PETROGRAPHIC ANALYSES OF

12 SIDE WALL CORE SAMPLES

ONSHORE

FROM KINGFISHER-1

Prepared for:

Teikoku Oil (Bonaparte Gulf) Company Ltd

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INTRODUCTION

Methods
A total of twelve thin sections have been made from side wall core samples in Kingfisher-1. After the sections where cut to 30 microns they where stained with Alizarin Red S and Potassium ferricyanide according to the Dickson (1966) method and then coverslipped. This stain is used to distinguish between calcite (red), ferroan calcite (blue), dolomite (no stain), and ferroan dolomite (turquoise). Mineral percentages where obtained through visual estimate. Grain size analysis was carried out on eight of the samples (Table 1), the remaining four are not well enough preserved for accurate grain size analysis to be carried out. Results of the grain size analysis are presented in Appendix 1. A visual grain size estimate was made of these samples. Two photomicrograph per sample have been taken so as to highlight the main petrographic features within the thin sections.

SUMMARY OF RESULTS AND INTERPRETATIONS

Sample Condition
Several of the samples have been highly deformed during the side wall coring process. This has led to shattering of grains and partial or complete disaggregation of samples. These factors make accurate identification of grain size, grain shape, sorting, degree of cementation and porosity/permeability impossible (Table 1). It has been noted within individual thin section descriptions which samples have been affected.

Rock Types
The samples from Kingfisher-1 are predominantly composed of quartz sandstones and dolomitic sandstones with varying authigenic clay contents. The dominant cement within the samples is authigenic silica, in the form of thin to thick authigenic overgrowths. The degree of cementation is highly variable from good to moderately poor. The porosity within the samples is low to good with a moderate permeability. The degree of permeability is generally controlled by the dolomite and authigenic clay content. Most samples with a high dolomite and/or clay content display a low porosity and permeability. The dolomite has formed within the primary intergranular pore space while the clays have been compacted into the pores after in situ alteration of detrital grains.

Mineralogy
The dominant mineral present within the samples examined is quartz, while lesser amounts of dolomite, illite, kaolinite, muscovite and pyrite are also present. Traces of zircon, tourmaline, glauconite, garnet, ferroan calcite, detrital clays and monozite have also been identified.

The quartz has a size range of coarse silt to pebbles with an average of approximately fine sand. The grain shape varies between very angular and well rounded and sorting is moderate to very poor. Authigenic silica overgrowths are generally common. The authigenic silica is usually present as a thick overgrowths, these commonly meet in triple point boundaries indicating unrestricted growth. The quartz grains predominantly display a straight to weakly undulose extinction, with minor composite grains and detrital chert. The detrital chert is commonly partially
dissaggregated, this appears to be due to the formation of illite along the internal boundaries of the grains.

Both authigenic and detrital clays are present within the section. The most common clays are authigenic illite and kaolinite. These clays are derived from the in situ alteration of detrital grains such as muscovite and feldspars. Partially altered grains are commonly visible. The clays are commonly compacted into the intergranular pore space. Minor detrital clays are also evident within the samples. The detrital clays appear to be highly micaceous and are compacted into the intergranular pore space. Trace of glauconite are also present in one sample.

Two phases of carbonate are evident; dolomite and ferroan calcite, with dolomite being dominant. The dolomite is present in the form of disseminated grains and as granular aggregates. Ferroan calcite is in the form of a massive sparry pore filling material. Both the carbonates display highly corrosive contacts with the detrital and authigenic grains.

Authigenic pyrite is generally associated with the authigenic dolomite or the partially altered muscovite grain. It is generally present as fine disseminated grains, with minor aggregates also present.

**POROSITY AND PERMEABILITY**

The porosity and permeability within the sandstones is generally good to poor. The porosity is often impossible to accurately determine due to the condition of the samples. The porosity that is present is of a primary intergranular nature. Authigenic clays, silica and dolomite have resulted in a reduction in the primary porosity.

**DEPOSITIONAL ENVIRONMENT**

The only environmental indicator within the samples is the presence of minor amounts of glauconite. This would tend to indicate deposition in a marine environment.

**DIAGENESIS**

All samples have undergone a similar diagenetic history. The initial phase of diagenesis appears to have been the formation of authigenic silica cement. This was followed by the alteration of the detrital grains to form authigenic clays. This alteration probably continued throughout the diagenetic history of the samples.

