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THE MILK RIVER FORMATION IN THE SUFFIELD AND MEDICINE HAT AREAS (SOUTHERN ALBERTA)

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Although every effort has been made to ensure accuracy , this Open File Report has not been edited for conformity with Geological Survey of Canada standards

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INTRODUCTION

The Upper Cretaceous Milk River Formation in the Bantry, Suffield and Medicine Hat areas has been known to be gas bearing since 1884, when the CPR drilled the Alderson No. 1 well and found gas at depths of between 1,151 and 1,155 feet in the southwest corner of section 29, township 15, range 10 west of the 4th meridian.

In 1941, the Department of National Defence began to use the natural gas from the Milk River Formation to service their installations at Ralston, Alberta, and the Suffield gas field was developed. In 1970, industry became interested in the shallow gas reserves and drilling activity increased. The gas reserves in the Milk River Formation were found to be large and widespread, but they are difficult to evaluate properly. In February, 1972, the National Energy Board asked the Geological Survey of Canada to examine the geological and lithological aspects of the Milk River Formation and to study its reservoir characteristics in the Bantry, Alderson, Suffield and Medicine Hat areas.

Because the Upper Cretaceous strata lie at a very shallow depth in Southern Alberta, all the boreholes drilled in the search for oil and gas have penetrated the Milk River Formation. Consequently, almost every borehole or well has some sort of information on the Milk River Formation, either as measured physical properties recorded on borehole logs or on records of drillstem tests or as chips of the rock itself. Since information obtained only from borehole logs is not sufficient for a proper evaluation of the Milk River gas reservoir, a study of the lithology was undertaken.

METHODS OF STUDY

A data search by Computer Data Processors Ltd. of a grid defined by township 9, range 1 west of the 4th meridian and township 18, range 15 west of the 4th meridian indicated that 9 out of the 1,738 boreholes drilled in this area had cored intervals in the Milk River Formation, of which only 8 were useful (Appendix I). Because none of the boreholes had cored a complete Milk River section, it was decided to make a composite lithological section of the productive intervals (Fig. 5).

After the core study was completed, an attempt was made to study the samples taken from well cuttings. Although they proved to be useful in defining the top and the base of the Milk River Formation, the samples were too contaminated with material from the up-hole section for a sand-shale ratio study.

It was found that unless special drilling muds are used, the bulk of the Milk River section will wash out. The montmorillonitic shale and thin friable silty sandstone beds are poorly represented or absent in the samples from wells drilled prior to 1960. More recent utilization of compressed air as a lubricant causes the shale and sandstone section to be blown out as dust. Thus good samples have been obtained only from recently drilled wildcat wells in which special precautions were taken. Even then the samples are not good enough for a detailed lithological study.

The following observations, therefore, are based strictly on a study of eight Milk River cores.

REGIONAL GEOLOGY OF THE MILK RIVER FORMATION

No attempt was made to do a regional study of the borehole logs. Because it was impossible in the time available to digest the large amount of data for a project like this, a data print out was obtained from Computer Data Processors Ltd. for Milk River structure and isopach values. Unfortunately the data proved to be of such poor quality that no further use of them was made.

Two cross-sections (Figs. 1 and 2), based on data obtained from core analyses, tie the Milk River stratigraphy farther south (Tovell, 1956; *see* also Fig. 4) to the Milk River Formation of the Suffield and Medicine Hat areas. The southern part of the Milk River Formation consists of three members. The upper, Deadhorse Coulee member consists of nonmarine shales, siltstones and sandstones; the middle, Virgelle sandstone member consists of porous marine sandstone; and the lower member, the transition beds, consists of silty shale. Thickness of the Milk River Formation ranges between 280 and 300 feet.

The cross-sections on figures 1, 2 and 3 show the "pinch out" of the Virgelle sandstone and the correlation of the Deadhorse Coulee member with the upper sandy part of the Milk River Formation in the Suffield and Medicine Hat areas, and the correlation of the transition beds with the silty shales of the lower part of the formation in the same area. To the north, the Milk River Formation is known to merge with the basal part of the Lea Park Formation because the sandy, Deadhorse Coulee equivalents are lost (*see* diagrammetric cross-section on Fig. 4 after W.M. Tovell, 1956).

The cross-sections and the lithology of the gas reservoir beds suggest that there is no connection between the gas trapped in the Suffield

and Medicine Hat areas and the fresh water trapped in the Virgelle sandstone to the south. The gas appears to have been formed locally in the shale and to have migrated into the porous sand lenses where it was trapped.

If this is true, the gas reservoir should have a pressure somewhat higher than normal. The fresh water in the Virgelle sandstone is connected to the surface and has, therefore, a normal pressure.

It is likely that the Milk River Formation is gas-bearing over a large area. The area south of the present fields and north of the Virgelle sandstone "pinch out" is known to be gas bearing (*see* Figs. 1, 2 and 3), and it is possible that both the Deadhorse Coulee member and the transition beds contain gas in the areas where the Virgelle sandstone was developed. For economical reasons, however, we can assume that the southern limit of the gas reservoir is just north of the Virgelle sandstone "pinch out". The northern limit of the prospective area is related to the facies change of the Milk River Formation and lies south of the Red Deer River. The Empress Utility No. 1 well drilled in 1946 near Empress, Alberta, in 7-13-23-1W4 tested gas at a rate of 5.4 million cubic feet per day.

THE MILK RIVER FORMATION IN THE SUFFIELD AND MEDICINE HAT AREAS

In the Bantry, Suffield and Medicine Hat areas, the Milk River Formation comprises an interval of interbedded very fine grained argillaceous sandstone, siltstone and silty shale marked at the top by a thin cherty pebble bed. It is overlain by shales of the Pakowki Formation and underlain by white speckled calcareous shales of the Alberta Formation. In the area under consideration, the Milk River Formation can be subdivided into an upper and lower part. The boundary between the two parts is not sharp.

The upper part of the Milk River Formation consists of variably argillaceous, very fine grained sandstone, interbedded with siltstone and silty shale. At or near the top of the formation is a thin pebble bed consisting of well-rounded black chert and light-coloured quartzites in an argillaceous, poorly sorted, fine- to very coarse grained sandstone matrix. This pebble bed is, in places, sideritic. There are poorly defined bands and nodules of siderite scattered throughout the Milk River Formation.

Bedding is poorly developed and individual beds are not sharply defined. The argillaceous sandstone and siltstone beds have a mottled appearance. Light grey, clean, well-sorted, porous sand and silt occurs in laminated beds or lenses, 1/8 to 1 inch thick and as burrow-like structures in the argillaceous matrix. The lenses are present either isolated in the matrix or piled up on top of each other to form poorly defined beds, 6 to 8 inches thick. They have laminations similar to current ripples and are thought to be the products of current and wave action. The mottled, argillaceous sediments were deposited in slack water and have been reworked by burrowing animals.

Near the base of the upper part of the Milk River Formation is a greenish grey shale bed, 2 to 4 feet thick. Although this shale bed can be recognized on electrical logs and can be correlated for some distance from one borehole to the other, it is not a consistent marker.

The lower part of the Milk River Formation is less sandy than the upper part and consists of silty shale interbedded with argillaceous siltstone. Scattered throughout the interval are thin (1/8 - 1 inch thick), light grey, clean, well-sorted, porous, very fine grained silty sand

lenses. In the top part the laminated lenses in places form beds from 2 to 6 inches thick. Towards the base the thin light-grey porous silty sand lenses become scarce, and disappear altogether where the shale becomes calcareous. The base of the Milk River Formation is transitional through a thin interval and is placed at the top of the calcareous white speckled shale.

Good porosity and permeability is confined to the clean, isolated sand lenses and the closely packed sand lenses that form beds. The argillaceous sandstone beds have little porosity and lack permeability. Porosity and permeability tests were performed on a number of cores by Core Laboratories of Canada.

The most useful measurements are from the ARCO Alderson well (10-4-15-10W4) and the ARCO IOD Medicine Hat well (10-14-15-4W4), because the lithology could be checked in the core. In the ARCO Alderson well, a variable argillaceous siltstone, in part very fine sandy and with no visible porosity, gives a horizontal permeability to air of 1.00 MD and a porosity per cent of 17.5 (plug 1). The thin (1/2 - 2 inches), well-sorted, clean, fairly porous siltstone and very fine sandstone beds give horozontal permeabilities ranging from 2.75 to 259.00 MD and porosity per cents range from 17.3 to 26.0 (*see* core description and core analysis).

In the ARCO IOD Medicine Hat well, the lower part of the Milk River Formation was completely cored and analysed. The bentonitic shale marker was analysed in samples 104, 105 and 106. Porosity per cent figures are respectively 31.4, 32.9 and 42.5, measured according to the "summation fluids" method (*see* core analysis report by Core Laboratories Canada Ltd. No. 913-124). The same method gives figures of 15.2 to 20.1 per cent

porosity for a very poorly porous argillaceous siltstone and silty shale sequence just above the shale "marker". Permeabilities to oil in this sequence are extremely low, smaller than 0.0163. Below the bentonitic shale "marker" every foot of the core was analysed, but somehow only in silty shale or argillaceous siltstone. Consequently very low permeabilities are recorded (smaller than 0.0001 MD). Porosity per cent figures measured according to the "summation of fluids" method range from 5.9 to 24.4 but average between 18 and 20. It is probable that the thin, porous silt and sand lenses, which were overlooked in the core, have similar permeability and porosity per cent figures to the ones recorded in the core analysis of the ARCO Alderson well.

THE MILK RIVER FORMATION AS RESERVOIR

From the preceding description, it is evident that the thin, porous, silty sand lenses and beds are the channels through which the gas flows into the borehole and it is assumed that the bulk of the gas reserve is held in the same beds.

In order to properly evaluate the potential of the Milk River Formation, information is required on the limits of the reservoir (both vertical and horizontal), the pressure of the gas in the reservoir, the space that is present within the reservoir (porosity) and the ability of the gas to move through the reservoir (permeability). The main problem in evaluating the Milk River gas reservoir is a lack of information. From the majority of the gas wells we know only that they produce gas from an interval somewhere in the Milk River Formation, and how much gas they are able to produce during a limited amount of time.

