correlate quite well with the dipmeter data.

Dips within the "Pebble Shale" are between 1° and 2°, with a northeast azimuth down to 7030'. At this point, the dips remain low, but their azimuths vary widely. Continuous coring revealed horizontal bedding, with no fracturing, to a depth of 7080', except for the vertical fractures due to the mechanics of coring. At 7080', slickensided surfaces were observed, with beds at a 5° angle to the wellbore. Coring through the remainder of the "Pebble Shale" revealed the presence of fractures, but essentially horizontal bedding.

Below the Jurassic-Cretaceous unconformity at 7137', the Kingak Formation displays dip values that appear to be random events down to 7250'. At that point, the data appear to be arranged in patterns, or sets, that have a southeast to east trend. These might be foreset beds within the silty shales.

OIL AND GAS INDICATIONS

While drilling operations were underway, the cuttings and drilling mud were monitored constantly for indications of oil and gas. Except for periods of malfunction, the flowline was monitored for the presence of total gas, and the chromatograph sampled this gas at regular intervals to determine the component fractions present. A portion of the ditch samples were also agitated in a blender, and the total gas and its components were again measured.

The well cuttings were examined by microscope and were placed under an ultraviolet light to detect visible hydrocarbons. Chloroethane was used as a solvent for dissolving traces of hydrocarbons which were not naturally visible.

A complete suite of logs was run after drilling ceased, which included DIL, BHC/GR, FDC/CNL/GR. These were used to compile the SARABAND log for the interval from 2606' to 7373'.

These methods and procedures were considered adequate to have detected the presence of any significant amounts of hydrocarbons. This well, however, did not encounter any significant hydrocarbons. Indications of oil were confined to four reports of weak fluorescence, or weak cut fluorescence, which was probably from dead oil or organic matter.

A minor show of gas was reported at 2510' in the Nanushuk Group, but a potential reservoir was not apparent from the logs. Gas shows of the high pressure, low volume type, were encountered near 6500', 6550', and 6600', near the base of the Torok Formation. Total gas from these intervals was 920, 1,380, and 1,380 units, respectively. Components were C_1 through C_4, with over 500,000 ppm of C_1 being measured on the lower two zones. Adequate reservoir rocks were not present, however. The gas from near 6600' is associated with a poorly developed sandstone, that is shown on the SARABAND to have a slight amount of residual hydrocarbons.

A similar gas show was encountered in the Pebble Shale Formation at 6920', where 1,357 units of gas were recorded. C_1 through C_4 were present, with C_1 comprising 240,000 ppm. No reservoir can be inferred from sample examination or log analysis. This gas probably came from fractures.

CONCLUSIONS

1. This test well was drilled to the prognosed objective horizon.

2. The objective Kuparuk River sandstones were not present at this location.

3. The concept of a velocity anomaly arising from channeling of these objective sandstones has been found to be invalid.

4. Additional prospects probably cannot be developed on this concept in this area.

5. The hydrocarbon potential of this test was fully evaluated.

6. The North Kalikpik Test Well No. 1 is a dry hole.

PERTINENT DATA AND APPENDICES

SUMMARY OF PERTINENT DATA*

WELL NAME:	North Kalikpik Test Well No. 1
API NO.:	50-103-20011
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	2766' FNL, 2593' FWL (SW 1/4), protracted Section 3, T13N, R2W, Umiat Meridian, North Slope, Alaska
COORDINATES:	Latitude: 70°30'33.023"N Longitude: 152°22'04.169"W X = 699,455.87 Y = 6,038,525.13 Zone 5
ELEVATION:	40 feet Kelly Bushing; 15 feet Ground
DATE SPUDDED:	February 27, 1978
TOTAL DEPTH:	7395' Driller; 7394' Schlumberger
DATE TOTAL DEPTH REACHED:	April 8, 1978
RIG RELEASED:	April 14, 1978
CASING:	20" @ 103' 13-3/8" @ 2603'
STATUS:	Plugged and abandoned

LOGGING RECORD:

DIL/SP	105-2609'
	2604-7388'
BHC/GR	106-2609'
BHC/GR/CAL	2604-7378'
CNL/FDC/GR/CAL	2604-7393'
HDT	2604-7392'
HDT Arrow Plot	2628-7391'
Saraband	2606-3500'
	3500-5100'
	5100-7372'
Mudlog	100-7395'
Geologist's Lithology Log	80-7395'
Birdwell Velocity Survey	140-7400'

