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W

AQUITAINE ALDER YT C-33

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WELLSITE COMPOSITE LOG	
1) 1:600 metric (2"=100 ft. equiv.) including interpretative Lithology Log based on Samples and Schlumberger Logs	Pocket
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WELL HISTORY

WELL NAME: Aquitaine Alder YT C-33

OPERATOR: Aquitaine Company of Canada Ltd.

LOCATION: Yukon Territory

CO-ORDINATES: Latitude: 65° 52' 01.6" N  
Longitude: 136° 51' 54.7" W

ELEVATIONS: Ground - 523.6 meters (1719 feet)  
K.B. - 530 meters (1738 feet)

WELL LICENCE NO:

SUPERVISION: Geological: Pi Geological Consultants (1971) Ltd.  
T. Boleantu, P. Geol. - 500-3714 m TD  
M. van Fraassen - 2751-2969 m  
Engineering: Consultants  
Gas-Logging: Western Mud-Logging Laboratories

CONTRACTOR: ADECO #5

SPUD DATE: March 8, 1978; December 13, 1978

SUSPENSION DATE: April 4, 1978; RIG RELEASE DATE: March 4, 1979

TOTAL DEPTH: 3714 m (12,181 feet)

CASING RECORD: 91.4 cm (36") @ 37.5 m (123 ft)  
50.8 cm (20") @ 89.3 m (293 ft)  
34.0 cm (13-3/8") @ 499 m (1637 ft)  
24.5 cm (9-5/8") @ 1321 m (4333 ft)

CORES: None

LOGGING RECORD:

<u>Run</u>	<u>Logs</u>	<u>Interval</u>	<u>Date</u>
1	DIL, HDT BHCS-G-Cal	503-89 m 503-Surface	March, 1978
2	DIL, HDT BHCS-G-Cal, Density- N-G-Cal	1317-499 m	December 27, 1978
3	DIL, BHCS-G-Cal	2923-1323 m	February 6, 1979
4	DIL, HDT, BHCS-G-Cal Density-N-G-Cal	3691-2700 m 3692-1200 m	March 27, 1979
5	Velocity Survey	3600-128 m (23 shots)	March 28, 1979

DRILL STEM TESTS: None

STATUS: D & A

FORMATION TOPS\*

<u>Age</u>	<u>Formation</u>	<u>Sample/Driller Depth (DD) m</u>	<u>Log (LD)* Depth (m)</u>	<u>Subsea Log Depth (m)</u>	<u>Subsea Log Depth (ft)</u>
	Kelly Bushing	530	0	+ 530	+ 1,739
PERMIAN	-Jungle Creek SS Surface	523.6 ft	6.4	+ 523.6	+ 1,118
PENNSYLVANIAN	-Ettrain Equivalent (LS & SH)		342 (1140')	+ 188	+ 617
	-Unit 2 (SH)	510	505	+ 25	+ 82
	-Upper Hart River (SH)	757	752	- 222	- 728
PENN.-MISS.	-Lower Hart River	1291	1288	- 758	- 2,487
MISSISSIPPIAN	-Mid-Lower Hart River (SS) (Birch Member)	1456	1451	- 921	- 3,022
	-Unit 1 (SH)	1634	1629	-1099	- 3,606
DEVONIAN (U)	-Imperial (SH)	2241.5	2226.5	-1696.5	- 5,566
	-? Fort Creek (Siliceous SH)	2790	2775	-2245	- 7,366
DEVONIAN (M)	-Ogilvie (LS)	2869	2854	-2324	- 7,625
	-Gossage (LS)	3066	3066	-2536	- 8,320
	-1st Dolomite	3263	3263	-2733	- 8,967
	-2nd Dolomite	3518	3518	-2988	- 9,803
TOTAL DEPTH	-Driller (12,181 ft)	3714	-	-3184	-10,446
	-Measure Log (fill on bottom)	3715.4	3695		

\*Confirmed by Aquitaine.

- From 480-1775 m, Sample Drill Depth (DD) - 5 m = Schlumberger Log Depth (LD)
- From 1775-2952 m, Sample Drill Depth (DD) - 15 m = Schlumberger Log Depth (LD)
- From 2938-3714 m (TD) Sample Drill Depth (DD) = Schlumberger Log Depth (LD)

Log error due to incorrect metric depth markers on Schlumberger cable. Measure out (14 m) depth correction at 2952 m, i.e., 2952 m old depth = 2938 m new depth (see Sample Log). Comparison of Schlumberger Log with Sample Driller Depths indicates an average of 15 meters difference from 1775 m trip to 2952 m strap out. The interpreted Lithology Log was corrected 10 m at 1775 m, in order to offer better correlation with the Sample/Driller Depths and to continue the average 5 m discrepancy between Sample and Log Depths. Prior to 1775 (i.e., 480-1775 m) Sample/Driller Depth - 5 ft. = Schlumberger Log Depth.

GEOLOGIC EVALUATIONPENNSYLVANIAN

THE ETTRAIN, LIMESTONES AND SHALES: sandy, bioclastic limestone, grading to calcareous sandstones were tight with no porosity or show.

MISSISSIPPIAN

UNIT 2 SILTSTONE AND SHALE: scattered fracture porosity soon after drilling out of 34 cm casing at 504 m caused lost circulation problems. No shows were noted except for dead oil stain at 550 m LD. The basal sandstone, (734-41.5 m) medium to coarse grained with chert pebbles, at the top and grading to dolomitic siltstone at the base indicated 5-10% intergranular porosity (1-2 m) within the upper 8 m sandstone; 20-30% siliceous overgrowth cement with 0-10% calcite cement (post siliceous overgrowth), no live show, although a slight increase in total gas from 20-100 units background to 232 units total gas. Log analysis indicates 15-25% porosity at the top of this sandstone grading to 6% porosity at the base.

UPPER HART RIVER SHALE: This lithology was essentially dark gray shale with scattered pyrite pellets and needles with minor laminations and thin beds of buff argillaceous micritic limestone grading calcareous siltstone. No porosity or shows.

PENNSYLVANIAN-  
MISSISSIPPIAN

LOWER HART RIVER SANDSTONE AND SANDY CHERTY LIMESTONE: The top interval 1288-1318 m LD (30 m) - 18 m net sand of which 7 m has calcite cement and a lower 12 m argillaceous sandstone and sandy shale, consisted of medium to coarse grained, well sorted, rounded chert and quartz grains with scattered coarse to very coarse grained chert pebbles up to 5 mm in size. No porosity or show was noted due to 5-10% argillaceous matrix, 15-20% calcareous cement and 5-10% siliceous cement with trace pyrite cement associated with argillaceous matrix lining the quartz grains. Cleanest sandstone (less argillaceous matrix) occurred at the top of the zone, however primary porosity was filled with secondary calcite cement. Good effervescence in acid suggests a limestone on first examination but is actually a very calcareous cement. A minor gas kick of 272 units (background 60 units) occurred from 1295-1297 m DD (1292-1295 m LD). No porosity or show was noted in the underlying very cherty limestone and dolomite (10-20% chert laminations and concretions) grading sandy. Minor increase in drilling rate and corresponding increase in gas - 100 units total gas from 40 unit background gas, was due to drilled formation shale gas.

MISSISSIPPIAN

LOWER HART RIVER SANDSTONE AND LIMESTONE (BIRCH RIVER MEMBER): Best sands were noted from 1456-1479.5 m DD (1451-1474.5 m LD) - 23.5 m, compared to 73 m in the neighbouring Blackstone YT D-77 well which contained gas shows. This consisted of medium

to coarse grained sands containing silt to very fine grained matrix, with increasing grain size with depth. One to 2 mm chert pebbles (40-60% of sample) were common, with only scattered poor porosity with traces of oil stain and trace yellow and brown fluorescence (less than 1%) contained within the recrystallized calcite cement. Due to the high calcite cement (20-30%), minor siliceous cement (0-10%), no porosity with any increase of gas was noted. The underlying limestone and sand laminae in shale immediately underlying this major cherty sand interval contained less than 1% yellow fluorescence usually associated with a recrystallized calcite cement with rare poor intercrystalline porosity. The best fluorescence in the well was noted in this limestone, possibly due to poor permeability and minor carbonate fluorescence. Higher gas detector readings were noted from shale drill breaks, i.e., 1532.5-1535 m DD and 1584-1587 m DD.

Interbedded calcareous sandstone was noted from 1552.5-65 m DD (1547.5-1560 m LD) - 12.5 m. These sands were fine to medium grained with scattered coarse grained chert pebbles containing 30% calcite cement with trace of yellow fluorescence in the calcite cement. No increase in gas readings were noted from the gas detector. The interval 1451-1479.5 m LD did not warrant a test in this well but is the best clastic sandstone developed in neighbouring wells. Secondary calcite cementation has destroyed any primary porosity.

UNIT 1 SHALE: This major shale unit consisted of brown carbonaceous shale with scattered pyrite and scattered anhydrite filled fractures. No shows were noted except from fine grained sandstone beds, 1781-1810 m (LD). These sands contained 15-30% quartz overgrowth cements, 5-15% intergranular porosity, dead oil stain and no fluorescence. This sandstone contained the best porosity noted in this well. No gas was noted from the gas detector. Minor increase in mud viscosity was possibly due to a high sulphate (anhydrite) formation water. Although increased viscosity would decrease any gas readings, lack of live shows were indicative of water filled porosity. From 1942-1949.5 m LD (5.5 m) and 1956-1964 m LD (8 m) these sandstones consisted of fine to medium grained sands, 0-3% porosity, trace asphaltic staining, 30% siliceous overgrowth cement, with no live shows or gas increase.

Mississippian gas shows indicated minor C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> gas content. This could have been the result of minor shale gas (bituminous) from 650-1320 m or contamination of the mud system by CCM additives, as only minor, spotty gas/oil shows were noted.

UPPER DEVONIAN

IMPERIAL FORMATION: The top of this formation was picked at 2241.5 m (LD) due to increased drill rate, increased shale gas of carbonaceous coaly shales and increased Gamma readings from the Gamma Logs. Essentially this dark grey to black shale

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GEOLOGIC EVALUATION

was laminated with scattered silty to fine grained sands (20% chert grains) from 2500-2506 m LD (20% chert), 2642-2658 m LD (16 m), 2695-2710 m LD (15 m). All sands contained 5-10% dolomitic/sideritic cement, 10-15% siliceous overgrowth cement plus 5-15% argillaceous matrix with no porosity, no shows. Anhydrite filled fractures were noted in more resistant brittle shales. Scattered pyritized radiolaria were noted from 2330-2390 m. The caving shale problems occurred below 2455 m (DD) especially bridging at a resistant sand ledge at 2500 m (LD) - the first major sand ledge below the caving shales above. Extensive caving occurred from 2455-2710 m (LD). Minor increased shale gas was noted with increased drill rate at 2428 m DD. A minor gas zone (1-2 m) was noted at 2643 m (DD) in fractured sandstone containing minor fracture porosity (often dolomite filled fractures). The gas increased to 350 units from 40 units background gas. Imperial shales in this well are thinner at 612.5 m compared to 824 m in the Blackstone YT D-77 well.

FORT CREEK SHALE: This top was based on increased Gamma content, decrease in silt laminations and increased siliceous content of the shale. Especially, very siliceous darker grey to black shale was noted below 2852 m (DD) or 2837 m (LD), with extensive fracture porosity, (quartz lined with quartz crystals common lining fractures), no shows, especially from 2840-50 m DD (2835-2845 m LD).

MIDDLE DEVONIAN

OGILVIE LIMESTONE: This bioclastic limestone with medium to coarse grained bioclasts including crinoid fragments contained asphaltic staining in primary intergranular porosity followed by secondary calcareous cement. Washout of this limestone indicated a possible minor porosity but no live show was noted. The gas detector was poorly maintained over this interval above 2900 m DD due to cold weather (-40°C). Minor chert content was noted (less than 1% chert from 940-967 m). The Ogilvie Formation (212 m) is thicker in this well compared to that in the Blackstone well (171.5 m) possibly due to less surface erosion.

GOSSAGE LIMESTONE: No shows or porosity was noted in this micritic greyish white limestone which graded slightly dolomitic.

1ST DOLOMITE: The interval from 3263-3292 m appears to be a transition zone of coarser, slightly dolomitic bioclastic limestone with the main dolomite zone below 3292 m (LD). Scattered pyrobitumen (black shiny) staining was noted in the scattered visual poor to fair porosity. No live gas shows were noted with only a minor increase of total gas of 84 units (background 30-40 units) was noted at 3358-60 m due to a 50% increase in drilling rate resulting from increased crystalline

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GEOLOGIC EVALUATION

dolomite - very fine crystalline dolomite containing visual poor to fair intercrystalline porosity. Log porosities were noted on the Lithology Log by thin lines ranging from 5-15%. Best porosities were noted from 3333-3344 m and 3365-3395 m. The base of this interval graded to an argillaceous dolomite with possible amphipora vestiges and scattered asphaltic staining especially from 3501-3518 m.

2ND DOLOMITE: This dolomite, as above, was basically a buff/white to light greyish white, representing a possible micritic limestone with scattered sparry calcite (fossil infilled and algal). Best porosity again occurred in coarser crystallinity - very fine crystalline dolomite especially from 3555-63 m, 3574-95 m, 3604-3626 m. Scattered pyrobitumen staining was again noted in these increased crystalline and porous zones (visual porosity 5-10%) and log porosity 10-15%. All drilling breaks related to coarser crystallinity and increased porosity occurred as 1/2 to 1 m intervals with no continuous drilling breaks or zones of porosity sufficient for any drill stem tests or cores. The dolomite becomes more calcareous below 3622 m and very calcareous at 3645-54 m. Less intercrystalline porosity due to reduced dolomitic crystallinity (under very fine crystalline size) was noted below 3622 m. No major reef development was noted but rather a back reef facies - micritic occurred in the Gossage Formation, including the 1st and 2nd Dolomites. No live shows or marked increase in gas readings were noted throughout the Gossage Formation except at 3625 m i.e. 88 units from background of 40 units, possibly due to minor drilling breaks in the gas saturated formation water. This represents drill gas only. The carbonate zone from the Gossage Top to 2nd Dolomite (452 m) is equivalent to that in the Blackstone YT D-77 well (478.5 m) indicating a broad, regional stable shelf deposit.

AQUITAINE ALDER YT C-33  
LITHOLOGICAL DESCRIPTION

INTRODUCTION

From 500 m - 3710 m, 5 meter samples were collected. The geograph depth recorder was not operational from 500 - 585 m but approximate times for the drilling time curve were recorded by the driller. Sample quality was good except from 580 - 680 m due to loss circulation problems in bypassing of shakers when samples were collected in the flow-line. Erratic gas readings were also recorded due to partial bypass of the mud flow line. The winter (1978) season continued the drilling program which was interrupted during the spring (1978) breakup when 13-3/8 inch casing was set at 499 m (1637 ft). In order to provide a correlation with previous lithologies, samples in this report were logged from 480 m (1590 ft) whereby a slight discrepancy occurs due to different geologist's description. The writer believes that the descriptions in this report are accurate as much as they are based on both samples and log evaluations. Due to an incorrect depth control on the Schlumberger cable, i.e., calibrated in footage from the previous year, it was found that

from 480-1775 m Drill Depth (DD) - 5 m = Schlumberger Log Depth (LD)  
from 1775-2952 m Drill Depth (DD) - 15 m = Schlumberger Log Depth (LD)  
from 2952-3714 m TD, Drill Depth = Schulumberger Log Depth (LD).

