NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

LISBURNE TEST WELL NO. 1

HUSKY OIL NPR OPERATIONS, INC.
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For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
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COMPOSITE LITHOLOGY LOG (In pocket)

GEOLOGIC SUMMARY

INTRODUCTION

The Lisburne Test Well No. 1 is located in the SE 1/4 of protracted Section 17, T11S, R16W, Umiat Meridian (see Figures 1 and 2). The location is in the southern portion of the National Petroleum Reserve in Alaska and is situated just north of the Brooks Range. Drilling of the well commenced on June 11, 1979. The well was plugged and abandoned on June 2, 1980, and the rig released. There was a suspension of operations from August 23 to October 24, 1979, due to a labor dispute between Nabors Alaska Drilling and the Roughneck and Drillers Association. Total depth at the time of abandonment was 17,000 feet (driller).

PRE-DRILLING PROGNOSIS

The Lisburne Test Well No. 1 was designed to test the Lisburne Group carbonates on a closed anticlinal structure created by thrusting from the Brooks Range (Figure 3). The anticline is elongate in a generally east-west direction with the major thrust fault being located to the north and northeast of the well location. The major seismic closure, as interpreted in the original prognosis, was picked to occur at a depth of 6,150 feet. The prospect originally was chosen as a 15,000-foot well, and at that depth the Lisburne would have been penetrated a total of four times according to seismic interpretations. Figure 4 is a reproduction of a portion of seismic line AS-76-5 and illustrates the multiple plates expected to be encountered in drilling the well.

The primary objective of the Lisburne well was rocks of the Lisburne Group. Reservoir porosity within the Lisburne would depend upon either dolomitization of the limestone or on open fractures developed through structural movement and deformation.

POST-DRILLING SUMMARY

The Lisburne Test Well No. 1 was drilled to a total depth of 17,000 feet and bottomed in limestones of the Lisburne Group, Late Mississippian, Zones 12 to 13 (Mamet). The Lisburne Group of carbonates was penetrated five separate times instead of the originally predicted four penetrations. The reliability and interpretation of the seismic data were remarkably accurate. The five thrust plates which were encountered, instead of the four which were interpreted, can even be explained by the fact that the well was drilled 2,000 feet deeper than originally planned, and the final or fifth plate was encountered below the 15,000 feet total depth in the prognosis. The final thrust plate was penetrated at approximately 15,320 feet.

7.

There were several minor shows of gas in the well starting at 585 feet and continuing to a depth of 16,850 feet. All the gas shows were of little significance and occurred in rocks with poor reservoir quality. Four drill stem tests were conducted with the recovery of little or no formation fluid on two tests, the recovery of 71 barrels of water (3,100 ppm chloride) on the third test, and gas to surface, but progressively diminishing, on the fourth test. Since none of the yields on drill-stem tests was significant and since log, core and sample analysis were unfavorable, no further evaluation was undertaken.

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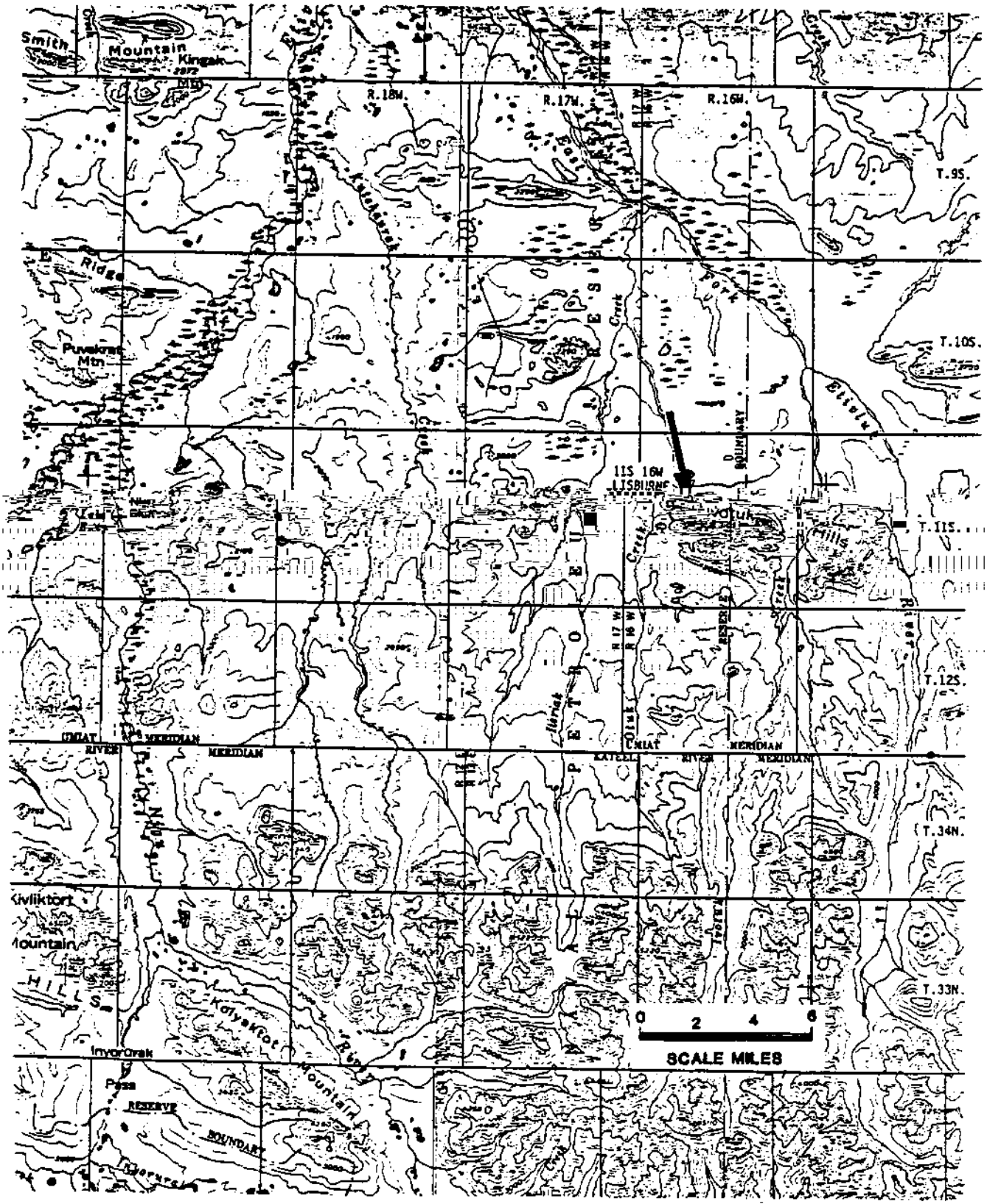
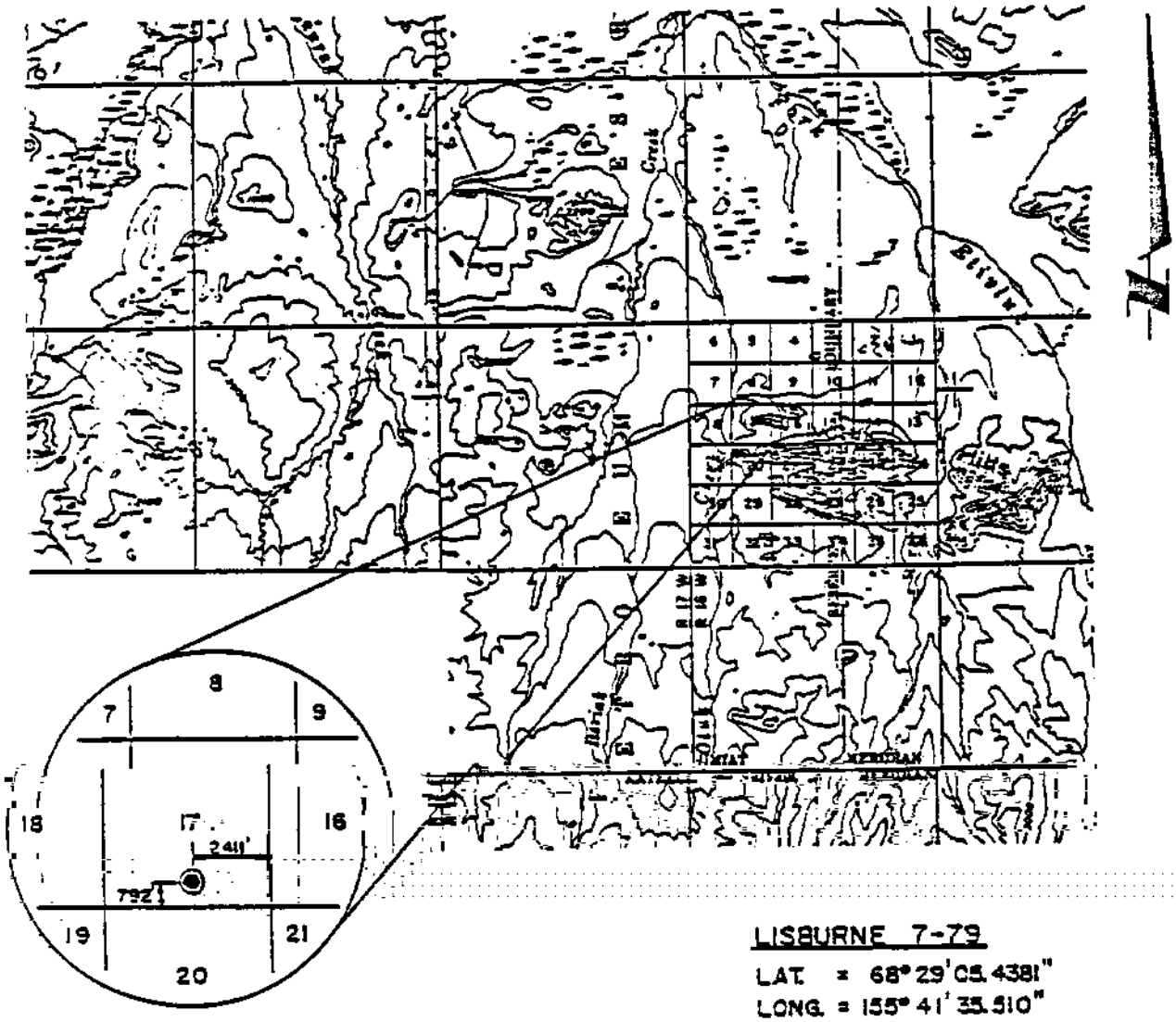


FIGURE 1
LOCATION MAP



LISBURNE 7-79

LAT = 68° 29' 05.4381"
LONG = 155° 41' 35.510"
Y = 5,296,127.35
X = 272,594.12
ZONE 5
ELEV.: 1834' PAD

0 2 4 6
SCALE MILES

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.

March 19, 1979

STATE OF ALASKA
49TH
JOHN H. HERRING
No. 953-S

AS STAKED

LISBURNE 7-79

SW¼ OF SE ¼ SEC. 17 T11S, R16W, UMIAT MERIDIAN, AK

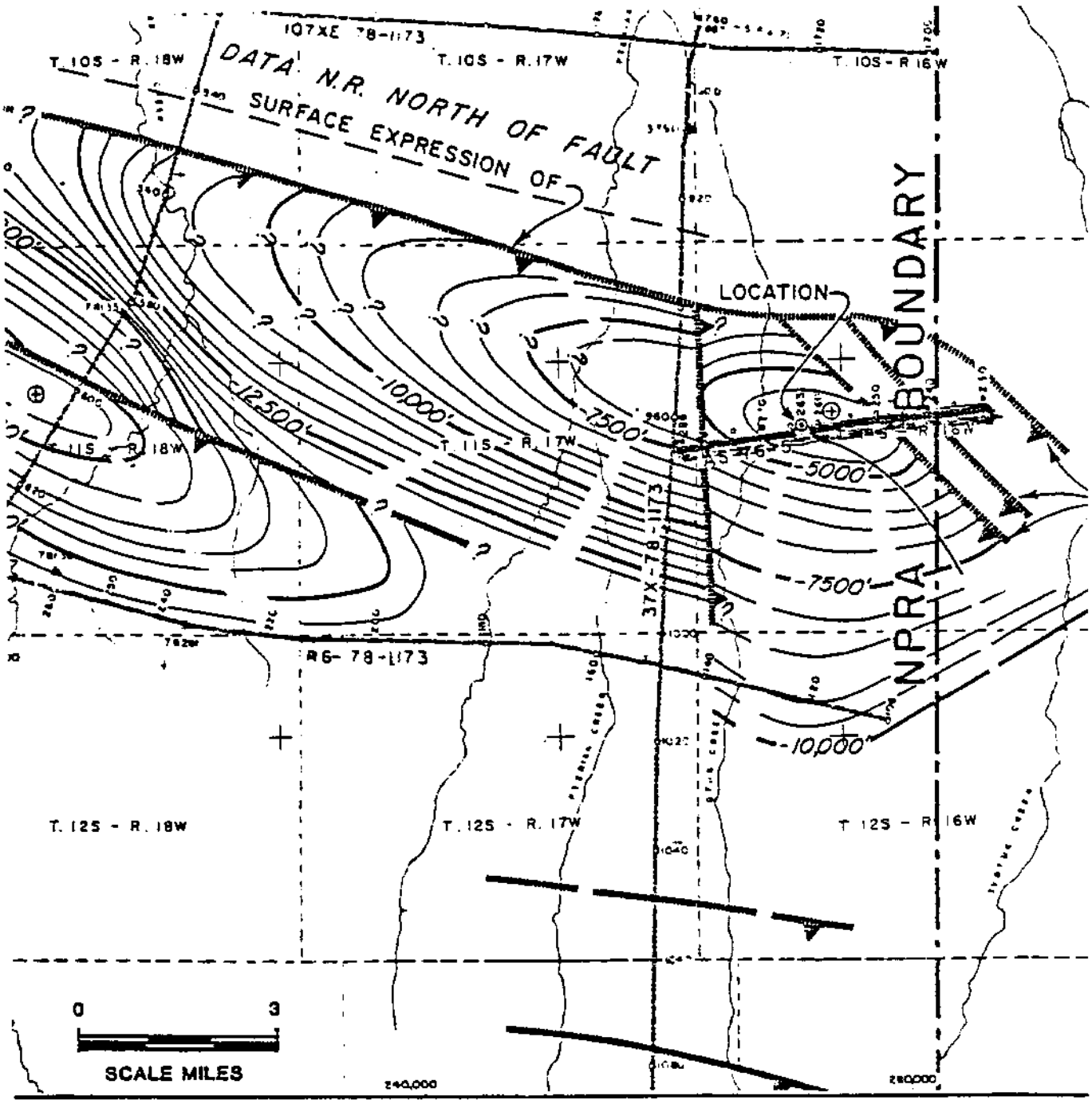
SURVEYED FOR

HUSKY OIL

N.P.R. OPERATIONS, INC.

Bell, Herring and Associates
ENGINEERS AND LAND SURVEYORS
3340 Arctic Blvd.
ANCHORAGE, ALASKA 99503

FIGURE 2
SURVEYOR'S CERTIFICATE



SHAPE MAP
(LISBURNE ?)

FIGURE 3
STRUCTURE MAP PROBABLE LISBURNE
Tetra Tech

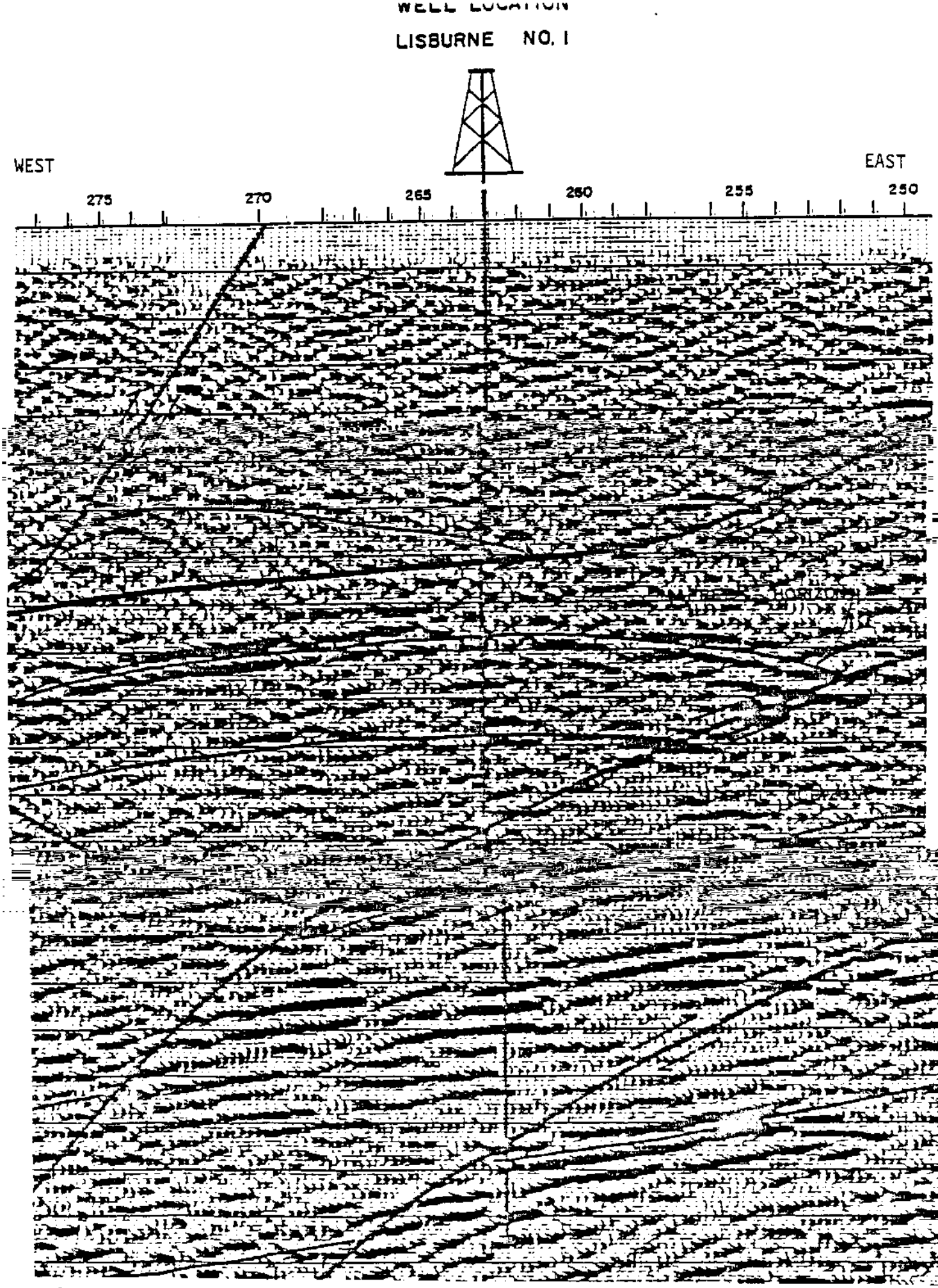


FIGURE 4 - A PORTION OF SEISMIC LINE AS-76-3 - LISBURNE TEST WELL NO. 1

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WELLSITE GEOLOGIST'S REPORT
BY
DAVID YOUNG

INTRODUCTION

Lisburne Test Well No. 1 was drilled near the northern edge of the Brooks Range in the southern part of the National Petroleum Reserve in Alaska. The test was drilled on a seismically defined structure with closure dependent on a thrust fault zone to the north and northeast and dips to the west, south, and east. The structural analog is the Rocky Mountain Overthrust Belt and the complexly thrusted Lisburne anticline is believed to be similar to this long structural trend. At Lisburne No. 1, five thrust plates were drilled with the well bottoming in Late Mississippian Lisburne Group limestone. No economic hydrocarbon deposits were encountered, although several small shows of gas were observed. Extremely low porosity was encountered in the objective Lisburne Group limestone. No abnormal geopressure conditions were encountered. A test for formation water at 7645-7662' yielded nearly fresh water (3,100 ppm chlorides).

STRATIGRAPHY

The stratigraphy of Lisburne Test Well No. 1 is complicated by a series of thrust plates which repeat the Lisburne Group five times. For this reason, the stratigraphy is discussed on a plate-by-plate basis.

PLATE 1: Surface - 8600'

The surface at Lisburne No. 1 is covered by tundra with surface rocks being Lisburne limestone float from the adjacent Ivotuk Hills (Lisburne Group outcrop). The well was spudded with a conductor pipe set at 130 feet. Sample control begins from that depth.

Torok and Fortress Mountain Formations undifferentiated: 130-2155'

The interval 130' to 2010' consists of an interbedded clastic sequence of marine siltstones, claystones, shales, and very fine grained sandstones. Colors range from gray to brown. The samples include rare occurrences of tripolitic chert, glauconite, and phosphate pellets.

From 2010' to 2155', a thick gray-green conglomeratic sandstone occurs which is of a type and description commonly found in exposures of the Fortress Mountain Formation.

Paleontological study of the cuttings by Anderson, Warren & Associates, Inc. indicates an age of Early Cretaceous (probable Aptian, Zone F-11). The samples suggest there is probable intertonguing of the Torok and Fortress Mountain Formations. The environment of deposition is thought to be open marine (possibly bathyal) based on type and distribution of fauna.

"Pebble Shale" equivalent: 2155-6940'

The interval 2155-6100' consists predominantly of interbedded gray shale and siltstone, with occasional thin partings of light gray and gray-brown, very fine grained, argillaceous sandstones. Rare patches of chert were also observed.

Age is determined to be Early Cretaceous (AWA Zones F-12 to F-13), with environment of deposition being open marine (probably basinal).

The interval 6100-6940' consists of interbedded dark gray and brown-gray organic shales and siltstones with a few beds of chert and siliceous shale. Thin stringers of argillaceous sandstone occur. Several radioactive shales occur in this interval which may be time equivalents of the "Pebble Shale" of the northern part of the NPRA.

Paleontological age determinations for the interval 2155-6940' assign an age of Jurassic to Early Cretaceous (Neocomian, undifferentiated). Environment of deposition is interpreted to be open marine (basinal), based on common radiolarians, rare agglutinated foraminifera, and lack of calcareous forms indicating probable deposition below compensation depths.

Shublik Formation: 6940-7408'

The Shublik is repeated in part or in its entirety in each of the five plates penetrated at Lisburne No. 1. The Anderson, Warren & Associates, Inc.'s study of the plates by M. B. Mickey breaks the sedimentary section in the Lisburne into eleven lithic units labeled A through K. Units C through F comprise the Shublik Formation. Unit C (6940-7000') is a tan, medium to dark brown argillaceous limestone or calcilutite. Unit D (7000-7210') is a dark gray-brown to black siliceous shale or siliceous, argillaceous limestone with conchoidal to subconchoidal fracture and rare shell impressions. Unit E (7210-7300') consists of a dark gray to black shale and dark gray to brown siltstone with local beds of medium gray shale with small phosphate pellets. Unit F (7300-7408') is composed of an interbedded sequence of dark brown siliceous shale, light greenish-gray siliceous shale and chert, in part with phosphate pellets, and a thin basal very fine grained, quartzose, glauconitic, silty sandstone.

Paleontological studies on the interval 6940-7210' indicate an age of Triassic (AWA Zone F-19) with depositional environment of outer shelf to foreslope and in part open marine. From 7210-7408', the age was determined to be Triassic-Permian (probable AWA Zones F-20 to F-21) with depositional environment of open marine (basinal). The AWA zone designation, if found to be correct, would place part of the Shublik down into the equivalent of the Sadlerochit and Lisburne Groups as far as age dating is concerned.

Lisburne Group: 7408-8600'

The Lisburne is informally subdivided into five lithic units labeled (downward) G through K in the Anderson, Warren & Associates, Inc.'s

report. Units G, H, I and J are present in all five plates, and Unit K is present additionally in Plates 3, 4, and 5.

Unit G (7408-8070') consists of two parts. The upper part (7408-7490') consists of limestone that is a tan-brown-white mottled, partly recrystallized bioclastic packstone-grainstone with common bryozoa, crinoids and spines. The lower part, from 7490' to 8070', is predominantly dolomite that is brown and tan mottled, fine to medium grained, recrystallized from wackestone and packstone with minor dark gray partly silicified lime mudstone or calcilutite. Nodular chert and chert replacement occur locally. Depositional environment is interpreted to be open platform to bank. The age is Late Mississippian (probable Mamet Zones 14 to 16).

Unit H (8070-8280') consists of brown and gray-brown, coarse grained mosaic-textured dolomite and limestone. The carbonates are partly silicified, locally with relict pellets and occasional crinoids. Environment of deposition is interpreted as open platform becoming restricted platform for the lower 60'.

Unit I (8280-8400') consists of brown glauconitic siltstone to fine-grained sandstone and dark gray-brown and dark gray to black shale. Depositional environment is interpreted as restricted platform, probably lagoonal.

Unit J (8400-8600') is composed predominantly of dolomite. The dolomite is dark brown, recrystallized, sucrosic, cherty packstone. The limestone is light gray to white, tan and brown mottled. Environment of deposition is open platform to bank. Age of the rocks from 8220' to 8600' is Late Mississippian (Mamet Zones 12 and 13).

At 8600', the first major thrust fault occurs and separates Plates 1 and 2.

PLATE 2: 8600-10,900'

Basal "Pebble Shale" equivalent and Shublik Formation, undivided: 8600-9670'

The lower part of Unit A described above lies at the top of Plate 2. Units B through F are fully repeated and lithologically very similar. The total thickness of these units expanded from 588' (Plate 1) to 850' probably owing to increased formation dip and folding as indicated by dipmeter data.

Lisburne Group: 9670-10,900'

Unit G (9670-10,330') is lithologically similar to that in Plate 1, but with a higher degree of silicification and less dolomitization present.

Unit H (10,330-10,540') is lithologically similar to that in Plate 1. The rocks are brown, medium to coarse grained, mosaic textured, recrystallized, partly silicified limestone and dolomite.

Unit I (10,540-10,690') in Plates 2, 3, and 4 differs considerably from Plates 1 and 5 (glauconitic siltstone, sandstone and shale), in being brown to black siliceous limestone and recrystallized wackestones and packstones, deposited in an open platform environment.

Unit J (10,690-10,900') is similar to that in Plate 1. The second major thrust fault is at a depth of 10,900'.

PLATE 3: 10,900-13,370'

Strata of Unit B lie at the top of Plate 3.

Units B through F (10,900-11,540') are consistent with Plates 1 and 2 with similar thickness, lithology, and log character.

Lisburne Group: 11,540-13,370'

Unit G (11,540-12,120') is more highly dolomitized than in Plates 1 or 2 with occasional crinoidal packstone relicts and coarse-grained mosaic dolomite. The higher degree of dolomitization may be indicative of supratidal conditions at least during part of the deposition of Unit G.

Units H, I and J (12,120-12,750') are undifferentiated in Plate 3. The log markers and lithology differences that defined Units I and J are poorly developed and not easily picked. On the basis of lithology and fauna, Anderson, Warren & Associates, Inc.'s break the interval down as follows: open platform to bank 12,120-12,270'; restricted (lagoonal) to open platform 12,270-12,630'; and open platform to bank 12,630-12,750'.

Unit K (12,750-13,370'), the last unit to be differentiated, occurs in Plates 3, 4 and 5. Lithology consists of buff, brown, gray-brown, argillaceous lime-mudstone, packstone and wackestone. The limestones are microfossiliferous to fossiliferous, locally dolomitic and locally cherty. They are interbedded with shale, which is very dark brown to black, micropyritic, in part silty, in part siliceous and in part dolomitic. There is also some brown and green-gray chert. Fossil evidence suggests an age of Late Mississippian (probable Mamet Zones 12 and 13) with depositional environment restricted platform to open platform. The third thrust fault is believed to be at 13,370'.

PLATE 4: 13,370-15,320'

Shublik Formation: 13,370-13,736'

The top of Plate 4 is in Unit E based on paleontology and lithology.

Unit E (13,370-13,610') in Plate 4 is twice the expected thickness. This may be caused by a minor thrust fault at a depth of 13,510' where dip and dip direction make sharp changes from 30° south to 6° east. Fair age dating of Triassic-Permian was encountered in Core No. 12 from 13,600.7-13,609'. Unit E could contain some pre-Shublik sediments, based on the age determinations.

Unit F (13,610-13,736') is a full normal section with key lithologic marker beds present, namely the light gray-green siliceous claystone with tan to pink phosphate pellets and the very fine grained to silty pyritic, glauconitic sand at the contact with the Lisburne.

Lisburne Group: 13,736-15,320'

Unit G (13,736-14,390') is lithologically similar to that in previous plates. Lithology is predominantly buff and gray medium crystalline mosaic dolomite interbedded with recrystallized bioclastic packstone, and silicified to cherty limestone.

Units H, I and J (14,390-14,930') are not readily subdivided in Plate 4. The overall environment of deposition and lithology are consistent with the other plates in being open platform to bank with some restricted platform deposition.

Unit K (14,930-15,320') is very similar in lithology to its first occurrence in Plate 3. Lithology and depositional environment are essentially the same. The fourth thrust occurs at the base of Unit K at a depth of 15,320'.

