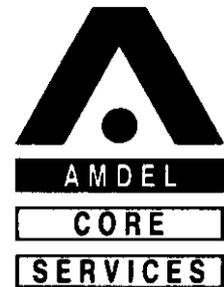


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**PETROLOGY REPORT**

**BASS #2, BASS #3, CORMORANT #1 & OUTCROP SAMPLE**

**BASS BASIN**

Report prepared for The Shell Company of Australia

by

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## INDEX

	PAGE
1. INTRODUCTION	3
2. METHODS	3
3. PETROLOGY	
3.1 Bass #2, Core 4, depth 3808'	4
3.2 Bass #2, Core 4, depth 3819'	5
3.3 Bass #3, Core 5, depth 5027'	6
3.4 Cormorant #1, Core 2, depth 3800'	7
3.5 Cormorant #1, Core 2, depth 3818'	8
3.6 Cormorant #1, Core 3, depth 4272'	9
3.7 Outcrop sample	10

## 1. INTRODUCTION

The Shell Company of Australia requested petrological descriptions of 7 samples from various wells in the Bass Basin. The aims of the study were to determine seal capacity and assess each sample for possible microfracturing and clay shrinkage. Samples studied were:

Well	Core No.	Depth (ft)	*Mercury Breakthrough Pressure (psia)
Bass #2	4	3808	86.3
Bass #2	4	3819	48.1
Bass #3	5	5027	1250.0
Cormorant #1	2	3800	481.0
Cormorant #1	2	3818	4170.0
Cormorant #1	3	4272	1920.0
Outcrop	-	-	8.3

\* Results obtained from High pressure mercury injection report 008/105 performed by Amdel Core Services.

## 2. METHODS

Samples were impregnated with araldite prior to thin section preparation. Blue dye was used in the araldite to facilitate description of porosity and permeability. Thin sections were systematically scanned to determine lithology, composition, porosity and textural relationships. All percentages given in thin section descriptions are based on visual estimates, not point counts.