The first phase of carbonate deposition appears to have been the emplacement of ferroan calcite followed by the dolomite. The formation of the carbonates then led to the dissolution of the authigenic and detrital quartz.

The final phase of diagenesis appears to have been the formation of authigenic pyrite. This also displays corrosive contacts with the quartz.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Grain Size Analysis</th>
<th>Sample Condition</th>
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</thead>
<tbody>
<tr>
<td>1237m</td>
<td>YES</td>
<td>Good sample. Heavily fractured minor unaffected areas.</td>
</tr>
<tr>
<td>1327m</td>
<td>YES</td>
<td>Very small sample. Generally adequate condition.</td>
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<tr>
<td>1487m</td>
<td>NO</td>
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<td>1633m</td>
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<tr>
<td>1767.5m</td>
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<td>1769.5m</td>
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Table 1. List of samples analysed, sample condition and whether grains size analysis was carried out.
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</table>
Kingfisher-1

Quartz

Feldspar

Rock Fragments
SAMPLE: Kingfisher-1 1237m

Mineralogy

Detrital
- Quartz: 69%
- Feldspar: 2%
- Muscovite: 3%
- Monozite: Trace
- Tourmaline: Trace
- Glaucnite: Trace
- Illite: 15%
- Kaolinite: 10%
- Chlorite: Trace
- Pyrite: Trace
- Silica: Trace
- Primary: Trace

Authigenic:

Porosity:

Description:

The sample is a massive and structureless quartz arenite. The rock is grain supported with the grain boundaries displaying concave/convex to weakly sutured contacts. Cementation is poor with authigenic silica providing the only visible cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very fine sand (0.08mm) and a maximum of medium sand (0.48mm), with an average of fine sand (0.233mm). Sorting is good. Grain shape has a range from very angular to rounded with an average of sub-angular. Authigenic silica overgrowths are present, these are generally thin (<0.001mm) and discontinuous. The extinction of the detrital quartz is generally straight (60%) to undulous (40%) with minor composite grains and detrital chert present.

Feldspar is also present as a framework grain. It has a similar size range as that of the detrital quartz. Albite and perthitic twinned grains are present with the albite twinned most common. The extinction angle of the albite twinned grains (approximately 10 degrees) indicates an albite/oligoclase composition. Illite alteration of the plagioclase is common, with partly and completely altered grains being evident. The illite accumulations have commonly been compressed into the intergranular pore space. Accumulations of kaolinite are common, these may also be partly derived from altered feldspars. The kaolinite can be seen to be derived from the alteration of detrital muscovite, as traces of muscovite can be identified within the kaolinite. Traces of kaolinite alteration can also be seen along the cleavage planes of the detrital muscovite. The authigenic kaolinite is commonly compacted into the intergranular pore space. The detrital muscovite has also altered to form authigenic illite.

Only traces of primary intergranular pore space are evident. The majority of the pore space has been infilled by authigenic clays.

Diagenesis:
1. Silica cementation
2. Alteration of feldspars to form illite and kaolinite
3. Alteration of muscovite to form kaolinite.
Figure 1. 1237.0m x192 XPL

Partially kaolinised muscovite grain. Kaolinite can be seen at F4 and the unaltered grain at C5. A feldspar grain almost completely altered to illite can be seen at H4. The Fractured nature of the grains is also evident at F3.
Figure 2. 1237.0m ×192 XPL
Illite altered detrital grain (E3) compacted into the primary intergranular pore space.
SAMPLE: Kingfisher-1 1327m

Mineralogy

Detrital:

Quartz 68%
Feldspar 3%
Muscovite 1%
Tourmaline Trace
Garnet Trace
Illite 8%
Kaolinite 5%
Ferroan Calcite 1%
Pyrite Trace
Silica Trace
Chlorite Trace
Primary 15%

Authigenic:

Porosity:

Description:

The sample is a massive and structureless quartz arenite. The rock is grain supported with the grain boundaries displaying curved to weakly sutured contacts. Cementation is moderate with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very coarse silt (0.05mm) and a maximum of coarse sand (0.9mm), with an average of medium sand (0.355mm). Sorting is good. Grain shape has a range from angular to rounded with an average of sub-angular/sub-rounded. Authigenic silica overgrowths are common, these are up to 0.05mm thick and discontinuous. The extinction of the detrital quartz is generally undulose (70%) to straight (30%) with minor composite grains and detrital chert present.