SIDEWALL CORES: **	Run No. 1 & Run No. 2, 76 shot, 70 recovered

CONVENTIONAL CORES:

No.	Interval	Recovery	Rock Unit
1	3810-3820'	10'	Nanushuk
2	4994-5004'	10'	Torok
3	5871-5881'	8'	Torok
4	6698-6708'	10'	Torok
5	6992-7026'	34'	"Pebble Shale"
6	7026-7047'	21'	"Pebble Shale"
7	7047-7107'	60'	"Pebble Shale"
8	7107-7136'	29'	"Pebble Shale"
9	7136-7140'	4'	"Pebble Shale" and Kingak
10	7140-7161'	21'	Kingak
11	7161-7163'	2'	Kingak
12	7163-7165'	2'	Kingak
13	7165-7167'	2'	Kingak
14	7167-7197'	30'	Kingak
15	7197-7225'	28'	Kingak
16	7225-7230'	3'	Kingak
17	7390-7395'	5'	Kingak

WELLSITE GEOLOGISTS: D. O. Bossort
Arlen Ehm

WELL LOG ANALYST: Armour Kane

DRILLING CONTRACTOR: PARCO, Rig 96

MUDLOGGERS: Geoservices

BIOSTRATIGRAPHIC ANALYSIS: Anderson, Warren & Associates, Inc.

* Copies and/or reproducibles of all geologic 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, paleo, and geochemical.

NORTH KALIKPIK TEST WELL NO. 1
DRILL CUTTINGS AND CORE DESCRIPTIONS
BY
D. O. BOSSORT - 80-4994'
ARLEN EHM - 4994-7395'

DRILLED DEPTH (FEET BELOW KELLY BUSHING)	
0- 80	No recovery.
80- 110	Sand; loose grains of Quartz, Chert, and mineralized Argillite: medium to coarse grained, with occasional pebbles, frosted to polished, pyrite common.
110- 170	Sample missing.
170- 200	Sand: loose, as above; shell fragments common.
200- 260	Shale-Clay: light gray, soft, chunky, pyrite abundant, trace of wood fragments with loose Sand: as above.
260- 410	Shale-Clay: light gray, soft, chunky, pyrite abundant, pyritic worm borings common.
410- 530	Shale: as above, becoming light to medium gray in part with trace of bentonite and coal.
530- 860	Sample missing.
860- 980	Sample not useable; few coarse cavings, light to medium gray shale.
980-1010	Calcite: white, coarse crystalline, with Siltstone: light gray, sandy in part, calcareous cement, occasional pyrite; grades to very fine grained sandstone in part; trace of large shell fragments, pyrite, and buff mudstone.
1010-1100	Calcite and Siltstone: as above, with Sandstone: light to medium gray, very fine to fine grained quartz and carbonaceous material, poorly sorted, slightly calcareous, tight, no show; Shale: medium brownish-gray, very carbonaceous, slightly silty, trace of Mudstone: buff, dolomitic, trace of pyritic shell fragments, pyritic worm borings.
1100-1160	Shale: dark brown, bituminous and carbonaceous, soft, silty in part, fissile in part, with Siltstone and Sandstone: as above; trace of calcite, shell fragments, mudstone and pyrite.

1160-1190	Sandstone: light gray, salt and pepper, fine to medium grained, subangular quartz, chert and carbonaceous grains, very calcareous, well cemented, tight; no shows, with Shale and Siltstone: as above; trace of Calcite and Mudstone: as above.
1190-1400	Sandstone: light gray, salt and pepper, mottled, buff in part, medium to coarse grained, subangular to subrounded, quartz and chert grains with occasional black carbonaceous grains and rare glauconite grains, calcite and siderite cement, well cemented, tight, no show; trace of lignite coal, and buff dolomitic mudstone.
1400-1430	Sandstone: light gray, salt and pepper, very fine to fine grained, subangular quartz and chert grains, calcite cement, trace of Siderite: well cemented, tight, no shows.
1430-1460	Sample missing.
1460-1490	Shale: dark brown, bituminous to carbonaceous, soft, grades to "dirty" lignite in part, with Shale: light gray, soft, micaceous, chunky to fissile.
1490-1580	Shale: light gray, as above.
1580-1610	Sandstone: light to medium gray, salt and pepper, very fine to fine grained, subangular quartz; chert; carbonaceous, and occasional Glauconite grains: calcareous, well cemented, tight, no shows, with Shale: light gray, silty, chunky, micaceous in part.
1610-1670	Shale: light gray, chunky, very silty to very finely sandy in part and with fine texture, micaceous in part, moderately indurated, with Sandstone: as above.
1670-1730	Shale and Sandstone: as above, with Shale: medium gray, smooth, "waxy", soft, occasionally calcareous.
1730-1760	Shale: light gray, as above.
1760-1850	Shale: as above, with Limestone: medium gray, very finely granular, dense, very finely silty, argillaceous.
1850-1970	Shale: as above, becoming calcareous in part with Limestone: as above.
1970-2030	Sandstone: light gray, salt and pepper, trace of ferric oxide stain, very fine to fine grained, subangular; quartz, chert, carbonaceous, and Glauconite grains: calcareous, trace of Siderite: well cemented, tight, no show, with trace of Mudstone: light buff to reddish-brown, dolomitic, trace of shell fragments, and pyrite.