PLATE 5: 15,320-17,000' - Total Depth

Unit F (15,320-15,396') differs in lithology from that in previous plates in that the light gray-green phosphatic siliceous shale and the basal glauconitic sandstone were not recognized in samples. Log character is also different from previous plates. Paleontology dates Unit F as Early Permian (AWA Zone F-21). The formation represented by Unit F is not determined, but the age dating places the rocks equivalent to the upper part of the Lisburne.

Lisburne Group: 15,396-17,000'

Unit G (15,396-16,000') appears to have the same approximate thickness in each plate encountered. The carbonates are much less recrystallized, and fair faunal preservation indicates an age of Late Mississippian (probable Mamet Zones 14 to 16). Lithology is interbedded packstone, wackestone and grainstone in part dolomitized with common nodular chert ranging from brown to gray and gray-green. Depositional environment is considered to be open platform to bank.

Unit H (16,000-16,220') consists of dark gray-brown to black siliceous mudstone interbedded with buff-mottled gray-brown bioclastic packstone grading to calcilutitic wackestone.

Unit I (16,220-16,310') appears to be similar to that in Unit I of Plate 1 with interbedded light gray to mottled dark gray argillaceous, glauconitic, micropyritic, sandy siltstone and mottled gray-brown, argillaceous, glauconitic biocalcarenite. This unit probably was deposited in a restricted platform (lagoonal) environment.

Unit J (16,310-16,410') is a buff to gray-brown packstone which grades to wackestone. These strata probably were deposited in an open platform to bank environment.

Unit K (16,410-17,000') is an interbedded sequence of bioclastic packstone and wackestone, cherty lime mudstone, chert, and black organic subfissile shale with local dolomitization. Paleontological determinations indicate an age of Late Mississippian (probable Mamet Zones 12 and 13). Depositional environment is considered to be restricted platform to open platform.

STRATIGRAPHIC CONCLUSIONS

(1) The Triassic-Permian units in Lisburne No. 1 differ considerably from time equivalent rocks in the northern portion of NPRA. The potential sandstone reservoirs (Kuparuk Sandstone, Sag River Sandstone and sandstones of the Sadlerochit Group) are completely lacking at Lisburne No. 1, and faunal associations indicate open-marine deep-water deposition.

(2) Rocks older than the Lisburne Group (Late Mississippian) were not definitely identified in the well, and the possibility of more thrust faults cannot be ruled out.

(3) The effect of the thrust faulting has been to cause fracturing in the Lisburne carbonates. However, the fractures have been filled with calcite and thus appear to have little potential as a reservoir.

(4) Diagenetic recrystallization of the Lisburne has reduced and nearly eliminated porosity to the point where average porosity for the Lisburne is 4%.

STRUCTURE

The structure at Lisburne No. 1 is a sequence of low angle overthrust plates that repeats the Lisburne Group and portions of the overlying Triassic-Permian at least five times. The well terminated in the basal portion of the Lisburne without having penetrated older strata thought to be Kayak Shale or Kekiktuk Conglomerate of the Endicott Group. There is a definite possibility that the five plates drilled are all allochthonous and that one or more additional plates could be present above the autochthonous Lisburne. Location of the well is thought to be near the axis of the Colville Trough where projections indicate the Lisburne could be as deep as 25,000'. The mechanism of the thrust faulting is thought to be crustal shortening of a magnitude of several hundred kilometers of movement to the North.

Plate 1

Dips above 6750' are scattered and mostly inconsistent, but there is an indication of moderate to high angle dips with a northwesterly direction. Cores also indicate high angle dips of 30° to 80° with common slickensides

and calcite vein filling, both indicators of intense diastrophism. From 6750' in AWA lithological Unit A, dipmeter data becomes good down to the top of the first Lisburne at 7408'. The dipmeter indicates dips of 14° to 28° to the east-northeast. In the first plate of Lisburne rocks, dipmeter data is generally poor in the carbonates to fair to good in shale-sandstone units. Unit I gives good dips of 20° to the northeast. Dips in the vicinity of 8600' (the first thrust fault) shows several northwest to southwest values and may represent drag folds.

Plate 2

In the post-Lisburne rocks, lithological Units A through F are present and are thicker than in any other plate. The greater thickness is thought to be due to fault related folding of beds. The dipmeter shows rapid changes in amount of dip and in direction throughout this interval. From 8600' to 8800', dip direction is to the northeast with dips ranging from 6° to 40°. From 8800' to 8830', the dip is mostly east to southeast with a rate of 18°, and then rotates to the southwest at a rate of 12° from 8830-8850'. From 8850' to 8940', dip reverses to the north-northeast averaging 30°. From 8950' to 9050', dip declines from 32° to 12° with dip direction to the southeast. In Units C, D, and E, dips range from 9° to 52°, averaging 24° to the northeast. Dipmeter data on the second plate of the Lisburne is spotty, but does show a northeast bias with dips in the range of 20° to 30°. Poor quality dipmeter data fails to show up the postulated second thrust fault at 10,900'.

Plate 3

Plate 3 is thought to start in lithological Unit B. Dipmeter data shows several random dips between 10,900' and 10,970'. From 10,970' to 11,220', low angle dips of 4° to 12° occur with dip direction to the west rotating to the southwest. At 11,220', dip direction changes to the east-northeast at 10° of dip. At 11,310', dip changes to 10° to the southeast. At 11,340', dip increases to 26° to the south-southwest. From 11,375' to 13,370', the dip changes to 10° in a southeast and occasional south direction.

The Lisburne shows fairly consistent dips of 12° to 18° to the south. Thrust fault No. 3 is postulated to be at 13,370'. Dipmeter data does not show any significant changes at this depth.

Plate 4

Plate 4 has an abbreviated post-Lisburne section with lithological Units A, B, C, and D missing. Dipmeter information on Unit E shows dips of from 20° to 36° to the south down to 13,520' where dips drop to 3° to 8° to the east and southeast. Dip in Unit F continues at 4° to 6° to the east and east-southeast. Dipmeter data in the upper portion of the Lisburne are poor. Data improves below a depth of 15,035' and indicates formation dip of from 6° to 12° to the west and southwest. Thrust fault No. 4 is believed to occur at or near this depth and the indicated folding probably represents drag folding.

Plate 5

Plate 5 also has a short post-Lisburne section, starting in Unit F, as identified by paleontology. The Unit does not conform lithologically with previously drilled Unit F's in that the gray-green siliceous mudstone and glauconitic sandstone are absent. Dipmeter data in Unit F is also poor with dip indicated to be 13° to the west-southwest. Dips in the Lisburne carbonates are consistent with this, indicating generally southwesterly dips of 8° to 16°, down to the last good data at 16,960'.

The well was terminated in the basal part of the Lisburne without having previously penetrated any older section.

DEVIATION

Deviation of the hole below 4700', where dipmeter data starts, indicates a drift angle of 10° to 12° with drift to the north-northeast. At a depth of 7000', drift changes to the north and gradually comes around to the northwest with a rate of 8°. At 8400', drift is to the east at a rate of 7° to 8°. Hole deviation increases to 11° with drift to the southwest at 9800'. Between 9800' to 12,500', deviation reduces from 11° to 6° with consistent drift to the southwest. From 12,500', drift is to the west-southwest at 5°. At 13,100', drift changes to the west northwest at 5°. The drift rotates from the northwest to the north between 13,400' and 14,700', with deviation dropping from 6° to 2°. From 14,700' to total depth, deviation increases gradually from 2° to 10° with drift to the northeast.

OIL AND GAS INDICATIONS

Poor shows and poor reservoir quality characterize the Lisburne No. 1 test well. There was no oil staining noted in the samples and the "shows" of hydrocarbons are limited to gas readings from the mud log.

Plate 1

Minor traces of gas and gilsonite were noted in the mud and in the samples beginning at a depth of 585' in siltstone. At a depth of 1540', traces of black tarry dead oil were observed on euhedral calcite crystal clusters.

Core No. 2, from 2075-2090.5', had black asphaltic oil on closed fracture faces with traces of bleeding oil and gas from tight, siliceous, fractured, conglomeratic sandstone.

At 2850', in a similar tight conglomeratic sandstone, minor gas was noted with some petroleum vapors, C_1 through C_4, being present.

From 3950' to 4100', an interval of tight siltstone, occasionally grading to sandstone, occurs. This siltstone gave low gas readings with some petroleum vapor, C_1 through C_4, being present.

From 5375' to 5500', a fair gas show was noted occurring in tight siltstones, silty sandstones and highly slickensided gray shales. Maximum gas recorded was 320 units with a chromatograph breakdown as follows: C_1, 42,000 ppm; C_2, 18,000 ppm; C_3, 500 ppm; and with traces of C_4.

Between 6130' and the top of the Lisburne at 7408', several gas peaks occur. The best gas kick encountered in the well occurred at a depth of 7060' with total gas of 1,150 units. Chromatograph breakdown was as follows: C_1, 230,000 ppm; C_2, 55,000 ppm; C_3, 2,500 ppm; C_4, 500 ppm. This was a quick "spike" that occurred in a 10' interval. This zone was tested by Drill-Stem Test No. 4 and recovered sweet gas at a maximum rate of 213 MCFGPD (see Appendix E) from a rapidly depleting reservoir (probably a fracture).

The first Lisburne carbonates (top at 7408') gave up low gas readings with several weak peaks of 80 to 90 units of total gas with traces of ethane and propane. Low overall porosities of 3% to 4.5% and fractures which generally are filled with secondary mineralization makes the Lisburne poorly prospective at this location. Drill-Stem Test No. 3 (7645-7662') was conducted in a zone of better than average porosity (8%). It recovered 71 barrels of nearly fresh formation water (3,100 ppm chlorides) and 2.14 cubic feet of sour-smelling combustible gas (see Appendix E). Core No. 7 (8038-8068') indicated closed and partly filled fractures and vugs with common gilsonite coatings and gassy odor on fresh breaks.

Plate 2

Several gas influxes were noted in post-Lisburne shales between 8790' and 9450'. The best of these peaks occurred at 8855' with a total gas reading of 340 units which was predominantly methane with a trace of ethane. Mud weight was increased gradually from 10.2 ppg to 10.8 ppg between 8790' and 9100' which further reduced the mud gas.

In the second Lisburne plate at a depth of 9753', circulation was lost using a mud weight of 10.9 ppg. By cutting mud weight to 10.5 ppg, circulation was restored. Several sharp gas "spikes" (10,280' and 10,615') were noted in the second Lisburne, containing C_1 only, and probably coming from fractures. Core No. 9 from 9728' to 9738' indicated slickensided fractures as well as fractures filled with gilsonite or calcite.

Plate 3

The post-Lisburne strata gave very low gas readings and had no shows.

The third Lisburne plate also had low gas readings (20 to 50 units) with one sharp "spike" at 12,535-12,540' of 1,072 units of total gas, mostly C_1 with traces of hydrogen and ethane. No sample shows or evidences of porosity were noted, leading to the conclusion that the gas occurred in fractures. Drill-Stem Test No. 1 (11,618-11,841'), which had mechanical problems, recovered a small amount of sweet gas from the sample chamber (see Appendix E).

Plate 4

The post-Lisburne rocks in Plate 4 had one sharp gas peak of 864 units at 13,518' with 171,000 ppm C_1 and a trace of C_2. This gas kick coincides with an interval of either tight folding or faulting as interpreted from the dipmeter. Gas indications below the 7-5/8" casing shoe at 13,650' were negligible.

The fourth Lisburne plate was drilled with a mud weight of 10.8 ppg, and gas was reduced to negligible amounts with a maximum of 25 units of total gas recorded. No oil shows were encountered. Porosity was very low, averaging 2% to 4%. Core No. 13 (13,859-13,870.5') indicated tight bioclastic packstone with dark-stained, closed fractures, some calcite-filled fractures, and some stylolites.

Plate 5

The post-Lisburne beds and the Lisburne carbonates down to total depth of 17,000' gave no good oil or gas shows. Due to spotty mud losses, mud weight was gradually reduced to 10.1 ppg at total depth. A slight gas kick of 210 units of methane only, was noted at 16,850' and dropped back immediately to 10 units (probable fracture). Cores 16, 17, 18, 19, and 20 were cut in the fifth Lisburne plate. No porosity was indicated, and the fractures are generally closed or calcite filled. Traces of gilsonite were noted in the cores and samples, and a black organic subfissile shale was noted at a depth of 16,950'.

CONCLUSIONS

1. The well proved up the multiple overthrusts thought to be present at Lisburne No. 1 location.

2. The well penetrated five different plates of Lisburne carbonates and younger rocks without having definitely recovered any older rocks of the Kayak Shale (Endicott Group). More allocthonous plates may be present above the autochthonous Lisburne.

3. Source rocks are present in the Jurassic and Cretaceous rocks, although their thermal maturity probably places them in the higher temperature range which permits only the occurrence of gas.

4. The common gilsonite found in the Lisburne carbonates probably represents oil which has been thermally altered.

5. Anticipated hydrocarbon reservoirs (Lisburne carbonate) are generally of poor quality with low primary porosities and with closed or calcite-filled secondary fractures.

6. No commercial hydrocarbons were encountered in any tests.

7. Nearly fresh water (3,100 ppm chlorides) was recovered from the first plate of Lisburne carbonates, indicating probable fresh-water flushing of the rocks at some earlier time.

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SUMMARY PERTINENT DATA, OPERATIONS & ANALYSIS*

WELL NAME:	Lisburne Test Well No. 1
API NO.:	50-137-20003
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	792' FSL; 2411' FEL SE 1/4, protracted Section 17, T11S, R16W Umiat Meridian, Alaska
COORDINATES:	Latitude: 68°29'05.4381" North Longitude: 155°41'35.510" West X = 272,584.12 Y = 5,298,127.35 Zone 5
ELEVATION:	1862' K.B.; 1834' Pad
CASING:	30" @ 129' 20" @ 1504' 13-3/8" @ 4509' 9-5/8" @ 8002' 7-5/8" @ 7700-13,650' (Liner)
DATE SPUDDED:	June 11, 1979
SUSPENDED PERIOD:	August 23, 1979 to August 24, 1979
TOTAL DEPTH:	17,000' Driller; 16,979' Schlumberger
DATE REACHED TOTAL DEPTH:	May 20, 1980
DATE RIG RELEASED:	June 2, 1980

LOGGING RECORD:

	Run No.	
DIL/SP/GR	1	129- 1,509'
	2	1,505- 4,516'
	3	4,509- 6,744'
	4	4,509- 8,024'
	5	8,005-13,645'
	6	13,650-16,965'

LOGGING RECORD: (Continued)

	Run No.	
BHC-Sonic/GR/TTI	1	129- 1,502'
	2	1,505- 4,521'
	3	4,509- 6,738'
	4	4,509- 8,020'
	5	8,005-13,645'
	6	13,650-16,966'
CNL/FDC/CAL/GR	1	1,505- 4,521'
	2	4,509- 8,024'
	3	8,005-13,645'
	4	13,650-16,980'
Birdwell Velocity Survey	1	250- 4,400'
	2	4,500- 8,000'
	3	4,500-16,942'
HRD-Dipmeter	1	4,509- 8,024'
	2	8,005-13,645'
	3	13,645-16,979'
DLL/GR	1	13,650-16,955'
Temperature Log	1 & 2	100-16,955'
CBL	1	100- 7,909'
	2	6,500-12,500'
Geogram		Surface-16,000'
Mudlog		129-17,000'
Coriband		4,518- 8,016'
		8,020-13,625'

SIDEWALL CORES: ** 45 shot; 31 recovered

CONVENTIONAL CORES:

No.	Interval	Recovery
1	1,554.1- 1,558.8'	4.0'
2	2,075.0- 2,090.5'	15.5'
3	2,990.0- 3,000.0'	9.0'
4	3,900.0- 3,910.0'	9.0'
5	5,340.0- 5,356.0'	16.0'
6	6,215.0- 6,225.0'	10.0'
7	8,038.0- 8,068.0'	30.0'
8	8,730.0- 8,740.0'	8.5'
9	9,728.0- 9,738.0'	10.0'
10	11,162.0-11,173.0'	11.0'
11	11,686.5-11,691.0'	4.0'
12	13,600.7-13,609.0'	7.7'

CONVENTIONAL CORES:
(Continued)

No.	Interval	Recovery
13	13,859.0-13,870.5'	11.5'
14	15,328.0-15,342.0'	12.0'
15	15,596.0-15,598.0'	0.0'
16	15,655.0-15,663.0'	3.0'
17	15,902.0-15,911.0'	4.8'
18	16,302.0-16,328.0'	22.5'
19	16,859.0-16,875.5'	12.0'
20	16,982.0-17,000.0'	14.5'

TESTS:

A total of four drill-stem tests were run, as follows:

DST No. 1 Interval: 11,618-11,841'
Perforations: 11,618-11,638' (20')
11,728-11,742' (14')
11,826-11,841' (15')

Recovered 3,000 feet of water cushion plus 2,100 feet (13.8 barrels) of rat-hole mud and mud filtrates. Pressure charts indicated mechanical problems existed in the tool assembly (see Appendix E for pressures and other details).

DST No. 2 - Interval: 7645-7662'

Misrun (Tool plugged).

DST No. 3 - Interval: 7645-7662'

Recovered 10 barrels of rat-hole mud and filtrate and 61 barrels of formation water (3,100 ppm Cl^-) with slight sour odor (see Appendix E for pressures and other details).

DST No. 4 - Interval: 7022-7104'

Gas to surface in 28 minutes at 220 psi, declined to 65 psi in 2 hours; calculated rate of 213 MCFPD on 1/4" choke. Recovered 16.6 barrels of slightly gas-cut rat-hole mud and filtrate (see Appendix E for pressures and
other details).

STATUS:

Dry and abandoned

WELLSITE GEOLOGIST:	David Young Ray Wermeyer W. D. Fenex
WELL LOG ANALYST:	Armour Kane
DRILLING CONTRACTOR:	Nabors Alaska Drilling, Inc., Rig 17
MUDLOGGERS:	The Analysts
BIOSTRATIGRAPHIC ANALYSIS:	Anderson, Warren & Associates, Inc.

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

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

** Sidewall cores were utilized for various analyses including: lithology, paleontology, and geochemistry.

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

R. WERMEYER	-	0- 2,075'
		5,860- 6,770'
		8,165-10,935'
		12,385-13,609'
D. YOUNG	-	2,075- 5,860'
		6,770- 8,165'
		10,935-12,385'
		13,609-15,340'
D. FENEX	-	15,340-17,000'

DEPTH DRILLED (FEET BELOW KELLY BUSHING)	
0 - 130	No samples.
130 - 180	Claystone: varicolored, light green, hard, blocky, slightly cherty, smooth, slightly dolomitic, with trace of black, hard, dry hydrocarbon along fractures, and Claystone: very light gray to dark gray, hard, in part silty, dolomitic to calcareous, smooth, in part micaceous; trace Calcite: clear, white; Chert: very light green, hard.
180 - 330	Claystone: light green, as above, noncalcareous, in part subconchoidal fracture, and Claystone: light gray, some dark gray, some banded light and dark gray, firm to hard, noncalcareous, in part slightly siliceous appearing, blocky, subconchoidal fracture, rare pyrite, occasional cherty appearance, very slightly micromicaceous, rare calcite veins, very rare fossil casts, locally interbedded with Limestone: calcilutitic, buff, hard, dense, locally Claystone: maroon, firm to hard, blocky, very slightly calcareous, subconchoidal fracture; trace Claystone: light blue-green, waxy to soapy appearance, firm, platy; and Claystone: medium gray, waxy to soapy appearance, firm, platy; trace Chert: cream, very light gray, hard; trace Calcite: white to milky.
330 - 420	Shale: dark gray, silty, blocky, and Shale: medium gray, some dark gray-brown, platy, smooth in part, blocky, in part silty, subconchoidal fracture, slightly cherty, waxy to soapy, interbedded with Siltstone: dark gray, blocky, hard, micaceous, probably carbonaceous, occasionally very finely sandy, rare pyrite, and Siltstone: medium gray; Chert: very light gray and light green.

420 -	450	Shale: dark gray, silty, as above, with trace Shale: light gray and maroon, as above, interbedded with Siltstone: very dark gray-brown, blocky, hard, slightly microfossiliferous, siliceous appearance, in part micaceous, trace Chert: very light gray.
450 -	510	Siltstone: very dark brown, blocky, in part micaceous, argillaceous, pyritic, firm to hard, occasionally very finely sandy, interbedded with Claystone: very light green, firm, blocky, slightly cherty, and Claystone: very light gray, blocky, firm, very minor Chert: very light green, some very light gray, trace pyrite.
510 -	560	Shale: red-brown, blocky, in part waxy and platy, hard, interbedded with Claystone: very light gray, blocky, hard, slightly dolomitic, waxy, and Siltstone: medium to dark gray, hard, blocky, grades to shale; Chert: light gray, hard.
560 -	720	Interbedded mudstone, claystone, siltstone and chert; Claystone: light gray to pale green, some blue-green, hard, in part slightly dolomitic, blocky, in part cherty and siliceous; Claystone: very light gray, very dark brown, some pale green, hard, blocky, in part cherty; Siltstone: brown to dark brown, hard, siliceous appearance, blocky, occasional chert veinlets; Chert: gray, brown, pale green, traces pyrite clusters.
720 -	820	Interbedded siltstone, mudstone and minor sandstone; Siltstone: gray-brown, hard, in part siliceous, blocky, rare calcite and chert veinlets; Mudstone: gray, locally dark brown to black, hard, locally slightly cherty, in part siliceous, rare gilsonite, and minor Sandstone: light gray, rare brown, very fine to fine grained, locally medium grained, subrounded, poor to fair sorting, rare black phosphate pellets, rare cream colored tripolitic(?) chert, very rare glauconite, poor to nil porosity, no show.
820 -	870	Interbedded siltstone, mudstone and trace to 5% sandstone and trace to 10% chert; Siltstone: dark brown to gray-brown and some medium gray, hard, blocky, siliceous, micaceous, locally with chert veinlets; and Mudstone: dark brown, medium gray and pale green, appears platy and waxy in part, hard, in part siliceous, occasional gilsonite; Sandstone: light gray, occasional medium grained (wacke), very fine to fine grained, subangular to subrounded, poor to fair sorting, slightly calcareous, scattered black phosphate(?), and rare glauconite grains, occasionally dolomitic, very argillaceous, poor to nil porosity, no show; Chert: smoky, white, pale green, occasionally brown and light gray and buff.

870 -	890	Interbedded Siltstone, Sandstone and Chert: as above.
890 -	960	Interbedded siltstone, claystone, chert and very thin sandstone stringers; Siltstone: brown, dark brown, medium to dark gray, as above; Claystone: brown, dark brown, medium to dark gray and pale green, hard, siliceous, in part cherty, in part platy and waxy, very rarely phyllitic sheen; Chert: varicolored, as above, and Sandstone: as above.
960 -	1190	Interbedded siltstone, claystone, thin stringers sandstone and traces pyrite; Siltstone: medium gray becoming brownish-gray to gray-brown, firm, slightly calcareous, very finely arkosic, blocky, very argillaceous, very finely pyritic and micaceous; Claystone: medium gray becoming brownish-gray to gray-brown, blocky, firm to hard, in part siliceous, locally very finely pyritic; Sandstone: as above; rare pyrite clusters; solids in mud have increased possibly due to clays washing out of siltstones and sandstones and/or erosion of these sediments coming up the bore hole.
1190 -	1220	Interbedded siltstone, claystone and sandstone; Siltstone: gray-brown, firm to hard, slightly dolomitic in part, in part very finely arkosic; Claystone: gray to gray-brown, firm, blocky; Sandstone: gray, very fine grained, subangular, moderately sorted, moderately cemented, slightly dolomitic, arkosic, scattered black material, possibly carbonaceous; trace Chert: smoky, mossy; trace pyrite.
1220 -	1450	Interbedded siltstone, claystone and sandstone; Siltstone: brownish-gray becoming locally medium to dark gray, blocky, firm to hard, slightly micaceous, locally and occasionally medium to coarse, angular, floating chert fragments; Claystone: brownish-gray, locally medium to dark gray, firm to hard, blocky, slightly silty, very finely micaceous; Sandstone: gray, very fine to fine grained, subangular to subrounded, moderately sorted, locally arkosic, moderately cemented, scattered black grains, possibly carbonaceous material, in part argillaceous, poor to very poor porosity, no show; occasional gilsonite filling porosity, and as veins in claystone and siltstone.
1450 -	1515	Siltstone and Claystone: as above, but gray-brown, and Sandstone: as above, but becoming very light gray, "salt and pepper", and calcareous in very bottom of interval.

1515 - 1530 Siltstone: medium to dark gray, hard, argillaceous, interbedded with Claystone: medium to dark gray, hard, silty and loose quartz grains, smoky, black, very coarse to granule, well rounded, occasionally brown with light orange talc.

1530 - 1554.1 Siltstone: medium gray, becoming brown-gray, in part very finely sandy, hard, blocky, very finely cherty, with interbedded Claystone: dark brown-gray, hard, blocky, fragments slickensided, and Sandstone: light to medium gray, as above, rare, very fine, pale green chert inclusions; trace of tarry dead oil on a few calcite crystal clusters.

1554.1 - 1558.8 Core No. 1: Cut 4.7', Recovered 4'

1554.1-1558.1' (4.0') Claystone/Shale: dark gray, hard, blocky, locally rare carbonaceous material, micropyritic, micromicaceous, fragmented and slickensided.

1558.1-1558.8' (0.7') No recovery.

1558.8 - 1590 Claystone: dark gray, as in Core No. 1 above, interbedded with Sandstone: as above.

1590 - 1690 Siltstone: brown-gray, hard, blocky, slightly dolomitic, micromicaceous, interbedded with Claystone/Shale: dark gray to brown-gray, as above, and Sandstone: as above, occasionally with coarse grains and very rare glauconite, calcareous, "salt and pepper"; traces Limestone: calcilutitic, light brown to brown, dense, hard, blocky.

1690 - 1750 Siltstone: medium to dark gray, hard, rare scattered carbonaceous material, blocky, dolomitic, interbedded with Claystone/Shale: gray, brown to brown-gray, firm to hard, blocky, fragments slickensided, waxy, and micaceous; Sandstone: medium to dark gray, speckled, "salt and pepper", fine to medium grained, subrounded to rounded, moderately well sorted, calcareous, moderately cemented, rare to common carbonaceous material, scattered cream colored tripolitic chert(?) locally rare very pale blue-green glauconite(?).

1750 - 1810 Siltstone: brown-gray, hard, blocky, micromicaceous, interbedded with Shale: dark brown-gray, firm to hard, blocky, fragments slickensided and waxy appearing; and Sandstone: as above, locally very argillaceous.

1810 - 1850 Siltstone: dark gray, as above, and Shale: dark gray, as above, and Sandstone: as above.

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1850 - 1980 Siltstone: brown-gray, locally dark gray, and Shale: brown-gray, locally dark gray, and Sandstone: as above.

1980 - 2020 Siltstone: brown-gray, as above, and Siltstone: dark brown, firm to hard, some soft, very argillaceous, calcareous, occasionally mottled dark brown and white with calcite veinlets, micromicaceous, and Shale: very dark brown, silty, calcareous, firm and dark gray, blocky, slickensided and waxy; Sandstone: gray, very fine to fine grained, subangular, moderately well sorted, moderately well cemented, calcareous, rare tripolitic chert, scattered carbonaceous material, rare, very pale blue-green grains.

2020 - 2075 Conglomeratic Sandstone: varicolored and mottled light and dark gray, "salt and pepper", variable fine to very coarse grained with very coarse to granule size inclusions of angular chert and shale and subrounded quartz, siliceous cement with some calcareous material, moderately cemented, firm to hard; Siltstone: medium to dark gray, and very dark brown, occasionally some medium grained, angular chert inclusions, as above, and Shale: dark gray and dark brown, as above, and Chert: predominantly gray and locally trace pyrite clusters.

2075 - 2090.5 <u>Core No. 2: Cut 15.5', Recovered 15.5'</u>

2075.0-2081.0' (6.0') Sandstone: light gray, hard, fine to medium grained, poorly sorted, light gray, green, black, white, few closed fractures dip 45°, some of fracture faces are calcareous, with slight porosity developed and containing black asphalt and brown oil stain with fair odor; yellow fluorescence and immediate yellow-white cut fluorescence, grains are subangular to subrounded, predominantly chert and quartz with silica and calcareous cement, some small shale clasts and possible slump deformation is present.

