Petrographic Analysis

Kingfisher-1
Onshore
(Part Two)

Prepared for:
Teikoku Oil (Bonaparte Gulf) Company Ltd

October 1994
INTRODUCTION

Methods

A total of thirty five thin sections have been made from side wall core samples in Kingfisher-1. Five of the samples proved to be predominantly composed of drill mud and were therefore unsuitable for petrographic analysis. After the remaining thirty one sections were cut to 30 microns they were 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 by point counting four hundred grains on each sample, however six of the samples were not of adequate quality for point counting. The mineral percentages for these samples was obtained through visual estimates (Table-3). Grain size analysis was also carried out on the thin sections, which were of adequate quality (Table-1), using the method described by Friedman (1958) by counting one hundred grains. Statistical analysis and a graphical representation of the results have been included in Appendix 1. Two photomicrographs per sample have been taken so as to highlight the main petrographic features within the thin sections. One photomicrograph of each of the samples which proved to be of inadequate quality for petrographic analysis have also been included.
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. It has been noted within individual thin section descriptions which samples have been affected and is summarised in Table 1.

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Table-1: Sample condition summary.
Rock Types

The samples from Kingfisher-1 are predominantly composed of quartz arenite and calcareous arenite, with minor sub arkose and quartz wackestones. 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.

Mineralogy

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

The quartz has a size range of fine silt to very coarse sand 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 quartz grains predominantly display a weakly undulose extinction, with minor composite grains and detrital chert. The detrital chert is commonly partially disaggregated, this appears to be due to the formation of illite along the internal crystal boundaries of the grains.

Both authigenic and detrital clays are present within the section. The most common authigenic clay is kaolinite. The clay is derived from the in situ alteration of detrital grains such as muscovite and feldspars. Partially altered grains are commonly visible. The clay is 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. Traces of glauconite are also present in eight of the samples.

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

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

The rock fragments present are in the form of volcanic fragments and detrital chert. The volcanic fragments are commonly partially altered to authigenic clays.
POROSITY AND PERMEABILITY

The majority of samples display no visible porosity. Trace percentages of porosity are present within several samples. The porosity data is summarised in Table-2.

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Table-2: Porosity.

The primary intergranular porosity has been reduced or completely removed by the emplacement of authigenic silica and later stage ferroan calcite. The high clay content within many samples has resulted in no primary porosity being present.

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. The distribution of the glauconite appears to be random throughout the section. A trace of marine fossil material has been identified at 2289.0m further supporting a marine origin.
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 certain detrital grains to form authigenic clays. The authigenic clay formation began when the sample was partly lithified as indicated by the clays being compacted into the intergranular pore space. The alteration of clays probably continued throughout much of the diagenetic history.

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

The final phase of diagenesis appears to have been the formation of authigenic pyrite which also displays corrosive contacts with the quartz.
REFERENCES


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Table-3: Mineral percentages
### Table-3: Mineral percentages

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Table-3: Mineral percentages
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<td>Trace</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Volcanic Fragments</td>
<td>Trace</td>
</tr>
<tr>
<td>Glaucnite</td>
<td>Trace</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>Trace</td>
</tr>
<tr>
<td>Dolomite</td>
<td>25.25%</td>
</tr>
<tr>
<td>Illite</td>
<td>0.75%</td>
</tr>
<tr>
<td>Silica</td>
<td>Trace</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a massive dolomitic quartz arenite. A variation in the relative proportions of authigenic dolomite and quartz is evident, however the disaggregated nature of the sample makes interpretation of the relationship of these variations impossible. The rock is predominantly grain supported, with the grain boundaries displaying concave/convex to sutured contacts. Minor regions of dolomite matrix support are also evident. Cementation appears to be very good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.05mm) to coarse sand (0.75mm) with an average of fine sand (0.19mm). Sorting is good to very good. Grain shape has a range from sub-angular to well rounded, with an average of sub-rounded. Authigenic silica overgrowths are commonly present, forming the primary cement. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite extinction.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned, untwinned and polysynthetic grains are evident. An extinction angle of approximately 8 degrees is present, indicating an albite composition.

The dolomite is present in a massive sparry form and as finer disseminated rhombs (approximately 0.1mm). The dolomite displays highly corrosive contacts with the detrital and authigenic silica. A trace of blue stain is associated with the dolomite, this may indicate traces of ferroan calcite or that the dolomite is ferroan.

A trace of primary intergranular pore space is evident which has been greatly reduced by authigenic silica and dolomite.
SAMPLE: 1872.0m cont.

Diagenesis

1. Silica cementation
2. Emplacement of dolomite
3. Dissolution of silica
Figure 1. 1872.0x192 XPL
Dolomite cemented quartz arenite. Highly corrosive contacts with the detrital quartz is evident, e.g. F5.
Figure 2. 1872.0m x192 XPL

Authigenic silica overgrowths are evident at B5, the contact of the overgrowth has been broken during side wall coring. A partially kaolinised feldspar is evident at F4. Authigenic dolomite is evident at H3, displaying highly corrosive contacts with the detrital quartz and feldspar.
SAMPLE: Kingfisher-1 1892.5m

Mineralogy

Detrital:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>73.50%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>3.0%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>2%</td>
</tr>
<tr>
<td>Rock Fragments</td>
<td>1%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Trace</td>
</tr>
<tr>
<td>Monozite</td>
<td>Trace</td>
</tr>
<tr>
<td>Dolomite</td>
<td>16.75%</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>1.50%</td>
</tr>
<tr>
<td>Illite</td>
<td>0.50%</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Pyrite</td>
<td>Trace</td>
</tr>
<tr>
<td>Silica</td>
<td>1.50%</td>
</tr>
<tr>
<td>Secondary</td>
<td>Trace</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a massive dolomitic quartz arenite. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.07mm) to medium sand (0.48mm) and an average of fine sand (0.20mm). Sorting is good. Grain shape has a range from sub-angular to well rounded with an average of rounded. Authigenic silica overgrowths are present, these are highly variable in thickness and are discontinuous. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains present.

Feldspar is also present as a framework grain. It has a similar size range as that of the detrital quartz. Polysynthetic, perthitic, albite and untwinned grains are present. The albite twinned grains generally display a low extinction angle (approximately 8 degrees) indicating an albite composition. Minor leaching of the albite twinned and untwinned grains is evident. Illite replacement is also evident and is preferentially associated with the untwinned grains.

Dolomite is present as disseminated rhombs and granular aggregates. Staining would tend to indicate that the dolomite is ferroan. The granular aggregates form elongate, discontinuous stringers. These have been interpreted as having formed as a replacement of detrital and/or authigenic clays. The disseminated dolomite rhombs are evident throughout the sample which are located along the margins of the detrital grains and within authigenic clay accumulations. The dolomite displays highly corrosive contacts with all detrital and authigenic minerals.
SAMPLE: 1892.5m cont.

Illitic clays are present as small intergranular accumulations and partially altered detrital grains. The intergranular accumulations are interpreted as having formed from the in situ alteration of detrital clays. The illite displays highly corrosive contacts with the detrital and authigenic quartz.

Pyrite is present as fine disseminated grains and granular aggregates. The disseminated grains are commonly present as thin (<0.01mm) laminations. These are heavily sutured. The laminations are interpreted as having formed as an alteration of thin laminations of organic rich detrital clays. Traces of red brown organic material can be seen associated with some of the pyrite laminations. The pyrite laminations are also present within the dolomite accumulations. This is interpreted as having formed in a clay rich stringer with the clays later being replaced by authigenic dolomite.

No porosity is apparent.

Diagenesis:

1. Silica cementation
2. Illitic replacement of detrital clays
3. Illite replacement of detrital grains
4. Illite dissolution of detrital grains.
5. Formation of pyrite
6. Dolomite emplacement and the removal of clays and dissolution of silica and feldspar.
Figure 3. 1892.5m x 75.6 XPL.
Quartz arenite with elongate dolomite accumulation. The dolomite appears to display highly corrosive contacts with the detrital and authigenic silica. Authigenic silica overgrowths are present at D1.
Figure 4. 1892.5 m x 192 XPL
Quartz arenite. The sutured nature of the grain contacts is visible at I5. Polysynthetic twinned microcline can be seen at D1. A trace of ferroan calcite is evident at B1, this can be seen to display corrosive contacts with the authigenic silica.
SAMPLE: Kingfisher-1 1893.5m

Mineralogy

Detrital:
- Quartz 78.50%
- Feldspar 2.25%
- Muscovite 6.50%
- Rock Fragments 1.50%
- Zircon Trace
- Tourmaline Trace
- Detrital Clay 0.50%

Authigenic:
- Ferroan Calcite 9.25%
- Dolomite 1.00%
- Illite Trace
- Silica Trace
- Opaque 0.50%

Porosity:

Description:

The sample is a quartz arenite. It displays a moderate lineation, defined by the alignment of the elongate axis of the detrital quartz. The rock is grain supported with grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be good, with authigenic silica and interlocking grains providing the main binding forces.

The dominant framework grain is quartz. Visual estimates of grain size range from sand (0.07mm) to coarse sand (0.50mm), with an average of approximately fine sand (0.25mm). Sorting is good. The grain shape varies from sub-angular to rounded with an average of sub-rounded. Thin authigenic silica overgrowths are rare. The overgrowths commonly have been partially removed by dissolution along the sutured boundaries. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (40%) and minor composite grains.

The feldspar grains display a similar grain size distribution as the detrital quartz grains. The grains are predominantly twinned according to the albite law, with minor polysynthetic twinning also evident. It is not possible to obtain an accurate twin extinction angle. However a low angle appears to be present, indicating an albite/oligoclase composition. Minor leaching of the feldspars is also evident.

Ferroan calcite is present in sparry and microsparry forms. It displays highly corrosive contacts with detrital and authigenic silica. The ferroan calcite appears to have infilled secondary intergranular pore space. The distribution of the ferroan calcite may indicate that it has replaced detrital clays. Possible dolomite is also present as indicated by unstained carbonates. This occurs in the same form as the ferroan calcite.

No porosity is evident or inferred.
SAMPLE: 1893.5m cont.

Diagenesis

1. Silica cementation
2. Illite formation
3. Ferroan calcite emplacement
4. Dissolution of silica and suturing of grain contacts.
Figure 5. 1893.5m x75.6 XPL
Quartz arenite. The highly sutured nature of the grain contacts is clearly evident. Minor micaceous clays are also visible, along the margins of several of the detrital grains. A rounded tourmaline can be seen at G1.
Figure 6. 1893.5m x192 XPL
Quartz arenite. Authigenic ferroan calcite at E2 displays highly corrosive contacts with the detrital quartz.
SAMPLE: Kingfisher-1 1894.9m

The sample is predominantly composed of drill mud and quartz fragments. No indication of the mineral composition or fabric can be obtained from the sample.