Data regarding the limits of the gas reservoir are obtained from information on logs, samples and cores taken during the drilling of a well. Data regarding the porosity and permeability are obtained from logs, and from permeability and porosity measurements on cores. Data regarding the pressure of the gas and its ability to move through the reservoir are obtained from production tests. Because of the interbedded character of the reservoir, the information obtained from borehole logs is limited. The thin porous sandstone and siltstone beds are not indicated on the logs as separate units, they are "averaged out" over three to five feet. Since the montmorillonitic shales swell in water and easily wash out only nine wells have cores available in the Milk River section, of which two are useful for reservoir analysis: the ARCO IOD Medicine Hat well in 10-14-15-4W4 and the ARCO Alderson well in 10-4-15-10W4.

Production tests were run on a large number of wells, and the most meaningful tests are those which measured the gas flow while the well was being drilled with air below casing. Accumulated flow rates are measured at different depths until the complete Milk River section is penetrated and the gas flow is at its highest level. The stabilized flow rate taken over a long interval of time is often a little lower than the maximum measured flow rate. It is possible that during the initial flow the argillaceous siltstone and silty shale contribute a small amount of gas to the reservoir because of their large surface of contact with the permeable sand lenses but ~~is~~ are rapidly depleted during the production test.

Only the thicker, more continuous beds are able to give measurable gas flows as is suggested by airflow tests conducted in some wells. AEG Alderson well (6-30-14-9W4) was tested this way and indicated an increase

in gas flow of 321 McF/d between 961 and 992 feet, just below the bentonitic shale "marker". This interval correlates with the top of core #2 in the AEG Alderson well (7-30-14-9W4), which has some fairly thick porous intervals (up to 9 inches).

The gas flows measured in the lower part of the Milk River Formation are comparatively small. In 6-30-14-9W4 an increase in the gas flow of 187 McF/d was measured between 1,022 and 1,052 feet and an increase of 43 McF/d between 1,082 and 1,112 feet. The last interval correlates with core #4 in AEG Alderson well (7-30-14-9W4) and has thin isolated porous silty sand lenses of 1/8 to 1 inch thick.

The ARCO IOD Medicine Hat well (10-14-15-4W4) is cased to a depth of 1,250 feet, thereby preventing production from the upper part of the Milk River Formation. This well produces at 76 McF/d out of numerous thin (1/4 - 1 inch), isolated, porous, silty sand lenses.

By comparing the amount of porosity with the total core footage, an average net pay per foot has been calculated for the few cored wells (*see* Table 1). It was necessary to treat upper and lower parts of the Milk River Formation separately (*see* Table I) because of the great difference in the amount of porosity.

If we use a net pay/gross pay ratio of 1/6 for the AEG Alderson 7-30-14-9W4 well, for the upper 148 feet (between 888' and 1,036') the estimated net pay figure will be 24 feet 8 inches. For the lower 120 feet (between 1,036' and 1,156') we could use a ratio of 1/20 and estimate the net pay at 6 feet. The total estimated net pay is thus 30 feet 8 inches for the 268-foot interval. A similar calculation for the ARCO Alderson well in 10-4-15-10W4 gives an estimated net pay of 31 feet 4 inches for a 278-foot interval. This well has an absolute

open flow (AOF) of 360 million cubic feet per day (McF/d). In the Medicine Hat area, no such estimates can be made because of the lack of data. Only one well, in which the pay section was completely cored, can be given a net pay figure. ARCO IOD Medicine Hat well (10-14-15-4W4) has a net pay of 3 feet 4 inches in the lower part of the Milk River Formation, which is 140 feet thick.

Unfortunatly the AEG Alderson well in 7-30-14-9W4 was tested only after completion and we are not able to localize the gas zone or zones in the section. There is, however, a well nearby which was tested on the way down, and we can use the knowledge obtained from this well to eliminate certain intervals which are not productive.

If we look at the flow test results of AEG Alderson 6-30-14-9W4, we see that four intervals are productive (*see* log cross-section 3).

Top of Milk River Formation at		816'
casing set at		882'
Air flow tests: (as reported by Well Information Services on card No. C71-188)	880' - 900'	no gas
	880' - 930'	no gas
	880' - 961'	9 McF/d
	880' - 992'	330 McF/d
	880' - 1022'	330 McF/d
	880' - 1052'	517 McF/d
	880' - 1082'	517 McF/d
	880' - 1112'	560 McF/d
	880' - 1142'	560 McF/d
	880' - 1173'	517 McF/d
	880' - 1180'	517 McF/d
Base of Milk River Formation at		1128'

Interval 930-961 feet flowed 9 McF/d; interval 961-992 feet flowed 321 McF/d; interval 1022-1052 feet flowed 187 McF/d and interval 1112-1142 feet flowed 43 decreasing to 0 McF/d. Apparently the best porosity is in intervals 961-992 feet, and 1022-1052 feet. In the nearby AEG Alderson well (7-30-14-9W4), the upper porous interval is partly cored.

Table I

Upper Part Milk River Formation

Location	Core Length	Net Pay	Net Pay/Core Length Ratio
6-28-13-12W4	120'	19'6"	1/6.1
7-30-14-9W4	60'	9'	1/6.6
10-4-15-9W4	20'	8"	1/30
10-4-15-10W4	46'6"	7'1"	1/6.5
11-6-12-9W4	40'	7'	1/5.6

Lower Part Milk River Formation

10-4-15-10W4 (core #6)	11'	6"	1/20.3
7-30-14-9W4 (core #3 and 4)	60'	3'1"	1/19.4
10-14-15-4W4	140'	3'4"	1/35.0

Core No. 2 (interval 1000-1030') has 8 feet of porosity out of 30 feet, a ratio of 1 to 3.75. From this information we can estimate the net pay of interval 961-992 feet in this well (6-30-14-9W4) as 8 feet. The net pay of interval 1022-1052 feet is probably only half as much, and the total net pay for the gas well in 6-30-14-9W4 would then be in the order of 12 feet, if we ignore the gas in the intervals that flowed 9 McF/d and 43→0 McF/d. This figure is more realistic than the 30 feet 8 inches of net pay for the AEG Alderson gas well, this figure being based only on an average amount of porosity per foot and the total thickness.

If we compare the results of the flow tests of other gas wells with the depth below the top of the Milk River Formation, we are able to localize the gas zones more precisely. In most wells, the upper 50 to 100 feet of the Milk River Formation are not productive and, in the Alderson field, production comes mainly from an interval between 50 and 200 feet below the top of the Milk River Formation (*see* Fig. 6).

Although it is not possible to establish net pay figures in the Alderson and Medicine Hat fields, it is apparent from the above discussion that the majority of the wells will have a net pay in the order of 10 to 30 feet. Little can be said about the areal extent of the gas reservoir, since field limits are not established.

CONCLUSIONS

The Transition beds and the equivalents of the Deadhorse Coulee member of the Milk River Formation are both gas-bearing north of the Virgelle sandstone pinch out. Production comes from thin beds and very thin lenses of very fine grained silty sandstone which are interbedded with argillaceous siltstone and silty shale. The thickness of the reservoir ranges between

280 and 300 feet, but the net pay figure in wells that produce between 200 and 400 McF/d probably does not exceed 32 feet. Wells producing less than 100 McF/d probably do not have more than 5 feet of net pay. The porous beds are too thin to show up on borehole logs and consequently no net pay figures can be derived from these records. Most wells have been drilled with water base muds, therefore, the sediments of the Milk River Formation are poorly represented in the well cuttings as the silty sands and montmorillonitic shales are easily broken up in the presence of water. The majority of the recently completed gas wells have been drilled with compressed air and the cuttings are reduced to dust. The gas potential of the Milk River Formation, therefore, can be determined only with the aid of core data or drill production tests, both of which are lacking over large areas. Our knowledge of the gas reservoir is therefore very limited.

Regionally, the Milk River Formation extends over a large area in Alberta and Saskatchewan but the prospective area is much smaller. Drill stem test data show the Milk River Formation to be gas-bearing from a line north of the Virgelle sandstone "pinch out" in the south to the Red Deer River in the north.

The economically producible gas is limited to the south half of the prospective area and coincides with the distribution of sand beds in the middle part of the Milk River Formation. The porous sand lenses in the lower part of the formation are much more widespread but do not appear to contain enough reserves to warrant exploitation.

Net pay figures in the Alderson and Medicine Hat areas are probably in the order of 10 to 30 feet.

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Appendix

Core Descriptions

H.B. Winnifred #1 (11-6-12-9W4) well

Core #1

Interval 1,000' - 1,002' recovered 2'8"

Interbedded sandstone (90%) and silty shale (10%)
Sandstone, grey, very argillaceous, very fine grained, silty, fairly well sorted, very slightly porous, with abundant micro-lenses of very fine sand. Sand consists of subangular quartz (90%), black chert grains (10%), and some glauconite. No porosity. Shale greenish grey to dark grey, silty, with very fine sand lenses. Beds poorly developed, 1/2 - 6 inches thick.

Core #2

Interval 1,003' - 1,010' recovered 7'

1,003' - 1,005'

Interbedded sandstone (90%) and silty shale (10%)
As in core 1.

1,005' - 1,007'

Interbedded silty shale (50%) and sandstone (50%)
As in core 1.

1,007' - 1,010'

Interbedded sandstone (90%) and silty shale (10%)
Sandstone, grey, argillaceous to very argillaceous, very fine grained, silty, as in core 1.
This sandstone is interbedded with 1/4- to 1-inch thick beds of grey-brown, very fine sandstone (10%), well sorted, clean, consisting of subangular quartz (90%) and black chert (10%), poorly to fairly porous. These beds are probably laminated. At 1,009' is a 2-inch thick, grey-brown, clean calcareous sandstone bed.

porous

Core #3

Interval 1,010' - 1,017' recovered 7'

1,010' - 1,011'

Shale. Greenish grey to dark grey, silty, with abundant micro-lenses of silt.

