SANTOS – STRIKE OIL

COMPILED FOR

SANTOS LIMITED

(A.B.N. 80 007 550 923)

CASINO-2

INTERPRETED DATA REPORT

PREPARED BY:
R. Subramanian
(Consultant)
February 2003

CASINO-2

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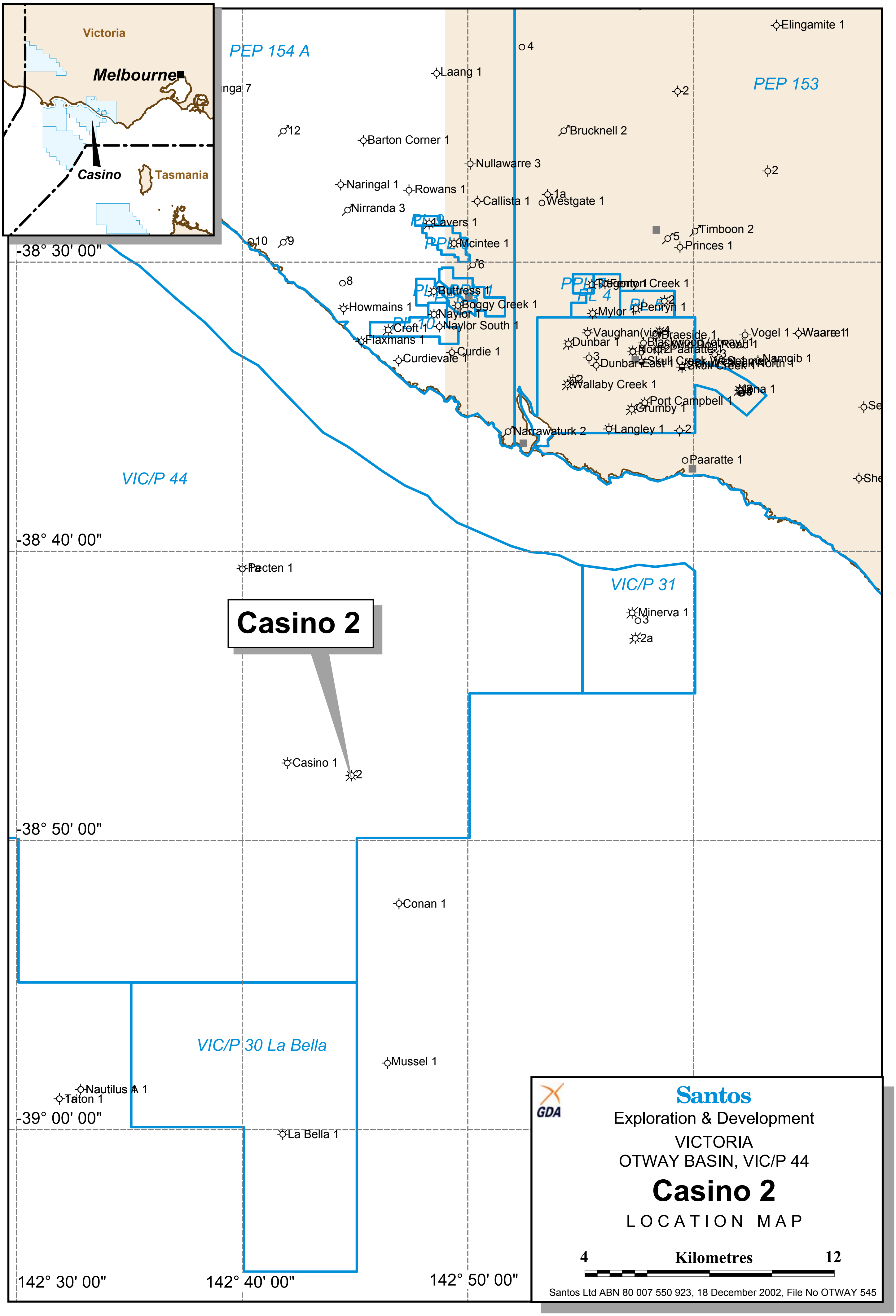
REGIONAL LOCATION MAP



Victoria
Melbourne
Casino
Tasmania
PEP 154 A
PEP 153
VIC/P 44
VIC/P 31
VIC/P 30 La Bella
Casino 2
Casino 1
Pecten 1
Minerva 1
Conan 1
Mussel 1
La Bella 1
Nautilus A 1
Triton 1
Elingamite 1
Laang 1
Barton Corner 1
Brucknell 2
Nullawarre 3
Naringal 1
Rowans 1
Callista 1
Westgate 1
Nirranda 3
Lavers 1
Mcintee 1
Timboon 2
Princes 1
Howmains 1
Buttress 1
Boggy Creek 1
Naylor 1
Naylor South 1
Croft 1
Flaxmans 1
Curdie 1
Curdievale 1
Mylor 1
Penryn 1
Dunbar 1
Vogel 1
Waarre 1
Namgib 1
Wallaby Creek 1
Port Campbell 1
Grumby 1
Narrawaturk 2
Langley 1
Paaratte 1
-38° 30' 00"
-38° 40' 00"
-38° 50' 00"
-39° 00' 00"
142° 30' 00"
142° 40' 00"
142° 50' 00"
GDA
Santos
Exploration & Development
VICTORIA
OTWAY BASIN, VIC/P 44
Casino 2
LOCATION MAP
4
Kilometres
12
Santos Ltd ABN 80 007 550 923, 18 December 2002, File No OTWAY 545

WELL CARD

WELL: CASINO-2	**WELL CATEGORY:** OFFSHORE GAS EXP **WELL INTENT:** GAS
SURFACE LOCATION: **LAT:** 38° 47’ 43.887” S **LONG:** 142° 44’ 50.746” E (GDA94) **NORTHING:** 5704463.79m **EASTING:** 651752.63m	
SEISMIC STATION: 2001 Casino 3D, Inline 6136, CDP 2400	
ELEVATION SEA FLOOR: -67.8m **RT** +25m	
BLOCK/LICENCE: Otway Basin - VIC/P 44	
TD 2112 m (Logr Extrap) 2108 m (Drlr)	
PBTD m (Logr) m (Drlr)	
TYPE STRUCTURE: Tilted Fault Block Closure	
TYPE COMPLETION: NIL	
ZONE(S):	

SPUD: 24-09-02	**TD REACHED:** 03-10-02
RIG RELEASED: 11-10-02	**CMPLT**:
RIG: OCEAN BOUNTY	
STATUS: PLUGGED AND ABANDONED (OAB)	
REMARKS: Well plugged and abandoned with gas shows observed in the Waarre Sandstone.	

HOLE SIZE	CASING SIZE	SHOE DEPTH	TYPE
914mm	762mm	137m	461 kg/m X56
445mm	340mm	691m	101 kg/m BTC L80

AGE	FORMATION OR ZONE TOPS	DEPTH (M) Drillers RT (m)	Subsea (m)	THICK-NESS (m)	HIGH (H) LOW (L)
Mid-Late Miocene	Seabed (Top Heytesbury Group)	93	68	598	-
Early-Mid Miocene	Gellibrand Marl	NP	-	-	-
Eocene – Oligocene	Nirranda Group: Narrawaturk Marl	NP	-	-	-
Eocene	Nirranda Group: Mepunga Fm	691	666	82	27m H
Eocene	Wangerrip Group: Dilwyn Fm	773	748	232	34m H
Eocene	Pember Mudstone	1005	980	76	NP
Palaeocene	Pebble Point Formation	1081	1056	57	On depth
Palaeocene	Massacre Shale	1138	1113	82	19m L
Late Cretaceous	Timboon Sandstone	1220	1195	62	NP
Late Cretaceous	Skull Creek	1282	1257	225	3m H
Late Cretaceous	Nullawarre Greensand	1507	1482	18	91m H
Late Cretaceous	Belfast Formation	1525	1500	223	77m H
Late Cretaceous	Flaxman Formation	1748	1723	9.5	NP
Early - Late Cretaceous	Waarre "C" Unit	1757.5	1732.5	129.5	11.5m H
Early - Late Cretaceous	Waarre "B" Unit	1887	1862	9	8m L
Early - Late Cretaceous	Waarre "A" Unit	1896	1871	85	12m H
Early Cretaceous	Eumeralla Formation	1981	1956	131	109m H
	Total Depth (Logger)	2112	2087		163m H

LOG INTERPRETATION					
INTERVAL(m)	Ø %	SW %	INTERVAL(m)	Ø %	SW %
Waarre Sandstone: 1745-1981m					
Net Pay: 37.3m	18.9	27			

PERFORATIONS	
FORMATION	INTERVAL
Nil	

CORES				
FORM	NO.	INTERVAL	CUT	REC

LOG	SUITE/ RUN	INTERVAL (m)	BHT/TIME/ REMARKS
PEX-DSI :	1 / 1		79.5°C / 9.0 hrs
GR		TD to 93	
Spectral GR		TD to 1650	
Resistivity		TD to 690	
SP		TD to 690	
HCAL		TD to 690	
Sonic (Upper Dipole)		TD to 1650	
Dt (Full waveforms)		TD to Signal Loss	* recorded to surface
Neutron-Density		TD to 690	
MDT-GR : (TOTAL : 32, 13 Good, 14 Curtailed/Tight, 3 Lost Seals, 2 Unstable, 3 samples collected)	1 / 2	1753.7 to 1944.5	
CST-GR : (26 of 30 shots recovered)	1 / 3	1016 to 2076	

PRODUCTION TEST RESULTS
No production test conducted.

SUMMARY:

Casino-2 was drilled as an Otway Basin gas exploration well in the offshore VIC/P44 licence and was designed to test a sand that is interpreted to be absent at the Casino-1 location. The well was contingent on the Casino-1 wildcat exploration well confirming that significant full stack amplitude and AVO anomalies indicate the presence of hydrocarbons within the prospect area. The Surface Location is Latitude: 38° 47' 43.887" S Longitude: 142° 44' 50.746" E (GDA94), Northing: 5704463.79m Easting: 651752.63m (MGA-94). The Seismic Reference is Inline 6136, CDP 2400. The Casino-2 location is 4.2km ESE of the proposed Casino-1 well and lies approximately 29 km south west of the town of Port Campbell, 21 km SW of the Minerva gas field and 23 km North of the LaBella gas field. The Casino structure is situated towards the western limit of the productive Waarre Sandstone play fairway of the Port Campbell Embayment. The water depth at the well location was 67.8m.

