

SECTION 3 - LITHOLOGICAL DESCRIPTION

SCARBOROUGH-1

CUTTINGS DESCRIPTION

<u>FROM</u>	<u>TO</u>	
0	- 1m	Light brown and dark reddish brown, iron cemented siltstones and fine to medium grained sandstones. (some sandstone less iron cemented than siltstone).
1	- 2m	Moderate red, light brown, dusky brown and black, black chips are all fine sandstones, and black staining is either bitumen or goethite. The chips are 50% black. Panning the sample the black material was not heavy.
2	- 3m	Dark yellowish orange, moderate yellowish brown, light brown, and black. Black fine to medium grained sandstone fragments have decreased to 5% of sample, mostly mud/clay stone, 20% Fe cemented fine sandstone and siltstone (moderate yellowish brown). A lot of loose clay washed out of sample.
3	- 4m	A lot of loose clay washed out of sample. Dark yellowish orange, moderate yellowish brown and minor light brown. Siltstone, fine sandstone and claystone in approximately equal proportions. Generally yellower than previous sample.
4	- 5m	A lot of loose clay washed out of sample but less than above. As for previous sample except large proportion of dark moderate brown fragments. Less claystone, mostly Fe stained and silicified fine sandstone and siltstone.
5	- 6m	Less clay than previous sample - not much washed out - other than that sample is the same in colour and composition.
6	- 7m	More clay than previous sample. Greenish grey as well as same colours as previous sample. Fine sandstone and siltstone, very little claystone.

SCARBOROUGH

CORE DESCRIPTION

FROM TO

8 - 16.19

Interbedded siltstone and mudstone and fine to medium grained sandstone.

Mudstone and siltstone - moderate reddish brown to very dusky red to pale yellowish orange.

Sandstone - moderate red to dusky red. Orange to red staining along fractures (percolation features).

Siltstone and mudstone are micaceous and finely laminated to massive (3-5cm maximum).

12.40 -

Sandstones - thinly bedded, intermittent bidirectional low angle cross bedding. Lathe like intraclasts/rip up clasts in a 4cm interbed. Colour dusky red to moderate red. Lathes have long axis roughly parallel to bedding.

14.48 -

Sandstone scour - light olive grey, medium grained
- sandstones becoming more dark grey to greyish black towards base.

15.6 -

Dark yellowish orange 16cm thick claystone (no visible laminated or bedding, slightly micaceous). Could be washing down hole at commencement of new run. (Gradational boundary to unit below).

16.19 - 17.07

Thinly interbedded siltstone, mudstone and fine sandstone. Dusky yellowish brown mudstone, moderate to dark moderate brown siltstone. Occasional light greenish grey to greenish grey fine sandstone. Beds are 1-3cm thick. Fluid escape and compactional soft sed deformation features.

17.07 - 50.83

Interbedded mudstone, siltstone and fine to medium grained sandstone.

Appears to be out of surficial weathering zone.

Mudstones - greyish black.

Siltstone - olive black to brownish black.

Sandstone - light grey to medium light grey.

Sandstone beds - 1-5cm thick, laminated and occasionally lathe like intraclasts with long axis of lathes aligned parallel to bedding. Common base - bed compactional features in siltstone and mudstone.

Vertical fracturing causing sandstone to boudinage above comp. features.

Occasional sandstone scours - 6cm, to 10 cm in thickness - often with lathes contained parallel to bedding in them. Also some compactional draping over edges of scour.

Sandstones - cross laminated/bedded (some bidirectional).

Siltstone and mudstones - finely laminated to structureless.

36.2 - 38.4 Zone of fracturing. Core broken, high angle soft sed. deformational, compactional features.

List of features in interval from 17.07 to 50.83

20.9	-	3cm bed of lathe-like fragments.
21.7	-	Compactional features.
22.19	-	5cm cross bedded sandstone.
22.62	-	Early scour/dewatering feature with later diagenetic changes.
23.7	-	Large sandstone scour.
24.3	- 24.43	Sandstone interbed.
26.36	-	Excellent example of boudinage character.
27.4	-28.05	Sandstone with occasional intraclast beds, low to medium angle cross beds, some large scale, occasional scours.
29.23	- 29.75	Large intraclast layer 6cm thick, basically thinly bedded sandstone unit. Compactional features common.

- 43.10 - Sandstone scour.
- 42.15 - Excellent boudinage feature with x bedded sandstone below.
- 44.39 - Excellent compactional features example.
- 48.20 - Large scour.
- 50.35 - 50.85 Vertical fractures.
- 50.83 - 51.60 Gradational change from unit above to unit below (massive sandstone). Interbedded sandstone, siltstone, mudstone with sandstone increasing in thickness and occurrence towards base (1-6cm thick).
- 51.60 - 55.20 Massive sandstone-light olive grey to light brownish grey at top to light brownish grey at base. With brownish grey staining in lenticular and irregular mottling mostly parallel to bedding. Thickly to massive bedded.
- 51.9 - 52.0 Olive black thin mudstone beds.
- 53.3 - 53.4 As for 51.9 - 52.0.
- 53.00 - Small intraclasts greenish grey to light olive grey and effervesce violently.
- 54.5 - 55 Vertical fractures displays effervescence.
Zones of increased porosity at 54.5 may be slightly calcareous.
- 55.20 - 56.69 Interbedded mudstone, siltstone and very fine to fine grained sandstone - greenish black to olive black mudstone, and dark greenish grey to greenish black siltstone and sandstone. Pinkish grey to light brownish grey lenticular and bands/laminae of mudstone. Sometimes these are gradational from greenish black to brownish black, up to pinkish grey cycles. Pyrite in flat circles in broken core (flat lying on bedding).
- 56.23 - Intraclasts, medium bluish and light brown intraclasts (5cm).
- 56.69 - 61.20 Thickly to massively bedded, medium to coarse grained sandstone - much finer toward base. Irregular vuggy patches of enhanced porosity. (As for 51.6-55.20m but more uniform pale yellowish brown colour throughout.)