Feldspar is also present as a framework grain. It displays a similar size range as that of the detrital quartz. Grains are generally tabular in shape. Polysynthetic, perithetic and albite twinning are identifiable. The polysynthetic twinning indicates a microcline composition and the extinction angle of the albite twinned grains (10 degrees) indicates an oligoclase/albite composition. Illite alteration of the plagioclase is evident. Partial leaching of the perthite and albite twinned grains is common.

Kaolinite is present compacted into the primary intergranular pore space. It is evident that this is, at least in part, derived from the alteration of detrital muscovite. Some of the kaolinite may also have been derived from the alteration of feldspars. Alteration of muscovite also appears to have formed authigenic illite clays.

The ferroan calcite is present in the form of a massive sparry pore filling material. It displays highly corrosive contacts with both the authigenic and detrital quartz.

Minor primary intergranular porosity with a good permeability is present. The porosity has been greatly reduced by the authigenic clays being compacted into the intergranular pore space.

Diagnosis:
1. Silica cementation
2. Alteration of detrital grains to form authigenic clays
3. Emplacement of authigenic calcite and dissolution of silica.
Figure 3. 1327.0m x192 XPL.
Detrital quartz and feldspar grains. Leaching of a feldspar grain is evident at E3. Indistinct authigenic silica overgrowths are evident at C5.
Figure 4. 1327.0m x192 XPL

In situ alteration of a feldspar grain to form illite can be seen at G3. Kaolinite can also be seen in the primary pore space (D5). It appears that the clay may have been emplaced into the pore space during the side wall coring process.
SAMPLE: Kingfisher-1 1487m

Mineralogy
Detrital:

Quartz           94%
Feldspar         Trace
Tourmaline       Trace
Muscovite        1%
Kaolinite        2%
Illite           3%

Authigenic:

NB: Very poor sample. The majority of the sample is composed of heavily shattered and disaggregated grains. This makes identification of minimum grain size, average grain size, grain shape, structure, fabric, mineral percentages and porosity impossible. The shattering of the sample is interpreted to have occurred during the side wall coring process. See figure.

Porosity:

Description:
The dominant constituent mineral is quartz. The maximum grain size is approximately coarse sand (0.60mm). Authigenic silica overgrowths are evident. They are generally thin (<0.01mm) and discontinuous.

Albite and untwinned grains are evident. Some illite alteration of the feldspar can be identified.
Figure 5: 1487.0 m x75.6 XPL

The heavily fractured and disaggregated nature of the sample is evident.
Figure 6. 1487.0m x192 XPL
The heavily fractured and disaggregated nature of the sample is evident.
SAMPLE: Kingfisher-1 1633m

Mineralogy
Detrital:
- Quartz: 84%
- Feldspar: 1%
- Volcanic Fragments: 1%
- Kaolinite: 2%
- Illite: 1%
- Silica: 1%

Authigenic:
- Primary: 16%
- Secondary: Trace

Porosity:

Description:
The sample is a massive and structureless quartz arenite. The rock is grain supported with the grain boundaries displaying curved to sutured contacts. Cementation is good with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very fine sand (0.09mm) and a maximum of medium sand (0.42mm), with an average of fine/medium sand (0.254mm). Sorting is moderately good. Grain shape has a range from angular to well rounded with an average of sub-rounded. Thick (up to 0.05mm) authigenic silica overgrowths are common. The authigenic overgrowths commonly meet in triple point boundaries. The extinction of the detrital quartz is generally undulose (69%) to straight (29%) with minor composite grains and 2% detrital chert present. The chert grains are commonly partially or completely disassembled with illitic clays present along the internal crystal boundaries.

Feldspar is also present as a framework grain. It has a similar size range as that of the detrital quartz. Polysynthetic, perthite and albite twinning are identifiable, with very thin albite twinning being dominant. The extinction angle of the albite twinned grains (8-10 degrees) indicates an albite/oligoclase composition. Partially leached feldspars are identifiable. Illite and kaolinite replacement of the feldspar is evident. Completely replaced illite and kaolinite grains are present. Some of the kaolinite may also have been derived from the alteration of detrital muscovite.

