

APPENDIX 4

CORE DESCRIPTION

<u>Interval</u>	<u>Core Description</u>
	<u>Corcoran Formation</u>
0.m - 2.0m	<u>Rotary drill to 10.3m.</u> <u>Sandy siltstone</u> , dark reddish brown to greyish red. Quartz grains comprise approximately 30% of sample, clear to moderate brown, fine to medium grained, sub rounded to rounded.
2.0m - 4.0m	<u>Siltstone with sandstone</u> , moderate olive brown to olive grey. Quartz grains as above but comprise only 20% of sample.
4.0m - 6.0m	<u>Siltstone with sandstone</u> , light olive brown to moderate olive brown. Quartz grains comprise 20%, clear to pale red fine to medium grained, rounded.
6.0m - 8.0m	<u>Silty claystone</u> olive grey to occasionally blackish red.
8.0m - 10.0m	<u>Silty claystone</u> , light olive grey to moderate olive brown, occasionally light olive brown.  <u>Cored 103mm, later reamed to 5-5/8".</u>
10.2m - 15.0m	<u>Silty mudstone</u> . Greyish olive at top grading to olive grey at base. Iron staining to light olive brown, associated with fractures and thin >3mm fine sandstone interbeds. 5mm thick fine to very fine sandstone at 13.7m, pale reddish brown in colour.
15.0m - 32.4m	<u>Silty mudstone grading to a muddy siltstone at base.</u> Greyish olive green, grades to dark grey to greyish black between 25.0 and 25.8m. Interbedded sandstones of between 1 & 5mm in thickness becoming more frequent towards base of interval. (below 28.4m). Unit is thinly laminated.  Between 15.0 & 15.2m are 3 low angle fractures with abundant iron staining surrounding core (up to 1cm) has been altered to a light olive brown colour. 15.3 - 15.45m - three fine to very fine grained, dark yellowish orange silty sandstones between 3mm and 1cm in thickness.

IntervalCore Description

- 15.0m - 32.4m (cont.) The mudstone has been altered to a light olive brown up to 2cm from the sands. Most likely as a result of surface ground water movement.
- 17.35m; 0.5-1.0cm thick dolomite band, very light olive grey in colour with minor mottled inclusions of dark grey mudstone.
- 18.35m; three thin (<4mm) lenses of calcareous very fine grained sandstone. 18.5 - 18.6m almost vertical fracture with vein of <1mm thick calcite infilling.
- 19.3m; 4cm thick zone of fine to medium grained sandstone with abundant calcite cement. Colour varies from light bluish grey to greenish black. Well developed wavy bedding. Immediately below is an 8mm thick zone of black organic rich siltstone, 5mm thick zone of black organic rich siltstone, 5mm thick olive grey mudstone and 4mm of fine grained sandstone with abundant glauconite; colour is greyish grey. 1.5cm of olive grey mudstone, 3mm of glauconitic sandstone (as above) and 5mm of black organic rich siltstone. The underlying 10cm of mudstone is greyish green in colour and represents increased glauconite content.
- 19.8m; 5-10mm thick calcareous fine grained sandstone. As for 19.3m, 20.29m low angle fault (10-15°) zone is up to 5mm thick and contains brecciated claystone in a soft light grey clay matrix.
- 32.4m - 36.8m Interbedded siltstone and sandstone grading to very fine sandstone. Sand units are generally less than 5mm although approach 2-3cm between 35.0 and 36.0m. Fining up cycles are evident with the thicker sand bodies. Interbeds dip between 10-20°. Siltstone: olive grey, finely laminated, hard and sub blocky. Sandstone - light olive grey, very fine grained, grading to siltstone. Siliceous cement common, with calcareous cement present in some of the coarser units. Slumping and cross bedding evident, fault intersection 32.9m, approximately 5mm wide zone of brecciated siltstone with calcareous cement. 33.3m small fault (3mm throw) associated with slumped silty sandstone, may be as a result of differential compaction.
- 36.8m Fault zone approximately 3cm wide dipping at 45°. Brecciated siltstone in a matrix of light olive grey clay with minor calcareous cement.