- 59.10 - 59.64 Greenish grey to medium bluish grey colour.
- 59.77 - 60.00 (oil staining (?)) - light brownish grey to brownish grey.
- 61.20 - 62.91 Interbedded siltstone and mudstone.(Gradational from unit above to unit below). Pyrite on vertical fractures in core.
- 62.19 - 78.18 Interbedded fine sandstone, siltstone and mudstone with siltstone dominant. Dark brown and grey and greenish black mudstone and siltstone. Sandstones greenish grey with light brown intraclasts (1mm).
- Soft sediment deformation, compactional features. Sandstone finely laminated, no visible porosity, intraclasts common. Almost ubiquitous. Siltstone - olive grey to brownish grey. Glauconite towards base of unit. Pyrite (mold) common on fractures. The glauconite is featuring highly in sandier parts of unit highlighting laminations and cross bedding. Soft sed def. clear with sub vertical tensional features i.e.
- Some scours visible, flaser bedding. Gradational change to sandier facies - sand becoming more common towards base.
- Interesting features in interval.
- 64.0 - 6cm bed of intraclasts
- 67.0 - 2cm bed of intraclasts
- 68.6 - Pyrite in fractures.
- 71.3 - Glauconite
- 72.6 - Glauconite 3cm bed in sandstone
- 74.95 - Compactional features.
- 75.73 - Flaser bedding.
- 78.18 - 79.24 Sandstone, thinly bedded, fine to medium grained- low angle bedding abundant, 2-15cm thick bedding. Light olive grey to light brownish grey, occasional yellowish grey. Brownish black laminae of mudstone, very thin.

- 79.24 - 81.7 Thinly interbedded mudstone, fine to medium grained sandstone-and siltstone - 1-5cm medium grained sandstone - mudstone - olive grey to brownish black, siltstone - greenish black, sandstone - medium dark grey to dark greenish grey. Compactional sed. features (wormlike) minor x-laminations, soft sed. deformation.
- 81.7 - 82.0 ? (Possibly further - as had to open hole for 6m).
Fine to medium grained thickly bedded to massive sandstone - very poorly sorted, silty matrix, light olive grey, some lithic shale intraclasts, with random orientation.
- 82.0 - 84.0 Siltstone and mudstone. (from cuttings)
Siltstone to mudstone - dark grey, rest - dark olive grey to greenish grey with roughly even proportions.
- 84.0 - 90.0 Siltstone or mudstone dom in dark grey, 5% fine/medium grained sandstone light olive grey to brownish grey.
- 90.50 - 91.55 Fine to medium grained, thinly bedded, dominantly sandstone with siltstone to mudstone - sandstone - light olive grey, siltstone - greenish black. Sandstones of the order 1-5cm. Siltstone and mudstone interlaminae mostly 1-2mm up to 1cm maximum.
- 91.55- 95.20 Interbedded fine to medium grained sandstone, mudstone, minor siltstone - sandstone light olive to grey to greenish grey, mudstone - olive black to green black - siltstone - olive grey to greenish black. Thin to medium bedding, abundant cross bedding intraclast layers, large scale scouring (up to 10cm deep) e.g: 91.84m compactional features abundant, vertical fractures, scour filled with intraclasts (lenticular) with lag deposits at base of scour - this feature is at 94.20m. Pyrite in graded bedding from fine sandstone at base to siltstone and then mudstone. Scours are apparently into mudstone.
- 95.20 - 97.00 Interbedded sandstone, siltstone and mudstone - dominant sandstone, siltstone and mudstone thinly interbedded with thin sandstone beds with thicker sandstone beds separating finer units, thinner beds of the order of 1cm thick, thick beds up to 7-20cm sandstone. Sandstone - light olive grey to yellowish grey, siltstone - dark greenish grey to greenish black, mudstone - brownish grey to olive grey.

Siltstone and mudstone as for previous description. Sandstone - char. by very thin lenticular, siltstone and mudstone intraclasts, oriented along bedding, generally 1-2mm thick and up to 2cm long, vuggy porosity developed. Where these intraclasts are weathered out, porosity along vertical fractures in sandstone, fine to medium grained, sharp contact with unit below angular in nature.

- 95.44 - 95.60 Finely laminated mudstone and siltstone interbedded interval.
- 96.26 - 96.65 Finely laminated mudstone and siltstone interbedded interval.
- 97.00 - 101.75 Fine to coarse sandstone - yellowish grey to light olive grey, coarser sandstone pale yellowish brown, dominated by upward fining graded sequences, intraclasts present but not as obvious as in previous sandstone interval, moderate to poor visible porosity, very thin laminae (organic) common in finer sandstone, very silicified in parts, possible glauconite in finer grained sandstone at about 97.8m. Rare thin siltstone/mudstone show compactional features as previously described. Gradational contact to laminated unit below becoming finer towards base.
- 100.84 - 10cm band of organic silty matter, finely lain showing compactional features and brittle fractures at an angle of 30° - could be synsedimentary brittle failure.
- 100.14 - 100.94 Conglomeratic clastic band, large variety of clasts sub angular to sub rounded, polymictic orthoconglomerate, clasts are quartz sandstone, mudstone, siltstone and other unidentifiable clasts. Black organic matter appears to have filtered down from above as for a sieve deposit and irregularly oriented matrix - medium to coarse sand with well rounded grains with some silt component. Black matter exhibits compactional features and movement out into matrix.
- 101.75 - 104.55 Interbedded fine to medium grained sandstone mudstone and minor siltstone
As for 91.55-95.20m but not as many scours. Interesting feature at 103.86m ? - cross bedding or small displaced block?