The porosity has been interpreted as being good with a good permeability. Pore spaces are commonly infilled by authigenic clays, however this is interpreted as happening during side wall coring where clays where forced into the pore spaces. A trace of secondary porosity has also been produced by the leaching of the detrital feldspars.

Diagenesis:
1. Silica cementation
2. Alteration of detrital grains to form authigenic clays.
Figure 7. 1633.0m x75.6 XPL
Quartz sandstone. Sutured contacts are evident on the quartz grains (eg. I4). Illitic clays present at B5.
Figure 8: 1633.0m x192 XPL

Kaolinite can be seen compacted into the intergranular pore space at C5. A partially illite altered grain is also evident at F3.
SAMPLE: Kingfisher-1 1767.5m

Mineralogy
Detrital:
- Quartz: 89%
- Feldspar: 1%
- Muscovite: Trace
- Dolomite: 5%
- Illite: Trace
- Silica: Trace
- Primary: 5%

Authigenic:

Porosity:

Description:
The sample is a quartz arenite. It displays a strong preferred orientation of the elongate axis of the detrital quartz and feldspar grains. The rock is grain supported with the grain boundaries displaying concave/convex to weakly sutured contacts. Cementation is moderate with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very fine sand (0.09mm) and a maximum of coarse sand (0.55mm), with an average of fine sand (0.242mm). Sorting is good. Grain shape has a range from angular to sub-rounded with an average of sub-angular. Authigenic silica overgrowths are common, these are generally thick (up to 0.05mm) and discontinuous. The extinction of the detrital quartz is generally straight (60%) to undulose (40%) with minor composite grains present.

Feldspar is also present as a framework grain. It has a similar size range as that of the quartz grains. Polysynthetic and albite and perthitic twinning are identifiable, with perthite twinned grains being most common. Leaching of the albite and perthite twinned feldspars is evident. Partial illite replacement is evident on some of the albite twinned grains.

Dolomite is present as fine (0.04mm) disseminated rhombs throughout the sample. The dolomite displays highly corrosive contacts with the detrital and authigenic quartz.

Good primary intergranular porosity with a probable high permeability is present.

Diagnosis:
- Authigenic silica cementation
- Dolomite emplacement and silica dissolution.
Figure 9. 1767.5m x192 XPL
Quartz sandstone. Thick authigenic silica overgrowths are evident at E3. A highly corrosive contact between the detrital grains and the authigenic dolomite can be seen at B5.
Figure 10. 1767.5m x192 XPL
Granular aggregate of authigenic dolomite can be seen at B5. Weakly sutured contacts are evident at G5.
SAMPLE: Kingfisher-1 1769.5m

Mineralogy

Detrital:

Quartz 49%
Feldspar 1%
Muscovite Trace
Zircon Trace
Dolomite 50%
Primary Trace

Authigenic:

Porosity:

NB. Very poor sample. The sample is very poorly lithified and heavily fractured. The fracturing has been interpreted as being formed during sampling. Accurate estimation of the grain size, shape or porosity of this sample is impossible.

Description:

The dominant framework grain is quartz. Visual estimates of grain size range from very fine sand (0.05mm) to medium/coarse sand (0.5mm) with an average of approximately fine sand (0.2mm). Sorting is moderate to poor. Minor authigenic silica overgrowths are present, these are generally thin (<0.01mm) and discontinuous. The extinction of the detrital quartz is generally straight to undulose with minor composite grains present. The authigenic silica has been extensively removed by contact with the authigenic dolomite.

Feldspar is also present as a framework grain. It has a similar size range as that of the quartz grains. Polysynthetic and albite and perthitic twinning are identifiable, with perthite twinned grains being most common. Leaching of the albite and perthite twinned feldspars is evident.

Dolomite is present as granular aggregates, as disseminated rhombs and as sparry pore filling material. The dolomite contacts are highly corrosive with the authigenic and detrital quartz.

