FINAL REPORT

CENTRALIA OIL PTY LTD
NO. 1 WATERHOUSE ANTICLINE
NORTHERN TERRITORY, AUSTRALIA

July 19, 1965
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ALL LOGS LISTED IN CONTENTS WERE NOT SUBMITTED WITH THIS REPORT.
CENTRALIA OIL PTY. LTD. NO. 1 WATERHOUSE ANTICLINE

Location:  Approximately Latitude  24° 01' south
           Longitude 133° 32' east

Spudded:  January 25, 1965

 Contractor:  Cactus Drilling Company
              San Angelo, Texas

Rig used:  a Fort Worth Spudder Co. "Jumbo J"

Casing left in hole:

  13-3/8"  48 lb @ 388' DF cemented w/415 sacks
  10-3/4"  40½ lb @ 1075' DF cemented w/100 sacks
  8-5/8"  28 lb @ 2443' DF cemented w/140 sacks

A 100 sack cement plug was placed in the bottom of the 8-5/8" casing.

Fresh water was encountered at 238' and water level was 200' to 300'
DF essentially throughout drilling.

No shows, slight petroliferous odor from 2150' to 2210'.
OPERATIONS

The Centralia Oil Pty. Ltd. #1 Waterhouse Anticline was drilled on a farmout from Magellan Petroleum (NT) Pty. Ltd. on OP-43 in Northern Territory. The well was located on the axis of the Waterhouse Anticline at approximately Latitude 24° 01' south, Longitude 133° 32' east. This location fell within the Waterhouse Block as shown in the pocket, the Waterhouse Block is the area affected by the above mentioned farmout agreement. The farmout was dated the 2nd of June, 1964, and the #1 Waterhouse Anticline satisfied the well requirements in the agreement.

The #1 Waterhouse Anticline was drilled on the axis of a large east-west trending anticline in the Amadeus Basin. This anticline is a prominent surface structure and is known as the Waterhouse Anticline and the Waterhouse Range. An aerial mosaic is enclosed in the pocket. The location is shown and was believed by Dr. Duncan McNaughton to be as near as possible the apex of the structure. The Jay Creek formation of Cambrian age outcrops in the core of the anticline. Surface work done by Mr. Keith Williams, our wellsite geologist, is enclosed in the appendix in which he correlates the surface outcrop of the Jay Creek in the Waterhouse Anticline with the Jay Creek section drilled in the Exoil #1 Alice well. From these studies he estimated that the Arumbera would be encountered at approximately 2200'. It was encountered in the Waterhouse Anticline well at 2255'.

A Fort Worth Spudder Co. 'Jumbo J' cable tool drilling rig was moved from Hobbs, New Mexico to the location by the Cactus Drilling Co. of San Angelo, Texas. The rig arrived on location January 15, 1965, and drilling was started January 25, 1965. A 15" bit was used from the surface to 390'. At 238' fresh water entered the hole and filled up to 210' DF. This water had a salinity of around 300 parts per million, as calculated from resistivity measurements. Samples were sent off to the Bureau of Mineral Resources for analysis. At 390', 13 joints, 378', of 13-3/8" J-55 48# casing were run into the hole and landed at 388' DF. This was cemented by B J Services, Inc. with 205 sacks of cement, no returns were received. A 13-3/8" blowout preventor was placed on the casing. The following day pressure was placed on the plug and it did not hold. The plug was drilled and the well cemented with 140 sacks, no returns were received. The following day the plug was pressurized up to 1000# psi and it held. 85 sacks of cement were pumped down the annulus. The plug was then drilled out with a 12" bit and as soon as the bit passed under the casing shoe the water returned to its previous level of 210'. At a depth of 439', 40' below the casing shoe, the well was squeezed with 125 sacks neat cement. The cement was encountered the following day at 369'. The hole made water as soon as the well reached 405' and returned to the original level of 210'. Drilling continued with the water level at 210' to a depth of 1075'. Drilling averaged approximately 25' per day. A water sample was caught at 1075' and sent to the Bureau of Mineral Resources for analysis. A Welex electrical log was run at TD of 1075', a guard log 382' to 1074', Gamma Ray Neutron 20' to 1074'. At this point 34 joints, 1080', of 10-3/4", 40.5# H-40 casing were run into the hole with a Texas pattern casing shoe. Casing was landed at 1075'. The casing landed at noon one day, the hole was bailed dry and let set over
night, no water entered the hole. The casing was then cemented with 80 sacks cement with 4% gel and 20 sacks neat cement, top and bottom plugs were used. A 10-3/4" blowout preventor was placed on the casing. The 10-3/4" casing was welded to the 13-3/8" casing and a 2" valve placed on the 13-5/8" casing. The hole was dry from 1075' to 1087', then fresh water re-entered the hole and rose to 300' DF. This water also had a salinity of around 300 parts per million. At 1270' the well was squeezed with 150 sacks of cement with 4% gel and pressured up to 1000# psi. The cement was found 60' up from the casing shoe, water entered the hole at 1105' and the water level was again 300' from the surface. Drilling was continued with a 10" bit and with the hole full of water to 2445'. The top of the Arumberra formation was encountered at 2255' however very little porosity was visible in the samples. At 2455' Welex electric logs were run. The Forxo caliper was run 1076' to 2445'; Gamma-Neutron was run from 1050' to 2445' and the guard log was run from 1076' to 2445'. The neutron log showed very little porosity in the Arumberra drilled to 2445'. It was felt that there was a possibility that hydrocarbons could be encountered at a greater depth when porosity developed, even though no shows had been encountered as yet. At this point 76 joints, 2463', of 8-5/8" 28# H-40 casing was set at 2443' with Texas pattern casing shoe. The casing was cemented with 80 sacks cement, 4% gel followed by 60 sacks neat cement. The 10-3/4" blowout preventor was installed on the 8-5/8" casing. The 8-5/8" was resting on its shoe on the bottom and was welded to the 10-3/4" casing with a 2" valve on the 10-3/4" casing. Fresh water commenced entering the hole as soon as the plug was drilled. It entered at the rate of approximately 10 barrels per hour. The fillup was as follows:

50'/hr @ 2460'
140'/hr @ 2471'

At this point it was decided that it was uneconomical to bail the hole dry and the hole was allowed to fill up with water. It filled up slowly to a depth of 337' DF. A sample was taken to the Bureau of Mineral Resources, the salinities were approximately 2600 parts per million at this time, as calculated from resistivity. Drilling continued with an 8" bit to a depth of 3060'. A 6-3/4" hole was drilled from 3060' to 3065' and the well was cored with a 6" core bit from 3065-81'. Recovery of the core was 100%. At this point Schlumberger electric logs were run, Gamma Ray-Neutron 2444-3060'; Laterologic 2444-3077'; Micro-Inverse Caliper 2444-3076'; Cement Bond Log 1050-2490'. A 100 sack plug was placed at the bottom of the 8-5/8" casing. The top of the plug was found at 2209' with a bailer. A joint of 8-5/8" casing was bullplugged and a 3" valve placed on it. This stands approximately 4' above ground level on the location. The rig was torn down and the location abandoned.
CENTRALIA WATERHOUSE NO. 1

GEOLOGICAL REPORT

G. K. WILLIAMS

June 1965
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REGIONAL GEOLOGY

The Amadeus Basin is roughly oval in shape, 400 miles long from west to east by 150 miles from north to south. Sedimentation was continuous through late Proterozoic to mid-Paleozoic with local unconformities on the basin margins and over some of the growing structures. The last episode of folding ended during the Devonian period. Since Devonian the basin has remained near or above sea level, alternating between periods of minor continental deposition, and periods of erosion deep and weathering.

Large fairly simple folds, usually not associated with major faulting are characteristic structures. These folds measure some miles in width and some tens miles in length. Most trend roughly east-west.

The Waterhouse anticline trends east-west. It is 30 miles long and 4 miles wide. It is slightly assymetrical in the vicinity of the well with dips on the north flank of about 40° and dips on the south flank of about 65°.

The Pacoota and Mereenie formations form the resistant rim of the structure. Erosion in the core has removed the upper 1,225' of the 'Jay Creek formation'. The closure is in the order of 4,000'.
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<th>Description</th>
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<td><strong>MESOZOIC AND TERTIARY</strong></td>
<td>Up to over 100 feet. Isolated mesas of sandstone, claystone, silicious 'Billy', laterite.</td>
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<td>- Unconformity -</td>
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<td><strong>DEVONIAN</strong></td>
<td>Pernjara Formation. Up to 3000 ft. An upper pebbly sandstone, a lower siltstone unit, all non-marine.</td>
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<td>- Local Unconformity -</td>
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<td><strong>ORDOVICIAN</strong></td>
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<td>Stairway Formation. Up to 1800 ft. Alternating sandstone, siltstone and shale; marine.</td>
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<td>Horn Valley Formation. Up to 900 ft. Dark shale, minor limestone; marine.</td>
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<td></td>
<td>Pacoota Formation. Upper part sandstone and shale, up to 1200 ft. Lower part sandstone, up to 1750 ft. Both marine.</td>
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<td><strong>CAMBRIAN</strong></td>
<td>(Pertaoorrt Group)</td>
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<td></td>
<td>Goyder Formation. Up to 1600 ft. Sandstone, sandy limestone, siltstone, shale. Marine.</td>
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<tr>
<td></td>
<td>'Jay Creek Formation'. Up to 5000 ft. An upper limestone unit, a middle unit of silty shale and dolomite, a lower unit which contains salt, not everywhere present.</td>
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</table>
Arumbera Formation. Up to 1200′
Sandstone, siltstone, minor shale, probably all marine.

- Local Unconformities -

UPPER PROTEROZOIC:

Pertatataka Formation. Up to 2000′+
Siltstone and shale, minor carbonates and sandstone. Probably all marine.

Arevonga Formation. Up to 1000′
Claystone, siltstone, sandstone, minor conglomerate and limestone. Partly aqueoglacial.

Bitter Springs Formation. 2500′+
Dolomite, limestone, shale, siltstone, minor sandstone, salt. Marine.

Heavitree Formation. 1500′+
Siliceous sandstone.

- Unconformity -

ARCHAEN:

Arunta Complex.
Metamorphosed sediments, granite, acid and basic dykes.

- Note:
The PERTAOORRTA Group undergoes rapid facies changes across the basin. Marine carbonates in the east are transitional westwards through inter-bedded carbonates and shale to inter-bedded shale, siltstone and sandstone to non-marine sandstone in the far west. About 15 formation and member names are in use at present. Correlations are not fully established. The term 'Jay Creek' as used is incorrect but convenient until subsurface to surface correlation is better established.
DESCRIPTION OF FORMATIONS DRILLED.

'JAY CREEK FORMATION'

Surface to 850'.

Interbedded silty shale and dolomite. Shale predominates, totals about 65% of the section. The shale beds vary from 5 to over 100 feet thick, the dolomite beds vary from 2 feet to 35 feet thick.

Shale - red-brown, minor green, often slightly dolomitic, hard, blocky. Composed of very fine quartz silt and clay minerals, would be logged by some geologists as siltstone.