2081.0-2090.5' (9.5') Conglomeratic Sandstone: gray-green, hard, medium, coarse, very coarse, pebbly and with shale and limestone clasts ranging in size up to 6" x 4", calcite-filled fractures develop

	some patchy intercrystalline porosity which frequently contains gassy oil and/or gas odor although porosity and permeability appear to be non-connected.
2090.5 - 2145	Conglomeratic Sandstone: as in Core No. 2, in part Sandstone: light gray, fine to medium grained with a few chert pebbles, subangular, slightly tripolitic with rare asphalt stain; no fluorescence, no cut.
2145 - 2190	Siltstone: medium gray, firm, slightly carbonaceous; interbedded with and gradational with Shale: medium gray, dark gray, hard, noncalcareous, in part silty, occasional thin beds of fine to medium grained sandstone, commonly tripolitic.
2190 - 2210	Shale: dark gray, hard, in part silty, trace light gray, hard shale.
2210 - 2330	Shale: gray-brown, slightly silty to nonsilty, firm, hard, noncalcareous, interbedded with and occasionally grading to Siltstone: medium gray, hard, slightly calcareous, and with a few thin beds of Sandstone: light gray, "salt and pepper", green, white, gray, black, commonly tripolitic weathered chert.
2330 - 2360	Sandstone: light gray, "salt and pepper", fine to very fine grained, medium hard, slightly calcareous, white, gray, clear, black, rarely green chert and quartz, commonly tripolitic, nil porosity; no stain, odor, cut, fluorescence; trace gilsonite; interbedded with Shale: gray, gray-brown, noncalcareous, slightly micromicaceous; trace calcite, some with drusy faces, probably from rare fractures.
2360 - 2430	Shale: gray-brown, gray, noncalcareous, medium hard, commonly slickensided, trace calcite; interbedded with thin medium gray, hard siltstone beds.
2430 - 2500	Shale: medium gray, dark gray, medium hard, commonly slickensided; interbedded with Siltstone: medium gray, medium hard, slightly carbonaceous, occasional trace of sandstone as previously described, probably cavings.
2500 - 2520	Shale: becoming gray-brown, medium hard, slightly silty, noncalcareous, white specks, possibly tripolitic chert; interbedded with Siltstone: as previously described, rare calcite, some with black dead oil stain.

2520 - 2660	Siltstone: medium gray, medium hard, occasionally slightly calcareous and carbonaceous, rare calcite vein interbedded with Shale: medium gray, medium hard, slightly silty to slightly micromicaceous.
2660 - 2690	Sandstone: light gray, medium to coarse grained, poorly sorted, light green-gray, gray, brown, angular to subangular, subrounded, predominantly chert, very hard, calcite cement; no stain, odor, cut or fluorescence; no porosity, trace gilsonite; interbedded with Siltstone and Shale: as previously described.
2690 - 2720	Sandstone-Conglomerate as at 2660', increase in grain size, no porosity; no shows, common calcite veinlets.
2720 - 2750	Sandstone: light gray, fine to medium grained, slightly pyritic in part, friable, possibly 10% porosity; no shows, in part Sandstone-Conglomerate: as previously described; interbedded with siltstone and shale.
2750 - 2810	Shale: medium gray, medium hard, slightly silty, slickensided with occasional chert pebbles; interbedded with medium gray Siltstone and Sandstone: as previously described at 2660'.
2810 - 2850	Sandstone: light gray, fine to coarse grained, poorly sorted, subangular to subrounded, hard in part with shaly matrix in part, with brown dolomitic cement, some euhedral calcite (probable vug or fracture fill), interbedded with medium gray slightly carbonaceous siltstone and medium gray slightly silty shale with some pebble inclusions; no shows, no porosity.
2850 - 2910	Sandstone: light gray, very fine to fine grained, "salt and pepper", medium hard, argillaceous, tight, in part conglomeratic sandstone with brown calcite cement, trace pyrite; interbedded with Siltstone: medium gray, and Shale: medium to dark gray.
2910 - 2940	Sandstone: light gray, fine to coarse grained, subangular, subrounded, poorly sorted, light gray, smoky, green, white, predominantly chert, slightly pyritic, some with silty matrix, interbedded with Shale: medium gray; and Siltstone: medium gray, medium hard, slightly carbonaceous.
2940 - 2970	Sandstone: as at 2850', interbedded with Shale: medium gray, moderately hard, slightly silty, with a few chert fragments and pebbles, also with Siltstone: medium gray, medium hard in part with thin laminations, calcite veins and traces of dead oil stain.

2970 - 2980 Shale: medium gray, medium hard, noncalcareous.

2980 - 2990 Shale: medium to dark gray, hard, silty, interbedded with medium gray siltstone.

2990 - 3000 Core No. 3: Cut 10', Recovered 9'

2990.0-2991.0' (1.0')	Siltstone: medium gray, hard, with interlaminated Shale: dark gray, hard, silty, bedding dips approximately 40°, near vertical slickensided fractures are common, with some calcite filled.
2991.0-2999.0' (8.0')	Shale: medium to dark gray, hard, silty, commonly slickensided, near vertical fractures, some probably older are calcite filled.
2999.0-3000.0' (1.0')	No recovery.

3000 - 3040 Shale: medium to dark gray, hard, silty, commonly slickensided with occasional thin beds of siltstone.

3040 - 3080 Shale: medium to dark gray, hard, noncalcareous, silty in part grading to siltstone, trace of tan, brown, orange clay mineral, rare calcite, probably fracture filling.

3080 - 3130 Sandstone: light gray, very fine to fine grained, "salt and pepper", gray, white, black, tripolitic chert; interbedded with Shale: gray-brown, firm, silty, and 10-20% Limestone: brown, hard, argillaceous, micritic; common white and brown calcite fracture filling.

3130 - 3180 Shale: gray-brown, medium gray, firm to medium hard, noncalcareous, silty, slickensided, in part subfissile, rare calcite fracture fill and euhedral calcite; occasional thin beds of Siltstone and Sandstone: as at 3080'.

3180 - 3220 Siltstone: medium gray, medium hard, with common white flecks of tripolitic chert; interbedded with Shale: as at 3130'.

3220 - 3260 Shale: gray-brown, gray, medium hard to firm, noncalcareous, slightly silty with dark brown dead oil stain; interbedded with thin stringers of medium gray Siltstone, and Limestone: brown, hard, micritic, calcite fracture filling; in part acicular crystals; no stain, odor, cut or fluorescence.

3260 - 3290	Siltstone: medium gray, hard with white flecks of tripolitic chert; interbedded with Shale: medium gray, gray-brown, medium hard, silty, noncalcareous, blocky.
3290 - 3360	Shale: medium gray, firm to medium hard, slightly silty; in part subfissile, in part slickensided, minor Limestone: brown-gray, argillaceous, slightly silty.
3360 - 3400	Siltstone: medium gray, medium hard, in part with white chert flecks; interbedded with shale and limestone stringers.
3400 - 3460	Shale: gray-brown, gray, subfissile, slightly silty, noncalcareous; interbedded with Siltstone: as at 3360'.
3460 - 3500	Siltstone: medium gray, gray-brown, noncalcareous, micromicaceous; interbedded with Shale: gray-brown, gray, medium hard, slightly silty, micromicaceous, and with rare trace of Limestone: brown, hard, micritic.
3500 - 3560	Shale: medium gray, gray-brown, light gray, gray-green, noncalcareous, slightly silty with rare slickensides, slightly carbonaceous; interbeds with siltstone.
3560 - 3620	Shale: gray-brown, medium gray, medium hard, slightly silty, noncalcareous, slickensided, in part subfissile.
3620 - 3660	Chert: light gray with brown mottling, brown, black, milky with disseminated pyrite, fractured with some calcite infiltration; interbedded with Shale: medium gray, gray-brown, brown-black, siliceous in part, with small chert fragments and pebbles, 5% green-gray chert conglomerate with shale matrix.
3660 - 3680	Shale: gray-brown, medium hard, subfissile, micromicaceous, slightly silty; interbedded with Siltstone: medium gray, hard, with tripolitic chert specks.
3680 - 3740	Shale: medium gray, gray-brown, medium hard, slightly silty, highly slickensided with trace light gray-green firm shale, with thin stringers of Siltstone: medium gray, trace with gilsonite and drusy calcite in small vug.
3740 - 3760	Siltstone: medium gray, medium hard, in part grading to very fine grained sandstone with white tripolitic chert specks, trace with gilsonite and drusy calcite in fracture or vug; interbedded with Shale: as at 3680'.

3760 - 3810	Shale: medium gray, firm, slightly silty, commonly slickensided, in part slightly carbonaceous, with trace free calcite and probable trace dead oil stain, trace light gray-green shale; interbedded with thin siltstone stringers with occasional pyrite clusters, rare chert pebbles.
3810 - 3837	Shale: as at 3760', with slight brown cast.
3837 - 3855	Chert: light green-gray with brown mottling; tan, white, translucent, thinly bedded with dark brown siliceous shale, and Shale: gray-brown, medium hard, subfissile with trace dead oil stain.
3855 - 3870	Shale: medium gray, gray-brown, medium hard, noncalcareous, slightly silty, slightly pyritic; trace light green shale with brown mottling and slickensides; interbedded with thin beds of chert conglomerate with small subangular to subrounded pebbles in a brown siliceous matrix and medium gray siltstone.
3870 - 3900	Shale: as at 3855', in part hard, blocky, siliceous, with thin interbeds of Sandstone: light gray, very fine grained, hard, siliceous, and Chert: varicolored, light green, medium green, tan, black and translucent white with disseminated pyrite.
3900 - 3910	Core No. 4: Cut 10', Recovered 9'
3900.0-3900.3' (0.3')	Shale: medium to dark gray, medium hard.
3900.3-3900.7' (0.4')	Sandstone: light gray, very fine grained, grades in part to siltstone.
3900.7-3901.5' (0.8')	Shale: as at 3900'.
3901.5-3906.5' (5.0')	Shale: dark gray with green mottling, green-gray, commonly subfissile, common small pebble-cobble size lithiclasts consisting of medium gray siltstone, commonly slickensided, poor bedding dip of approximately 80°, some bed deformation at 3903', common closed fractures with probable dead oil stain, rare pyrite coated nodule of siltstone.
3906.5-3909.0' (2.5')	Siltstone: medium gray, hard, interbedded with Shale: medium to

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dark gray, medium hard, highly slickensided, common closed fractures with probable dead oil stain on faces.

3909.0-3910.0' (1.0') No recovery.

3910 - 3960 Shale: gray-brown, gray, trace light green-gray, in part subfissile, firm to medium hard, slightly silty, occasionally slickensided; interbedded with Siltstone: medium gray, gray-brown, and Sandstone: light gray, very fine grained, slightly pyritic.

3960 - 4060 Interbedded Siltstone, Shale and minor Sandstone: as at 3910'.

4060 - 4090 Sandstone: medium gray, light gray, very fine to fine grained, medium hard, slightly calcareous, highly argillaceous; no oil show; interbedded with Siltstone: medium gray, gray-brown, and Shale: medium gray, gray-brown, firm, silty, occasionally slickensided.

4090 - 4180 Siltstone: medium to dark gray with occasional brown cast, medium hard, in part grades to Sandstone: light gray, very fine to fine grained, hard, tight, argillaceous; interbedded with Shale: medium gray, gray-brown, medium hard to firm, silty with common slickensides, rare trace of gilsonite and dead oil stain.

4180 - 4310 Shale: dark gray, medium to dark gray, medium hard, slightly silty, noncalcareous, slickensided; interbedded with Siltstone: medium gray, hard and with occasional stringers of Sandstone: light to medium gray, very fine to fine grained with tripolitic chert specks.

4310 - 4360 Shale and Siltstone: as above, at 4180' with trace black, siliceous shale, trace tan-brown, hard limestone and trace to 10% Chert fragments: black, tan, white, with thin stringers of Sandstone: light green-gray, fine grained and fine to coarse grained with chert fragments and dark green glauconite grains, and light green-gray shale (apple green).

4360 - 4440 Siltstone: medium gray, light gray, medium hard, interbedded with Shale: medium gray, light gray, gray-brown, silty, noncalcareous with rare slickensides, rare chert, trace asphalt, trace euhedral calcite, rare calcite-filled fractures, occasional sandstone stringer, light gray, very fine to fine grained, "salt and pepper", white, black, clear, gray quartz, subrounded to subangular, highly argillaceous.

4440 - 4510	Siltstone: medium to dark gray, light gray, medium hard, slightly carbonaceous; interbedded with Shale: medium to dark gray, in part light gray, in part with brown cast, silty; trace Sandstone: white to light gray with dark green glauconite grains and pyrite, rare calcite-filled fractures, occasionally slickensided.
4510 - 4570	Siltstone: medium gray, medium to dark gray, slightly carbonaceous, with rare pyrite nodules; interbedded with Shale: medium to dark gray, firm, slickensided.
4570 - 4630	Shale: medium to dark gray, firm, micromicaceous, slightly silty, noncalcareous with trace of light green firm shale; with thin beds of siltstone; Sandstone: light gray, light green-gray, very fine grained, clear quartz, medium hard, with tripolitic chert and slightly carbonaceous, and Limestone: brown, hard, micritic.
4630 - 4660	Siltstone: medium to dark gray, light gray, medium hard, slightly carbonaceous, micromicaceous with traces of dead oil stain; interbedded with Shale: as at 4570', and with thin stringers of sandstone and limestone.
4660 - 4700	Shale: medium to dark gray, light green-gray, highly slickensided; interbedded with Siltstone: medium gray, medium hard, with rare tripolitic chert specks, trace of Sandstone: light gray-green, soft with white clay mineral.
4700 - 4870	Shale: medium to dark gray, medium hard, micromicaceous, slightly silty, slickensided; interbedded with Siltstone: as at 4660', and with thin beds of Sandstone: tan, very fine grained, and Limestone: brown, hard, micritic.
4870 - 4890	Siltstone: medium gray, medium hard, slightly carbonaceous.
4890 - 4930	Shale: medium to dark gray, medium hard, slightly silty, slickensided with trace of dead oil stain; interbedded with Siltstone: as at 4870', with trace of light gray, brown, very fine grained, medium hard, quartz and tripolitic chert.
4930 - 5000	Siltstone: medium gray, firm, slightly carbonaceous; interbedded with Shale: as at 4890'; and with trace Sandstone: light gray, very fine grained, medium hard, calcareous cement, white, gray, clear, green quartz and chert.

5000 - 5020 Siltstone: light gray, medium hard, in part grades to very fine grained sandstone.

5020 - 5160 Shale: medium to dark gray, medium hard, slightly silty, noncalcareous, commonly slickensided, trace of dead oil stain; trace light gray shale; interbedded with Siltstone: medium gray, light gray, slightly calcareous, medium hard, and with occasional stringers of Sandstone: light gray, very fine grained, white, clear, green, subrounded quartz and chert, trace of black shale, trace of dead oil stain.

5160 - 5210 Siltstone: medium gray, light gray, medium hard; interbedded with Shale: dark gray, medium hard, slightly silty, slickensided, with occasional thin stringers of sandstone.

5210 - 5280 Shale and Siltstone: as described at 5160'.

5280 - 5340 Sandstone: light gray, brown-gray, medium gray, very fine grained, silty, friable, quartzitic, highly argillaceous, carbonaceous; no stain, odor, cut, or fluorescence; grades in part to siltstone and with thin beds of dark gray silty shale.

5340 - 5356 Core No. 5: Cut 16', Recovered 16'

5340.0-5354.2' (14.2')	Shale: dark gray, hard, brittle, highly crushed, slickensided, slightly silty, slightly calcareous, siltstone pods, pyrite lenses, some calcite-filled fractures.
5354.2-5354.5' (0.3')	Sandstone: tan, medium to coarse grained, with tan, calcite cement, rare fossils (possibly crinoids), subrounded clear quartz, tan clay mineral (probable altered chert), excellent dip of 30°, fair gas odor on fresh break, slight yellow cut fluorescence, nil to very slight porosity, large calcite-filled fracture dips at 70°.
5354.5-5356.0' (1.5')	Shale: as at 5340'.

5356 - 5420 Shale: dark gray, silty, slightly calcareous, interbedded with Siltstone: medium to light gray, and Sandstone: medium gray, light gray, brown-gray, very fine grained, slightly calcareous, highly argillaceous, common calcite vein filling, rare crinoid columns; no shows, rare quartz "floaters".

5420 - 5450	Shale: dark gray, silty in part with slickensides; interbedded with Siltstone: medium to dark gray, medium hard, occasional crinoid columns.
5450 - 5580	Shale: dark gray, medium gray, firm to medium hard, silty; interbedded with Siltstone: medium gray, light gray; and occasional stringers of Sandstone: light gray-green, very fine to fine grained, medium hard, white, clear, green quartz, and Limestone: brown, tan, hard.
5580 - 5640	Shale: medium gray, dark gray, medium hard to firm, slightly silty, slickensided; interbedded with Siltstone: medium gray, gray-brown, medium hard.
5640 - 5700	Siltstone: medium gray, dark gray, medium hard in part, slightly calcareous; interbedded with Shale: medium gray, dark gray, as at 5580'.
5700 - 5740	Shale: dark gray, medium gray, trace light gray, pyritic, slightly silty, in part slickensided; interbedded with Siltstone: as at 5640'.
5740 - 5830	Siltstone: medium gray, dark gray, occasionally light gray, firm to medium hard, interbedded with Shale: as at 5700', and with occasional stringers of Sandstone: light gray, medium gray, very fine grained, slightly calcareous, carbonaceous, argillaceous, with no shows.
5830 - 5860	Shale: medium gray, dark gray, light gray, black, silty, moderately hard with rare angular chert fragments, gray color, and rare subrounded coarse grained quartz "floaters"; interbedded with Siltstone: medium gray, dark gray, firm; and with thin stringers or vein filling of Calcite: tan, brown, white.
5860 - 5900	Shale: medium gray, firm, in part smooth, blocky to splintery, rare calcite veinlets, rare slickensides with some Shale: black, blocky, firm, and Claystone: pale green, firm, blocky, waxy; interbedded with Siltstone: medium gray to brownish-gray, firm, blocky, occasionally elongated fragments and rare stringers, gray-brown to light brown; Sandstone: fine to medium grained, subangular to subrounded, poorly sorted, moderately cemented, rarely dolomitic to calcareous, poor porosity; no show.
5900 - 5950	Interbedded Shale: medium gray, grades to gray-brown, rare black, as above, rarely micromicaceous, in part slickensided, rare well rounded, clear quartz grains with pale green, some light gray

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Claystone: as above, in part slickensided and waxy, rare pyrite, light brown chert and calcite veinlets, with Siltstone: as above.

5950 - 6020 Interbedded Shale: medium gray, blocky, waxy, slickensided in part, silty, some black, blocky, silty, with Claystone: pale green, some light green, smooth, waxy, and Siltstone: medium gray, some black, as above, with thin Sandstone stringers: light gray to light brown, very fine grained, subangular, argillaceous, fair sorting, moderately cemented, occasionally calcareous, poor to fair porosity; traces light brown calcite.

6020 - 6060 Interbedded Shale, Siltstone and Claystone: as above, with traces pyrite.

6060 - 6100 Interbedded Shale: medium gray, becoming brownish-gray, as above, and Claystone: pale green and light gray, as above, occasionally with gilsonite blebs, with very thin stringers, Sandstone: medium gray to pale green, fine to medium grained, angular to subangular, fair sorting, locally rare black grains and questionable tripolite, rare glauconite and gilsonite, moderately cemented, locally very slightly calcareous, poor porosity; no shows.

6100 - 6180 Shale: gray-brown to brown-gray, medium hard, blocky, occasionally slickensided and waxy, very locally, very rare, pale orange, well rounded quartz grains and occasionally angular, fine to medium chert fragments as inclusions and very locally rare lenses sandstone, very rare, very thin gilsonite stringers, suggestion of slump structure; interbedded with brown-gray siltstone, rarely calcareous, slightly micaceous, with some black, carbonaceous siltstone and dark brown siltstone becoming light gray, firm to hard, blocky, micromicaceous, and minor Claystone: pale green, as above, and varicolored chert, very locally dolomitic in very thin stringers, brown, hard, dense, argillaceous, and some Dolomite: buff.

6180 - 6215 Interbedded Siltstone, Shale, Claystone and Chert: as above, rare pyrite and locally thin stringers, Sandstone: very light gray, mottled white and brown, occasionally dark gray to black, very fine to fine grained, subangular to subrounded, fair sorting, rare scattered tripolite(?), moderately cemented, dolomitic to calcareous, poor to nil porosity; no show, rare mineral fluorescence.

6215 - 6225 Core No. 6: Cut 10', Recovered 10'

6215.0-6225.0' (10.0') Predominantly Siltstone: dark gray, firm to medium hard, micromicaceous, Shale: dark gray, medium hard; Claystone: pale green, firm, angular chert inclusions 5 to 10 mm, very rarely to 70 x 100 mm, common slump structures and contorted beds apparent where pale green claystone present; common hairline fractures sealed with calcite, others open and slickensided, dipping 0° to 50°; scattered asphaltic residue along fractures with pale yellow fluorescence; rare shows of bleeding gas.

6225 - 6290 Interbedded Siltstone: gray-brown to brown-gray, becoming dark brown to black, organic, some light gray, and Shale: gray, brown to brown-gray, as above, and Shale: dark brown to black, organic, some light gray; locally traces of Sandstone: light gray to medium gray, some light brown, very fine to fine grained, subangular to subrounded, well sorted, moderately cemented, dolomitic to calcareous, locally scattered tripolite, locally very thin stringers of gilsonite, poor porosity, no show, and minor Dolomite: pale green, mottled brown, contorted appearance, dense, dull orange mineral fluorescence; some Chert: pale green, smoky, buff, gray, light brown.

6290 - 6310 Interbedded Siltstone: dark gray-brown, blocky, micromicaceous, dolomitic, occasional chert inclusions, and Shale: dark gray to black, blocky, subconchoidal fractures, in part silty, very minor Claystone: light gray, some pale green, blocky to elongated, in part contorted, and Chert: mossy, gray, pale green, smoky.

6310 - 6345 Interbedded Siltstone: dark brown to black, argillaceous, blocky, organic, and Shale: medium gray to brown-gray, some black, blocky, minor Claystone: pale green and some light gray, blocky, firm, with minor Sandstone: light gray, some mottled light and dark brown, fine grained, subangular to subrounded, moderately sorted, moderately hard, calcareous, poor porosity; no show; Chert: varicolored.

6345 - 6378 Interbedded Siltstone: very dark brown to black, as above, and Shale: medium gray to brown-gray, some black and organic, and Dolomite: calcilutitic, light

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gray, becoming light brown, moderately hard, dense, cryptocrystalline, micropyritic, rarely microcrystalline, dull orange mineral fluorescence, and very minor Chert: varicolored.

6378 - 6413 Siltstone: very dark brown to black, argillaceous, organic, dolomitic to calcareous, blocky, with interbedded Shale: dark gray to black, blocky, organic, and trace Sandstone: black, very fine grained, subangular, very argillaceous and organic, calcareous, very silty, poor porosity; no show.

6413 - 6460 Interbedded Siltstone: medium gray to black, well compacted, blocky, becoming dark brown in part and locally striped brown and white, very calcareous, soft to firm, and Shale: medium gray to black, locally dark brown, firm to moderately hard, blocky, minor limestone, rare Dolomite: mottled white and dark brown, very argillaceous, silty, soft to firm, finely crystalline, and Chert: brown, black.

6460 - 6770 Siltstone: interbedded dark gray to black, locally gray-brown to dark brown, in part organic, shaly, blocky, locally micaceous, rare zones of fine to medium, angular chert, and Shale: dark gray to black, but predominantly gray-brown, blocky, and minor Claystone: pale green, some light gray, platy, waxy, and trace to minor Chert: brown, pale green, black, rare pyrite nodules and clusters, locally traces of Dolomite: buff, cryptocrystalline, dense, and Sandstone: light gray, buff, very fine to fine grained, moderately cemented, locally very argillaceous, locally rare tripolite, generally poor porosity; no show.

6770 - 6800 Shale: medium gray, light gray, moderately hard, with some calcareous veins; interbedded with Siltstone: medium gray, moderately hard, slightly carbonaceous, with rare tan pyritic chert.

6800 - 6840 Siltstone: medium gray, moderately hard, slightly calcareous, slightly pyritic, in part with brown siderite veining and mottling; interbedded with Shale: medium gray, dark gray, slightly calcareous, slightly carbonaceous, locally light gray-green, pyritic, waxy claystone, rare small lithiclast and rare pelecypod shell fragments.

6840 - 6945 Shale: dark gray, moderately hard, with common slickensides, flaky to blocky, with local siderite and calcareous veins, locally contorted bedding, in part grades to medium gray, slightly silty shale with local medium gray, carbonaceous, pyritic siltstone beds and minor chert occurrences, cream, black, brown.

6945 - 7000	Limestone: tan, brown, gray, hard, microcrystalline, tight, with common calcite-filled fractures and dead oil stain on faces, in part siliceous, in part with disseminated pyrite, rare shell fragments and unidentified small, round fossil ghosts; interbedded with Shale: light gray, medium hard, splintery, and Shale: dark gray and medium gray, in part siliceous.
7000 - 7105	Shale: dark gray, hard, siliceous, subconchoidal, commonly fractured with calcite vein filling, locally calcareous and pyritic, with rare, finely ribbed shell impressions (probably Monotis sp.); minor Limestone, Siltstone and Chert: tan, black, occasional pyrite occurrences.
7105 - 7130	Shale: highly mixed (probable cavings), dark gray, medium gray, light gray, gray-brown with siderite veins and patches; traces of light green shale, rare shell imprints.
7130 - 7215	Siltstone: dark gray, medium gray, moderately hard, with rare trace of gilsonite; interbedded with Shale: dark gray, medium hard, flaky to blocky, in part laminated with contorted bedding, and Shale: medium gray and light gray, locally pyritic, locally calcareous; rare shell impressions; Sandstone: trace to 10%, light gray, gray-brown, very fine to fine grained, subrounded, poorly sorted, clear, white, pink, argillaceous with poor porosity; no shows.
7215 - 7305	Siltstone: dark gray, medium gray, gray-brown, micromicaceous, micropyritic, locally laminated with shale, locally calcareous; interbedded with Shale: dark gray, gray-brown, micaceous, locally calcareous, locally siliceous, locally silty, with rare pyrite nodules; trace to 10%, Limestone: tan-brown, hard, microcrystalline; trace of Chert: tan, light gray, brown.
7305 - 7320	Shale: medium gray, medium hard, with tan spots (possibly phosphate pellets), in part dark gray; interbedded with Siltstone: medium gray, medium hard, poorly laminated and contorted, trace to 10% Sandstone: light gray, very fine grained, slightly calcareous, trace dead oil stain; no shows.
7320 - 7360	Shale: brown-gray, hard, flaky, becoming highly siliceous, Shale: medium gray, dark gray, micromicaceous; interbedded with Siltstone: medium gray, medium hard.

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7360 - 7395	Shale: light gray-green, hard, flaky; Shale: brown-gray, and dark gray, locally pyritic, disseminated and nodular, locally highly fractured with dead oil stain; interbedded with Siltstone: medium gray, medium hard, in part banded with dark gray shale.
7395 - 7490	Limestone: tan-brown-white mottled, medium hard, bioclastic, crinoidal grainstone, in part recrystallized; 10% to 20% white-brown, soft, chalky limestone, tight to very poor intercrystalline porosity; no shows; interbedded with Sandstone: white, very fine grained, medium hard, glauconitic, pyritic, with no shows, and Shale: medium gray and light gray-green, pyritic, thin stringers of fossiliferous Chert: white, brown.
7490 - 7565	Dolomite: tan-buff, brown-white, mottled, calcareous, biocalcarenite, cherty, in part brown, medium crystalline, rhombic, fair intercrystalline and small vug porosity; no shows; thin stringers of Chert: white, light gray translucent and buff.
7565 - 7585	Dolomite: brown, hard, slightly cherty, in part with relict biocalcarenite grains, crinoids; thin stringers of Shale: medium gray, dark gray, and Chert: amber to clear, mottled with white flecks.
7585 - 7905	Dolomite: brown-white, mottled, hard, macrocrystalline, medium crystalline mosaic, in part rhombic, Dolomite: brown, hard, micro-macrocrystalline, locally cherty, locally poor porosity, intercrystalline and small pinpoint vug, rare crinoid, no shows; local thin stringers of Sandstone: light to medium gray, very fine grained, argillaceous; Siltstone: medium gray; Shale: medium to dark gray, and Chert: amber, white-clear translucent, tan and brown.
7905 - 7930	Dolomite: brown-gray-white mottled, macrocrystalline, in part brown-gray microcrystalline, tight to poor porosity, no shows, no visible fractures, with thin beds of Sandstone: dark brown, fine grained, dolomitic, argillaceous; chert 5% to 10%, light brown, white translucent.
7930 - 8015	Dolomite: brown-white mottled macrocrystalline, fine to medium crystalline mosaic and rhombic, Dolomite: brown-gray microcrystalline to fine crystalline, tight to very slight porosity (non-effective); no shows, trace of black dead oil stain, Chert: 5% to 10%, tan, light gray, blue, smoky with brown mottling.

8015 - 8025 Dolomite: white to light gray-brown, mottled, hard, slightly calcareous, with relict crinoid stems, probable bioclastic packstone, with poor porosity, intercrystalline and small vugs; no shows.

8025 - 8038 Dolomite: as at 8015', in part becoming gray-brown, hard, argillaceous, finely crystalline, with interbedded Shale: dark gray, hard, slightly dolomitic.

8038 - 8068 Core No. 7: Cut 30', Recovered 30'

8038.0-8044.5' (6.5')	Shale: dark gray, hard, dolomitic, in part siliceous, with patches of brown dolomite, rare near vertical calcite-filled fractures, rare partly open vertical fractures are discontinuous, traces of black dead oil residue, gassy odor on fresh breaks.
8044.5-8065.5' (21.0')	Dolomite: gray-brown-white mottled, slightly calcareous, with nil to slight porosity, pinpoint to 5 mm vugs.
8065.5-8068.0' (2.5')	Dolomite: brown-white, interbedded with Shale: dark gray, slightly brecciated with dark stain on healed microfractures, poorly developed breakage and bedding dips approximately 30°, several large vugs 0.5 cm to 5 cm occur from 8066.0-8066.5', and are partly filled with medium crystalline sucrosic dolomite, rare partly open horizontal fracture, fair gas odor, trace of dead oil residue; no cut, no fluorescence.