IntervalCore Description

- 36.8m - 65.5m Siltstone with thin minor interbedded sandy siltstones and minor thin wisps of mudstone. Siltstones: olive grey to greyish olive, finely laminated, hard, sub blocky. Slumping of siltstones. Sandstones: light olive grey to light grey, grade from siltstones to very fine grained silty sandstones, coarser units have common mica and often calcareous cement, minor slumping. Mudstones: Thin black wispy seams up to several mm thick but generally less than 2mm, most likely organic rich. 41.7m; 2mm thick layer of greyish green glauconite over top of slumped sandy siltstone. 42.6m; small fault, dip 60°, sense is normal but is associated with smaller reverse fault of same dip. Indicates possible strike-slip movement.
- 58.9m; 5cm thick medium grey to dark grey sandstone. Grains are clear to predominantly medium dark to dark grey, well rounded and well sorted, abundant calcareous cement and quartz overgrowths, trace glauconite. No visible porosity. Sub vertical fracture over the length of the sand has brown stain and yellow fluorescence. This may represent some form of residual bitumen. 62.4 - 62.6m; well developed slumping of units.
- 65.5m - 66.7m Interbedded sandstone and siltstone, cross bedding and scours present at base of sand units. Sandstones: grade from siltstone, through to very fine sandstones (described above) to medium grained glauconitic sandstones with minor calcareous cement and quartz overgrowths. Beds range between 1 & 5cm in thickness and generally fine upwards into the overlying siltstone. Several thicker finer units occur between 66.0 & 66.4m. Scouring and crossbedding occur towards the base of the coarse sands. Siltstones: as above.
- 66.7m - 74.8m Siltstones with thin interbeds of sandy siltstone and minor laminae of mudstone, very similar to sequence between 36.8 & 65.5m. Fault zone between 68.05 & 68.5m. Fault cuts core at about 45° with numerous fractures and several zones of brecciation. Breccias consist of small <5mm angular fragments of siltstone in a silty clay matrix. Zones are up to 3cm thick. Smaller faults at 70.7 and 71.6m.
- 74.8m - 79.1m Interbedded siltstone and sandstone ranges from thinly interbedded/laminated (<5mm) to massively interbedded (<20cm). Sandstone: Light greenish grey, very light grey to greenish grey, very fine grained although some units grade to medium grained at the base. Poorly developed, fining upward cycles.

IntervalCore Description

74.8m - 79.1m (cont.) Occasional cross bedding and basal scours evident. 3mm bed of glauconitic medium grained sandstone is present at the top of a sand at 75.4m. All sands strongly cemented with quartz. No porosity. Thin fractures at 76.6m have quartz in-filling. Slumping and cross bedding evident in some of the finer sandstone. 79.0 - 79.1 has unusual vertical cross bedding. Siltstone: as for 66.7m - 74.8m.

Munyi Member - Abner Sandstone

79.1m - 81.6m Thinly interbedded siltstone (60%) and sandstone (40%). Interbeds range between several mm and 1-2cm, most commonly 5mm. Siltstone: As above. Sandstone: greenish grey very fine grained to fine grained, fining upwards cycles common in thicker (>1cm) units. Minor scours evident at the base of most sands. Frequent current bedding and slumping. Sands are well cemented with quartz.

80.2 - 80.4m; normal fault with 5mm throw dips about 70°. 80.9m; fault, 45° dip, evidence of drag on upper block.

81.6m - 83.5m Siltstone: Massive dark grey, hard, sub blocky.

83.5m - 89.9m No returns. Drilled with rotary bit for F.I.T.

89.4m - 93.3m Siltstone: Interbeds of sandstone (30%) becoming more common towards base. Siltstone as previously described, possibly grading to fine sandstone. Sandstone: Two types seen. (A) medium grained bluish grey sandstone between 5mm and 1cm in thickness. Upper and lower boundaries are often irregular indicating slumped deposition, abundant siliceous cement. (B) Very fine to fine grained pinkish grey sandstone, 2-3cm in thickness, often associated with coarser sand, only minor evidence of slumping.

93.3m - 105m Sandstone with interbeds and occasionally slumped siltstone (20%) and minor mudstone (trace). Unit shows chaotic slumping and strong sulphide mineralization, often associated with open fractures but disseminated throughout the more silty units. Minerals present include sphalerite, galena, chalcopryrite and quartz. Samples taken for analysis. 94.65m; sphalerite, galena in a fine to medium grained sandstone. 99.85 - 99.95m; very fine grained sandstone with sphalerite and quartz crystals along open fracture.

Interval

Core Description

93.3m - 105m  
(cont.)

Mineralization generally as disseminated crystals up to 2-3mm between 94.6m and 95.6m. Over this interval, mineralization comprises around 5% of sample but in isolated areas may reach 20%. Sphalerite is yellow to pink in colour. Between 99.6 and 100m similar mineralization but seems to be confined to open fractures that are up to 1cm wide - several small fractures below this interval also show signs of mineralization.

Siltstones: As described.

Mudstones: Dark grey to greyish black, most common at 99.4m.

All units show evidence of slumping with some scouring. Cross bedding and fining or coarsening upward cycles are not present.

Shows: Residual bitumen staining on vertical fracture at 93.8m, with dull yellow fluorescence. Dull orange fluorescence is associated with sulphide mineralization.

Hodgson Sandstone Member - Abner Sandstone

105m - 126m

Massive Sandstone: Very light grey to light grey, fine grained, becoming coarse between 17.8m and 120.4m strongly silica cemented over whole interval. No visible porosity. Interval between 114.2m and 117.9m contains interbedded and slumped siltstone (40%) as previously described.

Slumping is chaotic at top but decreases towards the base where interbedding is more common, individual units are up to 10cm in thickness. The remaining sandstone is characterised by absence of sedimentary structures, although some minor slumping is evident. Shows: The following intervals exhibit a bright yellow to blue white fluorescence, appears to be 100% at surface of core, but is only a spotted 20% of a fresh section of broken core; 107.8 - 107.9m, 108.9m, 109.8 - 110m, 110.15 - 110.25m. In addition, similar fluorescence is present in fractures between 110.5 & 110.85m, 112.5-112.7m. All fluorescence is associated with a streaming yellow white crush cut with weak ring residue. The shows in the sandstone appear restricted to those units with slightly coarser grain size. Zones still have negligible porosity and permeability as a result of quartz cement.