The Casino prospect is a tilted fault block closure defined by the 2001 Casino 3D seismic dataset (646 km2 of acquired data) and the proposed location tested the eastern flank of the structure. The primary objective in the well was the Waarre Sandstone. The critical risk on the prospect prior to the drilling of Casino 1 was related to the nature of updip cross fault seal; however this was mitigated from success at the Casino-1 location. The main risks were associated with the extent and quality of the reservoir. The prospect exhibits a significant full stack amplitude anomaly at the Waarre Sandstone with significant increase in amplitude with offset over the prospect. The prospect was interpreted as containing 2 separate Waarre sands. The Casino-2 well is placed to intersect the younger Waarre Sand (prognosed as being absent in Casino-1) in an up-dip location and appraise the older "non-amplitude" Waarre Sand in a down-dip location (relative to its proposed intersection in Casino-1). The following were the aims of the Casino-2 well:

1. To intersect the younger Waarre sand at its highest location on the structure and confirm the presence of hydrocarbons;
2. To obtain pressure data to confirm column height and gas samples to determine composition;
3. Provide an production point for any gas accumulation in the younger Waarre Sand;
4. To confirm the GWC in the older sand indicated by pressure measurements in Casino-2, correlated with Casino-1.

A successful hydrocarbon discovery at Casino-2 was intended to confirm an economic gas accumulation in the Casino structure and this could lead to a further development well at the crest of the structure to produce gas reserves in the older Waarre Sand.

Casino-2 was drilled by the semi-submersible Diamond Offshore drilling rig "Ocean Bounty". Casino-2 was spudded at 09:30 hrs on 24/09/02. A 914mm (36") hole was drilled to 140m and 760mm (30") casing run and set at 137m. A 445mm (17.5") hole was drilled from 140m to 700m with returns to the seafloor and 340mm (13-3/8") casing run and set at 691m. The blow out preventers were installed and pressure tested. A 311mm (12-1/4") hole was drilled from 700m to the core point of 1763m using 2 bits. MWD/LWD data (gamma ray, resistivity, sonic data and surveys) was acquired in this drilling phase. A 21m core was then cut from 1763 to 1794m with a 92% recovery. Drilling of the 311mm (12 ¼") hole continued from 1794m to the Total Depth of 2112m which was reached at 23:15 hrs on 03/10/02.

At Total Depth, the hole was circulated clean and the drillstring was pulled out of hole to run wireline logs. Schlumberger was rigged up and wireline logs were run as summarised above. After rigging down Schlumberger, a cement stinger was run in the hole to set cement abandonment plugs as per program; Plug 1: 2100m-1825m, Plug 2: 1825m-1550m, Plug 3: 720m-640m and Plug 4: 177m-127m. The rig was later released at 20:30 hours on October 11, 2002.

During drilling, gas shows were observed in the Waarre Formation. Subsequent log analysis identified 37.3m of pay with Average ∅=18.9% and Sw=27% in the Waarre Formation. The Waarre gas had a low CO_2 content of about 1% and was dry.

The penetrated depths of most formations in Casino-2 varied from their respective prognosed depths by upto 109m high (Eumeralla Formation) as can been seen in the table above. The Pebble Point and Skull Creek formations both were penetrated on depth and 3m high to their respective prognosed depths. The Nullawarre Greensand and the Belfast Mudstone were intersected 91m and 77m high to their respective predicted depths while the primary objective, the Waarre Sandstone was drilled 11.5m high to the prognosed depth.

Casino-2 was drilled as a vertical hole. Deviation Surveys were recorded using MWD/LWD tools in most of the 311mm (12.25") section while drilling, with the last survey being recorded at 2085.35m. At Total Depth, the estimated displacement was 24m towards 251°T direction with the estimated TVD of 2111.63m.

Casino-2 reached Total Depth of 2112m (2087m SS) at 23:15 hrs on 03/10/02. After running Suite 1 wireline logs, the well was plugged and abandoned. The rig was released at 20:30 hrs on 11/10/02.

AUTHOR: R. SUBRAMANIAN	**DATE**: February 2002

1. GEOLOGY

1.1 INTRODUCTION

Casino-2 was drilled as an Otway Basin gas exploration well in the offshore VIC/P44 licence and was designed to test a sand that was interpreted to be absent at the proposed Casino-1 location. The VIC/P44 license is held 50% by Santos (Operator) and 50% by Strike Oil NL. The well is contingent on the Casino-1 wildcat exploration well confirming that significant full stack amplitude and AVO anomalies indicate the presence of hydrocarbons within the prospect area. The Surface Location is Latitude: 38° 47' 43.887" S Longitude: 142° 44' 50.746" E (GDA94), Northing: 5704463.79m Easting: 651752.63m (MGA-94). The Seismic Reference is Inline 6136, CDP 2400. The Casino-2 location is 4.2km ESE of the proposed Casino-1 well and lies approximately 29 km south west of the town of Port Campbell, 21 km SW of the Minerva gas field and 23 km North of the LaBella gas field. The Casino structure is situated towards the western limit of the productive Waarre Sandstone play fairway of the Port Campbell Embayment. The water depth at the well location was 67.8m.

The Casino structure is a tilted fault block closure defined by the 2001 Casino 3D seismic dataset and the proposed location was to intended to test the eastern flank of the structure. The primary objective in the well was the Waarre Sandstone. The critical risk on the prospect prior to the drilling of Casino 1 was related to the nature of updip cross fault seal; however this was mitigated from success at the Casino-1 location. The main risks were associated with the extent and quality of the reservoir. The prospect exhibits a significant full stack amplitude anomaly at the Waarre Sandstone with significant increase in amplitude with offset over the prospect. The prospect was interpreted as containing 2 separate Waarre sands. The Casino-2 well is placed to intersect the younger Waarre Sand (prognosed as being absent in Casino-1) in an up-dip location and to appraise the older "non-amplitude" Waarre Sand in a down-dip location (relative to its proposed intersection in Casino-1). The aims of the Casino-2 well were:

1. Intersect the younger Waarre sand at its highest location on the structure and confirm the presence of hydrocarbons;
2. To obtain pressure data to confirm column height and gas samples to determine composition;
3. Provide an production point for any gas accumulation in the younger Waarre Sand;
4. To confirm the GWC in the older sand indicated by pressure measurements in Casino-2, correlated with Casino-1.

A successful hydrocarbon discovery at Casino-2 could confirm an economic gas accumulation in the Casino structure. This could lead to a further development well at the crest of the structure to produce gas reserves in the older Waarre Sand.

Casino-2 was drilled by the semi-submersible drilling rig "Diamond Offshore Ocean Bounty".

1.2 FIELD DESCRIPTION (after well proposal Casino-2)

Play Description and Analysis

The Casino prospect forms the eastern limit of a structural complex which extends westwards to the Children and Elanora prospects and links into the Southwest trending Pecten high in the north.

The Casino prospect is mapped as a tilted fault block closure with the primary reservoir being the Waarre Sandstone. The structure shows erosion of the upper section of the Waarre

Formation at the crest, with progressively younger section subcropping on the flanks of the structure. The reservoir at the crest of the structure was expected to be equivalent to the lower Unit "C" or Unit "B" Waarre Formation. A younger seismic event, truncated by an unconformity on the flank of the structure, was considered to be Upper Unit "C".

The vertical seal for the reservoir is provided by the Belfast Mudstone. The Belfast Mudstone is a good sealing lithology and is known to seal the thick gas columns at Minerva and LaBella fields, and the numerous onshore Port Campbell gas fields. The Belfast Mudstone also provides cross-fault seal for the Casino prospect. The Flaxman Formation is interpreted to be generally absent across the Casino structure.

To the west, the prospect relied upon seal across a small northwesterly trending fault. The presence of this fault was critical to the trapping mechanism. The fault has been recognised both on coherency data and seismic data. Uncertainty associated with the seismic pick on the downthrown side of this fault affected the thickness of cross-fault Belfast Mudstone.

The prospect is charged from mature source beds located within the underlying Eumeralla Formation, with migration either directly into the reservoir or via fault conduits. Charge is evidenced locally by the LaBella and Minerva fields to the east, and by "gas blossoms" in the Intra-Belfast sands to the west of the prospect.

The play has proven successful in the nearby Minerva, LaBella, Thylacine and Geographe gas fields. All of these fields exhibit full stack amplitude and AVO response. Such response is recognised as critical to success in the Waarre Formation play. The Casino Prospect also exhibits excellent full stack amplitude and a good AVO response.

In the Port Campbell Embayment and Mussel Platform, the Waarre gas play is a proven, commercial play type with numerous discoveries in fields such as Minerva, LaBella, Thylacine, Geographe, McIntee, Croft, Naylor, Mylor, Fenton Creek and Wallaby Creek. Gas is reservoired in the Waarre Sandstone in three way updip fault closures on the upthrown side of tilted fault blocks and horst blocks. Seal for the play consists of Belfast Mudstone as top seal and as a cross-fault seal. Structures are charged from mature source beds located within the underlying Eumeralla and/or Crayfish Group with migration directly into the reservoir or via fault conduits.

CO_2 is found in some reservoirs and this is deemed as a local charging effect related to magmatic source. A strong full stack amplitude anomaly with strong class II/III Amplitude Variation with offset response at the Waarre Sandstone horizon is seen on most fields and this is related to well developed gas saturated reservoir. Amplitude anomalies therefore are a very effective exploration tool for thick Waarre sandstone targets.

Reservoir Stratigraphy

The Waarre Sandstone reservoir was deposited as the initial post-rift sequence at the commencement of Turonian time. Microplankton at the base of the Waarre formation record the first evidence of wholesale marine incursion into the Otway Basin. The section is sub-divided into three sub-units – Waarre "A", "B" & "C".