2030-2090	Sandstone: medium gray, very fine grained to silty quartz and very fine to fine grained carbonaceous material, very calcareous, well cemented, tight, no show, with Limestone: medium dark gray, very fine grained, dense, very silty, argillaceous.
2090-2270	Sandstone: light to medium gray, salt and pepper, very fine to fine grained quartz, chert, and carbonaceous grains, calcareous, well cemented, tight, no show, with Sandstone: medium gray, as above.
2270-2300	Shale: medium to medium dark gray, silty, micaceous in part, with Shale: medium dark gray, very calcareous, silty.
2300-2420	Sandstone: medium gray, very fine grained, with Siltstone: very calcareous, well cemented, quartz and carbonaceous grains, with Shale: light to medium gray, soft, silty.
2420-2510	Sandstone and Shale: as above, with Shale: medium gray, silty.
2510-2540	Sandstone: gray, fine grained to silty quartz and carbonaceous grains, poorly sorted, calcareous, poorly cemented, fair porosity, trace of very spotty oil stain, spotty, very weak yellow fluorescence; gas show on gas detector.
2540-2615	Sandstone: light to medium gray, salt and pepper, very fine to fine grained, subangular quartz, chert, and carbonaceous grains, very calcareous, poorly sorted, moderately well cemented, tight. No show.
2615-2690	Shale: medium gray, soft, chunky; trace of pyritic worm borings, rare calcareous worm tubes.
2690-2720	Siltstone: medium gray, sandy, slightly calcareous, with Shale: as above, fossiliferous, calcareous worm tubes common, abundant pyrite, trace of pyritic worm borings.
2720-3020	Shale: medium to light gray, soft, chunky, silty in part, slightly calcareous in part, pyrite common, occasional calcareous worm tubes, occasional pyrite worm borings, very thin limonitic laminations common, with Siltstone: as above.
3020-3290	Mudstone: light gray to light gray-buff, sharp irregular fracture, moderately well consolidated, with Shale and Siltstone: as above; pyritic worm borings, calcareous worm tubes, limonitic laminations, all as above.

3290-3350	Sandstone: gray, very fine grained to silty, argillaceous, poorly sorted, poorly consolidated, poor porosity, no stain, no fluorescence, very weak yellow fluorescent cut, with Mudstone, Shale, and Siltstone: as above; trace of pyrite and calcareous worm tubes, as above.
3350-3410	Sandstone: as above, grading to Siltstone: gray, sandy, argillaceous, poorly sorted, moderate to poorly consolidated, calcareous, tight, no show.
3410-3560	Sandstone: gray, very fine grained to silty, quartz, chert, and mineralized carbonaceous grains, very calcareous, well cemented, tight, no shows.
3560-3620	Sandstone: as above, grading to siltstone, with Shale: gray, soft, silty, rare, calcareous worm tubes and pyritic worm borings, pyrite abundant.
3620-3680	Shale: medium dark gray, soft, silty in part, with Sandstone and Siltstone: as above, pyrite abundant, rare, calcareous worm tubes.
3680-3710	Dolomite: medium gray-buff, silty, slightly calcareous, with Shale: as above, becoming calcareous in part, silty, pyrite common, occasional calcareous worm tubes.
3710-3810	Dolomite: buff, slightly calcareous, silty, irregular fracture, well consolidated; abundant pyrite and pyritic worm borings, occasional calcareous worm tubes; trace of Shale: bluish-gray, soft, fine texture, smooth; trace of Claystone: very light gray, soft, bentonitic, micaceous, with Shale: as above, becoming calcareous.
3810-3820	<u>Core No. 1, Cut 10', Recovered 10'</u>
	3810.0-3820.0' (10.0') — Shale: dark gray, soft, weakly indurated, very finely silty, micromicaceous, abundant pyrite, worm borings.
3820-4220	Shale: dark gray, as above.
4220-4310	Samples 99% contaminated with walnut hulls; trace of Shale: as above.
4310-4340	Shale: as above.
4340-4370	Sandstone: light gray, salt and pepper, very fine to medium grained, subangular to subrounded quartz,