126m - 129.3m

Massive Sandstone: As above.

Shows: Fluorescence and cut as described above over 128.0 - 128.3m. Last 0.5m grades to underlying formation, i.e. very fine sandstone.

Interval

Core Description

129.3m -  
138.15m

Jalboi Member - Abner Sandstone

Interbedded massive sandstone (80%), mudstone (15%) siltstone (5%).

Sandstone: Very light grey to light grey, very fine to fine grained, medium grained between 135.1 & 135.5m, hard, silicified, no porosity, no bedding evident, but contacts with mudstones are slumped. May be a result of sediment movement during initial compaction and dewatering.

Mudstones: Dark grey to black, finely laminated, often occurring as collections of thin wisps in the sandstones. Beds are seldom more than a few mm thick with agglomerations to several cm between 136.6m 136.8m and 137.8m. 138.1m; mudstones are massively bedded but still show fine laminations and features related to dewatering.

Siltstone: Similar to that previously described but occurs mainly as small slumped inclusions in the sandstone.

138.15m  
- 169.15m

Crawford Formation

Interbedded sandstone (60%) siltstone (35%) with minor Mudstone (5%). Beds range between fine laminae to almost massively bedded 30-40cm, poorly developed graded bedding evident in some of the coarser units, minor scouring present at the base of most of the sand units.

Sandstone: Dominantly light bluish grey to greenish grey, very fine grained to fine grained. Common thin laminae of glauconite-rich sand, individual sand units exhibit a poorly defined fining upward cycle, however sands become finer grained and less common towards the base of the interval. Cross bedding evident towards the top of some of the coarser but thinner (3-5cm) sand units. 142.75 - 142.8m coarse almost conglomeratic sandstone with minor (10%) pale reddish brown siderite(?) mineralization.

Siltstone: Dark greenish grey to greenish black, grading to dark grey to greyish black at base of section. Beds vary from less than 1cm towards 138.15m up to 10-20cm at base (168.2m).

Mudstone: Greyish black to black, thin <1cm interbeds more common towards base of unit. Most beds are planar, those close to sandstones show evidence of minor slumping.

Interval

Core Description

138.15m  
- 169.15m  
(cont.)

Sedimentary Features: 165.6m moderate slump in sandstone and mudstone, marked cross bedding at 156.95m, and 163.7m. 167.15m - 167.23m massive to fine-medium grained sandstone, noticeable absence of similar sands in this part of section.

N.B. All sands lack porosity, no shows.

169.15m  
- 184.1m

Interbedded siltstone 70%, sandstone 20% and minor mudstone 10%. Interbeds vary from less than 1cm to 2-3cm in thickness. Thicker massive siltstones are common between 175.3m - 175.6m and 179.25m - 181m, i.e. very little sand in these intervals.

Sandstone: Very light grey grading to greenish grey, dominantly very fine grained with rare fine grained to coarse units. Micaceous, strongly cemented with silica, occasional glauconitic units, 169.1 - 169.3, 176.2, 181.6 - 182m. Glauconite occurs in coarser units which also show varying degrees of current bedding. Minor scouring evident at base of larger sand interbeds.

Siltstone: Medium grey to dark grey, grades to very fine sandstone in places, as described previously.

Mudstone: Very dark grey to black, rarely in beds greater than 0.5cm. Most common at top and bottom of unit.

Structure: Sediments form poorly to well developed fining upward cycles between 2 & 3 cm in thickness. Most common at top and bottom of interval, middle of unit comprising more massive siltstone. Sand content decreases towards base of interval.

3cm thick bed of yellowish grey siderite at 175.10m. Very high magnetic susceptibility.

184.1m  
- 184.85m

Fault zone dissects core at 45°, brecciated siltstone and sandstone in a clay matrix. Framework grains are up to 2cm across. Abundant carbonate cement towards base of fault zone.

184.85m  
- 192.5m

Interbedded siltstone (70%) sandstone (20%) and minor mudstone (10%). As for section between 169.15m & 184.1m, grades into underlying sandier unit. Small 45° fault at 185.5m may be related to larger fault above.

<u>Interval</u>	<u>Core Description</u>
192.5m - 211m	<p>Interbedded sandstone (50%) siltstone (50%) interbeds range from less than 1cm up to 10cm. Most sand/siltstone interbeds exhibit well defined fining upward patterns with a scour surface at the base.</p> <p>Sandstone: Same as previously described. Interval 204.7 - 205.1 has common glauconite and is slumped. Thin medium grained sandstones at 209.7m (1-1.5cm thick) 210.7 - 210.78m, &amp; 211m (3cm thick) appear to occupy deep scours.</p> <p>Siltstones: As previously described.</p>
211m - 222m	<p><u>Thinly laminated siltstone (60%) mudstone (30%) and sandstone (10%).</u> Laminae are usually less than 0.5cm. Unit lacks other sedimentary structures.</p> <p>Siltstone: As previously described.</p> <p>Mudstone: Dark grey to black, less common towards base of unit.</p> <p>Sandstone: As previously described except very fine grained. 2-3cm thick fine grained sandstone at 216.15m shows evidence of minor scouring.</p>
222m - 234.5m	<p><u>Laminated siltstone (60%) sandstone (30%) and mudstone (10%).</u> Grades from overlying finely laminated sequence to underlying bedded sandstone. Laminae are generally less than several mm but approach several cm at base. Individual constituents are similar to those already described.</p>
234.5m - 239.3m	<p>Sandstone interbedded with minor (&lt;10%) siltstone and trace mudstone. Interbeds are generally 2-3cm in thickness and show poorly developed fining upward cycles.</p> <p>Sandstone: Very light grey to greenish grey, very fine grained to fine grained well cemented with silica. Several coarser grained beds contain minor amounts of calcite, similar in nature to that described above. Siltstone and mudstone are similar to that already described.</p>
239.3m - 248m	<p><u>Finely laminated siltstone (80%) mudstone (10%) with minor sandstone (5%) and carbonate (5%).</u> Unit grades to interbedded sandstone/siltstone as above, becoming more calcareous towards the base, (the sands are replaced by thin carbonates) interbeds are generally less than 1mm in thickness.</p> <p>Siltstone: Dark greenish grey grading to mudstone Mudstone: Greyish black to black.</p>