8068 - 8085 Dolomite: gray-brown-white mottled, hard, with rare crinoid stems, poor to nil porosity, rare closed fractures with occasional patches of dark gray dolomitic shale; no shows.

8085 - 8110 Dolomite: tan-white, slightly mottled, pelletal ghosts, probable pelletal packstone, in part with black dead oil residue in interstices, locally brown-gray argillaceous, nil to poor porosity; no shows.

8110 - 8120 Dolomite: as at 8085', in part grading to brown-white mottled, poorly preserved crinoid packstone.

8120 - 8130 Chert: white, milky translucent with traces of microfossils.

8130 - 8165	Dolomite: gray-brown, medium crystalline, argillaceous, with rare crinoids, tight; no shows; locally brown-white mottled, local patches of Shale: dark gray, dolomitic.
8165 - 8215	Dolomite: dark gray-brown, in part mottled, macrosucrosic, medium to coarsely crystalline, hard, dense, argillaceous, and Dolomite: white, becoming mottled white and light gray-brown, pelletoidal, hard, dense, nil porosity, and Chert: white, very hard, conchoidal fracture, interbedded with Shale: black, hard, earthy, blocky, silty.
8215 - 8230	Limestone: white to gray-brown, mottled, fine to medium crystalline, micro to macrosucrosic, hard, dense, rare crinoid debris, in part pelletoidal, nil porosity, and Dolomite: dark gray, some clear, medium crystalline, argillaceous, hard, dense, and interbedded Shale: black, hard, well compacted, micaceous, silty, trace Chert: as above.
8230 - 8250	Limestone: as above, becoming light gray to buff, mottled, dolomitic, cherty, finely crystalline, microsucrosic, pyritic, dense, argillaceous, in part pelletoidal, minor Chert: black, very hard, interbedded with Siltstone: very dark gray to black, hard, dense, well compacted.
8250 - 8270	Shale: black, as above, with interbedded Limestone: white mottled, as above, with microveinlets and blebs of shale, and minor Dolomite: as above, and chert.
8270 - 8280	Shale: as above, with Limestone: as above, and trace Sandstone: clear to light gray, fine grained, quartzitic to quartzite, pyritic, glauconitic, hard, well cemented with silica, slightly calcareous, nil porosity.
8280 - 8315	Predominantly Sandstone: as above, with some Sandstone: brown, hard, fine to medium grained, subrounded, argillaceous, possible rare tripolite, slightly glauconitic, and interbedded shale, grading to Siltstone: as above, and Clay: gray, tan, soft when wet.
8315 - 8330	Predominantly shale, grading to Siltstone: dark gray to black, locally becoming gray-brown, hard, well compacted, rare glauconite, micaceous, with very thin stringers and pods; Sandstone: light gray to clear, speckled green, as above, and Clay: as above, locally with Sandstone: greenish-gray and gray-brown, fine grained, subanguiar, some medium grained, poor sorted, hard, well cemented, in part quartzitic to quartzite, dolomitic, scattered glauconite, micromicaceous.

8330 - 8405	Predominantly Shale: as above, and Siltstone: gray-brown, hard, blocky, argillaceous, in part very finely sandy, and interbedded with thin stringers and pods of Sandstone: as above, and very minor Clay: as above.
8405 - 8445	Limestone: very light gray to white, in part mottled white and dark gray, calcilutitic, with argillaceous microveinlets, firm to brittle, scattered, unidentifiable fossil hash, pelletoidal, dolomitic, pyritic, poor chalky porosity; no show, with local interbeds of Shale: very dark gray, hard, well compacted, dense, blocky, micromicaceous, silty, and minor Siltstone: gray-brown, hard, well compacted, very rare, finely ribbed shell casts, and Chert: very dark brown, black, in part subconchoidal fracture.
8445 - 8475	Predominantly Shale: dark gray-brown, hard, well compacted, in part siliceous, and interbedded Limestone: as above, and Dolomite: mottled white and brown, cherty, in part pelletoidal, local scattered fossil debris, occasional microsucrosic, rarely pyritic, and Chert: black, very dark brown, conchoidal to subconchoidal fracture.
8475 - 8555	Interbedded Dolomite: very dark brown to black locally, becoming gray-brown, in part macrocrystalline, locally fossil hash and relict fossil structures, slightly calcareous, hard, locally mottled tan and brown, hard, slightly calcareous, and Limestone: white, in part mottled and speckled white and dark gray, in part calcilutitic, common fossil hash, in part recrystallized to coarsely crystalline, argillaceous, in part dolomitic, cherty, rare pyrite, nil porosity, and Shale: dark gray-brown, blocky, hard, siliceous, well compacted, and Shale: very dark gray to black, in part organic, hard, in part well compacted, in part silty, and Chert: brown, very dark brown, black, conchoidal to subconchoidal fracture; very locally trace of sandstone, quartzitic to Quartzite: green, very fine to fine grained, well cemented with silica, dolomitic; nil porosity.
8555 - 8565	Interbedded Limestone: mottled, white and gray, and white and tan, as above, and Chert: varicolored, as above.
8565 - 8570	Interbedded Dolomite, Limestone and Chert: as above, and Shale: dark gray to black, blocky, hard, siliceous.

8570 - 8585 Interbedded Dolomite: dark gray to black, sucrosic, finely crystalline, argillaceous, occasionally gilsonite filling pores, occasionally relict fossil structures, slightly calcareous, and Chert: dark brown to black, rarely mossy.

8585 - 8610 Interbedded Shale: very dark brown to black, hard, blocky, well compacted, earthy, and some Shale: brown, hard, with dolomite and rare gilsonite: as above, and Chert: as above.

8610 - 8635 Predominantly Shale: black, hard, well compacted, and Shale (Mudstone): gray to medium gray, firm, in part waxy, becoming slickensided in part, occasional gilsonite veinlets, and Shale: gray-brown, hard, well compacted, rarely pyritic, occasional gilsonite veinlets, and minor Dolomite: as above; trace pyrite clusters at 8635', trace quartz grains, coarse to very coarse, frosted, subrounded, occasionally fractured.

8635 - 8680 Predominantly Shale (Mudstone): medium gray, waxy, in part slickensided, firm to hard, and Shale: dark gray to black, in part earthy, in part well compacted, locally silty, and Shale: gray-brown, locally becoming brown, locally siderite veinlets and inclusions, rare pyrite, rare gilsonite veinlets, rare chert.

8680 - 8690 Predominantly Shale: black, in part silty, organic, slightly pyritic, occasional gilsonite veinlets, in part cherty, rare calcite veinlets, and Shale (Mudstone): medium gray, in part slickensided, well compacted, occasional gilsonite veinlets.

8690 - 8710 Predominantly Shale: black, medium gray, gray-brown, as above; and minor Limestone: white, becoming buff to tan to brown, hard, in part siliceous, dolomitic, argillaceous, and traces pyrite nodules.

8710 - 8730 Shale: black, medium gray, gray-brown, brown, as above; scattered gilsonite veinlets and occasional siderite.

8730 - 8740 <u>Core No. 8: Cut 10', Recovered 8.5'</u>

8730.0-8731.0' (1.0') Shale: dark gray-brown, well compacted, blocky to subfissile, in part subconchoidal, fracture, common gilsonite veinlets.

8731.0-8734.0' (3.0') Shale: very dark gray to black, hard, well compacted, with gilsonite along slickensided fractures and

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	parting planes, of highly variable dip to maximum of 60°, with excellent dip at 8732' of 50°, becomes slightly earthy 8731.5-8733.0'.
8734.0-8735.0' (1.0')	Shale: very dark brown, hard, siliceous, common to abundant gilsonite along fractures and cleavage planes, micaceous.
8735.0-8736.0' (1.0')	Shale: black, as above.
8736.0-8738.5' (2.5')	Shale: very dark gray-brown, hard, well compacted, pseudo-siliceous, micropyritic, commonly slickensided and fractured, scattered to common gilsonite, rare to scattered pyrite pods.
8738.5-8740.0' (1.5')	No recovery.
8740 - 8775	Shale: brown to gray-brown, hard, well compacted, occasional siderite veinlets and pods, occasional gilsonite veinlets, rare pyrite clusters; interbedded Shale (Claystone): medium gray, hard, occasional abundant gilsonite veinlets, in part slightly silty, rarely slickensided, and Shale: black, firm to hard, organic, occasional abundant gilsonite, occasional clusters of oolites(?), traces of loose pyrite clusters.
8775- 8800	Shale: brown to gray-brown, black, and Shale (Claystone): medium gray, as above, and locally Shale: very dark gray, hard, blocky, well compacted and trace of quartz grains, very coarse, subrounded, clear to slightly milky, in part fractured, and trace Siltstone: black, soft, very argillaceous.
8800 - 8810	Predominantly Siltstone: very dark brown-black to black, very argillaceous, organic, soft to firm, blocky, possible phosphate pellets, grades to Shale and interbedded Shale: as above, with siderite veinlets and gilsonite.
8810 - 8825	Predominantly Shale: as above, and Siltstone: as above.
8825 - 8855	Predominantly Siltstone: very dark brown-black to black, organic, soft to firm, very argillaceous, rare gilsonite and siderite veinlets, rare micropyritic, possible phosphate pellets, earthy, and interbedded Shale: as above.

8855 - 8865 Predominantly Shale: as above, and Siltstone: as above.

8865 - 8895 Predominantly Shale: very dark brown-black to black, organic, firm to hard, very silty, micropyritic, in part subconchoidal fracture, slightly earthy, rare gilsonite; interbedded with Siltstone: very dark brown-black to black, organic, firm to hard, micropyritic, very argillaceous, rare pyrite veinlets, possible phosphate pellets.

8895 - 8910 Shale: very dark brown-black to black, as above, and Shale: gray-brown to brown, hard, well compacted, micropyritic, rare pyrite veinlets, blocky, very minor Clay: buff, silty, very soft when wet, and Shale: medium gray, in part silty, rare siderite, rare calcite veinlets, and minor Limestone: mottled white and very dark brown, dolomitic, finely crystalline, very argillaceous, blocky, firm to hard.

8910 - 8930 Shale: very dark brown to black, hard, well compacted, micropyritic, in part siliceous, and Siltstone: gray, tan, very argillaceous, soft when wet, becoming Siltstone: gray-brown.

8930 - 8940 Shale: very dark brown-black to black, and Siltstone: gray-brown, as above, and Shale: gray-brown, hard, well compacted, finely silty, blocky, rarely micropyritic.

8940 - 8950 Shale: very dark brown-black to black, as above; and minor Limestone: white mottled and speckled black, dolomitic, firm, very finely crystalline, very slightly argillaceous.

8950 - 8965 Shale: black, as above, and Shale: gray-brown, as above, and Claystone: gray-tan becoming medium gray, hard, rare siderite, rare micro black specks, occasional gilsonite veinlets.

8965 - 8975 Shale: black, and Shale: gray-brown, as above.

8975 - 9000 Shale: black, and Shale: gray-brown, as above; interbedded with Claystone: medium gray to green-gray, becoming light gray to tan-gray, smooth, in part slickensided, slight conchoidal fracture, rare siderite, rare gilsonite, and some Siltstone: gray-brown, argillaceous, dolomitic, firm, occasional trace of pyrite clusters.

9000 - 9010 Shale: very dark brown-black, hard, blocky, rare subconchoidal fracture, rare gilsonite, rare siderite, silty, occasional pyrite veinlets, micropyritic, and

Claystone: light gray to tan, hard, well compacted, in part slickensided, platy, rare micropyritic, rare siderite, rare gilsonite, very locally Limestone: brown, hard, siliceous, dolomitic, dense, becoming Dolomite: brown, mottled tan and brown, sucrosic, medium crystalline: hard, dense.

9010 - 9030 Shale: dark brown to very dark brown, and Limestone: white and brown, becoming buff, dolomitic, abundant recrystallized fossil hash, hard, occasional black residue, some relic fossil structures, dense, and some Shale: black, hard, well compacted.

9030 - 9050 Limestone: gray-tan to brown, mudstone, dolomitic, siliceous, hard, dense, and Limestone: buff, abundant lime mud, dolomitic, common fossil hash, recrystallized, and Limestone: mottled buff and light gray and white and light gray, common recrystallized lime mud, occasionally abundant fossil hash, firm to hard, occasional black residue, locally Dolomite: mottled light and dark brown, hard, recrystallized, mudstone, common fossil hash, and Shale: very dark brown, very silty, firm to hard, blocky, in part siliceous, and locally Mudstone: gray, some siderite, and gilsonite.

9050 - 9085 Limestone: tan to light brown, Mudstone: hard, dolomitic, siliceous, dense, and Limestone: light gray to buff, locally cream, in part recrystallized lime mud, very finely crystalline, hard, dense, and Shale: dark gray-brown to brown, hard, well compacted, rare siderite, rare mollusc impressions, possibly Monotis sp., in part silty, and Shale: black, hard, well compacted, in part siliceous, silty, in part earthy, organic, and locally Siltstone: black, firm to hard, argillaceous, organic, in part siliceous, micropyritic, and Chert: black, and Shale: gray-brown, in part siliceous.

9085 - 9095 Shale: black, as above; interbedded with Shale: brown to gray-brown, in part siliceous, hard, dense, and Siltstone: very dark brown-black to black, very argillaceous, organic, firm.

9095 - 9105 Predominantly Siltstone: very dark brown-black to black, as above, and Shale: black, as above, and Claystone: light gray, smooth, in part slickensided, rare siderite.

9105 - 9125 Predominantly Shale: black, becoming dark brown-black, hard, well compacted, organic, in part silty, micropyritic, rare coarse ribbed mollusc imprints, and other unidentified fossil casts, occasional calcite veinlets, and Siltstone: black, becoming very dark brown-black, in part gray-brown, organic, very

	argillaceous, firm to hard, micropyritic, rare calcite veinlets, and minor Limestone: light brown, very finely crystalline, recrystallized lime mud, slightly dolomitic, hard, dense, and locally Dolomite: brown, medium crystalline, sucrosic, argillaceous, and Chert: black, some brown.
9125 - 9155	Predominantly Siltstone: very dark brown-black to black, as above, and Shale: black, earthy, firm to hard, micropyritic, organic, and Chert: black, and very locally Limestone: brown, dolomitic, very finely crystalline, hard, dense, and Shale: gray-brown, hard, subfissile, and Shale: light to medium gray, platy, hard.
9155 - 9165	Predominantly Siltstone: very dark brown to black, as above, interbedded with Shale: black, as above, and minor Claystone: gray-brown, smooth, rare siderite and black chert.
9165 - 9205	Predominantly Shale: very dark brown to black, blocky, siliceous, micropyritic, rare pyrite veins, silty, rare gilsonite, and calcite on fractures, occasional calcite veins, rare mollusc casts, interbedded with Siltstone: black, hard, organic, very argillaceous, micropyritic, in part mottled white and black, abundant calcite, and Chert: black, brown, occasional calcite veinlets.
9205 - 9240	Shale: very dark brown, becoming black, hard, in part

yritic, very silty, and Chert: black and organic, micropy
very dark brown

Shale: very dark brown, very silty, ritic, possibly organic, blocky, and dark brown, very argillaceous, blocky, t: black and very dark brown, locally , Dolomite: very dark brown, very ne, microsucrosic, hard, argillaceous, ganic material, pyritic, rare fossil hash

9240 - 9265	Predominantly hard, micropy Siltstone: very hard, and Che minor stringers finely crystalli possibly some or

Shale: black, hard, in part silty, nd Siltstone: black, hard, very ropyritic, dolomitic, and Chert: black, ccasionally with calcite veinlets, very very dark brown, as above.

9265 - 9335	Predominantly micropyritic, argillaceous, mic rare brown, o locally Dolomite:

Shale: very dark brown, slightly tly silty, firm to hard, micropyritic, siliceous, and Siltstone: very dark ally mottled white and brown, very mitic, very argillaceous, firm to hard, ck, very dark brown, black, some gray

9335 - 9370	Predominantly dolomitic, sligh locally in part brown, occasio calcareous, dol and Chert: bla

and gray-brown, and Claystone: light gray, locally light brown, hard, well compacted, occasional siderite and gilsonite veinlets, and locally Shale: brown, well compacted, rare gilsonite.

9370 - 9425 Abundant Chert: black, brown, gray and varying amounts light gray claystone, very dark brown shale, Siltstone: dark brown, as above, and minor Dolomite: light gray to buff, in part soft, locally some recrystallized fossil hash.

9425 - 9455 Predominantly Shale: dark brown, blocky, hard, micropyritic, locally very silty, locally possibly phosphatic pellets, and Siltstone: very dark brown, argillaceous, probably organic, dolomitic, very locally common recrystallized fossil hash, and Shale: brown, elongated fragments, hard, and Claystone: light gray, as above.

9455 - 9485 Predominantly Shale: black, silty, firm to hard, micropyritic, blocky, in part dolomitic, and Siltstone: black, very argillaceous, micropyritic, and Claystone: light gray to gray-brown, slightly waxy, hard, some siderite, and rarely Claystone: pale green, siliceous, hard.

9485 - 9510 Predominantly Siltstone: dark brown to very dark brown, as above, and Shale: black, as above, and Shale: brown, hard, subfissile, and Claystone: as above.

9510 - 9555 Predominantly Claystone: light gray, gray, gray-brown, in part slightly waxy, gilsonite and siderite veins, and Shale: black, as above, with gilsonite, and Shale: gray, hard, subfissile, and Siltstone: black, becoming dark brown, firm, dolomitic, black and dark brown, very soft, silty, disperses in mud system.

9555 - 9585 Predominantly Clay: dark brown, soft to firm, very argillaceous, and Siltstone: speckled brown and white, soft, argillaceous, very calcareous, and Shale: brown, black, as above, and Claystone: gray-brown, as above, rarely Dolomite: mottled white and brown, very fine crystalline, microsucrosic.

9585 - 9590 Predominantly Shale: gray-brown to black, locally dark brown, hard, in part siliceous, micropyritic, blocky, and Clay (bentonite?): white, locally light gray, soft to firm, noncalcareous, slightly pyritic, and Chert: gray-brown, locally Dolomite: buff, hard, very finely crystalline, microsucrosic.

9590 - 9610	Shale: dark brown to black, hard, in part siliceous, micropyritic, blocky, and Clay (bentonite?): white, soft to firm, noncalcareous, slightly pyritic, and Chert: gray-brown, some black, occasionally light gray, rare calcite veinlets.
9610 - 9630	Shale: gray-brown, as above, in part siliceous, hard, becoming Claystone: light gray to gray-brown, rarely pale green, micropyritic, slightly siliceous, rare siderite, and Shale: dark brown, in part silty, blocky, hard, pyritic, some gilsonite, grades to Siltstone: dark brown, hard, very argillaceous, minor Clay (bentonite?): as above, and Chert: gray-brown.
9630 - 9650	Predominantly Claystone: pale green, slightly waxy, very siliceous, hard, micromicaceous, and Clay (bentonite?): as above, and Siltstone: dark brown, hard, very argillaceous, and Claystone: gray-brown, rarely micropyritic, hard, smooth, and Shale: dark brown, hard, blocky and tan chert.
9650 - 9660	Shale: black, becoming dark gray, hard, blocky, slightly silty, possibly organic, and Shale: gray-brown, slightly waxy, hard, blocky, and clay (bentonite?) and Claystone: pale green, siliceous, trace pyrite clusters and nodules.
9660 - 9670	Clean, very [illegible]

tone [illegible] quartz [illegible] clean [illegible] fine [illegible] sands
ately well sorted, hard, moderately well cemented
silica, dolomitic, scattered to common bright green
s, possibly glauconite, pyritic, poor porosity, 176
gas, and Limestone: white, chalky, dolomitic,
ly argillaceous, soft to firm, and traces of
ite: white to mottled buff and dark brown, very
ely crystalline, macrosucrosic, in part argillaceous,
o hard.

itic Limestone: white, becoming mottled white and
brown, fine to medium crystalline, locally very
ely crystalline, argillaceous, occasionally
stallized fossil hash, some recrystallized crinoid
s, hard, and minor Shale: dark brown, hard, well
acted, occasional recrystallized fossil hash,
ional gilsonite(?), and Chert: very dark brown,
, and trace Chert: mottled tan and brown, rare
age planes, rare rhombohedral ghosts, glassy,
onchoidal fracture, common to abundant dark brown
ic inclusions.

ominantly Chert: mottled tan and dark brown, as
e, and some black chert, minor Shale: very dark
n, hard, siliceous, blocky, in part subconchoidal
ure, and some dolomitic Limestone: as above.

9670 - 9715	Dolon dark coars recry debri comp occas black cleav subc orga
9715 - 9728	Pred abov brow fract

9728 - 9738 Core No. 9: Cut 10', Recovered 10'

9728.0-9734.8' (6.8')	Dolomite: very dark brown, very finely crystalline, microsucrosic, very bituminous or organic, very hard, with scattered black chert nodules and rare beds of 1"+ scattered recrystallized shell fragments, rare crinoid fragments, scattered closed fractures sealed with black bituminous(?) material, randomly oriented, with fracture and cavity at 9728', lined with euhedral crystals of calcite and quartz, with an angle of dip of 60°, and a fracture at 9732.5', lined with calcite and possibly quartz crystals, slickensided fractures at 9728.5', 9729.0', 9730.0', 9730.8', 9731.4', 9732.0', 9732.2', 9732.8' 9734.8', dipping 25-30°; abundant randomly oriented hairline fractures sealed with calcite and abundant recrystallized fossil debris in interval 9733.0-9734.8'; rare recrystallized crinoid debris, suggestion of sedimentary structures including current ripples; grain size suggests possibly originally siltstone, replaced by dolomite with prior or subsequent replacement by silica to form chert.
9734.8-9738.0' (3.2')	Abrupt contact with overlying dolomite; Limestone: slightly dolomitic, mottled light and dark brown, very coarsely crystalline, very hard, rare recrystallized crinoid debris; appears very argillaceous between 9736.0-9736.3'; high angle calcite-sealed fracture at 9736.5' dipping 65°; slickensided fracture at 9735.8' dipping 35° and at 9736.2' dipping 10° and several horizontal bituminous or organic sealed fractures at 9736.0'.

9738 - 9740 Limestone: dolomitic, mottled tan and brown, coarsely crystalline as in Core No. 9, nil porosity, and Limestone: very dark brown, very finely crystalline, dolomitic, bituminous or organic material filling pores, very hard, poor porosity; no show, and Shale: black, hard, well compacted, in part silty.

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9740 - 9753	Lost circulation. No samples.
9753 - 9770	Abundant cavings - lithology interpreted; dolomitic Limestone: mottled tan and brown, white and gray, predominantly recrystallized lime mud, in part argillaceous, and Shale: very dark brown, earthy, in part silty, hard, occasional calcite veins, trace free, clear, euhedral calcite crystals, some dolomite (calcareous) brown, drusy crystals.
9770 - 9815	Dolomitic Limestone: white, buff mottled white and very dark brown, primarily recrystallized lime mud, grading to abundant recrystallized fossil fragments, medium to very coarsely crystalline, and Limestone: white, in part chalky, scattered to common fossil debris, soft to firm, rare argillaceous veins, becomes more crystalline below 9805', and Shale: black, locally very dark brown, dolomitic, hard, well compacted, blocky and clear, euhedral calcite crystals, decreasing downward.
9815 - 9825	Limestone: white to buff, and mottled and streaked dark gray, with argillaceous material, abundant recrystallized lime mud, common recrystallized fossil fragments, and Limestone: mottled light and dark brown, in part dolomitic, medium to very coarsely crystalline and dolomite, grading to Limestone: black and mottled white and black, scattered fossil debris, very argillaceous, occasional calcite veins, hard, dense, and locally Shale: very dark brown to black, dolomitic, very hard, blocky.
9825 - 9855	Limestone: white and mottled white and dark gray, as above, and Limestone: buff, as above, and Limestone: dolomitic, mottled white and black, fine, rarely coarse fossil debris, and Chert: very light tan, hard, glassy, and Shale: black, dolomitic, trace clear, calcite rhombs, and Limestone: chalky, white, soft to firm, very fine recrystalline lime mud, rare to scattered inclusions of medium to coarse crystalline, possible recrystallized fossil debris.
9855 - 9880	Predominantly Chert: tan, mottled tan and brown, in part glassy, and Limestone: mottled white to buff, as above, and Limestone: dolomitic, mottled black and white, hard, fine to medium crystalline, argillaceous, becoming dolomite, calcareous, mottled black and white, very hard, fine to medium crystalline, and Shale: very dark brown to black, in part silty, hard, blocky.
9880 - 9905	Dolomite: mottled tan and very dark brown, becoming locally black and white, fine to medium crystalline, rarely coarsely crystalline, micro-macrosucrosic, in part

cryptocrystalline and siliceous, in part argillaceous, common to abundant dolomite rhombs, and Shale: black, in part dolomitic, with scattered to common dolomite rhombs, in part grades to dolomite, in part micropyritic, and with more pyrite veins, occasional gilsonite, probably organic, in part earthy, very rare, very fine ribbed fossil casts, and Chert: tan, some buff, and mottled tan and brown.

9905 - 9920 Dolomite: mottled white and brown, and white and black, some brown, as above, and Dolomite: siliceous, tan to brown, crypto-microcrystalline, microsucrosic in part, very hard with probable incomplete silicification of dolomite rhombs, and Shale: very dark brown to black, very siliceous, very hard, micro-vugs lined with drusy crystals, possible dolomite replaced by silica, occasional coarsely crystalline, rare veins, clear quartz, Chert: as above, and siliceous Dolomite: light brown, as above.

9920 - 9990 Dolomite: mottled white and gray, white and light brown, white and black, very dark brown, black, medium to coarsely crystalline, rare calcite veins, rare quartz veins, in part argillaceous, and Shale: very dark brown becoming locally black, very hard, micro-vugs lined with drusy crystals, in part siliceous, and Chert: light tan, as above, and siliceous Dolomite: as above.

9990 -10,010 Dolomite: predominantly very dark brown, some light brown, very fine to coarsely crystalline, rare very coarsely crystalline, rare recrystallized crinoid fragments, very argillaceous, very siliceous, and Shale: very dark brown, very hard, in part earthy and siliceous, and Chert: light tan, as above.

10,010-10,025 Dolomite: white and brown, brown, dark brown, black, fine to medium crystalline, in part common to abundant dolomite rhombs, very hard, argillaceous, and Shale: dark brown, earthy, siliceous, very hard, Chert: tan.

10,025-10,070 Dolomite: mottled white and brown, white, white to gray, very dark brown, very fine to medium crystalline, occasionally very coarsely crystalline, in part cryptocrystalline, very hard, in part very dense, very argillaceous, occasionally scattered to abundant dolomite rhombs, rare disseminated pyrite, and Chert: mottled tan and brown, tan, occasional rhomb ghosts, some light brown, very finely crystalline to cryptocrystalline, questionable very fine dolomite rhombs having sucrosic texture, probably incomplete silicification, and Shale: very dark brown, very hard, occasionally slightly dolomitic, siliceous.

10,070-10,165 Dolomite: calcareous, brown to very dark brown, medium to very coarsely crystalline, in part very argillaceous, rare calcite veins, and Shale: very dark brown, siliceous, blocky, becoming black, hard, siliceous, blocky, and Chert: light brown, tan, some buff, in part very fine to cryptocrystalline, dolomite rhombs, possible incomplete silicification, very rare quartz veins.

10,165-10,185 Limestone: mottled white and very dark gray, white, firm, in part soft, in part chalky, fine to medium crystalline, occasionally coarsely crystalline, very argillaceous, occasional crinoid fragments, abundant recrystallized fossil fragments, and Limestone: buff to light brown, predominantly recrystallized lime mud, firm to hard, and Dolomite: light brown, medium to coarsely crystalline, hard, with interbedded Shale: very dark brown to black, in part calcareous, in part siliceous, scattered dolomite and calcite rhombs, in part micropyritic with occasional very thin quartz veins.

10,185-10,200 Predominantly Dolomite: light to dark brown, in part black, medium to coarsely crystalline, hard, some very coarsely crystalline, occasional gilsonite, rare calcite veins, and very minor Limestone: white, and white and black, as above; rare vugs in dolomite lined with euhedral dolomite rhombs and occasional clear calcite veins in both dolomite and shale.

10,200-10,220 Dolomite: dark brown to black, some light brown, medium to coarsely crystalline, hard, argillaceous, some gilsonite, rare clusters of euhedral dolomite rhombs, probably vug lining, occasional clear calcite veins, occasional angular chert inclusions, and Shale: very dark brown to black, hard, occasionally scattered dolomite rhombs, occasionally micropyritic, occasionally clear calcite veins, some Chert: mottled white and brown, light and dark brown.

10,220-10,245 Dolomite: white, hard, medium to coarsely crystalline and brown, mottled white and brown, white and gray, black, medium to coarsely crystalline, some gilsonite, very hard, and Chert: white, mottled white and brown, some brown, hard, in part glassy, dolomite rhombs as inclusions, and some Chert: mottled brown, earthy; Shale: very dark brown to black, as above.