Dolomite - often limy, light tan, light grey and brown, rarely red, dense to very fine crystalline, usually devoid of texture; rare lamination, possibly algae in origin; nearly always silty, occasionally argillaceous. Porosity occurs in fractures and small vugs, intercrystalline porosity is very rare. The vuggy dolomite is often associated with signs of fractures or slickensides and it is assumed that it is partly a result of deep weathering along fractures. Chert is rare, pyrite and gypsum occur as traces.

850' to 1790'.

Interbedded silty shale and dolomite. Very similar to the overlying unit except that the lithologies are more evenly interbedded. The shale to dolomite ratio is the same as in the above unit, the shale and dolomite beds are thinner, rarely over 30' thick. Floating sand grains occur both in shale and dolomite throughout the section. A possible pebble zone occurs at 1695', sand grains and quartz crystals are most abundant in shale and dolomite from 1695' to 1790'.

Shale - red-brown, minor green, in part dolomitic, slightly to very silty, grading to siltstone, in part sandy, especially in the lower part of this interval. Mostly hard and blocky, but in part softer, fissile and micaceous. The ratio of silt to clay decreases roughly with depth.
Dolomite - as in the overlying unit, mostly silty, in part very silty, grading to dolomitic siltstone, dense to fine crystalline, in part anhydritic. Small amounts of good intercrystalline porosity occur between 1390 and 1490. Small vugs, usually associated with fractures are found throughout the section. Some of the fracture planes have a weathered appearance at least down to 1500'. Chert is more abundant than in the overlying section.

1790 to 1895'.

Dolomite and limestone with thin shale interbeds.

Dolomite - mottled white and dark brown, anhydritic, abundant chert.

Limestone - brown, earthy to sugary, silty to very silty, grading to limy siltstone, in part sandy. The sugary limestone is dolomitic. Chert is abundant, pyrite and quartz crystals are common. When dissolved in acid the limestone leaves a brown bituminous scum.

Shale - green and red, dolomitic, in part sandy.

1940' to 2040'.

Sandy shale - orange, very sandy, also containing abundant quartz crystals. The shale is very soft, it is the only shale in the 'Jay Creek' composed predominantly of clay minerals rather than very fine silt.

2040' to 2190'.

Siliceous limestone and chert, minor shale.

Limestone - light to dark brown, earthy to very fine crystalline, silty to very silty, in part grading to limy siltstone. Slightly to very siliceous, chert is very abundant. The limestone leaves a brown scum in acid. At 2150' there is fair to good porosity in sugary limestone, the fresh sample had a strong petroliferous odour.

Shale - below 2160' is a small amount of dark brown bituminous shale with a brown streak.
2190' to 2240'.

Silty shale - rusty red, soft, slightly micaceous, grading in part to shaly siltstone.

2240' to 2255'.

Limy dolomite - light grey to white, silty, sandy, in part micaceous, abundant chert.

ARUMBERA FORMATION 2255' (R.A. Log)

2255' to 2315'.

Sandy siltstone - rusty red, micaceous, very sandy, ranging up to very coarse grains, shale partings.

2315' to 3081' T.D.

Sandstone, minor siltstone and shale.

Sandstone - red, generally poor sorting, ranging from silt to coarse or very coarse. Grains are 95% quartz, the quartz grains are coated with red iron oxide film. The remaining grains include a white siliceous rock, soft white and green shale grains, rare red rock grains, dark heavy mineral grains, and a few light coloured feldspar grains. Most of the sandstone is loosely cemented by crystal overgrowths, a few layers are hard, well cemented by silica. The matrix consists of red clay-shale and silt. Pebbles are scattered below 2700', these consist of quartz, quartzite, chert, jasper and a siliceous rock. Shale pebbles were present in the core.

Most of the samples were recovered as loose sand grains so much of the section could not be evaluated for porosity. There were traces of poor to excellent porosity in a few cuttings. A few thin layers of good porosity were present in the core.
DISCUSSION.

1. The occurrence of fresh water.

The 'Jay Creek formation' contains interbedded dolomite and shale. The shale is hard and blocky, composed essentially of very fine silt — it is sufficiently competent to sustain open fractures. Evidence from samples and the bottom hole core show that open fractures occur to total depth. Fractures probably form a network continuous from the surface to at least 1,940'. The presence of fresh water in the Jay Creek formation can be interpreted as local accumulation of meteoric water.

It is not so evident that the fracture network connects the Arumbera Formation with the surface. There is a shale layer from 1940' to 2040' which is the only layer that could conceivably be a cap rock. The limestone below this shale contained the nearest approach to a 'show' that was encountered, i.e., a petrolierous odour from limestone. Casing was cemented about 200' into the Arumbera formation. Fresh water entered the hole as soon as the plug was drilled out. The water level continued to rise slowly and was still rising when drilling ceased, when it had reached a level 292' below the surface. The static water level in the 'Jay Creek formation' was at 210'. The similarity in water levels suggests a connection between the two formations.

(Note - When water analyses are available, the results should be discussed. G.K.W.)

2. Structure.

The well spudded exactly on the crest of the anticline as determined from outcrop, which occurs at the wellsite. These nearby beds dip at angles up to 30° and are quite variable. As the anticline is so narrow and tight, it would seem a remarkable coincidence that the well should encounter flat dips to total depth. However this appears to be the case. The only positive evidence of the attitude of the beds is from the bottom hole core. Although there are dips to 40° in the core, these are obviously cross-bedding dips. The majority of the core shows horizontal bedding. Evidence that the dips were cross-bedding, not true bedding, was especially convincing in the upper 2' of core. The direction of dip could be seen to rotate through about 40° in azimuth. Indirect evidence that the entire drilled section was essentially flat comes from the deviation records. The largest deviation of the hole from vertical was 1°.
3. **Regional Correlation.**

We do not have enough accurate stratigraphic and thickness control to draw significant conclusions. Assuming no structural complexities in the Waterhouse well the combined thickness of the interval from the top of the Goyder formation to the top of the Arumbara formation is 4480\' in the Waterhouse Range. This compares with 4236\' in Exoil Alice No. 1 well, and 3600\' in outcrop at Ellery Creek. The most significant facies change noted is the absence of 'Jay Creek' salt in Waterhouse No. 1. Or perhaps the anomaly is the presence of salt in Alice No. 1. The salt equivalent cannot be definitely determined, but it is probably the shale and limestone below 1900\'. On the other hand, salt may have been present and was mechanically squeezed out when the structure formed.

4. **Section below total depth.**

Local unconformities at or near the base of the Cambrian (Arumbara) are known from several structures farther west. Without geophysical data it would be dangerous to make detailed predictions regarding deeper strata. It is however, quite reasonable to forecast at least another 5000\' of untested section below total depth.
CENTRALIA OIL PTY. LTD.
#1 WATERHOUSE, N.T., AUSTRALIA

SAMPLE DESCRIPTIONS

10'-15'  Dolomite - Light tan, crypto to very fine crystalline, silty. Trace of porosity in tiny weathered out vugs.

15'-20'  Dolomite (60%) - Light tan, crypto crystalline, very silty. Siltstone (20%) - greenish grey, dolomitic, argillaceous; small irregular (1 m.m.) lumps of dolomite in some of the siltstone. Shale (20%) - red-brown, hard, blocky, silty, trace of fine mica; patches of green dolomitic shale.

20'-30'  Dolomite (50%), Shale (40%), Siltstone (10%).

30'-40'  Shale (70%), Dolomite (20%), Siltstone (10%).

40'-45'  Shale (90%) - red-brown, silty, hard, blocky, very slightly dolomitic, trace of very fine mica, slightly speckled with green; interlaminated or mottled with; Siltstone (10%) - greenish grey, dolomitic, argillaceous. (Note: there is only a slight difference in texture between this and the red shale.) Dolomite (trace) - tan, silty.

45'-50'  Shale (60%) - red-brown. LImy Dolomite (35%) - light tan, crypto crystalline, very silty, rare tiny vugs. A few cuttings indicate that the dolomite is interlaminated with green siltstone. Siltstone (5%) - as above. Trace of purple shale.

50'-58'  Shale (80%) - red-brown and purple, laminated and speckled with green siltstone and shale. The purple shale is softer and more micaceous. LImy Dolomite (20%) - light tan and red, very silty.

58'-65'  Shale - red brown, speckled and laminated with green, silty, slightly dolomitic, slightly micaceous. Mostly block, a few cuttings are laminated. Trace of tan and red dolomite and green siltstone.

65'-70'  As above.

70'-77'  Shale (80%) - red-brown, mottled with green, as above. Shale (15%) - green, hard, non-calcareous. Dolomite (5%) - tan, as above.

77'-82'  Shale (80%) - red-brown, as above but not dolomitic. Shale (10%) - green. Dolomite (10%).
82- 90' Shale (red-brown, mottled, and interbedded with green, silty, very fine mica. Dolomite (trace). Sandstone (trace) very fine grained, shaly, laminated, micro-micaceous.

90-100' Shale - as above. Trace of Dolomite.

100-110' Shale (70%) - As above. Sandstone-Siltstone (30%) - yellow-brown, fine silt to very fine sand, micro-micaceous. Trace of dolomite. Trace of gypsum in clear crystals.

110-120' Shale (40%) - as above. Dolomite (40%) - tan and grey, silty, argillaceous. Siltstone-Sandstone (20%) - As above. Gypsum occurs as laminae in the sandstone.

120-130' Dolomite (80%) - tan, crypto-crystalline, silty, rare small vugs. Shale (20%) - as above. Trace of siltstone-sandstone.

130-140' Dolomite (90%) - as above, trace of algal laminae in part argillaceous. Shale (10%) - as above.

140-150' Dolomite (80%) - as above. Limestone (20%) - light tan, crypto-crystalline, silty.

150-157' Shale - red-brown, silty to sandy (very fine sand), micro-micaceous. Trace of dolomite, trace of very fine sandstone.

157-165' Shale (80%) - green, hard, blocky, very slightly dolomitic and silty. Shale (10%) - red-brown, as above. Dolomite (10%) - as above.

165-171' Shale (80%) - green, as above. Dolomite (20%) as above. Trace of red-brown shale.

171-176' Shale (80%) - red-brown and green, interbedded. Dolomite (20%) - as above.

176-185' Shale - red-brown and green, as above. Trace of dolomite.

185-193' Shale (90%) - red-brown, as above, trace of green shale. Dolomite (10%) - as above.

193-200' Shale (70%) - as above. Dolomite (30%) - as above. Abundant tan, translucent chert.
200-207' Shale (80%) - as above. Dolomite (20%) - as above. Chert abundant.

207-215' Dolomite (60%) - as above, drusy, trace of chert. Shale (40%) - red-brown and green.

215-220' Shale (90%) - red-brown, trace of green, silty, micro-micaceous. Dolomite (10%) - light tan, crypto-crystalline, a few tiny vugs.

220-230' Shale - as above, trace of dolomite.

230-238' Shale (70%) - as above. Dolomite (30%) - as above, drusy vugs.