SAMPLE: Kingfisher-1 1897.5m

The sample is predominantly composed of drill mud and quartz fragments. No indication of the mineral composition or fabric can be obtained from the sample.

SAMPLE: Kingfisher-1 1899.0m

The sample is predominantly composed of drill mud and quartz fragments. No indication of the mineral composition or fabric can be obtained from the sample.

Although no indication of the lithology of these three samples it may be inferred that some similarity exists, indicated by there very poor condition.
Figure 7. 1894.9m x75.6 XPL

Totally disaggregated sample composed of quartz fragments and drilling mud.
Figure 8. 1897.5m x 75.6 XPI.
Totally disaggregated sample composed of quartz fragments and drilling mud.
Figure 9. 1899.0m x 75.6 XPL.
Totally disaggregated sample composed of quartz fragments and drilling mud.
SAMPLE: Kingfisher-1 1901.0m

Mineralogy

Detrital:
- Quartz: 86.25%
- Feldspar: 3.25%
- Muscovite: 0.75%
- Rock Fragments: 0.75%
- Tourmaline: Trace
- Zircon: Trace
- Clays: Trace
- Ferroan Calcite: 3.25%
- Dolomite: 2.50%
- Kaolinite: 0.50%
- Illite: 0.50%
- Silica: 2.25%

Authigenic:

Porosity:

Description:

The sample is a predominantly massive quartz arenite. A weak lineation is present, defined by the alignment of the elongate axis of the detrital quartz grains. The rock is grain supported, with the grain boundaries displaying concave/convex and sutured contacts. Cementation appears to be good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to coarse sand (0.54mm), with an average of fine sand (0.19mm). Sorting is good. Grain shape has a range from angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are commonly present, although often poorly defined. This is due to the lack of a well developed "dust" inclusion rim on the detrital grains. The extinction of the detrital quartz is generally undulose to straight, with minor composite grains present.

Feldspar is also present as a framework grain. It has a similar size distribution as that of the detrital quartz. Albite, polysynthetic and untwinned grains are evident. Minor illite alteration is evident, this is preferentially associated with the untwinned and albite twinned grains.

The dolomite is present as disseminated rhombs and heavily shattered aggregates. The shattered aggregates are interpreted as forming as a result of the side wall coring process. The dolomite displays highly corrosive contacts with the detrital and authigenic grains. A weak blue stain is present on the majority of the dolomite grains, indicating a probable ferroan dolomite composition. Ferroan calcite is also present as massive sparry pore filling material. It displays highly corrosive contacts with the detrital grains.

No pore space is evident.
SAMPLE: 1901.0m cont.

Diagenesis:

1. Silica cementation
2. Illitic clay formation
3. Dolomite emplacement and dissolution of detrital and authigenic grains.
Figure 10. 1901.0m x75.6 XPL
Quartz arenite. The shattered nature of the sample is evident in the left of the figure. The intact portion of the sample displays sutured contacts.
Figure 11. 1901.0m x192 XPL
Quartz arenite. Authigenic silica overgrowths are evident at G3. Minor authigenic dolomite is present at H4 and D4. Parallel fractures are evident through the detrital quartz, this is related to the side wall coring process.
Figure 12. 1905.0m x192 XPL
Quartz arenite. Authigenic ferroan calcite can be seen to be replacing detrital mica and partially chloritised mica. The ferroan calcite displays corrosive contacts with the detrital and authigenic silica.
SAMPLE: Kingfisher-1 1905.0m

Mineralogy

Detrital:

- Quartz: 84.25%
- Feldspar: 5.25%
- Muscovite: 0.25%
- Zircon: Trace
- Volcanic Fragments: 1.75%
- Ferroan Calcite: 7.50%
- Illite: Trace
- Kaolinite: Trace
- Silica: 1.0%

Authigenic:

- Trace

Porosity:

Description:

The sample is a quartz arenite. It displays a moderate lineation, defined by the alignment of the elongate axis of the detrital quartz. The rock is grain supported, with grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be good, with authigenic silica providing the primary cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to medium sand (0.37mm) with an average of fine sand (0.16mm). Sorting is moderate to good. The detrital grain shape is commonly difficult to determine due to the sutured nature of the grain contacts. Authigenic silica overgrowths are present, which appear to be thin and commonly poorly defined. This is due to the lack of well developed inclusion rims and the sutured nature of the grain boundaries. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (38%) and minor composite grains (2%).

The feldspar grains display similar grain size distribution as the detrital quartz grains. The grains are predominantly twinned according to the albite law, with minor polysynthetic twinning also evident. It is not possible to determine a twin extinction angle from this sample. Illite alteration of the feldspars is common. In some cases the detrital grain has been completely replaced leaving a "ghost" grain shape.

Ferroan calcite is present in sparry and microsparry forms. It displays highly corrosive contacts with detrital and authigenic silica. The ferroan calcite can be seen to be replacing the detrital muscovite. It is not clear if this is due to the formation of secondary porosity within the muscovite, or if the ferroan calcite is an in situ replacement.

Minor intergranular porosity is present. It appears to be of primary nature, this is, however not conclusive. The porosity may also be an artefact of the side wall coring process.
SAMPLE 1905.0m cont.

Diagenesis

1. Silica cementation
2. Illite formation
3. Dissolution of detrital micas
4. Ferroan calcite emplacement
5. Dissolution of silica
Figure 13. 1905.0m x192 XPL.
Quartz arenite. Thick authigenic silica overgrowths are evident (eg. E4). Authigenic ferroan calcite can be seen to post date the silica at F4.
SAMPLE: Kingfisher-1 1918.0m

Mineralogy

Detrital:
- Quartz: 93%
- Feldspar: 2%
- Muscovite: Trace
- Tourmaline: Trace

Authigenic:
- Ferroan Calcite: 5%
- Dolomite: Trace
- Illite: Trace
- Silica: Trace

Porosity: ?

NB. The sample is heavily shattered from the side wall coring process. Only traces of intact grains remain. This makes interpretation of porosity and structure impossible.

Description:

The sample appears to be a predominantly massive quartz arenite. A weak lineation is present, defined by the preferred orientation of the elongate axis of the detrital quartz grains. The rock is grain supported, with the grain boundaries displaying concave/convex to sutured contacts.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to fine sand (0.19mm), with an average of very fine sand (0.11mm). Sorting is moderate to good. Grain shape has a range from sub-angular to well rounded, with an average of rounded. Thin discontinuous authigenic silica overgrowths are commonly present. These are generally difficult to identify due to the shattered nature of the sample. The extinction of the detrital quartz is generally weakly undulose, with lesser straight and minor composite grains present.

A trace of feldspar is present within the sample. It displays a similar grain size as the detrital quartz grains. Polysynthetic, albite and untwinned grains are evident. Minor illite alteration of the grains is evident. Accumulations of illite are also present. These are interpreted as having been derived from the in situ alteration of detrital grains, possibly feldspar. Authigenic carbonates can be seen replacing the detrital feldspar grains.

Two phases of carbonate are present; dolomite and ferroan calcite. The structure of the two carbonates is not possible to determine, due to the shattered nature of the sample. Both the dolomite and ferroan calcite display highly corrosive contacts with the detrital quartz and feldspar.

It is not possible to determine the porosity due to the shattered nature of the sample.
SAMPLE: 1918.0m cont.

Diagenesis:

1. Silica cementation
2. Illite alteration of feldspars
3. Ferroan calcite emplacement and dissolution of quartz and feldspar
4. Emplacement of dolomite and continued dissolution of detrital and authigenic minerals.
Figure 14. 1918.0m x 75.6 XPL
Quartz arenite. Authigenic silica can be seen to be acting as the primary cement (eg. C5).
Figure 15. 1918.0m x192 XPL
Quartz arenite. Authigenic silica overgrowths are evident, acting as the primary cement.
SAMPLE: Kingfisher-1 1919.5m

Mineralogy

<table>
<thead>
<tr>
<th>Detrital:</th>
<th>Quartz</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feldspar</td>
<td>2.75%</td>
</tr>
<tr>
<td></td>
<td>Muscovite</td>
<td>0.25%</td>
</tr>
<tr>
<td></td>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td></td>
<td>Tourmaline</td>
<td>Trace</td>
</tr>
<tr>
<td>Authigenic:</td>
<td>Ferroan Calcite</td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td>Silica</td>
<td>Trace</td>
</tr>
</tbody>
</table>

Porosity:

Description:

The sample is a calcareous quartz arenite. It displays a moderate lineation, defined by the alignment of the elongate axis of the detrital quartz. The rock is predominantly grain supported with grain boundaries displaying point to curved contacts. Minor zones of matrix support are also present, with authigenic ferroan calcite forming the matrix material. Cementation appears to be good, with authigenic silica and ferroan calcite providing the cements.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.05mm) to coarse sand (0.52mm), with an average of fine sand (0.18mm). Sorting is good. The grain shape varies from sub-angular to well rounded, with an average of rounded. Thin authigenic silica overgrowths are present but rare. They form thin contact cements. The authigenic silica provided the initial cement. A great deal of the authigenic silica has been removed, through dissolution when in contact with authigenic ferroan calcite. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (40%) and minor composite grains.

The feldspar grains display a similar grain size distribution as that of the detrital quartz grains. The grains are twinned according to the albite law.

Ferroan calcite is present in sparry and microsparry forms. It displays highly corrosive contacts with the detrital and authigenic silica. The ferroan calcite has infilled all the primary intergranular porosity.

No porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Ferroan calcite emplacement
3. Dissolution of silica
SAMPLE: Kingfisher-1 1926.0.0m

The sample is predominantly composed of drill mud and quartz fragments. No indication of the mineral composition or fabric can be obtained from the sample.
Figure 16. 1919.5m x75.6 XPL
Calcareous quartz arenite. Detrital quartz grains within authigenic ferroan calcite (stained blue).
Figure 17. 1919.5m x192 XPL
Calcareaous quartz arénite. The margins of the detrital quartz grains can be seen to be corroded by the authigenic ferroan calcite.
Figure 18. 1926.0m x 75.6 XPL.
Totally disaggregated sample composed of quartz fragments and drilling mud.
SAMPLE: Kingfisher-1 1928.0m

Mineralogy

Detrital:

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<tr>
<th>Mineral</th>
<th>Percentage</th>
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<tbody>
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<td>83.75%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>4.50%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>1.50%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Trace</td>
</tr>
<tr>
<td>Volcanic Fragments</td>
<td>0.50%</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>0.75%</td>
</tr>
<tr>
<td>Illite</td>
<td>Trace</td>
</tr>
<tr>
<td>Opaque</td>
<td>0.75%</td>
</tr>
<tr>
<td>Silica</td>
<td>8.25%</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a quartz arenite. It displays a very weak lineation, defined by the alignment of the elongate axis of the detrital quartz. The rock is grain supported, with grain boundaries displaying sutured contacts. Cementation appears to be very good, with authigenic silica providing the cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.07mm) to medium sand (0.50mm), with an average of medium sand (0.26mm). Sorting is good. The grain shape varies from sub-angular to well rounded, with an average of rounded. Thick (up to 0.07mm) authigenic silica overgrowths are commonly present, forming the primary cement. Overgrowths commonly meet in triple point boundaries, indicating unrestricted growth into primary pore space. The extinction of the detrital quartz is generally weakly undulose (60%), with lesser straight (40%) and minor composite grains.