- 104.55 - 107.85 Medium to coarse grained sandstone - Similar to basal part of 97.00-101.75m interval. Top 70cm characterised by weathered out clay? Intraclasts in 20cm sandstone beds, with some thin mudstone beds exhibiting compactional features. Rest is medium to very coarse grained, poorly sorted, abundant x-beds, upward fining graded bedding, secondary Si cement but still irregular vuggy porosity present. Bitumen staining in most coarse grained sandstone, presence of thin (1-3cm) mudstone layers towards base sandstone - light olive grey, black brownish grey where bitumen stained.
- 105.23 - 2cm band of sandstone where pyrobitumen is present infilling vugs, deep black, conchoidal fracture, vitreous lustre.
- 105.85 - 1cm band of organic rich matter with gypsum? crystals growing out. Also occurs at 107.45m
- 106.24 - 106.64 Coarsest zone most heavily stained with bitumen, but varying amounts of bitumen staining occur throughout sections.
- 107.85 - 110.62 Interbedded fine to medium grained sandstone - As for 101.75 - 104.55m. Two thin granule (qtz) layers in basal 42cm of unit between mudstone and fine sandstone layers. Not as many scours as in 101.75 - 104.55m.
- Sands generally coarser, not as much pyrite.
- 110.62 - 112.21 As for 104.55 - 107.85m but not quite as coarse grained generally. Thin laminae of organic matter in sandstone intervals. These exhibit soft sed. def. Minor bitumen staining.
- 112.21 - 114.70 As for 107.85 - 1110.62m but silicified and generally finer grained sandstone except for coarser grained interbeds. Roughly equal proportions of sandstone, siltstone and mudstone. Upward fining graded bedding, with very coarse sandstone bases.
- Mudstone exhibits very common compactional features in thinly interbedded (maximum 1cm). Gradational contact over several meters with unit below.

114.70 - 121.85

Thickly to massively bedded sandstone, with occasional thinly interbedded siltstone and mudstone, fine sandstone.

Thickly bedded sandstone, medium to coarse grained occasionally very coarse. Large lathes up to 4cm long common (very soft mudstone), sandstone characterised by sharp basal contacts generally upward fining, low angle x bedding, vertical fractures mostly open and some with bitumen staining.

Sandstone - light olive grey to yellowish grey, with oil staining a medium bluish grey, greenish black bitumen staining is abundant.

Siltstone/mudstone interbeds 15-50cm thick (usually 15-20cm), and light bluish grey and pale yellowish brown and pinkish grey to brownish black.

Silicified, large intraclast deposits towards base, intraclasts have laminae of organic matter.

114.7 - 114.15

- oil stained sandstone.

117.28 -

Interbedded siltstone/sandstone.

116.4 - 116.54

Interbedded siltstone/mudstone.

116.75 - 116.53

Interbedded siltstone/mudstone.

118.65 -

Clay intraclast weathered out leaving large vug with bitumen inside with crystal faces. Coarse towards base with large mud intraclasts. Gradational boundary to unit below.

121.85 - 129.66

Interbedded (thinly) fine grained sandstone, siltstone and mudstone.

Common soft sediment deformation. Features, slumping, fractures filled with calcite?

Sandstone - yellowish grey to light olive grey.

Siltstone - 60cm at top, organic poor, light olive grey mudstone and siltstone for remainder - greenish black to olive black.

Some massive to chaotic siltstone to mudstone layers with slumping common, swirly texture like debris flow, characterised by ripply texture/bedding some x lamination in sandstone, boudinage type compactional features.

Chaotic flow layers - 18cm 1m thick.

129.66 - 150.14

Thinly interbedded organic rich mudstone and siltstone - rare thin interbeds of fine to very fine sandstone (laminated), siltstone and mudstone, brownish black in colour, very thin lenticular lathes of organic matter, aligned along bedding, soft sed. def./slumping. Sandstone - olive grey in colour. Towards base more massive and structureless siltstone - very like a debris - flow, laminated siltstone and mudstone not as frequent.

Siltstones where present are 2-6cm in thickness.

Slumping spectacular and present in zones up to 80cm thick.

Fractures at 45° to core, some filled with gypsum?

Thin lathes appear in slumped intervals with random orientation.

Very fine sandstone becomes more common towards base, x bedded commonly characterised feature slumped and contorted forming Augen-type features (eyes).

Brittle fractures associated with slumping pyrite not common. Gradational contact over 1 to 2m to unit below.

150.14 - 159.45

Thinly interbedded mudstone, siltstone and very fine sandstone - siltstone finely laminate, mudstone very finely laminate to massive and sandstone is thinly bedded and sometimes laminated.

Bedding regular with no soft sed. def, slumping or contortion.

Sandstone - light greenish grey to olive grey.

Siltstone - greyish black (organic?)

Mudstone - brownish black to black.

Sandstone most common at top, about 10%, < 5% toward base, occasion thin debris flows 5cm thick with disoriented lenticular laminae, pyrite nodules common, some greenish grey to dark greenish grey silty mudstone, 2 forms of pyrite nodules -

- 1 Those assoc. with bedding and
- 2 Discrete nodules with noticeable bedding distortion around them.

Mudstone toward base becoming very finely laminate, and in some cases almost varved.

159.45 - 168.70

As for 129.66 - 150.14m.

168.70 - 184.02

Thinly interbedded dom. mudstone, siltstone and occasional very fine sandstone to siltstone. - Sandstone - light bluish grey to medium bluish grey, siltstone - olive black, organic mudstone - brownish black.

Mudstone and siltstone are finely laminated especially the organic mudstone, very fine sandstones range in thickness from 2mm to 5cm, commonly x-bedded, and have compactional features at base. Flame structures and incipient ball and pillow structures.

Occasional massive mudstone beds with organic layers within exhibiting distorted bedding, with lathes of organic matter sometimes oriented along bedding, sometimes random orientation.

Pyrite nodules very common

- 1 and 2 as described before plus
- 3 speckled and dissem. in discrete bands.

Mudstone - most finely laminated, siltstones with some organic matter are almost massive/structureless - up to 5cm thick. Bidirectional x - lamination.