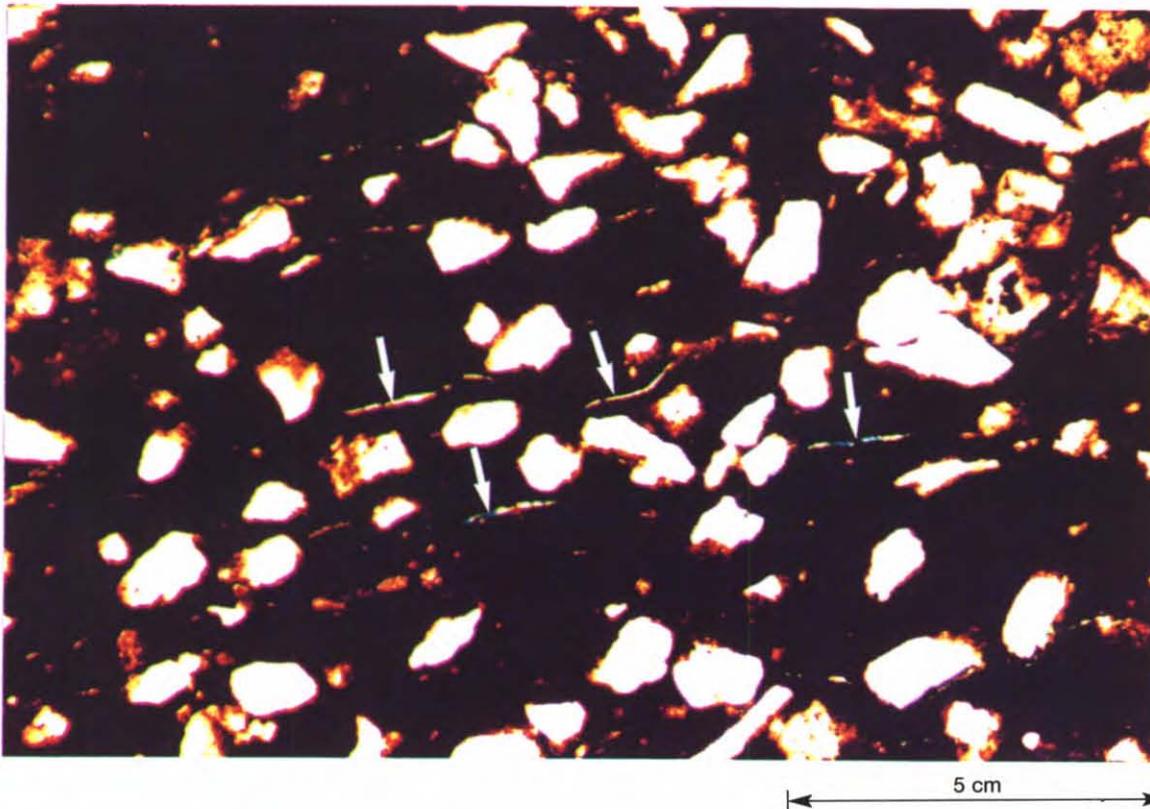
### 3. CORE PLUG PETROLOGY

#### 3.1 Bass #2, Core 4, depth 3808'

##### Thin section description

The sample is a fractured silty mudstone (Fig. 1) containing rare muddy siltstone lenses. Bedding is suggested by the alignment of mica flakes and weak alignment within the clays. Grains are subrounded to subangular with variable sphericity. Framework grains are composed of quartz (38%), mica (1%), lithics (3%), and trace amounts of feldspar (plagioclase), chertified fossil tests, glauconite, tourmaline and zircon. An elongate burrow partially filled with clay, contains secondary porosity as a result of partial dissolution. Anhedral clays comprising the matrix (55%) are the major constituent of the sample and are a very dark red brown, with rarely visible alignment. Authigenic minerals and cements are composed of trace amounts of pyrite, chert nodules, inherited quartz overgrowths and carbonate microspar and spar. Isolated oversized and elongate pores (tr) are secondary in nature and have resulted from dissolution.

Microfractures (Fig. 1) within the sample are common (2%), they range in width from less than 0.01mm to 0.04mm and are of varying lengths parallel with bedding. The microfractures are thought to have been induced by either the release in pressure when the rock was exposed, or shrinkage of clays due to dehydration on exposure. In either case, in the subsurface this sample could possibly be an effective seal. The measured mercury breakthrough pressure of 86.3 psia suggests the opposite but this result has probably been influenced by the presence of these microfractures.



**Figure 1.** Thin section photomicrograph illustrating induced microfractures (arrows) reducing the seal capacity of this silty mudstone. Plane light. Field of view 0.88mm.

### 3.2 Bass #2, Core 4, depth 3819'

#### Thin section description

This sample is very similar to that from 3808' with less clay material (Fig. 2). It is a muddy siltstone with irregular and discontinuous, partially interconnected mudstone stringers and patches of iron rich micritic carbonate cement. The sample is fractured, both parallel and perpendicular to bedding with the largest fractures noted in the mudstone stringers. Bedding is suggested by the alignment of mica flakes, elongate grains and clays. Framework grains are silt sized, subangular to subrounded and moderately to poorly spherical.

Constituent grains are quartz (49%), mica (2%), lithics (5%), and traces of plagioclase and potassic feldspar, chertified fossil tests and glauconite. Matrix (35%) is a dark red brown colour and is composed of anhedral clays that display weak alignment. Authigenic minerals and cements include micritic iron rich carbonate (2%), pyrite (tr) cubes and inherited quartz overgrowths (tr). Porosity in both primary and secondary in nature. Primary intragranular pores (tr) occur in fossil tests and intergranular (2%) pores are evident between grains. Secondary ?shrinkage pores (tr) are associated with glauconite grains and oversized dissolution pores (tr) are partially filled with micritic carbonate. Irregular zones where matrix is limited exhibit primary intergranular and secondary oversized pores.

Fractures (Fig. 2) are very common (4%), they range in width from less than 0.01mm to 0.05mm wide and are of varying lengths. The largest fractures are evident in the mudstone stringers and were probably induced by shrinkage of the clays. The measured mercury breakthrough pressure of 48.1 psia indicates this sample would not be an effective seal. If the effects due to artificial microfractures are removed then this sample is possibly a moderate to leaky seal.