At 2952 m a strap out correction revealed an approximate 14 m error. Both sample logs and interpretive lithology logs correspond to the Driller Depth and drilling times. However the interpretive Lithology Log has been corrected with Sonic/Gamma Interval Lithology compared with Sample Description. The following sample description is interpretive, based on Driller Depth, using Schlumberger Log characteristics for more accurate definition of clastic zones. Lost circulation zones due to fracture porosity were encountered at 582 m which was cemented off at 650 m, as well as from 1255 - 1290 m. Please refer to the Interpretive Lithology Log when referring to these typed descriptions at both scales of 1:600 and also of 1:1200 scale (Can Strat Equivalent Scale).

(Description by Aquitaine Geologist, March 1978).

In Feet

<u>In Feet</u>		JUNGLE CREEK - SURFACE
0-	30	very poor sample - mostly mud.
30-	45	<u>Shale</u> - medium to dark grey, very slightly calcareous, fissile in part.
45-	60	<u>Shale</u> - as above, very slightly micromicaceous, ? sponge spicules.
60-	75	<u>Shale</u> - as above, trace ? gypsum bands.
75-	90	<u>Shale</u> - as above, ? pyrite worm tube.

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LITHOLOGICAL DESCRIPTION

- 90- 105      Shale - as above.
- 105- 120      Shale - as above, poor sample - muddy
- 120- 135      Shale - as above, very slightly calcareous, very slightly fissile, very slightly micromicaceous.
- 135- 150      Shale - medium to dark grey, slightly flakey, slightly calcareous.
- 150- 270      Shale - as above, fissile in part.
- 270- 285      Shale - as above, becoming darker in colour and harder.
- 285- 300      Shale - dark grey, hard, slightly silty, non-calcareous.
- 300- 315      Shale - as above, very slightly calcareous.
- 315- 345      Shale - as above, trace pyrite, slightly micromicaceous.
- 345- 375      Shale - as above, (mainly cavings ?).
- 375- 450      Shale - dark grey, non-calcareous, softer, non-silty, trace pyrite.
- 450- 465      mostly cavings.
- 465- 480      Shale - as above.
- 480- 555      Shale - dark grey, medium hard, non-calcareous, trace micromicaceous, trace pryite nodules with grey quartz centres.
- 555- 570      mostly cavings.
- 570- 585      Shale - as above.  
Dolomite - trace, dark grey brown to dark brown grey, cryptocrystal-  
line, argillaceous.
- 585- 600      missing
- 600- 615      Shale - medium to dark grey, fissile in part, micromicaceous, calcareous in part, glauconitic in part, pyritic in part.
- 615- 630      Shale - as above, very slight trace dark brown chert, trace pyritized ? work tube.
- 630- 645      Shale - as above, slightly dolomitic in part, non-glauconitic, no chert.

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- 645- 660 Shale - as above, glauconitic in part, only slightly pyritic, very slightly silty.
- 660- 675 Shale - dark grey, slightly micromicaceous, slightly fissile, calcareous, non-glauconitic, slightly pyritic with pyritized ? worm tube, trace calcite.  
Limestone - trace dark grey brown, cryptocrystalline.
- 675- 690 Shale - as above, only slightly calcareous, very slightly glauconitic, very slightly pyritic.
- 690- 705 Shale - medium-dark grey, soft, silty in part, micromicaceous, fissile to blocky, trace pyrite, trace cream marl.
- 705- 720 Shale - as above, trace calcareous vein.
- 720- 735 Shale - medium to dark grey, medium soft, fissile to blocky, slightly to very calcareous, micromicaceous, trace pyritic, trace marl.
- 735- 810 Shale - as above, moderately to very calcareous.
- 810- 825 Shale - as above, trace calcite crystalline, trace ostracoda.
- 825- 855 Shale - as above, no ostracoda.
- 855- 900 Shale - as above, occasional very fine black biotite flakes.
- 900- 915 Shale - medium to dark grey, fissile to slightly blocky, calcareous, very slight trace pyrite, trace glauconite, trace biotite flakes, trace ostracoda.
- 915- 930 Shale - as above, no visible ostracoda.
- 930- 945 Shale - as above, only trace glauconite.
- 945- 960 Shale - as above.  
Limestone - medium brown grey to dark grey brown, cryptocrystalline.
- 960- 975 Shale - as above.  
Limestone - as above, trace pyrite blobs.
- 975- 990 Shale - (97%) - as above.  
Limestone - (13%) - as above, pyrite minor.

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LITHOLOGICAL DESCRIPTION

- 990-1005      Shale - as above.  
                 Limestone - trace, no glauconite, occasional calcareous crystalline  
                 and pyrite blob.
- 1005-1020      Shale - (98%) - medium to dark grey, micromicaceous, fissile to  
                 slightly blocky, calcareous, calcite veining, occasional pyrite.  
                 Limestone - (2%) - medium to dark brown to brown grey, crypto-  
                 crystalline.
- 1020-1035      Shale - as above, slightly glauconitic, very slightly pyritic.  
                 Limestone - very slight trace - as above.
- 1035-1080      Shale - as above.
- 1080-1110      Shale - as above.  
                 Limestone - trace light grey, very slightly glauconitic and pyritic,  
                 cryptocrystalline.
- 1110-1125      Shale - (90%) - medium to dark grey, fissile to blocky, micro-  
                 micaceous in part, very slightly glauconitic, limey to dolomitic.  
                 Limestone - (10%) - medium grey, very argillaceous, slightly glau-  
                 conitic in part, cryptocrystalline.
- 1125-1140      Shale - (90%) - as above.  
                 Dolomite - (7%) - medium grey, cryptocrystalline.  
                 Limestone - (3%) - light to medium grey, cryptocrystalline.
- 1140            TOP - ETTRAIN EQUIVALENT - 1140' (342 m) (+188 m)
- 1140-1155      Shale - (90%) - as above, grading to very argillaceous limestone.  
                 Limestone - (10%) - as above, slightly dolomitic.
- 1155-1170      Shale - as above.
- 1170-1185      Shale - (75%) - medium to dark grey, blocky, slightly calcareous,  
                 to dolomitic, slightly glauconitic in part.  
                 Limestone - (25%) - light to medium grey, argillaceous, glauconitic,  
                 cryptocrystalline.
- 1185-1200      Shale - (90%) - as above, very calcareous to dolomitic, occasional  
                 calcareous crystalline.  
                 Dolomite - (10%) - as above.

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- 1200-1215      Shale (85%) - medium to dark grey, blocky, calcareous to dolomitic, limy in part, trace ? ostracoda.  
  
                 Dolomite - (5%) - as above, argillaceous, cryptocrystalline.  
  
                 Limestone - (10%) - light to dark grey, argillaceous, cryptocrystalline.
- 1215-1230      Shale - (75%) - as above.  
                 Limestone - (20%) - as above.  
                 Dolomite - (5%) - as above, glauconitic.
- 1230-1245      Shale - (80%) - as above, very fine glauconitic in part.  
                 Limestone - (15%) - as above, trace white to light grey.  
                 Dolomite - (5%) - as above.
- 1245-1260      Shale - (85%) - as above, very limy.  
                 Limestone - (15%) - as above, dolomitic in part.
- 1260-1275      Shale - (65%) - medium to dark grey, slightly fissile to blocky, calcareous to dolomitic, very slight trace glauconite.  
  
                 Limestone - (25%) - dark brown grey to medium grey, dolomitic, argillaceous, occasional glauconite, cryptocrystalline.  
  
                 Dolomite - (10%) - light to medium grey, argillaceous in part, glauconitic, cryptocrystalline.
- 1275-1290      Shale - (80%) - as above.  
                 Limestone - (20%) - as above.
- 1290-1305      Shale - (60%) - as above, trace pyrite.  
                 Limestone - (40%) - as above.
- 1305-1320      Shale - (85%) - as above.  
                 Limestone - (15%) - as above.
- 1320-1335      Shale - (80%) - as above.  
                 Limestone - (20%) - as above.
- 1335-1350      Shale - (25%) - as above.  
                 Limestone - (75%) - as above, occasional large glauconitic pebbles.
- 1350-1365      Shale - (50%) - as above.  
                 Limestone - (50%) - as above.

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- 1365-1380      Shale - (10%) - as above.  
                 Limestone - (20%) - as above.  
                 Dolomite - (70%) - medium to dark brown grey, calcareous, argil-  
                 laceous, glauconitic in part, cryptocrystalline.
- 1380-1395      Shale - (10%) - as above.  
                 Limestone - (25%) - as above.  
                 Dolomite - (65%) - as above, trace calcareous vein.
- 1395-1410      Shale - (20%) - as above.  
                 Limestone - (30%) - as above.  
                 Dolomite - (50%) - as above.
- 1410-1425      Shale - (30%) - as above.  
                 Limestone - (30%) - as above.  
                 Dolomite - (40%) - as above, becoming very calcareous.
- 1425-1440      Shale - (25%) - as above.  
                 Limestone - (25%) - as above.  
                 Dolomite - (50%) - as above, moderately calcareous.
- 1440-1455      Shale - (40%) - as above.  
                 Limestone - (10%) - as above.  
                 Dolomite - (50%) - as above.
- 1455-1470      Shale - (30%) - as above.  
                 Limestone - (20%) - as above, grading to calcareous shale.  
                 Dolomite - (50%) - as above, grading to dolomitic limestone.
- 1470-1485      Shale - (40%) - as above.  
                 Limestone - (40%) - as above.  
                 Dolomite - (20%) - as above.
- 1485-1500      Shale - (60%) - as above.  
                 Limestone - (40%) - as above.
- 1500-1515      Shale - (50%) - as above.  
                 Limestone - (50%) - as above, trace calcareous veins.
- 1515-1530      Shale - (50%) - as above.  
                 Limestone - (50%) - as above.
- 1530-1545      Shale - (30%) - as above.  
                 Limestone - (50%) - as above.  
                 Dolomite - (20%) - dark brown grey, dense, tight, crypto-  
                 crystalline, trace ? brachiopoda fragments.

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- 1545-1560      Shale - (10%) - as above, slightly calcareous to dolomitic, glauconitic in part.  
                 Limestone - (90%) - as above, trace pyrite.
- 1560-1575      Shale - (60%) - as above, trace ? brachiopoda shells.  
                 Limestone - (40%) - as above.
- 1575-1590      Shale - (90%) - as above, trace pyrite, trace brachiopoda fragments.  
                 Limestone - (10%) - as above.
- 1590-1605      Shale - (60%) - as above.  
                 Limestone - (40%) - as above.
- 1605-1620      Shale - (80%) - as above, slightly dolomitic.  
                 Limestone - (20%) - as above, slightly dolomitic.
- 1620-1635      Shale - (60%) - as above.  
                 Limestone - (40%) - light cream to grey to medium grey, fine to medium crystalline, argillaceous in part, glauconitic in part, fossil in part, tight, some medium to dark grey chert.
- 1635-1650      Shale - (65%) - as above, trace crinoid fragments.  
                 Limestone - (35%) - as above, trace crinoid fragments, ? sponge spicules, abundant brachiopoda fragments with free and interbedded medium to dark grey chert.

(Description by Thomas Boleantu, P. Geol., December 1978 - March 1979).

In Metres

- 480 - 491.5 m (DD)      SILTSTONE, ARGILLACEOUS, medium greyish brown with 10-40% argillaceous matrix content, 10% dolomitic cement, blocky occasionally fine grained with minor laminations.  
1575-1612.5 ft      SILTSTONE (10%), light to medium greyish brown, coarse silt grading minor very fine grained, less argillaceous content, i.e., 10% argillaceous matrix and 20-30% dolomitic cement (staining indicates essentially a dolomite cement), scattered glauconite grains.  
                 SHALE, dark grey to dark greyish brown, silty, slightly dolomitic, hard, dense, brittle with scattered shell fragments (brachiopod) and scattered spicules, 20% argillaceous laminations within this major silty unit.
- 491.5 - 494 m      SANDSTONE, light brown, medium to coarse grained, fossiliferous  
1612.5-1621 ft      and sandy grains with scattered round chert pebbles (2%), round dark grey, occasionally white grading very coarse to granules 2-3 mm in size, scattered glauconite and sponge

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spicules, fossiliferous fragments include coquina with 20-30% calcareous cement and gradations to silt and very fine grained matrix. This interval grades from a very calcareous sandstone to a sandy biointramicrite, however it is believed to be essentially a detrital coquinoid sandstone.

- 494 - 502 m  
1621-1647 ft. SILTSTONE, ARGILLACEOUS, as above, with minor gradations to SILTY SHALE (10%), medium to dark grey, as above, and slightly ARGILLACEOUS SILTSTONE, blocky, dolomitic with scattered fossil fragments and minor sandstone laminations with scattered chert grains, grading silty and minor LIMESTONE COQUINA, coarse to very coarse grain, biospyrite to biomicrite, grading sandy.
- 499 m  
1637 ft 13-3/8" casing set in March, 1978. Previous TD 502.9 m (1650 ft), casing shoe 499 m (1637 ft).
- 503 - 506.5 m  
NEW HOLE  
December, 1978 LIMESTONE, white to light grey, very silty to very fine grain sand, grading 40% silt and sand grains, i.e., sandy biomicrite with gradations to very fine grain sandstone with calcareous cement (30-40%). Scattered black carbonaceous grains, minor laminations of CALCAREOUS SANDSTONE, very fine grained, as above, white, slightly glauconitic, trace poor porosity.
- 506.5-508.5 m SILTSTONE, light grey, argillaceous, 20-30% limey and dolomitic cement, as above, with minor SANDSTONE laminations, white, silty to very fine grained with calcareous cement, i.e., 90% silt, 10% very fine grained content, scattered glauconite.
- 508.5-510 m SANDSTONE, white, very fine grained with 30% white calcareous cement, scattered pelecypods and sponge spicules, i.e., coquinoid fragments, grading slightly argillaceous, light brown SILTSTONE.
- 510 m (DD)  
505 m (LD) UNIT 2 SHALE (+25 m)
- 510 - 520 m ARGILLACEOUS SILTSTONE, medium to dark grey, blocky, massive, with 10-20% argillaceous matrix and 10-30% dolomitic cement grading minor scattered calcareous cement, scattered pelecypod and spicular fragments with minor gradations of slightly argillaceous SILTSTONE and SANDSTONE as above.