Zones of darker mudstone and siltstone brownish black with mudstones mostly black.

Very fine sandstone beds still present and becoming more discrete with sharper transitions between mudstone and siltstone. This hole has similar characteristics to Alex-1 with graded bedding from mudstone, sharp change to sandstone, gradual transition to siltstone, gradual transition to mudstone. This character is not quite as pronounced in this interval as in Alex-1. Disseminated pyrite becoming more common dispersed throughout core - 4th kind of pyrite.

Fewer fine sandstone towards base.

Sharp transitions between mudstone and siltstone.

Features in this interval

- 165.3 - 165.2 Very fine sandstone cross laminated, in 4-5cm beds.
- 168.53 - 168.7 Debris flow with disoriented organic lathers.
- 171.20 - Ground core.
- 173.18 - Slump feature.
- 174.22 - 177.20 Darker coloured interval of mudstone/siltstone with pale very fine sandstone.
- 182.45 - 184.05 Darker coloured section of mudstone/siltstone.
- 184.02 - 200.0 Interbedded siltstone and mudstone with rare interbeds of very fine sandstone - brownish black to olive black silty mudstone.

N.B. occasional kerosene odour.

Olive grey to greyish black, mudstone, silty mudstone mostly 10cm thick, finely 1cm mudstone 1-2cm thick and varve like, base of silty mudstone sometimes brownish grey to olive grey, possibly due to more oxidising conditions, pyrite nodules common particularly towards top of silty mudstone just below laminated mudstone.

- 185.7 - Gradational colour change to lighter silty mudstone olive grey lower in interval and 11cm mudstone are olive grey to olive black, occ. to rare greenish grey silty mudstone interbeds, laminations become finer and more prevalent lower in section.
- 188.85 - 188.9 Very fine x-lam sandstone bed.
- 198.6 - 198.65 Very fine x-lam sandstone bed.
- 200 - Kerosene odour.
- 200.0 - 204.85 Interbedded very fine sandstone, siltstone and mudstone, (very slight kerosene odour) more sand than in previous interval. Less zones of fine laminations. More massive interbeds of siltstone.

Sandstone - light olive grey and medium grey,
siltstone - dark greenish grey to olive black,
mudstone - olive grey, dark grey and some black.

Grading upward sequence from very fine sandstone to organic rich siltstone to very black organic mudstone which exhibit a varve like character. These graded beds feature commonly, sandstone up to 5cm thick, siltstone 10-30cm, mudstone - between 1 and 5cm.

Siltstone and sandstone are structureless to massive, with organic lathes sub parallel to bedding common throughout interval Small pyrite nodules up to 2mm wide common.

204.85 - 217.37

Similar to above except no very fine sandstone intervals Interbedded siltstone, silty mudstone and mudstone, similar fining upward seq. from siltstone to silty mudstone (organic rich) to mudstone. Siltstone (structureless to massive) brownish grey to olive black, mudstone - olive grey and brownish black.

At top of unit even proportions of siltstone and mudstone with slightly less siltstone toward the base to 90% mudstone at base of unit. No kerosine odour detected. Rare pyrite nodules.

217.37 - 221.30

As for above interval except that all interbedded siltstone and mudstone is laminated. No structureless intervals. Occasional 2-4cm very fine sandstone intervals between all finely laminated mudstone and siltstone, sandstone - olive grey.

Mudstone - greyish black to brownish black and dark greenish grey to olive grey, siltstone - dark greenish grey pyrite modules common.

221.30 - 233.80

As for 204.85 to 217.37. Except all laminated and almost varve like. Kerosene odour detected. Brownish black to black, also some brownish grey to brownish black.

Pyrite nodules and bands common (no speckled).

233.8 - 268.60

Major facies change over gradational interval of 1m. Interbedded greenish grey siltstone and silty mudstone with brownish grey to brownish black mudstone. Unit distinct and char. by green colour of siltstone and silty mudstone which dominate interval in thickness and occurrence, from 4-35cm thick. Black mudstone 2-10cm thick. Greenish colour may be result of finely dispersed glauconite in siltstone and some glauconite is visible in rare very fine sandstone layers of 20.5cm thickness.

Thicker uniform green beds and thin uniform blacker beds at top of unit which become less discrete lower down and roughly of equal thickness.

- 239.06 Thin glauconite band.
- 241.50 Small fault 0.25 cm disp.
- 245.94 Glauconite band.
- 250.73 Well developed glauconite bed.
- 253.20 Glauconite band.
- 268.6 - 301.80 Gradational interval from above and to below unit. Very finely laminated and interbedded siltstone and mudstone - light olive grey to olive grey, olive black to olive brown mudstone. Olive green mudstone dominant in upper part of interval, mudstone/siltstone roughly equal in middle third, olive black mudstone dominates in lower part of section, pyrite nodules common as are vertical to 1cm offset on fault sub vertical fractures and faults. Filled with carbonate (effervesce). Kerosene odour present which increases with increasing occurrence of olive black mudstone. Thin carbonate lenses 1-2cm thick intermittently occur often with bitumen.
- Brownish grey to black mudstone colour change towards base of unit.
- 1cm thick medium to coarse grained sandstone at 291.58m. Occasional brown yellow to gold fluorescence along some fractures - partings and carbonates.
- Features in interval.
- 281.60 - Fault small low angle but with ? displacement.
- 281.89 - 1cm thick carbonate lense.
- 283.3 - 284.7 High angle fault with 1cm displacement.
- 291.9 - 1cm thick carbonate lense with gold and yellow fluorescence.
- 291.58 - 1cm sandstone medium to coarse.
- 300.0 - 300.30 Carbonate infilled sub vertical fractures.