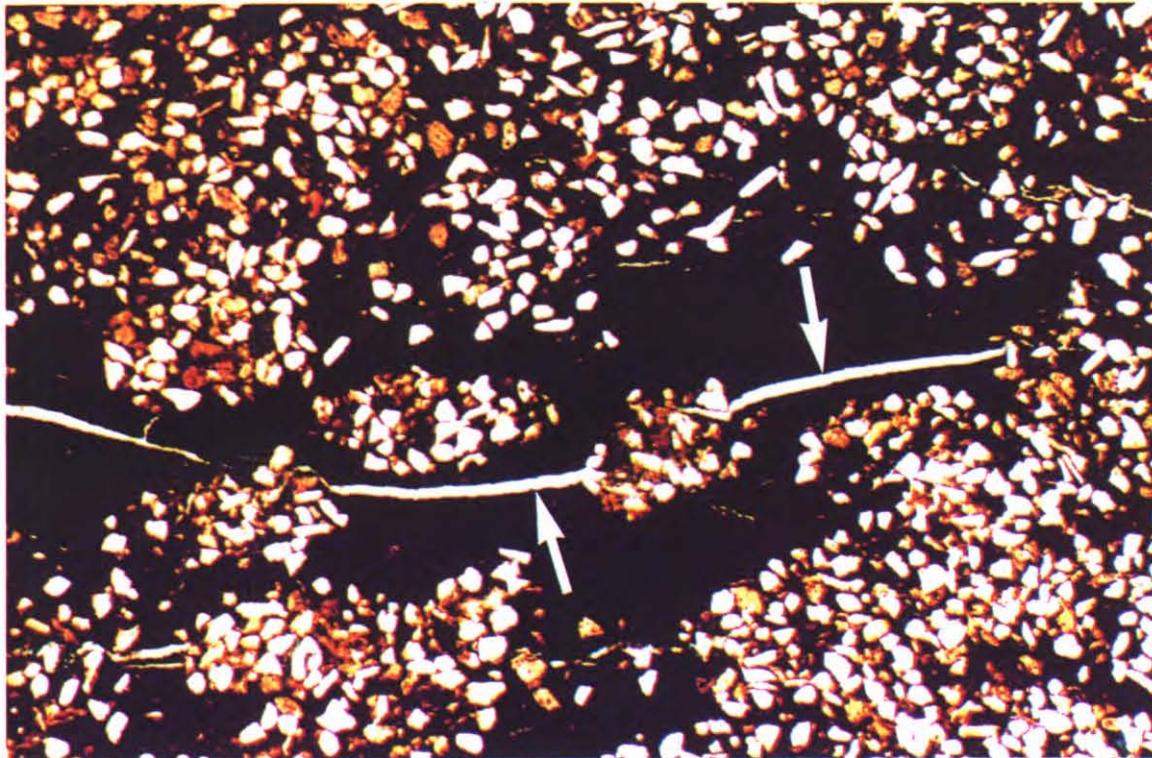


Figure 2. General thin section photomicrograph illustrating large induced microfractures (arrows) associated with muddy zones. Plane light. Field of view 2.72mm.

5 cm

### 3.3 Bass #3, Core 5, depth 5027'

#### Thin section description

The sample is a muddy siltstone with abundant muddy stringers, very similar to the Bass #2 samples. Fractures parallel to the stringers are evident, but are not as common as the previous samples. Burrow like features, most of which are partially filled by glauconite and pyrite framboids are evident. Subrounded to subangular framework grains have moderate to poor sphericity.

Silt sized grains are composed of quartz (60%), mica (1%), potassic and plagioclase feldspar (tr), lithics (5%), glauconite (1%), chertified fossil (foram) tests (tr) filled with pyrite, tourmaline (tr) and zircon (tr). Matrix (30%) is red brown in colour, and composed of anhedral to poorly aligned clays. Authigenic minerals and cements include micritic carbonate (tr) and pyrite (2%). Primary intergranular pores are rare, as are oversized dissolution pores and minor porosity is preserved in the burrow-like features.

Fractures are most common in the muddy stringers but are relatively minor (tr) in this sample. They are typically up to 0.02mm wide and of varying lengths. The measured mercury breakthrough pressure of 1250 psia suggests this sample is a good seal and that result is supported by the petrological examination. The silty nature of the sample does not downgrade the seal capacity as the majority of the pores are choked by matrix.