Interval

Core Description

239.3m - 248m  
(cont.)

Sandstone: Very light grey to light grey.

Carbonate: Calcite, very fine grained to fine grained no other structure evident. Thickness of beds <1mm.

Mainoru Formation

248m - 251.95m

Siltstone (80%) with mudstone (20%). Mudstones are finely laminated and more common towards base of unit. Individual laminae are <1mm thick, laminae occur in groups up to 3-4cm in thickness. Siltstones are more massively bedded.

Siltstone: Greenish grey at top grading to light greenish grey from 249.6m. Calcite cement present in coarser silts. Calcite also present along 1-2mm wide sub vertical fractures between 248.4m & 248.8m.

Mudstone: Black as previously described. N.B: Two intervals (249.5m - 249.7m & 251.65m - 251.85m) comprised of a moderate greenish yellow to light olive mudstone, moderately soft, blocky.

251.95m - 252.8m

Limestone: Coarse to very coarse grained, becoming calcitic at base, colour is highly variable, dominantly white to greenish grey but occasionally moderate reddish brown to dark yellowish orange, especially in top 10cm. This may represent some very fine grained dolomitization. Greyish black to black mudstone interbeds of several mm thickness are present at 252.25m. Also several mudstone clasts of 1-2cm diameter at 252.35cm. Sub vertical fractures of 2-3mm thickness are filled with white calcite.

Upper part of unit is chaotic, possibly as a result of slumping. Lower part is more ordered.

252.8m - 279m

Interbedded siltstone (50%), sandstone (30%) and mudstone (20%), forming often well defined fining upward cycles varying in thickness from several cm to 10-20cm.

Siltstone: Light olive grey to dark greenish grey. Grades from mudstone to very fine sandstone, hard and blocky.

Sandstone: Bluish white to medium bluish grey, very fine to fine, occasionally medium grained, (coarser units are associated with abundant glauconite and mica). Sands are more common in upper half of sequence.

<u>Interval</u>	<u>Core Description</u>
252.8m - 279m (cont.)	<p>Approximately 30% of sand units are calcareous, in particular, relatively massive very fine to fine sand between 256.4 &amp; 257m shows abundant calcareous matter, most often as cement. Sands become finer grained and less common towards base of unit.</p> <p>Mudstone: Greyish black to black, hard, rarely occurs in units greater than a cm thick, most common around middle of unit.</p> <p>Overall, unit coarsens up from dominantly siltstone at base to dominantly sandstone at top, made up of stacked, thin, fining upward cycles. Frequent evidence of minor scouring, slumping and cross bedding.</p>
279m - 283.4m	<p><u>Interbedded sandstone (70%) and siltstone (30%).</u> Bedding varies from less than 2mm, in the finer units, up to 5-10cm in several of the sands. Scouring is common, occasional slumping.</p> <p>Sandstone: Calcareous, very light grey to light grey, white where pure calcite. Dominantly very fine grained to fine grained, no porosity.</p> <p>Siltstone: Greenish grey to dark greenish grey. Grades to rare greenish black mudstone, hard, blocky.</p> <p>In addition to the sandstone, small wisps of white calcite occur throughout the unit, but are most common between 282.6m and 283.4m.</p>
283.4m - 306.7m	<p><u>Interbedded and slumped siltstone (80%) and sandstone (20%).</u> Beds range from 5mm up to 10cm. Slumped and occasionally scoured.</p> <p>Siltstone: As previously described.</p> <p>Sandstone: Very light grey to light grey, very fine grained, abundant calcite cement, poorly developed fining upward cycles evident towards lower part of interval. Sands are most common at base and top of interval. Possible fault between 297.8m &amp; 298m. Dip is approximately 60°.</p>
306.7m - 309.7m	<p><u>Siltstone:</u> Dusky blue green, strongly glauconitic. Grades to greyish black mudstone around 309m. Minor slumping but predominantly fine (several mm) laminae. Thin &lt;2mm glauconite interbeds between 307.61 and 307.8m.</p>

Interval

Core Description

309.7m - 318.10m Interbedded siltstone (60%), calcareous siltstone (30%) and mudstone (10%). Calcareous siltstone increases in quantity towards the base. Beds vary from several cm up to 20-30cm. Bed boundaries often contorted, especially towards base of unit. Mudstone is present only in lower half of unit.