chert, and black carbonaceous grains, altered glauconite(?), silty, poorly sorted, slightly calcareous, moderately consolidated, tight, no show.

4370-4625 Shale: dark gray, moderately indurated, very finely, silty, micromicaceous, trace of pyrite and pyritic worm borings.

4625-4994 Shale: as above, becoming moderately well indurated, pyrite rare.

4994-5004 Core No. 2, Cut 10', Recovered 10'

4994.0-5004.0' (10.0') Shale: dark gray, firm, moderately indurated, very thinly laminated, micromicaceous, especially along laminations, trace of pyrite, occasional sandstone in laminations, cut-and-fill laminations, and some scattered replaced cross-laminations; sandstone is predominantly Quartz: fine to very fine grained, subrounded to subangular, some medium crystalline fragments, moderate to poorly sorted, slightly calcareous; abundant small scattered "faults" from apparent slumping, some possible bioturbation or turbation from expulsion of water or gas; abundant large, scattered fractures at approximately 30° to 45° to wellbore; bedding planes dip at 15° angle.

5004-5070 Shale: as in Core No. 2.

5070-5090 Shale: as above, but becoming silty in part.

5090-5120 Shale: as above, with Sandstone: becoming glauconitic and containing carbonaceous fragments; contains tarry residue, gives off pale yellow cut residue when heated.

5120-5210 Shale and Sandstone: as above, with a trace of black, vitreous mineral with conchoidal fracture, resembling subbituminous coal, no show, but has milky-white streaming cut fluorescence.

5210-5240 Shale with minor Sandstone: as above, with possible crinoid fragment, rare calcite fragments, and possible manganese pellets.

5240-5290 Shale and minor Sandstone: as above, with a trace of clear to translucent quartz grains, surface pitted in part.

5290-5330	Shale and minor Sandstone: as above, with a trace of dense, calcareous mineral (siderite?).
5330-5380	Shale and minor Sandstone: as above, with unidentified fossil, and with a trace of weathered, frosted quartz grains and a trace of translucent quartz grains.
5380-5440	Shale and minor Sandstone: as above, with a trace of calcite, probably from fracture lining, and with a trace of translucent quartz grains, as above.
5440-5680	Shale and minor Sandstone: as above, with traces of translucent quartz grains, as above, and with a trace of brown, dense calcareous mineral (siderite?).
5680-5871	Shale: as above, but becoming more silty.
5871-5881	Core No. 3, Cut 10', Recovered 8'

5871.0-5879.0' (8.0')	Shale: dark gray, very well indurated, very thinly laminated, micromicaceous, especially along laminations, trace of pyrite; interlaminated shaly Siltstone: medium gray to dark gray, micromicaceous, interlaminated Sandstone: fine to very fine grained, light gray to medium gray, poorly sorted, predominantly quartz with some rock fragments, calcareous in part; sandstone is cut-and-fill, cross-laminated, and small scale ripple cross-laminated; bedding planes normal to the wellbore.
5879.0-5881.0' (2.0')	No recovery.

5881-5990	Shale, Siltstone, and Sandstone: as in Core No. 3.
5990-6050	Shale, Siltstone and Sandstone: as above, with a trace of very fine grained quartz grains and carbonaceous fragments in soft, tan, clay matrix.
6050-6200	Shale, Siltstone and Sandstone: as above, with a slight increase in sandstone.
6200-6300	Shale, Siltstone and Sandstone: as above, with shale chips becoming splintery.
6300-6370	Shale, Siltstone and Sandstone: as above, with a trace of tan, firm claystone.