Diagnosis:

1. Authigenic silica
2. Dolomite emplacement and silica dissolution.
Figure 11. 1769.5m x75.6 XPL

Dolomitic quartz sandstone. The fractured nature of the sample is evident at B1. Disseminated dolomite rhombs and granular aggregates are present displaying highly corrosive contacts with the quartz grains.
Figure 12. 1769.5m x192 XPL

Authigenic dolomite can be seen to have highly corrosive contacts with the detrital quartz. The heavily fractured nature of the quartz is also evident (eg. B2).
SAMPLE: Kingfisher-1 1776m

Mineralogy
Detrital:
- Quartz 48%
- Feldspar 1%
- Muscovite Trace
- Dolomite 50%
- Pyrite Trace
- Primary 1%

Authigenic:

Porosity:

Description:
The sample dolomitic quartz arenite. A very weak lineation is defined by a preferred orientation of the elongate axis of the detrital quartz. The rock is grain supported with the grain boundaries displaying concave convex/contacts. Cementation is moderate to poor, with authigenic silica providing the dominant cement. Authigenic dolomite has removed some of the silica cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very coarse silt (0.04mm) and a maximum of medium sand (0.35mm), with an average of fine sand (0.137mm). Sorting is moderate to good. Grain shape has a range from angular to rounded with an average of sub-angular. Authigenic silica overgrowths are present, these are generally thin (<0.001mm) and discontinuous. Much of the authigenic silica overgrowths have been removed by corrosive contact with the authigenic carbonate. The extinction of the detrital quartz is generally straight (70%) to undulose (30%) with minor composite grains present.

Feldspar is also present as a framework grain. It has a similar size range as that of the quartz grains. Polysynthetic and albite and perthite twinning are identifiable, with perthite twinned grains being most common. Leaching of the albite and perthite twinned feldspars is evident.

Dolomite is present as fine disseminated rhombs (0.05mm) and as granular aggregates. The concentration of the dolomite is highly varied throughout the sample. The sections with high contents of dolomite are less well preserved due to their more friable nature. The dolomite displays highly corrosive contacts with the quartz and authigenic silica. Within the areas of high dolomite concentration, almost all detrital and authigenic silica has been removed. Cementation is provided by authigenic silica, this has been partially removed by contact with the authigenic dolomite.

Primary intergranular pore space has been almost completely infilled by authigenic dolomite.

Diagenesis:
1. Authigenic silica cementation
2. Dolomite emplacement and quartz dissolution.
Figure 13. 1776.0m ×75.6 XPL
Dolomitic quartz sandstone. The corrosive nature of the dolomite is evident throughout the sample.
Figure 14. 1776.0m x192 XPL.
Granular aggregate of authigenic dolomite displaying highly corrosive contacts with the detrital chert.
SAMPLE: Kingfisher-1 1785.5m

Mineralogy
Detrital:
- Quartz: 76%
- Feldspar: 1%
- Zircon: Trace
- Tourmaline: Trace
- Dolomite: 10%
- Ferroan Calcite: 2%
- Silica: Trace
- Illite: 1%
- Primary: 10%

Authigenic:

Porosity:

Description:
The sample is a well cemented quartz sandstone. A moderately strong lineation is evident, defined by the orientation of the long axis of the detrital quartz grains. The lineation is further defined by the presence of organic/clay rich laminae. The rock is grain supported with the grain boundaries displaying curved to concave/convex contacts. Cementation is well developed, with authigenic silica providing the dominant cement. Authigenic ferroan calcite is also present as a minor cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very fine sand (0.06mm) and a maximum of medium/coarse sand (0.5mm), with an average of fine sand (0.256mm). Sorting is good. Grain shape has a range from sub-angular to rounded with an average of sub-rounded. Authigenic silica overgrowths are commonly present, these are generally thick (up to 0.05mm) and discontinuous. The extinction of the detrital quartz is generally straight (70% of grains) to undulose (30%) with minor composite grains present.

Feldspar is also present as a framework grain. It has a similar size range as that of the quartz grains. Polysynthetic and albite and perthite twinning are identifiable, with perthite twinned grains being most common. Leaching of the albite and perthite twinned feldspars is evident.

Two phases of carbonate are evident; dolomite and a ferroan calcite. The ferroan calcite appears to pre-date the dolomite and is present in a massive sparritic form. The dolomite is present as small (0.05mm) rhombs and as fine granular aggregates. The dolomite generally displays highly corrosive contacts with the authigenic and detrital quartz.

Micaceous detrital clays are present along thin laminae. Brown organic matter and authigenic pyrite is commonly associated with the clays.