1,011' - 1,013'

Interbedded sandstone (40%) and argillaceous siltstone (60%).
Siltstone, grey, argillaceous, grading to very silty shale, non-porous, with micro-lenses of shale; sandstone light grey brown, very fine grained, in part very silty and grading to siltstone, clean, consisting of quartz (90%) and black chert (10%), well sorted, poorly to fairly porous. Some beds with micro-lenses of argillaceous material. Beds 1/2 - 2 inches thick. Contacts at 1,011 and 1,013 not sharp.

1,013' - 1,016'

Interbedded siltstone (30%) and argillaceous siltstone (60%) and silty shale (10%).
Siltstone, light grey-brown, clean, very slightly porous, in beds of 1/2 to 1 inch thick.

2 1/2 inch porous

Siltstone, grey, argillaceous, with micro-lenses of shale.
Shale, grey to dark grey, silty, with micro-lenses of silt.

1,016' - 1,017'	Shale, greenish grey to dark grey, silty, with small lenses and micro-lenses of silt.
Core #4	Interval 1,017' - 1,025'
1,017' - 1,020'6" 3 1/2" porous	Shale, greenish grey to dark grey, silty, with small lenses and micro-lenses of silt. At 1,018' thin sandstone beds, one 1/2-inch bed of grey, argillaceous to slightly argillaceous sandstone, very fine grained with dark grey argillaceous lenses, slightly porous and one 1" thick calcareous sandstone, light grey-brown, very fine to fine grained, poorly sorted, tight. At 1,019'6" two 1 inch beds of light grey-brown siltstone, very fine sandy, porous. Contact at 1,020'6" not sharp.
1,020'6" - 1,025' 15" porous	Interbedded argillaceous siltstone (60%) sandstone (30%) and silty shale (10%) Siltstone, grey, argillaceous, very fine sandy in part, with abundant micro-lenses of silt and shale. Sandstone light grey-brown, clean, very fine grained, some beds very silty, other beds very fine to fine grained, well-sorted, fairly porous beds 1/2 to 4 inches thick, ?laminated. At 1,024' a 4 inch, very fine, in part fine-grained, fairly porous sandstone bed. Shale, greenish grey to dark grey, silty, increasing from 1,024' - 1,025' to 30%.
Core #5	Interval 1,025' - 1,032' recovered 7'
1,025' - 1,031' 25" porous	Interbedded argillaceous siltstone (60%), sandstone (30%) and silty shale (10%) as interval 1,020'6" - 1,025'. Beds 1/2 - 4 inches thick. Also siltstone, light grey-brown, well sorted, porous, in laminated beds.
1,031' - 1,032'	Siltstone, light grey-brown, clean, slightly very fine sandy, laminated, fairly porous, in part with micro-lenses of shale.
Core #6	Interval 1,032' - 1,040'
1,032' - 1,040' 27" porous	Interbedded siltstone (90%) and silty shale (10%) Siltstone, light grey-brown (30%), in part slightly very fine sandy, well sorted, porous, as laminated beds 1/2 - 4 inches thick. Siltstone, grey (60%), argillaceous, with micro-lenses of shale or wavy laminated. Shale, greenish grey to dark grey, silty. Interval is bedded, but beds are unsharp defined, beds 1/4 - 4 inches thick.

Dome Cecil (6-28-13-12W4) Well

Core #1 — Interval 760' - 780' recovered 20'

760' - 772'± — Sandstone, grey, salt and pepper, argillaceous, very fine grained, silty, fairly well sorted, very poorly porous or tight, with irregular micro-lenses of argillaceous material. Sandstone is massive and has a somewhat cloudy appearance. Some parts have light grey lenses of clean, very fine- to fine-grained sand, 1/16 to 1/8 inch thick, non-porous. Scattered light grey beds of laminated, fairly well sorted, very fine sand (1/2 to 1 1/2 inch thick) are present at 770' (2" porous) and at 771'2", and are interbedded with very argillaceous sandstone beds, grey to dark grey in colour.

2" porous — At 770' is a dark grey shale bed.
Interval has scattered white pelecypod and gastropod shells. Contact at 772' very gradational.

±772' - 780' — Interbedded sandy shale (70%) and sandstone (30%)
Shale, grey to dark grey, very silty and very fine sandy, grading to very argillaceous sandstone in upper part of interval. Sand and silt occur as micro-lenses in shale matrix. Black lignite fragments are common on bedding planes.

3" porous — Sandstone, light grey to grey, salt and pepper, very fine grained, very silty, fairly well sorted, wavy laminated with shale inclusions. Sandstone in poorly defined beds and lenses of 1/2 to 1 1/2 inch thick, slightly to fairly porous.
Total porosity 3 inches.

Core #2 — Interval 780' - 800' recovered 20'

780' - 795' — Interbedded silty shale (80%) and silty sandstone (20%)
Shale, grey to dark grey, very silty and very fine sandy, with abundant micro-lenses of silt and sand and with (20%) light grey, thin (1/2-to 3-inch thick) poorly defined beds and lenses of very fine grained silty sand, which is fairly well sorted, wavy laminated with shale (ripple-beds) and poorly to fairly porous.

At 781' — a 1 1/2-inch sandstone bed, slightly porous (1/2 inch) with micro-lenses of shale

781'6" — a 1-inch sandstone, slightly porous (1/2 inch), as above

783' — a 3-inch sandstone bed, non-porous, very argillaceous and with micro-lenses of shale

784' — a 2 1/2-inch sandstone, very argillaceous, with wavy shale laminae, non-porous, with shell fragments. Bed is a silty shale with abundant clean sand laminae and lenses 1/16 to 1/8 inch thick.

11" porous

784'6" a 2-inch bed as 784', non-porous
785'2" a 2 1/2-inch bed as 784', non-porous
from 786' to 787'2" sandy shale, with abundant sand laminae, grading to very argillaceous sandstone. Sand laminae and lenses are sparsely porous up to 1/2 inch thick.
789' a 3-inch very argillaceous sand with wavy shale laminae, non-porous
789'6" a 1-inch sandy siltstone bed, slightly porous
790' a 1 1/2-inch and a 1-inch very argillaceous silty sand with shale lenses, non-porous
790'6" a 1-inch very argillaceous silty sand with shale lenses, non-porous
792'6" a 1-inch bed as 790'6"

Contact at 795' not sharp.

795' - 799'6" Sandstone, grey, argillaceous, very fine grained, fairly well sorted, very slightly porous, subangular grains of quartz, black chert and glauconite, abundant micro-lenses of shale. In places clean, very fine to fine, fairly porous sand lenses are present, up to 1/2 inch thick.

At 796'6" is a brown sideritic band, 3 inches thick, poorly defined.

799'6" - 800' Sandstone, grey, argillaceous, very fine to fine grained, very glauconitic, slightly porous, with abundant light grey clean sand lenses.

6" porous

At 799'6" 1/2 inch fairly good porosity in light grey sand.

Core #3 Interval 800' - 820' recovered 20'

800' - 800'2" Sandstone, grey, argillaceous, very fine to fine grained, very glauconitic, as 799'6" - 800'.

800'2" - 806'6" Sandstone, grey, argillaceous to very argillaceous, very fine grained, fairly well sorted, glauconitic, non-porous, with micro-lenses of shale, scattered pelecypod shells and some lignitic plant fragments. Poorly bedded, massive interval.

806'6" - 809' Sandstone, grey, argillaceous, very fine, in part very fine to fine grained, with irregular lenses of light grey clean sand, which is slightly porous.
At 807' a 4-inch interval with abundant light grey, clean, very fine to fine sand lenses, slightly porous.

8" porous

From 807'6" - 808' abundant sand lenses and beds (up to 1/2 inch) as at 807, in part well sorted, fine grained, glauconitic and poorly to fairly porous. Lower 2 inches (at 808') are light grey and calcareous.

809' - 820'

Interbedded sandstone (80%) and sandy shale (20%)
Sandstone, light grey and grey, very fine to fine grained, fairly well sorted with poor to good porosity, subangular to subrounded quartz (80%) and black chert (20%) and trace of green glauconite, in places with abundant micro-lenses of shale. Scattered pelecypod shells.

4'6" porous

Shale, grey to dark grey, silty, with abundant light grey sand lenses.
From 809' - 810' fair to good porosity, some shaly inter-beds 1 - 2 inches thick.
From 810' - 812' fair porosity, sand in beds of 1/4 - 1 inch in matrix of sandy shale.
At 812' a 2-inch thick brownish, silty, sand bed in part sideritic, slightly porous.
From 812' - 817' sand beds up to 2 inches thick in very sandy shale with sand lenses. In this interval 50% has good to excellent porosity, remainder is very slightly porous.

817' - 820'

Interbedded sandstone (80%) and argillaceous sand-stone (20%). Sandstone, light grey, fine grained poorly to fairly porous, calcareous from 817' - 818'6", irregular and wavy laminated with grey, argillaceous sand. Two beds of non-porous, grey, argillaceous sand. Two beds of non-porous, grey, argillaceous sand with lignitic plant remains (2" and 4" thick). Some pelecypod shells are present.

2'6" porous

Core #4

Interval 820' - 840' recovered 20'

820' - 823'

Interbedded sandstone (80%) and argillaceous sand-stone (20%). Sandstone, light grey, very fine to fine grained, fairly well sorted, in part porous, in part calcareous, subangular quartz (90%) black chert (10%) and some glauconite. This light grey sand occurs as irregular lenses in a matrix of grey argillaceous sandstone, very fine grained, very slightly porous, with abundant shale lenses and shale beds up to 6" thick.
From 820' - 821'2" is a grey, argillaceous sand with light grey clean sand lenses, poorly porous.

1'2" porous

From 821'2" - 822' non-porous, light grey, clean, cal-careous sand beds, 2 inches thick, very fine to fine grained, separated by grey, argillaceous and calcareous sand beds.
From 822'6" - 823' a light grey, laminated, very fine to fine-grained, non-porous sandstone.

823' - 838'

Interbedded sandstone (80%) and sandy shale (20%)
Sandstone, light grey, (40%) clean, very fine to fine grained, fairly well sorted, with good to excellent porosity, subangular quartz (90%), black chert (10%), and glauconite. The light grey beds are poorly defined, 1/4 - 6 inches thick.