The "A" unit represents a basal transgressive systems tract (TST) characterised by flooding of an incised valley with sediments deposited under marginal marine/estuarine conditions. Lithologically, the unit is similar to the underlying Eumeralla Formation from which it is sourced. The unit is comprised of fine to coarse grained lithic sandstone, interbedded with thin beds of silty carbonaceous mudstone. Onshore the sandstones are dominantly fluvial, but offshore marine conditions are indicated by coarsening upward beds.

Unit "B" was deposited under estuarine conditions. Onshore, Unit "B" is comprised of carbonaceous mudstone with thin interbeds of coal. Glauconitic mudstone and siltstone, with thin interbeds of dolomitic and calcareous sandstone, is common. Offshore wells show greater marine influence with increasing glauconitic content and common occurrence of dinoflagellates and microplankton.

Unit "C" is characterised by initial estuarine/deltaic conditions succeeded by high-energy sands. The unit consists of fine to very coarse grained quartzose sandstone deposited in thick, blocky to fining upwards beds. The sandstone is carbonaceous and thin coals are occasionally developed. Basinwards, the sandstone becomes finer grained with fining upwards beds developed in Mussel-1 and LaBella-1.

As the transgression progressed, the valley system was flooded with the Flaxman Formation and Belfast Mudstone.

Main reservoir development is in the Unit "C", but Units "B" and "A" also contain reservoir sands. The Eumeralla Formation has the potential to develop permeable sands but reservoir quality is invariably low.

Seal

All successes in the Port Campbell Embayment and Mussel Platform Waarre Sandstone play have been from high-side, tilted fault blocks or horst blocks. The ultimate top seal to the Waarre reservoir is the marine Belfast Mudstone. The Flaxman Formation was deposited between the Waarre Reservoir and the Belfast seal under transitional marine conditions. It is a potential waste or "thief" zone but acts as a separate seal and reservoir system in the Minerva and LaBella gasfields. The Flaxman Formation is interpreted to be absent over the Casino structure but may be preserved down flank. Intra-Belfast sandstones are developed in the mid-upper part of the Belfast Mudstone and have the potential to act as thief zones. Valid traps tested and dry are generally interpreted to have fault throw large enough to juxtapose Waarre reservoir against younger sandstones (i.e. the Intra Belfast or Nullawarre/Paaratte sandstone). The Conan structure is believed to have failed due to the cross fault juxtaposition of the Waarre Reservoir against Intra Belfast Sands.

Hydrocarbon Charge

Hydrocarbons are sourced in the Mussel Platform from the Eumeralla Formation. Analysis of the condensates and oils from the area suggest a non-marine origin with both algal and higher land plant components (Type III Kerogen). Maturation studies indicate that the top of the hydrocarbon window lies at about 2,500m (subsea). Therefore the mature Eumeralla source units which directly underlies the gasfields are most likely to charge the overlying structures through source-reservoir juxtaposition or via fault conduits. With many of the structures being present prior to the Belfast deposition, the timing of generation and migration does not appear to be a major issue. However drilling has shown that as well as the risk of hydrocarbon charge, there can be a risk of CO_2 rather than hydrocarbon emplacement.

$C0_2$ Issues

The distribution of CO_2 within the Port Campbell Embayment appears to be related to the introduction of a restricted volume of CO_2 at a number of locations and its subsequent migration. The CO_2 is considered to be mantle sourced and is likely to have occurred with the emplacement of igneous bodies during the Miocene.

A review of the high-resolution aeromagnetic data onshore has been undertaken in an effort to understand the distribution of deep-seated faulting, believed to be the conduit for CO_2 migration as well as the emplacement of igneous bodies. The results of the study indicate the presence of an intrusive body marginal to the coast and proximal to a major NNE-SSW lineament. This lineament appears to be coincident with major faulting identified on the seismic and is seen as a likely conduit for the emplacement of CO_2 at the Langley and Grumby Fields. While an intrusive is not identified at the Boggy Creek Field, a similar trending lineament is mapped through the Boggy Creek well location, and this is interpreted to be the source of the CO_2.

Geophysical Prognosis

Interpretation and mapping of the Casino prospect was based on the Casino 3D survey that was recorded in October and November 2001, and the fast tracked 3D volume (FTC) generated as part of the production processing flow. The data quality is good in the Casino area.

The proposed Casino-2 location would test the eastern flank of the structure. The primary objective in the well was the Waarre Sandstone, with a prognosed mean average pay of 45m across the structure**.** The critical risk on the prospect was related to the nature of updip cross fault seal. The prospect exhibits a significant full stack amplitude anomaly at the Waarre Sandstone with significant increase in amplitude with offset (AVO) over the prospect. The prospect was interpreted as containing 2 separate Waarre sands. The Casino-2 well is placed to intersect and appraise the older Waarre Sand in a down-dip location and the younger Waarre Sand (prognosed as being absent in Casino-1) in an up-dip location. The older sand was tested in an up-dip location by the Casino-1 well.

The Casino prospect is mapped as a tilted fault block closure with the primary reservoir of the Waarre Sandstone. The structure shows erosion of the upper section of the Waarre Formation at the crest, with progressively younger section subcropping on the flanks of the structure. The reservoir at the crest of the structure is likely to be equivalent to lower Unit "C" or Unit "B" Waarre Formation.

The greater Casino structural closure area partially relies on cross fault seal to the west where Waarre reservoir juxtaposes the Belfast Mudstone section. Similar seal potential has shown to be effective at the majority of accumulations of the Waarre sandstone within the Port Campbell Embayment. Near and far-offset volumes were used to evaluate the AVO response over the Casino prospect, demonstrating amplitude increases with offset at the Waarre sandstone level. In defining the prospectivity within the 3D survey the near top of the Waarre sandstone was mapped over the entire survey area. This event, in the prospect locale, represents a combination of the interpretation of both the Waarre "older" and "younger" sands, and is referred to as the "combined" pick. The full stack amplitudes on the "older" and "younger" Waarre sands show anomalies that are coincident with the Casino prospect closure at ~1,450 and ~1,550 msec respectively.

The location for the proposed Casino-2 well was selected on inline 6136 CDP 2400. The Casino-2 well is placed to intersect and appraise the older Waarre Sand in a down-dip location and the younger Waarre Sand (prognosed as being absent in Casino-1) in an up-dip location.

The geophysical prognosis depth conversion utilised the Pecten-1A velocities.

1.3 WELL LOCATION

Casino-2 is located in the Otway Basin, Victoria Offshore VIC/P44 license. The Surface Location details are given below. The Casino-2 location is 4.2km ESE of the Casino-1 well and lies approximately 29 km south west of the town of Port Campbell, 21 km SW of the Minerva gas field and 23 km North of the LaBella gas field. The Casino structure is situated towards the western limit of the productive Waarre Sandstone play fairway of the Port Campbell Embayment. The water depth at the well location was 67.8m.

The Surface Surveyed Location for Casino-2 is :

Latitude:	38° 47’ 43.887” South
Longitude:	142° 44’ 50.746” East (GDA-94).
Easting:	651 752.63 m
Northing:	5704 463.79 m (MGA-94)
Rig	Diamond Offshore - Ocean Bounty

The Seismic Location for Casino-2 is:

Inline 6136, CDP 2400.
2001 Casino 3D seismic dataset.

2. RESULTS OF DRILLING

2.1 STRATIGRAPHY & GEOPHYSICAL PROGNOSIS

While drilling Casino-2, the penetrated depths of the different formations varied from their respective prognosed depths as can been seen in the table in the Well Card. The Nullawarre Greensand and the Belfast Mudstone were intersected 91m and 77m high to their respective predicted depths. No specific pattern was observed in the variation from prognosed depths.

The Waarre Formation, which constitutes the main reservoir, is a prominent and generally reliable seismic reflector. However due to the extremely complex post-depositional faulting in the area, the reflector is very broken-up in a regional sense. During the drilling of Casino-2 the primary objective Waarre Sandstone was penetrated 11.5m high to the prognosed depth. The depth prognosis was accurate given that Casino-2 was a wildcat well. Depth conversion was not considered an issue. The gas sand has a strong amplitude anomaly confirming the effectiveness of the prognosis.

The gross thickness of the Waarre Formation was 223.5m, which was thinner than the seismically prognosed thickness of 321m.

2.2 STRATIGRAPHY & DEPOSITIONAL ENVIRONMENT (Drillers MDRT Depths)

The well card at the front of this report tables the subsea elevations and thickness of formations penetrated in Casino-2. A brief description of lithology and interpreted environments of deposition follows. More detailed descriptions can be found in Section 4.1 of the Basic Data Report.

Total depth for Casino-2 was reached at 2112m (D & L), in the Early Cretaceous **Eumeralla Formation,** of the **Otway Group**. The well intersected 131m of the Eumeralla, the top coming in at 1981m. The formation consists of interbedded argillaceous sandstone and siltstone, with very minor coal. The sandstones are off-white to light and medium greenish-grey, and range in size from very fine to coarse, but are dominantly medium-grained. They are angular to subangular, poorly to moderately well sorted, better sorted towards the base, contain weak to moderate silica and minor pyritic cements and have a common to abundant white argillaceous matrix in part the sandstone is matrix supported. The Eumeralla contains common grey, green and dark lithics. There are traces of black carbonaceous detritus, trace mica flakes in part and trace to common glauconite grains. The sandstone varies from friable to occasionally moderately hard but only exhibits a very poor to poor porosity. No oil fluorescence was observed. The Eumeralla was deposited in a high-energy fluviatile environment, probably in a major braided stream system where there was an abundant supply of sand-sized volcanic detritus. The source of the volcanic material is unknown, but due to results from age dating, it appears that volcanism was contemporaneous with sedimentation (Abele *et al*, 1995). In the eastern portion of the Otway Basin the Eumeralla has been dated to be Aptian to Albian. The Eumeralla was deposited in a high-energy fluviatile environment, probably in a major braided stream system where there was an abundant supply of sand-sized volcanic detritus. The source of the volcanic material is unknown, but due to results from age dating, it appears that volcanism was contemporaneous with sedimentation (Abele *et al*, 1995). In the eastern portion of the Otway Basin the Eumeralla has been dated to be Aptian to Albian.