Primary intergranular porosity is present with a moderate to good permeability. A reduction of the pore space has been caused by the authigenic carbonate, as well as silica overgrowths.

Diagonsis:
1. Silica cementation
2. Ferroan calcite cementation
3. Continued silica cementation
4. Dolomite emplacement and dissolution of silica
5. Pyrite formation.
Figure 15. 1785.5m x 75.6 PPL
Quartz sandstone with primary intergranular porosity stained blue. Authigenic clays are present infilling the porosity at F2. Dolomite is evident as fine rhombs throughout the sample.
Figure 16. 1785.5m x192 XPL.
Authigenic silica overgrowth evident acting as a cement (E4). Authigenic dolomite can be seen along the margin of the quartz grains partially removing both authigenic and detrital quartz.
SAMPLE: Kingfisher-1 1794.5m

Mineralogy
Detrital:
Quartz 39%
Feldspar Trace
Authigenic:
Dolomite 60%
Pyrite Trace
Porosity:

NB. The sample is very poorly preserved due to its friable nature. This has led to difficulties in manufacturing the thin section resulting in a small poor quality section. It is not evident whether the sample described is representative of the lithology or not.

Description:
The sample is a massive and structureless sandy dolomite. It is matrix supported with authigenic dolomite providing the matrix for the detrital quartz and feldspar. Cementation appears to be poor with granular dolomite providing the only cement.

The dolomite is present in the form of a granular aggregate. It displays extremely corrosive contacts with the detrital grains. Authigenic pyrite is commonly associated with the dolomite.

A visual grain size estimate of the detrital quartz range of coarse silt (0.03mm) to medium sand (0.30mm) with an average of approximately very fine sand (0.1mm). These grain sizes may not represent the grain size of the detrital grains when deposited due to dissolution of the grains due to contact with the corrosive dolomite. No authigenic silica overgrowths are evident. The grain extinctions are predominantly straight (70%) with lesser undulose (30%).

The feldspars present are perthite, albite and microcline. These have also been heavily corroded by contact with the authigenic dolomite.

No porosity is apparent.

Diagnosis:

1. Dolomite emplacement and silica dissolution.
Figure 17. 1794.5m x 75.6 XPL

Authigenic dolomite with detrital quartz grains "floating" in it. A trace of silica cementation is evident at B2. The dolomite displays highly corrosive contacts with the quartz grains.
Figure 18. 1794.5m x 192 XPL
Authigenic dolomite with quartz 'floating'. The corrosive nature of the dolomite contact is clearly evident.
SAMPLE: Kingfisher-1 1795.5m

Mineralogy
Detrital:
- Quartz: 47%
- Feldspar: Trace
- Dolomite: 50%
- Illite: 3%
- Pyrite: Trace
- Primary: ?

Authigenic:

Porosity:

NB. Poor sample. Only minor sections of the sample are well preserved with the rest being highly shattered and partially dissagregated. This is interpreted to have occurred during the side wall coring and/or the thin section manufacturing process.

Description:
The sample is a massive and structureless dolomitic quartz sandstone. The sample is predominantly grain supported with minor proportions of matrix support. Within the grain supported section the grain boundaries display curved to sutured contacts. The matrix material is provided by authigenic dolomite. Given the size of the sample provided it is not possible to determine what controls the relative proportions of dolomite. Cementation is poor with authigenic silica and authigenic granular dolomite providing the dominant cements.

The dominant framework grain is quartz. Visual estimates of grain size range from very fine sand (0.07mm) to coarse sand (0.8mm) with an average of approximately medium sand (0.5mm). Sorting is moderate. Grain shape has a range from very angular to rounded with an average of sub-angular. Authigenic silica overgrowths are present, they are commonly indistinct due to poorly defined inclusion rims. The extinction of the detrital quartz is generally straight (59%) to undulose (40%) with 1% detrital chert present.

Feldspar is also present as a framework grain. It has a similar size range to that of the detrital quartz. Polysynthetic, perthitic and albite twinning are identifiable. Minor leaching of the feldspars is evident. Illite alteration of the feldspars has occurred, in some cases the detrital grain has been completely replaced.

The dolomite is present in the form of disseminated rhombs and as granular aggregates. It displays highly corrosive contacts with the detrital quartz and feldspar grains. Within some portions of the sample the detrital grain contacts have been completely removed.