4' porous

Sandstone, grey (40%), argillaceous, very fine to fine

grained, as above, with abundant shale laminae and lenses, slightly porous.
Shale, grey to dark grey, variable sandy, beds 2 - 4 inches thick, with most shale beds in basal 5 feet of interval.
Two light grey, calcareous sand beds are present at 829' (2 inches) and at 834' (2 inches).

838' - 840'

Interbedded sandstone (50%) and sandy shale (50%)
Shale, grey to dark grey, silty, with micro-lenses of silt and very fine sand, and with black lignitic plant fragments. Beds 1 - 2 inches thick.
Sandstone, light grey (10%), very fine to fine, in part fine grained, clean, very porous, present as 1/4- to 1/2-inch beds in a matrix of sandstone grey (40%) argillaceous, very fine grained, slightly porous, with micro-lenses of shale.

12" porous

Core #5

Interval 840' - 860' recovered 20'

840' - 860'

Interbedded siltstone (60%) sandstone (20%) and silty shale (20%).
Siltstone, grey, argillaceous, very fine sandy, with micro-lenses of shale.
Sandstone, light grey, clean, very fine grained, in beds 1/2 to 5 inches thick, well sorted, with fair to good porosity, subangular quartz (90%) and black chert (10%).
Shale, grey to dark grey, very silty and very fine sandy with abundant micro-lenses of silt and very fine sand.
Interval is bedded, 1/2 - 6 inches, but beds are poorly defined.
Light grey sand beds are present at:

840'	1/2 inch	good porosity
840'2"	1/2 inch	good porosity
840'6"	1/2 inch	good porosity
841'	1 inch	good porosity
841'2"	1/2 inch	fair porosity
842'2"	1/2 inch	good porosity
843'6"	1/2 inch	poor-fair porosity
844'	2 inch	fair porosity, glauconitic
845'	1 inch	poor-fair porosity
845'4"	1/2 inch	poor-fair porosity
846'	1 inch	fair porosity
847'	1 inch	fair-good porosity
847'8"	1/2 inch	poor-fair porosity
848'	5 inch	fair porosity
848'6"	6 inch	good-very good porosity
851'6"	one 1/2 inch siltstone, poorly porous, with micro-lenses of shale.	
	one 2 inch siltstone as above	
852'8"	one 1 1/2-inch silty sand, as above	

	852'2"	1 inch silty sand with pelecypods, slightly porous
	853'6"	1 inch silty sand with shale lenses, as above
39" porous	855'	1 inch silty sand, poor-fair porosity
	856-856'6"	interval with very fine sand lenses, 1/2 inch thick, 2" fairly porous
	856'6"	2 inches very fine sand, poor-fair porosity
	857-858'6"	interval with six 1/2 inch very fine sand beds, fairly porous, and two 1-inch very fine sand lenses, fairly porous, in matrix of grey, argillaceous, very sparsely porous sandstone.

Core #6 Interval 860' - 880' recovered 20'

860' - 880'

Siltstone (90%) interbedded with sandstone (5%) and shale (5%).

Siltstone, grey, argillaceous to very argillaceous, in part with abundant micro-lenses of silt and very fine sand in part with micro-lenses of shale, non-porous. Beds poorly defined, 6 - 24 inches thick.

Sandstone, light grey, very fine grained, silty in part, well sorted, poorly-fairly porous, laminated, subangular quartz (90%) and black chert (10%). Beds 1/4 - 1 inch thick.

Shale, grey to dark grey, silty, with laminae and lenses of silt.

Light grey, in part porous sand beds at:

	860'	1/2 inch fair-poor porosity
	860'6"	1/2 inch as above
	862'	three 1/4 lenses of very fine sandy silt, poorly porous
	871'	1 inch cross-laminated, poorly porous
11" porous	872'	1/2 inch very fine sandy silt, with argillaceous matrix, poorly porous
	873'	1 inch very fine sand, fairly porous
	874'	1/2 inch very fine sandy silt, poorly porous
	875'	two 1/2-inch beds very fine sand, poorly porous and one 1/4-inch bed
	875'6"	1/2-inch bed very fine sand, fairly well porous
	876'6"	1 inch-bed and a 1/2-inch bed very fine sand, poorly porous
	878'	two 1/2-inch beds very fine sand, poorly porous
	879'	1/2-inch bed as above
	874'6"	1/2-inch bed, discontinuous, as above
	874'8"	1/2-inch bed, very fine sand, poorly porous

Gander Med. Hat (6-1-14-7W4) well

Core #1

Interval 997' - 1,016' recovered 4'

Shale (80%), greenish grey, slightly silty, interbedded with sandstone (10%) grey, very argillaceous, very fine grained and silty, and shale (10%) very silty and sandy. The argillaceous sandstone is poorly sorted and has abundant micro-lenses of shale.

AEG Alderson (7-30-14-9W4) well

Core #1

Interval 925' - 955'

925' - 955'

Siltstone, greenish grey, salt and pepper, very fine sandy, variable argillaceous, in places grading to very fine silty sandstone, consisting of subangular grains of light-coloured quartz (90%) and dark-coloured chert or carbonaceous fragments (10%), no porosity. Siltstone is very poorly bedded and very much interwoven with thin irregular wavy shale laminae. Abundant, usually poorly preserved, small, horizontal wormburrow structures are present throughout interval.

scattered porosity total 12"

Some thin beds and lenses (1/8" - 1/4") of light grey coloured, laminated, very fine sandy, siltstone are present, which are oil stained and porous in places. These silt beds do not make up more than 5% of the total core.

At about 937' two light grey silt beds occur, which are not porous. The upper bed is 2 1/2 inches thick, the lower one, 1 inch thick. Both have sharp, irregular lower contacts and gradational upper contacts.

From 934 1/2' - 935' is a grey shale bed with scattered, small, flattened, horizontal silt infilled wormburrows.

Core #2

Interval 1,000' - 1,030'

1,000' - 1,000'9"

9" porous

Siltstone, light grey brown, salt and pepper, very fine sandy and grading to very silty sandstone, noncalcareous, slightly oil-stained, with fair to good intergranular porosity, well sorted, subangular grains of light-coloured quartz (80%) and dark-coloured chert and carbonaceous material (20%). Interval is very well and regularly laminated due to difference in grain size and mineral content. Lower contact is not sharp and interbedded with greenish grey argillaceous siltstone.

(plug no. 1 at 1,000.9 gives 19.6% porosity)

1,000'9" - 1,002'

1'3" porosity

Closely interbedded sandstone (50%) and shale (50%). Sandstone, grey brown, salt and pepper, variably argillaceous very fine grained, calcareous, with in places poor intergranular porosity, well sorted subangular and subrounded grains of light-coloured quartz (90%) and dark-coloured chert, carbonaceous material and brownish fragments of fish scales (10%). Sandstone has abundant argillaceous inclusions up to 1/4" thick (horizontal worm burrows?).

Shale, dark grey, micromicaceous, soft.

Interval is bedded (1/4 - 2 inches thick). Sandstone beds up to 1 1/2 inches thick, irregular and lens-like. Lower contact at 1,002' is sharp.

1,002'

Pebble bed. A 1/2- inch-thick bed with rounded pebbles up to 3/4 inch in diameter of black chert and light grey-brown siderite in a matrix of very fine grained sandstone.

1,002' - 1,009'

3'6"

Closely interbedded sandstone (50%) and shale (50%). Sandstone, light grey-brown to grey-brown, salt and pepper, noncalcareous, very fine grained, with fair to good oil-stained porosity from 1,002' - 1,003', and with poor to fair porosity from 1,003' - 1,009', fairly well sorted subangular and subrounded light-coloured quartz (90%) and dark-coloured black chert, carbonaceous material and fragments of fish scales (10%). Sandstone is present as irregular beds of 1/4 - 1 1/2 inches thick or as numerous small (1/4 - 1/2 inch) inclusions (worm burrow?) in shale.

Shale, dark grey, micromicaceous, soft, with carbonaceous flakes.

From 1,005' - 1,009' interval is less sandy, 30% sand, as thin beds (1/4 - 1/2 inch) and as small horizontal burrow-like structures, lens-like.

1,009' - 1,009'8"

8" porosity

Siltstone, grey-brown, very fine sandy and grading to very fine sandstone, noncalcareous, somewhat argillaceous, with poor to fair porosity, well sorted subangular quartz (90%) and dark grains (10%) as above.

Interval is laminated and crossbedded in top part and interbedded with argillaceous laminae in lower part. Lower contact gradational, upper contact with shale, sharp but conformable.

1,009'8" - 1,012'	Closely interbedded shale (70%) and sandstone (30%). Sandstone, grey-brown salt and pepper, non-calcareous, very fine grained, as above, variable argillaceous, and very slightly porous or nonporous. Sandstone is present in irregular beds 1/4 - 1/2 inch thick.
8" porous?	Shale, dark grey brown, soft, somewhat micromicaceous, with carbonaceous flakes and fish scale fragments. Shale beds 1/2 - 1 1/2 inches thick.
1,012' - 1,013' 11" porous	Sandstone, grey-brown, salt and pepper, slightly oil-stained, noncalcareous, very fine grained, with fair to good and in places good intergranular porosity. Grains are fairly well sorted, subangular and subrounded, 90% light-coloured quartz, 10% dark-coloured chert, carbon and fish scale fragments. Interval is interbedded with shale in lower 2 inches and at 1,013' a lignite veinlet is present.
1,013' - 1,013'6"	Closely interbedded shale (50%) and sandstone (50%) as 1,009'8" - 1,012'. Beds irregular, lens-like, up to 1/4 inch thick.
1,013'6" - 1,015' 3" porous?	Sandstone (80%) closely interbedded with shale (20%). Sandstone, grey-brown, salt and pepper, noncalcareous, variable argillaceous, very fine grained, as in interval 1,012' - 1,013', poorly porous in part. Sandstone beds somewhat laminated, 1/4 - 1 inch thick. Shale, dark grey-brown, micromicaceous, with carbonaceous flakes.
1,015' - 1,030'	Closely interbedded shale (80%) and sandstone (20%). Shale, dark grey-brown, soft, interbedded with thin (1/4 - 1/2 inch) irregular beds and lenses of sandstone as above. The sandstone of the sandstone beds is grey-brown, salt and pepper, noncalcareous, fairly well sorted, as above, within places fair intergranular porosity. At 1,016' is a 6 inch thick very fine grained sandstone bed with shell remains in situ. At 1,018'6" is a 2-inch interval with light yellowish coloured, somewhat nodular shale beds that have shell fragments and that are associated with green glauconitic shale occurring as a coating on the yellow shale lenses.
Core #3	Interval 1,075' - 1,105'
1,075' - 1,105'	Closely interbedded sandstone (50%) and shale (50%). Shale, dark grey, soft, micromicaceous interbedded with numerous thin very small sand and silt infilled, flattened, horizontal worm burrows that take up 40 to 60% of the total volume.