Siltstone: As above.

Calcareous siltstone: Very light grey to medium grey, very fine grained but with larger (several mm) inclusions of pure calcite which gives a mottled texture. Contains very fine sand and common siltstone. Appears lightly contracted and often broken up, possibly as a result of dewatering during compaction. Boundaries with adjacent siltstone and muds are also contracted, especially in the lower part of the sequence.

Mudstone: Dark reddish brown, occasionally very dark red. Occurs in beds less than 2-3cm and is more common towards base of interval, hard, breaks with a conchoidal fracture. Where beds occur in siltstone they are relatively undisturbed, but are broken, slumped and contorted where associated with limestone.

318.1m - 350.2m Interbedded calcareous siltstone (40%), siltstone (30%), and mudstone (30%). Beds generally vary in thickness between 1 & 5 cm. Fine laminae sometimes present. Siltstones and units above and below, are broken and contorted, almost brecciated, appears more as a result of sediment movement during compaction and dewatering (fluid escape structures), than slumping etc. The thicker units of siltstone and mudstone are less disturbed with planar laminae often present.

Calcareous siltstones: Siltstones and mudstones have same characteristics as previously described. Limestones towards base of unit appear to have a slightly higher clastic content, i.e. very fine sandstones and siltstones.

350.2m - 358m Mudstone, massive dark reddish brown, hard sub-vitreous to vitreous. Thin interbeds of laminated calcareous siltstone and siltstone 2cm thick, as previously described. Between 356.5 & 356.7m; laminated siltstone with several 0.5-1cm irregular beds of very calcareous siltstone.

Interval

Core Description

358m - 396.7m

Interbedded siltstone (40%), mudstone (40%), and very calcareous siltstone (20%). Bedding ranges from finely laminated in the siltstones, finely laminated to occasionally massive in the mudstones to laminated and chaotic in the calcareous siltstones. Individual units range in thickness between less than 1cm to several 10's of cm in the siltstone and mudstone. Generally less than 5cm in the calcareous siltstones.

Siltstone: Greyish green to dusky green, hard, blocky, sub-vitreous and finely laminated. Laminae are contorted in and around the calcareous siltstone.

Mudstone: Dark reddish brown, hard, sub vitreous to vitreous, occasionally massively bedded.

Calcareous siltstones: Similar to that previously described, white to light greenish grey, very fine grained, abundant calcite cement and occasional small <3mm lumps of pure calcite forming poorly defined layers, these also occur in some of the siltstones and mudstones. Layers vary between 1 - 5 cm and are more common in upper half of the interval.

Structure: Sedimentary structure is confined to the calcareous siltstone and the adjacent muds and siltstones. Calcareous units are almost brecciated, possibly as a result of slumping or more likely as a result of dewatering and compaction. Minor evidence of algal mounding in calcareous siltstones in the bottom of the unit.

396.7m - 438.6m

Massive mudstone: Dark reddish brown, hard, vitreous. Contains minor amounts of siltstone as described above. Occurs as very fine specks in the mudstone and as isolated beds up to several cm in thickness.

Limmen Sandstone

438.6m - 477.6m

Sandstone: Light grey to medium light grey, very fine grained to medium grained, occasional thin, light olive grey siltstones and mudstones in top several metres of section, grains are well rounded and moderately sorted, strong quartz overgrowths and quartz cement, predominantly no visual porosity, but occasional thin poor porosity.

Interval

Core Description

438.6m - 477.6m  
(cont.)

Shows: Good oil shows between 450.18m - 452.73m, over following intervals: 450.18m - 450.195m, 450.205m - 450.225m, 450.4m - 450.45m, 450.51m - 450.54m, 450.59m - 450.61m, 450.62m - 450.65m, 451.14m - 451.3m, 451.8m - 452.1m (patchy), 452.1m - 452.5m, 452.5m - 452.67m (patchy), 452.67m - 452.73m.

Shows as oily surface on core (looks like vegetable oil), very little to no petroliferous odour, 1 unit gas, 80% yellow fluorescence with slow yellow white cut. No ring residue zones with oil, has no visual porosity. Several zones that show poor porosity in the oil zone appear to have only a residual bitumen in pore surrounds, indicates possible flushing post-diagenesis. Zone doesn't warrant testing due to very little apparent porosity in oil areas.

Also 458.45m - 458.65m small vertical fracture well cemented with quartz, similar shows to the above.

10cm zone of fracturing around 445m. Fractures range in size between 1 & 5mm, abundant dark crystal growths, possible sphalerite. Chalcopyrite also evident in minor amounts. Unit is becoming coarse to very coarse around 463m and then back to fine at base.

Mantungula Formation

477.6m - 481.7m

Mudstone: With interbeds of dolomitic mudstone and dolomite towards base. Mudstones vary from greyish green to greenish grey over the following intervals; 477.6m - 477.8m, 478.85m - 479.15m and 479.4m - 489.2m. Remaining mudstones are greyish red purple to dusky red purple. Units are massively bedded at top of interval with minor dolomitic layers at 477.8m & 479.2m. This interval is also associated with some minor siderite mineralization. The lower 1m of interval contains interbedded and slumped units of dolomitic mudstone and dolomite. Dolomitic mudstones are pale pink to pale red purple while the dolomite is pale blue to pale pink.