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- 520 - 550 m SILTSTONE, light to medium greyish brown, slightly argillaceous with scattered carbonaceous clasts and scattered spicules, occasional glauconite grains, coarse silt grading very fine grained with estimates of 30-70% silt content and 20-40% argillaceous content grading to 10-20% argillaceous content and 5-10% dolomitic cement. Hard, dense, blocky, scattered intergranular porosity with interbeds of ARGILLACEOUS SILTSTONE with increasing argillaceous content, medium to dark greyish brown, grading silty shale and SANDSTONE (5%), white to light grey, dolomitic, very fine grained to silty, scattered glauconite and black carbonaceous clasts, 20-30% dolomitic cement, as above, thin platy laminations in beds less than 1 m in thickness. NOTE: These dolomitic sandstone thin beds are well noted on the Schlumberger Logs due to the dolomitic content of the cement.
- 550 - 569 m SILTSTONE, slightly argillaceous (10-20% argillaceous content), slightly dolomitic, blocky, hard, dense, occasional scattered brachiopod fragments and scattered black carbonaceous grains, trace pyrite with minor laminations  
DOLOMITIC SILTSTONE, white to light brown and greyish brown with gradations to very fine grained sand up to 50%, sandy, averaging 10% very fine grained, scattered shell fragments, scattered dead oil stain, no fluorescence, trace intergranular porosity.
- 569 - 570.5 m SANDSTONE, buff brown, very fine grained, grading silty, very calcareous, i.e., 30% calcareous cement with gradations to LIMESTONE, white, dolomitic, sandy, biosparite, scattered very fine grain glauconite, trace sparry calcite due to fracture porosity.
- 570.5-573 m ARGILLACEOUS SILTSTONE, medium to dark greyish brown with gradations to cleaner siltstones, i.e. 5-15% argillaceous content, scattered black carbonaceous grains, scattered very fine glauconite grains with 5-10% calcareous dolomitic cement. Trace white sparry calcite filled fractures.
- 573 - 578 m DOLOMITIC SILTSTONE, light to medium grey, 20-30% dolomitic cement, 5-15% argillaceous matrix, scattered spicules, scattered carbonaceous grains, trace glauconitic grains, scattered sparry calcite filled fractures with calcite veinlets noted in siltstone and shale with minor gradations to silty sandy dolomite and argillaceous siltstone as above.
- 578 - 585 m NO SAMPLE. Lost circulation at 582 m, tripped out with no returns. Poor samples from 585-690 m due to intermittent bypassing shakers as a result of lost circulation material in flowline. Lost circulation was believed to occur due to fracture porosity in intervals 565-615 m and 630-650 m. Intermittent returns resulted in poor samples. Sample description over these intervals of poor returns are based on Schlumberger Logs with correlation to samples.

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- 578 - 601 m ARGILLACEOUS SILTSTONE (15-30% argillaceous matrix) with scattered black carbonaceous grains with gradations to shalier medium to dark greyish brown siltstone. Scattered glauconite grains with minor gradations of siltier dolomitic laminations with up to 5% white calcite spar fracture filling in the sample 590-595 m, fracture porosity with minor gradations to SANDSTONE, white, very fine grained, calcareous dolomitic cement, slightly glauconitic grading to dolomitic siltstone.
- 601 - 606 m DOLOMITIC SILTSTONE, medium to dark grey, blocky, hard, dense, numerous calcite veinlets, with 10% white sparry calcite filled fractures, scattered black carbonaceous grains and very fine grained glauconite grains, with laminations of slightly argillaceous siltstone and gradations to WHITE SANDSTONE, very fine to fine grained, occasionally medium grained, white calcareous cement. NOTE: poor samples due to lost circulation and trip at 604 m.
- 606 - 628 m SHALE, medium to dark grey with estimated 20-30% silt content at top grading to less than 5% silt content to base, black carbonaceous, slightly fissile with decreasing laminations of silty argillaceous dolomite and dolomitic siltstone laminations. NOTE: this decrease in dolomitic siltstone laminations results in a decrease in sparry white calcite fracture filling with no fracture spar calcite noted below 615 m. Scattered black carbonaceous grains and very fine grained glauconitic grains. Scattered brachiopod fragments with increase in SHALE, dark greyish black, slightly fissile, less than 5% silty, occasionally calcareous, blocky, hard.
- 628 - 643 m SHALE, light to medium grey, 5% silt content, calcareous with 10-15% calcareous content with 1-2% white calcite spar veinlets filling fractures. Scattered black carbonaceous grains with 10-20% SHALE, dark grey, negligible silt content, blocky, softer.
- 643 - 650 m SHALE, medium to dark grey, decrease in calcareous content, less than 10%, less than 5% silt content, blocky to fissile, softer than above. Scattered white calcite spar filled fractures, possible caving from more resistant zone above. NOTE: Lost circulation zones at 627 m and 646 m possibly due to fractured zones above this shale.
- 650 - 661 m SHALE, light to medium greyish brown with 10-15% silt content, slightly calcareous, blocky with occasional silty laminations, scattered black carbonaceous grains, occasional coarse grained Pyritized wood fragments, with interbeds of less calcareous, medium to dark grey shale, decrease silt content and increase in argillaceous content.

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- 661 - 678 m SHALE, as above, interlaminated.  
SILTY SHALE, light to medium greyish brown with 15% silt content, occasionally glauconitic, slightly calcareous dolomitic, blocky, hard, dense, with occasional very coarse to very fine grain silt grains, and  
SHALE, medium to dark grey, blocky, trace calcareous dolomitic content, decrease silt, scattered pyrite grains and black carbonaceous grains. Poor samples due to bypass over shaker. i.e., high LCM content. Trace dull brown fluorescence in 10% of sample, possibly due to increase in carbonaceous content of shale.
- 678 - 683 m SHALE, medium to dark grey, slight silt content, trace fine grained pyrite grains and carbonaceous grains, 5% dull brown carbonaceous fluorescence.
- 683 - 685 m INTERLAMINATED SHALE, medium to dark grey as above,  
SHALE, light to medium greyish brown, 15-20% silt content, slightly dolomitic, laminations, trace coarse silt, grading very fine grain sandstone, glauconitic grains.
- 685 - 700 m SHALE, medium to dark greyish brown to dark grey, hard, dense, blocky, less than 5% silt content, trace to 5% calcareous dolomite laminations, trace pyritized carbonaceous grains and crinoid occicles, trace to 10% dull brown carbonaceous fluorescence. NOTE: slight increase in gas is possibly due to these carbonaceous shales.
- 700 - 703 m SANDSTONE, white, mottled salt and pepper with white quartz grains, and grey and white chert grains, subangular to subrounded, very fine grains - 10%, medium grained - 70%, coarse grained - 20%, occasional well rounded chert pebbles, 20-30% siliceous cement, hard, tight, no fluorescence. The very fine grained sand possibly represents matrix.
- 703 - 712 m SHALE, light greyish brown with high silt content of up to 30% silt grains, blocky, 20% dolomitic calcareous content, slight effervescence indicative of dolomitic shale, scattered glauconite grains, trace oil stain and 10% dull brown carbonaceous fluorescence in shale with minor laminations of  
SANDSTONE, chert pebble conglomerate, coarse grained - 20%, medium grained - 80%, grading very coarse grained chert, siliceous cement, trace glauconite.
- 712 - 720 m SHALE, light to medium greyish brown, with decreasing amount of silt content, i.e. 10-15% silt, slightly dolomitic, blocky, hard, dense, scattered glauconite and pyrite grains with gradations of dark grey shale with scattered very fine grain and silt grains. NOTE: This sample has a high LCM content averaging 25%, i.e. sawdust.

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- 720 - 722 m SHALE, light to medium grey, as above, occasionally silty, 15-20% silt content, slightly dolomitic with minor sandy laminations, very fine grained - 40%, fine grained - 60%, with trace chert grains forming a harder resistant thin bed.
- 722 - 734 m SHALE, dark grey, less silty than above, slightly calcareous, with floating well-rounded chert grains and chert pebbles, trace glauconite and minor laminations of slightly silty shale, and white argillaceous siltstone, slightly calcareous grading coarse silt.
- 734 - 741.5 m SANDSTONE, white to cream, salt and pepper, with well rounded chert pebbles, fine grained - 10%, medium grained - 80%, coarse grained - 10%, becoming coarser i.e., becoming coarse grained - 90%, very coarse grained - 10% to base, poor to fair sorting, chert pebbles common especially in very coarse grained and pebble size, quartz grains are subangular to subrounded with 20-30% siliceous cement - overgrowths, scattered 0-10% porosity in 10% of the sample, minor secondary calcareous cement (after siliceous cement), trace white kaolinitic scattered glauconite grains, trace pyrite, no live fluorescence, weak cut, 20% dark brown fluorescence (dead oil stain), minor laminations of silty and argillaceous sandstones.
- 741.5-755 m SILTSTONE, light grey, occasionally very fine grained, dolomitic, grading calcareous cement, hard, platy, scattered brachiopod spines, slightly argillaceous with up to 20% argillaceous matrix, with minor laminations of SANDSTONE, white, as above, medium to coarse grained, and SHALE, medium to dark grey, slightly silty, calcareous, hard, dense, blocky, siliceous, scattered black carbonaceous grains.
- 757 m (DD)  
752 m ((LD) UPPER HART RIVER FORMATION
- 757 - 760.5 m INTERBEDS of SHALE, dark greyish black, slightly calcareous, blocky, slightly softer than above, occasional fissile laminae, black carbonaceous grains, slightly silty, i.e., less than 5% silt content, slightly micromicaceous with minor siltstone dolomitic, slightly calcareous, hard, platy at base (30-60% silt content).
- 760.5-789 m SHALE, dark grey, occasionally black, blocky, medium hard, occasionally fissile, slightly calcareous, occasional pyrite nodules (scattered medium to coarse grained framboidal pyrite).
- 789 - 792.5 m SHALE, medium grey to greyish brown, blocky, slightly dolomitic, slightly silty, ie, increased silt content than above, scattered brachiopod fragments, interlaminated with softer shale, as above, with scattered glauconite and black carbonaceous grains.

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- 792.5-804 m SHALE, medium to dark grey, occasionally black, blocky, occasionally fissile, slightly dolomitic, decreased silt content, scattered black carbonaceous grains, and occasional pyrite spheres, slightly micromicaceous, non-dolomitic and non-silty gradations, pyrite grains appear to have replaced carbonaceous grains, occasionally grading medium graywacke and trace argillaceous siltstone.
- 804 - 807 m SHALE, dark grey to black, as above, slightly dolomitic. NOTE: slight increase in dolomite content causes an increase in resistivity and a denser dolomitic shale zone.
- 807 - 839 m SHALE, dark grey to black, as above, occasionally fissile, occasionally dolomitic with decrease in silt content with depth.
- 839 - 853 m SHALE, dark grey, silty, dolomitic, with up to 30% silt content, grading argillaceous dolomitic siltstone laminations, blocky, slightly glauconitic, occasionally grading very fine grained, with increased silt content of the sample and interbedded SHALE, dark grey to black, non-silty, carbonaceous, blocky, hard, dense, trace glauconite, scattered carbonaceous grains, trace pyrite needles and grains (increased pyrite spheres common in darker shale. Below 839 m there is a slight increase in calcareous silt content).
- 853 - 864 m SHALE, dark grey, slightly calcareous (increased calcareous content) with minor laminations of SILTY SHALE (10-20%), dolomitic, glauconitic..
- 864 - 868 m LIMESTONE, buff to light brown, dolomitic, slightly silty, hard, platy, grading SHALE, medium to dark grey, slightly dolomitic, slightly silty, with increased dolomite and silt content, scattered glauconite grains, scattered black carbonaceous grains, scattered pyrite grains.
- 868 - 873 m SHALE, medium to dark grey, slightly dolomitic, slightly silty (15% silt content), hard, platy, grading coarse silt grains with silty laminations, scattered glauconite, carbonaceous grains and pyrite grains as above. NOTE: increased shale content i.e., more carbonaceous, below 868 m.
- 873 - 876 m LIMESTONE, medium brown, argillaceous, silty, dolomitic, thin laminations grading silty dolomitic shale as above.
- 876 - 904 m SHALE, dark grey to black, as above, with scattered carbonaceous grains, slightly dolomitic, blocky, occasionally fissile, hard, to medium hard, scattered brachiopod fragments with minor laminations of SHALE, slightly dolomitic, silty grading argillaceous siltstone, with higher carbonate content.

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- 904 - 907 m LIMESTONE, buff to light brown, microcrystalline, slightly dolomitic, platy, argillaceous, grading calcareous coarse siltstone.
- 907 - 931 m SHALE, dark grey to black, as above, blocky, slightly silty, increased calcareous content with minor laminations of CALCAREOUS SHALE, medium grey, slightly silty, thin laminations, trace pyritized worm tubules, scattered carbonaceous grains and pyrite nodules.
- 931 - 933 m LIMESTONE, white to buff, pure clean bioclastic to biospyrite, occasionally pelspyrite, occasionally silty, excellent effervescence in acid, scattered fine grained bioclasts and interclasts. NOTE: This is the cleanest limestone noted to date.
- 933 - 948 m SHALE, dark grey to black, blocky, carbonaceous, occasionally silty, medium hard, trace dolomitic with slight increase in calcareous content below 948 m with depth. Scattered silt size black carbonaceous grains and scattered silt size pyrite grains, possibly replacing the carbonaceous grains, scattered pyrite needles and framboidal spheres. Minor laminations of medium grey dolomitic shale laminations.
- 948 - 950 m DOLOMITIC SHALE, medium grained, hard, dense, blocky.
- 950 - 965 m INTERLAMINATED SHALE, medium grey and greyish brown, calcareous to dolomitic, platy, hard, dense, grading dark greyish black, carbonaceous, blocky shale less dolomitic with scattered glauconite and silt grains, silt and glauconite content to 15%, and interlaminations of LIMESTONE, light grey, argillaceous, silty, microcrystalline, glauconite common.
- 965 - 976 m SHALE, medium to dark grey, less silty and less calcareous than above, blocky, massive, scattered micromicaceous, scattered glauconite grains and pyrite spots, scattered black carbonaceous grains with trace shale, slightly calcareous, as above.
- 976 - 985 m SHALE, calcareous, grading argillaceous limestone, blocky, calcareous spicules, possible brachiopod spines, trace pyritized crinoid segments with minor interbeds of SHALE (40%), medium dark grey, trace calcareous, blocky, carbonaceous, occasionally fissile, as above.
- 985 - 993 m SHALE, medium to dark grey and black, trace calcareous and silty i.e., less calcareous than above, scattered glauconite and floating silt grains, trace pyrite spots.
- 993 -1000 m SHALE, greyish black, blocky, carbonaceous, trace silty with interlaminations of