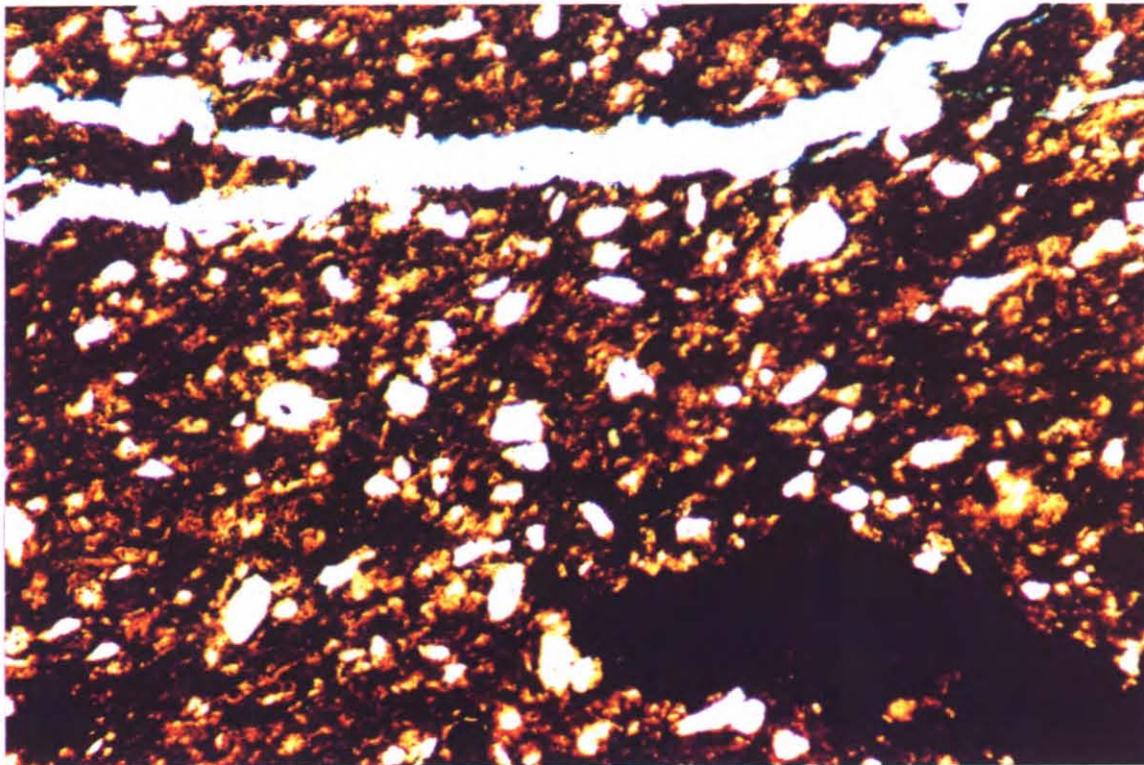
### 3.4 Cormorant #1, Core 2, depth 3800'

#### Thin section description

The sample is a silty, carbonate rich mudstone (Fig. 3) with discontinuous lenses of chloritic siltstone and opaque stringers. There are minor fractures up to 0.09mm wide and abundant fractures less than 0.01mm wide. Framework grains are subangular to subrounded with moderate to poor sphericity.

Framework grains are composed of quartz (10%), mica (1%), lithics (1%), chertified fossils (forams) filled with pyrite and other fossil fragments (1%), glauconite (1%), and traces of amber material of unknown composition, plagioclase feldspar and zircon. Matrix consists of weakly aligned anhedral brown clays (54%) and opaque (?organic) stringers (2%). Authigenic minerals and cements include irregular patches and stringers of pyrite (5%) and patches of iron rich micritic carbonate (20%) within the matrix. Primary intergranular pores (1%) are restricted to the silty lenses and intragranular pores (tr) in the forams are evident.

The measured breakthrough pressure of 481 psia suggests this is not a good seal. Microscopic examination shows the presence of fractures (Fig. 3) of two sizes which would not have been evident in hand specimen. These induced fractures may have biased the mercury injection data, artificially reducing the breakthrough pressure. They are suspected to be shrinkage fractures incurred at the surface due to drying and the sample is therefore probably a good seal in the subsurface. Fractures account for up to 3% of the total rock composition.



**Figure 3.** Thin section photomicrograph of a large induced fracture in this sample. The pore filling material is composed of a mixture of matrix clays and carbonate. An anhedral patch of pyrite (black) is evident. Plane light. Field of view 0.88mm.