The Late Cretaceous **Sherbrook Group** overlies the Early Cretaceous Eumeralla in the Otway Basin. The **Waarre Formation** makes up the oldest formation of the group and is dated to be Turonian in age (Partridge, 1997).

The Waarre Sandstone reservoir, which was intersected at 1739m, was deposited as the initial post-rift sequence at the commencement of Turonian time. Microplankton at the base of the Waarre formation record the first evidence of wholesale marine incursion into the Otway Basin. The section is sub-divided into three sub-units – Waarre “A”, “B” & “C”.

The 85m thick “A” unit represents a basal transgressive systems tract (TST) characterised by flooding of an incised valley with sediments deposited under marginal marine/estuarine conditions. Lithologically, the unit is similar to the underlying Eumeralla Formation from which it is sourced. The unit is comprised of fine to coarse grained lithic sandstone, interbedded with thin beds of silty carbonaceous mudstone. Onshore the sandstones are dominantly fluvial, but offshore marine conditions are indicated by coarsening upward beds.

Unit “B” which was 9m thick was deposited under estuarine conditions. Onshore, Unit “B” is comprised of carbonaceous mudstone with thin interbeds of coal. Glauconitic mudstone and siltstone, with thin interbeds of dolomitic and calcareous sandstone, is common. Offshore wells show greater marine influence with increasing glauconitic content and common occurrence of dinoflagellates and microplankton.

Unit “C” is characterised by initial estuarine/deltaic conditions succeeded by high-energy sands. The 129.5m thick unit consists of fine to very coarse grained quartzose sandstone deposited in thick, blocky to fining upwards beds. The sandstone is carbonaceous and thin coals are occasionally developed. Towards the basin, the sandstone becomes finer grained with fining upwards beds developed in Mussel-1 and LaBella-1.

Log analysis identified 37.3m of net pay in the Waarre Sandstone. The sandstone is off-white to light brownish-grey to light grey, very fine to very coarse, but dominantly fine to medium in size, though dominantly medium grained towards the base. The grains are angular to subrounded, poorly to moderately sorted, generally contain a weak to moderate silica cement. There is trace to common white to light grey argillaceous matrix throughout, clear to opaque quartz grains, and minor black coaly detritus. The sandstone is friable to moderately hard, has poor to fair visible porosity without any hydrocarbon fluorescence. The sandstone packages are generally blocky in shape. The basal Waarre is interpreted to be shallow marine to marginal marine. After the transgression in the lower part of the Waarre, the formation became more regressive, depositing the best reservoir sands in the lower coastal and delta areas.

The following is the Summary from the Petrology Report on samples from Casino-1 and Casino-2. The detailed report is attached in Appendix V: Petrology Report.

"Santos Ltd. submitted 16 samples to PGPC from the wells Casino-1 and Casino-2 in the Otway Basin. Samples were selected from the Late Cretaceous (Turonian) Waarre Formation for detailed petrological description. The aims of the study were to ascertain the lithology, mineralogy, sediment provenance, diagenetic alteration and factors controlling reservoir quality. All samples were described in thin section and selected samples were submitted for X-ray diffraction and scanning electron microscopy.

Lithics decrease in abundance from Unit A to Unit Ca/Cb in the Waarre Formation causing a change in lithology. Typically sandstones in Unit A are fine to medium grained, moderately well to well sorted, mineralogically immature litharenites. The base of Unit Ca is characterised by fine to medium grained, poor to well sorted sublitharenites. In the cored interval of Unit Ca the sandstones are very fine to coarse grained, poor to well sorted, sublitharenites, subarkose and quartzarenites. Unit Cb is comprised of a medium to coarse grained, moderately well sorted quartzarenite.

Sediment provenance varied during deposition of the Waarre Formation and may be related to rifting and tectonic movements on the King Island High and/or the Kanmantoo Fold Belt. Metamorphic and igneous (plutonic and volcanic) lithics which are dominant in the Waarre Formation could have been sourced from both these areas. At the base of Unit A the thick mudstone has a very high percentage of chlorite-smectite that probably weathered from a volcanic source (?Eumerella Formation). Unit A litharenites contain biotite and opaques that are not apparent in shallower units and sediment was derived from both metamorphic and igneous terrains. Unit Ca in Casino-2 has a thick muddy interval in the middle which is comprised of both kaolinite and illite. Below the muddy interval there are more lithics (including volcanics), and both plagioclase and K-feldspar. It would appear that the igneous/metamorphic terrain remained the prime source. However, in Casino-1 Unit Ca is almost devoid of all igneous lithics and only the deepest sample contains both plagioclase and K-feldspar. It is possible that this well is located further from the igneous source than Casino-2. Above the muddy interval lithics are less abundant, volcanics are absent and there is no plagioclase in Unit Ca from Casino-2. It would appear that there was a decrease in the impact from volcanic sources at this time. Furthermore, lithics concentrate in the finest grained sediments indicating the hydraulic regime also controlled their distribution. Unit Cb in Casino-2 had a similar sediment provenance to the upper part of Unit Ca above the muddy interval.

Depositional environments in the Waarre Formation were dominantly marine but do show a range in hydraulic energy. Unit A may vary from continental shelf to channel fill on a lower delta plain with evidence of minor exposure in the channels. The thick muddy interval in Unit Ca could represent either prodelta or delta front deposits. Unit Ca below this muddy interval may be comprised of distributary channels and/or mouth bars but there is no indication of exposure. Relatively thick cutinite from Casino-1 may suggest vegetation was adapted to periods of aridity during deposition of Unit Ca. Above the muddy interval the core could be interpreted as a slow regressive sequence (possibly aggradation) from shoreface/shelf with Cruziana ichnofacies, through a strandplain and sandy tidal flat (Skolithos ichnofacies) with tidal channels to a fluvial channel. A sandy tidal flat with mangroves may explain the high percentages of organic matter preserved in the core.

Distribution of early diagenetic glaucony, pyrite and siderite were related to the depositional environments. Glaucony concentrates in those sediments assigned to the shoreface and continental shelf. Pyrite may be marginal marine and the siderite formed possibly as a result of pulses of fresh water into the marine depositional environments. Other authigenic minerals formed later in the diagenetic sequence and display vertical zonation in their distribution that in part may be related to differences in detrital mineralogy. Prismatic quartz overgrowths are absent from Unit A, possibly because of the high percentage of lithics. Quartz and feldspar overgrowths both occur in Unit Ca below the muddy interval in Casino-2 but only quartz overgrowths occur in the cored interval. Plagioclase feldspars and volcanic lithics may have provided the elements necessary for both feldspar overgrowths and late diagenetic calcite spar cements. Calcite spar has cemented permeable sands below the muddy interval in Unit Ca and in Unit A, but not in the upper cleaner sands. There are trace amounts of ankerite/dolomite associated with the calcite. Other authigenic minerals include kaolinite, illite, and chlorite which have formed as alteration products of specific detrital grains.

Reservoir quality was primarily controlled by facies and sediment provenance. Reservoir quality has been reduced where there are high percentages of ductile grains, abundant organic matter and/or extensive bioturbation. These controls are overprinted by the distribution of calcite spar and on a minor scale localised pore filling late diagenetic pyrite cement. Calcite spar appears to concentrate in sandstones that would initially have had good permeability and both plagioclase and volcanic lithics were present. Where this spar is abundant, primary intergranular pores have been completely occluded. Reservoir quality is better preserved in channel facies (tidal and fluvial) in the regressive sequence at the top of Unit Ca. However, grain fracturing in very permeable zones has artificially enhanced permeability during coring. Barite and sylvite have precipitated in pores and pore throats from the drilling mud."

In the Otway Basin, the Waarre Formation was transgressed by another flooding event (conformably overlain) by the **Flaxmans Formation.** In the Casino-2 well the Flaxmans Formation was intercepted at 1748m and is 9.5m thick. The **Belfast Mudstone** conformably overlies the Flaxmans Formation. Its top came in at 1525m and is 223m thick. The Belfast Mudstone, along with the Flaxmans Formation, is the seal for the Waarre reservoir. The Belfast Mudstone is largely made up of a medium to dark grey, medium olive- to medium brownish-grey, yellowish grey siltstone with only minor stingers of sandstone (very fine to medium grained, occasionally very coarse, common to abundant matrix, moderately hard, poor to fair porosity). The siltstone is moderately argillaceous grading to claystone, has trace glauconite, a trace of calcareous detritus, a trace to common carbonaceous detritus and flecks, and a trace of pyrite and micromica. It is soft to firm and amorphous to subblocky. The Belfast is dated as being mainly Turonian to Campanian (Abele *et al*., 1995), but perhaps only Coniacian to Santonian (Partridge, 1997). It was deposited below storm wave base in a low-energy marine conditions in a prodelta situation.

The **Nullawarre Greensand** conformably overlies the Belfast with a top intersected at 1507m and is 18m thick. Unlike Casino-1, no pay was identified in the Nullawarre Greensand. The formations is predominantly made up of a clear to translucent, medium green, very fine to fine grained sandstone. The sandstone has subangular to subrounded grains, is moderately well sorted, and has a weak silica cement. Glauconite is common and in traces locally. The sandstone is friable to moderately hard and has a poor to fair porosity. No hydrocarbon fluorescence was observed. The Nullawarre is regarded as being Santonian to Campanian in age and a marine deposit formed above storm wave base. It may be a sheet sand which accumulated on the upper part of the shelf (Abele *et al*, 1995).