ZONES OF FLUORESCENCE

268.0 - 270.0	Oily film on core straight out of hole.
281.18 - 281.20	Gold brown and green-excellent and bright.
288.12 - 288.16	Green/yellow.
288.17 - 288.20	Green/yellow.
291.89 - 291.90	Gold yellow with white - excellent example oil.
299.8	Yellow fluorescence.
300.11	Yellow fluorescence.
300.18 - 300.24	Yellow fluorescence.
302.71 - 302.76	Yellow and blue white.
305.51 - 305.54	Blue white.
305.85	Blue white fluorescence.
307.76	Excellent brown fluorescence.
318.90	Brown? fluorescence in carbonate.
336.21 - 336.30	Yellow green fluorescence in carbonat e filled fractures.
339.39 - 339.40	Blue white fluorescence in carbonat bed.
<u>301.80 - 372.98</u>	<u>Brownish black to black - finely le</u> inated to <u>massive mudstone</u> , for top two metre then black. Characterised by very thin (1mm to cm) carbonate lenses with pyrite at centre and al o massive pyrite lenses and nodules ranging f om 1-3cm. Fractures common with carbonate inf lling, occasionally with brecciated appear nce and vugs filled with carbonates and oil? St ongest kerosene odour detected in this hol but moderate cf: Alex-1. Fluorescence yellow an golden brown along partings.
303.7 -	Pyrite nodule/lense like massive, i regular outline.
304.1 - 304.5	Vertical fractures infilled with ca bonates.
306.90 -	Pyrite nodule.
314.85 and 314.27 and 314.36	Carbonate lenses with minor pyrite.

- 316.23 - 1/2cm carbonate lense with pyrite at centre.
- 316.28 - Pyrite nodule.
- 316.83 - Thin carbonate lense.
- 317.06 - Thin carbonate lense.
- 317.10 - 2cm massive pyrite layer.
- 317.90 - 1cm carbonate layer with pyrite at centre.
- 318.30 - 1cm carbonate layer with pyrite at centre.
- 320.5 - Very thin carbonate layer.
- 320.97 - Carbonate pyrite layer.
- 321.5 and 321.98 Thin carbonate layers.
- 311.0 - 311.20 Fine fracture - vertical filled with carbonate.
- 322.15 - 0.5cm massive pyrite layer/nodule.
- 322.82 - Thin carbonate lense and associated pyrite.
- 323.62 - Fractured mudstone with floating fractured clasts and carbonate infilled cracks and vugs with drusy carbonate crystals.
- 324.12 - 2cm pyrite layer.
- 324.22 - Thin carbonate lense.
- 324.70 - Thin carbonate lense.
- 324.96 - Thin carbonate lense.
- 325.32 - 1cm massive pyrite nodule.
- 326.00 - Thin carbonate lense.
- 327.2 - Thin carbonate lense.
- 327.36 - 2cm massive pyrite nodule.
- 328.70 - 4cm pyrite.
- 330.23 - Thin carbonate and pyrite.
- 331.87 - Thin carbonate and pyrite.

- 332.10 - Thin carbonate and pyrite. Between last 2 measurements there is a high angle fracture zone.
- 332.45 - 332.57 Brownish grey to dusty brown massive mudstone.
- 335.54 - 336.50 Interval of fracturing and calcite venation.
- 336.27 - 10cm zone of crushed black shale, large calcite filled vugs, pyrite and bitumen. Green yellow fluorescence.

Zones of Fluorescence

- 354.54 - Brown gold fluorescence in carbonate.
- 354.85 - Brown gold fluorescence in carbonate.
- 355.26 - Brown gold fluorescence doesn't appear to be associated with carbonate lenses.
- 355.76 - Brown Gold Carbonate fluorescence.
- 355.92 - Brown Gold Carbonate fluorescence.
- 356.20 - Green Fluorescence.
- 357.32 - Green yellow fluorescence.
- 357.75 - Blue/white outside, yellow inside.
- 358.00 - Blue/white fluorescence.
- 359.70 - Yellow green and white - excellent
- 361.18 - Yellow green.
- 361.23 - Yellow green.
- 361.51 - Yellow green.
- 361.73 - Yellow green nodule.
- 364.53 - Green fluorescence.
- 366.7 - Green Fluorescence.
- 368.03 - Yellow blue gold.
- 368.35 - Oil bright gold fluorescence.

List of characteristics of interval 301.80 - 372.98

- 337.40 - 340.88 Zone of increased occurrence of calcite "beds" and infilled fractures.
- 338.99 - Zone of calcite with vugs infilled with mudstone, blue white fluorescence - 1cm thick.
- 345.25 - 2cm massive pyrite layer, compactional features and bitumen - unusual texture - "turbulent".
- 351.3 - 1cm band of pyrite in lenticular horizontal masses which reticulate, dark centres to pyrite masses. Thin carbonate lense either side.
- 351.90 - 353.20 1.3m drilled over core - ground up.
- 354.20 - 2m moderate brown interval with calcite lenses assoc. above.
- 356.00 - 369.10 Calcite veins horizontal and subvertical also common.
- 359.35 - Pyrite nodule with compactional drape around it suggested it is an early diagenetic feature pre-significant compaction. Carbonate lense appears to thin over it - later than nodule? suggestion. Possibly assoc. bitumen with it.
- 359.70 - 3cm zone of dom. carbonate some bitumens and significant pyrite at base of zone. Vugs in carbonate filled with drusy carbonate crystals.
- 361.70 - 5cm zone of carbonate nodule with lenses surrounding it. Vugs at centre filled with calcite crystals and dark bituminous? matter.
- 364.50 - Thin carbonate lense.
- 365.73 - Vertical fractures infilled with thin carbonate. Vertical fracture crosscuts horizontal carbonate lense with pyrite and in some places dislocates carbonate lense. In others places it does not appear to pass through. Vertical fracture post-dates or is concurrent with lense.
- 368.30 - Carbonate lenses and 45° fracture. Carbonate lense appears to develop from fracture and in other areas in zones of complex fractures carbonate lenses appear to be dislocated by faults - complex developmental history.