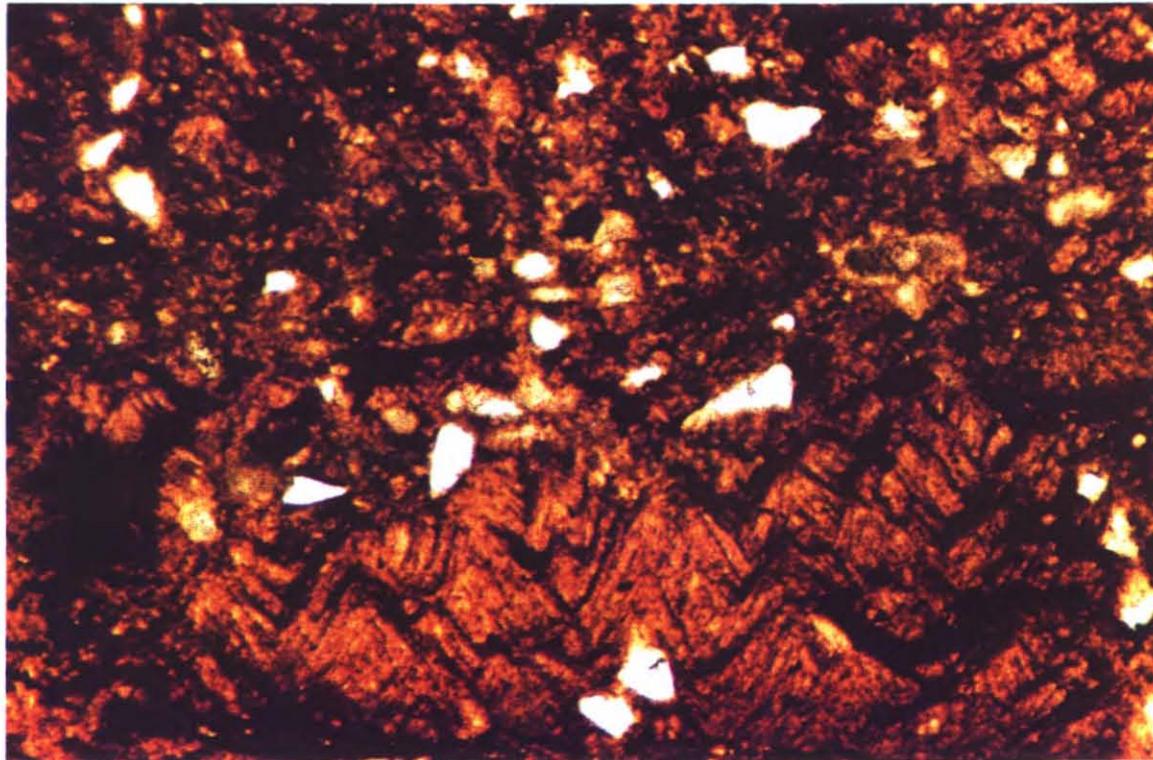
### 3.5 Cormorant #1, Core 2, depth 3818'

#### Thin section description

This sample is a micrite (microcrystalline limestone) that contains possible carbonate pseudomorphs after ?swallow tail gypsum crystals (Fig. 4). These crystals are typically associated with muddy and opaque (?organic) stringers. Terrigenous grains are silt sized, but shape is difficult to ascertain due to the micritic carbonate cement.

Terrigenous grains and allochems are composed of quartz (5%), glauconite (tr), opaques (1%), lithics (traces of chert) and foraminiferal tests (tr). Clays (3%) are concentrated in the stringers along with opaque material (2%). The dominant component is micritic carbonate (79%) which is possibly iron rich (?siderite). Anhydral clean carbonate spar (7%), ?limonite (tr) and pyrite (2%) are also present. No porosity is evident.

The breakthrough pressure of 4170 psia for this sample indicates that it is an excellent seal. This result is confirmed by the petrological description. Only one fracture less than 0.01mm wide and 1mm long is evident and this was probably induced. The absence of porosity (Fig. 4) and therefore permeability, indicates that the sealing capacity is high for this sample.



5 cm

Figure 4. Thin section photomicrograph of micrite with pseudomorphs after ?swallow tail gypsum. Note the absence of pores and induced fractures. Plane light. Field of view 0.88mm.