Scattered throughout the core are silt and sandstone beds or lenses, 1/8 - 2 inches thick, some with fairly good porosity and light brown oil stain (3% of total length of core).

Between 1,090' and 1,090'6" are three 1/4 - 1/2 inch thick siltstone beds with fairly good porosity. These siltstone beds are well sorted and laminated with sharp irregular lower contacts and sharp upper contacts. At 1,093' is light brown siderite nodule 2 1/2 inches thick.

total 12" porous

At 1,098' is a 3-inch-thick siltstone bed, the upper 1 inch well laminated with poor to fair porosity the lower 2 inches light brown coloured and cemented by siderite.

At 1,098'10" again a 2-inch thick light brown siderite nodule.

From 1,101'6" - 1,102' are two light grey beds of very fine grained sandstone. The upper one is 1 inch thick, calcareous, argillaceous very fine grained, non-porous. The lower one is 2 inches thick, grey, laminated, noncalcareous. The upper half of this bed is argillaceous, the lower half is clean, well laminated, light brown oil stained and porous. Lower contacts of both sandstone beds are sharp and irregular, erosional, the upper contacts are sharp and appear conformable.

From 1,102' - 1,105' are scattered thin, very fine sand and silt lenses, in part calcareous, in part noncalcareous, in part oil stained and porous. They are up to 1/2 inch thick and 1 1/2 inches long. At 1,103'6" is a 1/2 inch bed of porous very fine, silty sandstone.

Core #4

Interval 1,120' - 1,150'

1,120' - 1,124'8"

Very closely interbedded sandstone (40%) and sandy shale (60%). Sandstone, grey, salt and pepper, noncalcareous, variably argillaceous, very fine grained, well sorted, in part clean and with fair to good intergranular porosity, subangular and subrounded light-coloured quartz (90%) and dark-coloured chert grains, carbonaceous material and fish scale fragments. Shale, dark grey, soft, variable silty and sandy, with abundant small (1/2 inch) sand lenses.

some thin porous beds

Interval is very closely interbedded, sandstone beds irregular, lens-like, 1/8 - 1/2 inch thick, crossbedded in part, often grading to the worm burrow-like sand lenses found in the shale beds.

1,124'8" - 1,124'10" 2" porous	Sandstone, light grey, salt and pepper, calcareous, very fine grained, well sorted with, in part, good intergranular porosity. Sandstone bed is irregular and somewhat nodular.
1,124'10" - 1,125'8"	Very closely interbedded sandstone (40%) and sandy shale (60%) as interval, 1,120' - 1,124'8".
1,125'8" - 1,126' 2" porosity	Sandstone, light grey and grey, salt and pepper, calcareous, very fine grained, fairly well sorted, slightly porous, subangular and subrounded grains of quartz (90%) and dark grains (10%), chert, carbonaceous mat and "shale pebbles". Upper part of sandstone bed light brown coloured and sideritic. Lower part of interval has a lens of light grey, well sorted and well laminated sand.
1,126' - 1,128'6"	Very closely interbedded sandy shale (60%) and sandstone (40%) as 1,120' - 1,124'8". Sandstone beds 1/4 - 1/2 inch thick or less.
1,128'6" - 1,128'8" 1" porosity	Sandstone and siltstone beds. Beds 1/4 to 1 inch thick. Siltstone, grey, salt and pepper, poorly porous, laminated. Sandstone, grey, salt and peper, very fine grained, porous, interlaminated with shale.
1,128'8" - 1,130'	Very closely interbedded sandy shale (60%) and sandstone (40%) as 1,120' - 1,124'8".
1,130' - 1,130'4"	Siltstone, light grey to grey, salt and pepper, variable very fine sandy, calcareous, very poorly porous or tight, laminated with argillaceous material and in part crossbedded.
1,130'4" - 1,131'	Very closely interbedded sandy shale (80%) and sandstone (20%) as 1,120' - 1,124'8".
1,131' - 1,131'2"	Sandstone, grey, salt and pepper, very fine grained, slightly oil stained, noncalcareous, fair porosity. Upper contact sharp, lower contact gradational.
1,131'2" - 1,134'4"	Closely interbedded sandy shale (70%) and sandstone (30%) as interval 1,120' - 1,124'8".
1,134'4" - 1,134'8" 2" porosity	Interval with a one-inch-thick siltstone and sandstone bed. Upper bed is a laminated sandstone bed, light grey and grey, salt and pepper, very fine grained, noncalcareous, with fairly good porosity. Lower bed is a laminated siltstone, light grey to grey, noncalcareous, with poor to fair porosity.

1,134'8" - 1,138'	Closely interbedded sandy shale (60%) and sandstone (40%). Most sandstone is in the form of small lenses.
1,138' - 1,145'10"	Shale (95%) with some sandstone (5%). Shale, dark grey to grey, soft. Sandstone has scattered thin (1/8 - 1/4 inch thick) irregular beds and lenses.
1,145'10" - 1,146' 2" porosity	Siltstone, light grey, salt and pepper, calcareous, laminated, non-calcareous, grey-coloured silt and very fine sand, poor intergranular porosity, exceedingly crossbedded.
1,146' - 1,149' some thin porous beds	Siltstone, grey, salt and pepper, argillaceous, very fine sandy intricately interbedded with irregular wavy shale stringers, very slightly porous or tight. Interval has scattered thin beds and lenses (1/8 - 1/4 inch thick) of very fine sandstone with poor to fair intergranular porosity. These well-sorted sand stringers do not take more than 5% of total interval.

ARCO IOD Med. Hat (10-14-15-4W4) well

Core #1	Interval 1,240' - 1,270' recovered 30'
1,240' - 1,244'4"	Very closely interbedded siltstone (60%) and silty shale (40%). Siltstone, grey, salt and pepper, argillaceous, with small discontinuous shale inclusions (flasers), in part somewhat porous, beds 1/16 - 1/2 inch thick. Shale, grey - dk. grey, very silty, with abundant (50% of interval) irregular laminae and lenses of silt and very fine sandy silt 1/16 - 1/8 inch thick. Plugs 91 - 96 are in this interval.
1,244'4" - 1,244'10"	Nodules. Silty sideritic nodules in a matrix of green-grey glauconitic shale. Nodules up to 1 1/2 x 4 inches. Plug #97 taken at upper contact of silty shale, glauconitic shale and nodule gives 19.9% porosity. There is no porosity visible in the rock.
1,244'10" - 1,249'6"	Very closely interlaminated siltstone (70%) and shale (30%) as 1,240' - 1,244'4" but more argillaceous and without porosity. Lower contact at 1,249'6" very gradational.
1,249'6" - 1,253'	Shale, greenish grey and light grey, micaceous, not silty, swells up readily in water. Scattered white shell fragments are present. Plug 104 - 107 in this interval.

1,253' - 1,258'±	Very closely interlaminated siltstone (70%) and silty shale (30%) Siltstone, grey, argillaceous, very fine sandy in places, non-porous or very slightly porous, is present as thin irregular laminae, beds and lenses up to 1/4 inch thick in matrix of silty shale. Lower contact at 1,258' very gradational.
1,258'± - 1,270'	Shale (95%) grey - dark grey, variably silty, with 5% siltstone as above. At 1,264' a grey-brown nodule of sideritic claystone within a 1-inch thick, laminated, porous, very fine grained sandstone bed.
2 1/2" porous	From 1,266' - 1,267' four beds of laminated very fine grained, sandstone, grey, well sorted, porous. These ripple-beds are sharply defined and three beds are 1/2 inch thick and one is 1 inch thick. Plugs 134 and 135 are in silty shale.
Core #2	Interval 1,270' - 1,300' recovered 30'
1,270' - 1,278'	Shale (95%) grey - dark grey, variably silty, with abundant irregular laminae and small lenses of grey silt. At 1,272'8" a 1/2-inch thick bed of very fine sandy siltstone, laminated and porous.
1 1/2" porous	From 1,275'4" - 1,276'6" four siltstone beds from 1/4 - 1/2 inch thick, laminated and porous, (plugs 149 and 150 in shale). Total two 1/2 inch and two 1/4 inch porous.
1,278' - 1,279'6"	Shale (95%) grey - dark grey silty, with abundant irregular laminae and thin lenses of sandy silt and
1/2" porous	also two 1/4-inch thick beds of very fine grained, laminated, porous sandstone.
1,279'6" - 1,282'	Shale (95%) grey - dark grey, silty, with abundant irregular laminae and lenses of very fine sandy silt and thin beds of laminated, very fine grained, porous
1" porous	sandstone. Beds 1/4 - 1/2 inch thick. Total porous 1/4 + 1/4 + 1/2 inch.
1,282' - 1,284'6"	Shale, grey - dark grey, silty, with numerous irregular laminae and lenses of silt.
1,284'6"	Pebble zone. Well-rounded black chert and brown sideritic claystone pebbles up to 1/4 inch in diameter and very coarse grains floating in a matrix of silty shale. Plug #163.
1,284'6" - 1,300'	Shale, grey - dark grey, soft, slightly silty, slightly pyritic, without silt lenses and laminae. With light brown, rounded sideritic patches from 1,284'6" - 1,285'6". Scattered white shell fragments. Interval becomes more silty towards the base of the core.