The **Skull Creek Mudstone,** (sometimes considered part of the Paaratte Formation), conformably overlies the Nullawarre Greensand. The top of the mudstone was encountered at 1282m and is 225m thick. It comprises a medium to dark brownish-grey, grading to brown black siltstone which is argillaceous and grades to a silty claystone. The Skull Creek Mudstone commonly has dispersed fine to medium quartz grains, trace glauconite and trace disseminated pyrite. It is soft to firm and generally amorphous to subblocky. A pro-delta environment of deposition is interpreted for the Skull Creek and an age of Santonian has been attributed to the Skull Creek Mudstone.

The top of the youngest formation of the Sherbrook Group, the **Timboon Sandstone** was intersected at 1220m. The formation is 62m thick and is made up of thin to fairly thick sandstone packages, interbedded with siltstone. The sandstone is pale grey to grey, clear to translucent, predominantly medium grained to minor coarse grained. The sandstone is moderately well sorted and the grains are subrounded to subangular in part. The sandstone has a weak siliceous cement, has trace lithic fragments and traces of disseminated pyrite. The sandstone is friable to loose, and occasionally in moderately hard aggregates. No hydrocarbon fluorescence was observed. The interbedded siltstone is light to medium brown to brown grey, arenaceous, slightly calcareous with minor disseminated pyrite. The siltstone is firm to moderately hard and subblocky. The Timboon Sandstone was deposited in a deltaic environment, in this case, presumably delta plain, and has been dated to be Campanian to Maastrichtian in age in the Otway Basin.

The **Massacre Shale** overlies the Timboon Sandstone. It was penetrated at 1138m and is 82m thick. The formation consists of siltstone interbedded with minor sandstone. The siltstone is medium grey, medium to dark brown, arenaceous and grades to silty sandstone, carbonaceous in part, has rare white argillaceous laminations, has common disseminated pyrite and is moderately hard to occasionally very hard and generally subblocky. The interbedded sandstone are pale to medium grey, clear to translucent to off white, medium to coarse grained. There are occasional very coarse subrounded polished bit-fractured quartz fragments. The sandstone is moderately poorly sorted with subangular to minor angular grains. The sandstone has common moderate strong calcareous and dolomitic cement, minor white argillaceous matrix and occasional medium grey silty matrix. Disseminated pyrite is common and the aggregates are hard to occasionally very hard aggregates. There are loose grains in part and no hydrocarbon fluorescence was observed. The Massacre Shale forms the boundary between the Cretaceous and the Tertiary.

Overlying the Massacre Shale is the oldest unit in the **Wangerrip Group**, the **Pebble Point Formation**. At Casino-2, the Pebble Point is 57m thick and was intersected at 1081m. The formation is composed of interbedded claystone and sandstone. Sandstone is pale grey, clear to translucent, predominantly medium grained with minor coarse grained, becoming coarser with depth, moderately well sorted, with subangular to minor angular grains and occasionally subrounded grains. The sandstone has trace weak to moderately hard siliceous cement. It is partly friable to moderately hard, generally loose and has fair inferred porosity but no hydrocarbon fluorescence. The interbedded claystone is medium grey and medium to dark brown, slightly arenaceous, siliceous in part, partly silty, soft to firm, occasionally very hard, dispersive, amorphous to subblocky. The environment of deposition for the Pebble Point is interpreted to be shallow water, nearshore, restricted marine with periodic influxes of coarse detrital material. Various megafossils and microfossils have been identified in the formation that indicate an age ranging from Maastrichtian for the oldest strata, to Palaeocene, and even Late Palaeocene (Abele *et al*, 1995).

Conformably overlying the Pebble Point is the **Pember Mudstone**, which was penetrated at 1005m and is 76m thick. The formation consists mainly of claystone which is medium to dark brown, slightly arenaceous, silty, predominantly soft and minor firm, dispersive and amorphous to subblocky. The claystones are interbedded with minor sandstones which are pale brown, translucent, predominantly coarse grained, well sorted and with subrounded grains, with trace moderately strong to strong siliceous cement, with trace silty matrix. The aggregates are moderately hard to hard and loose in part with generally poor visual porosity and no hydrocarbon fluorescence. The Pember Mudstone was deposited in a marine environment where there was restricted circulation and low energy conditions, probably below or close to storm wave base. It has been given an age of Late Palaeocene to Early Eocene (Abele *et al*, 1995) based on a study of associated palynomorphs.

The **Dilwyn Formation** conformably overlies the Pember Mudstone at Casino-2 and was penetrated at 773m and is 232m thick. The section consists predominantly of sandstone with minor interbedded silty claystone. The sandstone is pale to medium grey, also minor pale yellow, is medium to coarse grained, moderately well sorted, with predominantly subrounded to rounded grains and partly subangular grains, with trace pyrite cement, with trace lithic fragments and commonly loose. The sandstone has a fair inferred porosity but no hydrocarbon fluorescence. The claystone is medium to dark grey and dark brown, soft to firm, occasionally hard, with trace pyrite and is very soft, very dispersive and non fissile.

Both macrofossils and microfossils from the Dilwyn have been dated to be Early Eocene. The environment of deposition is interpreted to be shallow marine, with the cleaner sandy portions representing shoreface deposits of a coastal barrier system and the interbedded section possibly back beach lagoon sediments, with some breaching occurring. Another interpretation is that the Dilwyn could have formed in a lower delta plain area with the sands, distributary channels and mouth bars, and the clays, the interdistributary bay fills (Abele *et al.*, 1995).

The Dilwyn Formation is the youngest unit of the Wangerrip Group, and is unconformably overlain by the **Mepunga Formation**, the oldest formation of the **Nirranda Group**. In the Casino-2 well the Mepunga was intersected at 691m and is 82m thick. The massive sandstone is medium brown to occasionally dark brown, partly medium yellow brown, coarse to very coarse grained and minor medium grained, moderately well sorted, with grains that are subrounded to occasionally rounded and minor subangular. The sandstone has a weak siliceous cement and common Fe-staining. There are traces of glauconite and trace pyrite. The sandstone is poorly consolidated and loose in part and partly friable to moderately hard. The porosity is inferred to be fair with no hydrocarbon fluorescence being observed. There are trace of claystone which is medium brown, slightly to very silty in part, with abundant dispersed very fine to grit-sized brown-stained quartz grains in places. It is slightly calcareous in part, with a trace of glauconite, trace to common pyrite and is very soft, very dispersive and non fissile. According to dating of forams, molluscs and palynomorphs discovered within the Mepunga, an age of Middle Eocene to Early Oligocene has been given. The sandstones have been interpreted as being deposited in beach and nearshore locations as barrier islands, whereas the claystones regarded as estuarine and some as deep lagoonal in origin (Abele *et al,* 1995).

The **Narrawaturk Marl** overlies the Mepunga Formation with a conformable contact. Since all returns were to the seafloor while drilling this formation, cuttings samples were not available for study. The Gamma Ray wireline log was run over this section, above the 340mm casing but the formation top has not been picked. Formations younger than the Narrawaturk Marl are behind casing and were not studied. These include formations (typically limestones) of the **Heytesbury Group** like the Clifton Formation which grades into the **Gellibrand Marl** which is overlain, with a transitional contact, by the **Port Campbell Limestone**, the topmost formation of the Heytesbury Group. The Port Campbell Limestone is Middle to Late Miocene in age and was deposited in a moderate-energy, continental shelf environment, above fair weather wave base. It is uncertain if all these formations were penetrated Casino-2 prior to installing the marine riser, when all returns were to the seafloor.

2.3 HYDROCARBON SUMMARY (Logger's MDRT Depths)

Ditch gas values were monitored and recorded in units (U) by F.I.D (flame ionisation detector) Total Gas detector, where one unit is equivalent to 200 ppm (parts per million) of methane gas in air. The ditch gas was also monitored for hydrocarbon gas composition by a F.I.D. chromatograph. Gas composition refers to percent components of the hydrocarbon alkane series: (methane, ethane, propane, butane and pentane). Gas compositions are quoted as the percentage ratios of these five gases (i.e. 94/2/1/1/1 denotes 94% C1, 2% C2, 1% C3, 1% C4 and 1% C5). Ditch cuttings were tested for hydrocarbon fluorescence by using an ultra-violet fluoroscope.

Since returns were to the seafloor in the 914mm (36") and 445mm (17.5") sections, gas readings are not available. After drilling out the 340mm (13-3/8") casing shoe at 691m returns were to the surface and realtime gas monitoring was possible. From the casing shoe at 691m to 1322m (40m into the Skull Creek Formation), the Background Total Gas in trace to 7 units (but mostly trace to 3 units) was recorded and consisted of 100% C1. From 1322m to the top of the top of the Nullawarre Greensand at 1507m, the Total Gas ranged from 7 to 17 units, comprising of 100% C1. Within the Nullawarre Greensand, gas readings were a maximum of 20 units over a background of 14 units and the gas was composed of 100% C1. In the Belfast Formation background gas ranging from 4 to 22 units was recorded and consisted of 100% C1. In the Flaxmans Formation the gas increased to 102 units over a background reading of 15 units.

In the upper Unit "C" of the Waarre Formation, the primary target for the well, total gas ranged increased significantly to a maximum of 548 units over a general background of 15 units. The composition of the gas was 98/tr/1.5/tr/tr %. In the sand package at 1830m, the gas increased again to peak at 501units with a composition of 98/tr/1/tr/tr %.

The gas in the Unit "B" and Unit "A" to a depth of 1950m range between 15 and 200 units with a composition of 100/tr/tr % with the higher gas readings from localised sand packages. Below 1950m the gas readings dropped off considerably to range between 10 and 17 units.

In the Eumeralla Formation the total gas remained low and ranged between 7 and 14 units and was composed of 100% C1.

2.4 SUMMARY

Casino-2 was drilled as an Otway Basin gas exploration well in the offshore VIC/P44 licence and was designed to test a sand that is interpreted to be absent at the proposed Casino-1 location. The well is contingent on the Casino-1 wildcat exploration well confirming that significant full stack amplitude and AVO anomalies indicate the presence of hydrocarbons within the prospect area. The Surface Location is Latitude: 38° 47’ 43.887” S, Longitude: 142° 44’ 50.746” E (GDA94), Northing: 5704463.79m Easting: 651752.63m (MGA-94). The Seismic Reference is Inline 6136, CDP 2400. The Casino-2 location is 4.2km ESE of the proposed Casino-1 well and lies approximately 29 km south west of the town of Port Campbell, 21 km SW of the Minerva gas field and 23 km North of the LaBella gas field. The

Casino structure is situated towards the western limit of the productive Waarre Sandstone play fairway of the Port Campbell Embayment. The water depth at the well location was 67.8m.