238-245' Dolomite - light grey to light brown, crypto-crystalline to very fine crystalline, slightly silty, about 5% of the cuttings show good inter-crystalline porosity. Gold fluorescence, no cut. Grey chert.

245-252' Dolomite - as above, only a trace of porosity. Trace of grey, dense, very silty and argillaceous dolomite.

252-259' Shale (90%) - red-brown, silty, micro-micaceous. Dolomite (10%) as above.

259-262' As above.

262-270' Shale - as above. Trace of dolomite.

270-277' Dolomite (80%) - as above, trace of intercrystalline porosity and vugs. Trace of grey laminated very silty argillaceous dolomite and green dolomitic siltstone. Shale (20%) as above.


285-290' Dolomite (50%) - as above. Shale (50%) - as above. Trace of green siltstone.

290-298' Shale (70%) - as above. Dolomite (30%) - as above.

298-305' Dolomite (70%) - as above. Several large pieces show slickenslides, lamination, patchy development of very fine crystalline sugary dolomite with excellent porosity, in part along the laminae. Only traces of porosity in the normal cuttings. Shale (30%) - as above.
Shale (80%) - red-brown, silty, rarely sandy. Dolomite (20%) - light grey, mostly crypto, some very fine crystalline, silty. Trace of very porous dolomite.

Dolomite (80%) - as above. Shale (20%) - as above.

Dolomite - light grey, some medium grey, micro to very fine crystalline, silty, small patches of sugary porous dolomite, traces of small vugs. Trace of pyrite, trace of dark argillaceous streaks in the dolomite.

Dolomite - light grey and light brown, as above.

Dolomite - as above.

Dolomite - as above, trace of fine crystalline clear calcite, probably lining vugs.

Dolomite (80%) - as above. Silty Shale (20%) - Green, dolomitic. Trace of chert, pyrite in small nodules and disseminated in the shale.

As above.

Dolomite (50%) - as above, fine crystalline calcite abundant. Shale (50%) - as above, in part green siltstone, disseminated pyrite abundant.

As above.

Dolomite - as above. The fine crystalline calcite appears to be in fractures and vugs. Trace of green and red-brown shale.

Shale (90%) - red-brown, dolomitic, silty, micromicaceous. Dolomite (10%) - as above.

As above, trace of medium grey dolomitic shale. Trace of fine crystalline calcite.

Shale - as above. Trace of dolomite.

As above.

As above.

As above.
385-390' Shale - as above.

390-398' Shale - as above. Trace of dolomite.


405-412' Dolomite - light tan, silty, micro, some very fine crystalline, calcareous dolomite. Trace of dark argillaceous layers.

412-417' As above. A few large cuttings indicate fracture faces with pyrite and leached small vugs.

417-420' Dolomite - light tan and brown, micro to very fine crystalline, silty. Trace of irregular argillaceous layers; trace of small vugs.

420-428' Dolomite (70%) as above. Shale (30%) - red-brown, hard, silty, slightly dolomitic. A few shale cuttings contain scattered grains of fine to coarse sand.

428-433' As above.

433-439' Shale (60%) - as above. No sand grains. Dolomite (40%) as above.

439-446' Shale (90%) - as above. Dolomite (10%) - as above.

446-451' Dolomite (80%) - light tan, micro-crystalline, silty, trace of dark argillaceous material as partings or on slickenslides. Shale (20%) - as above.

451-456' As above.

456-463' As above. Trace of green silty shale.

463-470' Dolomite (50%) - as above, clear calcite abundant. Shale (50%) - red-brown and green, hard, blochy, silty, slightly dolomitic.

470-473' Shale - red-brown, as above. Trace of green shale and dolomite.

473-476' As above.
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476-480' As above.

480-486' As above, trace of darker shale.

486-490' As above. The darker shale is harder, very silty (nearly a siltstone).

490-492' As above, trace of soft waxy shale (green).

492-500' **Silty Shale** - red-brown, slightly dolomitic, hard, blochy, trace of coarse sand grains. Trace of fine crystalline calcite. **Note:** The red-brown 'shale' is composed largely of very fine silt, and could be logged as siltstone.

500-510' **Silty Shale** - as above.

510-517' As above.

517-525' As above, a few large cuttings show slickensides with fine crystalline calcite along fractures, also a black, brittle mineral.

525-529' As above, trace of gypsum in crystals in the shale.

529-540' Silty shale - as above. Trace of clear fine crystalline dolomite mixed with a black mineral, which occurs as 1mm layers, possibly in fractures.

540-550' **Silty shale (70%)** - as above. **Dolomite (30%)** - rusty, rose and pale greenish grey, limy, very silty, argillaceous, dense.

550-560' As above, dolomite probably occurs as thin stringers in the shale.

560-572' **Silty shale** - red-brown, as above. Trace of dolomite.

572-578' As above.

578-583' **Silty shale** - as above, trace of light green silty shale, trace of pyrite.

583-587' **Silty shale (60%)** - red-brown and green. **Dolomite (40%)** - light tan, micro-crystalline, limy, very silty. Trace of pale green dolomitic siltstone, trace of pyrite.
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587- 592' **Dolomite** - light tan and brown, silty, rare sand grain, micro-crystalline. Trace of red-brown and green shale or siltstone.

592- 598' **Dolomite** - light to medium grey, micro-crystalline, silty; very fine silt laminae, also micro-stylolites and dark shale laminae.

598- 607' **Dolomite** - as above, trace of grey, blue-green and black chert.

607- 611' **Dolomite** - light tan, chert more abundant. Some of the chert is highly fractured.

611- 616' As above.

616- 620' **Dolomite** - as above, abundant fine fractures or vugs? Lined with sugary limestone and dolomite. Laminae and irregular patches of hard black argillaceous material. Trace of slickensides. Trace of pyrite.

620- 625' **Dolomite** - as above, many large cuttings, probably highly fractured. Some dark, very silty dolomite, grading to siltstone.

625- 631' As above, abundant small irregular vugs. Trace of red-brown silty shale.

631- 637' **Dolomite** - (50%) - As above. **Silty Shale** - (50%) - Red-brown.

637- 640' **Silty Shale** - (60%) - Red-brown, slightly dolomitic, very silty, micro-micaceous, hard, blocky. **Dolomite** - (40%) - As above.

640- 645' **Silty Shale** - (80%) - As above. **Dolomite** - (20%) - White, grey and tan, micro-crystalline, silty to very silty grading to siltstone; in part limy, abundant small vugs, some fine crystalline calcite, pyrite. Trace of chert.

645- 650' **Silty Shale** - (90%) - As above. **Dolomite** - (10%) - As above. Trace of green dolomitic siltstone. Trace of chert.

650- 655' **Silty Shale** - (50%) - As above. **Dolomite** - (50%) - Tan, brown and grey, micro-crystalline, silty to very silty, stylolites, pyrite. Vugs, fine fractures and open? fractures lined with euhedral dolomite and calcite.
655-660' Dolomite - (80%) - Grey, micro to very fine crystalline, limy, silty. Trace of dark partings and stylalites, trace of chert. **Silty Shale** - (20%) - Red-brown.

660-665' Dolomite - (90%) - As above. **Silty Shale** - (10%) - As above.

665-671' Dolomite - As above. Trace of shale.

671-676' Dolomite - Light tan and grey, micro-crystalline, silty. Trace of dark material, and fine crystalline dolomite and calcite, on fractures?

676-680' Dolomite - As above.

680-685' Dolomite - As above, some light grey limy dolomite. Trace of chert.

685-690' Dolomite - As above. Trace of red-brown silty shale.

690-695' Dolomite - (90%) - As above. **Silty Shale** - (10%) - Red-brown, hard, blocky, slightly dolomitic.

695-702' Dolomite - (60%) - Light grey, grey, micro-crystalline with abundant fine crystalline dolomite and calcite lining small irregular vugs and fractures, silty. Weathered appearance. **Shale** - (40%) - Red-brown, in part silty trace of green shale.

702-711' **Shale** - (60%) - As above. Dolomite - (40%) - Tan, micro-crystalline, silty, a few small vugs. Trace of black material - iron gasson? Trace of dark fractured chert.

711-716' Dolomite - (60%) - As above. Weathered appearance. **Shale** - (40%) - As above.

716-724' Dolomite - (80%) - As above, trace of medium grey very silty dolomite. **Shale** - (20%) - Red-brown, some green.

724-732' As above, trace of chert.

732-737' Dolomite - (40%) - As above. **Shale** - (60%) - Red-brown.
737-745' Dolomite - (70%) - As above, trace of pyrite. Weathered appearance, trace of a micro-breccia, dolomite fragments in a dark calcareous matrix. Shale - (30%) - Red-brown.

745-751' Shale - (60%) - Red-brown, some green, trace of green siltstone. Dolomite - (40%) - As above. Trace of micro-breccia.

751-755' Shale - (70%) - Red-brown and green. Dolomite - (30%) - As above. Trace of red dolomite.

755-760' As above.

760-764' As above. Green shale is not dolomitic.

764-770' Shale - (80%) Red-brown, some green, partly silty, hard, blocky in part, slightly dolomitic. Dolomite - (20%) Light tan, silty, limy, traces of slickensides associated with calcite and fine dolomite crystals.

770-775' Shale - (90%) As above. Dolomite - (10%) As above.

775-780' As above.

780-785' Shale - (95%) As above. Dolomite - (5%) As above.

785-790' As above.

790-796' Shale - (90%) As above. Dolomite - (10%) As above.

796-800' As above.

800-805' Shale - As above. Trace of dolomite.

805-814' As above.

814-822' As above. Trace of green, hard but fissile dolomitic shale.

822-830' Shale - Red-brown, some green, hard, mostly blocky, some slightly fissile. Trace of dolomite and greenish dolomitic siltstone.
830- 836'  Shale - As above; trace of grey shale, trace of dolomite, trace of pyrite.

836- 844'  As above; trace of clear calcite.

844- 850'  Shale - Red-brown, some green blocky to slightly fissile, in part silty to sandy (coarse silt to very fine sand) and micaceous. Trace of dolomite.

850- 857'  Siltstone and Shale - Red-brown, varies from shale containing very fine silt to a shaly siltstone composed of coarse silt ranging to very fine sand. The coarse silt is micaceous. Traces of green shale, silty dolomite and dolomitic siltstone.

857- 865'  Dolomite - (80%) Grey to greenish-grey, dense, silty to very silty, trace of tiny vugs. Pyrite. Shale-Siltstone - (20%) As above.

865- 870'  Dolomite - Brown, tan, grey and greenish-grey. The brown dolomite is silty, highly argillaceous, when dissolved leaves a brown bituminous? film. The greenish-grey dolomite is only slightly silty but very argillaceous? or anhydritic?, residue is pale green, soft. The different dolomites appear to be thinly (1 mm+) interbedded in some cuttings. Trace of red-brown shale.

870- 878'  Dolomite - (70%) Varicoloured as above. Shale - (30%) Green, dolomitic, gradational with dolomite. Trace of pyrite. A few very fine fractures (in the brown dolomite) filled with white calcite.