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- SHALE (10%), calcareous, medium to ark grey and dark greyish brown, slightly silty, platy, increased calcareous content, scattered pyrite common with black carbonaceous grains and silt-size pyrite grains replacing carbonaceous grains, 2% dull brown mineral fluorescence due to dolomitic content in shale.
- 1000-1035 m SHALE, dark grey, blocky, slightly calcareous, scattered silty, black carbonaceous grains with scattered pyrite spots (silt size), with minor interlamination of SHALE (10-20%), medium grey, slightly calcareous, laminations harder, platy, with continual effervescence in acid.
- 1035-1045 m SHALE, dark grey to black, carbonaceous, blocky, medium hard, scattered brachiopod with minor laminations of medium to dark grey, slightly calcareous shale as above. Scattered black carbonaceous grains and pyrite spots.
- 1045-1065 m SHALE, medium to dark grey, argillaceous, slightly silty, slightly calcareous, scattered silt size pyrite spots and blemps, silt grains and glauconite grains. Scattered brachiopod fragments with minor laminations of slightly calcareous shale.
- 1065-1078 m SHALE, dark greyish brown, slightly calcareous, blocky, hard, platy, grading slightly dolomitic, slightly micromicaceous, black carbonaceous grains (silt size), and pyrite spots, silt size replacing carbonaceous grains. Scattered white calcite spar crystals infilling fracture. NOTE: Possible fracture due to more resistant dolomitic shale bed of this zone.
- 1078-1102 m SHALE, medium to dark grey, blocky, essentially non-dolomitic, pyrite common, slightly silty with 5% slightly green mineral fluorescence due to laminations of SHALE, medium grey, very dolomitic, hard, dense, platy, laminations.
- 1102-1103 m LIMESTONE, light grey, argillaceous, biosparite, trace brachiopod fragments.
- 1103-1120 m SHALE, medium to dark grey, trace to non-dolomitic, blocky, occasionally fissile, scattered black carbonaceous grains, glauconite grains and pyrite spots replacing carbonaceous grains, with minor laminations of slightly silty shale. Trace green mineral fluorescence, ie, 2-5% possibly due to increase in carbonaceous or bituminous content.
- 1120-1168 m SHALE, medium to dark grey, blocky, occasionally fissile, non-dolomitic to slightly dolomitic, scattered brachiopod, pyrite carbonaceous grains, glauconite, as above, occasional pyrite nodules to 2 mm with minor laminations of

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- SHALE, dark grey, slightly dolomitic, hard, dense, with increase in dolomitic shale laminations from previous interval. Scattered brachiopods. NOTE: pyrite is more common in darker grey black, non-dolomitic shales.
- 1168-1185 m SHALE, dark grey to black, blocky, fissile, slight brown cast, with minor gradations to dark grey, slightly silty and dolomitic shale. Trace to 1% white calcite spar crystals lining fractures. Trace slickenside, minor greenish brown mineral fluorescence (dolomitic content). NOTE: minor partial mud loss from 1167-1180 m due to fractures. NOTE: Below 1168 m Schlumberger Logs also indicate slight decrease in dolomitic shale laminations, i.e., becoming shalier and more carbonaceous.
- 1185-1214 m SHALE, black with brown cast, grading dark grey, very carbonaceous, medium hard, blocky, occasionally fissile, scattered black carbonaceous grains, trace silty, rare pyrite, with minor gradations to non-dolomite and trace dolomite laminations, decrease in pyrite content, 40% dull brown fluorescence due to the increase in carbonaceous content of the shale and resulting slight increase in shale gas.
- 1214-1221 m SHALE, black, carbonaceous, as above, blocky to slightly fissile, with scattered pyrite nodules to 2.2 mm, with minor gradations to  
SHALE, dark grey, slightly dolomitic.
- 1221-1255 m SHALE, black, carbonaceous, as above, grading dark grey, non-dolomitic with trace pyrite nodules and laminae to 0.2 mm in size, occasional pyritized worm burrow, with minor silty dolomitic shale laminae, especially from 1235-37 and 1245-46.5 m. Scattered carbonaceous grains and both pyrite spots and spicular pyrite needles.
- 1255-1291 m SHALE, dark greyish brown and black-brown, as above, subfissile to blocky, non-dolomitic with laminations of  
SHALE (10-30%), dark greyish brown to dark grey, with occasional silty and slightly dolomitic gradations, scattered pyrite nodules. 3-5% white calcite spar crystals, filling fractures, trace fracture porosity resulting in minor mud loss, 3-5% dull brown carbonaceous fluorescence. Minor increase limey laminations from 1266-1269 m at 1283 m and 1287 m. NOTE: Fracture porosity possibly due to slight increase in carbonate content of these shales overlying the more resistant sandstones below.
- 1291 m (DD)  
1288 m (LD) LOWER HART RIVER FORMATION
- 1291-1300 m SANDSTONE, white to light brown, at top, very fine grained - 10%, fine grained - 80%, medium grained - 10%, grading coarser to base at medium grained - 80%, coarse grained - 20%. Fair sorted, sub-rounded, 15-25% calcareous cement, 5% siliceous overgrowths, and

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- 0-5% black argillaceous matrix, scattered coarse to very coarse grained chert grains, well rounded, mainly 10% white opaque chert, occasional pyrite cement, hard, tight, trace slickenside, trace fractures in sandstone, no show, with minor gradations to  
SANDSTONE, medium to dark grey, argillaceous (25-30% argillaceous matrix and 5% calcareous cement), very fine grained to fine grained with very coarse grained, round chert pebbles, often pyrite cement outlines limestone and quartz grains.
- 1300-1307 m SANDSTONE, as above, white to light grey, fair sorted, sub-rounded to well rounded, salt and pepper, with less than 5% black rock fragments, 5-10% argillaceous matrix, 10-20% calcareous cement, and 5-10% siliceous overgrowths, pyrite occurs as less than 5% of the cement, medium grained - 80%, coarse grained - 20%.  
CHERT - rounded pebbles, light grey to bluish grey, up to 6 mm in size, and minor gradations to  
SANDSTONE, medium gray, argillaceous, carbonaceous, as above, very fine grained with scattered chert pebbles, trace pyrite cement, no show.
- 1307-1308 m SANDSTONE, light to medium grey, argillaceous, as above, grading sandy shale.
- 1308-1315 m SANDSTONE, light grey, slightly argillaceous, occasionally light brown spotted white, possibly trace oil stain, hard, tight, medium grained - 70%, coarse grained - 20%, very coarse grained - 10%, grading chert pebbles, scattered limestone and dark rock fragments less than 5%, usually pyrite lined grains and gradations to  
SANDSTONE, argillaceous, grading sandy shale, 30-40% argillaceous matrix, siliceous cement 5-10%, calcareous cement 10-15%, fair sorted, subrounded, no show, hard, tight and  
CHERT (10%), pebbles, light to medium grey, well rounded, medium grained - 80%, very coarse grained - 20%, grading in size to 5 mm.
- 1315-1322 m SANDSTONE, light grey, grading medium grey, as above, medium grained - 70%, coarse grained - 20%, very coarse grained - 10%, 10% of the sandstone had white calcareous cement, trace pyrite rimming grains, calcite cement, pyrite cement, argillaceous matrix as above. 70% of the sandstone grains appear to be light bluish white chert, well rounded plus gradations to  
SANDSTONE (10%), light to medium grey, argillaceous with 30-40% dark grey, argillaceous matrix, trace blue fluorescence in sandstone appears to be calcite mineral fluorescence, hard, tight.  
CHERT (15%), pebbles grading from medium grain to granules up to 4-6 mm in size. The chert appears to be dark grey bedded laminae in sandstone.

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- 1321 m 244.5 mm casing was set at 1321 m according to Governmental regulations.
- 1322-1330 m SHALE, dark greyish black, dolomitic with scattered dolomite rounds in shale, hard, dense, platy, blocky, with minor sandstone laminations, very fine to fine grained, argillaceous, as above, with occasional calcite cement.
- 1330-1338 m SHALE, dark grey as above, with interlamination of LIMESTONE, light grey and greyish brown, slightly mottled, platy, hard, slightly siliceous with scattered white calcispar, argillaceous, slightly dolomitic, occasionally greyish brown. Poor samples following trip at 1321 m and 1335 m.
- 1338-1352 m ARGILLACEOUS DOLOMITE, dark grey, argillaceous, grading dolomitic shale, hard, dense, platy, slightly calcareous, with minor laminations of LIMESTONE (20-30%), buff to light brown, slightly mottled as above, slightly dolomitic, slightly argillaceous, hard, platy, grading siliceous with chert laminae, slightly silty, slightly mottled brown and white, possible representing interspyrite with silicified interclasts and limey spyrite. Minor white spar-calcite (5-10%) possibly representing either fracture infill or calcite fossil infill, excellent fluorescence, hard, tight, no porosity, trace effervescence from the dolomite plus CHERT (10%), light greyish brown and buff, platy, representing replacement chert in argillaceous siliceous dolomite.
- 1352-1357 m LIMESTONE, buff to light brown, occasionally mottled, slightly dolomitic and slightly siliceous, hard, platy, dense, grading cherty with gradations to CHERT (15%), buff to tan, thin laminations, grading limey and interlamination of DOLOMITE, dark greyish brown, slightly calcareous, slightly argillaceous, hard, platy, occasionally cherty, siliceous. NOTE: Above the limestone appears to be fairly clean, the argillaceous carbonates appear to have been dolomitized.
- 1357-1361 m DOLOMITE, argillaceous, siliceous, grading limestone, cryptocrystalline, buff to light brown, as above, hard, dense, tight, no porosity, no show, with 5% white spar calcite.
- 1361-1374 m LIMESTONE, dolomitic, slightly argillaceous, cryptocrystalline, slightly siliceous, hard, platy, recrystallized possibly representing a sandy limestone, occasionally limestone contains 60% rock fragments and 40% siliceous cement grading CHERT (10%-20%), light buff, spotted, dark greyish brown. The chert appears to be bedded grading limey, occurring as chert conglations and nodules due to high silica concentrate in the carbonates, and gradations to

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- DOLOMITE (30-50%), argillaceous as above grading argillaceous limestone, siliceous.
- 1374-1376 m ARGILLACEOUS DOLOMITE, grading limey, siliceous and cherty, grading dolomitic shale with gradations to dolomitic limestone and chert as above.
- 1376-1382.5 m INTERBEDDED DOLOMITE, dark greyish brown, siliceous, calcareous, argillaceous as above, and LIMESTONE, dolomitic, buff to light brown, occasionally soft, possibly a biosparite, cryptocrystalline with harder buff siliceous limestone and dolomite, trace white calcite spar (5%) and gradations to  
CHERT (20%) light to dark grey, grading limestone as above.
- 1382.5-1384 m SANDSTONE, white, medium grained - 90%, coarse grained - 10%, chert pebbles, light and dark chert, 10% argillaceous and siliceous matrix, 20-30% calcareous cement, slightly siliceous. grading to  
DOLOMITE, dark grey and greyish brown, slightly silty, grading DOLOMITIC SHALE, occasionally black plus  
CHERT (10%), nearly dark grey grading argillaceous, siliceous dolomite as above. NOTE: The above limestone dolomite possibly contains a great percentage of sand grains and siliceous content, however it is difficult to differentiate between silicified dolomite from original siliceous clastics.
- 1384-1395.5 m DOLOMITE, platy, slightly argillaceous, light brown, siliceous, hard, dense with increasing siliceous content, recrystallized with minor  
LIMESTONE, light buff to cream, occasionally light brown, possible biosparite recrystallized, occasionally chert, cryptocrystalline, soft to medium hard grading dolomitic with  
CHERT (10%) as above, dark grey chert bedded grading dolomite.
- 1395.5-1403 m LIMESTONE, buff to light brown and light grey, recrystallized, slightly dolomitic, slightly siliceous, occasional grading to chert with gradations to  
DOLOMITE (20%) and CHERT (20%) as above.
- 1403-1414 m LIMESTONE, light grey to buff, slightly recrystallized, slightly dolomitic, slightly argillaceous, possibly an original pelmicrite becoming less siliceous, platy, hard, dense, grading limey dolomite, slightly silty and grading  
DOLOMITE, medium to dark grey, limey, less argillaceous content, platy, grading dolomitic limestone, slightly silty with occasional dolomitic shale laminae plus minor  
CHERT, dark greyish brown, decreasing to 2-5% of sample.

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- 1414-1424.5 m INTERBEDDED DOLOMITE, dark grey, calcareous, grading dolomitic limestone, medium to dark grey, argillaceous, hard, platy, cryptocrystalline with trace sandstone and siltstone, plus minor gradations to SHALE, dark grey to black, grading sandy silty, dolomitic with trace chert pebbles (argillaceous matrix) becoming shalier at base.
- 1424.5-1431 m INTERBEDDED DOLOMITE, medium to dark grey, slightly argillaceous as above, and SHALE, dark greyish black, silty, non-dolomitic, medium hard, trace chert and minor limestone laminations, buff to light grey as above.
- 1431-1437 m SHALE, dark greyish brown and brownish black, very carbonaceous, silty with 10-40% silt content, non-dolomitic to slightly dolomitic grading CALCAREOUS SILTSTONE, medium hard, blocky, scattered fine grained, rounded quartz and chert grains, soft to medium hard. NOTE: The shale drills faster and produced a slight increase in formation shale gas due to increased penetration rate and carbonaceous content of the shale.
- 1437-1440 m DOLOMITE, dark grey, slightly calcareous, argillaceous, grading limestone, light grey, soft to medium hard and calcareous SANDSTONE, very fine grained to silty.
- 1440-1443 m SHALE, dark brownish black, very carbonaceous as above, slightly silty, scattered black chert pebbles. Logs indicate high Gamma readings for these shales.
- 1443-1445 m DOLOMITE, dark grey, platy, grading dolomitic limestone as above, scattered medium grain chert pebbles and grains in the dolomite.
- 1445-1451.5 m SANDSTONE, white to light grey, very fine grained - 80%, medium to coarse grained - 20%, basically quartz and chert grains, occasionally very coarse grained and chert pebbles ranging from 60-70% sand grains and 30-40% white calcareous cement, slight argillaceous matrix. The sandstone appears to grade to a sandy limestone as well. Minor interbeds of SHALE, dark greyish black, carbonaceous with dull brown fluorescence possibly due to the carbonaceous content of this shale. Sandstone contains 1% yellow fluorescence possibly due to the calcite cement in the sandstone.
- 1451.5-1456 m SHALE, dark greyish brown to black, slightly calcareous to non-calcareous, carbonaceous, slightly silty with minor laminations of

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SANDSTONE, white, as above, very fine to fine grained grading coarse grained, with 20-30% calcite cement, hard, tight, trace yellow fluorescence due to white calcite mineral fluorescence, poor sorting and scattered chert grains in the sandstone.

NOTE: the increase in sand grain content could be detrital sand and shale from the underlying sand zones.

1456 m (DD)

MID-LOWER HART RIVER FORMATION (BIRCH MEMBER EQUIVALENT)

1451 m (LD)

1456-1470 m

SANDSTONE, white, cherty with 40-60% chert grains, white to light grey, subangular to subrounded, poorly sorted, medium grained - 30%, coarse grained - 70% becoming coarser with depth, i.e., very coarse grained and pebbly 1-2 mm chert pebbles, 20-30% calcite cement of which 5-10% grades into a buff/white dolomite, 0-10% siliceous cement, fine grained sand appears to occur as matrix between the larger chert pebble grains, hard, tight, occasional scattered poor porosity and trace yellow fluorescence (possibly due to carbonate cement), trace brown oil stain, trace dull brown fluorescence. No effective porosity noted due to cementation infill with minor gradations to

SANDSTONE, light to dark grey, slightly argillaceous and silty resulting in minor drilling breaks, medium to coarse grained with 10% calcite cement, 10-15% siliceous cement, and 10-20% argillaceous matrix. Scattered 1-2 grains yellow fluorescence only.