10,245-10,365 Dolomite: mottled very dark brown to black and white, calcareous and black, some white, medium to coarsely crystalline, hard, abundant gilsonite, siliceous,

occasional veinlets of clear calcite, and Shale: very dark brown, black, hard, in part siliceous, occasional calcite veinlets, abundant gilsonite, very minor Chert: mottled white and dark brown, some white, light gray, brown, very locally Limestone: mottled white and very dark gray to black, chalky, soft, argillaceous.

10,365-10,545 Dolomite: white and mottled and streaked white and very dark brown to black, in part slightly calcareous, in part siliceous with incomplete silicification of dolomite rhombs, medium to coarsely crystalline, common to abundant gilsonite, and Shale: black, gilsonitic, hard, occasional clusters of euhedral dolomite rhombs, and very minor Chert: white with dolomite rhomb inclusions, mottled white and brown, buff, brown and very light gray, very locally Limestone: mottled white and very dark gray to black veins of argillaceous material, or gilsonite: soft, chalky; chert increases sharply to more than 30% below 10,460' and decreases to less than 10% below 10,520'.

10,545-10,580 Dolomite: buff to light brown, fine to medium crystalline, occasionally coarse crystalline, very hard, in part siliceous and very minor Shale: brown to black, earthy, and Chert: buff to light brown.

10,580-10,630 Limestone: tan to brown, some mottled buff to dark brown, firm, predominantly recrystalline lime mud, argillaceous, some banded very light and dark- gray, very finely crystalline, to microcrystalline, some recrystallized fossil hash, rare crinoid fragments, and Shale: brown, dolomitic, hard.

10,630-10,715 Dolomite: calcareous, brown, cryptocrystalline, some medium crystalline, scattered fossil debris, occasional scattered medium dolomite crystals, and Shale: very dark brown, hard, blocky, calcite crystals, white, euhedral.

10,715-10,765 Limestone: gray-tan, in part mottled white, becoming brown, very finely microcrystalline, firm, occasionally abundant fossil fragments, occasional calcite veins, predominantly recrystallized lime mud, argillaceous, and Limestone: mottled white and gray, scattered recrystallized fossil debris, micro-cryptocrystalline, lime mud, occasional crinoid fragments, and minor Shale: brown to dark brown, in part siliceous, occasional calcite vein, some black, micropyritic, hard, blocky and scattered calcite crystals.

10,765-10,810 Predominantly Dolomite: brown, occasionally mottled white and brown, finely crystalline, some very coarsely crystalline, rare gilsonite on fracture surfaces, and Shale: brown to very dark brown, hard, blocky.

10,810-10,870 Predominantly Limestone: brown, predominantly recrystallized lime mud, firm to hard, occasional rare fossil fragments, and Dolomite and Shale: as above, and Limestone: mottled and streaked white and gray, soft, argillaceous, chalky.

10,870-10,935 Shale: predominantly dark brown, occasionally black, soft to firm, in part hard, earthy, micropyritic, poor to moderately compacted, occasional calcite veins, and some free calcite.

10,935-10,965 Shale: dark gray-black, in part with brown cast, hard, slightly silty, commonly micropyritic, occasional pyrite lenses, and calcite veins, blocky, rare slickensided, with thin stringers of Limestone: tan-brown, dark brown, hard microcrystalline, micropyritic and with trace of black and clear chert, and trace of Sandstone: light gray, very fine grained, glauconitic.

10,965-10,969 Chert: light gray-buff, flaky, micropyritic.

10,969-11,005 Predominantly Shale: dark gray to black, hard, in part medium hard, silty, minor medium gray, light gray, firm, earthy shale, thin stringers of Limestone: light gray-white, medium hard, fine to medium crystalline, in part silty, tight, no shows; Chert: black, clear; Siltstone: light gray, firm, calcareous.

11,005-11,035 Shale: dark gray, hard, slightly calcareous, blocky, with rare disseminated pyrite, in part medium gray, medium hard, with traces of light gray, soft, earthy shale.

11,035-11,100 Limestone: tan-brown, hard, micro-cryptocrystalline, in part cherty, with small round unidentified fossil ghosts and probable Monotis sp. shell debris, occasional buff to light gray fine crystalline recrystallized limestone occurs, minor Chert (10-30%): clear, tan, black, rare traces of glauconite and siderite; minor Shale beds (10-20%): dark gray, hard, slightly calcareous with occasional Monotis sp. shell impressions; no shows, no porosity.

11,100-11,130 Limestone: buff to light gray, fine crystalline recrystallized, medium hard, in part with micro-fine crystalline pyrite; interbedded with Shale: dark gray,

hard, blocky, in part siliceous, and Chert: dark gray, black, clear with conchoidal fracture, occasional Monotis sp. impressions were noted in shales and rare trace of glauconite.

11,130-11,162 Shale: dark gray-black, hard, slightly calcareous, slightly silty, in part siliceous, common Monotis sp. impressions, rarely slickensided, locally common micropyrite and pyrite lenses, locally microlaminated bedding minor (0-10%), Chert: tan, black, dark gray.

11,162-11,173 Core No. 10: Cut 11', Recovered 11'

11,162.0-11,167.0' (5.0') Shale: dark gray-black, hard, slightly calcareous, siliceous, slightly contorted microlaminations, rare, small closed calcite vein, occasional patch of black chert, good dips of 25-30° noted.

11,167.0-11,170.0' (3.0') Shale: as above with thin calcite laminations or bedding plane becoming common.

11,170.0-11,173.0' (3.0') Shale: dark gray to black, as above, becoming highly fractured with large random calcite-filled fractures, some partly open (2-1/2" x 1") with drusy calcite surfaces, common vertical and horizontal slickensides, possible trace of graphite; no shows.

11,173-11,185 Shale: dark gray, hard, siliceous, slightly calcareous with common calcite-filled fractures, some free euhedral calcite, minor black chert.

11,185-11,235 Siltstone: dark gray-brown, medium hard, slightly calcareous, with common free calcite, local soft brown earthy shale, local patches of disseminated micropyrite, interbedded with Shale: dark gray, gray-brown, hard to medium hard, calcareous, in part siliceous, in part silty, with common calcite fracture fill and free euhedral crystals; trace to 10% black chert, rare Monotis sp. impressions.

11,235-11,265 Shale: dark gray-black, hard, calcareous, slightly silty, disseminated micropyrite, with thin pyrite lenses, calcite veins, in part firm, gray-brown, in part siliceous, interbedded with Siltstone: dark gray, hard, slightly calcareous, commonly micropyritic; Chert (10-20%): light gray with disseminated pyrite, black.

11,265-11,270	Chert: dark gray, pyritic, clear to tan, pyritic, black.
11,270-11,300	Shale: dark gray, hard, slightly calcareous, siliceous; with minor brown-gray, soft, earthy shale, interbedded with Siltstone: dark gray, hard, slightly calcareous.
11,300-11,320	Chert: light gray, medium gray, pyritic, with dark stain on fractures.
11,320-11,355	Shale: dark gray, hard, medium hard, silty, in part siliceous, non to slightly calcareous, interbedded with Siltstone: dark gray, medium hard, slightly calcareous, locally microlaminated, local micropyrite.
11,355-11,375	Shale: light gray-green, hard, siliceous, pyritic, interbedded with dark gray shale, and Siltstone: rare fracture with dark stain; local patches of Clay: light gray, soft, earthy.
11,375-11,380	Limestone: brown, hard, microcrystalline with black bituminous deposit in microfractures; Shale: dark brown, hard with probable ostracod; Shale: dark brown-gray, firm, flaky, micropyritic, micromicaceous.
11,380-11,460	Siltstone: dark gray, medium hard, slightly calcareous, local micropyrite, local microlaminations, locally dark gray-brown, micromicaceous, grades in part to Shale: minor brown to gray, firm earthy shale, thin dolomite stringers, buff, brown, argillaceous, microcrystalline.
11,460-11,475	Shale: medium gray, hard, siliceous, with small tan disseminated phosphate pellets, in part Shale: brown, hard, siliceous, blocky with small tan and rare large brown phosphate pellets.
11,475-11,500	Chert: tan-brown, light gray, in part gradational with siliceous Shale: in part with small tan to large brown phosphate pellets, rare dark stained hairline fractures, local pyrite.
11,500-11,525	Shale: light gray-green, light to medium gray, firm to medium hard, micropyritic, in part with pink laminations and small pink, phosphate pellets, occasional trace of white soft clay.
11,525-11,530	Clay: white, soft, earthy, disperses slightly in mud system.
11,530-11,545	Sandstone: white to light gray, very fine grained, silty, medium hard to hard, slightly dolomitic, with disseminated micropyrite.

11,545-11,555 Sandstone: white, very fine grained, hard, slightly dolomitic, in part with bright dark green glauconite and fine disseminated pyrite, interbedded with Shale: dark brown, hard, slightly dolomitic, and Dolomite: buff, medium crystalline with dusty gilsonite or iron oxide intercrystalline residue.

11,555-11,615 Dolomite: brown-gray, hard, fine crystalline, argillaceous, in part buff, medium crystalline, hard to medium hard, rhombic-mosaic, with fine black flecks, tight to poor porosity, in part silty; no shows; rare Chert nodule: white to buff mottled with unidentified microfossils; thin stringers of medium gray, very fine grained, firm, argillaceous sandstone.

11,615-11,645 Chert: white to brown mottled, translucent, with spines, bryozoa, and unidentified microfossils; Chert: gray-brown mottled, black, amber translucent with microfossils.

11,645-11,675 Dolomite: medium gray, medium hard, fine crystalline sucrosic, argillaceous, in part silty, common black chert nodules, rare calcite-filled fracture, poor porosity; no shows.

11,675-11,686.5 Dolomite: as above, with common black chert nodules.

11,686.5-11,691 Core No. 11: Cut 4.5', Recovered 4'

11,686.5-11,688.5' (2.0')	Chert: black and light gray mottled in large and small patches, with minor Dolomite: medium gray, finely crystalline, argillaceous, with random healed fractures, and local small patches of white calcite, tight; no shows, no dips.
11,688.5-11,690.5' (2.0')	Dolomite: gray-brown, fine crystalline, hard, with common patches and possibly clasts of predominantly black chert and some light gray mottled chert; no shows, no porosity, no dips.
11,690.5-11,691.0' (0.5')	No recovery.

11,691-11,700 Dolomite: brown to gray, fine to medium crystalline, sucrosic, hard, argillaceous, tight to slight porosity, in part with chert replacement, few dolomite rhombs in chert, interbedded with Chert: black-tan-light brown

mottled, and Shale: medium gray, brown, medium hard, with siderite veins, trace with black dead oil stain; no cut.

11,700-11,715 Chert: light brown, mottled, translucent, in part dark brown, blocky, conchoidal fracture.

11,715-11,730 Dolomite: gray-brown, fine to medium crystalline, medium hard, argillaceous, slightly silty, in part buff-brown-white mottled; interbedded with Chert: amber with white flecks, and white, cloudy to translucent.

11,730-11,755 Shale: dark gray, hard, siliceous, in part with scattered dolomite rhombs and calcite inclusions, occasional calcite-filled fracture, rare large crinoid stems; interbedded with Dolomite: gray-brown, fine to medium crystalline, hard, argillaceous, in part buff, medium to coarse crystalline with crinoid stems.

11,755-11,835 Dolomite: brown-buff-white mottled, fine to medium, occasionally coarsely crystalline, hard, tight, with occasional closed and filled fractures, some with surface coat of black gilsonite, rare to fairly common crinoid stems; no shows, thin band or nodules of Chert: light brown-white mottled, some white opaque.

11,835-11,895 Dolomite: gray-brown, fine to medium crystalline, hard, locally brown-buff-white mottled, medium to occasionally coarsely crystalline, tight; no shows; fairly common crinoid stems to rare bryozoa, probable recrystallized packstone-wackestone, thin stringers of Shale: dark gray, hard, siliceous, blocky, and Chert: tan-white mottled, light gray.

11,895-11,940 Dolomite: buff, medium crystalline mosaic, massive, locally brown-gray mottled, medium crystalline, hard, slightly argillaceous, occasional intercrystalline patch or fracture face of gilsonite; thin stringers of Shale: dark gray, hard, siliceous, blocky with occasional calcite inclusions, and Chert: tan, light gray.

11,940-12,092 Dolomite: becoming white-buff, increasingly clean, massive, medium crystalline mosaic, rare possible oolite ghost, occasional patch of intercrystalline gilsonite, tight; no shows, rare fracture with gilsonite coated faces; occasional stringers of Shale: dark gray, hard, with dolomite and calcite inclusions, rare nodules of Chert: white translucent, amber mottled; dolomite becomes slightly calcareous from 11,990'.

12,092-12,155	Dolomite, white with mottled patches of gilsonite, and Shale: fine to medium crystalline, hard, tight, massive; no shows, very rare crenulated shell fragments, local stringers of dark gray-black shale with dolomite inclusions, and Chert: light gray mottled and amber translucent.
12,155-12,165	Shale: medium gray-brown, medium gray with siderite veining, interbedded with Dolomite: buff-white, fine to medium crystalline, hard in part with gilsonite occurring intercrystalline and on fracture faces.
12,165-12,180	Dolomite: white-buff with dark mottling of shale and gilsonite, medium crystalline, hard, tight, with local stringers of Chert: white with dark gray mottling, and Shale: dark gray with dolomite inclusions.
12,180-12,235	Limestone: gray-brown, dark gray, in part tan recrystallized, fine crystalline, argillaceous, slightly dolomitic, tight, rare calcite or gilsonite filled fractures, rare crinoid stems and bryozoa fragments, local patches of brown chert; no shows.
12,235-12,245	Dolomite: gray-brown, dark gray, micro-fine crystalline, hard, argillaceous, calcareous with trace of brown chert.
12,245-12,290	Limestone: gray-brown, dark gray, microcrystalline, medium hard, hard, argillaceous, in part silty, flaggy, with rare calcite-filled fractures; no porosity; no shows.
12,290-12,325	Dolomite: buff-white, medium to coarse crystalline rhombic, highly recrystallized, medium hard, tight, with local patches of intercrystalline gilsonite, with interbedded Limestone: brown, dark gray-brown, hard, micro-cryptocrystalline, occasional trace of Chert: light gray mottled, slightly tripolitic.
12,325-12,385	Limestone: gray-brown, partly recrystallized, microcrystalline, medium hard, slightly dolomitic, argillaceous, with rare poorly preserved crinoid stem; also Limestone (10-20%): dark gray-brown, cryptocrystalline, hard, blocky, siliceous; occasional thin beds of Shale: black, medium hard, hard, siliceous, silty, calcareous, and Chert: dark brown with a conchoidal fracture, rare to fairly common calcite-filled fracture.
12,385-12,405	Limestone: gray-brown, hard, recrystallized fossil fragments, cherty, dense, and Chert: very dark brown to black, and very minor Shale: black, hard, blocky, pyritic.

12,405-12,415 Predominantly Limestone: as above, and some Limestone: black, hard, dense, micro to cryptocrystalline, rare fossil casts, occasional crinoid fragments, argillaceous, dolomitic, and minor Chert: as above, and Shale: dark gray-brown, hard, cherty, siliceous.

12,415-12,425 Limestone: as above, and Limestone: very dark brown to black, hard, recrystallized, fine to medium crystalline lime mud, and Shale: black, becoming dark gray-brown, siliceous, hard, and very minor Dolomite: light gray, medium to coarsely crystalline, hard, cemented with black organic material, and Chert: black, very dark brown, subconchoidal fracture.

12,425-12,435 Predominantly Limestone: gray-brown, in part mottled white and brown, hard, recrystallized lime mud, very finely crystalline, rare to scattered recrystallized shell fragments, in part dolomitic; occasionally calcite lined fractures; interbedded with Shale: medium gray, becoming dark gray to dark gray-brown, hard, blocky, slightly siliceous, silty, in part dolomitic, and minor Chert: black.

12,435-12,445 Predominantly Limestone: light gray, very finely crystalline, recrystallized lime mud, argillaceous, fine to medium grained shell fragments, rare, very small pelecypods, occasionally very thin shale laminae, interbedded with Shale: very dark brown to black, hard, siliceous, calcareous, micropyritic, in part silty, occasionally scattered very fine to fine dolomite rhombs, in part carbonaceous.

12,445-12,485 Limestone: gray-brown, some fossil fragments, occasionally calcite-filled fractures, argillaceous, generally finely to microcrystalline, and Shale: dark brown, silty, medium hard, dolomitic to calcareous, and minor Dolomite: white, coarsely crystalline, hard, some organic material, calcareous, and rare chert blocks.

12,485-12,505 Limestone: dark gray-brown to dark brown, lime mud, in part mottled and banded with dark argillaceous material, very argillaceous, occasional fossil fragments and crinoid fragments, micro to finely crystalline, moderately hard, and Shale: very dark brown, as above, and traces of Chert: black, rare calcite-filled fractures.

12,505-12,525 Limestone: gray-brown, in part mottled white and gray-brown, recrystallized lime mud, microcrystalline, rare, fine to coarse recrystallized fossil fragments, very argillaceous, moderate hard, and Shale: very dark

brown to black, in part siliceous, in part silty and slightly earthy, hard, and rare Chert: black.

12,525-12,580 Limestone: light gray-white, predominantly lime mud, scattered to common recrystallized fossil fragments including some crinoid fragments and rare fossil casts, slightly dolomitic, in part argillaceous, and Shale: very dark brown, hard, siliceous, blocky, occasionally dull luster, locally micropyritic, in part dolomitic, and dolomite rhombs, clear, euhedral crystals in a black organic matrix, generally medium rare, coarsely crystalline, sucrosic, calcareous.

12,580-12,615 Limestone: buff to brown, coarsely crystalline, recrystallized fossil fragments in lime mud matrix, slightly dolomitic, rare crinoid fragments, and Shale: as above, and occasional chert.

12,615-12,655 Limestone: gray-brown, predominantly recrystallized lime mud, finely crystalline to microcrystalline, rare fossil fragments, rare very thin calcite-filled fractures, dolomitic, argillaceous, and Shale: very dark brown to black, siliceous, silty, dolomitic, and Chert: very dark brown to black, subconchoidal fracture.

12,655-12,695 Limestone: buff to light brown, medium crystalline to coarsely crystalline, recrystallized fossil fragments and recrystallized lime mud, medium hard, in part argillaceous, rare crinoid fragments, and Shale: very dark brown, siliceous, medium hard to hard, blocky, silty, and Chert: brown speckled black, some buff and very dark brown to black.

12,695-12,725 Limestone: gray-brown to brown, locally mottled white and gray-brown, finely crystalline, locally medium, very coarse fossil fragments including rare crinoid fragments, hard, argillaceous, dolomitic, and traces of dolomite rhombs, clear, euhedral fine to medium crystalline, sucrosic occasionally gilsonitic, and Shale: very dark brown, as above.

12,725-12,750 Dolomite: white and mottled white and light gray-brown, medium to coarsely crystalline, firm to medium hard, macrosucrosic, calcareous, in part argillaceous, and Shale and Chert: as above.

12,750-12,760 Shale: very dark brown, in part black, medium hard, in part cherty, in part silty, in part slightly siliceous, calcareous, and with Dolomite: white, as above.

12,760-12,780	Dolomite: very dark brown, micro to cryptocrystalline, medium hard, argillaceous, and Limestone: mottled light and dark gray, predominantly lime mud, very argillaceous, firm, dense, and Limestone: gray-brown, very dolomitic, medium to coarsely crystalline, banded and mottled with argillaceous material, and Shale: as above, and Chert: black, subconchoidal fracture.
12,780-12,805	Limestone: as above, and Shale: very dark brown, earthy, silty, dull luster, occasionally questionable microfossils, very rare large ribbed fossil casts, and other fossil fragments, dolomitic, locally blue-gray, fine to medium chert nodules.
12,805-12,830	Limestone: gray-brown, very finely crystalline, locally rare to scattered medium grained fossil fragments, argillaceous, firm to medium hard, locally rare to scattered microfossils, and Limestone: brown to very dark brown, microcrystalline, predominantly lime mud, occasionally common fossil fragments, argillaceous, and minor Dolomite: brown to dark brown, finely crystalline, microsucrosic, argillaceous, and Shale: very dark brown, as above, and Chert: very dark brown to black, subconchoidal fracture.
12,830-12,855	Limestone: buff to light brown, medium crystalline, common fossil fragments, slightly argillaceous, abundant lime mud, and Limestone: dark brown, as above, and Shale: very dark brown, as above.
12,855-12,895	Limestone: mottled white and gray, recrystallized lime mud, rare coarse fossil fragments, slightly argillaceous, and Limestone: dark brown, as above, and Limestone: gray-brown, finely crystalline, very rare calcite-filled fractures, and Shale: very dark brown and black, slightly silty, slightly siliceous, cherty, and Chert: very dark brown and black, and Dolomite: clear, euhedral crystals, fine to medium crystalline, sucrosic, occasional gilsonite filling pores, and Chert: very dark brown and blue-gray.
12,895-12,950	Predominantly Shale: very dark brown to black, slightly siliceous, micropyritic, medium hard, occasionally with black organic material, and Dolomite: clear, euhedral crystals in very dark brown to black organic matrix, very finely crystalline, sucrosic, and Chert: blue-gray, dark brown and mottled clear and dark brown, and locally Limestone: mottled white and gray, medium to coarsely crystalline, dolomitic, medium hard.

12,950-12,980 Limestone: mottled white and brown, becoming buff to light brown, predominantly lime mud, rare to scattered fossil debris, including crinoid fragments, slightly argillaceous, and dolomite rhombs in gilsonite lined medium rehohedral crystals, sucrosic, and Shale: very dark brown to black, in part siliceous, slightly gilsonitic on fractures, micropyritic, and minor Chert: black, blue-gray, subconchoidal fracture.

Limestone: mottled buff and gray-brown, microcrystalline, scattered medium to very coarse fossil fragments, rare crinoid fragments, locally very argillaceous, in part dolomitic, locally quartz lined fractures, local dolomite rhombs, as above. Shale: very dark brown to black, in part siliceous, in part calcareous, occasional chert veins, pyritic, rare microfossils, and Chert: mottled tan and brown, blue-gray. 12,980-13,030

Limestone: mottled and occasionally banded white and dark gray, generally microcrystalline, rare medium to coarsely crystalline recrystallized fossil fragments, slightly argillaceous, occasionally pyritic, and Shale: black, blocky, in part silty, in part micropyritic, occasionally rare to scattered fine to medium fossil fragments, hard cherty dull luster, rare calcite veins. 13,030-13,055

Limestone: light gray, in part mottled light and dark gray, generally microcrystalline, rarely medium crystalline fossil fragments, argillaceous, occasionally pyritic, and Shale: dark brown, in part black, silty, earthy, in part siliceous, dolomitic, medium hard, locally scattered dolomite rhombs. 13,055-13,080

Limestone: light gray to gray-brown, abundant fossil debris, including occasional crinoid fragments, abundant recrystallized lime mud, in part argillaceous, occasionally medium fluted mollusca cast, and Shale: very dark brown to black, as above. 13,080-13,095

Limestone: mottled white and light gray, gray-brown and light gray, very coarsely crystalline, abundant recrystallized fossil fragments including crinoids, pyritic, argillaceous, and Shale: dark brown to black, as above. 13,095-13,125

Predominantly Shale: very dark brown, medium hard, micropyritic, occasionally calcareous and calcite veins, microfossiliferous in part, cherty, and Shale: brown, silty, earthy, soft to firm, occasional calcite veins, and Limestone: white and light gray and gray-brown, abundant fossil fragments, including microfossils and occasional crinoids, in part banded with brown shale laminae, slightly argillaceous. 13,125-13,150

13,150-13,165 Predominantly Shale: as above, and Limestone: mottled and banded light gray and gray-brown, predominantly recrystallized lime mud, occasionally coarse to very coarse fossil debris, medium hard, in part argillaceous.

13,165-13,195 Limestone: light gray-brown, generally, as above, but with common to abundant coarse to very coarse fossil debris, and Shale: dark brown, as above, rare to common microfossils and other fossil debris, silty.

13,195-13,220 Limestone: brown to dark brown, fine to coarsely crystalline, common fossil fragments, including occasional crinoid, occasional common chert fragments, very argillaceous, medium hard, and Limestone: light gray-brown, as above, and Shale: brown, micropyritic, silty, firm to medium hard, rare to scattered microfossils and fine shell fragments.

13,220-13,240 Predominantly Shale: dark brown, micropyritic, rare microfossils, calcareous, in part cherty, and Limestone: gray-brown, fine to medium crystalline, rare to scattered fossil fragments, very rare crinoids, occasionally rare to scattered microfossils, in part argillaceous.

13,240-13,295 Predominantly Shale: black, in part siliceous, rare micropyrite, dolomitic, occasional calcite veins, rarely cherty, and Limestone: light gray, becoming gray-brown, microcrystalline, medium hard, argillaceous, locally large recrystallized fossil fragments, locally pyritic.

13,295-13,310 Predominantly Limestone: gray-white, light gray and mottled white and gray, microcrystalline, firm to medium hard, argillaceous, in part very argillaceous, slightly dolomitic, and Shale: very dark brown, silty, micropyritic, blocky, slightly siliceous, occasional thin calcite veins.

13,310-13,325 Predominantly Shale: as above, occasionally with abundant dolomite rhombs, and Limestone: as above, and clear euhedral dolomite rhombs, microcrystalline, sucrosic, argillaceous, dense, and Chert: very dark brown.

13,325-13,340 Predominantly Chert: brown to dark brown, veined with gilsonite, subconchoidal fracture, rare coarse pyrite cubes, and Shale: as above, and dolomite rhombs in black matrix, euhedral crystals, and minor Limestone: as above.

13,340-13,355	Shale: dark brown to black, in part silty, micropyritic, pods and thin veins of gilsonite, and some Chert: as above, and Limestone, as above; Clay: light gray-brown, light gray, banded light and dark gray, possibly kaolinitic, soft to firm, slightly calcareous, in part argillaceous, in part pyritic.
13,355-13,370	Predominantly Chert: gray-green, some tan, black, subconchoidal fracture, micropyritic, and Shale: as above, and Clay: white, gray, as above.
13,370-13,405	Predominantly Shale: very dark brown to black, as above, locally minor chert and dolomite rhombs, as above, and Clay: light gray (possibly kaolinite) in part banded light and medium gray, soft, slightly water soluble, and Claystone: light gray-brown, becoming gray-green, micropyritic.
13,405-13,435	Predominantly Siltstone: very dark brown to black, in part soft, argillaceous, micropyritic, and grades to Shale: as above, and Claystone: as above, and Clay: as above.
13,435-13,480	Shale, Siltstone and Claystone: as above, and Limestone: mottled white and gray, some brown, microcrystalline, cryptocrystalline, argillaceous, local traces of dolomite rhombs, clear, fine, euhedral crystals.
13,480-13,513	Shale: dark brown, silty, well compacted, micropyritic, medium hard, and Siltstone: dark brown, argillaceous, moderately hard, and Mudstone: brown and microlaminated brown and white, very soft, deaggregates readily in water, dolomitic to calcareous, locally becomes the common rock constituent, locally Dolomite: brown, microcrystalline, sucrosic and locally clear, fine, euhedral dolomite rhombs, very locally Sandstone: gray-green, fine grained, subangular, well cemented with silica, dolomitic, scattered tripolite, scattered bright green glauconite.
13,513-13,540	Shale, Mudstone: as above, and Limestone: light gray, some brown-gray, buff, microcrystalline, medium hard and clear dolomite rhombs, finely crystalline, microsucrosic, occasionally in black matrix.
13,540-13,555	Predominantly Shale: dark brown, in part silty, micropyritic, dolomitic to calcareous, and Mudstone: brown, banded and microlaminated brown and white, very soft, deaggregating readily in water, calcareous, white, possibly kaolinite.

13,555-13,600.7 Predominantly Shale: as above, with decreasing Mudstone: as above, and Siltstone: dark brown, argillaceous, hard, in part siliceous, calcareous, and minor Limestone: mottled white and gray, finely to microcrystalline, hard, slightly siliceous, in part with poorly preserved fossil fragments.

13,600.7-13,609 Core No. 12: Cut 8.3', Recovered 7.7'

13,600.7-13,608.4' (7.7') Shale: very dark brown to black, very hard, well compacted, subconchoidal fracture, nodules and lenses of pyrite to approximately 1/4", rare pods of questionable, disseminated gilsonite; dips on pyrite lenses 0°, core appears slightly siliceous, with near vertical, closed fracture at 13,601.3-13,604.0' with dip of 80°; at 13,603.0', parallel fractures approximately 1" appear to enclose a healed crumbled (gouge) zone.

13,608.4-13,609.0' (0.6') No recovery.

13,609-13,657 Predominantly Claystone: gray-white, light gray, medium gray, light gray-green, firm in part soft, scattered tripolitic chert, occasional thin lense of Limestone: brown, in part mottled tan and brown, medium to coarsely crystalline, recrystallized fossil fragments, and lime mud, trace of Chert: gray-green, rarely black, brown-gray.