481.7m - 488.9m

Dolomitic fine grained sandstone: Greyish orange pink to moderate orange pink. Unit is less dolomitic at top and base. Common minor amounts of siderite between 482.3m & 482.6m. Between 483.2m and 483.6m, thin less than 2cm beds of broken greyish pink dolomite, 485m - 486.4m unit has a mottled texture. Thin laminae of black vitreous shale are present every 10-20cm. Laminae are usually less than 1mm and isolated, highly contorted due to post depositional sediment movement.

Interval

Core Description

488.9m - 494.6m Finely laminated calcareous siltstone (60%) and mudstone (40%). Interbeds are very fine <1mm and planar. Thicker beds of mudstone (12-3cm) at very base of unit.

Calcareous siltstone: Very light grey, generally more abundant towards base of unit.

Mudstone: Dark grey to greyish black, generally less common towards base of unit.

514.1m - 525.5m Dolomitic limestone: Light grey to medium light grey, occasionally medium dark grey associated with possible algal mounding. Hard and blocky. Occasional thin wisps of blackish grey to black mudstone. Mudstone is highly contorted indicating sediment movement during compaction. Algal mounding evident throughout section, mounds would appear to be only several cm across at top of unit but appear larger, perhaps 5-10cm, towards base. Areas between mounds (2cm wide, 10cm long on average) filled with brecciated dolomitized limestone.

Interpretation - Algal mounds = stromatolites

525.5m - 531.65m Dolomitic limestone: pinkish grey to light grey containing minor very coarse lumps of more calcic material, but is generally fine grained. Unit contains noticeable vuggy porosity <5% of total rock.

Vugs are of several mm in size, few are up to 1cm long and 5cm wide, often lined with very small calcite crystals.

No apparent communication between vugs. Porosity decreases below 530m and is absent below 530.6m.

Shows: A number of the small vugs at 526.15m & 526.35m have oil shows similar to those mentioned earlier, i.e. yellow fluorescence, slow yellow white crush cut. Vegetable-like oil on surface of core. No gas. Shows only cover about 10 sq cm of core surface.

531.65m - 563m Interbedded dolomitic limestone (80%) mudstone (20%). Interbeds range from several cm to massive, boundaries are planar to sub planar, but occasionally contorted in upper portion of unit.

Dolomitic limestone: Very light grey to pinkish grey, occasionally medium light grey. Very fine grained, occasionally contains medium to coarse grained material, especially in upper part of unit.

Interval

Core Description

531.65m - 563m  
(cont.)

536.4 - 538m; contains small amounts of calcite, usually less than 5mm across. These may represent some later filling of vuggy porosity. Units in lower part of section show no sedimentary structure. Limestones are contorted and occasionally brecciated over a 1-2cm interval.

Mudstone: Blackish grey to black, hard, sub-vitreous. Finely laminated to beds 10-20cm thick, dominantly planar. Mudstones less common towards base of interval. 531.8m thick 2cm algal coal, black, soft, vitreous and heavily broken up. Below 557m, mudstones grade to greyish green.

NATHAN GROUP

563m - 581m

Mudstone (70%) with interbedded siltstone (20%) and dolomitic limestone (10%) at top of units. Interbeds range from several cm to 10's cm at top, to massive mudstone from 570.5m. Bedding is uniform with little other sedimentary structure.

Mudstone: Dark reddish brown, hard, sub-fissile, contains minor amounts of medium grained sand and occasional medium grained glauconitic sandstone interbeds (2-3cm) in lower few metres of unit.

Siltstone: Olive green similar to that already seen in hole.

Dolomitic Limestone: As previously described. Siltstone and dolomitic limestone are generally present in upper half of unit, although some siltstone is present in lower half.

581m - 593.2m

Sandstone: 90% with interbedded mudstone (10%).

Sandstone: Moderate, reddish brown to moderate reddish orange, fine to medium grained. Contains abundant small 1cm x 0.5cm angular lumps of mudstone, becoming less common towards base of unit.

Mudstone: Dark reddish brown or pale green, blocky to sub fissile. Beds are rarely thicker than 2 or 3cm. Bands contain frequent small brecciated lumps of mudstone. Many of the red mudstones have green mudstone haloes. This may indicate that the colour change is due to a post depositional affect, i.e. secondary reduction of iron.

Fault: 594.2m, dips approx 60°. Fault contains moderate yellowish green mudstone(?) Soft and blocky.