1470-1479.5 m

SANDSTONE, light to dark grey, very fine grained - 70%, silt - 30% with scattered medium grained chert grains, 5-10% calcite cement, 10-20% argillaceous matrix, 0-10% siliceous cement with trace calcite spicules in dark matrix. No porosity, no show, no fluorescence. Minor gradations to

SANDSTONE, white, calcareous cement, fine to medium grained as above, and

LIMESTONE (10%), dark brownish grey, platy, argillaceous grading to

SHALE, dark greyish black, carbonaceous, slightly silty, slightly dolomitic

1479.5-1487.5 m

SHALE, black, dark greyish brown, slightly dolomitic at top grading to

LIMESTONE, dark greyish black, argillaceous, cryptocrystalline, platy, with minor gradations of

SANDSTONE, light to dark grey, 10-20% argillaceous matrix, 10% siliceous cement, medium grained - 20%, fine grained - 80%, trace intercrystalline porosity less than 1%, i.e. within calcite cement, less than 1% yellow fluorescence contained in sandstone calcite cement, trace fluorescence near interbeds with shale laminae, possibly indicative of poor permeability.

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- 1487.5-1490.5 m INTERBEDDED SHALE, black to dark greyish brown, slightly dolomitic, blocky and LIMESTONE, light to medium grey, occasionally dark grey, platy, argillaceous, cryptocrystalline, excellent effervescence in acid, with minor gradations to spotted Limestone, sandy grading silty to very fine grained - trace intercrystalline porosity with less than 1% yellow fluorescence in calcite cement.
- 1490.5-1493.5 m LIMESTONE, light to medium grey, slightly dolomitic, slightly argillaceous grading very argillaceous, dark grey (50/50 light and medium grey limestone), platy, cryptocrystalline, excellent effervescence in acid with minor laminations of SANDSTONE (10%), white, very fine to fine grained, 20-30% calcite cement, 0-10% argillaceous matrix, trace intercrystalline porosity with less than 1% yellow fluorescence contained in a calcite cement.
- 1493.5-1499 m SHALE, dark greyish brown to black, carbonaceous with scattered calcite crystals (spicules) occasional grading silty laminations with calcite cement i.e., 30-40% argillaceous matrix, 0-10% calcite cement and spicular cement grains, minor white spotted calcareous shale grading silty (5%) and SANDSTONE (5%) laminations, white to medium grey, calcareous cement, spotted argillaceous sandstone, very fine to fine grained, occasionally fine to medium grained, 20-30% calcite cement, 10% siliceous cement, trace intercrystalline porosity, scattered 1-2 grains fluorescent contained in calcite cement (mineral fluorescence).
- 1499-1521 m SHALE, black to dark grey, slightly calcareous, blocky, carbonaceous with higher Gamma readings at top and base of interval, brown streak, crushed shale produces brown drilling mud from cuttings, occasional white scattered calcite spicules, occasional scattered silt grains, trace micromicaceous, no show, with gradations to SHALE (10-40%), black to dark grey, spotted white with white calcite spicules to 1 mm length, very calcareous, slightly platy grading argillaceous limestone, no show. NOTE: marked drilling break from 1510-1511.5 m, i.e., increasing from 16 minutes per meter to 6 minutes per meter, was estimated as sandstone porosity and circulated up. However this drilling break and increased gas reading was found to be due to softer shale and gas is merely formation shale gas resulting from increased penetration rate.
- 1521-1525 m SHALE, medium greyish brown, very calcareous, spotted white, occasionally grading argillaceous limestone, blocky, medium hard to soft with occasional silty (argillaceous, calcareous) laminations.

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- 1525-1534 m SHALE, brownish black and black, slightly calcareous, grading to SHALE (30-40%), medium to dark greyish brown and black, spotted white, calcareous with calcite spicules, trace pyrite. Minor sandstone grains, calcite cement, very fine grained grading to argillaceous with scattered medium to coarse grained chert pebbles.
- 1534-1542 m SANDSTONE, argillaceous, medium to dark grey, 30-40% argillaceous matrix, medium to coarse grained, well rounded, poorly sorted, scattered white calcite cement grading calcareous with minor laminations of SHALE, black to dark brownish black, spotted white, grading limey shale, occasionally sandy grading to sandstone as above.
- 1542-1545.5 m SHALE, black to dark brownish black, spotted white, slightly calcareous, blocky, platy, occasionally sandy with increased Gamma reading: This shale provides another sharp drilling break and increased gas readings due to increased penetration rate resulting in formation shale gas.
- 1545.5-1549 m SANDSTONE, white, very calcareous with 20-40% calcite cement, silt - 10%, very fine grained - 70%, fine grained - 10%, with scattered medium to coarse grained chert - 10%, with minor gradations to ARGILLACEOUS SANDSTONE, as above, containing 30-50% argillaceous to silty matrix, hard, tight, no fluorescence, trace intergranular porosity (less than 3%) with intergranular porosity contained in recrystallized calcite cement, i.e., secondary intercrystalline porosity, poor permeability, with minor laminations of LIMESTONE, light to medium grey, platy grading shale. SHALE, dark greyish black, carbonaceous, as above, grading sandy laminae.
- 1549-1552.5 m SHALE, dark greyish brown, slightly calcareous, medium hard, blocky with high Gamma reading.
- 1552.5-1556 m INTERBEDDED LIMESTONE and SHALE. LIMESTONE, light grey, occasionally white, slightly argillaceous, slightly dolomitic, cryptocrystalline, platy, grading very fine grained sandstone, and SHALE, medium to dark grey, as above, scattered 1-2 grains of dull yellowish brown fluorescence in limestone. Poor sample after trip.
- 1556-1565.5 m SANDSTONE, white, 80% quartz grains, 20% white chert grains, medium grained - 40%, fine grained - 60%, trace coarse grains, hard, subrounded, well sorted, 30% white calcite cement with 0-5% siliceous cement. Tight, no porosity, trace 1-2% dull to light yellow fluorescence within calcite cement (possible mineral fluorescence). Variations occur between very calcareous sands grading to sandy limestone and limey sands.

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LITHOLOGICAL DESCRIPTION

- 1565.5-1582.5 m LIMESTONE, buff/white, sandy to silty, lithographic to crypto-crystalline, very slightly argillaceous with trace bedded chert grading medium to dark grey, argillaceous, platy, hard, siliceous, with minor gradations to SANDSTONE (5-10%), white, fine grained to silty with 30-40% calcite cement, grading sandy limestone, as above. CHERT (5%), buff/cream, bedded associated with siliceous, sandy limestone above.
- 1582.5-1587 m SHALE, brownish black, very carbonaceous, soft to medium hard, blocky, slightly calcareous with 10% spotted white calcite grains and spicules. NOTE: drilling break from 1584-86 m was circulated up, however drilling break was caused by softer shales with faster penetration rate also resulting in increased formation shale gas.
- 1587-1595 m SANDY LIMESTONE, white, buff, light grey, cryptocrystalline, hard, platy, grading medium grey argillaceous, sandy, siliceous, grading siliceous and cherty with BEDDED CHERT (up to 40%), large, nodular, milk white to clear buff with spotted brown spots, angular fragments due to drilling.
- 1595-1600 m CHERT, bedded, very coarse grained to 10 mm size, platy, grading siliceous limestone. Chert is slightly spotted, brown, representing silicified siliceous sandy limestone and calcareous sandstone. Minor gradations of SANDSTONE, white to light grey, slightly spotted with brown (oil stain), very fine grained, white calcite cement grading sandy, siliceous, grading chert, 20-25% calcite cement, 5-10% siliceous cement.
- 1600-1608 m SANDSTONE, white, with scattered brown spots (trace oil stain), silt - 30%, very fine grained - 60%, medium grained - 10%, white calcite cement - 30%, scattered carbonate grains mixed with sand grains with minor gradations of LIMESTONE, hard, platy, siliceous, grading to light brown chert having scattered brown spots, possibly representing silicified calcareous sandstone and sandy limestone, up to 30% silicification of limestone and sandstone.
- 1608-1609.5 m SHALE, dark grey to black grading dark grey, siliceous limestone, grading calcareous siltstone.
- 1609.5-1610.5 m SILTSTONE, silt grading very fine grained with high calcite cement, grading SILTY LIMESTONE with gradations to CHERT. NOTE: cryptocrystalline nature of these laminations result from silty content of limestone and silt laminations.

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LITHOLOGICAL DESCRIPTION

- 1610.5-1620 m      CALCAREOUS SHALE, black/brown, soft to medium hard, blocky, carbonaceous, slightly silty with both scattered silt grains and siltstone laminations as above, grading white to light grey silty limestone and calcareous siltstone, with scattered white calcareous spicules becoming increasingly argillaceous with depth and scattered high Gamma readings. Trace white calcite spar filled fractures present in this slightly calcareous shale below the more resistant sandstone and limestone unit above.
- 1620-1634 m      SHALE, black/brown with brown streak darker than above, non-calcareous to slightly calcareous, medium hard, blocky, carbonaceous, non-silty, occasional plant stem fragments - carbonaceous, scattered pyrite spots, silt size to very fine grained, replacing plant fragments, high Gamma readings throughout this interval. Occasional very carbonaceous bedding planes, occasionally subfissile.
- 1634 m (DD)  
1629 m (LD)      UNIT 1 SHALE
- 1634-1655 m      SHALE, black with brown streak, carbonaceous, soft to medium hard, fissile to blocky, non-calcareous, softer than above, trace pyrite nodules, trace anhydrite filled fractures (white to light brown) i.e. less than 1% fractures noted up to .2-.5 mm anhydrite veinlets, non-silty, occasional silty laminations, massive bedded, trace black shiny slickenside. NOTE: from log run 4 this zone caused caving problems - i.e. from 1640-60 m the hole was washed out greater than 15 inches.
- 1655-1698 m      SHALE, as above, dark grey to black with brown streak, blocky, medium hard, non-calcareous, non-silty with occasional siltier laminations, massive bedded, scattered pyrite - silt size grains possibly replacing plant fragments, occasionally 2 mm pyrite nodules, slightly micromicaceous, trace brownish grey ironstone laminations and/or concretions with trace silty, slightly limey laminae creating slower drilling noted at 1667 m, 1676 m and 1684.5-85.5 m.
- 1698-1716 m      SHALE, dark grey to black, and black with brown streak as above, scattered pyrite silt grains and pyritic framboidal spheres scattered calcite spar filled fractures with minor laminations of SILTSTONE (1-5%), grading silty limestone, light brown and greyish brown, thin laminae, grading ironstone concretions and laminae, trace chert, brownish black floating in shale.
- 1716-1731 m      SHALE, black with brown streaks, subfissile to fissile, hard, dense with decrease in pyrite nodules and decreasing silt and chert content.

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- 1731-1769.5 m (DD) SHALE, black with brown streaks as above, subfissile to fissile,  
1726-1764.5 m (LD) soft to medium hard, non-calcareous, non-silty, trace pyrite  
concretions and trace pyrite grains also occurring as dissem-  
inated crystals along bedding planes, possibly representing  
carbonaceous laminations with minor  
SILTSTONE (1-2%), laminations light to medium brown, argillaceous,  
slightly calcareous occurring as thin laminae especially noted  
from Logs at 1731 m, 1735 m, 1738-40 m, and 1753.5-54 m, 1760 m,  
trace ostracod noted and minor very fine grained sandstone noted  
at 1750 m.
- 1769.5-1775 m (DD) SHALE, black carbonaceous with brown streak as above, subfissile  
1764.5-1770 m (LD) to fissile, soft to medium hard, scattered pyrite blebs and  
laminae, trace pyrite laminae, trace pyrite laminae of 2 mm  
thickness, scattered pyrite crystals throughout, non-silty, non-  
calcareous, no ironstone noted with thin laminae of  
SILTSTONE, argillaceous, brownish-grey grading shale, slightly  
calcareous, occasionally black chert grains, occasionally  
increasing micromicaceous planes with thin hard resistant bed  
at top of this zone.
- 1775 m (DD) DEPTH CORRECTION - note an unofficial 10 m depth correction  
was drafted on the interpreted Lithology Log. This discrepancy  
was discovered during strap out at 2952 m however in order to  
better correlate this interpreted Lithology with drilling times  
and sample depths a correction was made at this point. It is  
believed that the error occurred during trip out of bit at  
1775 m.
- From 500 to 1775 m (DD) - 5 m = LD  
From 1775 to 2925 m (DD) - 15 m = LD  
From 2925 to TD (DD) = LD
- 1775-1786 m (DD) SHALE and MINOR SILTSTONE, as above.  
1760-1771 m (LD)
- 1786-1795 m (DD) SANDSTONE, white, clean, well rounded, well sorted, very fine  
1771-1780 m (LD) grained - 20%, fine grained - 80%, with angular quartz over-  
growths, slightly siliceous, 15-25% siliceous cement and 5-15%  
intergranular porosity, trace dead oil stain faint cut, no  
live show, with gradations of  
SILTSTONE, argillaceous grading very fine grained, scattered  
1% white anhydrite filled fractures, .5-1 mm in size, espec-  
ially in shales overlying this zone causing a slight increase  
in viscosity indicative of sulphate bearing formation water.
- 1795-1802 m (DD) SANDSTONE, white to light brown, fine grained - 80%, medium  
1780-1787 m (LD) grained - 20%, i.e., coarsening with depth, well rounded, well  
sorted with 98% quartz grains, minor white feldspathic grains  
less than 1%, 15-30% siliceous quartz overgrowths (siliceous  
cement), 0-15% porosity, 0-5% argillaceous matrix. NOTE:  
porosity was only noted in 30% of sample. Trace dead oil stain,  
no fluorescence, no live show, (containing Anhydrite-rich  
formation water) with gradations to

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- SILTSTONE (10%), greyish-brown, argillaceous, grading argillaceous sandstone with 30% argillaceous matrix and 70% silt to very fine grained sand.
- 1801.5-1804 m SHALE, dark grey grading argillaceous siltstone, scattered anhydrite laminae (fracture fill).
- 1804-1807.5 m SANDSTONE, white to light brown as above, very fine grained - 10-20%, fine grained 70-90%, medium grained trace to 10% becoming finer with base, hard, siliceous, platy, with good secondary quartz overgrowths, 0-30% siliceous cement, 0-10% porosity noted in 5-20% of sample, trace calcite cement, trace dead oil stain, no live show, with gradations to silty sandstone and shale.
- 1807.5-1809 m SANDSTONE, white, occasionally light brown, argillaceous, 0-5% porosity, 5-25% siliceous cement grading argillaceous siltstone, dead oil stain, trace anhydrite fill fractures.
- 1809-1814 m SILTSTONE, dark grey to greyish brown, argillaceous, grading sandy grading  
SANDSTONE, white occasionally light brown as above, grading argillaceous with 20-40% argillaceous matrix and 0-10% siliceous cement. Minor laminations of  
SHALE, dark grey, blocky as above with scattered anhydrite fill fractures. NOTE: maximum 5% porosity exists in 5% of sandstone sample.
- 1814-1815 m SANDSTONE, white to light brown, hard, dense, quartzitic, very fine grained - 80%, fine grained - 20%, trace dead oil stain.
- 1815-1821 m SHALE, dark grey, carbonaceous, slightly silty, blocky, with minor gradations to argillaceous, dark grey to greyish-brown siltstone, grading to thin laminae of sandstone as above.
- 1821-1830 m SILTSTONE, argillaceous, dark grey to greyish brown grading sandy as above with minor interlaminations of  
SANDSTONE, ARGILLACEOUS (5-15%), very fine grained - 40%, fine grained - 60%, argillaceous matrix, 25% siliceous cement, trace pyrite cement replacing argillaceous matrix, scattered 0-5% intergranular porosity, hard, dense, tight, trace dead oil stain and anhydrite filled fractures with gradations to  
SANDSTONE, white to light brown as above, thin laminae, very fine grained - 20%, fine grained - 80%, medium grained - trace, quartzitic, 25% siliceous cement.
- 1830-1835 m INTERBEDDED SILTSTONE, argillaceous as above, grading silty shale, slightly dolomitic, trace argillaceous sandstone laminae slightly dolomitic.