878- 882'  Dolomite - (70%) As above, mostly brown, calcite sealed fractures abundant, trace of drusy calcite. Irregular black partings. Shale - (30%) Green dolomitic,

882- 887'  Dolomite - (50%) As above. Shale - (50%) As above.

887- 890'  Shale - (90%) Red-brown and green, dolomitic. Dolomite - (10%) Brown and tan. Trace of dark brown dolomitic siltstone. Trace of pyrite, chert.

890- 896'  Shale - (70%) Red-brown, green, trace of black. Traces of calcite filled hair line fractures. Dolomite - (30%) Light tan, dense, silty.
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896-899' Dolomite - (50%) Brown and tan, silty, dense, dark irregular partings, trace of pyrite. Shale - (50%) Green and red-brown, in part silty, mostly blocky, some of the green shale is fissile.

899-902' Shale - (80%) Mostly red-brown, in part silty, some green, hard, blocky. Dolomite - (20%) Tan, silty, limy.

902-906' As above.

906-910' As above.

910-913' As above, shale less blocky, more fissile. Trace of pyrite.

913-918' Shale - (60%) As above. Dolomite - (40%) As above.

918-923' Shale - (90%) Red-brown, some green, blocky. Dolomite - (10%) Grey, tan, brown, silty, in part limy.

923-928' Shale - As above. Trace of dolomite.

928-935' As above.

935-940' As above.

940-944' Shale - (70%) As above. Trace of green shale. Dolomite - (30%) Light orange-tan, dense, silty.

944-950' Shale - (60%) As above. Silty Shale - (10%) Dark grey, very fine silt. Dolomite - (30%) As above.

950-956' Shale - (90%) Red-brown, in part silty, trace of green and black. Dolomite - (10%) As above. Trace of pyrite.

956-960' As above. Calcite inclusions in shale.


965-970' As above.

970-973' Silty Shale or Siltstone - (40%) Greenish-grey to medium grey, very fine silt, slightly dolomitic, micro-micaceous; pyrite and chalcopyrite? Shale - (30%) Red-brown. Dolomite - (30%) As above. Trace of black brittle shale, probably partings in dolomite, associated with calcite lined vugs.
973-976' Siltstone - (80%) Greenish-grey to grey, very fine up to coarse silt, in part a shaly habit, slightly dolomitic, micro-micaceous. Trace of red shale, black shale, dolomite. **Shale** - (10%) Red-brown. **Dolomite** - (10%).

976-980' Shale and Siltstone - (60%) Greenish-grey. **Shale** - (20%) Red-brown. **Dolomite** - (20%) Orange to tan. Trace of black shale. Trace of quartz (vein quartz?) pyrite and other sulphides (chalcopyrite?).

980-984' **Shale** - (50%) Red-brown, in part silty and micaceous. **Shale-Siltstone** - (40%) Greenish-grey. **Dolomite** - (10%) As above.

984-987' **Shale** - (80%) Red-brown and green, grading in part to siltstone. A few floating sand grains. **Dolomite** - (20%) Light grey to tan; dense, silty.

987-990' As above, pyrite.

990-995' As above.

995-1000' **Shale** - (80%) Red-brown, some green, silty, grading in part to siltstone, a few coarse sand grains. **Dolomite** - (20%) Orange-tan, dense, silty, irregular vugs or fractures with fine crystalline calcite, weathered appearance.

1000-1005' As above, trace of pyrite, chalcopyrite?

1005-1010' As above.

1010-1013' **Shale** - (90%) Red-brown, in part silty, slightly micaceous. **Dolomite** - (10%) Light-tan, grey, dense, silty, irregular small vugs, weathered appearance.

1013-1015' **Shale** - (80%) As above. **Dolomite** - (20%) Light grey, dense, silty, traces of irregular vugs and fractures lined with calcite crystals.

1015-1020' As above.

1020-1025' As above.

1025-1030' **Shale** - (90%) **Dolomite** - (10%).
1030-1035' As above.
1035-1040' As above.
1040-1045' As above.
1045-1048' Shale - (80%) Red-brown, siltier than above, in part grading to brown siltstone. Dolomite - (20%) As above. Trace of pyrite.
1048-1052' Dolomite - (70%) Grey, trace of reddish-brown, dense, silty. Shale - (20%) Red-brown. Siltstone - (10%) Brown, dolomitic, very fine silt, very fine dark mica. Trace of fine crystalline dolomite (from vugs?) Trace of pyrite.
1052-1054' Dolomite - (60%) Grey, tan, red-brown, silty to very silty, dense, trace of fine crystalline dolomite. Silty Shale - (40%) Red-brown, slightly to very dolomitic, very fine mica. Trace of brown dolomitic siltstone.
1054-1059' Dolomite - (90%) As above. Silty Shale - (10%). Trace of green micaceous shale. Trace of pyrite.
1059-1063' Dolomite - Mostly light grey, part with a greenish cast, some reddish-brown; dense, irregular patches of fine crystalline dolomite. May be anhydritic in part. Trace of pyrite.
1063-1067' Dolomite - (90%) As above, some intercrystalline and fine vug porosity. A lot of pyrite. Shale - (10%) Red-brown, minor green. Trace of green micaceous siltstone.
1067-1071' Dolomite - (70%) As above. Silstone - (20%) Green, grey and red-brown, dolomitic, fine mica. Shale - (10%) Red-brown, minor green.
1071-1073' Dolomite - (40%) Shale - (40%) Siltstone - (20%)
1073-1075' Shale - (90%) Red-brown, some green, silty. Dolomite - (10%) As above. Trace of brown siltstone.
1075-1078' Shale - Red-brown and green, silty, slightly dolomitic, very fine mica. The green shale grades to green siltstone. Trace of very silty dolomite.
1078-1087'  Shale - (60%) As above. Dolomite - (40%) White, micro to very fine crystalline, silty.

1087-1095'  As above.

1095-1103'  Dolomite - Light grey to greenish grey, dense silty to very silty, grading to dolomitic siltstone. Trace of green shale and siltstone.

1103-1111'  Dolomite - (50%) As above. Shale - (50%) Red-brown, and green, grading to siltstone. Trace of pyrite, trace of coarse rounded sand grains.

1111-1116'  As above.

1116-1121'  Shale - Siltstone - (70%) As above. Dolomite - (30%) As above. A few small vugs.

1121-1126'  As above.

1126-1131'  As above.

1131-1136'  Dolomite - (80%) As above. Trace of very fine sugary, porous dolomite. Shale - (20%) Red-brown, trace of green.

1136-1140'  Dolomite - Light grey, dense to very fine crystalline, about 5% has some intercrystalline porosity; a few tiny vugs.

1140-1146'  Dolomite - (90%) As above, in part greenish and very silty. Shale - (10%) Red-brown, minor green. Rare loose quartz granule; trace of floating quartz sand in green shale.

1146-1152'  Dolomite - (90%) Light grey, dense, silty. Shale - (10%) As above.

1152-1157'  As above, trace of pyrite.

1157-1163'  Shale - (80%) Red-brown, grey, green. Dolomite - (20%) As above. A few loose quartz grains.

1163-1170'  Shale - As above. Trace of dolomite.

1170-1175'  Shale - Red-brown and green. The green shale grades to green siltstone. Trace of dolomite.
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1175-1182' Shale - (80%) As above. **Dolomite** - (20%) As above.

1182-1185' As above.

1185-1190' **Dolomite - Siltstone** - (80%) Grey, greenish, dense, gradational from silty dolomite to dolomitic siltstone. **Shale** - (20%) Red-brown, green, in part very dolomitic.

1190-1197' **Dolomite - Siltstone** - (60%) As above. **Shale** - (40%) Red-brown, green and grey.

1197-1205' **Shale** - (90%) Mostly red-brown, micaceous, some green, sandy. **Dolomite** - (10%) Light grey, silty, dense to very fine crystalline, trace of vugs.

1205-1208' **Dolomite** - (80%) Light grey as above to greenish very silty dolomite or dolomitic siltstone. **Shale** - (20%) As above.

1208-1212' As above.

1212-1215' **Shale** - (80%) Red-brown, trace of green, silty, very fine mica. **Dolomite** - (20%) light grey, dense, silty to very silty, trace of fine crystalline sugary dolomite.

1215-1219' **Shale** - (60%) As above. **Dolomite** - (40%) As above.

1219-1223' **Dolomite** - (90%) As above. **Shale** - (10%) Red-brown, minor green, trace of grey.

1223-1225' **Dolomite** - Light grey, micro to very fine crystalline, slightly silty, rare small vug.

1225-1228' **Dolomite** - As above.

1228-1230' **Dolomite** - (90%) As above. **Shale** - (10%) As above.

1230-1234' **Shale** - Red-brown, mottled with green, silty, very fine mica, a few sand grains.

1234-1239' **Dolomite** - (90%) Light grey, silty to greenish grey, very silty, dense, signs of fractures lined by fine crystalline dolomite. **Shale** - (10%) Red-brown and green.
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1239-1243' Shale - (80%) Red-brown, minor green. **Dolomite - (20%)** As above.

1243-1247' Shale - (90%) As above. **Dolomite - (10%)** As above.

1247-1251' Shale - As above. Trace of dolomite.

1251-1255' **Dolomite - (60%)** Light tan, dense, silty. Shale - (40%) Red-brown and bright green, the green shale is in part very silty, grading to siltstone.

1255-1257' Shale - (70%) Red-brown, green specks. **Dolomite - (30%)** As above.

1257-1265' As above.

1265-1270' Shale - As above, trace of dolomite.

1270-1277' **Dolomite - (70%)** As above, in part greenish, very silty, grading to siltstone. Shale - (30%) Red-brown, some green, silty, dolomitic.

1277-1282' Shale - (90%) As above. **Dolomite - (10%)** As above.

1282-1287' Shale (70%) As above. **Dolomite - (30%)** As above.

1287-1291' **Dolomite - (90%)** Light tan, dense to very fine crystalline, silty, trace of drusy vugs. Shale - (10%) As above. Trace of green dolomitic siltstone.

1291-1294' **Dolomite - Siltstone -** Brownish to greenish grey, gradational from silty dolomite to dolomitic siltstone. Trace of green shale.

1294-1300' As above.

1300-1302' As above, trace of red-brown shale.

1302-1305' Shale - (90%) Red-brown, slightly to very silty, in part very dolomitic, in part micaceous. **Dolomite - (10%)** - tan and brownish grey, silty to very silty.

1305-1310' **Dolomite - Siltstone -** As 1291 - 1294 Trace of red-brown dolomitic shale.
1310-1315' Dolomite - Siltstone - (90%) As above. Shale - (10%) As above.

1315-1320' Shale - (50%) Red-brown, in part silty and dolomitic, micaceous. Dolomite - Siltstone - (50%) As above.

1320-1325' Shale - (90%) Red-brown, slightly fissile, micro-micaceous. Dolomite - Siltstone - (10%) light grey to greenish.