The Casino prospect is a tilted fault block closure defined by the 2001 Casino 3D seismic dataset (646 km2 of acquired data) and the proposed location tested the eastern flank of the structure. The primary objective in the well was the Waarre Sandstone. The critical risk on the prospect prior to the drilling of Casino 1 was related to the nature of updip cross fault seal, however this was mitigated from success at the Casino-1 location. The main risks were associated with the extent and quality of the reservoir. The prospect exhibits a significant full stack amplitude anomaly at the Waarre Sandstone with significant increase in amplitude with offset over the prospect. The prospect is interpreted as containing 2 separate Waarre sands. The Casino-2 well was placed to intersect the younger Waarre Sand (prognosed as being absent in Casino-1) in an up-dip location and appraise the older "non-amplitude" Waarre Sand in a down-dip location (relative to its proposed intersection in Casino-1). The following were the aims of the Casino-2 well:

- To intersect the younger Waarre sand at its highest location on the structure and confirm the presence of hydrocarbons;
- To obtain pressure data to confirm column height and gas samples to determine composition;
- Provide an production point for any gas accumulation in the younger Waarre Sand;
- To confirm the GWC in the older sand indicated by pressure measurements in Casino-2, correlated with Casino-1.

A successful hydrocarbon discovery at Casino-2 could confirm an economic gas accumulation in the Casino structure. This could lead to a further development well at the crest of the structure to produce gas reserves in the older Waarre Sand.

Casino-2 was drilled by the semi-submersible Diamond Offshore drilling rig "Ocean Bounty". Casino-2 was spudded at 09:30 hrs on 24/09/02. A 914mm (36") hole was drilled to 140m and 760mm (30") casing run and set at 137m. A 445mm (17.5") hole was drilled from 140m to 700m with returns to the seafloor and 340mm (13-3/8") casing run and set at 691m. The blow out preventer was installed and pressure tested. A 311mm (12-1/4") hole was drilled from 700m to the core point of 1763m using 2 bits MWD/LWD data (gamma ray, resistivity, sonic data and surveys) was acquired in this drilling phase. A 21m core was cut from 1763 to 1794m with a 92% recovery. Drilling of the 311mm (12 ¼") hole continued from 1794m to the Total Depth of 2112m which was reached at 23:15 hrs on 03/10/02.

At Total Depth, the hole was circulated clean and the drillstring was pulled out of hole to run wireline logs. Schlumberger was rigged up and wireline logs were run as summarised above. After rigging down Schlumberger, a cement stinger was run in the hole to set cement abandonment plugs as per program, Plug 1: 2100m-1825m, Plug 2: 1825m-1550m, Plug 3: 720m-640m and Plug 4: 177m-127m. The rig was later released at 20:30 hours on October 11, 2002.

During drilling, gas shows were observed in the Waarre Formation. Subsequent log analysis identified 37.3m of pay with Average ∅=18.9% and Sw=27% in the Waarre Formation. The Waarre gas had a low CO_2 content of about 1% and was dry.

The penetrated depths of the different formations in Casino-2 varied from their respective prognosed depths as can been seen in the table in the Well Card. The Nullawarre Greensand and the Belfast Mudstone were intersected 91m and 77m high to their respective predicted depths. No specific pattern was observed in the variation from prognosed depths. The primary objective, the Waarre Sandstone was drilled 11.5m high to the prognosed depth.

Casino-2 was drilled as a vertical hole. Deviation Surveys were recorded using MWD/LWD tools in most of the 311mm (12.25”) section while drilling, with the last survey being recorded at 2085.35m. At Total Depth, the estimated displacement was 24m towards 251°T direction with the estimated TVD of 2111.63m.

Casino-2 reached Total Depth of 2112m (2087m SS) at 23:15 hrs on 03/10/02. After running Suite 1 wireline logs, the well was plugged and abandoned. The rig was released at 20:30 hrs on 11/10/02.

3. REFERENCES

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APPENDIX I : ELECTRIC LOG EVALUATION RESULTS

Preliminary log analysis data only currently available. The final log analysis will be forwarded upon completion.

Preliminary log analysis identified 37.3m of net pay with Average ∅=18.9% and Sw=27% in the Waarre Formation.

No pay was identified in the Nullawarre Greensand.

A preliminary log interpretation plot is included in Enclosure IV.

APPENDIX II : MDT PRESSURE DATA

Santos **PRESSURE SURVEY**

WELL: Casino 2 RT: 25.0 metres Gauge Type : Quartz Page : 1 OF 2
WITNESS: M. D'Cruz / R Subramanian Time since last circ : 18.0 hrs Probe/ Packer Type : Std Date : 4/10/02 - 5/10/02

	FORMATION	DEPTH RT MD m	DEPTH SUBSEA m	EXPECT FORM PRESS PSIA	EXPECT TEMP deg C	FILE NO	TEST RESULTS HYDRO BEFORE PSIA	FORM PRESS PSIA	HYDRO AFTER PSIA	TEMP deg C	D/D MOB MD/CP	INTERPRETATION TYPE D/D	TYPE BUILD UP	DEPL S/C	COMMENTS FLUID TYPE
															CORRELATION
1	Waarre Cb	1753.7	1728.7			54	3146.30	-	-	71.5	-	N	Slow		Curtailed
2	Waarre Cb	1757.8	1732.8			55	3153.60	2827.50	3152.80	72.5	N/A	N	Slow		Good
3	Waarre Cb	1757.8	1732.8			55	3152.80	2826.95	3152.50	73.1	135.9	N	Rapid		Reset, Good
4	Waarre Cb	1760.0	1735.0			56	3155.60	2827.71	3156.03	73.6	313.7	N	Slow		Good
5	Waarre Cb	1765.5	1740.5			57	3161.50	2828.35	3160.57	73.9	953.1	N	Slow		Good
6	Waarre Cb	1762.5	1737.5			58	3167.58	2829.84	3166.11	74.3	669.9	N	Rapid		Good
7	Waarre Cb	1768.5	1743.5			59	3173.30	2829.10	3171.88	74.5	N/A	N	Rapid		Good
8	Waarre Cb	1768.5	1743.5			59	3171.88	-	3172.20	74.7	2.80	N	Slow		Reset, Curtailed
9	Waarre Cb	1773.5	1748.5			60	3181.79	2830.14	3181.20	75.0	157.40	N	Fast		Good
															CORRELATION
10	Waarre Cb	1777.5	1752.5			62	3189.50	2831.05	3188.70	75.2	865.70	N	Rapid		Good
11	Waarre Cb	1780.5	1755.5			63	3194.70	2831.26	3194.43	75.5	109.50	N	Rapid		Good; Plugging ??
12	Waarre Cb	1785.3	1760.3			65	3203.79	2832.16	3202.95	75.8	176.60	N	Good		Good
13	Waarre Ca	1832.7	1807.7			66	3291.70	-	3287.15	76.9	0.60	N	Slow		Curtailed
14	Waarre Ca	1834.5	1809.5			67	3291.12	(2836)	3290.45	77.7	3.40	N	Slow		Curtailed
15	Waarre Ca	1836.7	1811.7			68	3294.78	-	3294.58	78.0	3.20	N	Slow		Curtailed
16	Waarre Ca	1844.8	1819.8			69	3311.04	2832.08	3309.03	78.5	9.30	N	Slow		Curtailed
17	Waarre Ca	1857.0	1832.0			70	3333.86	-	3331.09	78.3	-	N	Slow		Curtailed
18	Waarre Ca	1859.5	1834.5			71	3335.79	1831.41	3335.33	79.3	7.50	N	Slow		Curtailed
19	Waarre Ca	1862.3	1837.3			72	3340.84	2830.60	3340.53	79.1	14.60	N	Slow		Tight
20	Waarre Ca	1881.5	1856.5			73	3378.23	2853.66	3374.49	79.7	12.50	N	Slow		Tight
21	Waarre Ca	1872.0	1847.0			74	3359.00	-	-	79.9	-	N	Slow		Unstable
22	Waarre Ca	1872.0	1847.0			74	3359.00	-	-	79.3	-	N	Slow		Unstable, Reset

Expected Temp Gradient: 0.04 10
Expected Water Gradient: 0.43
Mud Weight : 1.24 sg

Normal Drawdown : Pressure does not drop to zero
Limited Drawdown : Pressure drops to zero
Build Up types: Immediate, Rapid, Good, Slow.

Santos **PRESSURE SURVEY**

WELL: Casino 2 RT: 25.0 metres Gauge Type : Quartz Page : 2 OF 2
WITNESS: M. D'Cruz / R.Subramanian Time since last circ : 18.0 hrs Probe/ Packer Type : Std Date : 4/10/02 - 5/10/02

	FORMATION	DEPTH RT MD m	DEPTH SUBSEA m	EXPECT FORM PRESS PSIA	EXPECT TEMP deg C	FILE NO	TEST RESULTS HYDRO BEFORE PSIA	FORM PRESS PSIA	HYDRO AFTER PSIA	TEMP deg C	D/D MOB MD/CP	INTERPRETATION TYPE D/D	TYPE BUILD UP	DEPL S/C	COMMENTS FLUID TYPE
23	Waarre Ca	1872.0	1847.0			74	3357.81	2840.89	3357.84	79.90	12.80	N	Good		Good. Reset, 40cc/min d/d
24	Waarre Ca	1884.5	1859.5			75	3383.50	2860.29	3380.03	80.10	5.50	N	Good		Good
25		1906.5	1881.5			76	3422.20	-	3419.20	80.30	-	N	-		Lost Seal
26		1906.5	1881.5			76	3419.20	-	3418.20	80.40	1.80	N	Slow		Tight 30 cc/min.
27		1909.5	1884.5			77	3425.40	-		80.50	-	-	-		Lost Seal
28		1909.5	1884.5			77	3425.40	-		80.50	-	-	-		Lost Seal again
29		1909.3	1884.3			78	3425.20	(1430)	3424.40	80.50	5.70	N	Slow		Curtailed
30		1915.0	1890.0			79	3435.20	-	3434.33	80.70	2.20	N	Slow		Curtailed
31		1944.5	1919.5			80	3490.60	-	3486.80	89.90	21.00	N	Slow		Curtailed
															CORRELATION
	SAMPLING														
32	Waarre Cb	1764.0	1739.0			81	3165.00	2827.91	3167.50	77.90	(>1000)	N	Slow		Collected 4x450cc and 1 gallon
	TOTAL : 32 PRE-TESTS: 13-Good, 3 Lost Seals, 14 curtailed/tight, 2 Unstable														
	Purchased 2 x x450cc PVT Chambers + 1 x 1 gal Chamber opened at rigsite.														