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- 1835-1860 m SHALE, black, carbonaceous, blocky to fissile, trace micromicaceous, grading slightly silty and slightly dolomitic with minor laminations of SILTSTONE (10%), argillaceous, dark grey grading silty shale, trace pyrite laminations, rare pyrite grains, scattered anhydrite filled fractures, trace sandstone and argillaceous sandstone laminations with occasional carbonaceous grains in sandstone grading silt to very fine grained, occasional pyrite cement.
- 1860-1900 m SHALE, dark grey to black, carbonaceous, blocky, minor fissile, medium hard, scattered pyrite laminae and pyritic silt size grains, decreasing percent of siltstone laminations, i.e., 1-2% grading silty shale (5%), trace sandstone, white to light grey, argillaceous, very fine grained, grading silty, siliceous.
- 1900-1920 m SHALE, dark grey to black, carbonaceous, trace brown streak, blocky, micromicaceous, non-calcareous occasionally grading slightly silty representing a clean shale with occasional laminations of silty shale, scattered pyrite grains, laminae and nodules with laminations of SILTSTONE (10%), dark grey to black, argillaceous grading argillaceous siltstone, soft to medium hard, blocky, occasionally calcareous and occasionally minor sandstone laminae, white siliceous to grey argillaceous. At 1915 m scattered anhydrite filled fractures of 3 mm thickness. NOTE: anhydrite may occur as thin anhydritic laminations bedded with these shales and silty shales.
- 1920-1941 m SHALE, dark grey to black as above, blocky, carbonaceous, grading slightly silty with slight increase in SILTSTONE (10-20%), argillaceous, medium grey and greyish-brown, blocky, slightly calcareous, grading silty shale and minor gradations to argillaceous, silty to very fine grained silty sandy laminations, siliceous, scattered pyrite as above, trace calcite and anhydrite filled fractures.
- 1941-1947 m SILTSTONE, dark greyish brown, argillaceous grading silty shale, slightly calcareous, interlaminated with SHALE, dark grey to black, non-silty, blocky, fissile, with trace sandstone laminations, very fine to fine grained, quartzitic, hard, dense grading argillaceous sandstone, trace white anhydrite laminations.
- 1947-1954.5 m SANDSTONE, white, fine grained to medium grained at top with increasing grain size to depth, i.e. medium grained - 80%, fine grained - 20%, trace buff, quartz overgrowths common with 30% siliceous cement, hard, tight, platy, no porosity, no show at top with 0-3% porosity in less than 10% of the sample. Trace pyrobitumen - asphaltic staining, no live show.

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LITHOLOGICAL DESCRIPTION

- 1954.5-1961 m SHALE, black, blocky, medium hard, non-calcareous, slightly micromicaceous with scattered sandstone and argillaceous sandstone laminae.
- 1961-1969 m SANDSTONE, white, quartzitic as above grading coarser at top, i.e., medium grained - 70%, fine grained - 30% becoming finer with depth, i.e., fine grained - 70%, medium grained - 30%, hard, dense, siliceous, well sorted, well rounded, 25-30% quartz siliceous cement, scattered 0-5% porosity in less than 5% of sand sample, trace black asphaltic/pyrobitumen staining, no live show.
- 1969-1974 m SHALE, dark grey, blocky, non-silty grading silty shale and argillaceous siltstone as above (poor trip sample).
- 1974-1977 m SANDSTONE, white to buff, as above, fine grained - 90%, very fine grained - 10% with quartz overgrowths common, 30% siliceous cement, trace poor porosity in less than 3% of sand sample, minor laminations of SANDY SHALE, dark grey to blocky, NOTE: decreasing sand grain size with depth and increasing shale and silty shale laminations.
- 1977-1988.5 m SHALE, dark grey, blocky, non-silty, grading SHALE, slightly silty, black, carbonaceous, micromicaceous, occasionally dolomitic, grading non-silty shale as above with scattered pyrite grains and minor sandstone laminations, siliceous as above.
- 1988.5-1991 m SANDSTONE, white to buff, siliceous, as above, hard, tight, platy, very fine grained grading to slightly argillaceous.
- 1991-2005 m SHALE, black, blocky, carbonaceous, slightly micromicaceous, scattered pyrite grains and trace anhydrite filled fractures, minor laminations of SILTY SHALE as above, dark grey, micromicaceous.
- 2005-2029 m SHALE, dark greyish black, carbonaceous, blocky, slightly micromicaceous, non-calcareous with scattered silt sized pyrite grains, pyrite laminations common, scattered fracture filled fractures may possibly represent caved from above, with gradations to SILTY SHALE, slightly calcareous. NOTE: due to the condition of the casing wiper and jars at 2008 m the dark grey to black shale may represent caving and interval may actually represent a slightly silty shale. This would explain some of the anhydrite filled fractures as well.
- 2029-2031 m SILTY SHALE grading SILTSTONE, dark grey, scattered pyrite cement in silt, occasionally grading very fine grained, sandy, slightly calcareous.

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LITHOLOGICAL DESCRIPTION

- 2031-2088 m SILTY SHALE grading argillaceous siltstone, slightly calcareous with minor laminations of SANDSTONE (5-10%) light grey, argillaceous, grading from silt to very fine grained, medium hard, slightly argillaceous, siliceous with laminations to 1 mm in size. The sand percent ranges from silt - 60%, very fine grained - 40% and from very fine grained - 80% to fine grained - 20%, trace pyrite nodules to 1 mm in thickness, micromicaceous common along bedding planes. Scattered brown ironstone concretions.
- 2088-2093.5 m SILTSTONE grading argillaceous siltstone and silty shale, dark greyish brown, minor sandstone laminations, light grey, argillaceous, very fine grained - 70%, silt - 30%, trace pyrite cement.
- 2093.5-2099.5 m INTERLAMINATED SHALE as above, dark greyish black to fissile, blocky, slightly carbonaceous and gradations to SILTY SHALE with minor laminations of SANDSTONE, white, siliceous, 30% quartz overgrowths, very fine grained - 10%, fine grained - 80%, medium grained - 10%, hard, platy, grading silty, grading argillaceous, subrounded to well rounded, fair sorting, hard, tight. This sandstone contains grey light to medium grey subangular chert grains.
- 2099.5-2106.5 m SHALE, dark grey to black, fissile, blocky, medium hard, scattered pyrite nodules with minor gradations to SILTY SHALE (less than 5% silt), scattered black carbonaceous grains.
- 2106.5-2111 m SANDSTONE, light grey, occasionally light brown and white, argillaceous, scattered white chert grains, very fine grained - 10%, fine grained - 30%, medium grained - 60%, slightly siliceous, fair sorted, subangular to subrounded, 10-20% siliceous cement, 10-30% argillaceous matrix, scattered blue-white chert grains, hard, tight.
- 2111-2126 m INTERBEDDED SHALE, dark grey, black grading dark brownish-grey, fissile, blocky, scattered pyrite and carbonaceous grains, scattered pyrite nodules grading sandy and argillaceous sandstone with interlaminations of SANDSTONE (10-40%), light grey, poorly sorted, very fine grained - 20%, fine grained - 40%, medium grained - 40%, subangular, scattered carbonaceous partings (coaly), argillaceous matrix, slightly siliceous, slightly calcareous with scattered chert grains in sandstone especially sandstone laminations from 2113-14 m, 2117-18 m, and 2124.5-26 m.

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LITHOLOGICAL DESCRIPTION

- 2126-2168 m      SHALE, dark greyish black as above with decreasing sand laminations, fissile, blocky, scattered pyrite laminations and nodules with interlaminated SANDSTONE (5-10%), very fine grained - 80%, fine grained - 20%, siliceous and argillaceous, scattered black carbonaceous grains, fair sorting, subangular to subrounded, scattered chert grains, chert grains are blue-white, poor sorted, usually subangular, 20% siliceous cement, 10% argillaceous matrix, chert grains common throughout and diagnostic of these thin sandstone laminations, hard, dense, no show, scattered pyrite cement associated with argillaceous matrix of the sandstone. The sandstone grades to a silty shale as well.
- 2168-2224 m      SHALE, dark greyish black, occasionally medium grey, blocky, increasing fissility, pyrite nodules common usually associated with siltstone laminations. Shale is interlaminated with minor siltstone.  
SILTSTONE, light grey to brown, grading argillaceous, occasionally very fine grained, scattered pyrite cement, hard, dense, slightly dolomitic (2-5% of sample). NOTE: abundant pyrite spots and spicules common along bedding planes at 2220 m, trace ironstone, medium brown, nodular, slightly dolomitic.
- 2224-2233 m      SHALE, dark grey to black, as above grading darker, very carbonaceous, slight increase in silt laminae, slightly calcareous and  
SILTSTONE, light brown, argillaceous, slightly calcareous, with scattered carbonaceous/coal grains.
- 2233-2241.5 m      SHALE, as above with scattered pyrite spicules common along bedding planes plus minor siltstone laminations as above. Logs indicate a slight Gamma increase, i.e., transition weathered zone of underlying Imperial Formation.
- 2241.5 m (DD)  
2226.5 m (LD)      IMPERIAL FORMATION
- 2241.5-2258 m      SHALE, dark grey, greyish brown, non-black, ie, lighter color than above, fissile, occasionally slightly calcareous, no siltstone noted, micromicaceous, pyrite spots common, no ironstone noted, marked increase in Gamma level of Log. NOTE: The top of the Imperial Formation was picked at the top of this zone due to slight drilling break, increased Gamma reading and change in shale character becoming light, as well as being less silty and increased carbonaceous content, resulting in slight background gas increase.
- 2258-2260 m      SHALE, dark grey, blocky, very carbonaceous, scattered pyrite crystals and grains replacing carbonaceous grains, fissile, trace pyrite laminations with minor gradations to silty, dark grey shale, slightly to very calcareous with pyrite cement in siltstone laminations. This unit has a high Gamma reading from the Gamma Log.

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LITHOLOGICAL DESCRIPTION

- 2260-2300 m SHALE, dark grey to black, blocky, grading very carbonaceous with minor coal laminae to .05 mm, scattered pyrite grains, hard, brittle, scattered pyrite spicules along bedding planes, with minor laminations of SILTY SHALE (5%), dark grey as above, slightly calcareous with scattered pyrite cement and siltstone, grading silty shale.
- 2300-2330 m SHALE, dark grey to black, massive, blocky, grading minor fissile, brittle, slightly carbonaceous, slightly micromicaceous, trace pyrite laminations and nodules, scattered pyrite lineations and pyritic spots (spicules) along bedding planes with decrease in silty shale as above.
- 2330-2340 m SHALE, dark greyish black as above, grading 50% medium to dark grey, trace coal and carbonaceous laminations, slight increase in silty calcareous shale, occasional pyrite nodules, trace pyrite specs, scattered round pyritized spheres .5 mm in size with small surficial knobs possibly representing pyritized radiolaria.
- 2340-2387 m SHALE, dark grey to black grading lighter medium to dark greyish brown, occasional interlaminations of silty, slightly calcareous shale, scattered pyrite nodules to rare pyrite nodules, scattered round spheroidal pyrite spherical radiolaria .1-.2 mm common from 2360-2375 m. NOTE: increasing shale cave was noted over shakers after 2350 m.
- 2387-2427 m SHALE, dark grey to black, occasionally dark greyish brown, less carbonaceous than above, slightly waxy, blocky (more blocky than above), slightly silty with slight increase in micromicaceous partings. No pyrite nodules noted however scattered pyrite laminations and lineations present, trace pyritic spicules and round pyritic spheroidal radiolaria common to .2 mm with gradations to SHALE, dark grey to dark greyish brown, slightly silty and blocky grading minor SILTY SHALE, medium grey, grading argillaceous, silty, slightly calcareous and increase to SILTSTONE (10-20%) especially below 2400 m, medium grey to light greyish brown, hard, dense, siliceous, argillaceous, grading silty shale, occasionally very fine grained, trace micromicaceous and scattered black carbonaceous grains, slightly dolomitic grading buff, silty dolomite especially interlaminated towards base of unit; occasionally very fine to fine grained argillaceous sandstone, poorly sorted, argillaceous matrix with scattered round radiolaria to .4 mm at 2410 m. Trace white cryptocrystalline limestone.