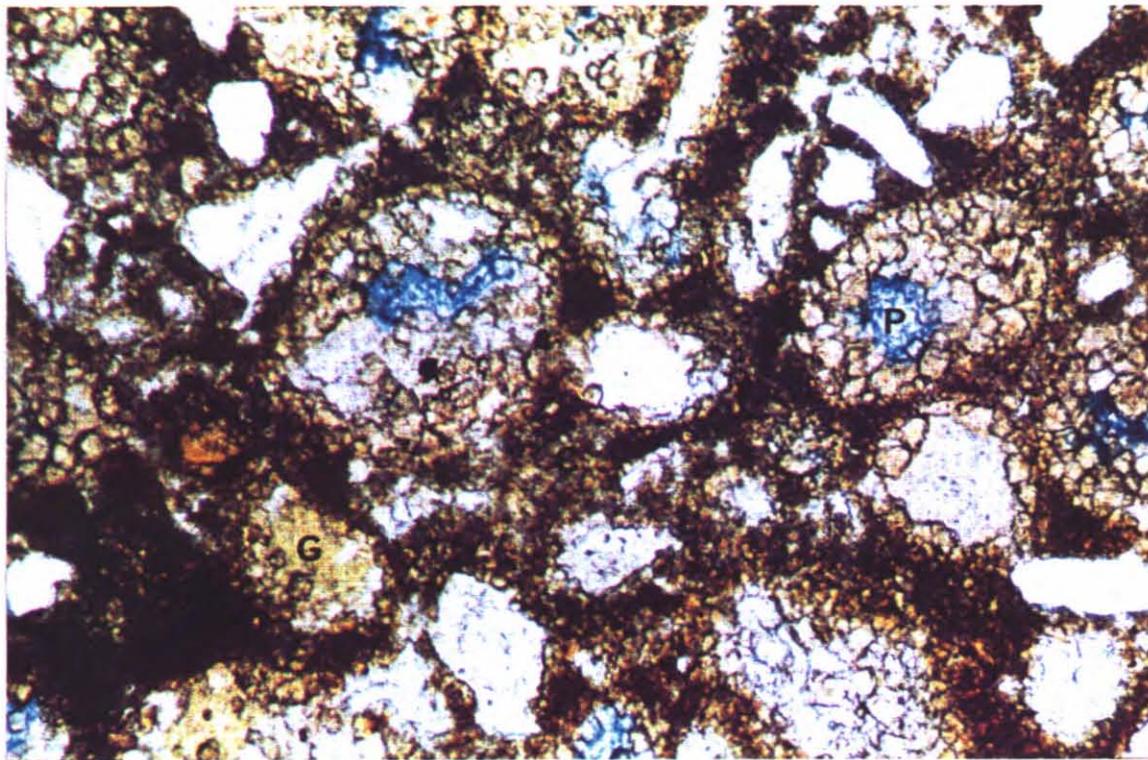
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### 3.6 Cormorant #1, Core 3, depth 4272'

#### Thin section description

The sample is a wackestone or pelsparite. Allochems are predominantly composed of glauconite pellets (20%) that are partially replaced by clear carbonate spar and rimmed by dusty spar (Fig 5). Terrigenous components are minor, with shape and sphericity governed by the carbonate cement. They are composed of very fine to fine grained quartz (7%), lithics (1%), and traces of mica and rounded zircon. The dominant components of the limestone are anhedral to subhedral dusty iron rich microspar (37%) with lesser micrite (5%) and spar (15%), suggesting neomorphic replacement. Where carbonate has replaced the glauconite pellets it is clean subhedral to euhedral spar in the centre and dusty spar on the rims. Anhedral patches of iron rich material (2%) and pyrite (2%) are also evident. Porosity is dominated by secondary dissolution pores (10%) within the pellets. The pores range from 50 to 300 microns in diameter but do not appear to be interconnected.

The breakthrough pressure of this sample is measured as 1920 psia, reflecting the overall lack of fractures. Although up to 10% porosity is detected, the absence of pore throats connecting these pores (Fig. 5) has limited permeability and therefore the sample is a good seal.



5 cm

**Figure 5.** Thin section photomicrograph of dissolution pores (P) in replaced glauconite (G) pellets. No fractures are evident and primary intergranular porosity is occluded by carbonate (C). Plane light. Field of view 0.88mm.