The feldspar grains display a similar grain size distribution as the detrital quartz grains. The grains display polysynthetic and albite twinning, untwinned grains are also present. Illitic replacement of the feldspars is evident (confined to the albite and untwinned grains). Completely illite replaced grains are evident, these are interpreted as being formed from the complete in situ alteration of detrital feldspar grains.

Ferroan calcite is present in sparry and microsparry forms. It displays highly corrosive contacts with the detrital and authigenic silica.

A trace of intergranular porosity is evident. This appears to be secondary, forming as a result of the removal of clays. It is, however not clear whether the clays were removed during sampling or in situ.
Diagenesis

1. Silica cementation
2. Illite formation
3. Ferroan calcite emplacement
4. Dissolution of silica
Figure 19. 1928.0m x 75.6 XPL
Massive quartz arenite. Thick authigenic silica overgrowths are evident at C5. The good crystal shape of the overgrowth would tend to indicate growth into unrestricted pore space. Sutured contacts are also evident.
Figure 20. 1928.0m x 192 XPL
Quartz arenite. Authigenic silica overgrowths form the dominant cement. Minor authigenic ferroan calcite is evident at D3 and H3.
SAMPLE: Kingfisher-1 1941.5m

Mineralogy

**Detrital:**
- Quartz: 91%
- Feldspar: 4%
- Muscovite: 3%
- Tourmaline: Trace
- Illite: 1%
- Pyrite: Trace
- Silica: 1%

**Authigenic:**

**Porosity:**

NB. The sample is in extremely poor condition. The sample is completely shattered with virtually no intact grains remaining. This makes accurate identification of the fabric and porosity impossible. The preserved portion of the sample may not be representative of the rock.

Description:

The sample is a massive quartz arenite. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be good, with authigenic silica providing the cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.11mm) to medium sand (0.41mm), with an average of fine sand (0.24mm). Sorting is good. Grain shape has a range from angular to rounded with an average of sub-rounded. Authigenic silica overgrowths are present, these are commonly thick (up to 0.03mm) and discontinuous. The overgrowths are generally difficult to recognise due to the shattered nature of the sample and the sutured grain boundaries. Inclusion rims marking the edge of the detrital grain are also poorly defined, with overgrowths being indicated by grain shape.

Feldspar is also present as a framework grain. Albite twinned grains are present. A trace of illite alteration along twin planes is evident. Illite is also present as intergranular accumulations. These are interpreted as having formed from the complete in situ alteration of detrital material. No indication as to the precursor of the illite is evident.

Pyrite is present as massive pore filling material. It appears to be replacing the authigenic illite. The pyrite displays highly corrosive contacts with the detrital quartz grains.

An accurate assessment of the pore space is impossible due to the sample condition, however there does not appear to be any porosity.
SAMPLE: 1941.5m cont.

Diagenesis:

1. Silica cementation
2. Illite replacement of detrital grains
3. Pyrite emplacement and dissolution of illite and silica.
Figure 21. 1941.5m x75.6 XPL
Quartz arenite. The heavily fractured nature of the sample is evident. Minor suturing of the grain boundaries is also evident.
Figure 22. 1941.5m x192 XPL
Quartz arenite. Heavily fractured. Authigenic silica overgrowths are evident at 15.
SAMPLE: Kingfisher-1 2002.0m

Mineralogy

Detrital:
- Quartz: 58%
- Feldspar: 5.25%
- Muscovite: 5.5%
- Biotite: 3.25%
- Zircon: Trace
- Tourmaline: Trace
- Clays: 26.75%
- Rock Fragments: 0.5%
- Glauconite: Trace

Authigenic:
- Ferroan Calcite: 0.75%
- Kaolinite: Trace
- Chlorite: Trace
- Silica: Trace

Porosity:

Description:

The sample is a quartz wackestone. A weak lineation is present, defined by the alignment of the elongate mica laths. Both grain supported and matrix and grain supported regions are evident. The grain supported regions display point to curved contacts. The matrix material is provided by detrital clays. The degree of cementation is variable, depending on the clay content. Higher degrees of cementation are evident in the quartz rich sections.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine silt (0.07mm) to medium sand (0.48mm), with an average of fine sand (0.20mm). Sorting is moderate to good. Grain shape has a range from very angular to rounded, with an average of sub-angular. Minor thin and discontinuous authigenic silica overgrowths are present. The extinction of the detrital quartz grains are generally undulose with lesser straight and minor composite grains.

Feldspar is also present as a framework grain. It has a similar size range as the detrital quartz, however the grain shape tends to be more tabular than the detrital quartz. Albite twinned and polysynthetic twinned and untwinned twinned grains are evident. The feldspar grains are commonly partially leached. Authigenic ferroan calcite is evident infilling secondary porosity created within the feldspar grains.

The detrital clays present are highly micaceous and form an amorphous matrix material. Dark, possible organic, material is rarely associated with the detrital clays. This material forms elongate stringers.

Both biotite and muscovite are evident. These are commonly bent and broken and partially exfoliated. Traces of possible kaolinisation of the micas is also evident. Some chlorite replacement of the biotite may also have occurred.

No primary or secondary porosity is evident or inferred.
Diagenesis

1. Silica cementation
2. Kaolinite and chlorite formation
3. Dissolution of feldspars
4. Ferroan calcite emplacement
Figure 23. 2002.0m x 75.6 XPL
Massive quartz wackestone. Detrital quartz with a micaceous clay matrix. Only minor cemented grains are evident (eg. H3).
A detrital muscovite grain is evident at F3. It has undergone bending, as a result of compression against other grains. The grain appears to be pressed between the quartz grains at F3 and G4. The centre region of the mica has been supported by a clay accumulation (E4). This is interpreted as having formed as a result of the complete in situ alteration of a detrital grains.
SAMPLE: Kingfisher-1 2050.0m

Mineralogy

Detrital:  
Quartz 35.0%  
Feldspar 1.0%  
Tourmaline Trace  
Volcanic Fragments Trace  
Muscovite 2.25%  
Ferroan Calcite 27.25%  
Illite Trace  
Dolomite 34.50%  
Silica Trace

Authigenic:

Porosity:

Description:

The sample is a massive dolomitic quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported with, the grain boundaries displaying point contacts. Cementation appears to be very good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of medium silt (0.02mm) to fine sand (0.13mm), with an average of coarse silt (0.05mm). Visual analysis also identified the presence of grains up to very coarse sand (1.10mm). Sorting is very good. Grain shape has a range from very angular to rounded, with an average of sub-angular. Traces of very fine authigenic silica overgrowths are evident, forming the primary cement. The overgrowths have been heavily corroded by contact with the authigenic carbonate. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (40%) extinction.

Feldspar is also present as a framework grain. It has a similar size and shape ranges as the detrital quartz. Albite twinned and untwinned grains are evident, with albite twinned being dominant. A twin extinction angle of approximately 10 to 15 degrees has been obtained, indicating an albite to oligoclase composition.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is present as fine granular aggregates. These aggregates are preferentially concentrated along the margins of detrital grains. The dolomite can be seen to possess highly corrosive contacts with the detrital and authigenic silica as well as the authigenic ferroan calcite. Ferroan calcite is present in the form of massive sparry pore filling material which also displays highly corrosive contacts with the detrital and authigenic silica.

No primary or secondary porosity is evident or inferred.
Diagenesis

1. Silica cementation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite and continued dissolution of silica.
Figure 25. 2050.0m x 75.6 XPL
Calcareous quartz arenite. Authigenic dolomite and ferroan calcite (stained blue) are evident.
Figure 26. 2050.0m x192 XPL.
Authigenic ferroan calcite and dolomite with detrital quartz grains. Both phases of carbonate can be seen to display highly corrosive contacts with the detrital grains. No direct evidence for the relative timing for the two phases of carbonate is evident, although the dolomite is interpreted as replacing the ferroan calcite.
SAMPLE: Kingfisher-1 2289.0m

Mineralogy

Detrital:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>50.75%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>2.25%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Trace</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>46.75</td>
</tr>
<tr>
<td>Clays</td>
<td>Trace</td>
</tr>
<tr>
<td>Chlorite</td>
<td>Trace</td>
</tr>
<tr>
<td>Silica</td>
<td>Trace</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a massive calcareous arenite. The rock is grain supported, with the grain boundaries displaying point to curved contacts. Cementation appears to be good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to medium sand (0.37mm), with an average of fine sand (0.16mm). Sorting is good. Grain shape has a range from angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are present forming a thin contact cement. The overgrowths are heavily corroded by contact with the authigenic ferroan calcite. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite.

Feldspar is also present as a framework grain. The grains have a similar size and shape range as that of the detrital quartz. Albite twinned and untwinned grains are evident. Partial leaching of the feldspars is common, with authigenic ferroan calcite infilling the secondary pore created by the leaching.

Ferroan calcite is present in a massive sparry pore filling form and as a finer granular aggregate. In several cases the granular aggregates have only partially taken the stain. However they are interpreted as being completely of ferroan calcite composition and not dolomite. The granular aggregates are preferentially associated with the detrital grain margins. Both forms of ferroan calcite display highly corrosive contacts with the detrital and authigenic silica. In some cases detrital grains have been completely replaced, leaving "ghost" structures in the ferroan calcite. A trace of calcareous fossiliferous material is also evident.

No primary or secondary porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Ferroan calcite emplacement
3. Dissolution of silica
Figure 27. 2289.0m x 75.6 XPL
Ferroan calcite (stained blue) cemented quartz arenite. The ferroan calcite appears to have replaced detrital fossiliferous material evident at F5.
Figure 28. 2289.0m x192 XPL
Ferroan calcite cemented quartz arenite. Minor authigenic silica overgrowths are evident (eg. E4). These can be seen to pre-date the ferroan calcite. The ferroan calcite also displays corrosive contacts with both the authigenic and detrital silica.
SAMPLE: Kingfisher-1 2294.0m

Mineralogy

<table>
<thead>
<tr>
<th>Detrital</th>
<th>Authigenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>Ferroan Calcite</td>
</tr>
<tr>
<td>Feldspar</td>
<td>Illite</td>
</tr>
<tr>
<td>Muscovite</td>
<td>Kaolinite</td>
</tr>
<tr>
<td>Zircon</td>
<td>Anhydrite</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Chlorite</td>
</tr>
<tr>
<td>Clays</td>
<td>Silica</td>
</tr>
</tbody>
</table>

Porosity:

NB. The sample is in a very poor condition and is predominantly disaggregated. Only minor portions of the sample remain intact. These intact areas are unlikely to be representative of the sample.