*** Note: Above readings noted real-time. Software picks could vary slightly. Refer final log presentation.**

Expected Temp Gradient: 0.04
Expected Water Gradient: 0.43
Mud Weight : 1.24 sg

Normal Drawdown : Pressure does not drop to zero
Limited Drawdown : Pressure drops to zero
Build Up types: Immediate, Rapid, Good, Slow.

APPENDIX III: HYDROCARBON SHOW REPORT

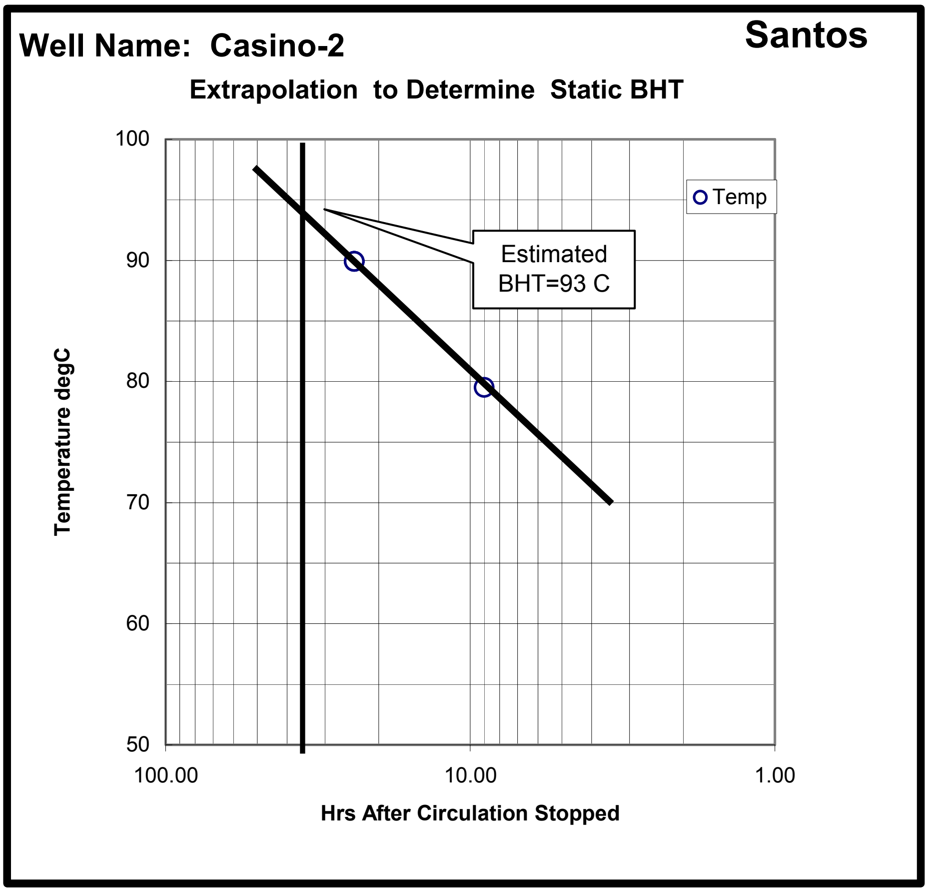
No hydrocarbon fluorescence was observed in Casino-2.

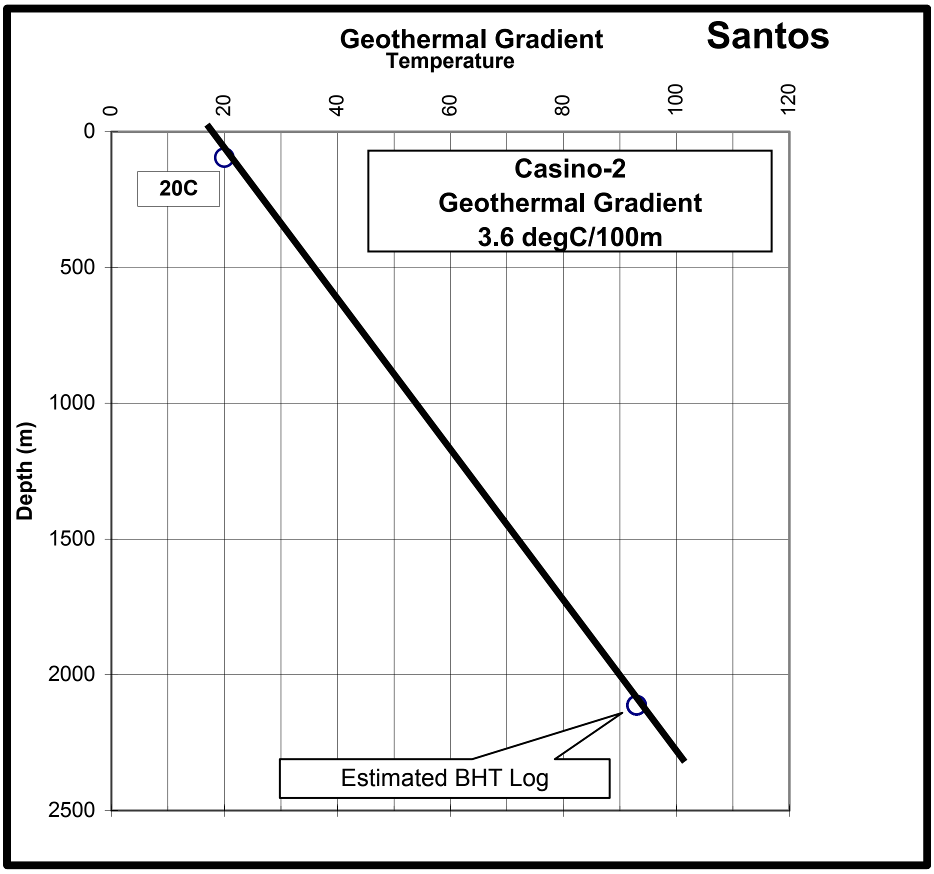
APPENDIX IV : GEOTHERMAL GRADIENT

Data from Wireline Logs were used to estimate a Geothermal Gradient. An extrapolated static bottom hole temperature of 93°C at 2112' and a geothermal gradient of 3.6°F/100m were calculated from downhole temperatures recorded during logging operations. These estimates compare favourably with the Geothermal Gradient estimate of 3.5°F/100m for the Casino-1 well.

LOG	TEMP	DEPTH	TIME SINCE LAST CIRCULATION
PEX-HALS-DSI-HNGS	79.5°C	2112m	9.00 hrs
MDT	89.9°C	1994m	24.00 hrs
SURFACE	20°C	95m	

The results are depicted graphically overleaf.


Well Name: Casino-2
Santos
Extrapolation to Determine Static BHT
Temp
Estimated
BHT=93 C
Temperature degC
100
90
80
70
60
50
100.00
10.00
1.00
Hrs After Circulation Stopped


Geothermal Gradient
Temperature
Santos
0
20
40
60
80
100
120
20C
Casino-2
Geothermal Gradient
3.6 degC/100m
Depth (m)
0
500
1000
1500
2000
2500
Estimated BHT Log

APPENDIX V : PETROLOGY REPORT

16 samples from Casino-1 and Casino-2 were selected from the Late Cretaceous (Turonian) Waarre Formation for detailed petrological description. The aims of the study were to ascertain the lithology, mineralogy, sediment provenance, diagenetic alteration and factors controlling reservoir quality. All samples were described in thin section and selected samples were submitted for X-ray diffraction and scanning electron microscopy.

A detailed report is attached overleaf.

Report prepared for:

SANTOS LTD
91 King William St
Adelaide
SA 5000

PETROLOGY REPORT

CASINO-1 & CASINO-2

OTWAY BASIN (VIC/P 44)

Report prepared by:

Dr S E PHILLIPS
PGPC
1c Short Crescent
Beaumont SA 5066

January 2003

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CONTENTS

Front cover:
Thin section photomicrograph of Casino-2, core plug 1, depth 1763.18mRT. Plane light. Horizontal field of view 4.0mm.

1. SUMMARY

Santos Ltd submitted 16 samples to PGPC from the wells Casino-1 and Casino-2 in the Otway Basin. Samples were selected from the Late Cretaceous (Turonian) Waarre Formation for detailed petrological description. The aims of the study were to ascertain the lithology, mineralogy, sediment provenance, diagenetic alteration and factors controlling reservoir quality. All samples were described in thin section and selected samples were submitted for X-ray diffraction and scanning electron microscopy.

Lithics decrease in abundance from Unit A to Unit Ca/Cb in the Waarre Formation causing a change in lithology. Typically sandstones in Unit A are fine to medium grained, moderately well to well sorted, mineralogically immature litharenites. The base of Unit Ca is characterised by fine to medium grained, poor to well sorted sublitharenites. In the cored interval of Unit Ca the sandstones are very fine to coarse grained, poor to well sorted, sublitharenites, subarkose and quartzarenites. Unit Cb is comprised of a medium to coarse grained, moderately well sorted quartzarenite.