- 368.40 - Mod. yellowish brown 2cm interval, very soft.
- 369.10 and 369.80 Pyrite layers massive.
- 372.98 - 380.10 Interbedded light and dark mudstones. Light mudstone - pale yellow brownish to light dark grey to light grey.
- Dark mudstone - dark grey to brownish black to black.
- Mostly thinly interbedded, occasional interbeds up to 2-15cm thick.
- At base and top of unit beds from 3mm to 1cm, with middle of unit 5-6cm thick (maximum 15cm).
- Occasional current features in darker mudstone - swirly poorly developed features. Common sub horizontal low angle faulting features with displacement.
- 375.62 -375.92 Calcite bed, with 2cm irregular shale lense toward top, irregular at top with waving fractures filled with bitumen ? and pyrite. Basal contact sharp with shale below. Calcite crystal surface, give wet core a mottled appearance.
- 376.58 - 3cm carbonate unit rich in dissem. pyrite, surrounded by darker shale beds.
- 375.30 - Greyish red very thin fissile platy beds in 3cm thick unit. Very good porosity - possibly clays (tend to have oily surfaces yet soak up water fast).
- 372.16 - 373.18 Flaky unit - yellowish brown fluorescence (oil).
- 374 - Fracture on bedding surface with yellowish brown fluorescence.
- 379.34 - 1cm flaky layer no fluorescence.
- 380.09 - Yellowish brown fluorescence.
- 380.10 - 391.82 As for 301.80 - 372.98m
- 381.62 - Interesting massive pyrite bed with dissem. contacts above and below with black shale.
- 385.88 - 386.00 Oil with bright yellow fluorescence.

- 386.32 - 386.36 Thin massive carbonate unit with ripple like upper contact.
- Gradational contacts both at top and base of unit with increasing amounts of lighter mudstone interbeds toward base.
- 391.82 - 424.61 As for 372.98 - 380.10 except with uniformly thin to medium thickness interbeds of light/dark mudstone with top 10m being dom. by dark mudstone then even proportions of light and dark to base.
- Light mudstone occasionally some light brownish grey - brownish grey to light brownish grey, dark mudstone - brownish black.
- 393.05 - Pyrite 0.5cm massive.
- 400.21 - Fresh break along bedding plane has yellow fluorescence.
- 402.85 - 402.90 Irregular surfaces of light mudstone, possibly? current features, brittle displacement high angle.
- 405.85 - 405.90 Fracture with displacement x-cutting light and dark mudstone.
- 402.65 - (3mm) small carbonate unit.
- 308.65 - Fracture.
- 415.26 - 4cm carbonate unit with fibrous/dendritic texture and pyrite and bitumen no fluorescence. Irregular contact, sinerysis features.
- 415.41 - 415.47 OIL Staining.
- 419.22 -419.33 OIL Staining.
- 418.64 - Carbonate layer 0.5cm.
- 419.82 - Carbonate layer 2cm. Massive pyrite with 2 glauconite bands above and blow (2mm thick).
- 420.12 - Glauconite (1cm) bed with minor carbonate.
- 421.8 - OIL - bright whitish yellow fluorescence 3cm.
- 424.41 - Small 0.5cm carbonate bed.

CALCAREOUS INTERVALS

399.64 - 399.94	
400.47 - 400.76	
402.86 - 402.89	
406.11 - 406.15	
408.42 - 405.50	
412.27 - 412.74	
412.88 - 413.03	
413.76 - 413.82	
415.20 - 415.32	
421.24 - 421.51	
421.96 - 422.10	
<u>424.61 - 452.68</u>	As for 301.80 - 372.98m.

Fluorescence

425.33 - 425.67	Calcareous zone with 10cm nodule at base with sinerysis features.
426.26 -	Dull Yellow Brown.
436.88 -	Bright bl-white yellow vuggy carbonate.
427.82 -	Blue white in vugs.
427.82 - 428.42	OIL, Bright yellow in fracture. Yellow blue white.
441.35 - 441.50	Bronze yellow white in vertical fractures.
442.16 -442.38	Yellow white, blue white with brown streak.
444.22 - 444.32	Blue white.
445.20 -	4cm massive pyrite band.
447.20 -	Thin pyrite nodule 1cm.

- 447.22 -447.45 Carbonate unit top boundary nodule, base is scour? (irregular angular contact) Bl/white speckled, minor yellow.
- 448.70 - Carbonate nodule.
- 448.86 - Bl-white in fracture carbonate nodule 14cm thick and calcite all way through.
- 450.78 - 451.04 OIL yellowish white and green speckled.
- 451.64 - 451.86 OIL.
- 453.68 - 564.86 Organic rich massive or extremely finely laminated mudstone. (This core will break up in transport unless care is taken). Very flaky and brittle when in contact with water. Suggestion it may be the hydrophobic nature of the H/C contained within which causes it to crack up. Some carbonate intervals. The organic matter is sometimes concentrated into laminae some of which exhibit almost recumbent folding on a scale below. Colours - medium bluish grey to dark greenish grey, with dark organic rich layers brownish black in colour.
- Areas of - brownish grey to dark greenish grey, and medium bluish grey.
- 453.31 - 453.78 Carbonate, nodular and fibrous to irregular with interbedded shales.
- 453.56 - 453.62 Calcareous interval.
- 453.62 - 453.80 Carbonate nodule vuggy porosity with oil bleed.
- 457.07 - 457.17 OIL bleed in flaky unit.
- 464.38 - Calcite bed 1cm thick.
- 464.12 - Blue white fluorescence.
- 464.00 - Green fluorescence.
- 480.00 - Calcite layer - veins and yellow white fluorescence.
- 479.60 - Yellow green and blue white fluorescence.
- 485.45 - Organic rich interval with recumbent fold.
- 490.30 - 30° bedding.
- 495.02 - Organic laminae with recumbent nature.
- 512.99 - Calcareous silty interval.