Description:

The sample is a quartz arenite. The structure and fabric of the sample is difficult to accurately determine due to the disaggregated nature of the sample. However it appears to be massive, although variations in the clay content are evident. Both grain supported and matrix and grain supported regions are evident. The grain supported regions display concave/convex to sutured contacts in the quartz rich sections and point contacts in the clay rich sections. The matrix material is provided by clays (it is not clear whether the clay rich regions are intact or have been disrupted by the side wall coring process). The degree of cementation is variable, depending on the clay content. Higher degrees of cementation are evident in the quartz rich sections.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.05mm) to fine sand (0.19mm), with an average of very fine sand (0.11mm). Sorting is good. Grain shape has a range from angular to well rounded, with an average of sub-rounded. Minor authigenic silica overgrowths are present, which are thin and discontinuous. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite extinctions.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned and polysynthetic twinned grains are evident. The feldspars are commonly partially leached. Illite replacement of the feldspars is evident, in some cases the whole detrital grains has been replaced.
SAMPLE 2294.0m cont.

The ferroan calcite is present in a massive sparry form. This can be seen to be infilling secondary porosity within feldspars as well as replacing clays. The ferroan calcite displays highly corrosive contacts with the detrital and authigenic silica, as well as feldspars and clays.

The clays present are illite, kaolinite, chlorite and possibly detrital clays. The chlorite and illite are present as an amorphous pore filling material. These authigenic clays are interpreted as having formed as a result of the in situ alteration of detrital clays. Small accumulations of kaolinite are also present. These are probably the result of complete in situ alteration of detrital grains.

No primary or secondary porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Illite and chlorite formation
4. Ferroan calcite emplacement
5. Dissolution of silica
Figure 29. 2294.0m x192 XPL
Quartz arenite. A partially kaolinised detrital feldspar grain is evident at G3. Traces of the original grain remain at F3. Authigenic kaolinite is also present at C3.
Figure 30. 2294.0m x192 XPL
Partially disaggregated quartz arenite. Illitic clays are evident at G2. These appear to be related to in situ alteration of the detrital albite grain at I3.
SAMPLE: Kingfisher-1 2295.5m

Mineralogy

Detrital:
- Quartz: 60.0%
- Feldspar: 2.75%
- Muscovite: 32.0%
- Rock Fragments: 0.25%
- Zircon: Trace
- Glaucophane: Trace

Authigenic:
- Ferroan Calcite: 2.75%
- Illite: 2.25%
- Chlorite: Trace
- Silica: Trace

Porosity:

Description:

The sample is a quartz arenite. The rock appears to display minor bedding, with clay and quartz rich zones being evident (the clays may also be an artefact of the side wall coring process, however they have been interpreted as being real). The clays may represent clay lenses or discrete beds, the sample is not in good enough condition to tell which. The thickness or continuity of the beds is also impossible to determine from the sample. A strong lineation is evident within the clays, defined by elongate mica laths and clay stingers. Stringers of dark, possible organic, material further define the lineation. A weak lineation is evident within the quartz rich portions of the sample, defined by the preferred orientation of the elongate axis of the detrital quartz grains. The sample is predominantly grain supported, with minor areas of matrix support. The grain supported regions display point to curved grain boundaries within the clay rich portions and concave/convex to sutured in the quartz rich zones. Cementation is variable, from poor in the clay rich zones to good in the quartz rich zones. Authigenic silica provided the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of medium silt (0.03mm) to medium sand (0.34mm), with an average of fine sand (0.13mm). Sorting is good. The grain shape varies from very angular to well rounded, with an average of sub-rounded. Minor authigenic silica overgrowths are present, and are preferentially associated with the quartz rich portions of the sample. The overgrowths are generally thin and discontinuous. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains.

The detrital clays present are pale brown in colour and highly micaceous. Minor recrystallisation appears to have occurred, forming the authigenic clays, illite and chlorite. Dark, possible organic, material is commonly associated with the clays. Opaque grains, probably pyrite, is also associated with the detrital clays. This is present in the form of fine (<0.01mm), disseminated grains and small granular aggregates.
SAMPLE 2295.5m cont.

The ferroan calcite is present in a sparry pore filling form. It can be seen to be infilling secondary pore spaces within feldspars, created by leaching the detrital grains. The ferroan calcite displays highly corrosive contacts with detrital and authigenic silica and detrital and authigenic clays. A trace of possible dolomite may also be associated with the ferroan calcite, as indicated by staining.

No porosity is evident or inferred. The porosity has been removed by the infilling of primary pores by authigenic silica, followed by authigenic ferroan calcite.

Diagenesis

1. Silica cementation
3. Continued silica cementation
4. Illite and chlorite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 31. 2295.5m x75.6 XPL
Massive quartz arenite. Sutured grain contacts are evident throughout the sample.
Figure 32. 2295.5m x192 XPL
Quartz arenite. Minor ferroan calcite is evident at C3 and B2. These can be seen to display corrosive contacts with the detrital quartz grains. A trace of chloritised mica is evident along the detrital grain boundary (E3). This is interpreted as having formed from the in situ alteration of detrital micas.
SAMPLE: Kingfisher-1 2296.6m

Mineralogy

Detrital:
- Quartz: 61.5%
- Feldspar: 4.0%
- Tourmaline: Trace
- Volcanic Fragments: 0.50%
- Muscovite: 0.50%

Authigenic:
- Ferroan Calcite: 33.50%
- Chlorite: Trace
- Silica: Trace

Porosity:

Description:

The sample is a massive calcareous quartz arenite. The rock is predominantly grain supported, with minor regions of matrix support. Grain boundaries within the grain supported regions display curved to point contacts. The matrix material is provided by authigenic ferroan calcite. Cementation appears to be good.

The dominant framework grain is quartz. Grains size analysis indicates a size range of medium silt (0.02mm) to coarse sand (0.90mm) with an average of very fine sand (0.11mm). Sorting is good to very good. Grain shape has a range from very angular to rounded with an average of sub-rounded. Authigenic silica overgrowths are commonly present forming the primary cement. A great deal of dissolution of the overgrowths has occurred through contact with the authigenic ferroan calcite. The extinction of the detrital quartz is generally undulose (70%), with lesser straight extinctions (30%).

Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica. Minor granular aggregates are present along the margins of the detrital grains.

No primary or secondary porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Ferroan calcite emplacement
3. Dissolution of silica
Figure 33. 2296.6m x75.6 XPL.
Massive quartz arenite with ferroan calcite cement (stained blue). The corrosive nature of the ferroan calcite is evident (eg. B3)
Figure 34. 2296.6m x192 XPL
Ferroan calcite cemented quartz arenite. A trace of authigenic silica cement is evident at B4. The majority of the authigenic silica appears to have been removed by the authigenic ferroan calcite. The detrital feldspar can be seen to be particularly affected by the ferroan calcite. A heavily corroded feldspar is evident at E3.
SAMPLE: Kingfisher-1 2297.5m

Mineralogy

<table>
<thead>
<tr>
<th>Detrital:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>74.25%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>1.75%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>1.75%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Volcanic Fragments</td>
<td>Trace</td>
</tr>
<tr>
<td>Glaucorite</td>
<td>Trace</td>
</tr>
<tr>
<td>Clays</td>
<td>1.25%</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>16.25%</td>
</tr>
<tr>
<td>Dolomite</td>
<td>3.0%</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>0.75%</td>
</tr>
<tr>
<td>Ilite</td>
<td>0.50%</td>
</tr>
<tr>
<td>Anhydrite</td>
<td>Trace</td>
</tr>
<tr>
<td>Chlorite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Silica</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Authigenic:</th>
<th></th>
</tr>
</thead>
</table>

Porosity:

Description:

The sample is a massive calcareous quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported, with the grain boundaries displaying point to curved contacts. Cementation appears to be good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of fine silt (0.01m) to fine sand (0.22mm) with an average of very fine sand (0.10mm). Sorting is moderate to good. Grain shape has a range from sub-angular to well rounded, with an average of sub-rounded. Authigenic silica overgrowths are commonly present, forming the primary cement. The overgrowths commonly display good crystal shape, indicating growth into unrestricted pore space. Corrosion of the overgrowths and detrital grains are evident. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite extinctions.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned and untwinned grains are evident. A trace of illite alteration of the feldspar is also evident. Partial leaching of several feldspar grains has occurred.

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

Brown, micaceous clays are present, occurring as poorly defined elongate accumulations. Detrital quartz grains can be seen "floating" within the clays. These detrital clays are also common along the margins of detrital grains. Minor chlorite alteration of the detrital clays is present.
SAMPLE 2297.5m cont.

No primary or secondary porosity is evident or inferred. Late stage ferroan calcite appears to have infilled all primary intergranular porosity.

Diagenesis

1. Silica cementation
2. Illite formation
3. Chlorite formation
4. Ferroan calcite emplacement
5. Dissolution of silica
Figure 35. 2297.5m x 75.6 XPL
Quartz arenite. Authigenic silica is evident, acting as a primary cement. Ferroan calcite (stained blue) is also present.
Figure 36. 2297.5m x192 XPL

Authigenic silica overgrowths are evident (eg. C3). Ferroan calcite is evident at I4, and appears to be replacing detrital grains, possibly micas.
SAMPLE: Kingfisher-1 2533.0m

Mineralogy

Detrital:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>83.00%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>1.75%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Volcanic Fragments</td>
<td>1.00%</td>
</tr>
<tr>
<td>Glauconite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>2.5%</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>5.00%</td>
</tr>
<tr>
<td>Illite</td>
<td>1.25%</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>4.00%</td>
</tr>
<tr>
<td>Dolomite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Chlorite</td>
<td>Trace</td>
</tr>
<tr>
<td>Opaque Material</td>
<td>Trace</td>
</tr>
<tr>
<td>Silica</td>
<td>0.50%</td>
</tr>
<tr>
<td>Primary</td>
<td>0.50%</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a massive quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported, with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.11mm) to very coarse sand (1.30mm), with an average of medium sand (0.33mm). Sorting is moderate to poor. Grain shape has a range from sub-angular to rounded, with an average of sub-rounded and generally elongate. Authigenic silica overgrowths are commonly present, forming the primary cement. The overgrowths are up to 0.05mm thick and preferentially associated with more coarse grains. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (40%) extinctions.

Feldspar is also present as a framework grain. It has an average grain size of 0.2mm. Albite twinned and untwinned grains are evident. A twin extinction of approximately 8 to 11 degrees has been determined, giving a composition of albite to oligoclase. Illite alteration of the feldspar is common, in some cases grains appear to have been completely replaced.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing in situ alteration of detrital grains, followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral. Traces of feldspar are also evident within the kaolinite accumulations, indicating another probable source for the kaolinite.
SAMPLE 2533.0m cont.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is present as fine granular aggregates and minor fine disseminated rhombs. The dolomite appears to be preferentially associated with the authigenic clays. Ferroan calcite is present in a massive sparry pore filling form, displaying highly corrosive contacts with both detrital and authigenic silica.