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LITHOLOGICAL DESCRIPTION

- 2427-2448.5 m SHALE, medium and dark grey, slightly silty (less than 10% silt content) with trace SILTSTONE (5%), light grey as above, occasionally sandy, occasionally dolomitic. NOTE: marks decrease in silt content of shale and siltstone lamination. No pyrite noted in samples.
- 2448.5-2472 m SHALE, medium to dark grey, grading darker grey, slightly silty, slightly micromicaceous, increased carbonaceous percentage, slightly micromicaceous, occasional scattered pyrite crystals with minor gradations SILTSTONE (3-5%), argillaceous, medium to dark grey, slightly dolomitic, micromicaceous with slight increase in silt content in this interval with possible gradations to sandstone laminae especially from 2452-2455 m (LD). SANDSTONE, white to light grey, dolomitic cement 10-20%, argillaceous matrix 5-20%, fine grained - 10%, medium grained - 20%, very fine grained - 70%, silt - 10%, with white angular chert grains common, slightly siliceous 5-15% with matrix 5% ranging from silt to very fine grained and argillaceous, angular fragments include both shale, carbonate grains and scattered chert grains.
- 2472-2485 m SHALE, as above, medium and dark grey, slightly micromicaceous, trace scattered pyrite crystals with minor laminations of SILTSTONE, as above grading argillaceous sandstone, as above, scattered siliceous spore cases, slightly spiny, fine grained. NOTE: Below 2464 m trip high percentage of large shale cave passing over shakers. Caving shale noted from Log Run #4, especially from 2455-2710 m, i.e. 12-16" hole diameter washout and 2485-95 m greater than 16" washout and 2510-2610 m greater than 16" washout.
- 2485-2496 m SHALE, medium to dark grey as above, medium hard, micromicaceous, fair pyrite with interlaminations of SILTSTONE, light grey, slightly dolomitic, scattered pyrite, carbonaceous grains, grading to SANDSTONE, white to light grey, very argillaceous, very fine grained - 90%, silt - 10%, with floating white chert grains of fine to medium grain size, scattered medium grained coal grains and pyrite grains. Chert is light bluish grey with 5-10% argillaceous matrix, 0-10% dolomitic cement, 0-20% siliceous cement, hard, dense, laminated.
- 2496-2505 m SHALE, medium grey, blocky, micromicaceous with minor gradations to siltstone and sandstone as above.
- 2505-2511 m SANDSTONE, buff to light grey, salt and pepper, very fine grained - 40%, fine grained - 55%, medium grained - 5%, 10-15% siliceous cement, 10-15% dolomitic cement and 5-15% argillaceous matrix grading argillaceous sandstone, sandy shale and silty shale, hard, dense, tight, medium hard, no porosity noted, clastic grains consist of salt and pepper due to 20% bluish grey chert grains, subangular to subrounded.

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LITHOLOGICAL DESCRIPTION

- 2511-2528 m SHALE, medium grey, blocky as above, laminations of SILTSTONE (10-20%), light grey grading argillaceous, siliceous with occasional scattered shale clasts, medium grained, subrounded and occasional quartz pebbles and laminations of SANDSTONE (15-30%), white, buff/light grey, salt and pepper, dolomitic, siliceous with both shale and chert grain clasts, very fine grained - 60% to fine grained - 40% as above, grading very fine grained - 20%, fine grained - 70%, medium grained - 10%, with minor gradations to light grey, argillaceous sandstone, hard, dense, tight, medium sorted, subangular chert, subrounded quartz grains.
- 2528-2531.5 m SANDSTONE, as above, buff to light grey, silt - 50%, very fine grained - 30%, fine grained - 10%, medium grained - 10%, poorly sorted, salt and pepper with floating fine to medium grained subangular chert grains in the silt, to very fine grained sandstone matrix, occasionally white dolomitic cement, scattered pyrite and shale clasts, occasional scattered white feldspar grains, trace fossil fragments in sandstone, silicified with gradations to SILTSTONE, as above, light grey grading sandstone, slightly argillaceous.
- 2531.5-2573 m SHALE, medium grey, blocky to fissile, occasionally dessicates in acid, slightly waxy, micromicaceous, occasional dolomitic if slightly silty with gradations to SILTSTONE (10-15%), argillaceous, laminations, very coarse silt grading very fine grained, dolomitic with minor gradations to SANDSTONE (1-5%) very fine grained to silt, light grey, argillaceous with floating medium grained chert grains, occasionally coarse grained chert clasts, siliceous, NOTE: chert content appeared to be 20% of total sand grains representing tripilictic chert, i.e., bluish white with white rim usually occurring as floating grains larger than sand grains. Poor sorting plus argillaceous matrix indicates a greywacke type of sandstone, occasional chert pebbles, very fine grained.
- 2573-2624 m SHALE, medium grey, micromicaceous, waxy, blocky, fissile, medium hard with decreasing sandstone content, minor laminations of SILTSTONE (5-10%) as above, very argillaceous, slightly dolomitic, up to 20-40% argillaceous matrix in the argillaceous siltstone, and gradations to SANDSTONE (0-1%), light grey, silt to very fine grained with occasional floating very fine to fine chert grains, i.e., chert grains are floating in a silt and shale matrix, rare pyrite nodules.

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LITHOLOGICAL DESCRIPTION

- 2624-2637 m SHALE, as above possibly representing cavings, lithology appears to be essentially SILTY SHALE, grading siltstone, light grey, slightly dolomitic laminations, i.e., slight increase in silt and sandstone contents inferred from Logs.
- 2637-2647 m SHALE, medium grey, blocky to fissile, micromicaceous with increased micromicaceous partings, no pyrite noted in medium grey shale, minor silty shale and sandstone as above.
- 2647-2663 m SANDSTONE, buff to light grey, salt and pepper, greywacke type sandstone, poor to medium sorted, silt - 20%, very fine grained - 10%, fine grained - 60%, medium grained - 10%, occasionally coarse grained with scattered floating medium to coarse chert grains, 5-10% dolomitic cement, 10-20% siliceous cement, less than 5% argillaceous matrix with gradations to SILTSTONE (30-40%), salt and pepper, light grey, buff with scattered white chert with occasional black chert grains, argillaceous, trace pyrite grading very fine grained, scattered floating medium grain. NOTE: presence of high silt content indicates poor permeability. Silt is associated with all sandstone clasts. No porosity, no show, trace white dolomitic filled fractures and slickenside present especially from 2645-2655 m.
- 2663-2668.5 m SILTSTONE, light to medium grey, argillaceous, hard, dense, siliceous as above, grading to silty shale, medium grey, micromicaceous, scattered pyrite.
- 2668.5-2673 m SANDSTONE, as above, light grey, salt and pepper, silt - 50%, very fine grained - 40%, fine grained - 10%, grading minor medium grading, grading SILTSTONE, light to medium grey, argillaceous, hard, dense, siliceous.
- 2673-2685.5 m SHALE, medium grey, micromicaceous, grading slightly silty as above with scattered floating quartz and chert grains with interlaminated SILTSTONE (10-50%), buff to light grey as above, grading medium grey, very argillaceous, medium hard to argillaceous percentage grading minor sandstone laminations.
- 2685.5-2690 m SANDSTONE, white to light grey, silt - 40%, very fine grained - 5%, fine grained - 50%, medium grained - 5%, 0-5% dolomitic cement, 5-20% siliceous cement, 5-10% argillaceous silt matrix, subangular to subrounded, floating white chert grains, medium grained, salt and pepper, micromicaceous with minor laminations of SHALE, medium dark grey, micromicaceous and gradations to SILTSTONE, very argillaceous as above.

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LITHOLOGICAL DESCRIPTION

- 2690-2700 m SHALE, medium to dark grey, slightly silty, micromicaceous with laminations of SILTSTONE (20%) as above, very argillaceous and gradations to SANDSTONE (10-15%), light to medium grey, argillaceous, slightly dolomitic, slightly siliceous, salt and pepper, as above, silt - 60%, very fine grained - 30%, fine grained - 10%, salt and pepper with chert grains, 10-20% argillaceous matrix to silty matrix representing a dirty sandstone, grading siltstone, medium sorted.
- 2700-2715 m SANDSTONE, light grey to white, salt and pepper, silt - 50%, very fine grained - 40%, fine grained - 10%, medium sorted, subrounded to subangular, especially subangular chert, scattered fine grain sand laminations, slightly dolomitic, slightly argillaceous, siliceous, scattered carbonaceous and shale clasts, scattered medium to coarse grain chert grains with gradations to SILTSTONE (40-50%), light grey, argillaceous, very coarse grain silt grading very fine grain silt.
- 2715-2740 m SHALE, medium to dark grey, micromicaceous, slightly silty with interlaminations of SILTSTONE (10-50%), buff/grey, slightly dolomitic, salt and pepper grading very fine grained and SANDSTONE (15-20%), white to light grey as above, silt - 60%, very fine grain - 30%, fine grain - 10%, scattered medium grained, grading dolomitic and siliceous cement, minor argillaceous matrix. NOTE: this interval has an increased total percent of over 60% silt, both occurring as definite silt laminations and as silt matrix within the sandstone. This is indicative of poor permeability. No porosity and no show noted. Scattered angular chert grains common.
- 2740-2745 m SILTSTONE, light grey to light brown as above, grading argillaceous, grading sandy with minor silty shale partings, slightly dolomitic grading SANDSTONE, light grey, silt - 60%, very fine grained - 35%, fine grained - 5%, occasionally very dolomitic with 15-20% dolomitic cement however average contains 10-20% black argillaceous matrix and siliceous cement, poor sorted.
- 2745-2769 m SHALE, medium grey, very micromicaceous, silty as above, slightly micromicaceous, blocky with trace SILTSTONE (10-20%), argillaceous, medium and dark grey, grading light grey, dolomitic. NOTE: new increase in dolomitic cement in both siltstone and sandstone plus trace fossils. Siltstone grades to SANDSTONE (5-10%), silt - 60%, very fine grained - 20%, fine grained - 15%, 0-5% siliceous cement, 5-10% argillaceous matrix and 5-25% white dolomitic cement (note increase in dolomitic cement), scattered fossils noted in dolomitic cement, subrounded to subangular, medium sorted.

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LITHOLOGICAL DESCRIPTION

- 2759-2763 m SILTSTONE, as above, light grey, occasionally medium grey, salt and pepper grading very fine grained, grading to SANDSTONE, as above, silt - 50%, very fine grained - 30%, fine grained - 20%, argillaceous to dolomitic with floating medium grained argillaceous shale clasts and medium to coarse grained white chert clasts, medium sorted, subangular to subrounded.
- 2763-2790 m SHALE, medium grey, blocky grading silty, slightly micromicaceous with minor gradations of SILTSTONE (10%), medium grey to greyish brown, dolomitic anhydritic cement with scattered medium grained chert and carbonaceous casts plus shale clasts grading to laminations of SANDSTONE (5%), argillaceous, light to medium grey, dolomitic, salt and pepper, silt - 70%, very fine grained - 20%, fine grained - 10%, occasionally medium grained, medium sorted, subangular to subrounded.
- 2790-m (DD)  
2775 m (LD) FORT CREEK FORMATION (?)
- 2790-2808 m SHALE, medium to dark grey becoming darker with less siltstone laminations and increasing carbonaceous content, Logs indicate high Gamma reading, possibly representing formational change due to decrease in silt and increase in Gamma readings, scattered pyritic laminations, less than 1% silt laminations. Shale grades slightly siliceous, platy, hard, dense, micromicaceous.
- 2808-2814 m SHALE, medium to dark grey as above, blocky, with slight increase in silt content with gradations to SILTSTONE (1-2%), argillaceous grading very fine grained, occasionally dolomitic, siliceous.
- 2814-2830 m SHALE, medium to dark grey, micromicaceous, carbonaceous as above, slightly siliceous with occasionally scattered pyrite nodules, trace siltstone laminations as above.
- 2830-2849 m SHALE, medium grey as above, blocky to fissile, micromicaceous, carbonaceous, dessicates slightly in acid, dull lustre with trace to no siltstone laminations which are very dolomitic and siliceous. Scattered white quartzitic slickenside, trace fracture porosity containing both quartz and calcite fracture filling throughout this interval, scattered pyrite with slight increase in pyrite content to base of interval.
- 2849-2852 m SHALE, dark grey to black, siliceous, carbonaceous, micromicaceous with marked increase in Gamma reading from Logs.

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LITHOLOGICAL DESCRIPTION

- 2852-2860 m SHALE, dark grey to black, siliceous occasionally cherty, hard, dense, brittle, fissile to blocky, carbonaceous, micromicaceous, scattered pyrite and scattered calcite and siliceous filled fractures, trace laminations of SILTSTONE, light brownish grey grading sandy.
- 2860-2869 m SHALE, dark grey to black as above, siliceous grading black chert laminations, scattered white siliceous, spheroids, very fine grained, with up to 2-10% chert content, siliceous, occasionally grey chert, buff to light grey chert laminae with evidence of siliceous limestone grading siliceous siltstone, grading silty chert. Trace fracture porosity with quartz crystal growth within fracture porosity.
- 2869-m (DD)  
2854 m (LD) OGILVIE FORMATION
- 2869-2895 m LIMESTONE, white occasionally greyish white, biosparite to biomicrite with crinoidal fragments to 2 mm in diameter and fossil fragments 1-2 mm in size. Slightly argillaceous, slightly mottled due to fine to coarse grain clasts, limestone grades to recrystallized microcrystalline, medium hard, dense. Trace asphalt staining along laminations in the limestone and occasionally between carbonate clastic grains, no live show.  
NOTE: logs indicate washout of limestone from 2881-2891 m (2866-76 m LD).
- 2895-2910 m LIMESTONE, as above, white (excellent effervescence in acid) decrease in argillaceous content, bioclastic limestone with vestiges of 1-2 mm fossil fragments and crinoids, trace asphaltic staining, no live show, no porosity.
- 2910-2924 m LIMESTONE, white as above, grading slightly dolomitic with minor gradations to  
LIMESTONE, light grey, slightly argillaceous, slightly recrystalline and gradations to  
LIMESTONE, medium to dark grey, occasionally black lithographic argillaceous, hard, dense, brittle.
- 2924-2940 m LIMESTONE, medium to dark grey and greyish brown, occasionally mottled grading slightly recrystalline with increasing dolomite alteration, grading lithographic hard, brittle, dense, argillaceous with minor dark grey very argillaceous limestone (L)  
NOTE: Mottled limestone possibly represents a biomicrite with occasional crinoidal vestiges.
- 2940-2952 m (DD)  
2925-2937 m (LD) LIMESTONE, light grey, microcrystalline, occasionally slightly dolomitic to very dolomitic, intermicrite with both medium to coarse grained bioclasts with gradations to

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LITHOLOGICAL DESCRIPTION

LIMESTONE, medium grey, very dolomitic, argillaceous, slightly mottled with very fine clasts in the medium to dark grey, micritic argillaceous matrix.

2952 m

Trip and 14 m strapout correction, i.e., 2952 m old depth becomes 2938 m new depth. The Drillers Depth was corrected at this point and correlation with Schlumberger Logs should clarify both Log and Sample Descriptions. In considering an average correction of 15 m a 10 m correction has been carried through from 1775-2952 m where a 5 m error occurred from 500-1775 m, thus at 2952 m uncorrected depth, both errors were corrected. Below 2952 m (2938 m corrected depth) Drillers Depth equals Schlumberger Log Depth.

2938-2950 m (DD)  
2937-2950 m (LD)

LIMESTONE, light grey as above, microcrystalline, very limey, slightly dolomitic with recrystallized limestone, excellent effervescence in acid, scattered white biospar and biomicrite grading medium grey, slightly argillaceous. NOTE: this interval appears to be less argillaceous from Logs than the previous interval.

2950-2967 m

LIMESTONE, medium grey grading light to dark grey, slightly mottled, occasionally medium greyish brown, slightly siliceous, and cherty with gradations to LIMESTONE (10%), dark grey, argillaceous grading dark greyish brown, siliceous, occasionally chert, hard, dense, brittle. This interval appears to be less argillaceous than above. Grading slightly dolomitic with up to 30-40% dolomite crystals, slightly silty, scattered crinoid fragments especially in argillaceous laminations. NOTE: crinoid fragments are more noticeable in argillaceous limestone due to contrasts between clastic grain size and darker argillaceous matrix.