510.23 -

Very calcareous interval.

General interval becomes siltier and is less prone to disintegration, slumping and soft sed. def. "features" common, little blebs of organic matter common, oriented mainly along bedding, some random debris type flows common also up to 50cm thick, mostly 10cm thick, occasionally with readily ident. base and large organic flakes 4cm and 1cm as rafted features.

Colour - medium bluish grey and mostly dark greenish grey. More laminations towards base as siltstone amount.

Rare thin very fine sandstone laminae, which are distorted and contorted due to slumping.

Soft sed. def. common at 551m. At 553m, 8cm thick carbonate nodule with pyrite at edges, pyrite extends perpendicular from base into centre, and 1cm of the same at 552.50m. Dark greenish grey, greenish black with organic rich laminae of brownish black, much more visible laminae texture than massive.

Siltstone most common in basal 10-15m with laminae and constant amounts of debris flows and soft sed. def.

Vertical fractures begin to appear towards base (last 4m). Colour here is 5GY 4/1 (dark greenish grey) to greenish black, OM is brownish black.

564.80 -

Unusual feature cross curring laminae - a band of black OM? 2mm wide at 450.

564.86 - 571.46

Gradational boundary to unit of about 3m between last interval and this interval. Over gradation is interbedded silty mudstone-olive grey and brownish black, 1-5cm interbeds. Basal part brownish black to black thinly bedded 0.5-3cm mudstone.

Towards base occasional lighter siltstone brownish grey to olive grey with some base bed compactional features e.g. flame structures.

Shiny carbonaceous partings between beds and fracture surfaces, diagnostic characteristic some 600. Thin plastic platy mineral straight but of hole on parting surfaces feels slippery graphitic?

- 565.68 - Pyrite nodule 1cm massive.
Basal contact sharp.
- 571.46 - 595.95 Olive grey to olive black silty mudstone -
interbedded with occasional thin mudstone
laminae. Soft sed. def., debris flows dominate,
some lighter coloured siltstone - light brownish
grey to brownish grey. Bedding 15-20°, in silty
mudstone are cast features of siltstone, more
regularly bedded toward base and becomes dark
greenish grey, soft sed. def. common, siltstone
interbeds in abundance to equal proportion with
silty mudstone.

Ball pillow and flame structures also. Some low
angle small scale x bedding and possibly ripples.

Appears to be mudstone drapes over siltstone.

Unit becomes generally darker towards base and
laminations become more discrete light/dark bands.
- 588.76 - 1cm siltstone x-bedded, low angle.
- 590.41 - 6cm of interbed siltstone/mudstone with 1cm
siltstone high angle x bedded.
- 590.56 - 591.27 Soft sed. def. in form of slump.
- 592.25 - 1cm siltstone bed, load cast structures at base.
- 593.99 - 3cm siltstone - slumped and contorted.

Loading features at base brownish grey to olive
black. Brownish black organic siltstone - light
grey to light brownish grey.
- 595.95 - 607.00 As for 564.86 - 571.46 but horizontally bedded.
- 601.30 - 601.50 Calcite veins.
- 596.58 - Pyrite nodule.

N.B. 601.40-601.80
oil/graphite/slickensides/anthracite/ siltier
toward base ??? Olive black at top to slightly
lighter at base.
- 607.00 - 616.32 Finely laminate silty mudstone and mudstone, occ.
siltstone, olive grey to dark greenish grey (5GY
4/1) - same features as 595.95 - 607.00 but
different colour. Gradational change over 0.5m at
top, sudden boundary at base.

Claystone massive, silty mudstone laminated, lighter in colour towards base to lighter shade of olive grey.

616.32 - 619.64

At base and top there are quite a few siltstone laminae alternate light/dark, in middle is massive mudstone. At top is soft sed. def. with 1cm siltstone disloc. by brittle failure.

Small amounts of faulting (sim char. to boudinage) fluid escape over 5cm of 4 successive layers with boudins increasing in distance apart up sequence.

Blue black staining in parts cross cutting laminations? OIL? at 619.16m.

Similar otherwise to 595.95 - 607.00m.

Brownish black to black mudstone medium grey siltstone.

Minor shiny graphitic material present also on fractures.

619.64 - 621.12

Uniformly massive claystone-from green grey at top to light olive grey/olive grey at base.

Toward base are rare medium sized quartz gns (basal 5-10cm).

621.02 -

10cm band of siltstone with thin stringers of fine to medium grained sandstone with black irregular subhorizontal zones of H/C fluid alteration.

BESSIE CREEK SANDSTONE

621.12 - 630.53

Massive medium to coarse grained quartz sandstone.- Medium dark grey to brownish grey. Char by mottle surface texture, lighter mottles represent silica sandstone, darker are sandstone with visible porosity filled with bitumen? Suspected x bedding masked by mottling, stylolites common - 1.5cm, many sub-vertical to vertical open fractures. Si, pyrite and bitumen line fractures.

Greenish grey mottles at 625.00 - 625.2m.

624.85 - 624.95

Interval silty mudstone and medium grained sandstone thinly interbedded.

627.64 - 627.70

6cm silty mudstone bed.

Bitumen appears to impede silicification to a certain extent.