13,657-13,670 Predominantly Chert: brown-gray, with rare dark scattered pellets, possibly phosphate, also Chert: light gray, subconchoidal in part, with rimmed and zoned oolites with a "birds-eye" look, thin stringers of Mudstone: medium gray, flaky, and white-light gray soft claystone.

13,670-13,680 Shale, probably Mudstone: light gray, slightly siliceous, hard with tan-pink microphosphate pellets, minor light gray soft claystone and brown-gray subconchoidal chert.

13,680-13,745 Shale: light gray, medium hard to hard, slightly siliceous, with disseminated micropyrite, locally with a green cast, minor Claystone: light gray, soft, becoming silty at 13,715'.

13,745-13,750 Shale: light to medium gray, hard, slightly siliceous, micropyritic, interbedded with white to light gray, silty, glauconitic claystone, and Chert: tan, white-milky mottled with dark gray stain and closed microfractures.

13,750-13,760 Limestone: buff-tan, medium hard, hard, in part siliceous, recrystallized, tight; no shows; interbedded with Shale: light gray to medium gray, silty, and Chert: tan, white, clear, trace of Siltstone: light gray with glauconite and disseminated pyrite.

13,760-13,785 Predominantly Dolomite: light gray, finely crystalline, sucrosic, with intercrystalline Gilsonite: firm to medium hard, slight visible porosity; no shows; rare crinoid; interbedded with Chert: dark gray-brown, subconchoidal, also amber and white with dark mottling, minor Shale: medium gray, dark gray, hard, siliceous; trace of light gray siltstone with glauconite and micropyrite.

13,785-13,840 Predominantly Chert: dark gray-brown, dark gray, amber, becoming white mottled and light gray at 13,825', minor thin beds of Dolomite: medium gray, finely crystalline, medium hard, and Limestone: tan, recrystallized crinoid packstone, medium hard, in part siliceous with some replacement chert, tight, no shows.

13,840-13,859 Predominantly Limestone: tan to brown, partly recrystallized bioclastic packstone, medium hard, rare stylolite, in part siliceous, probably crinoid and bryozoa, few calcite-filled fractures, local patches of soft chalky white limestone, tight; no shows; minor Chert: tan-amber, translucent, dark gray, medium gray.

13,859-13,870.5 <u>Core No. 13: Cut 11.5', Recovered 11.5'</u>

13,859.0-13,870.5' (11.5') Limestone: tan to brown, crinoidal packstone and grainstone, hard, dark contorted, dark gray shale beds dipping at 30°, occasional stylolites, common closed dark stained vertical and 40° dipping fractures and 60-80° dipping calcite-filled fractures, tight; no shows, sulfur odor on fresh break.

13,870.5-13,920 Limestone: white-buff, tan, gray-buff mottled, bioclastic packstone, medium hard to hard, recrystallized, poorly preserved crinoids, in part hard, siliceous with some chert replacement; Chert: dark gray, brown, tan translucent, tight; no shows.

13,920-13,970	Limestone: medium gray, gray-buff mottled, fine crystalline, argillaceous, dolomitic, in part highly siliceous, poorly preserved crinoid stems, interbedded with Dolomite: white, gray-brown, fine crystalline mosaic in part with intercrystalline gilsonite, and Chert: gray-white mottled tripolitic, tight; no shows; thin shale stringers, dark gray, hard, siliceous, in part with dolomite rhombs.
13,970-14,000	Dolomite: gray-buff, buff-white, medium crystalline mosaic, in part argillaceous, in part siliceous, tight; no shows, interbedded with Limestone: gray-buff, medium hard, buff, soft chalky, some free calcite, and with thin Chert beds: medium gray mottled, tripolitic, dark gray.
14,000-14,035	Dolomite: buff-white, medium crystalline mosaic, hard, tight, no shows, rare crinoid stem, with thin stringers of buff, chalky limestone, and Chert: light gray, tripolitic, tan, translucent.
14,035-14,135	Dolomite: medium gray, in part with white mottling, fine to medium crystalline mosaic, hard, with occasional poorly preserved crinoids, locally buff-white, tight; no shows, with thin stringers of Shale: dark gray, hard, siliceous, in part with dolomite rhombs, and Chert: dark gray, brown, light gray, tripolitic.
14,135-14,200	Dolomite: buff-white, fine to medium crystalline mosaic, medium hard to hard, in part with gray mottling, slight intercrystalline porosity to tight; no shows, rare crinoid stem, occasional thin stringers of Shale: dark gray, hard, siliceous, in part with dolomite rhombs, and Chert: medium gray, buff, tripolitic.
14,200-14,265	Dolomite: buff, buff-gray, fine to medium crystalline, medium hard, tight; no stain, odor, cut or fluorescence; with thin beds of Chert: light gray, tripolitic, tan, white translucent, and Shale: dark gray, hard, siliceous, in part with dolomite rhombs.
14,265-14,335	Dolomite: white-buff, buff, buff-gray, fine to medium crystalline, in part with intercrystalline gilsonite, tight with no shows, interbedded with Chert: medium gray, mottled, tripolitic, buff replacement chert, local shale beds, dark gray, hard, siliceous, in part with dolomite rhombs.
14,335-14,395	Dolomite: white-buff, increasingly clean, fine crystalline, hard, in part with siliceous replacement, tight; no shows; with thin beds of Chert: white-clear translucent, light gray, buff-tan, tripolitic, translucent.

14,395-14,450	Dolomite: dark gray, fine crystalline, hard, argillaceous, interbedded with Dolomite: buff-white, fine crystalline, tight; no shows; occasional thin beds of Shale: dark gray, hard, siliceous, and Chert: buff mottled, tripolitic, light gray, dark gray mottled, subconchoidal, tan, tripolitic.
14,450-14,480	Chert: dark gray, gray-brown, light gray, tripolitic, subconchoidal; interbedded with Dolomite: dark gray, gray-brown, fine crystalline, hard, argillaceous, tight, in part siliceous, thin stringers of shale and dark gray, medium hard, calcareous siltstone.
14,480-14,495	Limestone: brown, fine crystalline, medium hard, occasionally tan, chalky, tight; no shows; interbedded with Chert: dark gray, light gray mottled, tripolitic.
14,495-14,515	Siltstone: dark gray-brown, medium hard, calcareous, micropyritic, slightly laminated, flaky, with thin stringers of Limestone: brown, finely crystalline, medium hard, slightly argillaceous, and Dolomite: gray-white mottled, fine crystalline, argillaceous, tight; no shows.
14,515-14,550	Shale: dark gray-brown, hard, calcareous, micropyritic, with rare pyrite nodules, few small recrystallized fossils, shells, spines, interbedded with Limestone: gray-brown, brown, fine crystalline, medium argillaceous, poorly preserved fossil fragments, y dolomitic.
14,550-14,565	one: brown, fine crystalline, in part medium d packstone with crinoid stems, slightly dolomitic, no shows, interbedded with Shale: dark gray, calcareous, slightly silty.
14,565-14,585	te: gray-brown, fine crystalline, sucrosic, y friable, argillaceous, in part calcareous, in part with slight intercrystalline porosity; no shows, edded with Limestone: brown, gray-brown, n hard to hard, slightly argillaceous, trace white limestone.
14,585-14,640	ninantly Dolomite: brown-gray, gray, fine lline, medium hard to hard, argillaceous, in part eous, with rare poorly preserved crinoid stem, patches of clean sucrosic dolomite and patches of dolomite with relict grainstone outlines, thin ers of Limestone: dark gray, hard and white, , and with Chert: dark gray-brown, light gray ucent, subconchoidal, blocky.

14,640-14,725	Predominantly Dolomite: gray-brown, dark gray, fine crystalline, sucrosic to mosaic, medium hard, argillaceous, in part slightly calcareous, with rare crinoid stem, tight, no shows; with thin stringers of Limestone: dark gray, fine crystalline, hard and gray-brown, soft, argillaceous, also occasional patch of Shale: dark gray, hard, calcareous, micropyritic.
14,725-14,865	Predominantly Dolomite: increasingly dark gray, gray-brown, fine crystalline, medium hard to hard, argillaceous, in part with mottling and white recrystallized rounded fossils, probable crinoid stems; with local patches of Shale: dark gray, medium hard to hard, dolomitic, silty, and Chert: dark gray, occasionally dark brown with dolomite crystals and rare poorly preserved microfossil fragments, subconchoidal, rare euhedral clear calcite (dog tooth spar); no visible porosity; no shows.
14,865-14,895	Dolomite: dark gray, gray-brown, occasionally buff-brown, fine crystalline, argillaceous, medium hard, tight; no shows, few calcite-filled fractures; interbedded with Chert: dark gray-brown, conchoidal, in part with disseminated micropyrite.
14,895-14,930	Chert: light gray translucent, milky white, mossy, translucent, tan-amber, with dark stain microfractures, in part tripolitic with rare microfossil fragments; interbedded with Dolomite: buff, brown-buff, fine crystalline, sucrosic-mosaic, medium hard, tight, slight intercrystalline porosity; no shows, in part gray-brown, fine crystalline dolomite.
14,930-14,950	Shale: dark gray-black, hard, siliceous, blocky, with disseminated micropyrite; interbedded with Chert: dark gray-black, gray, brown-amber translucent, in part gradational with siliceous shale, with occasional thin stringers of Dolomite: dark gray-brown, fine crystalline, hard, argillaceous.
14,950-15,055	Predominantly Chert: dark gray-brown, dark gray, clear, light brown-amber translucent, conchoidal to subconchoidal, interbedded with thin beds of Shale: dark gray, hard, siliceous, and Dolomite: gray-brown, fine crystalline, hard, argillaceous, tight with no shows.
15,055-15,080	Predominantly Chert, as at 14,950', interbedded with Limestone: buff-brown, medium grained, recrystallized, bioclastic, crinoidal packstone, fine to medium hard, in part chalky, tight; no shows, few calcite-filled fractures, and Shale: dark gray-black, medium hard, micropyritic, micromicaceous.

15,080-15,105 Siltstone: gray-brown, dark gray, firm to medium hard, calcareous, micropyritic, micromicaceous; interbedded with Shale: dark gray, medium hard, micropyritic; and Limestone: buff-brown, fine to medium grained, recrystallized bioclastic packstone, medium hard, in part chalky, with poorly preserved crinoids, shell fragments and rare shell impressions.

15,105-15,175 Predominantly Limestone: buff-gray, medium grained, bioclastic packstone, in part gray-brown, fine crystalline, recrystallized, argillaceous, medium hard with occasional poorly preserved fossil fragments, tight; no shows; interbedded with Siltstone: dark gray-brown, dark gray, firm, medium hard to hard, calcareous, in part micropyritic, with occasional stringers of Chert: clear, amber-light brown translucent, and Chert: dark gray-brown conchoidal.

15,175-15,225 Shale: dark gray, hard, calcareous, becoming in part siliceous at 15,205'; interbedded with Limestone: gray brown, buff-brown mottled, fine crystalline, medium hard, argillaceous, with rare shell fragments, crinoids, in part becoming siliceous at 15,205', with stringers of Chert: dark gray, slightly calcareous.

15,225-15,285 Predominantly Shale: gray-brown, dark gray, medium hard to hard, calcareous, micropyritic, locally siliceous, locally silty, interbedded with thin beds of Limestone: buff-brown, gray-brown, fine crystalline, medium hard, argillaceous, with few poorly preserved fossil fragments and crinoids, locally grades to calcareous dolomite; Chert: light gray translucent mottled, dark gray, slightly calcareous; no shows.

15,285-15,315 Limestone: buff-brown mottled, fine to medium grained, recrystallized bioclastic packstone with poorly preserved crinoids and shell fragments, in part gray-brown, fine crystalline, argillaceous, in part with intergranular pyrite, tight; no shows, interbedded with Shale: dark gray, hard, calcareous, micropyritic, locally silty, in part with microlaminations, occasional thin stringers of siltstone and light brown translucent chert.

15,315-15,328 Shale: dark gray, hard, calcareous, slightly silty, with common calcite-filled fractures, becoming medium gray, noncalcareous, micromicaceous, firm to medium hard at 15,325', interbedded with Limestone: buff-brown, fine to medium grained, medium hard, recrystallized bioclastic packstone with poorly preserved microfossils, crinoids, shell fragments, worm tube, tight; no shows.

15,328-15,342 Core No. 14: Cut 14', Recovered 12'

15,328.0-15,332.3' (4.3')	Shale: dark gray, medium hard, subfissile, highly slickensided, noncalcareous, with large 2-4 cm pyrite nodule and patches, with fair bedding dips of 20-40°, trace of bleeding gas; no odor, no shows.
15,332.3-15,334.5' (2.2')	Limestone: buff-gray, mottled, contorted large calcite grains may be bioclastic in origin, with intergranular shaly patches and pyrite patches, hard, tight, with some near vertical closed microfractures.
15,334.5-15,339.7' (5.2')	Shale: dark gray, hard, siliceous, with occasional patches of medium hard, subfissile shale as at 15,328'.
15,339.7-15,340.0' (0.3')	Limestone: as at 15,332.3' with a few calcite-filled fractures dipping at 50°.
15,340.0-15,342.0' (2.0')	No recovery.

15,342-15,367 Shale: dark gray to black, fissile, flaky, siliceous, organic, well indurated, micropyritic in part, with bands of Chert: smoky to dark gray to translucent pale orange.

15,367-15,374 Dolomite: medium dark gray, very argillaceous, medium to coarsely crystalline rhombs, moderately indurated, very poor intercrystalline porosity; no odor, stain, fluorescence or cut.

15,374-15,402 Shale: as above, with streak of Dolomite: as above, at base.

15,402-15,425 Limestone: calcilutitic, buff-medium gray-brown, mottled, micro to finely crystalline, chalky in part, some spar calcite (fracture fill), stylolitic, well indurated, dense, with chert nodules, dark gray to black.

15,425-15,450 Limestone: as above, grades to calcarenite, recrystallized mosaic texture, rare large fossil fragments (crinoids, brachiopods), becomes chalky in part, finely crystalline, well indurated, dense, nil porosity, stylolitic.

15,450-15,485 Limestone: calcilutitic, slightly calcarenitic, as above, grades to dark gray brown, argillaceous, crypto-microcrystalline, well indurated, dense, becomes chalky in part, with black chert nodules.

15,485-15,540 Limestone: calcarenitic, buff to medium gray-brown (composed of large fossil fragments in finely crystalline matrix, recrystallized lime mud), well indurated, dense, nil porosity; with interbedded Limestone: medium dark gray-brown, medium crystalline euhedral calcite matrix with sucrosic appearance, rare large fossil fragments, moderately indurated, very poor intercrystalline porosity with rare black gilsonite void filler in part, abundant chert nodules, as above.

15,540-15,565 Dolomite: buff to rare dark gray mottled, crypto to medium crystalline, well indurated, stylolitic, chalky in part, rare indistinct fossils, becomes very argillaceous towards base, nil porosity; with chert nodules, dark gray to translucent pale orange.

15,565-15,596 Dolomite: medium gray-brown to dark gray-brown, argillaceous, finely to medium crystalline, well indurated, some indistinct fossils, with thin streaks of Dolomite: as above, with Chert: as above.

15,596-15,598 Core No. 15: Cut 2', Recovered 0'

15,596.0-15,598.0' (2.0') No recovery.

15,598-15,655 Limestone: calcarenitic in part, buff to medium gray-brown, argillaceous in part, recrystallized fine to medium crystalline, stylolitic, chalky in part, well indurated, dense, nil porosity; grades to Limestone: calcilutitic, dark gray, argillaceous, crypto to microcrystalline, well indurated, dense, with some chert nodules, as above, and some calcite-filled fractures.

15,655-15,663 Core No. 16: Cut 8', Recovered 3'

15,655.0-15,658.0' (3.0') Dolomite: very limy in part, medium gray-brown to buff, grades from finely to coarsely crystalline, recrystallized, stylolitic, with black carbonaceous material, isolated large pods of Dolomite: very limy, generally fine to medium crystalline, near vertical fractures with calcite filling, scattered nodules of pale brown chert; some near horizontal

laminae, some relict indistinct fossils, scattered black gilsonite in coarsely crystalline fraction, generally well indurated, nil to very poor intercrystalline porosity, no fluorescence or cut; becomes darker brown, argillaceous towards base, highly fractured with nodules of dark gray chert at base.

15,658.0-15,663.0' (5.0') No recovery.

15,663-15,675 Dolomite: buff, gray-brown, as above.

15,675-15,710 Limestone: calcarenitic, medium to dark gray-brown, argillaceous, chalky in part, finely to medium crystalline, stylolitic, common large fossil fragments, rare black phosphate pellets, well indurated, dense; grades to Limestone: calcilutitic, dark gray, argillaceous, crypto-microcrystalline, some chert and calcite-filled fractures.

15,710-15,721 Dolomite: as above.

15,721-15,754 Limestone: calcarenitic, as above, with rare phosphate pellets, grades to Limestone: calcilutitic, as above.

15,754-15,810 Dolomite: buff to medium gray-brown, mottled, slightly argillaceous in part, finely to coarsely crystalline, recrystallized, moderately well indurated, nil to very poor intercrystalline porosity, with rare scattered gilsonite void filler, no fluorescence or cut; with some Chert: buff to brown.

15,810-15,835 Dolomite: medium gray-brown, mottled, finely to medium crystalline, grades to very argillaceous, very finely crystalline to cryptocrystalline, becomes chalky in part, with abundant dark gray, argillaceous veining, moderately indurated, dense, nil to very poor intercrystalline porosity.

15,835-15,865 Dolomite: dark gray-brown, very argillaceous, cryptocrystalline, well indurated, dense, common chert nodules, nil porosity.

15,865-15,902 Dolomite: predominantly buff to medium gray-brown, mottled, recrystallized, medium to coarsely crystalline, chalky in part, slightly argillaceous, moderately indurated, nil to very poor intercrystalline porosity, with abundant chert nodules, dark gray to translucent gray-brown, becomes very argillaceous towards base, medium to finely crystalline.

15,902-15,911	Core No. 17: Cut 9', Recovered 4.8'	
	15,902.0-15,906.8' (4.8')	Dolomite: buff to tan, recrystallized medium to coarsely crystalline, stylolitic with black carbonaceous material, some veining with calcite fill and calcite-filled fractures towards base, common large dark gray chert nodules, well indurated, dense, convoluted structure resulting from alternating pods of Dolomite: mottled dark gray-brown, argillaceous, siliceous, finely crystalline, well indurated, dense, abundant, scattered calcite blebs (recrystallized fossil?), very fractured at base with dips of 50-60°.
	15,906.8-15,911.0' (4.2')	No recovery.
15,911-15,955	Dolomite: as above.	
15,955-16,035	Dolomite: tan to mottled medium gray-brown, argillaceous in part, medium to occasional coarsely crystalline, recrystallized, moderately well indurated, dense, with abundant chert nodules, calcite-filled fractures; grades to buff, medium to coarsely crystalline in part.	
16,035-16,075	Dolomite: dark gray-brown to black, very argillaceous, finely crystalline, well indurated, dense, nil porosity, grades to medium gray-brown, chalky in part, with abundant Chert nodules: as above.	
16,075-16,120	Dolomite: buff, mottled gray-brown, argillaceous, chalky in part, finely to medium crystalline, recrystallized, well indurated, dense, with abundant chert nodules, as above, becomes very argillaceous, grades to Marlstone: black, cryptocrystalline, very well indurated, calcite-filled fractures.	
16,120-16,190	Limestone: calcarenitic, dolomitic, medium gray-brown, mottled, recrystallized, medium to coarsely crystalline, fossil fragments, some spar calcite fracture fill, chalky in part, well indurated, dense; grades to Limestone: calcilutitic, dark gray-brown, very argillaceous, crypto-microcrystalline, abundant chert nodules.	
16,190-16,220	Limestone: calcarenitic, as above, medium to coarsely crystalline, predominantly buff.	

16,220-16,243 Limestone: calcarenitic, as above, becomes slightly argillaceous, mottled gray-brown, rare pyrite, finely disseminated.

16,243-16,280 Interbedded Siltstone: sandy in part, quartzitic, light gray, mottled to dark gray, argillaceous, reworked, common green glauconite pellets, abundant micro to finely disseminated pyrite, with rare nodules, common red hematite inclusions, rare large chert inclusions, very well indurated, dense, nil porosity, with thin Shale: dark gray, smooth to silty, platy, siliceous, moderately indurated.

16,280-16,319 Limestone: calcarenite, mottled gray-brown, argillaceous, chalky in part, finely disseminated pyrite scattered throughout, common green glauconite pellets, abundant fossil fragments, moderately indurated, dense, with some chert nodules.

Strap out at 16,319'; 17' upward correction to 16,302'

16,302-16,328 Core No. 18: Cut 26', Recovered 22.5'

16,302.0-16,306.5' (4.5') Limestone: calcilutitic, very dark gray-brown, argillaceous, very fine to finely crystalline, predominantly lime mud matrix with large scattered fossil fragments (crinoids, brachiopods, sponge spicules) abundant very fine to micropyritic inclusions, very well indurated, dense, nil porosity, no fractures.

6.5-16,318.0' (11.5') Limestone: calcarenitic, calcilutitic, medium gray-brown, mottled, less argillaceous, medium to coarsely crystalline, predominantly recrystallized lime mud matrix with abundant scattered fossil fragments (crinoids, etc.) scattered micropyritic inclusions, abundant scattered near horizontal laminations, with occasional streaks (1-3") of Siltstone: dark gray to

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very argillaceous; very
s; rare large fossil
s, very well indurated,
ome black chert nodules,
very poor intercrystalline

black;
calcareou
fragment
dense,
nil to
porosity.

16,318.0-16,320.0' (2.0')	Siltstone: black, very argillaceous, very calcareous, rare large fossil fragments (crinoids, etc.), micropyritic.
16,320.0-16,324.5' (4.5')	Limestone: calcilutitic, calcarenitic, medium to dark gray, brown, mottled, essentially as above, but becoming more argillaceous, medium to finely crystalline, pyritic.
16,324.5-16,328.0' (3.5')	No recovery.

16,328-16,340 Limestone: as above.

16,340-16,385 Limestone: as above, grades to Dolomite: mottled gray-brown, argillaceous, finely to medium crystalline, well indurated, dense, nil porosity, with interbedded Calcilutite: dark gray-brown, cryptocrystalline, very argillaceous.

16,385-16,420 Limestone: calcarenitic, slightly dolomitic, medium gray-brown, buff to mottled, clean to very argillaceous, recrystallized, medium to coarse grained, abundant black chert nodules, rare calcite-filled fractures, abundant fossil fragments, with interbedded Calcilutite: dark gray-brown, argillaceous, cryptocrystalline, as above.

16,420-16,450 Limestone: calcarenitic, buff to medium gray-brown, mottled, clean, medium crystalline to coarsely crystalline, recrystallized, abundant fossil fragments and black chert nodules, calcite-filled fractures, with interbedded Calcilutite: as above, cryptocrystalline, micropyritic.

16,450-16,505 Limestone: calcarenitic, as above, grades to Calcilutite: calcarenitic, dark gray-brown, very argillaceous, finely to medium crystalline matrix with large scattered fossil fragments, micropyritic, stylolitic, well indurated, dense, with black chert nodules, becomes more argillaceous towards base.

16,505-16,530 Limestone: calcilutitic, dark gray-brown, very argillaceous, cryptocrystalline, grades to Limestone: calcilutitic, calcarenitic, dark gray-brown, argillaceous, as above.

16,530-16,615 Limestone: calcarenitic, calcilutitic, light to dark gray-brown mottled, medium to coarsely crystalline, abundant large fossil fragments, chalky in part, very argillaceous in part, abundant chert nodules,

calcite-filled fractures, becomes less argillaceous towards base, with streaks of Calcilutite: dark gray-brown, cryptocrystalline, as above.

16,615-16,675 Predominantly Limestone: calcilutitic, slightly calcarenitic (scattered large fossil fragments) gray to dark gray-brown, very argillaceous, very fine to finely crystalline, common black chert nodules, calcite-filled fractures, rare pyrite inclusions, moderate to well indurated, dense, grades to Calcilutite: cryptocrystalline in part.

16,675-16,695 Dolomite: mottled medium to dark gray-brown, very argillaceous, fine to medium crystalline, some large recrystallized fossil fragments, well indurated, dense, with abundant black chert nodules.

16,695-16,745 Dolomite: buff to tan, medium to coarsely crystalline, recrystallized, siliceous, indistinct fossil fragments, well indurated, dense, with streaks of Dolomite: as above, very argillaceous, abundant chert nodules.

16,745-16,765 Dolomite: mottled dark gray-brown, very argillaceous, finely to medium crystalline, sucrosic, well indurated, dense, with chert nodules (40-50%).

16,765-16,780 Predominantly Chert: black, translucent, smoky, gray-brown to pale orange.

16,780-16,790 Dolomite: as above, very argillaceous, abundant chert nodules.

16,790-16,800 Chert: as above.

16,800-16,825 Dolomite and Chert: as above.

16,825-16,859 Limestone: calcarenitic, medium mottled gray-brown, grades to dark gray-brown, very argillaceous, chalky in part, finely crystalline matrix with coarse fossil fragments, well indurated, dense with streaks of calcilutite, dark gray, very argillaceous, crypto to very finely crystalline, some calcite-filled fractures, abundant chert nodules, with interbedded Shale: black, organic, subfissile to platy, micropyritic, slightly calcareous, siliceous, moderately indurated, smooth to silty texture.

16,859-16,875.5 Core No. 19: Cut 16.5', Recovered 12.0'

16,859.0-16,869.0' (10.0') Limestone: calcarenitic, calcilutitic, mottled gray-brown to dark gray-brown, predominantly

		lime mud matrix, recrystallized finely to medium crystalline, becoming very argillaceous, grading into Shale: black, with abundant fossil fragments (brachiopods, crinoids, etc.), rare near vertical closed calcite-filled microfractures, banded and pod appearing sedimentary structures (ripple undulations); abundant shale laminations, with intercalated Shale: black, organic, smooth texture, siliceous, platy to subfissile, micropyritic, very well indurated, brittle with abundant black chert nodules.
	16,869.0-16,871.0' (2.0')	Limestone: calcilutitic, dark gray-brown very argillaceous, crypto to microcrystalline, very well indurated, brittle, dense, with abundant black chert bands and nodules, rare calcite-filled microfractures.
	16,871.0-16,875.5' (4.5')	No recovery.
16,875.5-16,890	Limestone: as above, with chert nodules and intercalated Shale: as above.	
16,890-16,900	Shale: black, as above.	
16,900-16,925	Limestone: calcilutitic, calcarenitic, mottled medium to light gray-brown, argillaceous, finely to medium crystalline, with rare to common large fossil fragments, well indurated, rare pyrite inclusions; grades to Calcilutite: dark gray-brown, very argillaceous, cryptocrystalline, with thin interbedded Shale: as above.	
16,925-16,950	Interbedded Limestone: calcilutitic, slightly calcarenitic, as above, with thin Shale streaks: as above.	
16,950-16,958	Shale: black, as above.	
16,958-16,969	Limestone: calcilutitic, dark gray-brown, argillaceous, finely crystalline, well indurated, dense, grades to Calcarenite: mottled gray-brown, generally finely crystalline matrix with large fossil fragments, argillaceous, moderate to well indurated, dense.	

16,969-16,982	Strap out at 16,969'; 13' downward correction to 16,982'	
16,982-17,000	Core No. 20: Cut 18', Recovered 14.5'	
	16,982.0-16,996.5' (14.5')	Limestone: calcilutitic, slightly calcarenitic, dark gray-brown, finely crystalline, rare to common large fossil fragments (crinoids, etc.), in lime mud matrix, very argillaceous, rare near vertical closed calcite-filled fractures, abundant black shale laminations, rare black chert nodules, well indurated, brittle, dense, nil porosity.
	16,996.5-17,000.0' (3.5')	No recovery.

17,000 Feet Total Depth

Log Analysis

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

Formation Evaluation

August 6, 1979

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

Dear Mr. Hewitt:

Schlumberger began logging operations on Lisburne Test Well No. 1 at 0430 hours on July 24, 1979, and immediately hit a bridge at 1560, just below the casing shoe which required a clean-out run. They re-entered the hole at 1500 hours and upon completion of the run found the R_m curve to be faulty. The trouble was finally traced to a panel malfunction and the log was re-run satisfactorily except the SP curve failed to print on the 2" film. There was difficulty in setting up and calibrating the FDC, the trouble was found and the resulting log was good. By 0730 hours on July 25, a total of 17.5 hours after the clean-out, BHC and Velocity Survey had been completed. Sidewall cores and dipmeter were cancelled because of the badly washed bore-hole.

No identifiable formation tops could be found on the logs and no zones of interest were seen, all the formations appearing to be tight, hard and of low porosity.

Very truly yours,

A. Kane

A. Kane

Log Analysis

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

Formation Evaluation

August 27, 1979

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

Dear Mr. Hewitt:

On August 22, 1979, Schlumberger began logging on Lisburne Test Well No. 1 at 1030 hours and had successfully completed DIL and BHC by 1530 hours the same day. Log quality is good and no tool failures or lost rig time occurred. There are a few "spikes" but no cycle skips on the sonic and the SP curve, even though the mud was quite fresh, is nondescript with very little character.