<u>Interval</u>	<u>Core Description</u>
592.2m - 608m	<p data-bbox="532 309 1344 407"><u>Massive mudstone with occasional sandstone (10%) interbeds.</u> Sandstone interbeds are more common at top of unit.</p> <p data-bbox="532 443 1360 725">Mudstone: Massive, two colours. Pale green and moderate reddish brown. Hard, sub-fissile. Boundaries between two colours are irregular, not depositional and sharp. Occasionally brown mudstones are surrounded by a green mudstone halo. Also green mudstone is almost always near sandstone interbeds while brown is isolated from sands. Suggestion is that green colour is a post-depositional affect.</p> <p data-bbox="532 761 1110 792">Sandstone: As previously described.</p>
608m - 633.4m	<p data-bbox="532 855 1354 1057"><u>Sandstone (75%) with interbedded mudstone (25%).</u> Sandstone beds range in thickness from several cm to a metre. Mudstone beds are rarely more than several cm in thickness. Boundaries are often sub-planar but occasionally irregular, (boundaries do not appear slumped).</p> <p data-bbox="532 1093 1354 1191">Sandstone contains large proportions of mudstone as framework grains and matrix. Occasionally enough to give the sandstone a mottled texture.</p> <p data-bbox="532 1227 1338 1379">Sandstone: Greyish pink to pale red, fine to occasionally medium grained at base. Contains frequent mudstone as framework and matrix and less frequent but common mudstone clasts up to 1cm x 0.5cm. No apparent current bedding.</p> <p data-bbox="532 1415 1273 1541">Mudstone: As previously described, with green mudstone becoming absent towards base. Note previous comments regarding alteration of red mudstone to green colour.</p> <p data-bbox="532 1576 1354 1639">Fracture: 619.1m - 619.2m, dips approximately 60°. Approximately 0.5cm wide and full of quartz.</p>
633.4m - 669.5m	<p data-bbox="532 1662 1338 1899"><u>Interbedded mudstone (60%), and sandstone (40%).</u> Unit becomes sandier towards the base with mudstones being replaced by muddy sandstones. Interbeds are generally several 10's of cm in thickness, although they tend to be thicker at top and base of unit. Bed boundaries are generally planar, although scouring and slumping do occur.</p> <p data-bbox="532 1935 1338 2047">Mudstones: Two types as described above. Further evidence that the green colour is a post depositional affect is that it appears to be associated with more porous units.</p>



Interval

Core Description

- 633.4m - 669.5m  
(cont.) Sandstone: As described, but contains abundant clay below 659m giving sand a dominantly mottled greyish red to dark reddish brown colour along with the greyish pink cleaner sands. The mud is distributed throughout the sand in a relatively random fashion. Muddier units cross over bedding boundaries. Large scale cross bedding evident around 657-658m. Smaller scale cross bedding frequently evident in basal sands.
- 669.5m - 710m As for unit above, perhaps slightly more sand-dominated with sand units showing occasional cross bedding. Below 693.4m, dip ranges up to 30° but is not uniform. Often some units (1m) will have structural dips of 30° then next metre will be flat lying. Also signs of faulting 60°, structural dip may be related to drag along these faults.
- 710m - 762m Interbedded sandstone (60%) and mudstone (40%).  
Unit is very similar to the last two. Interbeds vary from one or two cm up to almost a metre. Thin wisps (2-3mm) mudstone are also present in some of the sandstones. Bed boundaries vary from planar to lightly contorted and slumped with occasional small scale cross bedding in sandstones. Cross-bedded units are seldom more than 2cm thick.
- Sandstone: Pinkish grey to dark reddish brown, contains large amount of red brown clays. Fine to occasionally medium grained. Most sands contain varying amounts of clays, predominantly red-brown in colour. Contains frequent mudstone clasts, perhaps indicating that the mudstones were occasionally emergent and were reworked. Sandstones are well cemented with quartz and quartz overgrowths are common. Sands are very hard.
- Mudstones: Same as previously described. Reddish brown variety is predominant. Hard, vitreous to sub vitreous, grades into muddy sandstone in places. Predominantly massively bedded, but occasional thin irregular laminae. The olive grey mudstones appear to be an alteration product of the brown mudstones, occasionally light, clear sheets of mica up to ½mm in diameter.
- Structure: Unit is predominantly dipping at 30°. 10cm zone of quite intense fracturing at 713.3m. Poor core returns over 727.1m to 736m, may indicate zone of fracturing or faulting. Dips decrease to between 10 & 20° below 750m. Sandstone/mudstone interfaces become regularly brecciated below 740m, also common evidence of small-scale dewatering structures revealed cm in size. Frequent small-scale brecciated faulting approximately every metre.

Interval

Core Description

762m - 815.6m

Interbedded sandstone (50%) and mudstone (50%) becoming more sand dominated towards base (80%). Unit is overall very similar to those previously described. Interbeds range between several cm and massive mudstone units up to several metres. Bed boundaries are often brecciated and upper part of section appears to be due to sediment movement during dewatering and compaction. Below 777m, frequent evidence of mud cracks being infilled by coarser grained material. Cracks are usually  $\frac{1}{2}$  cm wide, 2-3cm long, occasionally larger. Indicates that area was very shallow, becoming emergent at the base. Sediment lithology is as previously described with current bedding becoming more common in the sands.

762-762.4m mudstone unit containing frequent very small thin wisps of dolomite and larger 2-3mm clasts of brown mudstone. 763.0m - 763.05m vein of moderate pink to light red dolomite associated with a fault and fracturing. 768.6-769m; zone of faulting (dipping 60°) with common calcite mineralization along fractures.

Mineralization is 2-3mm wide. Faulting may have occurred when sediments were quite soft as plastic deformation is evident. Units generally dip at between 10 & 30°.