Minor primary intergranular porosity remains after infilling by authigenic silica and authigenic ferroan dolomite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 37. 2533.0m x 75.6 XPL
Massive quartz arenite. Minor ferroan calcite is evident at F3.
Figure 38. 2533.0m x192 XPL
Massive quartz arenite. Authigenic kaolinite is evident at I1. A trace of detrital feldspar is associated with the kaolinite, indicating a possible source. Ferroan calcite is present at C2, this can be seen to display highly corrosive contacts with the detrital grains.
SAMPLE: Kingfisher-1 2535.5m

Mineralogy
Detrital:
- Quartz: 91%
- Feldspar: 3%
- Zircon: Trace
- Muscovite: 1%
- Volcanic Fragments: 1%

Authigenic:
- Kaolinite: 3%
- Illite: Trace
- Ferroan Calcite: 1%
- Silica: Trace

Porosity:

NB. The sample has been heavily fractured and disaggregated during the side wall coring process. The petrographic information presented below may therefore not be representative for the in situ lithology.

Description:

The sample is a massive quartz arenite. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.09mm) to very coarse sand (1.50mm), with an average of medium sand (0.28mm). Sorting is moderate to poor. The grain shape is difficult to determine due to the sutured nature of the grain contacts. However on grains where the detrital shape is recognisable the grain shape varies from sub-angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are evident, however these are commonly indistinct due to dissolution, resulting in sutured grain boundaries and the lack of a well developed inclusion rim to mark the edge of the detrital grain. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains.

The feldspar displays a similar grain size distribution as that of the detrital quartz grains. The grains are predominantly twinned according to the albite law, with possible traces of untwinned feldspar also present. Partial illite replacement of the detrital grains is evident. In some cases the detrital grain appears to be completely replaced.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing the in situ alteration of detrital grains, followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral. Traces of feldspar are also evident within the kaolinite accumulations, indicating another probable source for the kaolinite.
SAMPLE 2535.5m cont.

Ferroan calcite is present in a massive sparry pore filling material. It displays highly corrosive contacts with both the detrital and authigenic silica.

No porosity is evident or inferred. The porosity has been removed by the infilling of primary pores by authigenic silica followed by authigenic ferroan calcite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
Figure 39. 2535.5m x75.6 XPL
Heavily shattered quartz arenite. A shattered tourmaline grain is present at H6.
Figure 40. 2535.5m 192 XPL
Massive quartz arenite with illite replaced detrital grains at E3.
Figure 41. 2537.0m x75.6 XPL

Massive quartz arenite. The sutured nature of the grain margins is evident (eg. B1). A heavily leached detrital feldspar is evident at C4.
SAMPLE: Kingfisher-1 2537.0m

Mineralogy

Detrital:

- Quartz: 77.25%
- Feldspar: 2.75%
- Tourmaline: Trace
- Zircon: Trace
- Volcanic Fragments: 0.75%
- Muscovite: 4.25%

Authigenic:

- Kaolinite: 5.75%
- Illite: 1.0%
- Ferroan Calcite: 1.25%
- Dolomite: 1.25%
- Chlorite: 0.50%
- Anhydrite: 0.50%
- Silica: 4.75%

Porosity: Trace

Description:

The sample is a massive quartz arenite. The rock is grain supported, with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.08mm) to coarse sand (0.51mm), with an average of fine sand (0.19mm). Sorting is moderate. Grain shape has a range from angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are present forming the primary cement. The overgrowths are up to 0.04mm thick, however they are commonly indistinct due to the lack of well defined inclusion rim. Dissolution of authigenic overgrowths is evident on sutured grains. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned and untwinned grains are evident, with untwinned being dominant. A twin extinction angle of approximately 10 degrees has been measured, indicating an albite/oligoclase composition. Illite alteration of the feldspars is also evident.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing the in situ alteration of detrital grains followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral.

Chlorite is present throughout the sample in the form of elongate micaceous grains and amorphous material compacted into intergranular pore space. The chlorite is interpreted as having being derived from the in situ alteration of detrital micas (biotite) and detrital clays.
SAMPLE 2537.0m cont.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is present as fine granular aggregates and minor fine disseminated rhombs. The dolomite appears to have replaced detrital and possibly authigenic clays. Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts, with both detrital and authigenic silica. Minor dolomite rhombs are also present, these appear to be preferentially associated with feldspathic volcanic fragments.

Only traces of primary intergranular porosity are present, the majority of the porosity has been obliterated by the authigenic silica and, to a lesser extent, ferroan calcite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite and chlorite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 42. 2537.0m x192 XPL
Massive quartz arenite with authigenic kaolinite compacted into the intergranular pore space.
SAMPLE: Kingfisher-1 2538.0m SWC 31

Mineralogy

<table>
<thead>
<tr>
<th>Detrital:</th>
<th>Authigenic:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>Ferroan Calcite</td>
</tr>
<tr>
<td>Feldspar</td>
<td>Illite</td>
</tr>
<tr>
<td>Zircon</td>
<td>Kaolinite</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Dolomite</td>
</tr>
<tr>
<td>Muscovite</td>
<td>Anhydrite</td>
</tr>
<tr>
<td></td>
<td>Silica</td>
</tr>
</tbody>
</table>

Porosity:

**NB:** The sample is in poor condition having been heavily fractured and disaggregated during the side wall coring process. This makes accurate identification of the fabric, and porosity impossible.

Description:

The sample is a massive quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is evident. The rock is grain supported, with the grain boundaries displaying sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.07mm) to coarse sand (0.80mm), with an average of medium sand (0.27mm). Visual identification also identified grains up to very coarse sand (1.10mm). Sorting is moderate. Grain shape has a range from sub-angular to well rounded, with an average of sub-rounded. Thick authigenic silica overgrowths are common (up to 0.04mm). The authigenic silica overgrowths form the primary cement. The extinction of the detrital quartz is generally weakly undulose (60%), with lesser straight (40%) extinctions.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing the in situ alteration of detrital grains followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral. Traces of feldspar are also evident within the kaolinite accumulations, indicating another probable source for the kaolinite.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is present as fine granular aggregates and minor fine disseminated rhombs. Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica.
The shattered nature of the sample makes accurate identification of porosity impossible, however no porosity is evident within the intact portions of the sample.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 43. 2538.0m SWC 31 x75.6 XPL
Massive quartz arenite. Minor authigenic ferroan calcite (stained blue) is evident at (F3). A ferroan calcite fossil fragment can also be identified at E5.
Figure 44. 2538.0m SWC 31 x192 XPL
Massive Quartz arenite. Minor ferroan calcite is evident at l2.
SAMPLE: Kingfisher-1 2538.0m SWC 34

Mineralogy

Detrital:
- Quartz: 86.0%
- Feldspar: 5.0%
- Tourmaline: Trace
- Zircon: Trace
- Muscovite: 1.50%
- Volcanic Fragments: 0.25%
- Monazite: Trace

Authigenic:
- Kaolinite: 3.25%
- Illite: 0.25%
- Ferroan Calcite: 0.50%
- Dolomite: 2.0%
- Chlorite: 0.25%
- Anhydrite: Trace
- Silica: 1.0%

Porosity:

Description:

The sample is a massive quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to coarse sand (0.80mm) with an average of fine sand (0.23mm). Visual analysis has also identified grains up to very coarse sand (2.2mm). Sorting is moderate to poor. Grain shape has a range from sub-angular to rounded with an average of sub-rounded. Authigenic silica overgrowths are commonly present forming the primary cement. The extinction of the detrital quartz is generally undulose with lesser straight and minor composite extinctions.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned and untwinned grains are evident, with untwinned being dominant.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing in situ alteration of detrital grains, followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral.
SAMPLE 2538.0m cont.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is present as fine granular aggregates and minor fine disseminated rhombs. The dolomite appears to have replaced detrital and possibly authigenic clays. Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica. Minor dolomite rhombs are also present, these appear to be preferentially associated with feldspathic volcanic fragments. A trace of siderite may also be present, however accurate identification is not possible due to the fractured nature of much of the sample.

No primary or secondary porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 45. 2538.0m SWC 34 x75.6 XPL
Massive quartz arenite. The grains can be seen to be partially disaggregated and shattered, due to the side wall coring process.
Figure 46. 2538.0m SWC 34 x192 XPL
Massive quartz arenite. Authigenic silica overgrowths are evident (eg. D3). Authigenic kaolinite is present compacted into the intergranular pore space at H4. Authigenic ferroan calcite (I2) can be seen to be replacing a detrital feldspar grain, only traces of the grain remain at G2.
SAMPLE: Kingfisher-1 2644.0m

Mineralogy

Detrital:
- Quartz: 81.50%
- Feldspar: 2.0%
- Zircon: Trace
- Rock Fragments: 0.75%
- Kaolinite: 7.25%
- Illite: 1.0%
- Ferroan Calcite: 6.25%
- Chlorite: Trace
- Opaque Material: Trace
- Silica: 1.25%

Authigenic:

Porosity:

Description:

The sample is a massive quartz arenite. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of medium silt (0.03mm) to very coarse sand (1.30mm), with an average of medium sand (0.44mm). Sorting is moderate. Grain shape has a range from angular to well rounded, with an average of sub-rounded/rounded. Thick authigenic silica overgrowths are commonly present. The authigenic silica provides the dominant cement within the sample. Minor proportions of the overgrowths can be seen to have formed good crystal shape, indicating unrestricted growth into open pore space. The extinction of the detrital quartz is generally undulose (80%), with lesser straight (18%) and minor composite grains (2%) extinctions.

Feldspar is only present in trace quantities, however it can be seen to be partially altered to illite and in some cases only traces of the detrital grain remain.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing the in situ alteration of detrital grains followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral. Traces of feldspar are also evident within the kaolinite accumulations indicating another probable source for the kaolinite.

Ferroan calcite is present in a massive sparry pore filling material. It displays highly corrosive contacts with both the detrital and authigenic silica.

No porosity is evident. The porosity has been removed by the infilling of primary pores by authigenic silica, followed by authigenic ferroan calcite.
SAMPLE 2644.0m cont.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
Figure 47. 2644.0m x75.6 XPL
Massive quartz arenite. A detrital feldspar at F3 can be seen to have been partially replaced by authigenic kaolinite at E3. Minor ferroan calcite is evident at I2.
Figure 48. 2644.0m x300 XPL.
Massive quartz arenite. Minor authigenic kaolinite (F2) and ferroan calcite (F4) are evident.
SAMPLE: Kingfisher-1 2675.0m

Mineralogy

Detrital: Quartz 60%
Authigenic: Ferroan Calcite 40%
Porosity:

Description:

The sample is a massive calcareous quartz arenite. The rock is predominantly grain supported, with minor regions of matrix support. The grain supported regions display point to curved contacts. The matrix material is supplied by authigenic ferroan calcite. Cementation is very good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to coarse sand (0.92mm) with an average of medium sand (0.45mm). Sorting is moderate. Grain shape has a range from sub-rounded to well rounded with an average of rounded. Authigenic silica overgrowths are commonly present but have undergone a great deal of dissolution through contact with the authigenic ferroan calcite. The authigenic silica provided the initial cement. The extinction of the detrital quartz is generally undulose with lesser straight and minor composite.

Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica. The ferroan calcite can be seen to have completely replaced detrital grains, resulting in pseudomorphs or "ghost grains" being present. The ferroan calcite can be seen to become more granular as it replaces the detrital grains.

No primary or secondary porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Ferroan calcite emplacement
3. Dissolution of silica
Figure 49. 2675.0m x 75.6 XPL
Massive calcareous quartz arenite. Authigenic ferroan calcite (stained blue) can be seen infilling the intergranular pore space. The ferroan calcite can also be seen to have corrosive contacts with the detrital quartz.
Figure 50. 2675.0m x75.6 XPL
Massive quartz arenite with authigenic ferroan calcite. The calcite can be seen to have completely replaced detrital grains leaving ghost grains within the ferroan calcite (eg. H3).
SAMPLE: Kingfisher-1 2692.0m

Mineralogy

Detrital: Quartz 84.50%
          Feldspar 1.25%
          Muscovite 0.50%
          Tourmaline Trace
          Zircon Trace
          Volcanic Fragments 0.50%
          Glauconite Trace

Authigenic: Kaolinite 5.25%
            Illite 1.0%
            Ferroan Calcite 3.0%
            Dolomite/Siderite 2.0%
            Chlorite Trace
            Silica 2.0%

Porosity:

Description:
The sample is a massive quartz arenite. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.07mm) to coarse sand (0.74mm), with an average of fine sand (0.22mm). A weakly bi-modal grain size distribution is apparent, however the poor quality of the sample makes accurate quantification impossible. A weak bi-modal distribution also appears on the grain size analysis histogram. Sorting is moderate to poor. Grain shape has a range from sub-angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are present, forming the primary cement. The overgrowths are up to 0.06mm thick and are best preserved on the coarser grains. Dissolution of authigenic overgrowths is evident on sutured grains. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite extinctions.

Feldspar is also present as a framework grain. It has a similar size and shape range as the detrital quartz. Albite twinned and untwinned grains are evident, with untwinned being dominant. Illite alteration of the feldspars is also evident.

Kaolinite is present as large accumulations, up to 0.50mm in diameter. These accumulations have been compacted into intergranular pore space. The kaolinite is interpreted as representing the in situ alteration of detrital grains, followed by compression. Traces of detrital muscovite are commonly associated with the kaolinite, indicating one probable source mineral.

Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica. Minor dolomite rhombs are also present, these appear to be preferentially associated with feldspathic volcanic fragments.
SAMPLE 2692.0m cont.

Only traces of primary intergranular porosity are present, the majority of the porosity has been obliterated by the authigenic silica and to a lesser extent ferroan calcite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 51. 2692.0m x192 XPL
Massive quartz arenite. Thick authigenic silica overgrowths are evident (eg. E3).
Figure 52. 2692.0m x192 XPL
Massive quartz arenite. Thick authigenic silica overgrowths are evident (eg. C4). Authigenic kaolinite can be seen compacted into intergranular pore space at F4. This is interpreted as having formed from in situ alteration of detrital grains.
SAMPLE: Kingfisher-1 2697.0m

Mineralogy

Detrital:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>79.50%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>11.50%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>1.0%</td>
</tr>
<tr>
<td>Rock Fragments</td>
<td>0.75%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>2.50%</td>
</tr>
<tr>
<td>Illite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>3.0%</td>
</tr>
<tr>
<td>Chlorite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Silica</td>
<td>1.25%</td>
</tr>
</tbody>
</table>

Authigenic:

Description:

The sample is a massive sub arkose. The rock is grain supported, with the grain boundaries displaying heavily sutured contacts. Cementation appears to be good, with authigenic silica and interlocking grains providing the main binding forces.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.05mm) to coarse sand (0.70mm) with an average of fine sand (0.21mm). Sorting is moderate. The detrital grain shape is difficult to determine due to the heavily sutured grain boundaries as well as the lack of well defined inclusion rims. Authigenic silica overgrowths are present, however the sutured nature of the samples makes identification difficult. Dissolution of authigenic silica during the formation of the sutured contacts is also evident. The extinction of the detrital quartz is generally undulose (60%) with lesser straight (38%) and minor composite grains (2%).

The feldspar grains display a similar grain size distribution as the detrital quartz grains. The grains are predominantly twinned according to the albite law. The twin plane extinction angle is approximately 10 degrees, indicating an albite/oligoclase composition.

Kaolinite is present in the form of small accumulations along the margins of the detrital grains. It is interpreted as having formed as an in situ alteration of detrital micaceous clays. This is supported by traces of detrital micaceous clays within the kaolinite. Illitic clays are also present. These appear to have formed as an in situ alteration of detrital grains, such as feldspar and possible volcanic fragments.

Ferroan calcite is present in a microsparry to granular form. It appears to be replacing clays and/or infilling secondary pore space created by the removal of clays. The ferroan calcite can be seen to display highly corrosive contacts with the other detrital and authigenic grains.

No porosity is evident or inferred.

59
SAMPLE 2697.0m cont.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Illite formation
4. Ferroan calcite emplacement
5. Dissolution of silica and clays
Figure 53. 2697.0m x75.6 XPL
Massive sub arkose. The sutured nature of the grain boundaries is clearly evident.
Figure 54. 2697.0m x192 XPL
Massive sub arkose. A heavily leached feldspar grain is evident at H4. Ferroan calcite (stained blue) is present (H6), displaying highly corrosive contacts with the detrital grains.
SAMPLE: Kingfisher-1 2717.0m

Mineralogy

Detrital:

<table>
<thead>
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<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>76.0%</td>
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<tr>
<td>Feldspar</td>
<td>13.5%</td>
</tr>
<tr>
<td>Zircon</td>
<td>Trace</td>
</tr>
<tr>
<td>Muscovite</td>
<td>3.5%</td>
</tr>
<tr>
<td>Volcanic fragments</td>
<td>0.75%</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>Trace</td>
</tr>
<tr>
<td>Glauconite</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

Authigenic:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaolinite</td>
<td>0.50%</td>
</tr>
<tr>
<td>Illite</td>
<td>3.0%</td>
</tr>
<tr>
<td>Ferroan Calcite</td>
<td>1.75%</td>
</tr>
<tr>
<td>Dolomite</td>
<td>0.25%</td>
</tr>
<tr>
<td>Opaque Material</td>
<td>Trace</td>
</tr>
<tr>
<td>Silica</td>
<td>0.50%</td>
</tr>
</tbody>
</table>

Porosity:

NB. The sample has been heavily fractured and disaggregated during the side wall coring process. As a result only minor portions of the sample are still intact. The petrographic information presented below may therefore not be representative of the in situ lithology.

Description:

The sample is a massive sub arkose. A very weak preferred alignment of the elongate axis of the detrital quartz grains is present. The rock is grain supported, with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderate to good, with authigenic silica providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of very fine sand (0.80mm) to coarse sand (1.00mm), with an average of medium sand (0.32mm). Sorting is moderate. The grain shape is difficult to determine due to the sutured nature of the grain contacts. However on grains where the detrital shape is recognisable the grain shape varies from very angular to rounded, with an average of sub-rounded. Authigenic silica overgrowths are evident, however these are commonly indistinct this is due to dissolution, resulting in sutured grain boundaries and the lack of a well developed inclusion rim to mark the edge of the detrital grain. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains.

The feldspar grains display a similar grain size range and distribution as the detrital quartz grains. Perithetic, albite and untwinned grains are evident. Minor leaching of the feldspars has occurred, this is predominantly associated with the albite twinned grains. Illitic replacement of the feldspar appears to have occurred, with some completely replaced grains being evident. Illitic clays are also associated with the in situ alteration of detrital volcanic fragments.
SAMPLE 2717.0m cont.

Two phases of carbonate are present; dolomite and ferroan calcite. The dolomite is present in the form of fine granular aggregates. These are located along the grain margins and display highly corrosive contacts with all contacting minerals. The ferroan calcite is present in a massive sparry pore filling material. It displays highly corrosive contacts with both the detrital and authigenic silica.

No porosity is evident or inferred. The porosity has been removed by the infilling of primary pores by authigenic silica followed by authigenic ferroan calcite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite and dissolution of all other detrital and authigenic grains.
Figure 55. 2717.0m x 75.6 XPL

Massive sub arkose. A well rounded tourmaline is evident at B4. An albite twinned feldspar located at J4 can be seen to have been heavily leached.
Figure 56. 2717.0m x 192 XPL
Massive sub arkose. Minor illitic clays are evident infilling intergranular pore space at F6.
SAMPLE: Kingfisher-1 2749.0m

Mineralogy

<table>
<thead>
<tr>
<th>Detrital</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>31.5%</td>
</tr>
<tr>
<td>Feldspar</td>
<td>1.5%</td>
</tr>
<tr>
<td>Muscovite</td>
<td>1.0%</td>
</tr>
<tr>
<td>Clays</td>
<td>Trace</td>
</tr>
<tr>
<td>Glaucnite</td>
<td>Trace</td>
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<tr>
<td>Ferroan Calcite</td>
<td>66.0%</td>
</tr>
<tr>
<td>Pyrite</td>
<td>Trace</td>
</tr>
<tr>
<td>Kaolinite</td>
<td>Trace</td>
</tr>
<tr>
<td>Silica</td>
<td>Trace</td>
</tr>
</tbody>
</table>

Authigenic:

Porosity:

Description:

The sample is a massive calcareous arenite. The rock displays regions of both grain support and matrix support. The grain supported regions have been greatly reduced by the corrosive nature of the ferroan calcite, which forms the main matrix material. Where grain boundaries are evident, they generally display point contacts. Cementation appears to be good, with authigenic ferroan calcite providing the cements providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of medium silt (0.02mm) to fine sand (0.22mm), with an average of very fine sand (0.08mm). Sorting is moderate good. The grain shape varies from very angular to rounded, with an average of angular. The grains are also commonly elongate. Traces of authigenic silica overgrowths are present. The detrital grains and the overgrowths are generally heavily corroded by contact with authigenic carbonates. The extinction of the detrital quartz is generally weakly undulose, with lesser straight and minor composite grains.

The feldspar grains display a similar grain size distribution the detrital quartz grains. The grains are generally tabular in shape. They are predominantly twinned according to the albite law, with possible traces of untwinned feldspar also present. An accurate twin plane extinction angle could not be obtained, but a generally low angle appears to be present, indicating an albite/oligoclase composition.