No identifiable formation tops could be seen and it is believed the formation may be Fortress Mountain although I believe this is open to question. No correlation with other wells can be found.

There are a number of zones exhibiting fairly clean gamma ray response but these are characterized by high resistivity and low sonic porosities of 4% to 11% and so are of little interest. The bore hole is badly washed out but it is not possible to determine what the actual diameter is because the BHC caliper reaches only to 15 inches; however, only about 500 feet of the hole is to gauge, the rest being 15 inches or greater.

Very truly yours,

A. Kane

Log Analysis

ARMOUR KANE

Formation Evaluation

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

November 29, 1979

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

Dear Mr. Hewitt:

Schlumberger began logging at Lisburne Test Well No. 1 at 1300 hours on November 23, 1979, and finished DIL, CNL/FDC, BHC, HRD, Birdwell Velocity Survey and sidewall cores twenty four hours later at 1300 hours November 24. Log quality was excellent except for the usual SP drift and here again the IL_m and LL_8 were lower than on the previous run but not as much so as at the SeaBee well. The bore-hole was very badly washed out from casing to 6500 feet - the HRD calipers were saturated at 19" and in some spots the recorded bulk density was 1.5 g/cc as compared to the mud density of 1.3 g/cc indicating a hole size of perhaps 30". This large hole size had an adverse effect on Neutron, Density and Sonic curves making them virtually useless above 6500 feet.

Formation tops were: Shublik, 6945 and Lisburne, 7408. Since there are no correlative wells nearby these tops were selected from the well logs and the geologist's lithology log. No zones of interest were encountered and spot checks of porosity by CNL/FDC crossplots indicated the majority of porosity in the Lisburne is in the 3% to 4.5% range with a few intervals reaching 6%-8% and one interval, 7928-38, showing a 13% porosity. These porosities are confirmed from sonic measurements using a limestone matrix velocity of 21,000 ft/sec. A tabulation is attached. Because there is no practical way of computing or estimating a value of Rw no Sw calculations were made.

Again, Larry Nelson and his crew performed a faultless operation both as to rig time consumed and log quality.

Very truly yours,

A. Kane

A. Kane

Log Analysis

COMPANY: HUSKY OIL/NPR OPERATIONS, INC. | WELL: LISBURNE N° 1

FIELD: NORTH SLOPE | COUNTY: | STATE: ALASKA

DEPTH	ϕ_D	ϕ_N	ϕ_C	LITH.	ΔT	ϕ_S	REMARKS
6830-58	10	11	10	LS	60	9	
6960-7100	9	9	9	LS	57	7	
7100-14	9	13	11	LS	60	9	
		LISBURNE FORMATION					
7410-18	3.5	3.5	3.5	L	50	4	
7436-42	3.0	3.0	3.0	L	50	4	
7444-50	6.0	3.0	4.5	SDS/SOL	51	5	
7456-64	4.0	8.0	6.0	SOL/SOD	53	6.5	
7466-7500	2.0	3.0	2.5	L	50	4	
7500-10	6.0	10	8.0	SOL/SOD	55	8	
7530-44	3.0	9.0	6.5	SOL/SOD	52	6	
7630-40	0	8.0	4.5	SOL/SOD	49	4	
7680-90	1	3.0	2.0	L	48	3	
7720-30	0	7.0	4.0	SOL/SOD	52	6	
7764-86	4	9.0	7.0	SOL/SOD	50	4	
7830-60	3	9.0	6.0	SOL/SOD	50	4	
7928-58	15	11	13	SDS/SOL	62	10	
7940-50	0	6.0	3.5	SOL/SOD	50	4	

Log Analysis

ARMOUR KANE

Formation Evaluation

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

May 27, 1980

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

Dear Mr. Hewitt:

At 0030 hours, May 20, 1980, at Lisburne Test Well No. 1 Schlumberger began a temperature log but discovered they had only enough cable to reach 15,900 feet, 1100 feet short of bottom. They had no idea how this could happen! They pulled out of the hole at 0500 hours May 20 and a replacement drum was ordered from Dead Horse to be flown in by Hercules. While awaiting its arrival a mud-conditioning run was begun. The replacement drum was delivered at 1100 hours May 20 and the pipe was out of the hole at 1800 hours, the second temperature log was begun at 1830 hours and successfully completed at 2300 hours with a maximum temperature of 228° F.

The DLL was begun at 2330 hours and completed at 0500 hours May 21. Log quality was good except for the SP which was drifting so badly we did not record it on film but only on tape. Resitivities for about 2000 feet of open hole were greater than 40,000 ohms (the LL_D saturated at that value) and most of the remainder was 2,000 to 10,000 ohms.

It was necessary to send to Dead Horse for some CNL/FDC leads which had been forgotten, so, while waiting, the BHC was begun at about 0600 hours May 21 but the tool failed at 15,000 feet. They came out, changed tools and successfully completed the log at about 1600 hours. Log quality was very good except for a few spikes and skips.

The CNL/FDC was begun at 1730 hours May 21 but the recorded log was deemed invalid because of negative corrections up to -.15 and bulk densities much too low. After pulling out the cable was found to be leaking badly and they started cutting it back and after cutting about 3500 feet the leak was cured. The second CNL/FDC was completed at 0600 hours May 22, resulting in a good log.

The dipmeter was begun at 0800 May 22 and completed at 1330 hours with no problems and the following CBL/VDL was completed at 1830 following which Birdwell Velocity Survey was begun. The Birdwell survey and the second temperature log were completed at 1000 hours May 23. Maximum temperature was 246° F. Total lost rig time is in the order of 23 hours. None of the above problems can be attributed to Engineers McNaughton and Lightner, both of whom were most conscientious and cooperative in keeping me informed of their problems and cheerfully went about the numerous re-runs.

Top of the 4th Lisburne was found at 13,736 and top of the 5th Lisburne at 15,398. The 15,398 figure is the top of the massive limestone from log response.

No zones of interest were encountered because of the very dense, low porosity rocks. Cross-plotting of CNL/FDC response indicates porosities of 0% to 3% and shows zones of almost 100% dolomite and some of 100% limestone together with combinations of the two in varying percentages. "M" and "N" plots determinations verify these lithologies.

Very truly yours,

A. Kane

Log Analysis

COMPANY: HUSKY OIL/NPR OPERATIONS, INC. | WELL: LISBURNE No 1

FIELD: NORTH SLOPE | COUNTY: | STATE: ALASKA

DEPTH	ϕ_D	ϕ_N	ΔT	ϕ_S	ϕ_C	Lith LS/Dol	REMARKS
13900-20	-2.5	0	50	2	0	90/10	
13920-40	-5	1.5	50	2	0	50/50	
14080-90	-6	3	47	0	0.5	15/85	
14340-50	-3	3	50	2	3	L	
14530-830	-6	3	50	2	0.5	15/85	
15120-270	0	0	52	3	0	L	
15400-80	-3	0	49	1	0	80/20	
15650-850	-4	2	50	2	0.5	50/50	
16040-80	-6	2	49	0	0	20/80	
16470-540	0	0	50	2	0	L	

ABOVE FIGURES ARE AVERAGE VALUES OVER SOME FAIRLY LONG INTERVALS.

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

LOGGING REPORT

WELL NAME LISBURNE #1

Date July 24, 25, 1979 Driller Depth 4510'

Elevation 1862' KB Logger Depth 4522'

Logs Run and Intervals

GR/SP/DIL	1505-4516'
GR/CAL/CNL/FDC	1505-4521'
GR/BHC	1505-4521'
Birdwell Velocity Survey	Top shot 250 - Bottom shot 4400

Additional Logs to Run

[illegible]

[illegible]	[illegible]	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
NO ZONES OF INTEREST					

Discussion:

No HRD or CST because of badly washed out borehole.
All formations tight and of low porosity.

[illegible] & Correlations:

No identifiable tops or correlations. (All lithologies interpreted as Kfm - Fortress Mtn)

DAVE YOUNG

D-1 ARMOUR KANE

HUSKY

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

LOGGING REPORT

WELL NAME LISBURNE #1

Date August 22, 1979 Driller Depth 6773'

Elevation 1862' KB Logger Depth 6750'

Logs Ran and Intervals

GR/SP/DIL	4509-6744'
GR/CAL/BHC	4509-6738'

Additional Logs to Run

None

Zones of Interest

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

Discussion:

All zones showing comparatively clean GR response are of [illegible] porosity from [illegible]. Only about 500' of open hole are to gauge. Remainder is all greater than 15" the maximum reach of the BHC Caliper.

Log Tops & Correlations:

No identifiable formation tops or correlation with other wells.

Plots:

RAY WERMEYER
Site Geologist

D-2 ARMOUR KANE
Log Analyst

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

LOGGING REPORT

WELL NAME LISBURNE #1

Date November 23-24, 1979 Driller Depth 8016'

Elevation 1862' KB Logger Depth 8030'

Logs Run and Intervals

GR/SP/DIL	4509-8024'	CST-Sidewalls 6168-8002'
GR/CAL/CNL/FDC	4509-8024'	Shot 45, Rec. 30
GR/BHC	4509-8020'	
HRD-Dipmeter	4509-8024'	
Birdwell Velocity Survey - Top: 4500'; Btm: 8000'		

Additional Logs to Run

NONE

Zones of Interest

[illegible]	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content

No apparent zones of interest

Lisburne: Spot CNL/FDC Cross-plots indicate most porosity is in the 3-4.5% with a few intervals 6-8%. One interval, 7928-7938', shows 13%+

Borehole very badly washed out from casing to 6900'. HRD calipers are saturated at 19" indicating that diameter is more than 19". In some places bulk density reads 1.5 g/cc vs. mud density of 1.3, suggesting a huge hole.

Log Tops & Correlations:

Possible top Shublik	6945'
Lisburne	7408'

Tops from logs - no correlative wells available.

[illegible] Plans.

DAVE YOUNG
Wellsite Geologist

ARMOUR KANE
Log Analyst

D-3

HUSKY

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

LOGGING REPORT

WELL NAME LISBURNE #1

Date February 29, 1980 Driller Depth 13,650'

Elevation 1862' KB [illegible] Logger Depth [illegible]

Logs Ran and Intervals

DIL/GR/SP	8005-13,645'	GR to 7730'
BHCS/GR/TTI	8005-13,642'	GR to 7770'
CNL/FDC/GR/CAL	8010-13,650'	GR to 7710'
HDT-Dipmeter	8005-13,650'	

Additional Logs to Run

None. CST Sidewalls were not run due to hard hole condition.

Zones of Interest

CNL/FDC	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Probable Fluid Content
11,618-648'	30'	Approx. 22'	Ls/Dol	5-12%	Gas (?)
11,672-678'	6'	6'	Ls/Dol	6%	Gas (?)
11,827-842'	15'	15'	Ls/Dol	6-9%	Gas (?)

Discussion:

Water saturation could not be calculated for above intervals due to saturated R_T readings across entire carbonate intervals on DIL log.

Log Tops & Correlations:

Shublik/Base 1st Lisburne Thrust	8590'
Top 2nd Lisburne Thrust	9670'
Fault ?/Base 2nd Lisburne Thrust	10,900'
Top 3rd Lisburne Thrust	11,630'
Top Endicott/Kayak Shale	13,370'

Recommendations:

None at present time; may consider test of potential gas horizons after complete log analysis.

HARRY HAYWOOD/RAY WERMEYER

D-4 Wellsite Geologist

Log Analyst

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

LOGGING REPORT

WELL NAME LISBURNE #1

Date May 19-23, 1980 Driller Depth 17,000'

Elevation 1862' K.B. Logger Depth 16,982'

Logs Ran and Intervals

Temperature Log (2)	100-16,955'	CBL -	6500-12,500'
DLL/GR	13,650-16,965'	Velocity Survey: top 4500'; btm. 16,942'	
BHCS/GR	13,650-16,966'		
CNL/FDC/GR/CAL	13,650-16,980'		
HRD-DIPMETER	13,645-16,979'		

Additional Logs to Run

Zones of Interest

Zone	Gross Thickness	Net Feet of Porosity	Lith	Porosity	Permeable Fluid Content
NO ZONES OF INTEREST *					

Discussion:

*FDC/CNL Cross Plots indicate porosity range of 0-3% over the interval and indicate zones ranging from 100% Limestone to 80% Dolomite, 20% Limestone.

Log Tops & Correlations:

Top 4th Lisburne	13,736'
Top 5th Lisburne	15,398'

Drill Stem Tests:

None for logged interval. Drill stem tests are scheduled for intervals above 13,650'.

DAVE YOUNG
D-5 Wellsite Geologist
ARMOUR KANE
Log Analyst

REVISED PRELIMINARY REPORT
NOTE: REPLACES PRELIMINARY REPORT ISSUED ON 5-27-80

HUSKY

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

DRILL STEM TEST REPORT FORM

WELL NAME LISBURNE #1 DST. NO. 1 DATE 5-25 - 26, 1980 (Revised 5-30-80)

Formation Tested LISBURNE
Perfs: 11,826-11,841', 11,728-11,742'
Test Interval 11,618-11,638'
Total Depth PBTD 13,400'

Choke Size: Surface 1/4" Bottom Hole 3/4"

Hole Size 7 5/8" csg
5" Drill pipe Length 2681' I.D. 4.276"
3½" Drill Pipe Length 8061' I.D. 2.602"
Packer Depth(s) 11,584' Ft.
Depth Tester Valve 11,529' Ft.
Cushion Type Fresh water Amount 3000'

TEST DATA

Tool open at 1723 hrs, 5-25-80
1st open * 34 min.
1st shut in 38 min (recycled tool)
2nd flow period 60 min.
2nd shut-in period 124 min.
Final flow period 118 min.
Final shut-in period 303 min.
Unseated packer at 0338 hrs, 5-26-80 hrs.

RESISTIVITY/CHLORIDE DATA

		Resistivity		Chloride Content
Recovery Water	(Filtrate)	@ °F.		400 ppm
Recovery Mud		@ °F.		ppm
Recovery Mud Filtrate		@ °F.		400 ppm
~~xxxxxxxxx~~ Cushion		@ °F.		200 ppm
Mud Pit Sample Filtrate		@ °F.		200 ppm
Mud Weight	10.2	vis	38	cp

Description of 1st flow period Opened w/no blow, reset tool and packer.
Description of 2nd flow period Opened w/faint blow, decreasing through period.
Description of final flow period Opened w/weak blow continuing throughout period. SFP less than or equal to 1 psi. No fluid to surface.

PRESSURE DATA

TEMPERATURE	Gauge No. J-234 Depth: 11,559 ft.	Gauge No. J-241 Depth: 11,565 ft.	Gauge No. J-254 Depth: 11,605 ft.	Gauge No. J-1317 Depth: 11,609 ft.
	48 Hour Clock	48 Hour Clock	48 Hour Clock	96 Hour Clock
Est. °F.	Blanked Off No	Blanked Off No	Blanked Off Yes	Blanked Off Yes
Actual 164 °F.	Pressures Field / Office	Pressures Field / Office	Pressures Field / Office	Pressures Field / Office
Initial Hydrostatic	6204	6221	6218	6227
* Initial FLOW Final	2554	2584	2624	2593
Final Flow Closed In	4937	4959	4995	4985
Initial FLOW Final	6166	6221	6236	6227
Second Flow Closed In	3932	3976	4032	3984
	4993	5034	5088	5040
	5012	5015	5069	5022
* Initial FLOW Final	4770	4829	4847	4829
Final Flow Closed In	5031	5033	5088	5040
	5012	5015	5069	5022
Final Hydrostatic	6185	6203	6199	6208

RECOVERY DATA

	Type	Amount	Depth Back Pres. Valve	Surface Choke	Bottom Choke
Recovered 3000'		Feet bbl of water cushion, Chlorides 200 ppm			
Recovered 2100'/13.8 bbls		Feet bbl of rat hole mud and filtrate, Chlorides 400 ppm			
Recovered		Feet bbl of			
Recovered		Feet bbl of			

Remarks
* Surface mechanical indications on initial open indicated tool not open, chart analysis now indicates tool only momentarily opening on all periods.

1st Sample Chamber: Pressure 1090 psi, recovered 1 cu ft gas and 1850 cc mud filtrate.
2nd Sample Chamber: Will be analyzed in Anchorage.

Water cushion Chlorides 200 ppm
Recovery fluid Chlorides 400 ppm

DATE YOUNG

11-78

HUSKY

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

PRELIMINARY REPORT

DRILL STEM TEST REPORT FORM

WELL NAME LISBURNE #1 DST. NO. 2 (misrun) DATE 5-28-80

Formation Tested: LISBURNE
Test Interval: 7645-7662'
Total Depth: PBTD 7680'
Choke Size: Surface 1/4" Bottom Hole 3/4"

Hole Size: 9 5/8" csg
Drill Collar Length: ____ I.D. ____
Drill Pipe Length: (5") 7541' I.D. 4.276"
Packer Depth(s): 7610 Ft.
Depth Tester Valve: 7555 Ft.
Cushion Type: None Amount ____

TEST DATA

Tool open at: 0119 hrs, 5-28-80 hrs.
Initial flow period: 60 min.
Initial shut-in period: 11 (recycled tool) min.
Final flow period: 59 min.
Final shut-in period: 148 min.
Unseated packer at: 0557 hrs., 5-28-80 hrs.

RESISTIVITY-CHLORIDE DATA

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

Description of initial flow period: Opened tool w/no blow continued thruout period. Tool plugged after initial open.

Description of final flow period: Opened tool w/no blow continued thruout period. Tool plugged.

PRESSURE DATA

TEMPERATURE	Gauge No. J-109 Depth: 7585 ft.	Gauge No. J-313 Depth: 7591 ft.	Gauge No. J-379 Depth: 7631 ft.	Gauge No. J-867 Depth: 7635 ft.
	48 Hour Clock	48 Hour Clock	48 Hour Clock	48 Hour Clock
Est. °C	Blanked Off No	Blanked Off No	Blanked Off Yes	Blanked Off Yes
Actual 125 °C	Pressures Field / Office	Pressures Field / Office	Pressures Field / Office	Pressures Field / Office
Initial Hydrostatic	4033	4027	4054	4068
First Flow Period — FLOW Initial	718	727	769	772
First Flow Period — FLOW Final	3070	3059	3081	3094
First Flow Period — Closed In	3083	3085	3094	3107
Second Flow Period — FLOW Initial	2877	2855	2866	2869
Second Flow Period — FLOW Final	3070	3072	3081	3094
Second Flow Period — Closed In	3095	3097	3106	3119
Third Flow Period — FLOW Initial				
Third Flow Period — FLOW Final				
Third Flow Period — Closed In				
Final Hydrostatic	4046	4041	4049	4063

RECOVERY DATA

	Type	Amount		Depth Back Pres. Valve	Surface Choke	Bottom Choke
Cushion		Feet bbl of				
Recovered	110'/1.95	Feet bbl of	Rat hole mud			
Recovered		Feet bbl of				
Recovered		Feet bbl of				
Recovered		Feet bbl of				

Remarks: Charts indicate tool was plugged essentially thruout test after initial open of 1st flow period.

DAVE YOUNG

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

HUSKY

DRILL STEM TEST REPORT FORM

WELL NAME LISBURNE #1 DST. NO. 3 (retest) DATE 5-28 - 29, 1980

Formation Tested LISBURNE
Hole Size 9 5/8"
Test Interval 7645-7662' (retest)
Drill Collar Length - I.D.
Total Depth PBTD 7680'
Drill Pipe Length 7541' I.D. 4.276"
Choke Size: Surface 1/4" Bottom Hole 3/4"
Packer Depth(s) 7610' Ft.
Depth Tester Valve 7554.9 Ft.
Cushion Type None Amount

TEST DATA

Tool open at 1804 hrs, 5-28-80 xxx.
Initial flow period 67 min.
Initial shut-in period 122 min.
Final flow period 478 min.
Final shut-in period 720 min.
Unseated packer at 1711 hrs, 5-29-80 hrs.

RESISTIVITY CHLORIDE DATA

	Resistivity		Chloride Content
Recovery Water (Spl chamber)	@ ___ °F.		3100 ppm
Recovery Mud	@ ___ °F.		___ ppm
Recovery Mud Filtrate	@ ___ °F.		___ ppm
Mud Pit Sample	@ ___ °F.		___ ppm
Mud Pit Sample Filtrate	@ ___ °F.		200 ppm
Mud Weight 10.2	vis 38		cp

Description of initial flow period: Opened tool w/moderate blow increasing to moderately strong blow in 46 min, FWHP less than or equal to 1 psi, shut in well for 2 hrs.

Description of final flow period: Opened tool w/moderate blow increasing to moderately strong blow in 5 hrs and continuing thruout remainder of period w/FWHP 15 psi. No fluid to surface.

PRESSURE DATA

TEMPERATURE	Gauge No. J-109 Depth: 7585 ft.	Gauge No. J-3313 Depth: 7590 ft.	Gauge No. J-379 Depth 7631 ft.	Gauge No. J-867 Depth: 7635 ft.
	48 Hour Clock	48 Hour Clock	48 Hour Clock	48 Hour Clock
Est. °C	Blanked Off No	Blanked Off No	Blanked Off Yes	Blanked Off Yes
Actual 124 °C	Pressures	Pressures	Pressures	Pressures
	Field / Office	Field / Office	Field / Office	Field / Office
Initial Hydrostatic	4046	4053	4068	4071
Initial Flow: FLOW Initial	114	115	122	124
FLOW Final	500	510	522	529
Closed In	2902	2914	2919	2921
Initial Flow: FLOW Initial	527	535	547	554
FLOW Final	1694	1695	1696	1740
Closed In	3069	3072	3077	3081
Final Flow: FLOW Initial				
FLOW Final				
Closed In				
Final Hydrostatic	4033	4040	4055	4058

RECOVERY DATA

Cushion	Type	Amount	Depth Back Pres Valve	Surface Choke	Bottom Choke
Recovered	10 bbls	xxx bbl of	Rat hole mud and filtrate		
Recovered	61 bbls	xxx bbl of	formation water with sl sour odor		
Recovered		Feet bbl of			
Recovered		Feet bbl of			

Remarks: Recovery fluids on reverse out ranged from 2100 ppm Cl_2 at top of apparent formation water fluid to maximum 2900 ppm Cl_2 at bom of fluid column. Sample chamber recovery: 2.14 cu ft "sour" gas and 1966 cc formation water w/3100 ppm Cl_2.

DAVE YOUNG

129

HUSKY

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

REVISED 6-3-80

DRILL STEM TEST REPORT FORM

WELL NAME LISBURNE #1 DST. NO. 4 DATE 5-30 to 6-1-80

Formation Tested SHUBLIK
Hole Size 9 5/8" csg.

Test Interval 7022-7104'
Drill Collar Length None I.D.

Total Depth PBTD 7230'
Drill Pipe Length 6989' I.D. 4.276"

Choke Size:
Surface 1/8" & 1/4" Bottom Hole 3/4"

Packer Depth(s) 6983.8 Ft.
Btm tail pipe 7014'
Depth Tester Valve Ft.

Cushion Type None Amount

TEST DATA

Tool open at 2326 hrs, 5-30-80 xx
Initial flow period 120 min.
Initial shut-in period 244 min.
Final flow period 480 min.
Final shut-in period 960 min.
Unseated packer at 0532 hrs, 6-1-80 xx

RESISTIVITY CHLORIDE DATA

		Resistivity		Chloride Content
Recovery Water	None	@	°F.	ppm
Recovery Mud		@	°F.	ppm
Recovery Mud Filtrate		@	°F.	400 ppm
Mud Pit Sample		@	°F.	ppm
Mud Pit Sample Filtrate		@	°F.	200 ppm

Mud Weight 10.2 vis 38 cp

Description of initial flow period: Opened w/strong blow thru 1/8" choke, FWHP 75 psi in 4 min, changed to 1/4" choke in 14 min w/190 psi FWHP, GTS* in 28 min w/FWHP 220 psi. FWHP declined to 125 psi in 1 hr. 4 min. and further declined to 65 psi in 2 hrs. (end of FP)

Description of final flow period: Opened thru 1/4" choke w/60 psi FWHP increasing to 136 psi in 25 min at calculated rate of 213 MCFPD and specific gravity 0.60, pressure declined slowly thruout remainder of flow period to 10 psi at end of period (8 hrs).

PRESSURE DATA

TEMPERATURE	Gauge No. J-109 Depth: 6959 ft.		Gauge No. J-313 Depth: 6965 ft.		Gauge No. J-379 Depth: 7005 ft.		Gauge No. J-867 Depth: 7010 ft.	
	48 Hour Clock		48 Hour Clock		48 Hour Clock		48 Hour Clock	
Est. °C	Blanked Off	No	Blanked Off	No	Blanked Off	Yes	Blanked Off	Yes
Actual 118 °C	Pressures Field	Office	Pressures Field	Office	Pressures Field	Office	Pressures Field	Office
Initial Hydrostatic	3751		3753		3776		3781	
First Period FLOW Initial	320		319		327		322	
First Period FLOW Final	205		205		228		223	
First Period Closed In	1266		1262		1274		1271	
Second Period FLOW Initial	269		268		276		272	
Second Period FLOW Final	171		171		175		173	
Second Period Closed In	2273		2269		2285		2295	
Third Period FLOW Initial								
Third Period FLOW Final								
Third Period Closed In								
Final Hydrostatic	3725		3709		3756		3756	

RECOVERY DATA

	Type	Amount		Depth Back Pres. Valve	Surface Choke	Bottom Choke	
Cushion	None						
Recovered	932'/16.6 bbls	Feet bbl of	slightly gas cut rat hole mud and filtrate				
Recovered		Feet bbl of					
Recovered	(Spl Chamber #1)	Feet bbl of	0.81 cu. ft. gas, no liquid.				
Recovered		Feet bbl of					

Remarks *Separator bypassed for 1st 30 min. of IFP.

FLOW DATA FROM NORELCO SEPARATOR FINAL FLOW PERIOD

Time Into FFP	Tubing Press.	Choke	Flow Rate	Specific Gravity
25 min.	136 psi	1/4"	213 MCFPD	0.60
100 min	67 psi	1/4"	55 MCFPD	0.60
265 min	33 psi	1/4"	17 MCFPD	0.64
370 min	30 psi	1/4"	11 MCFPD	0.64
480 min	(Final shut in) too small to calculate rate.			

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GAS ANALYSIS REPORT

Company Husky Oil Company Date June 10, 1980 Lab No. 3897

Well No. Lisburne No. 1 Location

Field NPRA Formation

County Depth DST No. 1

State Alaska Sampling Point Tool Sample Chamber

Line pressure ____ psig; Sample pressure 1050 psig; Temperature ____ °F; Container number

Remarks

Recovered 13562 cc gas, 1000 cc fluid (GCM)

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	3.64	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	96.34	
Ethane	0.02	
Propane & Higher	TRACE	TRACE
	100.00	TRACE
GPM of pentanes & higher fraction	0	
Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis)	973	
Specific gravity (calculated from analysis)	0.569	
Specific gravity (measured)	0.570	

Remarks:

F-1

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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-1
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Initial Influx on Reverse Out

REMARKS & CONCLUSIONS: Sample taken 5-26-80 @ 0248 Hrs.