Between 805.2 & 807m is a brecciated fault zone, with numerous open fractures between 805.2 & 807m. Open fractures are generally several mm wide and several cm long,  $\frac{1}{2}$  cm wide at 805.9m. Fractures do not appear interconnected and are lined with small (1-2mm) quartz crystals. Below 806m, fractures are 100% filled with calcite. Faulting may extend down to 808m. Between 807 & 808m, rocks have high variable dip (60°) and common calcite filled fractures. Small fault at 813m, with 2-3mm wide vein of calcite.

815.6m - 870m

Interbedded, sandstones (50%), muddy sandstones (40%) and mudstones (10%). Sandstones are laminated to massive and occasionally cross bedded. Mudstones occur as thin (<1cm) often broken layers. Occasional evidence of mudcracks or dessication. Distinction between sandstones and muddy sandstones is not clear cut, but tend to conform to poorly defined beds. Lithologies are as previously described but with mudstones being replaced by muddy sandstones, very poorly sorted. No apparent coarsening or fining upward patterns. Bedding planes generally dip at 20° - 30°, rare sub-vertical veins of calcite usually less than 2-3mm wide, up to 20cm long.

Interval

Core Description

815.6m - 870m  
(cont.)

Common faulting below 866m, dips also increase to around 45°. Faulting is prevalent between 867 & 871m. Faults appear to dip at 45° but with opposite strike to bedding planes, appears syndepositional indicating perhaps listric faulting.

870m - 892.5m

Mudstones (55%) and sandstones (45%). Same lithologies as described for most of previous 300m.

Mudstone - comprised of silty mudstone and occasional claystone. Dark reddish brown and dark greenish grey to green grey colour.

Sandstone - generally very fine to fine, occasionally medium grained, pinkish green to green or pink. Seems to have red colour caused by iron cementation of available pores. When low porosity and cemented; accounts for pale pink colour. Abundant mudstone intraclasts and thin beds.

892.5m - 929.9m

Sandstone (70%) and mudstone (30%). Mudstone in above unit most common towards base. Faulting not present in this unit. Again division based on relative proportion of same lithologies as seen in units above.

Sandstone - heavily silicified, minor iron staining/cement. Sub-horizontal planar bed boundaries. Abundant red - brown mudstone intraclasts often confined to this zone within sandstone beds.

Most common succession of green mudstone passing up into red - brown.

Same unit below about 900m, 90% sandstone 10% mudstone.

Intraclasts numerous, often localised at bases. Sandstone beds 10-20cm thick. Intraclast zones generally 5cm thick.

More sandstone at base, more intraclast layers, stained zones in sandstone. Occasional dewatering zones - vertical areas, "pipes", where no staining in sandstone or mudstone. Mudstone is green.

Gradational change to unit below. Gradually more mudstone, mostly red - brown in thicker beds.

Interval

Core Description

929.9m - 949.6m Mudstone/siltstone (50-60%) and sandstone (40-50%).

Mudstone - dominantly micaceous, red - brown siltstone with occasional green mudstone - generally claystone. Irregular boundaries on what appears to be fluid invasion fronts.

Mudstone intraclasts - lenticular, sub horizontal, generally sharp edged and very angular. Mudstone interbedded with sandstone. Again green mudstone generally at centre of mudstone interbeds with red - brown tops and bottoms, having small circular green bodies internal to red - brown intervals.

Sandstone - very fine to fine grained with occasional medium grained beds, generally 10-15cm thick. Pale pink, very fine, thin, green mudstone interbeds. 1-2cm red - brown mudstone interbeds.

Scours into sandstone. Generally green mudstone. Irregular upper contact, abundant low angle planar cross-beds in medium sandstone, surface appears arkosic. Very silicified. Thin wispy green mudstone, almost intraclasts. Surface chimney - like dewatering structures, pale pink sandstone with red brown sandstone. Gradational boundary to unit below.

949.6m - 968.6m Sandstone 80% and mudstone 20%.

As for base of unit 892.5m to 929.9m.

Sandstone - abundant well developed cross-bedding. Intraclasts - generally irregular sandstone beds with red - brown siltstone thin beds 2-5cm. Occasional claystone red - brown to 5cm. Quite often irregular and chaotic intermixed with siltstone. Sandstone and stained siltstone light pink and stained pink - brown. Also vertical water escape chimneys - paler colour. Abundant sandstone dykes and chimneys toward base.

Mudstone - generally thin occasional beds to 5m increasing towards base.

Base unit marked by 1cm light green chloritic fault zone, dip 30°. Very abrupt change.

Interval

Core Description

968.6m - 1000.0m Mudstone (95%) and sandstone (5%).  
(T.D.)

Mudstone - dominantly red - brown with lesser parts green 5%. Green colour localised around porous sandstone beds and fractures. Same mottled colouring and irregular boundaries between the two colours as described before. Vertical fracture at base of unit. Irregular invasion around this. Mudstone, mostly claystone, minor fine siltstone.

Sandstone - Very fine to fine grained, occasionally medium, cross-bedded. Scours and irregular basal contacts. Occasional minor calcite cement. Occasional irregular small sandstone bodies in middle mudstone units - perhaps sandstone dykes. Occasional intraclasts in based beds.

E.O.H.