Core #3 — Interval 1,300' - 1,330' recovered 30'

1,300' - 1,300'4" — Shale, grey - dark grey, silty.

1,300'4" - 1,311' — Silty shale (90%) interbedded with sandstone (10%)
Shale, grey - dark grey, silty and very fine sandy, with abundant irregular laminae and lenses of silt and very fine sand. Sandstone, grey, salt and pepper, very fine grained, fairly well sorted, subangular quartz grains (90%) and black chert (10%). In places with fair intergranular porosity. Sandstone beds are irregular, 1/4 - 1/2 inch thick, discontinuous and are laminated with shale (ripple-beds).
Porous sandstone beds are present at:

	1,300'4"	1 1/2 inch interbedded (plug 192)
	1,300'8"	1/2 inch
	1,301'4"	1/4 inch
	1,302'	1/4 inch
	1,302'6"	1/2 inch, sparsely porous
	1,303'4"	1/2 inch
9 3/4" porous	1,303'6"	1 inch argillaceous, non-porous, with small nodule.
	1,303'10"	1/4 inch
	1,304'	1 inch, very sparsely porous, argillaceous (plug 200)
	1,304'1"	1/2 inch
	1,304'2"	1/4 inch
	1,304'6"	1/4 inch
	1,305'10"	1/4 inch
	1,306'6"	1/4 inch
	1,306'8"	1/2 inch
	1,307'2"	1/2 inch
	1,307'8"	1/4 inch
	1,308'	1/4 inch
	1,308'4"	1/2 inch, sparsely porous
	1,309'	1 inch, very sparsely porous
	1,309'6"	1/4 inch, sparsely porous
	1,309'8"	1/4 inch

Contact at 1,311' not sharp.

1,311' - 1,330' — Shale, grey - dark grey, silty and very fine sandy with abundant irregular laminae and lenses of very fine sandy silt and occasional (5%) thinly laminated sand beds and lenses up to 1/4 inch thick. At 1,313'4" is a light grey-brown sideritic nodule. From 1,314' - 1,315' abundant porous very fine sand lenses and two 1/4-inch thick discontinuous sand beds are present (ripple-beds and lenses).

±7" porous

Porous sand beds at:

1,314'	1/4 inch thick
1,314'2"	1/4 inch thick
1,316'2"	1/4 inch
1,322'	1/4 inch
1,325'2"	1/4 inch
1,327'2"	1/4 inch
1,328'	a 4-inch interval with small porous sand lenses 1/4 - 1 inch thick. Plug 237
1,328'6"	1/4 inch
1,328'10"	1/2 inch

from 1,329' - 1,330' abundant small porous sand lenses (plug 240).

Core #4

Interval 1,330' - 1,360' recovered 30'

1,330' - 1,341'6"

Silty shale (90%) interbedded with sandstone (10%)

Shale, grey - dark grey, silty, with abundant irregular laminae and lenses of very fine sandy silt and scattered thinly laminated beds and lenses (1/4 - 1 inch thick) of very fine silty sandstone (ripple-beds and lenses).

5 1/4" porous

Porous sandstone beds at:

1,330'2"	3/4 inch thick, argillaceous, very slightly porous
1,330'6"	1 inch, as above
1,331'	1 inch, as above
1,332'6"	2 inches with three 1/4-inch porous beds
1,332'8"	1/2 inch porous
(1,334'	1 inch, argillaceous, non-porous)
1,334'6"	1/4 inch slightly porous
1,335'	1/4 inch, as above
1,336'6"	1/4 inch, as above
1,337'10"	1/4 inch, as above
1,339'	1/4 inch, as above

At 1,335'6" and 1,337'8" unsharp defined sideritic nodules are present.

1,341'6" - 1,342'

Closely interbedded sandstone (70%) and silty shale (30%). Sandstone, grey, salt and pepper, argillaceous, very fine-grained, non-porous, occurs as small lenses (flasers) in silty and very fine sandy shale matrix. Plug 260 in sandstone measured a permeability Koil < 0.0001.

1,342' - 1,348'6"

Silty shale (90%) interbedded with sandstone (10%)

As interval 1,330' - 1,341'6"

Porous sandstone beds at:

1,342'2"	1/4 inch thick, poorly porous, discontinuous
1,344'6"	1/4 inch thick, as above

	1,345'	1/4 inch thick, as above
3 1/2" porous	1,345'2"	1/4 inch thick, as above
	1,346'6"	1/2 inch, poorly porous
	1,347'	1/2 inch, as above
	1,347'?"	1/4 inch, as above
	1,348'2"	1/4 inch, as above
	1,349'6"	four 1/4-inch thick porous beds and a 4-inch argillaceous sandstone bed (plug 274).

At 1,346' is a large unsharp defined sideritic nodule (plug 269).

1,348'6" - 1,360'

Silty shale (85%) interbedded with sandstone (15%) as 1,330' - 1,341'6"

Porous sandstone beds at:

	1,349'6"	two 1/4-inch thick beds
	1,350'	two 1/4 inch, slightly porous
9 1/4" porous	from 1,350'6"	- 1,351' three 1/4 inch, slightly porous
	1,351'6"	three 1/4 inch, slightly porous
	1,352'	one 1/2 inch thick, slightly porous
	1,352'4"	two 1/2 inch, as above
	1,353'	one 1/2 inch, as above
	1,353'2"	one 1/4 inch, as above
	1,353'6"	one 1/4 inch, as above
	1,354'	two 1/4 inch, as above
	1,355'	two 1/2-inch thick beds, slightly porous (plug 284)
	1,355'6"	one 1/2 inch, as above
	1,355'8"	one 1/2 inch, as above
	1,356'	one 1/4 inch, as above
	1,358'	three 1/4 inch, as above
	from 1,359'2"	- 1,359'6" four 1/4-inch thick beds, slightly porous
	1,360'	one 1/4 inch, slightly porous

At 1,359' is a grey-brown unsharp defined sideritic band

Core #5

Interval 1,360' - 1,390' recovered 30'
(plugs taken for analysis are not numbered)

1,360' - 1,363'10"

Shale, grey - dark grey, silty, with numerous discontinuous laminae and lenses of silt, scattered white shell fragments and very fine sandy silt beds.

1/4" porous

At 1,362'6" a 1/4 inch bed and a 1/4-inch thick lens of very fine sandy silt, very slightly porous.
At 1,363'6" a 1/4 inch argillaceous silt bed, non-porous.
At 1,363'8" a 1/4 inch lens of arg. silt, non-porous.

1,363'10" — Pebble zone, 1 1/2 inches thick, consisting of well-rounded black chert pebbles up to 1/2" in diameter floating in a matrix of shale.

1,363'10" - 1,369' — Shale, grey - dark grey, silty, as 1,360' - 1,363'10", with less than 5% silt beds. Very fine sandy silt beds are present at:

1,364'4"	one 1/4-inch thick, laminated silt bed, non-porous, two 1/4-inch, very fine and silty sand beds, laminated and slightly porous.
1" porous — 1,365'	one 1/2 inch, slightly porous, laminated, very fine, sandy silt bed with a plug taken out.
1,366'	two 1/4 inch, non-porous, very fine, sandy silt lenses.
1,366'6" to 1,367'	six laminated and discontinuous beds of argillaceous non-porous silt.
1,367'6"	a 1 inch discontinuous, laminated, non-porous silt bed
1,368'	three discontinuous, laminated, silt beds, argillaceous, non-porous, 1/4 inch thick

At 1,365' is a 1-inch thick, light greenish grey, unsharp defined shale bed.

1,369' - 1,371' — Shale, grey - dark grey, slightly silty, interbedded with light greenish grey shale.

1,371' - 1,388' — Shale, (95%), grey - dark grey, silty, with abundant irregular and discontinuous laminae and lenses of silt and 5% laminated, very fine, sandy silt beds up to 1 inch thick. These beds are present at:

1,371'8"	one 1-inch thick, laminated, sparsely porous, very fine sand bed.
1,372'6"	one 1-inch thick bed, as above, with a 1-inch thick sideritic nodule just above it.
1,373'	one 1/4-inch thick, slightly porous, very fine sandstone bed.
1,374'	one 1/4-inch sandstone bed as above.
1,367'	one 1 inch, fairly porous, very finely laminated sand bed.
1,377'	one 1/2-inch sand bed as above.
1,377'6"	one 1/2-inch sand bed as above.
1,379'	one 1/4-inch lens of sand as above with sideritic nodules up to 1 inch in diameter.
1,381'	one 1/2-inch sandstone bed as at 1,367'.

9 1/2" porous	1,381'6"	one 1/4-inch sandstone bed as at 1,367'.
	1,384'	two 1/4-inch, laminated, very fine grained sand beds, poorly porous
	1,384'6"	one 1/4-inch, discontinuous and slightly porous, laminated, very fine-grained sand bed.
	1,385'4"	one 1/4 inch bed as at 1,384'6".
	1,385'6"	two 1/4-inch beds as at 1,384'6".
	1,386'	two 1/4-inch beds as at 1,384'6".
	1,386'6"	one 1-inch and one 1/2-inch sand bed as at 1,384'6"

1,388' — Pebble zone, 2 inches thick, consisting of sideritic siltstone pebbles and black chert pebbles, well rounded, up to 1 by 1/2 inch in diameter, floating in a matrix of shale.

1,388' - 1,390' — Shale, grey - dark grey, silty, with abundant irregular and discontinuous laminae and lenses of silt and laminae of very fine sand.

Core #6 — Interval 1,390' - 1,420' recovered 27'

1,390' - 1,412'± — Shale, (95%) grey - dark grey, silty, with discontinuous laminae and lenses of silt and very fine-grained, silty, laminated sandstone in beds up to 1/2 inch thick.
Scattered white shell fragments.