Some porosity with a moderate permeability is present. It is, however, not evident what percentage of the porosity is a product of the side wall coring and thin section manufacturing process. The porosity has been reduced, and in some places completely obliterated, by the emplacement of authigenic dolomite.

Diagnosis:

Silica cementation
Alteration of feldspars to form authigenic clays
Emplacement of authigenic dolomite and dissolution of detrital grains.
Figure 19. 1795.5m x75.6 XPL
Quartz sandstone displaying an alignment of the elongate axis of the detrital quartz grains. Authigenic dolomite can be seen along the grain margins. Sutured quartz boundaries are evident at I2.
Figure 20. 1795.5m x192 XPL

Fine granular aggregate of authigenic dolomite. The fractured nature of the sample is clearly evident within the quartz grain at H3.
SAMPLE: Kingfisher-1 1798.5m

Mineralogy

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<td>Zircon</td>
<td>Trace</td>
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<tr>
<td>Dolomite</td>
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<td>Illite</td>
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</tr>
<tr>
<td>Silica</td>
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<tr>
<td>Primary</td>
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Authigenic:

Porosity:

<p>| |</p>
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</table>

NB. Very poor sample with only minor portion of the sample remaining intact after the side wall coring process.

Description:

The sample is a quartz arenite. The sandstone displays a strong lineation defined by the alignment of the elongate axis of detrital quartz. The rock is grain supported with the grain boundaries displaying curved to sutured contacts. Cementation is good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very coarse silt (0.06mm) and a maximum of medium sand (0.4mm), with an average of very fine sand (0.187mm). Sorting is good. Grain shape has a range from angular to well rounded with an average of rounded. Authigenic silica overgrowths are common and up to 0.03mm thick. The overgrowths are generally indistinct due to the lack of well defined inclusion rims. Triple point contacts are common within the overgrowths. The extinction of the detrital quartz is generally weakly undulose (70% of the grains) to straight (30%) with minor composite grains and detrital chert present.

Feldspar is also present as a framework grain. It has a similar size range as that of the quartz. Polysynthetic, perthitic and albite twinning are identifiable. Partial leaching of the feldspars is common, this is preferentially associated with the perthitic grains. Illite alteration of the plagioclase is evident.

Muscovite is present in the form of bent and broken laths. Broken fragments of muscovite are also compacted into the intergranular pore space. Minor partial kaolinite alteration is evident. Illite replacement of the muscovite is also apparent. Pyrite alteration is commonly associated with the muscovite. Illite is also located along the margins of the detrital grains, this may be due to dispersal of altered grains or the in situ alteration of detrital clays. The illite tends to display corrosive contacts with the adjacent grains.

Dolomite is present as disseminated rhombs throughout the sample. The dolomite displays highly corrosive contacts with the detrital and authigenic quartz.

An accurate assessment of the pore space is not possible due to the fractured nature of the sample. It does, however, appear that some primary intergranular porosity is present although extensive authigenic silica emplacement has greatly reduced the porosity and permeability.
SAMPLE: Kingfisher-1 1798.5m cont.

Diagnosis:

1. Silica cementation
2. Alteration of micas
3. Dolomite emplacement.
Figure 21. 1798.5m x192 XPL
Quartz sandstone with a partially illite replaced detrital feldspar grain at G4.
Figure 22. 1798.5m x192 XPL
Quartz sandstone. A dolomite rhomb is evident at E2. This has formed in the primary intergranular pore space, corroding the surrounding grains. Authigenic illite is evident along the margin of the detrital grains at D5. A partially illite replaced grain is present at G6.
SAMPLE: Kingfisher-1 1799.5m

Mineralogy

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Authigenic:

Porosity:

Description:

The sample is a massive quartz arenite. A very weak lineation is evident within the sample, defined by a preferred orientation of the elongate axis of the detrital quartz grains. The rock is grain supported with the grain boundaries displaying curved to sutured contacts. Cementation is good with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis through counting one hundred grains gives a minimum size of very fine sand (0.07mm) and a maximum of medium sand (0.43mm), with an average of fine sand (0.208mm). Sorting is good. Grain shape has a range from angular to well rounded with an average of sub-rounded. Thick (up to 0.15mm) authigenic silica overgrowths are common. The overgrowths commonly completely infill primary intergranular pore space. The extinction of the detrital quartz is generally straight to undulose with minor composite and detrital chert grains present.