Two phases of ferroan calcite are present. One phase, interpreted as being the first phase, is composed of massive sparry ferroan calcite infilling fractures and replacing detrital grains. The detrital grain replacements are generally elongate features. No evidence for the type of detrital grain replaced could be identified, however the shape would tend to infer micas or fossil material. The other phase of ferroan calcite occurs in a more granular form, forming the main matrix material within the sample. This appears to be the replacement of a detrital clay matrix. Some portions of this phase has not taken the carbonate stain, possibly indicating dolomitic composition. However the crystal form and crystal shape would tend to indicate this is not the case, and the variations in the stain are related to the staining technique rather than the composition. The ferroan calcite displays highly corrosive contacts with the framework grains.

63
SAMPLE 2749.0m cont.

No porosity is evident or inferred. The porosity has been removed by the infilling of primary pores by authigenic silica followed by authigenic ferroan calcite.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Ferroan calcite emplacement
4. Dissolution of silica
Figure 57. 2749.0m x75.6 XPL.
Calcareous arenite. Detrital quartz grains with authigenic ferroan calcite (stained blue). The ferroan calcite can be seen to have replaced some form of fossil material at D2.
SAMPLE: Kingfisher-1 2798.0m

Mineralogy

Detrital:
- Quartz: 74.75%
- Feldspar: 2.50%
- Zircon: Trace
- Glaucnite: Trace
- Muscovite: 7.25%
- Biotite: Trace
- Detrital Clay: 2.0%
- Ferroan Calcite: 3.75%
- Dolomite: 9.50%
- Kaolinite: 0.25%
- Opaque Material: Trace
- Silica: Trace

Authigenic:

Porosity:

Description:

The sample is a quartz arenite. It displays a strong lineation defined by the alignment of mica laths and detrital clay/authigenic dolomite accumulations. A weak preferred orientation of elongate axis of the detrital quartz is also evident. The rock is grain supported, with the grain boundaries displaying curved to point contacts and minor sutured contacts.

The dominant framework grain is quartz. Grain size analysis indicates a size range of medium silt (0.02mm) to very fine sand (0.09mm), with an average of coarse silt (0.05mm). Sorting is very good. Grain shape has a range from angular to rounded with an average of sub-angular and generally elongate. Minor authigenic silica overgrowths are present. These form a thin contact cement. The extinction of the detrital quartz is generally undulose (60%), with lesser straight (40%) extinctions.

Detrital clays are pale brown in colour and highly micaceous. They are present along the grain boundaries of the detrital grains. A great deal of replacement of the detrital clays by authigenic dolomite is evident.

Dolomite is present as fine granular aggregates. It can be seen to be replacing both detrital and authigenic clays. It also displays highly corrosive contacts with the detrital and authigenic silica. Ferroan calcite is present in a granular microsparry pore filling form. It is not clear whether the ferroan calcite has infilled primary or secondary porosity, however it is more likely to be secondary porosity. The ferroan calcite displays highly corrosive contacts with the detrital and authigenic silica.

No primary or secondary porosity is identifiable or inferred.
SAMPLE 2798.0m cont.

Diagenesis

1. Silica cementation
2. Illite formation
3. Ferroan calcite emplacement
4. Dissolution of silica
5. Emplacement of dolomite
Figure 58. 2749.0m x 192 XPL
Ferroan calcite and detrital quartz grains. The ferroan calcite can be seen to display highly corrosive contacts with the detrital grains. The ferroan calcite also appears to have replaced some detrital material, probably fossiliferous, to form the elongate feature at F4.
Figure 59. 2798.0m x 75.6 XPL
Quartz arenite. A weak preferred orientation of the elongate axis of the detrital quartz grains are evident.
Figure 60. 2798.0m x192 XPL.
Quartz arenite. Ferroan calcite (stained blue) can be seen infilling intergranular pore space. The carbonate can be seen to posses highly corrosive contacts with the detrital grains. Detrital micas can be seen compacted along the detrital grain boundaries.
SAMPLE: Kingfisher-1 2842.5m

Mineralogy

Detrital:
- Quartz: 73.75%
- Feldspar: 2.0%
- Muscovite: 2.0%
- Volcanic Fragments: 1.25%
- Glaucnite: Trace

Authigenic:
- Ferroan Calcite: 13.0%
- Dolomite: 6.0%
- Kaolinite: 0.25%
- Illite: 1.75%
- Silica: Trace

Porosity:

Description:

The sample is a massive quartz arenite. The rock is grain supported, with the grain boundaries displaying point to curved contacts. Minor sutured contacts are also present. Cementation appears to be good, with authigenic silica and ferroan calcite providing the cements providing the dominant cement.

The dominant framework grain is quartz. Grain size analysis indicates a size range of coarse silt (0.06mm) to coarse sand (0.70mm) with an average of fine sand (0.21mm). Sorting is moderate to good. The grain shape varies from angular to rounded, with an average of sub-angular/sub-rounded. The grains are also commonly elongate. The elongate grains may define a weak lineation, however the poor sample condition makes accurate recognition of this impossible. Authigenic silica overgrowths are commonly present. They are generally heavily corroded by contact with authigenic carbonates. The authigenic silica has provided the initial cement. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains.

The feldspar grains display a similar grain size distribution as the detrital quartz grains. The grains are predominantly twinned according to the albite law, with possible traces of untwinned feldspar also present. An accurate twin plane extinction angle could not be obtained, but a generally low extinction angle is indicated. This would give an albite/oligoclase composition. Minor illitic alteration of the feldspars is evident.

Two phases of carbonate are present; dolomite and ferroan calcite. The dolomite is present in the form of fine disseminated rhombs and granular aggregates. It is preferentially located along the boundaries of the framework grains, and is interpreted as having replaced detrital clays. The dolomite displays highly corrosive contacts with the authigenic and detrital quartz. The ferroan calcite is present in a massive sparry pore filling material. It displays highly corrosive contacts with both the detrital and authigenic silica.

No porosity is evident or inferred. The porosity has been removed by the infilling of primary pores by authigenic silica followed by authigenic ferroan calcite.
SAMPLE 2842.5m cont.

Diagenesis

1. Silica cementation
2. Kaolinite alteration of detrital grains
3. Continued silica cementation
4. Illite formation
5. Ferroan calcite emplacement
6. Dissolution of silica
7. Emplacement of dolomite
Figure 61. 2842.5m x75.6 XPL
Quartz arenite. Fine granular dolomite is located along the detrital grain boundaries. Minor ferroan calcite is also evident (stained blue).
Figure 62. 2842.5m x 192 XPL
Quartz arenite. Authigenic ferroan calcite is present at C4 displaying highly corrosive contacts with detrital grains.
SAMPLE: Kingfisher-1 2976.0m

Mineralogy

Detrital:

Quartz 67.25%
Feldspar 2.0%
Glaucnite Trace
Muscovite 21.75%
Tourmaline Trace

Authigenic:

Ferroan Calcite 6.0%
Dolomite 2.0%
Kaolinite 0.50%
Illite 0.25%
Chlorite 0.25%
Silica Trace

Porosity:

Description:

The sample is a quartz arenite. It displays a moderate lineation defined by the alignment of elongate micas and authigenic clays. The rock is grain supported with the grain boundaries displaying concave/convex to sutured contacts. Cementation appears to be moderately good.

The dominant framework grain is quartz. Grain size analysis indicates a size range of fine silt (0.01mm) to very fine sand (0.09mm), with an average of coarse silt (0.04mm). Sorting is good. Visually, the grain size has an almost bi-modal distribution, with minor portions of the sample having an average grain size of (0.02mm), however this is not reflected in the grain size analysis histogram. The relationship between the various grain sizes is not evident. The grain shape varies from sub-angular to well rounded with an average of sub-rounded. Traces of authigenic silica overgrowths are evident. These are generally thin and discontinuous. The extinction of the detrital quartz is generally undulose, with lesser straight and minor composite grains.

The feldspar grains display a similar grain size distribution as the detrital quartz grains. Albite and polysynthetic twinned grains are evident.

Clays are present along the margins of the detrital grains. These appear to be illitic, however their very fine size makes accurate identification impossible. Detrital muscovite grains are also present, compacted along the margins of the detrital grains. The muscovite may have provided a source for some of the authigenic clays present.

Two phases of carbonate are present; dolomite and ferroan calcite. The ferroan calcite is present as a massive sparry pore filling material. It appears that it is infilling secondary porosity created within the detrital muscovite grains. The ferroan calcite displays highly corrosive contacts with the muscovite and detrital framework grains. The dolomite is present as microsparry granular aggregates. It can be seen to possess highly corrosive contacts with the detrital and authigenic grains.
SAMPLE 2976.5 cont.

No porosity is evident or inferred.

Diagenesis

1. Silica cementation
2. Illite formation
3. Ferroan calcite emplacement
4. Dissolution of silica
5. Emplacement of dolomite
Figure 63. 2976.0m x75.6 XPL
Quartz arenite. It displays a moderate lineation, defined by the alignment of elongate micas and authigenic clays. Minor ferroan calcite (stained blue) is evident.
SAMPLE: Kingfisher-1 3054.0m

Mineralogy
Detrital:
Quartz
Feldspar
Ferroan Calcite
Illite
Dolomite
Chlorite
Silica

Authigenic:

Porosity:
Description:

NB. The sample is in very poor condition, having been heavily shattered during the side wall coring process. The shattering has resulted in minor intact areas remaining. This makes accurate identification of structure, fabric, porosity and grain size difficult.

The minor intact portions of the sample would tend to indicate that it is a predominantly massive calcareous quartz arenite. It appears to be grain supported with grain boundaries displaying sutured contacts. Cementation appears to be good with both authigenic silica and ferroan calcite providing the cements.

The dominant framework grain is quartz. Accurate identification of the grain size, shape and sorting is not possible due to the sample condition. A visual estimate of the average grain size is medium sand (0.25mm). Grain size analysis has also been carried out, this may however, be misleading due to sample condition. The grain size analysis gave a size range of medium silt (0.03mm) to coarse sand (0.71mm), with an average of medium sand (0.28mm). Authigenic silica overgrowths are present, although often difficult to identify due to the lack of well developed inclusion rims and the sutured nature of the grain contacts. Dissolution of the overgrowths is also evident. The extinction of the detrital quartz is generally undulose (80%), with lesser straight (19%) and minor composite (1%) grains.

Two phases of carbonate are evident within the sample; ferroan calcite and dolomite. The dolomite is not attached to any framework grains but occurs as loose granular aggregates within the slide. The relationship to the sample is therefore impossible to determine. Ferroan calcite is present in a massive sparry pore filling form. It displays highly corrosive contacts with both detrital and authigenic silica.

It is not possible to determine the porosity of the rock, however no porosity is evident within the preserved sections of the sample.
SAMPLE: 3054.0m cont.