	At 1,390'	one 1/4-inch thick, laminated, very fine sand bed, poorly porous.
	1,390'6"	three 1/4 inch lenses of sand as above.
	1,391'	one 1/4-inch bed as at 1,390'.
	1,393'	two 1/4-inch beds as at 1,390'.
	1,393'6"	two 1/4-inch beds as at 1,390'.
6" porous	1,394'	one 1/4-inch bed as at 1,390'.
	1,394'6"	one 1/4-inch discontinuous bed as at 1,390'.
	1,395'	one 1/2-inch bed as at 1,390'.
	1,397'4"	a 3/4-inch sandstone bed, very fine- to fine-grained, laminated, fairly porous and with fish scales and thin shell fragments.
	1,397'8"	two 1/4-inch beds as at 1,390'
	1,398'2"	two 1/4-inch discontinuous beds as at 1,390'.
	1,398'6"	two 1/4-inch beds as at 1,390'.
	1,400'6"	one 1/4-inch bed as at 1,390'.
	1,405'4"	one 1/4-inch bed as at 1,390'.

1,412'± - ?1,420'

top Alberta Fm. 1,410'

Shale, grey - dark grey, somewhat calcareous, slightly silty, with scattered laminae of white calcareous specks, fairly regularly laminated with discontinuous laminae and lenses of light grey, calcareous silt.
No very fine grained sand beds.
At the bottom of the core is a 1/2-inch thick, light grey, calcareous shale bed with abundant white calcareous specks.

Core #7

Interval 1,420' - 1,450'

1,420' - 1,450'

Shale, grey - dark grey, calcareous, slightly silty, fairly regular, light grey laminated with silt and layers rich in calcareous white specks. Occasionally complete shell skeletons of pelecypods are present in the shale.

Interval 1,240 - 1,450' has a total of approximately 57 inches porosity.

DND-28 Suffield (10-4-15-9W4) well

Core #1

Interval 896' - 916' recovered 20'

896' - 916'

Siltstone, grey - dark grey, very argillaceous. Abundant microlenses and "clouds" of very fine sandy silt in a silty shale matrix. Scattered laminated beds of argillaceous siltstone 1/4" - 2" thick are present in interval. Large elongated pelecypod shells occur at 900'8" and at 902'6".
At 899' is a thin (1/2" - 1" thick?) bed of light grey sandstone, very fine to fine grained, well sorted, somewhat calcareous, very slightly porous, consisting of 90% light-coloured, subangular quartz, 10% black chert and some glauconite. This sandstone bed has been analysed and only one little piece is left in the core box. Grey, argillaceous siltstone beds are present at:

	897'	1/2 inch non-porous
8" porous	897'6"	2 inches fine sandy with small wavy shale lenses (ripple-laminations), very sparsely porous.
	899'	1/2 inch - 1 inch sandstone, as above, very sparsely porous.
	900'	1/2 inch non-porous
	900'6"	1/2 inch slightly argillaceous, fairly porous.
	901'	1 inch very fine sandy, sparsely porous.

901'6"	1/2 inch very fine sandy, good-excellent porosity.
902'	1 inch non-porous
903'6"	1/4 inch very fine sandy, fairly porous.
904'	1/2 inch clean, very fine sandy, laminated, fairly porous, discontinuous.
906'6"	1/8 - 1/4 inch clean, very fine sandy, laminated, fairly porous, discontinuous.
907'	1/4 inch as above.
907'6"	1/2 inch as above, sparsely porous.

From 909' - 916' are abundant, 1/8 - 1/4 inch thick, very fine sandy silt lenses, poorly - fairly porous, in part laminated. A total of fourteen is 1/8 inch thick, others are thinner. Total porosity estimated at 2 inches.

ARCO Alderson (10-4-15-10W4) well

Core #1 — Interval 826' - 834' recovered 4'

?830' - ?832' — Very closely interbedded siltstone (70%) and shale (30%).
Siltstone: grey, salt and pepper, argillaceous, non-porous, consisting of subangular quartz and dark chert grains.
Shale: grey - dark grey, in irregular thin stringers up to 1/8 inch thick. The siltstone is present as irregular micronodular beds up to 1/8 inch thick: ripple-beds.

?832' - ?834' — Sandstone (60%) interbedded with siltstone (40%)
Sandstone: grey, argillaceous, in part calcareous, consisting of a silt and shale matrix with abundant floating, poorly sorted, fine to coarse, in places very coarse, well-rounded and subrounded grains of quartz (90%), black chert (10%), non-porous. Sandstone is in part grey-brown and sideritic. Some greenish colour is evident between the sand grains (glauconite?) and pyrite is common. Poorly preserved channel-like crossbedding was noticed.
This sandstone is interbedded with grey argillaceous unsharp defined siltstone.

Note: Logs show interval 826' - 830' as shale. It is suggested that the upper part of the core has been lost during the process of coring.

Core #2 — Interval 834' - 854' recovered 1'6"

Siltstone, grey, in places very fine sand, variably argillaceous, no porosity. Abundant irregular structures that could represent ripple-beds (flaser bedding?). Plug 1 at 834' has been analysed and gives a porosity of 17.5% and a horizontal permeability of 1.00 MD.

Core #3 — Interval 909' - 924' recovered 10'

909' - 911' — Siltstone, grey, variably argillaceous, fairly soft, no porosity, abundant poorly preserved ripple-beds.

911' - 913' — Interbedded siltstone (80%) and very fine sandstone (20%)
Siltstone, grey, variably argillaceous, very fine sand, in part soft, not porous, with abundant irregular ripple-beds (flaser bedding).
Sandstone, grey, salt and pepper, very fine grained, silty; well sorted and with good intergranular porosity; subangular light-coloured quartz (80%) and 20% dark chert grains and carbonaceous fragments. Sandstone beds are laminated and vary in thickness from 1/2 - 1 inch.
Just below 911' is a 2-inch thick light grey-brown bed of very fine-grained sideritic sandstone.

3" porous

913' - ?916' — Very closely interbedded siltstone (50%) and silty shale (50%)
Siltstone, grey, argillaceous, non-porous, as irregular ripple-beds in shale. Shale, dark grey, soft, in part silty.
At 912' a 1-inch thick, well-sorted, laminated and fairly porous siltstone bed which has been analysed in plug 2 (17.3% porosity & 2.75 MD hor. perm.). The interval 913' - ?916' is only represented by 1 foot.

1" porous

?916' - ?919' — Siltstone, grey, argillaceous, with abundant thin shale inclusions and abundant ripple-bed structures (flaser bedding). No porosity. There are only 2 1/2' in core.

?919' - ?920' — Closely interbedded siltstone (50%) sandstone (20%) and shale (30%)
Siltstone, grey, argillaceous, non-porous.
Shale, grey - dark grey, silty.
Sandstone, grey, salt and pepper, very fine grained, well sorted, porous, consisting of 80% subangular quartz and 20% dark chert grains, glauconite and carbonaceous material.
Sandstone and siltstone occur as thin irregular and micro-nodular beds up to 1/2 inch thick.
This interval is represented by only 6 inches.

?920' - 924'	Siltstone, grey, argillaceous, non-porous, with thin, microscopic shale inclusions. The siltstone is closely interbedded with silty shale in lower part of interval. Beds 1/16 inch thick and very irregular.
Core #4	Interval 960' - 974' recovered 12'
960' - 962'8" 1" porous	Closely interbedded sandstone (50%) and shale (50%) Shale, grey - dark grey, silty, with abundant irregular laminae and lenses of very fine-grained, very silty sandstone and siltstone. Beds 1/16 inch thick. At 960'6" is a 1-inch thick, porous siltstone bed which was analysed as plug 3 (20.3% por. & 134 MD hor. perm.).
962'8" - 962'10" 2" porous	Siltstone, grey, salt and pepper, very fine sandy, with fair to good intergranular porosity. This siltstone bed has been analysed in plug 5. (porosity 22.9%; hor. perm. 18.90 MD).
962'10" - 963'3"	Shale, grey - dark grey, silty.
963'3" - 963'4"	Siltstone, grey, salt and pepper, slightly oil stained, very fine sand, well sorted, with good intergranular porosity. This siltstone bed has been analysed in plug 6 (porosity 20.2% hor. perm. 259.00 MD).
963'4" - 964'6"	Sandstone, grey, salt and pepper, very fine grained in part grading to siltstone, argillaceous, fairly well sorted, in places slightly porous, consisting of subangular light grey quartz (70%) and black carbonaceous material, some glauconite and black chert grains. Sandstone has thin, discontinuous argillaceous laminae (flasers), that become more abundant towards the base.
964'6" - 964'10" 1/2" porous	Very closely interbedded shale (60%) and siltstone (40%). Shale, grey - dark grey, silty in part, beds 1/8 - 1/16 inch thick, irregular. Siltstone, grey, salt and pepper, very fine sandy, in places grading to very fine sandstone, somewhat glauconitic, in places porous. Beds 1/16 - 1/8 inch thick. There is a 1/2 inch thick, porous, very fine sandstone bed present which is analysed in plug 7 (por. 26.0%; hor. perm. 259.00 MD).
964'10" - 966'6"	Closely interbedded sandstone (70%) and shale (30%) Sandstone, grey, salt and pepper, very fine grained, fairly well sorted, argillaceous in part, fair porosity. Beds 1/16 - 1 1/2 inch thick, irregular and lens-like. Sandstone has abundant small rounded vugs that probably represent washed-out shale inclusions. They look like flasers. Near the base of this interval is a 1/2-inch thick, well-sorted, very fine grained sandstone bed. Lower contact of interval gradational.