1325-1330' Shale - (70%) as above. Dolomite - Siltstone - (30%) as above.

1330-1334' Shale - (50%). Dolomite - Siltstone - (50%).

1334-1340' Shale - (90%) red-brown, some green. Siltstone - (10%) green, dolomitic. Trace of dolomite.

1340-1345' Dolomite - Siltstone - (90%) light tan, grey, green, grades from slightly silty dolomite to siltstone. Shale - (10%) red-brown.

1345-1352' Dolomite - Siltstone - as above. Trace of green shale.

1352-1356' Dolomite - Siltstone - (80%). Shale - (20%) Red-brown, minor green, slightly fissile.

1356-1361' As above, chert, trace of pyrite. Trace of fine crystalline porous dolomite.

1361-1365' Dolomite - (70%) light tan, dense, slightly silty. Siltstone - (20%) green, dolomitic. Shale - (10%) red-brown, minor green.

1365-1370' Shale - (50%). Dolomite - (40%) trace of fine crystalline. Siltstone - (10%).

1370-1375' Dolomite - (60%) light grey and tan, brown, dense to very fine crystalline, silty, black partings. Shale - (30%) red-brown, minor green. Siltstone - (10%) green, dolomitic.

1375-1378' Dolomite - (80%). Shale - (10%). Siltstone - (10%).

1378-1380' Dolomite - as above, trace of small vugs and inter-crystalline porosity, trace of siltstone and shale.
1380-1385' Dolomite - (90%). Siltstone - (10%). Trace of shale.
1385-1388' As above.
1388-1391' Dolomite - (90%) light grey or brown, dense, to very fine crystalline, trace of fine crystalline, silty. Trace with leached spheres - oolites? Shale - (10%) dark green, hard, fissile.
1391-1395' Dolomite - as above. Trace of very fine crystalline, very porous, sugary dolomite. Trace of pyrite. Trace of green shale.
1395-1399' Dolomite - (90%) as above. Shale - (10%) dark green.
1399-1402' Dolomite - (90%) light grey and brown, dense, silty, in part greenish and very silty. Shale - (10%) green and red-brown.
1402-1405' Dolomite - light tan, micro to very fine crystalline, fine vug and intercrystalline porosity. Trace of pyrite. Trace of green shale.
1405-1407' As above, only a trace of porosity.
1407-1411' Dolomite - (80%) as above. Shale - (20%) red-brown and green.
1411-1416' Dolomite - (70%) light tan, to greenish, dense, silty to very silty, trace of fine vugs and very fine crystalline porous dolomite. Shale - (30%) red-brown, minor green.
1416-1421' As above.
1421-1426' Shale - (90%) red-brown, green patches, rare sand grains up to 2 mm. Dolomite - (10%) light grey and brown, dense, rare very fine crystalline, vuggy fractures?
1426-1430' Dolomite - (70%) light grey and greenish grey, dense, in part with very fine vugs, weathered appearance, silty to very silty. Shale - (30%) red-brown, minor green.
1430-1434' Dolomite - (50%) as above. Shale - (50%) as above.
1434-1437' Shale - (70%) as above. **Dolomite** - (30%) as above.

1437-1442' **Shale** - (90%). **Dolomite** - (10%). Trace of chert.

1442-1447' Shale - (95%). Trace of purple shale. **Dolomite** - (5%), abundant vuggy dolomite with weathered fractured appearance.

1447-1452' **Shale** - (70%). **Dolomite** - (30%) light grey, brown, dense, silty, abundant small vugs, trace of fine crystalline dolomite. The large cuttings show irregular fracturing.

1452-1458' Shale - (80%). **Dolomite** - (20%) in part greenish, very silty, less vuggy than above.

1458-1464' Shale - (80%) red-brown and green. **Dolomite** - (20%) light grey brown, dense to very fine crystalline, silty, very vuggy, trace of very fine crystalline porous dolomite.

1464-1470' As above.

1470-1474' **Shale** - (90%) red-brown, minor green, micromicaceous. **Dolomite** - (10%) as above.

1474-1479' As above.

1479-1485' **Shale** - (70%) red-brown, minor green, trace of mica. Trace of black pyritic shale. **Dolomite** - (30%) light brown, dense to very fine crystalline, abundant small vugs, fractured, weathered appearance.

1485-1490' **Shale** - (90%) as above. **Dolomite** - (10%) as above.

1490-1495' **Shale** - (50%) dark green, in part silty, in part very dolomitic. **Shale** - (40%) red-brown, micromicaceous. **Dolomite** - (10%) as above.

1495-1500' As above.

1500-1506' **Dolomite** - (80%) pale grey, brown and greenish grey, dense, silty, anhydritic. **Shale** - (20%) red-brown and green.
1506-1510' Dolomite - (90%) as above. Trace of reddish dolomite. Shale - (10%) as above. Trace of pyrite.

1510-1515' Dolomite - as above. Trace of shale.

1515-1519' Dolomite - as above.

1519-1523' Dolomite - as above.

1523-1529' Dolomite - (70%) as above. Shale - (20%) red-brown, in part fissile and micaceous. Shale - (10%) green, dolomitic.

1529-1534' Shale - (80%) red-brown as above, trace of green shale. Dolomite - (20%) as above.

1534-1539' As above.

1539-1542' Shale - (60%). Dolomite - (40%).

1542-1546' Shale - (50%). Dolomite - (50%).

1545-1549' Dolomite - (80%) pale grey, brown, dense, silty, anhydritic. Shale - (20%) red-brown, green.

1549-1552' Dolomite - as above, trace of fine vugs in fine crystalline dolomite. Trace of shale.

1552-1556' Dolomite - (80%). Shale - (20%) red-brown and green, in part micaceous.

1556-1562' Shale - (60%) red-brown, trace of green. Dolomite - (40%) as above. Trace of chert and pyrite.

1562-1570' Shale - (80%). Dolomite - (20%).

1570-1575' Dolomite - (50%) as above, some fine crystalline vuggy dolomite. Shale - (40%) red-brown. Shale - (10%) green, in part very dolomitic.

1575-1580' Dolomite - (70%). Shale - (30%) red-brown, minor green. Chert abundant.

1580-1585' Dolomite - (50%). Shale - (50%) chert abundant.

1585-1589' Dolomite - as above, trace of fine crystalline vuggy dolomite. Trace of shale. Some chert and pyrite.
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1589-1595' Dolomite - (80%) light grey and light brown, dense to very fine crystalline, silty. Shale - (20%) red-brown, minor green, micro-micaceous, fissile.

1595-1600' Shale - (90%) red-brown. Dolomite - (10%).

1600-1605' Shale - (70%). Dolomite - (30%).

1605-1611' Dolomite - (90%) light grey to light brown, micro to very fine crystalline, slightly silty. Shale - (10%) red-brown.

1611-1617' Dolomite - (80%) as above. Shale - (20%) red-brown, some green.

1617-1623' Dolomite - light brown, micro to very fine crystalline, a few small vugs and a trace of intercrystalline porosity. Patches of clear anhydrite. Chert abundant.

1623-1631' Dolomite - (90%) light grey and light brown, as above. Chert abundant, Trace of pyrite. Shale - (10%) red-brown, minor green.

1631-1642' Shale - (90%) as above. Dolomite - (10%) Chert abundant.

1642-1647' Shale - (60%). Dolomite - (40%) light grey, dense to fine crystalline, trace with good intercrystalline porosity. Trace of red chert which has faint organic texture.

1647-1651' Dolomite - light grey and light brown, mostly microcrystalline, trace of very fine and fine crystalline with porosity. Abundant chert, in part red with organic? texture.

1651-1653' Dolomite - as above, chert; trace of coarse sand grains.

1653-1656' Dolomite (70%) as above, chert. Shale - (30%) red-brown, blocky in part silty.

1656-1661' Shale - (80%) as above, micro-micaceous. Dolomite - (20%).

1661-1667' Shale - (90%). Dolomite - (10%).
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1667-1672' As above.

1672-1675' **Dolomite** - light brown, micro-crystalline, trace of drusy vugs, trace of black partings.

1675-1677' **Dolomite** - light brown, brown, silty, micro to very fine crystalline, trace of drusy vugs, trace of chert.

1677-1679' **Dolomite** - as above. Brown chert, trace of pyrite, trace of green dolomitic siltstone.

1679-1685' **Dolomite** - (80%) as above. **Siltstone** - (15%) green, slightly dolomitic, shaly. **Shale** - (5%) red brown. Abundant coarse, rounded quartz grains occur in the shale. Dark brown chert, trace of pyrite.

1685-1687' As above, abundant chert - grey, white, red.

1687-1691' **Dolomite** - (80%) white, micro to very fine crystalline. **Dolomite** - (20%) light greenish grey, silty, grading to green shale. Abundant chert, abundant quartz sand grains, also large fragments of quartzite - pebbles? Trace of red-brown shale.

1691-1695' As above, trace of light brown siltstone to very fine sandstone with scattered coarse grains.

1695-1697' **Dolomite** - (60%) white, light brown, light green. **Shale** - (40%) red brown. Trace of green shale, scattered sand grains, a possible cast of a salt crystal. Chert abundant, sand grains more abundant than above.

1697-1700' **Shale** - (80%). **Dolomite** - (20%) chert, very abundant sand grains, a few are found in the red shale.

1700-1705' **Shale** - (90%). **Dolomite** - (10%) chert, abundant sand grains up to very coarse, some seen in place in the red shale, some in a jumbled matrix of green shale and dolomite.

1705-1707' **Dolomite** - (80%) white, very fine crystalline. **Shale** - (20%) red-brown, abundant sand grains.

1707-1713' **Dolomite** - (70%) white, trace of brown, dense to fine crystalline, trace of small vugs. **Shale** - (30%) red-brown, in part silty. Trace of chert: abundant coarse sand grains.
1713-1720' Dolomite - (60%) brown, micro-crystalline, silty, in part limy. One probable fracture face lined with large calcite crystals. Dolomite - (20%) white, as above. Shale - (20%) Abundant sand grains, trace of chert.

1720-1727' Dolomite - brown, micro to very fine crystalline, silty, faint pellet texture, slightly limy. A few drusy vugs. Trace of chert, pyrite.

1727-1732' Dolomite - as above.

1732-1737' Dolomite - as above.

1737-1742' Dolomite - as above, red chert. Trace of clear quartz crystals.

1742-1748' Shale - (90%) green and red-brown. Pyrite, coarse frosted sand grains, clear quartz crystals, sometimes in clusters. Dolomite - (10%).

1748-1753' Shale - (90%) green, red-brown and purple. Dolomite - (10%). Trace of quartz crystals.

1753-1755' Dolomite - (50%) light grey, dense, silty. Shale - (50%) as above.

1755-1760' Shale - red-brown, mottled with green. Trace of dolomite, chert, quartz crystals.

1760-1764' Shale - (50%) as above. Dolomite - (50%) light grey, greenish grey, silty, anhydritic? Abundant coarse to very coarse rounded quartz grains, mostly loose in the sample, a few embedded in dolomite. Quartz crystals and clusters.