- 630.53 - 632.73 Thin interbeds regular 1-2cm of siltstone and sandstone (fine to medium, mostly fine).
- 630.88 - Quartz with bitumen - ? almost looks metamorphic - very hard greenish grey-mineral very interesting.
- General colour - sandstone - light brownish grey to pinkish grey to greenish grey - some are medium to dark grey with bitumen staining.
- Mudstone/siltstone - extremely variable in colour in greens and blacks. Dark greenish grey, greenish black to brownish black to olive black.
- Minor x-bedding, horizontal to subhorizontal bedding.
- Vertical fractures with green mineral.
- 632.73 - 633.61 Sandstone and mudstone-couplets typically 10-15cm sandstone, 2-3cm mudstone. Sharp base to sandstone. Occasional gradation upwards into mudstone.
- Sandstone - medium with pale greenish tinge and where bitumen stained greyish black to dark grey.
- Mudstone - greyish black to black. Abundant bitumen staining in sandstone, occasionally in irregular patches - basal 10cm bitumen staining with green nodules at centre.
- 633.61 - 634.53 As for 630.53-632.73 m except not as abundant green mineral in this interval.
- 634.53 - 634.63 10cm very coarse sandstone with abundant bitumen in matrix, very light grey quartz grains set in a blackish matrix with stylolite developed at base.
- 634.63 - 645.77 Fine to occ. medium sandstone, mostly appears massive with some thin bedding towards base, x-bedding also evident towards base, medium dark grey to brownish grey, stylolites common, vertical fractures open, some with bitumen crystals? Massive sandstone where fractured (vertical), stylolites have defined x bedding and thin bedding by graphite/bitumen on stylolite surface.
- 642.65 Oil/Water contact - basal boundary of bitumen staining.
- Numerous rounded and flattened intraclasts - very soft clay with rounded quartz grains contained within.

645.77 - 653.00

Pinkish grey and very light grey to light grey sandstone, with medium dark grey to dark grey thin organic rich layers and intraclasts - mudstone. Thinly bedded sandstone with OM. rich layers of undulating nature. Sandstone normally 1-4cm (thickest 10cm) organic mudstone 3mm - occ 1cm thick.

Sandstone - fine grained and silic, with lower visible porosity. Fluorescences in mudstone intraclasts and rarely the mudstone intralayers with yellow green fluorescence. Possible x-bedding.

Compaction features - pillows into mudstone. Occasional pink tinges as mottling in sandstone.

Some intraclasts angular, rounded and some lenticular. Less organic matter in basal 2m sandier interval.

653.00 - 663.71

Moderate to thickly bedded sandstone-with occasional organic mudstone laminae and angular mudstone intraclasts, incipient stylolites common most commonly at base of coarse sandstone which then fines upwards. Also marked stylolite occurrence at colour changes usually green above red. Bitumen (?), dark material filling stylolites. Sandstone beds - average 12-15cm. Mudstone - laminae 2-3mm generally intraclasts 1cm.

Towards base more stylolites and less mudstone.

Sharp contact with unit below - medium course sandstone at base, silicified and vertical fractures with siliceous linings.

Sandstone - base - very light grey
 - middle - light brownish grey
 Mudstone - dark grey with light greenish tinge.

Sometimes blotchy alteration colours indicative of water influx - pale red to moderate red.

- greenish grey to dark greenish grey and greyish blue green with some dusky blue green.

- occasional mod reddish brown bands < 1cm thick and centred around bedding planes/fractures.

Large scale x bedding present.

Fine to medium grained mostly - some almost coarse grained.

Some intraclasts have platy silver mica assoc. and other contain rounded quartz grains.

653.00 - Beginning of alteration zone.

660.70 - End of alteration zone.

CORCORAN FORMATION

663.71 - 666.70 Interbedded fine to occasionally medium grained sandstone and siltstone.

Sandstone - light grey to medium light grey (darker = finer).

Siltstone - greyish yellow green and greyish green lower in seq.

Sandstone - has scours with coarse sandstone at base fining up to siltstone.

- 0.6m sandstone at 664.82 very light green below 665.42 is green, interbedded sandstone/siltstone more siltstone, many more compactional features with sandstone "dykes", x-bedding scours, silic sandstone, and basal metre has more olive tones.

666.70 - 688.57 Thinly interbedded fine sandstone and silty mudstone to mudstone.

Sandstone - medium light grey to light grey.

Mudstone - medium dark grey to dark grey.

Sandstone - 0.5-5cm thick average 3cm.

Mudstone - 0.5 - 3cm thick average 1cm even distribution of sandstone mudstone and compactional features common with ball and pillows - bedding undulose to slightly dipping (depositional dip), very well developed scours and x bedding, festoon ripple x bedding, almost hummocky cross strat, ripple effect evident in scours. Occasional flaser bedding, occasional 10cm siliceous sandstone beds show peculiar distortions broken up by fluid escape.

667.0 61cm band of fine sandstone thickly bedded (top 20cm exhibits fluid escape described above).

Marked soft sed. def. - mixture of scouring features and fluid escape.

- 671.76 - 671.98 Finely laminated fine sandstone siltstone and mudstone, laminae 1/2mm thick with ball and pillow and flame structure - finely laminated but quite high sandstone content.
- Pyrite infilling fluid escape. Scouring commonly ? with char. or unit.
- 677 - 677.12 As for 671.76 - 671.98.
- 678.60 - 678.84 As for 671.76 - 671.98.
- 682.24 - 682.40 As for 671.76 - 671.98.
- 682.92 - 683.10 As for 671.76 - 671.98.
- 683.60 - 684.00 As for 671.76 - 671.98.
- 686.85 - 688.10 Sandstone - sandier sequence with rare O.N. laminae classic fluid escape structures.
- 688.57 - 691.4 Similar to above unit but more siltstone/mudstone with occasional sandstone laminae and much finer.
- Sandstone - medium grey.
- Mudstone - greyish black to brownish black - overall colour.
- Mudstone - finely laminae to massive 1cm-10cm.
- Sandstone - massive to finely laminated 1-2cm.
- Compactional features common, excellent ball and pillow structure, excellent boudin features, small scale low angle x beds in sandstone.

E O H

KEYWORDS

Hodgson Downs SD5314; Drill Rotary; Drill Stratigraphic; Petroleum; Geochemistry; Drilling Mud; Well Logs; Geophys Borehole; Hydrocarbon Potential; Analysis Source Rock; Maturation; Reservoir; Source; Proterozoic; Geothermal; Petrography; Porosity

LOCATION

Hodgson Downs SH5314; EP4; Scarborough-1; McArthur Basin; Northern Territory