966'6" - 969'	Closely interbedded siltstone (80%) and shale (20%) Siltstone, grey, salt and pepper, very argillaceous, non-porous. Shale grey - dark grey, silty in part. Some scattered thin beds (1/8 - 1/2 inch) of very fine grained sandstone are present and also numerous sand inclusions (lenses).
969' - 971'6" 20" poorly porous	Closely interbedded sandstone (70%) and shale (30%) Sandstone, grey, salt and pepper, very fine grained, silty and in part grading to siltstone, fairly well sorted, in part argillaceous, with in places fair intergranular porosity. Sandstone beds are irregular, lens-like, 1/16 - 1/8 inch thick. Shale, grey - dark grey, silty.
971'6" - ?974'	Shale, dark grey, silty, with white shell remains. Only 6 inches are present in core.
Core #5	Interval 974' - 996' recovered 19'
974' - 974'6"	Closely interbedded shale (80%) and siltstone (20%) Siltstone, grey, as 1/16 - 1/8 inch thick irregular lenses and beds. Shale, grey - dark grey, silty.
974'6" - 976'6"	Shale, grey - dark grey, somewhat silty, with irregular lenses and laminae of argillaceous siltstone. At 976' a 1 inch plug taken out (misplaced?).
976'6" - 976'9" 3/8" porous	Very closely interbedded shale (50%) and sandstone (50%) Shale, grey - dark grey, somewhat silty. Sandstone, grey, salt and pepper, very fine grained, glauconitic, somewhat argillaceous, in places porous. Sandstone as irregular 1/8-inch thick lenses and beds. At 967'6" a 1/8" sand bed with good porosity.
976'9" - 976'11"	Siltstone, light grey-brown, sideritic, tight.
976'11" - 977'6" 1/2" porous	Shale, grey - dark grey, somewhat silty. At 977'2" is a 1/2-inch thick, irregular sandstone bed, very fine grained, glauconitic, porous. Lower contact at 977'6" fairly sharp.
977'6" - 979'2"	Very closely interbedded sandstone (50%) and shale (50%) Sandstone, grey, salt and pepper, silty, very fine grained, argillaceous, as irregular laminae and lenses up to 1/16 inch thick in matrix of shale, or as beds up to 1/2 inch thick. Shale, grey - dark grey, silty.
979'2" - 980'6"	Shale, grey - dark grey, somewhat silty. At 979'5" is a 1/2-inch thick porous sandstone bed, grey, very fine grained. At 980' is a 1/2-inch thick, very fine sandy, porous siltstone bed, analyzed in plug #8. (por. 25.3%; hor. perm. 44.30 MD).

980'6" - 981'6"	Siltstone, grey, argillaceous. At 981'6" is a 1-inch thick laminated and somewhat sideritic, light grey siltstone bed.
981'6" - 981'8"	Shale, grey - dark grey, somewhat silty.
981'8" - 982'	Very closely interbedded shale (60%) and sandstone (40%) Shale, grey - dark grey, in part silty. Sandstone, grey, salt and pepper, very fine grained, present as thin (1/16") irregular laminae and lenses.
1/2" porous	At 982' is a 1/2-inch thick, porous siltstone bed, grey, slightly oil stained, laminated, which is analysed in plug 9 (porosity 19.4%; hor. perm. 1.64 MD).
982' - 983'	Shale, grey - dark grey, silty, with thin irregular laminae of silt.
983' - 984'	Closely interbedded shale (60%) and siltstone (40%) Siltstone, grey, salt and pepper, somewhat argillaceous, laminated and in part micro-crossbedded, slightly porous,
8" porous	in beds of 1/2 inch thick. At 984' is a 1-inch thick, very fine-grained, silty sandstone bed with little porosity.
984' - 984'2"	Shale, grey - dark grey, silty.
984'2" - 984'6"	Sandstone, grey, salt and pepper, argillaceous, very fine grained, poorly porous, with abundant grey shale
4" porous	laminae and lenses 1/16 inch thick.
984'6" - 986'6"	Siltstone (80%) interbedded with shale (10%) and argillaceous sandstone (10%) Siltstone, grey, salt and pepper, in part very fine sand and grading to silty sandstone, laminated, well sorted,
19" porous	porous, consisting of 90% subangular quartz and 10% black chert. The porous beds are present from 984'6" - 986'6" and two sample analyses have been done: plug 10 (por. 21.3%; hor. perm. 8.35 MD). Shale, grey - dark grey, silty. Sandstone, grey, argillaceous, very fine grained, little porosity, with abundant shale laminae 1/16 inch thick.
986'6" - 987'	Shale (90%) grey - dark grey, silty, interlaminated with silt (10%) in lenses 1/16 - 1/8 inch thick.
987' - 988'	Siltstone (80%) interbedded with shale (20%) Siltstone, grey, salt and pepper, as in interval 984'6" - 986'6", well laminated and in places micro-crossbedded
9" porous	very fine sandy in part, porous. Shale, grey - dark grey, silty, with abundant silt lenses as 986'6" - 987'. Plug 11 is in this interval (porosity 21.2%; hor. perm. 52.60 MD).

988' - 988'6"

Shale, grey - dark grey, with abundant small silty sand lenses 1/16 inch thick.

988'6" - 992'±

Very closely interlaminated sandstone (50%) and shale (50%)
Sand is present as irregular lenses up to 1/16 inch thick, very fine grained and silty, argillaceous, in matrix of grey to dark grey silty shale. Occasionally, thin beds (1/2 inch) of siltstone occur, which are well sorted, clean, laminated and porous.

1 1/2" porous

At 989'2" 1/2 inch, plug 12 (por. 21.3%; hor. perm. 3.21 MD), and at 991, 1/2 inch siltstone.
Lower contact at 992' very gradational.

992'± - 993'

Very closely interlaminated shale (60%) and siltstone (40%)
Silt is present as abundant irregular laminae and lenses up to 1/16-inch thick, often very fine sand, grey, argillaceous, in matrix of grey - dark grey silty shale.

993' - 993'6"

Very closely interlaminated sandstone (50%) and shale (50%)
Sand, grey, salt and pepper, argillaceous, very fine grained, silty non-porous, is present as abundant irregular laminae and lenses up to 1/16 inch thick in matrix of shale, grey - dark grey, silty.

Core #6

Interval, 1,060' - 1,078' recovered 11'

1,060' - 1,064'

Closely interlaminated shale (70%) and sand (30%)
Sand is grey, very fine grained and very silty grading to very fine sandy silt, and is present as irregular laminae and lenses up to 1/16 inch thick in a matrix of grey - dark grey silty shale. Some intervals are more sandy (up to 50%): 1,061' - 1,061'8" and 1,062'6" - 1,064'.

1,064' - 1,065'6"

Shale (90%) closely interbedded with sand and silt (10%)
Shale, grey - dark grey, soft, with regular thin beds, laminae (up to 1/8 inch thick) and lenses of very fine sandy siltstone, grey, argillaceous; in part clean laminated and poorly porous.

1,065'6" - 1,066'

Very closely interbedded siltstone (60%) and shale (40%)
Silt, grey, salt and pepper, in part argillaceous, occurring as thin laminated beds up to 1/4 inch thick and as irregular laminae and lenses in a matrix of silty shale. Shale, grey - dark grey, silty.

1/2" porous

1,066' - 1,070'6"

Sandstone (90%) very closely interbedded with shale (10%)
Sandstone, grey, salt and pepper, variably argillaceous, very fine grained in places grading to very fine sandy siltstone, in general non-porous, consisting of 90% light-coloured

subangular quartz and 10% black chert. Sandstone has abundant rounded vugs that are probably washed-out shale inclusions. Some sand, light-coloured beds and lenses (1/8 - 1/2 inch thick) are fairly well sorted, porous, laminated in part, and sometimes calcareous.

5 3/8" porous

At 1,066'6"	one 1/8-inch thick porous sand bed.
At 1,066'8"	one 1/2-inch thick calcareous, non-porous sand lens.
At 1,067'	one 1-inch thick interval with porous sand lenses
At 1,068'	2-inch poorly porous in thin partly calcareous sand lenses.
From 1,068'2"	- 1,068'5" a light grey calcareous sand bed, non-porous.
At 1,068'6"	2-inch thick sand lenses, poor porosity in a few, in part calcareous
At 1,070'	1/2-inch thick bed, fair porosity in a 1 inch interval with very fine to fine-grained sand lenses.

1,070'6" - 1,070'10" Shale, (90%) grey - dark grey, silty, with abundant irregular laminae and lenses of very fine sand (10%).

1,070'10" - 1,071'6" Very closely interbedded sandstone (80%) and shale (20%) as interval 1,066' - 1,070'6". No porosity.

N.W. Tilley #5 (3-17-17-12W4) well

Core #1 Interval 910' - 912'6" recovered 1'

Shale, greenish grey, slightly silty, with occasional white pelecypod shells and a one-inch-thick bed of grey sandstone, argillaceous, very fine to fine grained, in part well sorted and laminated, crossbedded with a very argillaceous sandstone with shale inclusions and lignite fragments.

Core #2 Interval 912 1/2' - 915' recovered 1'

Shale, as above, with some light grey laminae and lenses of sand, very fine grained, well sorted, slightly porous, beds 1/8 inch thick.

Core #3 Interval 930' - 932'4" recovered 1'

Shale, greenish grey, slightly silty. Interval has one thin (1/8 to 1/4 inch) bed of white very calcareous sand, fine grained with abundant calcite crystals and white and brown pelecypod shell fragments.

Core #4 Interval 932'4" - 934' recovered 6'

Shale, greenish grey, slightly silty as above. There is one (1/16 inch thick) bed with dark grey calcareous shale and white calcareous specks.

Core #5 Interval 934' - 936'4" recovered 1'

Shale, greenish grey, slightly silty.

Core #6 Interval 936'4" - 941' recovered 2 1/2'

Shale, greenish grey, slightly silty. At the top is a brown sideritic bed, 2 inches thick.

Core #7 Interval 941' - 943'4" recovered 2 1/2'

Shale, greenish grey, silty and very finely sandy in part, with thin beds (up to 2 inches?) of very argillaceous sandstone, very fine to fine grained. There is one 1/8-inch bed with poorly sorted, rounded, coarse to very coarse, black chert grains and light-coloured quartz grains, green glauconite grains and white clay pebbles, all floating in a matrix of very pyritic sandy shale.

Core #8 Interval 943'4" - 950' recovered 2 1/2'

Shale, greenish grey, very silty and very fine sandy, grading to very argillaceous sandstone; with numerous thin shale inclusions. There is a 1/2-inch bed of grey-brown argillaceous limestone in this interval.

Core #9 Interval 960' - 962'6" recovered 2 1/2'

Sandstone, greenish grey, very argillaceous, poorly sorted, very fine to fine grained, with abundant micro-lenses of shale. No bedding visible. No porosity.

Core #10 Interval 962'6" - 965' recovered 2 1/2'

Sandstone, as core #9, but grading to very sandy shale from 963'6" to 964'6".