1764-1768' Dolomite - as above, abundant sand grains.

1768-1774' Dolomite - medium grey, silty to very silty, anhydritic. A few sand grains. Trace of gypsum.

1774-1780' Dolomite - as above, trace of gypsum.

1780-1785' Dolomite - light brown to medium grey, micro to very fine crystalline, very silty.

1790-1795' Dolomite - (50%) as above. Silty shale - (50%)
greenish grey, very fine silt, pyritic. Trace
of red-brown siltstone.

1795-1802' Silty-shale - (20%) greenish, as above. Shale -
(40%) red-Brown. Siltstone - (40%) red-brown,
micro-micaceous.

1802-1807' Shale - (90%) red-brown, minor green, abundant
sand grains up to very coarse, mostly quartz, a
few red rock fragments, grains mostly loose, a
few seen in the shale matrix. Siltstone - (10%)
red-brown.

1807-1811' Shale - as above, sand grains abundant.

1811-1815' As above, trace of dolomite.

1815-1822' Shale - as above, no sand, trace of gypsum.

1822-1826' Shale - (90%) as above. Dolomite - (10%) light
tan, micro-crystalline, silty.

1826-1832' Shale - red-brown, in part micaceous, trace of
green shale. Trace of dolomite. Trace of red-
brown siltstone.

1832-1838' As above, trace of gypsum.

1838-1844' Shale - red-brown, minor purple in part micaceous,
trace of dolomite, trace of siltstone.

1844-1849' As above.

1849-1855' Shale - (60%) as above. Siltstone - (40%) red-
brown, micaceous.

1855-1860' As above, trace of dolomite.

1860-1865' Shale - (80%) as above. Siltstone - (20%) as above.
Trace of gypsum.

1865-1873' Shale - red-brown, in part micaceous. Trace of
gypsum.

1873-1880' Shale - as above, trace of gypsum, trace of brown
dense anhydritic dolomite.
1880-1885' Shale—(70%) as above. Dolomite—(30%) light brown, dense, silty, anhydritic.

1885-1888' Shale—(70%) red-brown, minor green. Dolomite—(30%) as above, abundant chert.

1888-1891' Shale—(50%) as above. Dolomite—(50%) as above, and Dolomite—mottled white and dark brown, anhydritic, crystals of anhydrite or gypsum. Abundant chert.

1891-1895' Dolomite—(90%) as above. Abundant chert. Shale—(10%) trace of brown limy siltstone.

1895-1900' Dolomite—(80%) as above. Shale—(10%). Siltstone—(10%) light brown very limy.

1900-1905' Shale—(20%) red-brown, micromicaceous. Shale—(20%) green, dolomitic, a few sand grains. Dolomite—(20%) tan, dense, silty. Siltstone—(40%) light brown, very limy. Traces of chert, fine crystalline dolomite, clear crystalline gypsum, quartz, sand grains.

1905-1910' Shale—(40%) green. Shale—(10%) red-brown. Dolomite—(30%). Siltstone—(20%) Trace of gypsum, sand grains.

1910-1915' Shale—(50%) red-brown. Shale—(10%) green, trace of brecciated fragments in a silty matrix. Limestone—(40%) brown, earthy argillaceous, very silty (about 50% silt) petroliferous?—dissolves leaving a brown scum. Trace of black chert, pyrite, black shale partings in limestone.

1915-1920' Red shale—(10%) in part sandy. Green shale—(10%). Silty limestone—(75%). Black chert—(5%).

1920-1927' Red shale—(10%). Green shale—trace. Silty limestone—(85%) Note—at this is in part so silty it could be described as a siltstoned, also it is in part chertified. Chert—(5%). Trace of quartz crystal clusters, clear fragments of quartz (large crystals?) pyrite, coarse sand grains.

1927-1930' Red shale—(20%). Green shale—(20%). Silty siliceous limestone—(60%). Abundant brown and black chert.
1930-1935' As above.

1935-1943' Red shale - trace. Green shale - (20%). Dolomitic silty limestone - (80%) light to dark brown, slightly to very silty, sugary texture. Abundant pyrite, trace of clear calcite crystals, also clear gypsum anhydrite.

1943-1949' Green shale - (30%) in part silty, in part very pyritic. Silty limestone - (70%). Abundant chert, quartz, pyrite and loose sand grains.

1949-1953' Red shale - (20%). Green shale - (30%). Siliceous silty limestone - (50%) light tan, brown, dense, somewhat earthy texture. Trace of chert, pyrite, sand grains.

1953-1958' Green shale - (70%). Siliceous silty limestone - (20%). Shale - orange-brown, sandy, silty, slightly limy, very soft. Abundant loose fine sand.

1958-1962' Green shale - (70%). Dolomite - (20%) light brown, dense, silty. Orange shale - (10%).

1962-1968' Green shale - (40%). Orange shale - (40%) - very sand or silty, also containing euhedral quartz crystals, soft. Silty dolomite - (20%). Abundant loose sand.

1968-1975' As above.

1975-1982' Green shale - (10%). Orange shale - (50%). Trace of dolomite, anhydrite. The rest of the sample is angular fragments, small crystals and grains of quartz. Presumably the section is orange shale with sand grains and quartz crystals, and much of the shale washes away.

1982-1988' As above.


1993-1999' As above.

1999-2005' As above.

2005-2011' As above.
2011-2017' As above.
2017-2025' As above.
2025-2030' As above.
2030-2035' As above.
2035-2040' As above.
2040-2047' As above.
2047-2055 Shale - (10%) as above. Limy siltstone - (90%) brown to medium grey, (A toss-up whether to log as siltstone or limestone). Trace of light brown, silty, very fine crystalline sugary dolomite. Trace of quartz and gypsum crystals, chert.
2055-2062' Silty limestone - limy siltstone - (90%) as above siltstone. (about 3 pieces out of 5 dissolve leaving a pile of silt). Limy dolomite - (10%) light brown, silty, very fine crystalline, sugary, porous. Light and dark brown chert, trace of brown earthy silicious carbonate.
2062-2067' Silty limestone - dolomitic, light brown, earthy to very fine crystalline, abundant dark brown chert. Some cuttings leave a brown bituminous? film on dissolving.
2067-2071' Silty limestone - as above, in part siliceous. Abundant dark brown and tan chert.
2071-2077' As above.
2077-2085' As above.
2085-2091' As above, in part dark brown.
2091-2094' Silty dolomitic limestone - dark brown, some light brown, earthy to very fine granular. Abundant chert.
2094-2100' As above.
2100-2105' As above.
2105-2110' As above.
2110-2115' As above. Trace of good porosity in the brown limestone.

2115-2120' As above, trace of gypsum.

2120-2125' Silicious rock - light brown, earthy, slightly limy. In appearance it is similar to some of the above limestone - perhaps silicified silty limestone. Abundant dark brown chert.

2125-2130' As above.

2130-2135' Silty dolomitic limestone - light brown and brown, mostly earthy, some very fine crystalline, in part silicified, abundant chert. Limestone leaves a brown scum in acid.

2135-2140' As above but more silicified.

2140-2145' As above.

2145-2148' As above, trace of good intercrystalline porosity in brown sugary dolomitic limestone.

2148-2153' Silty limestone - (20%) dark brown, dense. Dolomitic limestone - (80%) light brown, very fine sugary texture, silty fair to good porosity, no fluorescence or cut - strong petrolierous odour. Trace of chert.

2153-2155' As above.

2155-2162' Silicious limestone - light brown earthy texture. Abundant dark brown chert. Trace of dark brownish black bituminous shale brown streak.

2162-2167' As above, about 5% dark shale. Chert very abundant.

2167-2172' As above.

2172-2180' Limestone - (95%) light brown, in part dolomitic, in part siliceous, earthy, dense to very fine crystalline, abundant dark brown chert. Shale - (5%) dark brown, bituminous. Trace of pyrite, quartz crystals.

2180-2185' Limestone - (95%) brown, earthy to very fine fragmented texture, silty, in part siliceous. Clear crystals of calcite. Abundant chert. Dark shale - (5%).
2185-2192' As above.
2192-2198' As above, texture earthy to very fine granular, trace of fragmental.
2198-2205' As above.
2205-2212' Shale - (80%) rusty red, soft, silty, slightly micaceous. Limestone - (20%) as above.
2212-2220' Silty shale and shaly siltstone - gradational from shale to silt. Some limestone and chert cavings?
2220-2225' As above.
2225-2230' As above.
2230-2235' As above.
2235-2243' As above.
2243-2246' Silty shale - (40%) as above. Limy dolomite - (60%) light grey, very fine granular, silty to very silty, in part sandy. Sand grains up to coarse in shale as well as the dolomite, trace of sandstone.
2246-2255' Silty dolomite - as above.
2255-2259' Silty dolomite - as above. Trace of good inter-crystalline porosity. Abundant light and dark chert. Trace of siltstone as below.
2259-2265' Dolomite - (80%) white to grey, earthy to dense, in part siliceous, light coloured chert is very abundant. Siltstone - (20%) rusty red, in part sandy (very fine) micaceous, speckled with white and dark grains. Similar to above silty shale in appearance. Abundant fine to very coarse rounded quartz grains.
2265-2270' Sandy siltstone - as above, grades from coarse silt to fine sand, shale partings, abundant loose sand grains. Abundant chert - cavings?
#1 Waterhouse - Sample Descriptions

2270-2275' Sandy siltstone - red-brown, slightly dolomitic, micaceous. Trace of greenish siltstone, red shale, pyrite, large sand grains.

2275-2280' As above, loose sand grains are very abundant.

2280-2285' Sandy siltstone - (80%) orange-brown, micaceous. Shale - (20%) dark red, micaceous. Loose sand grains.

2285-2295' As above. Abundant dolomite and chert - cavings?

2292-2301' Shaly siltstone - (30%) red-brown. Shale - (40%) red-brown. Chert, quartz - some limestone - 30% cavings?

2301-2310' Siltstone -(90%) sandy. Shale - (10%). Abundant quartz and chert.

2310-2315' As above.

2315-2320' As above. Trace of light coloured sandstone.

2320-2327' Sandstone - red-brown, very fine grained, silty, shaly, slightly dolomitic, trace of dark grains, rare coarse grain. Some micaceous silty shale, probably as partings. Trace of light grey or greenish sandstone. No visible porosity.

2327-2332' As above.

2332-2336' Sandstone - (80%) lighter than above, miliceous. Silty shale - (20%) red-brown, micaceous.

2336-2341' Sandstone - light orange, minor light grey, fine grained, fair sorting, in part silty, siliceous cement, slightly dolomitic. About 5% of the grains are non-quartz: soft white or greenish grains, black grains, and a transparent mineral which may be feldspar. Trace of poor porosity.

2341-2347' Sandstone - light grey to reddish, otherwise as above, green shale grains are common. Trace of green micaceous shale.

2347-2353' Sandstone - very fine to fine grained minor siltstone.
2353-2358' As above.

2358-2365' Sandstone - over half the sample is loose quartz grains, fine grained, ranging from very fine to medium. Remainder as above. Trace of quartz crystals, patches of gypsum.