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	44	1.93	Sulfate	20	0.42
Potassium	8	0.20	Chloride	8	0.23
Calcium	31	1.55	Carbonate	0	—
Magnesium	10	0.82	Bicarbonate	235	3.85
Iron	—	—	Hydroxide	—	—
Total Cations		4.50	Total Anions		4.50

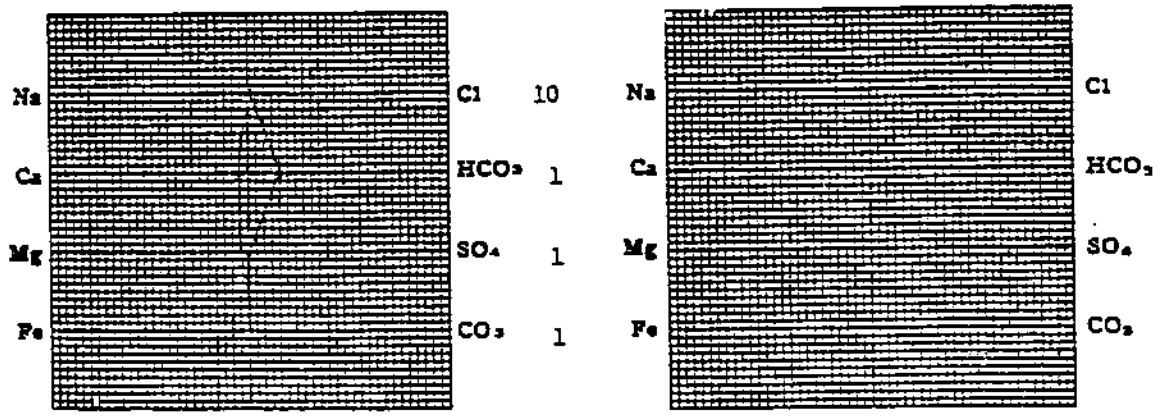
Total dissolved solids, mg/l 238
NaCl equivalent, mg/l 183
Observed pH 7.6

Specific resistance @ 68°F.:
Observed 31 ohm-meters
Calculated 31 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value in above graphs includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Hawthorne calculation from components

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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-2
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Last of Reverse Out

REMARKS & CONCLUSIONS: Sample taken 5-26-80

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2177	94.72	Sulfate	1380	28.70
Potassium	9	0.23	Chloride	200	0.56
Calcium	30	1.50	Carbonate	80	2.66
Magnesium	3	0.25	Bicarbonate	3950	64.78
Iron	–	—	Hydroxide	–	—
Total Cations		96.70	Total Anions		96.70

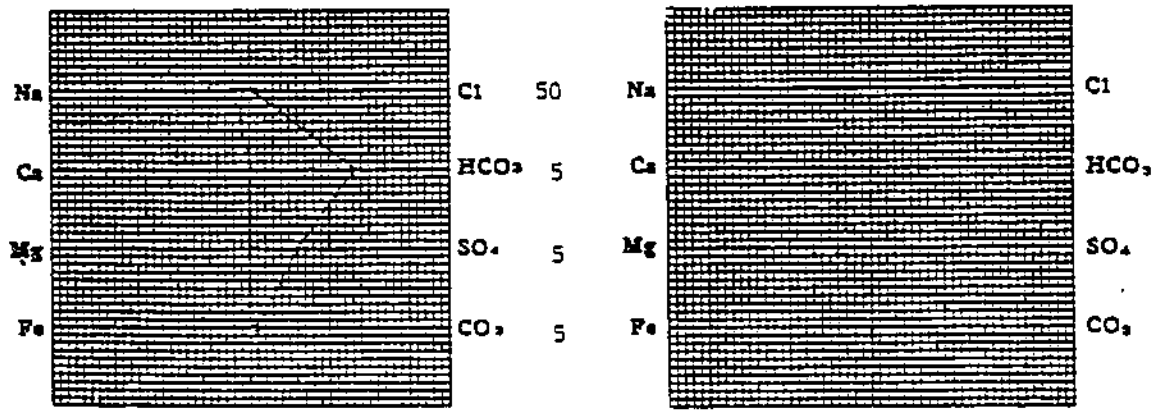
Total dissolved solids, mg/l 5842
NaCl equivalent, mg/l 4278
Observed pH 8.2

Specific resistance @ 68°F.:
Observed 1.38 ohm-meters
Calculated 1.41 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value is shown for groups including Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Doering & Hawthorne calculation from components

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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-3
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM MFE Sample Chamber

REMARKS & CONCLUSIONS:

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2516	109.43	Sulfate	1440	29.95
Potassium	27	0.69	Chloride	260	7.33
Calcium	20	1.00	Carbonate	560	18.65
Magnesium	1	0.08	Bicarbonate	3370	55.27
Iron	–	—	Hydroxide	—	—
Total Cations		111.20	Total Anions		111.20

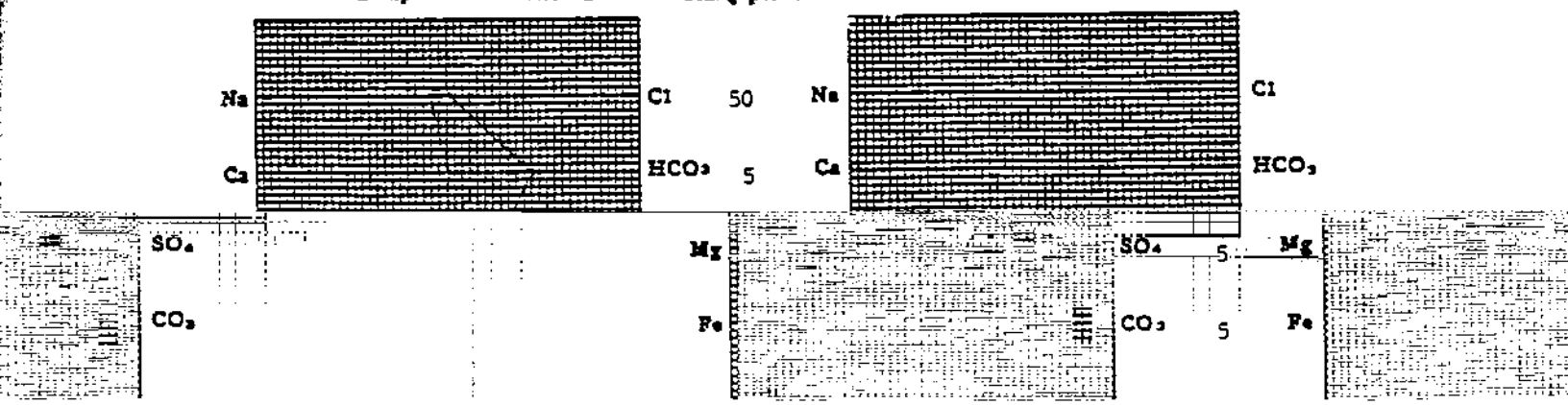
Total dissolved solids, mg/l 6499
NaCl equivalent, mg/l 5160
Observed pH 8.8

Specific resistance @ 68°F.:
Observed 1.19 ohm-meters
Calculated 1.25 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value is above cations includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Hawthorne calculation from components

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WATER ANALYSIS REPORT

Husky Oil Company
Tisburne No. 1
...
NPRA
Alaska

DATE June 10, 1980 LAB NO. 3897-4
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Test Sample

OPERATOR
WELL NO.
FIELD
COUNTY
STATE
REMARKS &

CONCLUSIONS

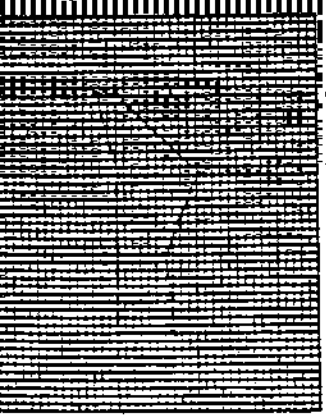
	mg/l	meq/l
Chloride	2767	120.38
Sulfate	45	1.15
Carbonate	18	0.90
Bicarbonate	5	0.08
Hydroxide	0	0.00
Total Solids	122.51	
pH	7086	
Eh, mV	5917	
mg/l	19.2	

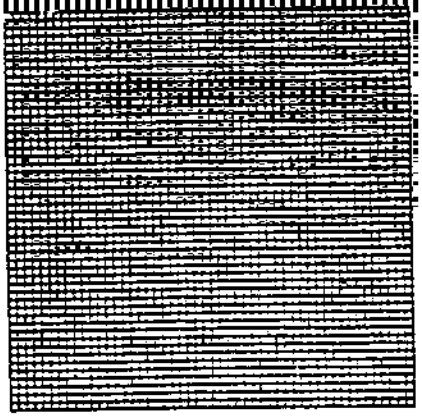
	mg/l	meq/l
Calcium	1400	69.82
Magnesium	240	19.74
Sodium	1040	45.23
Potassium	3170	81.09
Iron	3	0.11
Total Anions	122.51	
Specific Resistance @ 68°F	0.10	
Chlorine	8465	
Calcium		

Scales
Anions
Cations
Total Hardness
Iron
Total Dissolved Solids
NaCl Equivalent
Observed pH

WATER ANALYSIS PATTERN

Scale
Sample above described
MEQ per Unit





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

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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-6
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Final Fluid to Surface

REMARKS & CONCLUSIONS: Sample taken May 29, 1980

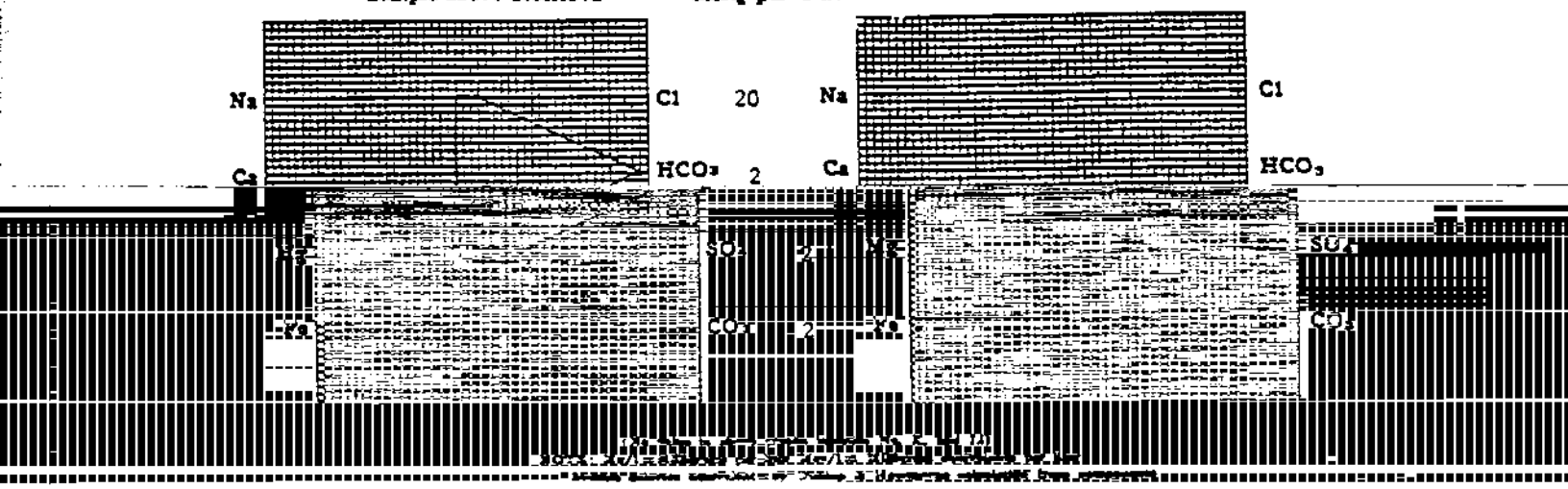
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2545	110.70	Sulfate	170	3.54
Potassium	25	0.64	Chloride	1710	48.22
Calcium	18	0.90	Carbonate	440	14.65
Magnesium	12	0.99	Bicarbonate	2855	46.82
Iron	–	—	Hydroxide	–	—
Total Cations		113.23	Total Anions		113.21

Total dissolved solids, mg/l	6338	Specific resistance @ 68°F.:	
NaCl equivalent, mg/l	5730	Observed	1.07 ohm-meters
Observed pH	8.3	Calculated	1.10 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-7
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Final Mud to Surface

REMARKS & CONCLUSIONS: Sample taken May 29, 1980

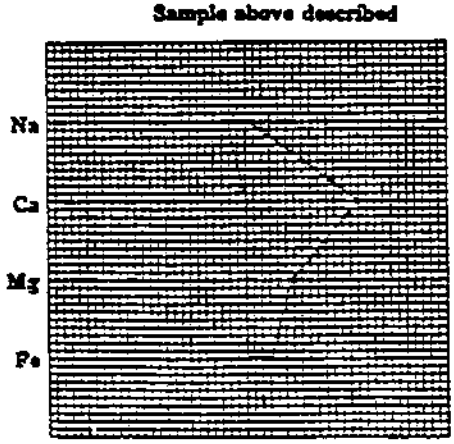
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2694	117.19	Sulfate	1360	28.29
Potassium	15	0.38	Chloride	250	7.05
Calcium	26	1.30	Carbonate	440	14.65
Magnesium	4	0.33	Bicarbonate	4220	69.21
Iron	-	—	Hydroxide	-	—
Total Cations		119.20	Total Anions		119.20

Total dissolved solids, mg/l 6886
NaCl equivalent, mg/l 5365
Observed pH 8.5

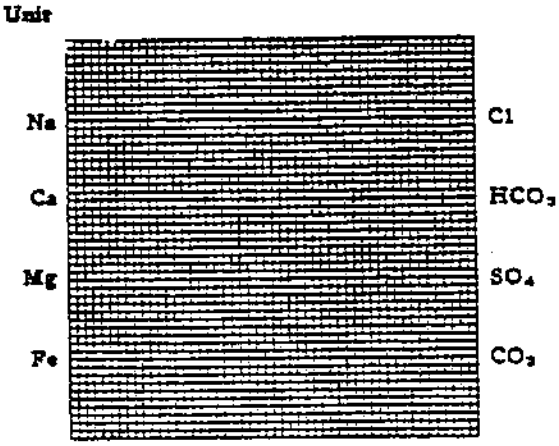
Specific resistance @ 68°F.:
Observed 1.13 ohm-meters
Calculated 1.15 ohm-meters

WATER ANALYSIS PATTERN

Sample above described



Scale
MEQ per Unit



50
5
5
5

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

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WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-8
LOCATION
FORMATION
INTERVAL DST No. 1
SAMPLE FROM Sample Chamber Fluid

REMARKS & CONCLUSIONS:

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2546	110.77	Sulfate	130	2.70
Potassium	25	0.64	Chloride	1770	49.91
Calcium	26	1.30	Carbonate	0	—
Magnesium	13	1.07	Bicarbonate	3730	61.17
Iron	—	—	Hydroxide	—	—
Total Cations		113.78	Total Anions		113.78

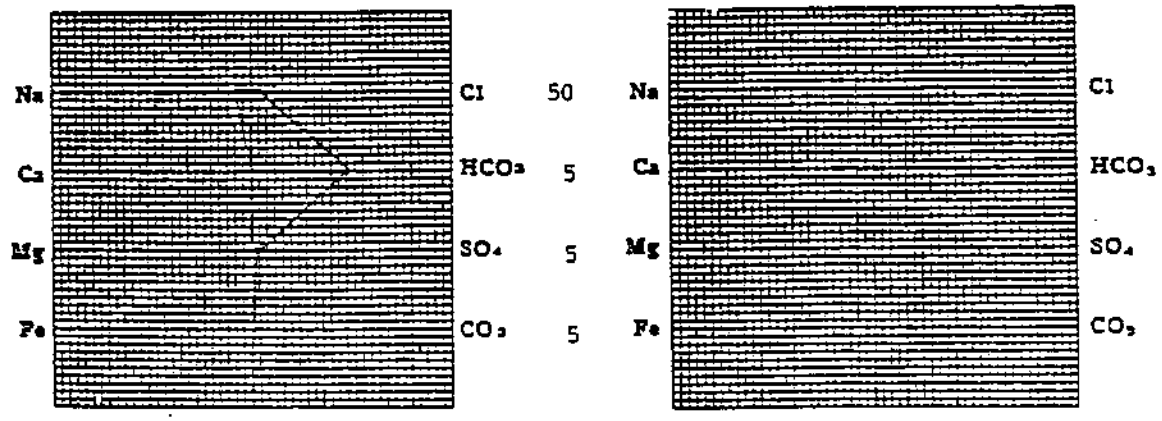
Total dissolved solids, mg/l 6364
NaCl equivalent, mg/l 5464
Observed pH 7.5

Specific resistance @ 68°F.:
Observed 1.15 ohm-meters
Calculated 1.20 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



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

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GAS ANALYSIS REPORT

Company Husky Oil Company Date June 5, 1980 Lab No. 3955

Well No. Lisburne No. 1 Location

Field NPRA Formation

County Depth DST No. 3

State Alaska Sampling Point Tool Sample

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

Remarks Fluid Recovered 1375 cc

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	2.84	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	97.11	
Ethane	0.05	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction 0

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) 981

Specific gravity (calculated from analysis) 0.569

Specific gravity (measured) 0.570

Remarks:

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GAS ANALYSIS REPORT

Company Husky Oil Company Date June 9, 1980 Lab No. 3978-1

Well No. Lisburne No. 1 Location

Field NPRA Formation

County Depth DST #3 (7645-60)

State Alaska Sampling Point Sample Chamber

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

Remarks

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	2.30	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	97.68	
Ethane	0.02	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction 0

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) 988

Specific gravity (calculated from analysis) 0.563

Specific gravity (measured) 0.565

Remarks:

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WATER ANALYSIS REPORT

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

DATE June 5, 1980 LAB NO. 3955-1
LOCATION
FORMATION
INTERVAL DST No. 3
SAMPLE FROM Test Tool

REMARKS & CONCLUSIONS: Recovered 1375 cc GCM

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3412	148.41	Sulfate	120	2.50
Potassium	22	0.56	Chloride	1770	49.91
Calcium	40	2.00	Carbonate	0	—
Magnesium	13	1.07	Bicarbonate	6075	99.63
Iron	—	—	Hydroxide	—	—
Total Cations		152.04	Total Anions		152.04

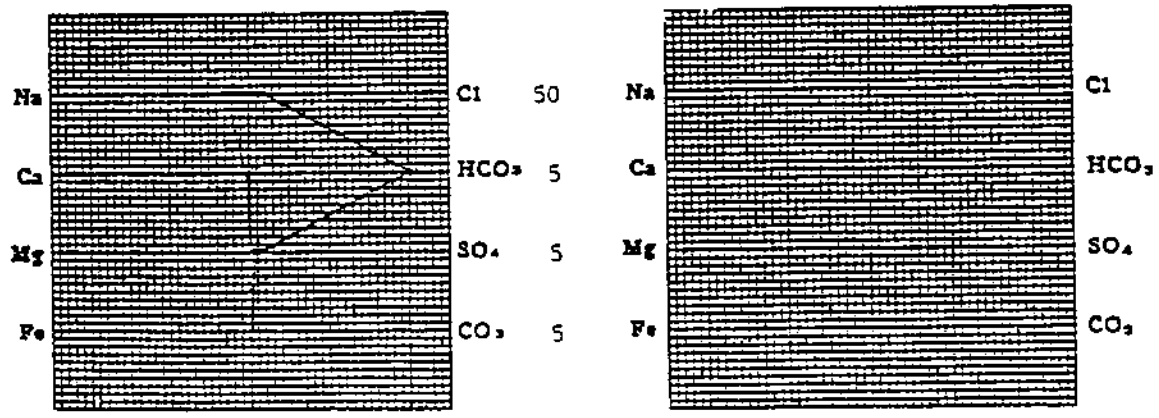
Total dissolved solids, mg/l 8396
NaCl equivalent, mg/l 6968
Observed pH 7.3

Specific resistance @ 68°F.:
Observed 0.97 ohm-meters
Calculated 0.96 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



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

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WATER ANALYSIS REPORT

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

DATE June 11, 1980 LAB NO. 3978-3
LOCATION
FORMATION
INTERVAL DST No. 3 (7645-60
SAMPLE FROM Sample Chamber fluid

REMARKS & CONCLUSIONS:

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3534	153.72	Sulfate	165	3.43
Potassium	18	0.46	Chloride	1780	50.20
Calcium	21	1.05	Carbonate	0	—
Magnesium	10	0.82	Bicarbonate	6245	102.42
Iron	—	—	Hydroxide	—	—
Total Cations		156.05	Total Anions		156.05

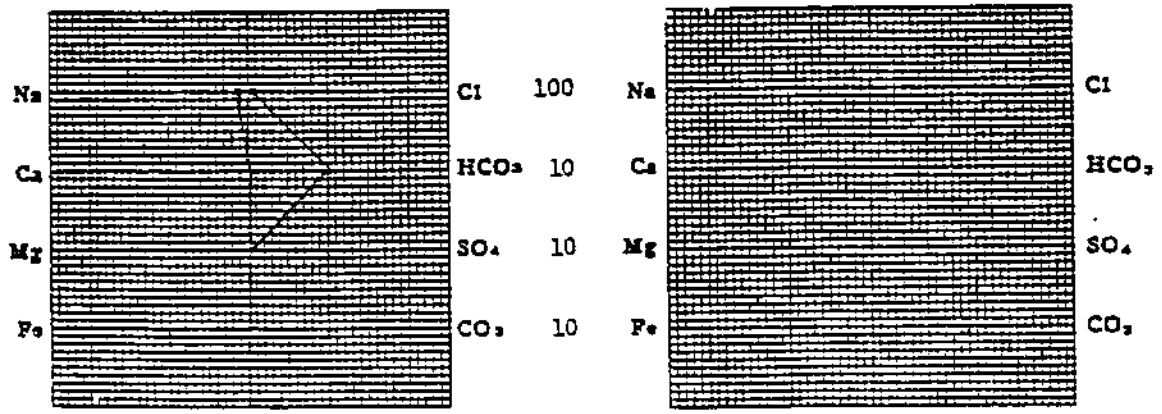
Total dissolved solids, mg/l 8631
NaCl equivalent, mg/l 7140
Observed pH 7.6

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

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



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

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WATER ANALYSIS REPORT

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

DATE June 11, 1980 LAB NO. 3978-4
LOCATION
FORMATION
INTERVAL DST #3 (7645-60)
SAMPLE FROM Above Lower Chamber

REMARKS & CONCLUSIONS:

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3650	158.79	Sulfate	160	3.33
Potassium	15	0.38	Chloride	1740	49.07
Calcium	15	0.75	Carbonate	520	17.32
Magnesium	8	0.66	Bicarbonate	5540	90.86
Iron	-	—	Hydroxide	-	—
Total Cations		160.58	Total Anions		160.58

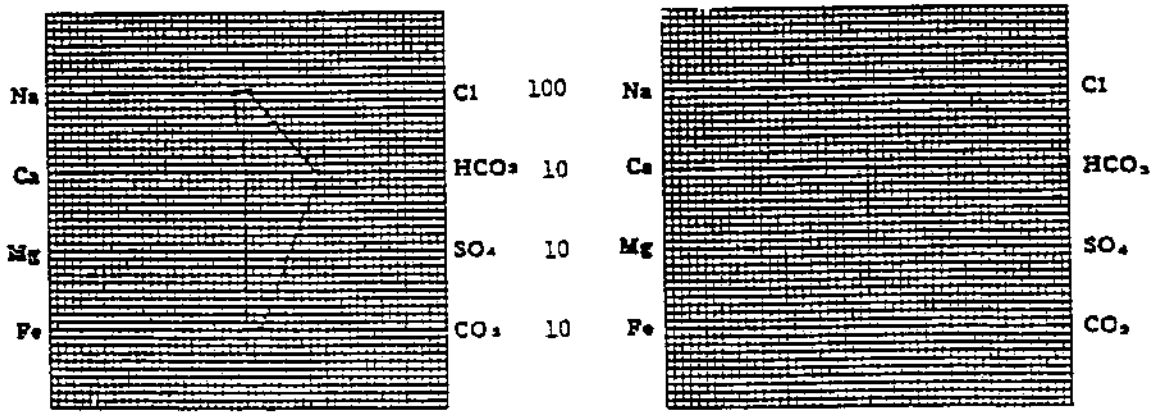
Total dissolved solids, mg/l 8861
NaCl equivalent, mg/l 7666
Observed pH 8.2

Specific resistance @ 68°F.:
Observed 0.81 ohm-meters
Calculated 0.87 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale MEQ per Unit



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

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

P.O. BOX 4-1278
Anchorage, Alaska 99509

TELEPHONE (907)-279-4014 · 274-3364

ANCHORAGE INDUSTRIAL CENTER
5633 B Street

WATER ANALYSIS REPORT

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

DATE June 10, 1980 LAB NO. 3897-5
LOCATION
FORMATION
INTERVAL DST No. 3 (7645-62)
SAMPLE FROM Middle Fluid of Reverse Out

REMARKS & CONCLUSIONS: Sample taken May 29, 1980

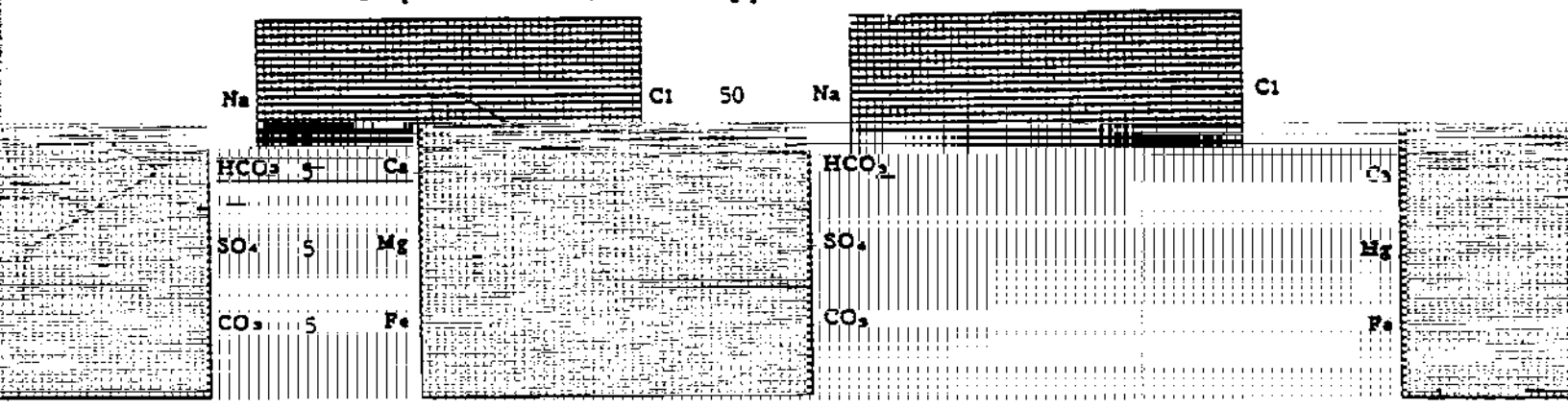
Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	3070	133.53	Sulfate	280	5.82
Potassium	25	0.64	Chloride	1480	41.74
Calcium	44	2.20	Carbonate	0	—
Magnesium	10	0.82	Bicarbonate	5465	89.63
Iron	—	—	Hydroxide	—	—
Total Cations		137.19	Total Anions		137.19

Total dissolved solids, mg/l 7625
NaCl equivalent, mg/l 6523
Observed pH 7.5

Specific resistance @ 68°F.:
Observed 0.97 ohm-meters
Calculated 1.00 ohm-meters

WATER ANALYSIS PATTERN

Scale
Sample above described MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalents by Dunlap & Havenhorst calculations from components.

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GAS ANALYSIS REPORT

Company Husky Oil Company Date June 11, 1980 Lab No. 3978-2

Well No. Lisburne No. 1 Location

Field NPRA Formation

County Depth DST No. 4 (7022-7104)

State Alaska Sampling Point Bubble Hose

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

Remarks

Component	Mole % or Volume %	Gallons per MCF
Oxygen	0	
Nitrogen	1.98	
Carbon dioxide	TRACE	
Hydrogen sulfide	—	
Methane	97.94	
Ethane	0.08	
Propane & Higher	TRACE	TRACE
Total	100.00	TRACE

GPM of pentanes & higher fraction 0

Gross btu cu. ft. @ 60° F. & 14.7 psia (dry basis) 991

Specific gravity (calculated from analysis) 0.563

Specific gravity (measured) 0.565

Remarks:

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

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

TELEPHONE (907)-279-4014
274-3384

ANCHORAGE INDUSTRIAL CENTER
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WATER ANALYSIS REPORT

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

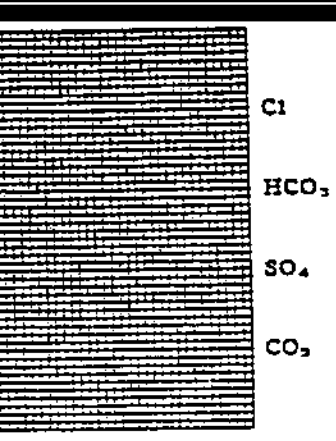
DATE June 11, 1980 LAB NO. 3978-5
LOCATION
FORMATION
INTERVAL DST No. 4(7022-7104)
SAMPLE FROM First Fluid Return-Reverse Out

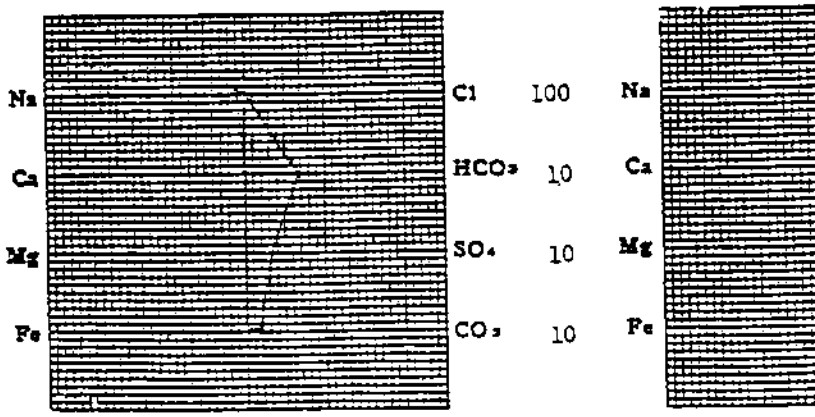
REMARKS & CONCLUSIONS:

			2604	53.27	
			10	0.28	
				.05	
			2	0.16	
1420	29.54				
40	3.95				
480	15.98				
3980	65.27				
	114.74	Total Cations		114.74	
			5655		
			5167		
			8		

WATER ANALYSIS PATTERN

Sample above described | MEQ per Unit





(No value is shown where cations include Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligrams equivalents per
Sodium chloride equivalent by Dunlap & Havenhorst calculation fr

LISTING OF OTHER AVAILABLE GEOLOGICAL DATA

A. Final Biostratigraphic Report, Foraminifera, by Anderson, Warren & Associates, Inc., dated June 19, 1980.

B. Final Biostratigraphic Report, Palynology, by Anderson, Warren & Associates, dated June 19, 1980.

C. Preliminary Results, Lithologic Study of Repeated Sections by Anderson, Warren & Associates, Inc., dated April 10, 1980.

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