### 3.7 Outcrop Sample

#### Thin section description

The sample is a very fine grained, muddy sandstone with anhedral patches and lenses of opaque anhedral clays. Fractures and shrinkage cracks are pronounced in this sample. Subrounded to subangular framework grains are composed of quartz (42%), oxidised glauconite (10%), lithics (5%), and traces of mica (commonly chloritised), feldspar, tourmaline, zircon and chertified fossil tests partially filled with pyrite. Shrinkage of the clay material away from the framework grains is extensive. Opaque material (20%) in the matrix is probably a clay that has been oxidised on exposure. Authigenic minerals and cements include quartz (tr), pyrite (tr) and chlorite (2%). Secondary pores (tr) due to the dissolution of feldspar and other labiles are evident.

The breakthrough pressure of 8.3 psia suggests this sample would not be an effective seal. Seal capacity has been greatly affected by clay shrinkage (Fig. 6) which has induced up to 15% pore space. Fractures (5%) are also present, they tend to concentrate in the lenses of oxidised clays and are also interpreted as artifacts of exposure. The high proportion of induced porosity and permeability did not allow an accurate determination of seal capacity for this sample.

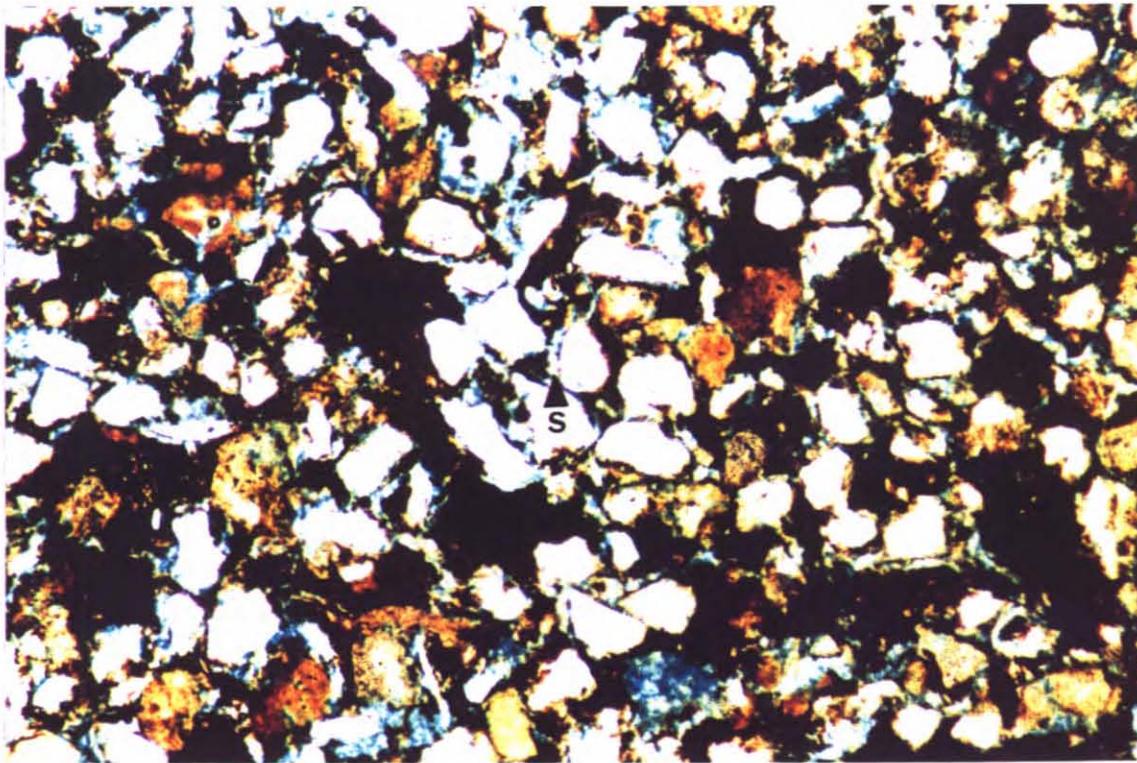


Figure 6. General thin section photomicrograph illustrating shrinkage pores (S) within the muddy sandstone. Plane light. Field of view 0.88mm.