2365-2373' Nearly all loose fine sand. Rare rock fragments show the sand is cemented in part by secondary quartz, with clay film surrounding the enlarged grains, little or no porosity.

2373-2381' As above - (95%). Cavings? - (5%) - green shale, siltstone, red shale, chert.

2381-2388' As above.

2388-2394' As above. Abundant greenish, sandy, micaceous siltstone.

2394-2402' Sand - as above. Trace of green shale, in part very micaceous.

2402-2411' As above, some pyrite as cement. The consolidated cuttings show most of the sand is bound by a silty or clay matrix and is tight, a few cuttings are cemented by quartz regrowth.

2411-2419' As above, only a trace of pyrite.

2419-2428' As above.

2428-2437' As above, pyrite more abundant.

2437-2447' As above, only a trace of pyrite.

2447-2453' Sandstone - red-brown, fine grained, the red colour is from a film of iron oxide around each quartz grain. Cement or matrix is partly silica (crystal growth) partly dolomite, partly a clay film around grains. Light and dark, unidentified grains form about 5% of the sand. Some pyrite as cement. No visible porosity. Trace of micaceous siltstone.

2453-2459' Sandstone - as above. About half the sample is of loose grains.

2459-2467' As above.
2467-2471' Sandstone - (80%) very fine grained. Shale - (20%) dark red and light green, micaceous.

2471-2480' Sandstone - (90%) as above, very fine to fine. Shale - (10%) as above.

2480-2491' Sandstone - as above, trace of lighter coloured sandstone. Minor green and red shale, trace of siltstone.

2491-2499' Sand - all of the sample consists of loose very fine to fine red coated sand grains. Trace of mica, pyrite, green shale. Many quartz grains show crystal faces.

2499-2515' As above, a few sandstone fragments showing cementation as described above.

2515-2527' Sandstone - (90%) as above, mostly in grains. Shale - (10%) light green and dark red. Trace of pyrite cement.

2527-2539' Sandstone - as above. Trace of shale.

2539-2550' As above.

2550-2557' Sandstone - (90%) as above, in part very silty and micaceous. Some pyrite cement. Shale - (10%) green, micaceous.

2557-2560' Sandstone - red, very fine to fine grained, in part silty and micaceous, some pyrite cement. Trace of red and green shale.

2560-2565' As above. Trace of white shale? or rock flour.

2565-2570' Sandstone - red, very fine grained, silty. Trace of white shale.

2570-2579' Sandstone - (30%) as above. Sandy siltstone - (20%) red, shaly. Shale - (50%) red, micromicaceous.

2579-2590' Sandstone - (90%) red, very fine to fine grained, silty, shaly, micaceous. Shale - (10%) green and red, green shale is very micaceous.

2590-2600' As above.
Shale - (90%) dark red, micromicaceous. Sand - (10%) loose very fine grains.

Shale - (20%) as above. Silty sandstone - sandy siltstone - (80%) red, in part siliceous.

Silty sandstone - (70%) red, very fine grained, micaceous, in part siliceous. Shale - (30%) as above.

Shale - (70%) micaceous. Siltstone - (30%) red, shaly, micaceous. Trace of green shale.

Shale - (60%) micaceous. Silty sandstone - (40%) very fine grained. Trace of green shale.

Shale - (40%). Silty sandstone - (60%).

Silty shale - red, micaceous, minor siltstone.

Shale - (80%) mostly silty, in part soft, fissile, non-silty, micaceous. Siltstone - (20%) greenish and brownish grey, very slightly dolomitic, hard, siliceous. Trace of green shale.

Sandy siltstone - (90%) greenish and reddish grey, in part very fine grained silty sandstone, micaceous, a few bright green grains (probably not glauconite) hard, siliceous, laminated with: Shale - (10%) red and bright green, in part silty.

Silty sandstone - (70%) more sand than silt, otherwise as above. Shale - (30%) red-brown, minor green, in part silty and sandy. A few loose very coarse sand grains.

Sandstone - (80%) orange and red brown, very fine grained, but poorly sorted, scattered coarse to very coarse quartz grains, minor mica, shaly silty matrix, some silicification. A few green grains. Loose grains to over 1 mm are abundant. Shale - (20%) red-brown, minor green, in part silty.

Shale - (70%) as above. Sand - (30%) mostly loose grains, very fine to small granules.
$1$ Waterhouse - Sample Descriptions

2680-2687' Sandstone - (90%) orange-brown, fine grained, poorly sorted, ranging from very fine to very coarse. Cemented by quartz regrowth, original grain outlined by iron oxide. Nearly all quartz, a few dark grains - pyrite? Slightly dolomitic, trace of large white dolomite crystals. Trace of poor porosity. Shale -(10%) red-brown, minor green and white, in part silty.

2687-2692' As above, no porosity.

2692-2698' As above.

2698-2703' As above, rare fragment of chert (pebbles?).

2703-2709' As above.

2709-2715' As above.

2715-2722' Sandstone - (80%) as above. Shale - (20%) dark red-brown, fissile, micaceous, some bright green.

2722-2728' Sandstone - (90%) mostly red or orange brown, patches of white, very fine grained with a few (mostly loose grains) grains to 1 mm, silty matrix, less siliceous than above. Shale - (10%) as above.

2728-2735' Sandstone - (90%) orange-brown, very fine grained, rare coarse grain, in part silty, in part siliceous. Shale - (10%).

2735-2741' Silty sandstone - (80%) as above, but more silty and more coarse and very coarse grains. Shale - (20%) as above, minor siltstone.

2741-2748' Shale - (70%) as above. Sandstone - (30%) fine to very fine, silty, poorly sorted, abundant coarse - very coarse grains.

2748-2754' Shale - (40%) as above. Sandstone - (60%) as above.

2754-2760' As above, sandstone is in part non-silty, trace of poor porosity.

2760-2765' Shale - (10%). Sandstone - (90%) fine grained, ranging from very fine to coarse, mostly as loose grains.
#1 Waterhouse - Sample Descriptions

2765-2770' Shale - (30%). Silty sandstone - (40%) very fine grained. Loose sand - (30%) as above.

2770-2775' As above, abundant quartz grains up to 2 mm.

2775-2781' Shale - (20%). Sandstone - (80%) mostly loose grains, as above.

2781-2787' As above, coarse grains and granules very abundant. These grains are spherical, well rounded, frosted.

2787-2794' Shale - (40%). Silty-sandstone - (60%) very fine grained, rare coarse grain.

2794-2798' Shale - (20%) red-brown, only a trace of green. Sandstone - (80%) mostly loose grains - very fine and fine, with abundant grains to 2 mm.

2798-2804' Shale - (50%). Sandstone - (50%) very fine grained, silty, shaly, micaceous, rare patches with crystals of dolomite.

2804-2809' Shale - (70%) in part sandy. Sandstone - (30%) as above, rare coarse grain.

2809-2814' As above.

2814-2819' As above.

2819-2826' Shale - (40%). Sandstone - (60%) much of the sample is of loose grains.

2826-2835' Sandstone - mostly loose grains, fine grained, fair sorting, range from silt to coarse; in the few cuttings the grains are bound by crystal growth. Less than 5% shale.

2835-2840' Sandstone - as above, a few cuttings? of very soft shaly sandstone, these swell a little and disintegrate rapidly in water. If these are cuttings, not reaggregations in the drilling fluid, then the sand has a red bentonite clay matrix. Abundant coarse grains, granules and fragments of pebbles, clear quartz, milky quartz, white, yellow, pink and red chert or jasper, trace of oolitic texture in one chert fragment. (from eroded Bitter Springs or Areysonga). About 5% shale, cavings?
#1 Waterhouse - Sample Descriptions

2840-2845' Sandstone - (80%) red and orange brown, very fine grained, trace of dark grains and green shale grains, hard, siliceous. Some loose grains, trace of coarse grains. Shale - (20%) red, micaceous.

2845-2850' Shale - (60%) in part sandy. Sandstone - (40%) mostly loose fine grains, partly siliceous as above. A few coarse grains and pebble fragments.

2850-2855' As above.

2855-2861' As above.

2861-2865' Sandstone - (90%) very fine to fine grained, mostly siliceous, part as loose grains, in part silty and shaly. Shale - (10%).

2865-2868' Sandstone - (90%) very fine grained, silty. Shale - (10%).

2868-2873' Sandstone - fine and medium grained, rare coarse grain. Half the sample is of chips with siliceous cement and no porosity; the rest is of loose grains.

2873-2880' Sandstone - (90%) fine to medium grained, mostly loose grains. Trace of poor porosity in the cemented chips. Rare cutting of friable sand loosely cemented at grain contacts by quartz overgrowths, excellent porosity. These may indicate that most of this sample and much of the one above is of friable porous sandstone. No fluorescence, but patches of the loose sand cut in Carbon Tetrachloride giving yellow fluorescence. This is the same reaction as is obtained from grease from the drilling line. No trace of the grease can be found in the sample, however the fluorescence may be contamination. Shale - (10%) in part sandy. A few fragments of yellow chert pebbles.

2880-2885' Loose sand - (40%) as above. Sandstone - (40%) fine grained, siliceous cement. Shale - (20%).

2885-2889' Sandstone - fine grained, rare medium and coarse grain, mostly loose sand, cuttings are cemented by silica, trace of poor porosity. Trace of red shale.

2889-2892' As above.
#1 Waterhouse - Sample Descriptions

2892-2897' Sandstone - (80%) very fine to fine grained, in part shaly, mostly loose grains. Shale - (20%) silty and sandy.

2897-2902' Sandstone - (90%) as above. Shale - (10%) as above.

2902-2905' Sandstone - as above, trace of shale.

2905-2911' As above, nearly all loose sand.

2911-2917' Sand - fine grained, fairly well sorted, range from very fine to medium, abundant dark heavy mineral grains in the very fine faction, nearly all loose sand. The few cuttings show traces of fair to excellent porosity. Abundant grease contamination.

2917-2925' As above.

2925-2933' As above.

2933-2941' Sand - less well sorted, medium grained, range very fine to very coarse, pebble fragments (including a white rock and yellow jasper). Some fair porosity in the few cuttings. Dark heavy mineral grains abundant in the fine faction, very abundant in the very fine faction.

2941-2946' As above.

2946-2950' As above.

2950-2956' Sand - (90%) fine grained, abundant white siliceous rock fragments. Shale - (10%) in part silty and sandy.

2956-2962' Sand - as above, trace of shale.

2962-2969' Sand - medium grained, range very fine to very coarse, pebble fragments.

2969-2975' As above.

2975-2982' As above.

2982-2990' As above - A few cuttings, traces of poor to excellent porosity.
#1 Waterhouse - Sample Descriptions

2990-2998'  As above.
2998-3005'  Sand - mostly fine and medium, range very fine to coarse.
3005-3012'  As above.
3012-3020'  As above.
3020-3025'  As above, a few very coarse grains.
3025-3033'  As above.
3033-3042  As above.
3042-3047'  As above.
3047-3050'  As above.
3050-3055'  As above.
3055-3060'  As above.
3060-3065'  As above.