6370-6490	Shale, Siltstone and Sandstone: as above, with a slight increase in sandstone.
6490-6605	Sandstone: moderate brown, light gray and medium gray, fine to very fine grained, predominantly subangular to subrounded quartz and rock fragments, some carbonaceous fragments, poorly to moderately porous; some interlaminated tarry substance, which gives off bright yellow cut fluorescence when heated; predominantly interlaminated clayey shale and shaly Siltstone: as above; rare pyrite, no odor, stain, cut, or fluorescence; gas show in detectors.
6605-6698	As above, with decrease in sandstone content, no odor, stain, cut, or fluorescence.
6698-6708	Core No. 4, Cut 10', Recovered 10'
6698.0-6708.0' (10.0')	Shale: dark gray, very well indurated, very thinly laminated, micromicaceous, especially along laminations, trace of pyrite; interlaminated shaly Siltstone: medium gray to dark gray, micromicaceous; interlaminated Sandstone: fine to very fine grained, poorly sorted, predominantly quartz with some rock fragments, calcareous in part; sandstone is present as laminations, cut-and-fill cross-laminations, small scale ripple cross-laminations; shale parts easily in "poker chip" pieces; sandy parts are very hard and part with difficulty; bedding planes normal to well-bore; no show, slight odor on breaking. (NOTE: Sandstone is about 10% of entire core.)
6708-6860	Sandstone, Siltstone, and Shale: as above; trace of Limestone(?); light greenish-gray tuff with bright gold mineral fluorescence; trace of very thinly laminated, carbonaceous sandstone; increase downward in pyrite.
6860-6890	Tuff: buff and light greenish-gray, becoming common; first appearance of black vitreous organic matter, which gives pale straw cut fluorescence; trace of siderite(?); Sandstone: as above, increasing in abundance, becoming thin bedded, increasing amounts of fine grained sandstone, less of the very fine grained fraction; Shale: very finely laminated, with dark laminations of mica and organic matter.

6890-6992	Tuff: as above, and organic Shale: as above, increasing downward in abundance; trace, only, of sandstone; show of gas at 6920-6930'.	
6992-7026	Core No. 5, Cut 34', Recovered 34'	
	6992.0-7026.0' (34.0')	Shale: dark gray to black, organic in part, rare brown shale with bright gold fluorescence and streaming pale yellow cut fluorescence; bitumen in laminations; some tarry residue with pale yellow cut fluorescence; bentonite in minor amounts, one bed 1/2" thick; abundant greenish-gray tuff in laminations 1-5" thick; pyrite; very rare rounded, frosted quartz grains; core bleeding as from fractures, no odor, stain, cut or fluorescence.
7026-7047	Core No. 6, Cut 21', Recovered 21'	
	7026.0-7047.0' (21.0')	Shale: brown and dark gray to black, as in Core No. 5, but with increasing amount of brown, organic shale, which fluoresces as in Core No. 5; rare tuff, bentonite, and pyrite; some tarry residue as in Core No. 5; one pebble of chert, 1/2" in diameter, near the top; one sandstone clast, 1" x 2", near base; odor of crude oil on breaking core; no stain, cut, or fluorescence.
7047-7107	Core No. 7, Cut 60', Recovered 60'	
	7047.0-7107.0' (60.0')	Shale: dark gray to black, as above, pyrite and marcasite common as replacements of worm borings and fecal matter; a few thin beds of moderate brown claystone, to 12" thick; shale is blocky to fissile; no odor, stain, cut, or fluorescence.
7107-7136	Core No. 8, Cut 29', Recovered 29'	
	7107.0-7136.0' (29.0')	Shale: as above, with minor claystone, and trace of pyrite and marcasite; no odor, stain, cut, or fluorescence.