2967-2981 m

LIMESTONE, light grey, microcrystalline, soft, recrystallized becoming saccyroidal, slightly dolomitic, slightly siliceous with trace chert gradations and minor interlaminae of LIMESTONE (5%), dark grey, argillaceous.

2981-2991 m

LIMESTONE, light grey and greyish white as above, grading medium grey (slight increase in argillaceous content and argillaceous laminae), recrystallized, slightly microcrystalline with trace porosity in microcrystalline limestone, and gradations to LIMESTONE, medium grey, slightly argillaceous to very argillaceous, hard, platy, slightly siliceous possibly due to increased quartz clastic content.

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LITHOLOGICAL DESCRIPTION

- 2991-3005 m Limestone, light grey to light greyish white, platy, slightly dolomitic, cryptocrystalline grading slightly microcrystalline with ghost vestiges of medium to coarse grained clasts, scattered dolomite crystals to .05 mm (10-40% dolomite crystal replacement) possibly originally an intermicrite or pelmicrite with gradations to  
Limestone, medium grey occasionally dark grey with scattered 10-70% replacement dolomite crystals, darker grey limestone represents a slight increase in argillaceous content, trace fine to medium grained sand grains masked by secondary dolomitization with scattered dolomite crystals.
- 3005-3023 m Limestone, light to medium grey, slightly dolomitic, lithographic, grading dark greyish brown, hard, platy, with minor gradations to  
Limestone, light greyish white as above, micritic, slightly dolomitic. NOTE: Logs indicate partial washout from 3055-3068 m.
- 3066 m (DD)  
3066 m (LD) GOSSAGE FORMATION
- 3066-3113 m Limestone, light grey grading light to medium grey, slightly dolomitic, platy, slightly argillaceous, grading limey dolomite, microcrystalline, slightly saccyroidal with minor gradations to  
Dolomite, medium to dark grey, argillaceous, grading  
Dolomite, black, hard, dense, slightly siliceous, slightly cherty, scattered crinoidal and fossil fragments possibly a biomicrite with black argillaceous micritic matrix.
- 3113-3151 m Limestone, light grey, scattered dolomitic, occasionally microcrystalline, slightly argillaceous, vestiges of biomicrite and crinoidal fragments, slightly recrystalline with minor laminations of  
Limestone (5-10%), dark grey, blocky, argillaceous, limey grading dolomitic limestone plus minor gradations to buff/white, cryptocrystalline limestone containing sparoids, trace gastropod and crinoidal fragments. Trace asphaltic stain at 3135 m. Logs indicate poor porosity from 3125-3135 m.  
Limestone, white to greyish white grading light grey, slightly recrystalline, very limey, definitely non-dolomitic, cryptocrystalline, recrystalline, occasionally microcrystalline and slightly friable with minor gradations to  
Limestone, white to buff grey and bluish white, lithographic, non-dolomitic, scattered calcispheres, hard, brittle, platy, trace asphaltic staining and trace porosity at top of this interval. Minor laminations of  
Limestone, as above, medium to dark grey (10%), slightly argillaceous, recrystalline, slightly dolomitic limestone.

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LITHOLOGICAL DESCRIPTION

- 3193-3226 m Limestone, light greyish white and white, recrystalline, soft, slightly dolomitic, possibly biomicrite becoming mottled, light grey and white in acid with slight increase in laminations of  
Limestone (10-20%), light grey to medium grey, slightly argillaceous, slightly dolomitic and minor gradations to  
Limestone, buff to light brown, lithographic, with scattered calcispheres (algae), hard, tight.
- 3226-3263 m Limestone, buff and greyish white, lithographic, hard, platy, dense with vestiges of pelospirite and scattered 10% dolomite crystal replacement, calcispheres common (algae) with minor gradations of white and medium grey limestone as above. Trace asphaltic staining and scattered poor porosity from 3245-50 m and 3260 m due to minor gradations of crypto to microcrystalline, slightly dolomitic limestone in possibly less than 1% of the sample.
- 3263 m (DD) TOP FIRST DOLOMITE MEMBER  
3263 m (LD)
- 3263-3292 m Limestone, white, biosparite, chalky, grading cryptocrystalline to occasionally microcrystalline with increase in crystallinity dependent on recrystallization of medium to coarse crystalline biosparite. Excellent effervescence. NOTE: Although this unit has been placed in the First Dolomite on the basis of Logs, the writer believes the true top of the First Dolomite is at the base of this interval. Increase in Log porosity is due to recrystallization of the coarser clastic limestone. Minor gradations to light greyish white micritic, platy limestone as above, with calcispheres and minor limestone, light to medium grey, mottled, slightly dolomitic, cryptocrystalline, slightly argillaceous, trace asphaltic stain at 3285-90 m with trace poor porosity, i.e., less than 2% of sample.
- 3292-3319 m DOLOMITE, light grey to bluish grey, slightly argillaceous, slightly calcareous, blocky, hard, brittle, cryptocrystalline, occasionally grading microcrystalline and occasionally very fine crystalline (less than 10% very fine crystalline producing scattered poor porosity within this coarser crystalline dolomite), minor gradations to  
DOLOMITE (10-30%), light grey to bluish grey, slightly calcareous, slightly argillaceous, cryptocrystalline to microcrystalline, brittle, hard, dense.
- 3319-3330 m DOLOMITE, buff/white, platy, brittle, microcrystalline as above, grading 15-20% very fine crystalline with scattered poor intercrystalline porosity, no show with minor gradations to  
DOLOMITE (20%), light bluish white to grey, cryptocrystalline, very brittle, hard, platy, slightly argillaceous. NOTE: variable drilling rates indicative of increased crystallinity - faster drilling rate and decreased crystallinity, more brittle and argillaceous - slower drilling.

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LITHOLOGICAL DESCRIPTION

- 3330-3360 m DOLOMITE, buff/white, occasionally greyish white, slightly calcareous, microcrystalline, platy, massive, scattered sparry calcite eyes (calcspheres) with gradations to 5-10% very fine crystalline containing scattered poor porosity with minor laminations of  
DOLOMITE, white to greyish blue, slightly calcareous to very calcareous, cryptocrystalline to microcrystalline, hard, dense, slightly argillaceous. NOTE: no asphaltic staining or show was noted in any of this porosity.
- 3360-3380 m DOLOMITE, as above, buff/white occasionally greyish white with scattered calcite sparry eyes, occasional scattered pyrite crystals with 30-40% very fine crystalline gradations, scattered poor to fair porosity, occasionally fine crystalline with gradations to  
DOLOMITE, greyish blue white as above, cryptocrystalline to microcrystalline, slightly calcareous, slightly argillaceous with no porosity noted due to decreased crystallinity.
- 3380-3405 m DOLOMITE, light greyish white to white, microcrystalline with scattered large coarse grained spar dolomite crystals, scattered gradations of 10-30% very fine crystalline, dolomite with trace asphaltic staining in poor to fair porosity associated with coarser crystallinity, asphaltic staining occurs from 3390-3405 m in 1-2 grains and in less than 5% of the porosity, no live show was noted, no marked increase in gas reading was noted. The lighter dolomite grades to  
DOLOMITE, as above (5-10%), light greyish white and bluish white, microcrystalline to cryptocrystalline, slightly argillaceous, hard, dense, platy, slightly calcareous.
- 3405-3415 m DOLOMITE, buff/white as above, cryptocrystalline with scattered dolomitic spar crystals grading 40% microcrystalline, 10% very fine crystalline with interlocking dolomitic crystals scattered poor to fair porosity in coarser crystalline dolomite, no show. NOTE: This dolomite appears to be cleaner with less argillaceous laminations.
- 3415-3437 m DOLOMITE, buff/white as above, hard, dense, platy, cryptocrystalline with dolomitic spar crystals, scattered calcite crystals grading dolomitic limestone. Dolomite is basically a cryptocrystalline with 25-30% microcrystalline and 5-10% very fine crystalline, occasionally medium crystalline with trace scattered poor porosity in the coarser crystalline dolomite, with scattered laminations of  
DOLOMITE (5-10%), light greyish white to medium greyish blue, slightly argillaceous, slightly calcareous, cryptocrystalline, scattered quartz crystalline, sparry dolomite with 1-2 mm dolomitic spar filled vugs. Logs indicate slight increase in porosity.

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- 3437-3451 m DOLOMITE, buff/white as above, slightly limey, grading dolomitic limestone, cryptocrystalline, grading 30-40% microcrystalline and 5-10% very fine crystalline, scattered white calcispar, poor to fair intercrystalline porosity noted in this cleaner dolomite.
- 3451-3501 m DOLOMITE, light greyish white to buff/white, slightly calcareous with slight increase in crystalline size and slight increase in argillaceous content and slightly argillaceous dolomite laminations. Essentially cryptocrystalline with gradations from 30-60% microcrystalline, 10-20% very fine crystalline and 5-20% very fine crystalline with increasing crystallinity towards base, scattered poor porosity, occasional scattered asphaltic staining towards base with gradations to DOLOMITE, light greyish brown, slightly argillaceous, calcareous; cryptocrystalline to microcrystalline, no porosity and gradations to DOLOMITE (10-40%), medium to dark grey, argillaceous grading very calcareous, mottled, cryptocrystalline to very fine crystalline. NOTE: Although crystallinity has been increasing within this interval the dolomite crystals appear to be interlocking with resulting lower porosity.
- 3501-3518 m DOLOMITE, limey, medium to dark grey, mottled, slightly argillaceous, microcrystalline to very fine crystalline with brown mottled light to dark greyish brown, essentially microcrystalline - 70%, very fine crystalline - 20%, trace to 20% very fine crystalline, poor to fair intercrystalline porosity reduced by interlocking dolomite crystals, rare asphaltic staining, scattered 1-5% white spar calcite crystals possibly representing vug infill, minor gradations to DOLOMITE, light grey and buff, microcrystalline to very fine crystalline, slightly mottled with medium to coarse grain clastic ghosts. NOTE: The sparry calcite crystals appear to be more common in darker argillaceous dolomite. This mottling effect of light and dark could represent amphipora vestiges.
- 3518 m (DD) TOP SECOND DOLOMITE MEMBER  
3518 m (LD)
- 3518-3536 m DOLOMITE, buff to cream grading dolomitic limestone, fairly clean, non-argillaceous, essentially microcrystalline - 50-70%, very fine crystalline - 10-30%, fine crystalline - 5-10%. NOTE: The dolomite crystals are interlocking producing scattered poor porosity in the fine crystalline portion of the dolomite. Scattered asphaltic staining at the top of this interval becoming less crystalline with depth. Minor gradations of medium to light greyish white dolomite, slightly argillaceous.

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- 3536-3550 m DOLOMITE, buff/white to greyish white as above, slight increase in argillaceous content, essentially microcrystalline grading to cryptocrystalline. NOTE: 5-10% white chalky fossiliferous limestone logged in the composite log possibly represents caving from chalky limestone intervals up above.
- 3550-3575 m DOLOMITE, white to buff and light greyish white, platy, medium hard, slightly calcareous, slow effervescence, slightly argillaceous with thin argillaceous laminae, coarser crystallinity than above ranging from cryptocrystalline - 10-20%, microcrystalline - 40-60%, very fine crystalline - 30-55%, fine crystalline - 5%, trace asphaltic staining rare at top of this zone, scattered poor to fair porosity in less than 5% of sample, restricted to samples exhibiting very fine crystalline dolomite, with minor gradations of DOLOMITE, light greyish white, slightly argillaceous, slightly limey.
- 3575-3595 m DOLOMITE, white to buff/white as above, grading darker greyish white dolomite, slight decrease in crystallinity size, averaging 30-40% cryptocrystalline, 50-60% microcrystalline and 10-20% very fine crystalline. Scattered poor porosity in 1-5% of the sample, i.e. with increased crystallinity, trace asphaltic staining, no live show or increased gas readings from the gas curve, with gradations to DOLOMITE (10-30%), medium to dark grey and greyish brown, mottled, slightly argillaceous, slightly calcareous with possible amphipore fossil, occasional scattered quartz grains - fine grained.
- 3595-3608.5 m DOLOMITE, slightly limey, white to greyish white and buff white i.e., decrease in argillaceous content, occasionally light brown, hard, dense, cryptocrystalline - 10-40%, microcrystalline - 50-60%, very fine crystalline 10-20%, scattered poor to fair intercrystalline porosity restricted to the very fine crystalline dolomite, i.e., in less than 5% of the sample, minor white calcite spar possibly representing sparite filled vugs (5% of sample).
- 3608.5-3622 m DOLOMITE, white to buff/white as above with slight increase in interlamination of slightly argillaceous light grey dolomite, very slightly calcareous, grading saccyroidal with interlocking crystals averaging 80-90% microcrystalline and 10-20% very fine crystalline, trace poor porosity in less than 1% of sample.
- 3622-3645 m DOLOMITE, white grading buff/white, occasional saccyroidal white, slightly calcareous with vestiges of fine to medium grained clast ghosts, occasionally dolomitic limestone with evidence of recrystalline saccyroidal texture, cryptocrystalline - 10%, microcrystalline 70-80%, very fine crystalline - 10-15% and occasionally fine crystalline 5%, scattered poor to fair intercrystalline pinpoint porosity and intercrystalline porosity in less than 5% of the sample, rare asphaltic staining, with

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minor gradations to light greyish white, slightly argillaceous dolomite.

- 3645-3654 m LIMESTONE, dolomitic, grading a very calcareous dolomite, microcrystalline, hard, platy, slightly argillaceous, slightly darker than above, cryptocrystalline to microcrystalline, rare porosity.
- 3654-3673 m DOLOMITE, white to buff white as above (NOTE: with daylight sample appears light greyish white, under microscope light sample appears buff/white and white), hard, dense, platy, occasionally saccyroidal, cryptocrystalline - 10%, microcrystalline - 70-80%, very fine crystalline - 10-20%, scattered poor pinpoint and intercrystalline porosity in less than 5% of the sample, minor gradations of DOLOMITE, light greyish white to light grey, slightly limey, slightly argillaceous, cryptocrystalline, hard, dense, platy, slightly fractured with calcite filled hairline fractures, 5% scattered white calcite spar crystals.
- 3673-3711 m DOLOMITE, as above, white and buff/white to greyish white, slightly calcareous (steady effervescence on bottom of acid), microcrystalline to very fine crystalline grading saccyroidal, white dolomite, to crystalline - 10-20%, microcrystalline - 60-70%, very fine crystalline - 15-20%, fine crystalline - trace to 5%, scattered poor porosity in less than 10% of the sample, i.e. in coarser crystalline portion, intercrystalline and pinpoint porosity, trace pyrobitumen asphaltic staining in very fine crystalline dolomite at 3680-85 m, no live show noted, with minor gradations and laminations to DOLOMITE (5%), slightly limey, light bluish grey, slightly argillaceous with occasional scattered pyrite crystals, hard, dense, tight.
- 3714 m (DD) TD DRILLER
- 3715.4 m TD MEASURE OUT.
- 3695 m (LD) TD SCHLUMBERGER (Bottom Fill).