CORE NO. 1  3065' to 3081"  Rec. 16'

Sandstone: red, generally medium grained, grains ranging from very fine to coarse, scattered small pebbles, poor to fair sorting with thin well sorted (generally medium or coarse) bands. Grains are 95% quartz, rest are a fairly soft white mineral, a green mineral and black grains (heavy minerals?), rare red grains, a few light coloured feldspar grains. The sand is fairly friable, the grains loosely bound by secondary quartz. The matrix is red-brown clay or iron-oxide which coats each grain and fills most of the pore spaces. Porosity is spotty, from none to very good, the latter is confined to the sorted medium and coarse layers. Thin pebble bands and scattered small (1/8") pebbles. Large pebbles, up to 1" are of red or green shale, and a white cherty rock, small pebbles are of the latter.

3065-3069'  fine grained, poorly sorted, cross bedding dips 20° to 25°: No visible porosity.
3069-3081' Medium grained, porous, faint horizontal bedding, breaks into poker chips. Three layers each 1' thick of fine, tight sandstone with cross-bedding dips from 15° to 40°. The cross-bedded basal foot is in part greenish grey, rich in dark and green mica. The colour boundaries are partly regular along forset beds, partly as irregular flame structures. Two partly open fractures occur, these dip 80. One 3" long occurs at 3068', one 10" long occurs at 3079' - 3080'.
RESUME OF PROFESSIONAL QUALIFICATIONS & EXPERIENCE

G. K. WILLIAMS

Graduate of the University of Alberta:
Bachelor of Science (Honors), Geology, 1950

Society Membership:
Alberta Society of Petroleum Geologists
The Association of Professional Engineers of Alberta
The Geological Association of Canada
The Australasian Institute of Mining & Metalurgy

Record of Experience:
1950-51: Geologist with the Alberta Oil & Gas Conservation Board, Calgary, Alberta.
--subsurface studies

1951-53: Well-site Geologist with Canadian Well Services Ltd., 328A 8th Avenue W., Calgary, Alberta.

--extensive field mapping in Western Canada
--well-site work including geological and completion work
--direction of exploration in remote areas including road construction, movement and supply of camps, technical supervision of wildcat, stratigraphic and structure test drilling
--subsurface studies
--land evaluation

1959-61: Associate with D. Bruce Bullock & Associates Ltd., 627 8th Avenue West, Calgary, Alberta.

1961-present: Manager, Bullock & Associates Pty. Ltd., Brisbane, Queensland, Australia.
--field work in:
  Amadeus Basin (3 months)
  Bowen Basin (1 month)
  Sydney Basin (5 months)

--review of literature:
  Queensland
  Amadeus Basin
  Murray Basin
COMPARISON, ALICE NO. 1 TO WATERHOUSE.

The pertinent geological section in Alice No. 1 is as follows.

<table>
<thead>
<tr>
<th>System</th>
<th>Formation</th>
<th>Depth</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordovician</td>
<td>Pacoota</td>
<td>2115 to 3004</td>
<td>889 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3004 to 3850</td>
<td>846 ft</td>
</tr>
<tr>
<td>Cambrian</td>
<td>Goyder</td>
<td>3850 to 7240</td>
<td>3390 ft</td>
</tr>
<tr>
<td>Jay Creek</td>
<td>Unit 1</td>
<td>3850 to 4220</td>
<td>370 ft</td>
</tr>
<tr>
<td></td>
<td>Limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit 2</td>
<td>4220 to 4860</td>
<td>640 ft</td>
</tr>
<tr>
<td></td>
<td>Limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; shale</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit 3</td>
<td>4860 to 5810</td>
<td>950 ft</td>
</tr>
<tr>
<td></td>
<td>Shale,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; dolomite</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit 4</td>
<td>5810 to 6650</td>
<td>840 ft</td>
</tr>
<tr>
<td></td>
<td>Dolomite</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; shale</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit 5</td>
<td>6650 to 7240</td>
<td>590 ft</td>
</tr>
<tr>
<td></td>
<td>Shale</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; salt</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arumbera</td>
<td>7240 to 7518 ft</td>
<td>278 ft</td>
</tr>
</tbody>
</table>

Note: The term 'Hugh River Shale' was not used in the report on Alice No. 1, nor is it used by the B.M.R. in mapping the Waterhouse Range. The Hugh River shale is probably equivalent to units 3, 4 and 5.

I have recently investigated the outcrop in the Waterhouse Range in an attempt to establish where in the section Waterhouse No. 1 spudded.
RESULTS.

Waterhouse spudded somewhere near the top of Unit 3. The forecast depth to the Arumbera is between 2,000' and 2,300'. The shale and salt unit is forecast between 1400' and 1700'.

DISCUSSION.

GOYDER.

The Goyder member is easily recognizable in outcrop although the top of the formation cannot be accurately picked. A shale break in the basal Pacoota beds present at the Waterhouse can be correlated with a marker in the Alice well. The combined Goyder and basal Pacoota interval measures 1165' in the field and 1040' in Alice No. 1. Because there is a poorly exposed zone in the measured outcrop section, with small folding and possible repetition of beds, the measurements may be too thick. The difference in thickness of 125' is within the limit of possible error of measurement, therefore the Goyder cannot be confidently said to be thicker at Waterhouse.

The lithology in outcrop is mainly fine sand, silt and clay intermixed in varying proportions. Carbonates are present but rare. There is much more carbonate logged in the Alice well.

JAY CREEK.

Unit 1 is 370' thick in Alice No. 1 and consists of pellet limestone. In outcrop at the Waterhouse 425' of pellet limestone with some interbedded shale was measured. No conclusions regarding regional thickness changes should be drawn from these measurements because of the gradational nature of the upper and lower contacts, both in outcrop and in Alice No. 1.

Unit 2 in Alice No. 1 is 640' thick, and consists of limestone with 20% shale. In the Waterhouse the equivalent section is about 500 feet thick, and is not exposed except for a few thin beds of calcareous siltstone.
From about 500 feet below the base of Unit 1 to the core of the anticline the section is covered except for a few 1' to 10' beds of silty dolomite. There are no markers which can be used to the Alice No. 1 section.

MEASUREMENTS.

The lowest useful marker common to the Waterhouse surface and to Alice No. 1 is the top of the Jay Creek member, ie the top of unit 1 limestone. This marker is exposed near the Waterhouse well on both flanks of the anticline. Because of the poor exposure and the variability in the dip of the beds, an accurate measurement is not possible. The order of the thickness however can be established with little doubt - there does not seem to be any significant faulting or structural complexity. From the top of unit 1 to the well site the interval was measured as 1100' on the south flank and 1350' on the north flank.

REGIONAL FACIES AND THICKNESS CHANGES.

The Cambrian is nearly all carbonates 60 miles northeast of Waterhouse No. 1, and nearly all clastics 60 miles west of Waterhouse No. 1. For the 1,000 ft. drilled so far in Waterhouse No. 1, the ratio of shale to dolomite is about the same as in the equivalent section in Alice No. 1. For the higher section, the lack of outcropping beds may indicate a much higher percentage of shale in the Waterhouse Range than in Alice No. 1.

We do not have enough accurate measurements to predict thickness changes between Waterhouse No. 1 and Alice No. 1. The combined Goyder and Jay Creek intervals for nearby areas are as follows.

<table>
<thead>
<tr>
<th>Area</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice No. 1</td>
<td>4236'</td>
</tr>
<tr>
<td>30 miles north-east of Waterhouse No. 1</td>
<td>3840'</td>
</tr>
<tr>
<td>James Range B</td>
<td>3600'</td>
</tr>
<tr>
<td>30 miles south-west of Waterhouse No. 1</td>
<td>3600'</td>
</tr>
<tr>
<td>Ellery Creek</td>
<td>3600'</td>
</tr>
<tr>
<td>60 miles north-west of Waterhouse No. 1</td>
<td>3600'</td>
</tr>
</tbody>
</table>

G.K. Williams.
ALICE NO.1

PACOOTA

marker in basal

GOYDER

(1040')

(1165')

Difference due to errors in measuring

unit 1

(370')

unit 2

(425')

(1100' to 1350')

JAY CREEK

4860

WATERHOUSE No. 1 outcrop

unit 3

5810

unit 4

6650

unit 5

7240

(salt & shale)

ARUMBERA

-1400' to 1700

-2000' to 2300'*

* Note: Assuming no thickness change from Alice No. 1

Vertical scale: 1" = 500'

G.K. Williams March, 1965
<table>
<thead>
<tr>
<th>Depth</th>
<th>Date</th>
<th>Conductivity</th>
<th>Remarks</th>
</tr>
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<tr>
<td>2445'</td>
<td>5/5/65</td>
<td>463 M/\muhos</td>
<td>(before cementing) 2160</td>
</tr>
<tr>
<td>2475'</td>
<td>5/5/65</td>
<td>3298 &quot;</td>
<td>(after cementing) 306</td>
</tr>
<tr>
<td>2700'</td>
<td>10/5/65</td>
<td>3401 &quot;</td>
<td></td>
</tr>
<tr>
<td>2990'</td>
<td>17/5/65</td>
<td>3472 &quot;</td>
<td></td>
</tr>
<tr>
<td>3050'</td>
<td>18/5/65</td>
<td>3367 &quot;</td>
<td></td>
</tr>
<tr>
<td>Analysis by</td>
<td>Name of Bore</td>
<td>4 MILE</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
<td>--------</td>
<td></td>
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<tr>
<td></td>
<td>WATERHOUSE NO. 1</td>
<td>LEASE</td>
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<td></td>
<td>CLASS</td>
<td>BORE No.</td>
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### ANALYSIS (Results in parts per million)

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<th>14.2.65</th>
<th>211.2.65</th>
<th>3</th>
<th>29.4.65</th>
<th>4</th>
<th>29.4.65</th>
<th>5</th>
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<tr>
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<td>364</td>
<td>176</td>
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<td>not det.</td>
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<td>Calcium</td>
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<tr>
<td>DEPTH</td>
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<td>723'</td>
<td></td>
<td>(1075')</td>
<td>(2447')</td>
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<tr>
<td>pH</td>
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<td>8.1</td>
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<tr>
<td>Total Salts</td>
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<td>634 approx.</td>
<td>440 approx.</td>
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### REACTING VALUES

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<th></th>
<th>rCl-</th>
<th>r(SO4 + NO3)</th>
<th>r(CO3 + HCO3)</th>
<th>r(Na + K)</th>
<th>rCa</th>
<th>rMg</th>
<th>Total Reacting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>%</th>
<th>Cl-</th>
<th>(SO4 + NO3)</th>
<th>(CO3 + HCO3)</th>
<th>(Na + K)</th>
<th>Ca</th>
<th>Mg</th>
<th>Total % Error</th>
</tr>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Remarks:** This E.H. of this sample was noted to be very high at 12.1. It is felt that this pH is due to contamination during collection. No further analysis will be performed on this sample.