Feldspar is also present as a framework grain. It has a similar size range as that of the detrital quartz. Polysynthetic, perthitic and albite twinning as well as untwinned grains are identifiable. The polysynthetic microcline appears to be dominant. Partial and complete illite alteration of the feldspars is evident. The illite altered grains are commonly compacted into the intergranular pore space.

Muscovite is present as bent and broken laths. These are commonly partially or completely altered to illite. Pyrite is also commonly associated with the partially altered muscovite. Illite can also be seen along the margins of some of the detrital grains. It generally displays corrosive contacts with the detrital grains. Kaolinite is also present. This has formed as a result of the alteration of either muscovite and/or feldspars. The kaolinite is generally present compacted into the intergranular pore space.

The dolomite present is in the form of disseminated rhombs scattered throughout the sample. These display highly corrosive contacts with the detrital and authigenic silica.

A moderately good porosity and permeability appears to be present.
SAMPLE: Kingfisher-1 1799.5m cont.

Diagenesis:

1. Silica cementation
2. Kaolinisation
3. Formation of illite
4. Formation of pyrite
5. Emplacement of dolomite and dissolution of the detrital and authigenic quartz.
Figure 23. 1799.5m x75.6 PPL
Quartz sandstone. Primary intergranular porosity is present (stained blue).
Figure 24. 1799.5m 192 XPL

Well cemented quartz sandstone. The weakly sutured nature of the grain contacts is evident. At D4 a detrital grain completely replaced by authigenic illite is present. Unaltered feldspars can be seen at I3 and A4.
APPENDIX-1
Grain Size Analysis
KINGFISHER-1 1327mm

Statistical Summary

- Original number of samples: 100
- Samples removed by filter: 0
- Samples left after filtering: 100
- Samples greater than zero: 100
- Minimum sample value: 0.050
- Maximum value: 0.900
- Mean: 0.355
- Standard Deviation: 0.124
- Standard Error of Mean: 0.012
- Median: 0.475
- Geometric Mean: 0.332
- Geometric Standard Deviation: 1.492
- Skewness: 0.732
- Kurtosis: 5.576
- Sum of samples: 35 510
- Sum of samples > 0.0: 35 510
Statistical Summary

- Original number of samples: 100
- Samples removed by filter: 0
- Samples left after filtering: 100
- Samples greater than zero: 100
- Minimum sample value: 0.090
- Maximum value: 0.420
- Mean: 0.254
- Standard Deviation: 0.078
- Standard Error of Mean: 0.008
- Median: 0.255
- Geometric Mean: 0.241
- Geometric Standard Deviation: 1.409
- Skewness: 0.010
- Kurtosis: 2.223
- Sum of samples: 25.400
- Sum of samples > 0: 25.400
KINGFISHER-1 1767.5m

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PERCENTAGE vs. mm
**KINGFISHER-1 1776m**

### Statistical Summary

- **Original number of samples**: 100
- **Samples removed by filter**: 0
- **Samples left after filtering**: 100
- **Samples greater than zero**: 100
- **Minimum sample value**: 0.090
- **Maximum value**: 0.350
- **Mean**: 0.137
- **Standard Deviation**: 0.098
- **Standard Error of Mean**: 0.005
- **Median**: 0.195
- **Geometric Mean**: 0.128
- **Geometric Standard Deviation**: 1.462
- **Skewness**: 0.659
- **Kurtosis**: 5.129
- **Sum of samples**: 13,670
- **Sum of samples > 0.0**: 13,670
KINGFISHER-1 1785.5m

Statistical Summary

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KINGFISHER-1 1798.5m

Statistical Summary

- Original number of samples: 100
- Samples removed by filter: 0
- Samples left after filtering: 100
- Samples greater than zero: 100
- Minimum sample value: 0.060
- Maximum value: 0.400
- Mean: 0.187
- Standard Deviation: 0.057
- Standard Error of Mean: 0.007
- Median: 0.230
- Geometric Mean: 0.174
- Geometric Standard Deviation: 1.477
- Skewness: 0.450
- Kurtosis: 0.204
- Sum of samples: 18.660
- Sum of samples > 0.0: 18.660