Diagenesis

1. Silica cementation
2. Ferroan calcite emplacement
3. Dissolution of silica
4. Emplacement of dolomite
Figure 64. 2976.0m x300 XPL
Quartz arenite. Illitic clays are evident along the margins of detrital grains. These are interpreted as having formed from in situ alteration of detrital micas.
Figure 65. 3054.0m x75.6 XPL
Massive quartz arenite. Authigenic silica overgrowths are evident at F2. Authigenic ferroan calcite (stained blue) is also present. This can be seen to display corrosive contacts with authigenic and detrital quartz.
Figure 66. 3054.0m x192 XPL
Massive quartz arenite. Ferroan calcite can be seen infilling intergranular pore space.
APPENDIX 1

Grain Size Analysis
KINGFISHER-1 1872.0m

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KINGFISHER-1 1892.5m

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KINGFISHER-1 1901.0m

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Samples left after filtering ... 100
Samples greater than zero ... 100
Minimum sample value ... 0.060
Maximum value ... 0.540
Mean ... 0.196
Standard Deviation ... 0.077
Standard Error of Mean ... 0.008
Median ... 0.300
Geometric Mean ... 0.182
Geometric Standard Deviation ... 1.492
Skewness ... 1.097
Kurtosis ... 5.792
Sum of samples ... 19,590
Sum of samples > 0.0 ... 19,590
**KINGFISHER-1 1905.0m**

**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: 0.370
- Mean: 0.162
- Standard Deviation: 0.063
- Standard Error of Mean: 0.006
- Median: 0.215
- Geometric Mean: 0.151
- Geometric Standard Deviation: 1.945
- Skewness: 1.165
- Kurtosis: 4.213
- Sum of samples: 16,150
- Sum of samples > 0.0: 16,150
**KINGFISHER-1 1918.0m**

**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: 0.190
- Mean: 0.115
- Standard Deviation: 0.030
- Standard Error of Mean: 0.003
- Median: 0.120
- Geometric Mean: 0.112
- Geometric Standard Deviation: 1.303
- Skewness: 0.404
- Kurtosis: 3.070
- Sum of samples: 11,530
- Sum of samples > 0.0: 11,530
KINGFISHER-1 1919.5m

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: 0.050
- Maximum value: 0.520
- Mean: 0.182
- Standard Deviation: 0.076
- Standard Error of Mean: 0.008
- Median: 0.285
- Geometric Mean: 0.168
- Geometric Standard Deviation: 1.500
- Skewness: 1.381
- Kurtosis: 6.676
- Sum of samples: 18215
- Sum of samples > 0.0: 18215
### Statistical Summary

- Original number of samples: 100
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- Maximum value: 0.500
- Mean: 0.259
- Standard Deviation: 0.078
- Standard Error of Mean: 0.008
- Median: 0.285
- Geometric Mean: 0.246
- Geometric Standard Deviation: 1.389
- Skewness: 0.322
- Kurtosis: 3.187
- Sum of samples: 25,850
- Sum of samples > 0.0: 25,850
KINGFISHER-1 1941.5m

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KINGFISHER-1 2050.0m

Statistical Summary

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- Minimum sample value: 0.020
- Maximum value: 0.130
- Mean: 0.050
- Standard Deviation: 0.021
- Standard Error of Mean: 0.002
- Median: 0.075
- Geometric Mean: 0.045
- Geometric Standard Deviation: 1.524
- Skewness: 1.028
- Kurtosis: 4.403
- Sum of samples: 4.950
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Statistical Summary

- Original number of samples: 100
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- Standard Error of Mean: 0.006
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- Geometric Mean: 0.151
- Geometric Standard Deviation: 1.445
- Skewness: 1.165
- Kurtosis: 4.213
- Sum of samples: 16.150
- Sum of samples > 0.0: 16.150
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- **Samples greater than zero**: 100
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- **Maximum value**: 0.900
- **Mean**: 0.115
- **Standard Deviation**: 0.089
- **Standard Error of Mean**: 0.009
- **Median**: 0.460
- **Geometric Mean**: 0.102
- **Geometric Standard Deviation**: 1.577
- **Skewness**: 6.995
- **Kurtosis**: 61.566
- **Sum of samples**: 11,500
- **Sum of samples > 0.0**: 11,500
KINGFISHER-1 2297.5m

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 .... 0.010
Maximum value .... 0.220
Mean .... 0.105
Standard Deviation .... 0.040
Standard Error of Mean .... 0.004
Median .... 0.115
Geometric Mean .... 0.097
Geometric Standard Deviation .... 1.576
Skewness .... 0.362
Kurtosis .... 2.877
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<tr>
<td>Standard Error of Mean</td>
<td>0.017</td>
</tr>
<tr>
<td>Median</td>
<td>0.705</td>
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<tr>
<td>Geometric Mean</td>
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<td>Geometric Standard Deviation</td>
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</tr>
<tr>
<td>Skewness</td>
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</tr>
<tr>
<td>Kurtosis</td>
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<tr>
<td>Sum of samples</td>
<td>33,442</td>
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KINGFISHER-1 2535.5m

Statistical Summary

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<tr>
<td>Samples removed by filter</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Samples greater than zero</td>
<td>100</td>
</tr>
<tr>
<td>Minimum sample value</td>
<td>0.090</td>
</tr>
<tr>
<td>Maximum value</td>
<td>1.500</td>
</tr>
<tr>
<td>Mean</td>
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</tr>
<tr>
<td>Standard Deviation</td>
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<tr>
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<tr>
<td>Median</td>
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<tr>
<td>Geometric Mean</td>
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<tr>
<td>Kurtosis</td>
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<tr>
<td>Sum of samples</td>
<td>28.180</td>
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<td>Sum of samples &gt; 0.0</td>
<td>28.180</td>
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</tbody>
</table>
KINGFISHER-1 2537.0m

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: 0.080
- Maximum value: 0.510
- Mean: 0.198
- Standard Deviation: 0.082
- Standard Error of Mean: 0.008
- Median: 0.295
- Geometric Mean: 0.182
- Geometric Standard Deviation: 1.510
- Skewness: 0.960
- Kurtosis: 4.248
- Sum of samples: 19.760
- Sum of samples > 0.0: 19.760
KINGFISHER-1 2538.0m (SWC 31)

**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: 0.070
- Maximum value: 0.800
- Mean: 0.278
- Standard Deviation: 0.135
- Standard Error of Mean: 0.013
- Median: 0.435
- Geometric Mean: 0.249
- Geometric Standard Deviation: 1.607
- Skewness: 1.400
- Kurtosis: 5.897
- Sum of samples: 27,790
- Sum of samples > 0.0: 27,790
**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: 0.800
- Mean: 0.231
- Standard Deviation: 0.109
- Standard Error of Mean: 0.011
- Median: 0.430
- Geometric Mean: 0.209
- Geometric Standard Deviation: 1.575
- Skewness: 1.852
- Kurtosis: 9.697
- Sum of samples: 23,070
- Sum of samples > 0.0: 23,070
KINGFISHER-1 2644.0m

**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: 1.300
- Mean: 0.449
- Standard Deviation: 0.225
- Standard Error of Mean: 0.023
- Median: 0.675
- Geometric Mean: 0.394
- Geometric Standard Deviation: 1.719
- Skewness: 0.988
- Kurtosis: 4.392
- Sum of samples: 44,920
- Sum of samples > 0.0: 44,920
KINGFISHER-1 2675.0m

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... 0.920
Mean... 0.458
Standard Deviation... 0.200
Standard Error of Mean... 0.020
Median... 0.490
Geometric Mean... 0.403
Geometric Standard Deviation... 1.756
Skewness... 0.007
Kurtosis... 2.214
Sum of samples... 45,763
Sum of samples > 0.0... 45,763
KINGFISHER-1 2692.0m

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: 0.070
- Maximum value: 0.740
- Mean: 0.229
- Standard Deviation: 0.129
- Standard Error of Mean: 0.013
- Median: 0.405
- Geometric Mean: 0.194
- Geometric Standard Deviation: 1.719
- Skewness: 1.428
- Kurtosis: 5.704
- Sum of samples: 22,430
- Sum of samples > 0.0: 22,430
KINGFISHER-1 2697.0m

Statistical Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
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<tr>
<td>Samples greater than zero</td>
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<tr>
<td>Minimum sample value</td>
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<tr>
<td>Maximum value</td>
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<td>Kurtosis</td>
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KINGFISHER-1 2717.0m

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 ..... 0.080
Maximum value ..... 1.000
Mean ..... 0.327
Standard Deviation ..... 0.202
Standard Error of Mean ..... 0.020
Median ..... 0.540
Geometric Mean ..... 0.274
Geometric Standard Deviation ..... 1.829
Skewness ..... 1.280
Kurtosis ..... 4.482
Sum of samples ..... 32,700
Sum of samples > 0.0 ..... 32,700
KINGFISHER-1 2749.0m

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: 0.020
- Maximum value: 0.220
- Mean: 0.087
- Standard Deviation: 0.046
- Standard Error of Mean: 0.005
- Median: 0.120
- Geometric Mean: 0.076
- Geometric Standard Deviation: 1.715
- Skewness: 0.966
- Kurtosis: 3.311
- Sum of samples: 8,680
- Sum of samples > 0: 8,680
KINGFISHER-1 2798.0m

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 ........... 0.020
Maximum value .................. 0.090
Mean ................................ 0.050
Standard Deviation .............. 0.017
Standard Error of Mean ...... 0.002
Median .............................. 0.055
Geometric Mean ................. 0.046
Geometric Standard Deviation 1.488
Skewness .......................... 0.053
Kurtosis ........................... 2.362
Sum of samples ................. 4.980
Sum of samples > 0.0 ............ 4.980

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**KINGFISHER-1 2842.5m**

**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: 0.700
- Mean: 0.216
- Standard Deviation: 0.120
- Standard Error of Mean: 0.012
- Median: 0.380
- Geometric Mean: 0.188
- Geometric Standard Deviation: 1.692
- Skewness: 1.597
- Kurtosis: 6.749
- Sum of samples: 21,580
- Sum of samples > 0.0: 21,580
KINGFISHER-1 2976.0m

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: 0.010
- Maximum value: 0.090
- Mean: 0.040
- Standard Deviation: 0.019
- Standard Error of Mean: 0.002
- Median: 0.050
- Geometric Mean: 0.036
- Geometric Standard Deviation: 1.633
- Skewness: 0.704
- Kurtosis: 2.708
- Sum of samples: 3.990
- Sum of samples > 0.0: 3.990
KINGFISHER-1 3054.0m

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: 0.030
- Maximum value: 0.710
- Mean: 0.282
- Standard Deviation: 0.135
- Standard Error of Mean: 0.014
- Median: 0.370
- Geometric Mean: 0.250
- Geometric Standard Deviation: 1.693
- Skewness: 0.790
- Kurtosis: 3.376
- Sum of samples: 28240
- Sum of samples > 0.0: 28240