7136-7140	Core No. 9, Cut 4', Recovered 4'	
	7136.0-7140.0' (4.0')	Shale: as above, with argillaceous siltstone and silty claystone; calcareous, fossiliferous, brachiopods(?); no odor, stain, cut, or fluorescence.
7140-7161	Core No. 10, Cut 21', Recovered 21'	
	7140.0-7161.0' (21.0')	Shale: medium gray to dark gray, very well indurated, thinly laminated to very thinly laminated, predominantly blocky, rare subfissile, slightly micromicaceous; minor organic Shale: as above; some pebbles (concretions?), to 1" in diameter, possible ammonite at 7146', possible pelecypod at 7152'.
7161-7163	Core No. 11, Cut 2', Recovered 2'	
	7161.0-7163.0' (2.0')	Shale: dark gray, rare dark brown-gray, organic, pyrite worm trails, one ironstone concretion, 2" x 3", light brown to tan, highly calcareous with brown dolomite? vein filling; one quartzite cobble, 2" x 4".
7163-7165	Core No. 12, Cut 2', Recovered 2'	
	7163.0-7165.0' (2.0')	Shale: dark gray, rare dark brown-gray, organic, pyrite worm trails, trace of marcasite.
7165-7167	Core No. 13, Cut 2', Recovered 2'	
	7165.0-7167.0' (2.0')	Shaly Mudstone: dark gray, dark brownish-gray in part, organic, very well indurated, pyritized worm trails; ammonite at 7167'; no stain, cut, or fluorescence; odor on breaking core.
7167-7197	Core No. 14, Cut 30', Recovered 30'	
	7167.0-7197.0' (30.0')	Shaly Mudstone: as above, ammonite at 7197'; no stain or cut, slight cut fluorescence, odor on breaking.

7197-7225	Core No. 15, Cut 28', Recovered 28'	
	7197.0-7225.0' (28.0')	Mudstone: dark gray to black and dark brownish-gray, organic, very well indurated, pyrite worm trails and borings, very thinly laminated, but parts difficultly, large pelecypod at 7206'; some pelecypods at 7210'; no show; gas show of 1,150 units from fracture at 7220'.
7225-7230	Core No. 16, Cut 5', Recovered 3'	
	7225.0-7228.0' (3.0')	Mudstone: as above; some subfissile in part, very slightly micromicaceous; possible brachiopod at 7225'; very slight pinpoint bubbles from some parts.
	7228.0-7230.0' (2.0')	No recovery.
7230-7340	Shaly Mudstone: dark gray to black, as above, minor interlaminated Siltstone: moderate brown.	
7340-7385	Clay: gray, soft, sticky; Sandstone: moderate brown, fine to very fine grained, poorly sorted, slightly calcareous, and Sandstone: medium gray, fine to very fine grained, poorly sorted, possible oil stain (residual); Siltstone: brown, argillaceous, interlaminated; and Shale: gray, soft, clayey; all rock units appear interlaminated to interbedded.	
7385-7390	Core No. 17, Cut 5', Recovered 5'	
	7385.0-7390.0' (5.0')	Shaly Mudstone: dark gray to black and brown-gray; pyrite, ironstone concretion with calcite centers; no odor, stain, cut, or fluorescence; core bleeding pinpoint gas bubbles along fractures.

(Depth corrected from steel-line measurement to 7390-7395'.)

Total Depth: 7,395 feet.

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:

Final logs were run on North Kalikpik Test Well No. 1 on April 9 and 10, 1978. Schulmberger ran Dual Induction Laterolog, Neutron-Density, Compensated Sonic and Dipmeter plus Birdwell velocity survey and sidewall cores. Log quality was generally good although some equipment failure was experienced which did not result in significant amounts of lost rig time. 70 out of 76 sidewall cores were recovered which is remarkable considering the badly washed out hole which reached such dimensions that the Density log read nothing but the mud column in places. Caliper scaling on the Density is 10" to 20" but the bit-size line of 12-1/4" is based on an 8" to 18" caliper scale and so should be ignored.

Correlative log tops were: Torok, 3450; Pebble Shale, 6896; and Kingak, 7148. Correlations were very good with the Atigaru Point, Fish Creek and Teshepuk Lake wells. Very little sand was present below the Torok with the exception of about 22 feet of very shaly sand from 6584 to 6606 and from which there is no possibility of production. There were absolutely no zones of interest.

Very truly yours,

Armour Kane

Armour Kane

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

LOGGING REPORT

WELL NAME North Kalikpik Test Well No. 1

Date April 9 - 10, 1978 Driller Depth 7395'

Elevation 40 ft. K.B. Logger Depth 7394'

Logs Run and Intervals

Dual Induction-Laterolog	2604-7394'
Neutron-Density	2604-7394'
Compensated Sonic	2604-7384'
Dipmeter	2604-TD

Additional Logs to Run

Zones of Interest

Depth	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
No zones of interest.					

Discussion:

Log Tops & Correlations:

	N. Kalikpik	Fish Creek	Atigaru
Torok	3450'	3710'	4160'
"Pebble Shale"	6896'		
Kingak	7148'	7275'	7275'

Additional Evaluation Plans:

A. Ehm
Wellsite Geologist

A. Kane
Log Analyst

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