Sediment provenance varied during deposition of the Waarre Formation and may be related to rifting and tectonic movements on the King Island High and/or the Kanmantoo Fold Belt. Metamorphic and igneous (plutonic and volcanic) lithics which are dominant in the Waarre Formation could have been sourced from both these areas. At the base of Unit A the thick mudstone has a very high percentage of chlorite-smectite that probably weathered from a volcanic source (?Eumerella Formation). Unit A litharenites contain biotite and opaques that are not apparent in shallower units and sediment was derived from both metamorphic and igneous terrranes. Unit Ca in Casino-2 has a thick muddy interval in the middle which is comprised of both kaolinite and illite. Below the muddy interval there are more lithics (including volcanics), and both plagioclase and K-feldspar. It would appear that the igneous/metamorphic terrane remained the prime source. However, in Casino-1 Unit Ca is almost devoid of all igneous lithics and only the deepest sample contains both plagioclase and K-feldspar. It is possible that this well is located further from the igneous source than Casino-2. Above the muddy interval lithics are less abundant, volcanics are absent and there is no plagioclase in Unit Ca from Casino-2. It would appear that there was a decrease in the impact from volcanic sources at this time. Furthermore, lithics concentrate in the finest grained sediments indicating the hydraulic regime also controlled their distribution. Unit Cb in Casino-2 had a similar sediment provenance to the upper part of Unit Ca above the muddy interval.

Depositional environments in the Waarre Formation were dominantly marine but do show a range in hydraulic energy. Unit A may vary from continental shelf to channel fill on a lower delta plain with evidence of minor exposure in the channels. The thick muddy interval in Unit Ca could represent either prodelta or delta front deposits. Unit Ca below this muddy interval may be comprised of distributary channels and/or mouth bars but there is no indication of exposure. Relatively thick cutinite from Casino-1 may suggest vegetation was adapted to periods of aridity during deposition of Unit Ca. Above the muddy interval the core could be interpreted as a slow regressive sequence (possibly aggradation) from shoreface/shelf with Cruziana ichnofacies, through a strandplain and sandy tidal flat (Skolithos ichnofacies) with tidal channels to a fluvial channel. A sandy tidal flat with mangroves may explain the high percentages of organic matter preserved in the core.

Distribution of early diagenetic glaucony, pyrite and siderite were related to the depositional environments. Glaucony concentrates in those sediments assigned to the shoreface and continental shelf. Pyrite may be marginal marine and the siderite formed possibly as a result of pulses of fresh water into the marine depositional environments. Other authigenic minerals formed later in the diagenetic sequence and display vertical zonation in their distribution that in part may be related to differences in detrital mineralogy. Prismatic quartz overgrowths are absent from Unit A, possibly because of the

high percentage of lithics. Quartz and feldspar overgrowths both occur in Unit Ca below the muddy interval in Casino-2 but only quartz overgrowths occur in the cored interval. Plagioclase feldspars and volcanic lithics may have provided the elements necessary for both feldspar overgrowths and late diagenetic calcite spar cements. Calcite spar has cemented permeable sands below the muddy interval in Unit Ca and in Unit A, but not in the upper cleaner sands. There are trace amounts of ankerite/dolomite associated with the calcite. Other authigenic minerals include kaolinite, illite, and chlorite which have formed as alteration products of specific detrital grains.

Reservoir quality was primarily controlled by facies and sediment provenance. Reservoir quality has been reduced where there are high percentages of ductile grains, abundant organic matter and/or extensive bioturbation. These controls are overprinted by the distribution of calcite spar and on a minor scale localised pore filling late diagenetic pyrite cement. Calcite spar appears to concentrate in sandstones that would initially have had good permeability and both plagioclase and volcanic lithics were present. Where this spar is abundant, primary intergranular pores have been completely occluded. Reservoir quality is better preserved in channel facies (tidal and fluvial) in the regressive sequence at the top of Unit Ca. However, grain fracturing in very permeable zones has artificially enhanced permeability during coring. Barite and sylvite have precipitated in pores and pore throats from the drilling mud.

2. INTRODUCTION

Santos Ltd submitted five core plug offcuts and 11 sidewall cores to PGPC from the wells Casino-1 and Casino-2 in the Otway Basin. Samples were selected from the Late Cretaceous (Turonian) Waarre Formation for detailed petrological description. The aims of the study were to ascertain the lithology, mineralogy, sediment provenance, diagenetic alteration and factors controlling reservoir quality.

The client supplied hand specimen descriptions, a sedimentological core log from Casino-2, stratigraphic column and wireline logs for both wells from the relevant depth intervals to aid the petrology study. After a preliminary description of the thin sections to determine the preservation of texture in the sidewall cores the services listed below (Table 1) were provided by PGPC.

TABLE 1. SAMPLES & SERVICES

Sample	Depth (m)	TS description	Grain size analysis	Point count	XRD (Bulk & Clay)	SEM
CASINO-2						
CP 1	1763.18	*	*	*	-	*
CP 10	1765.80	*	*	*	B & C	*
CP 25	1772.88	*	*	-	-	-
CP 30	1774.43	*	*	*	-	*
CP 50	1780.46	*	*	*	-	*
SWC 21	1810.00	*	*	-	B & C	-
SWC 17	1845.00	*	-	-	B	-
SWC 15	1857.00	*	*	-	B & C	-
SWC 13	1871.00	*	*	-	-	-
SWC 12	1880.50	*	*	*	B	-
SWC 8	1901.00	*	-	-	-	-
SWC 7	1917.00	*	*	*	-	-
SWC 3	1963.00	*	-	-	C	-
CASINO-1						
SWC 18	1751.00	*	*	-	B	-
SWC 15	1769.00	*	*	-	-	-
SWC 12	1783.00	*	*	-	B & C	-

3. METHODS

Thin section

Core plugs and sidewall cores 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 prepared using standard techniques to produce a thickness of 30 microns (Adams *et al*, 1984). Those samples containing significant carbonate were half stained with alizarin red-S and potassium ferricyanide to differentiate the carbonate species (Adams *et al*, 1984). Thin sections were systematically scanned to determine lithology, composition, porosity and textural relationships. Siliciclastics have been classified according to guidelines by Folk (1974) and carbonates are classified using the nomenclature of Tucker (2001). Grain morphology (both sphericity and roundness) was estimated by comparison with charts in Pettijohn *et al* (1987), grain fabric (packing and texture) from the diagram in Tucker (2001) and sorting from diagrams by Harrell (1984). Percentages of composition given in the thin section descriptions are either visual estimates (Terry & Chilingar, 1955), or counts of 500 points (Stanton & Wilson, 1994). The basic data for grain size analyses was collected by measuring the long axis of 100 representative grains in thin section. The graphic mean and inclusive graphic standard deviation (Folk, 1974) were then calculated.

X-ray diffraction (XRD)

To determine bulk mineralogy by XRD, samples were ground in a Siebtechnick mill and back mounted into aluminium holders. Continuous scans were run of these powder pressings from 3^{o} to 75^{o} 2θ , at 1^{o}/minute, using Co Kα radiation, 50kV and 35mA, on a Philips PW1050 diffractometer. For detailed clay mineralogy a less than 5 micron size fraction was separated. This was obtained by hand crushing, addition of dispersion solution, mechanical shaking for 10 minutes and settling of the dispersed material in a water column according to Stokes' Law. The less than 5 micron fraction was pipetted off and prepared as an oriented sample on ceramic plates held under vacuum. Samples were saturated with Mg solution and treated with glycerol. Continuous scans of oriented clay samples were run from 3^{o} to 45^{o} 2θ at 1^{o}/minute. Peaks were identified by comparison with JCPDS files stored in a computer program called XPLOT.

Scanning electron microscopy (SEM)

Scanning electron microscope studies were undertaken on broken segments of samples mounted with araldite on aluminium pin-type stubs. The samples were evaporatively coated with carbon (15nm) and gold/palladium (20nm) prior to viewing in a Philips XL20 Scanning Electron Microscope at 20kV. The elemental composition of each mineral photographed was identified using an EDAX DX-4 energy dispersive spectrometer.

4. PETROLOGY

TABLE 2. POINT COUNT DATA

WELL	CASINO-2					
Stratigraphic Unit	Cb	Ca	Ca	Ca	Ca	A
Depth (mRT)	1763.18	1765.80	1774.43	1780.46	1880.50	1917.00
Sample	Cp 1	Cp 10	Cp 30	Cp 50	Swc 12	Swc 7
Lithology	quartzarenite	sublitharenite	quartzarenite	subarkose	litharenite	litharenite
Avg GS (mm)	medium-coarse sand (0.50)	v.fine sand (0.13)	medium sand (0.49)	fine sand (0.21)	medium sand (0.27)	fine sand (0.22)
Sorting (phi)	moderate (0.84)	moderate (0.96)	mod well (0.70)	well (0.44)	well (0.42)	well (0.44)
Shape	A-SA	A-SA	SA	A-SA	SA-SR	SR
Structures	laminae	none	laminae	laminae	?bedding	?bedding
	Volume percentage					
Framework grains						
- Quartz - mono	59.4	53.6	64.6	58.0	21.4	10.4
- poly	7.2	4.0	4.6	2.6	6.8	3.8
- Feldspar - Kspar	2.0	2.8	1.8	3.8	2.2	1.8
- plag	0.0	0.0	0.0	0.0	0.8	1.0
- Lithics						
- sedimentary	0.2	0.6	0.4	0.8	1.8	1.0
- metamorphic	0.2	5.6	0.0	1.6	7.2	14.0
- igneous	0.4	0.6	0.2	0.0	6.2	12.8
- Mica	0.2	2.2	0.4	1.0	0.4	0.2
- Accessory - zircon	0.0	0.4	0.0	0.2	0.0	0.0
- tourmaline	0.2	0.6	0.4	0.2	0.0	0.0
- rutile	0.0	0.2	0.2	0.2	0.2	0.2
- opaques	0.0	0.0	0.0	0.0	0.0	0.2
Matrix						
- Clay	0.0	0.8	0.0	0.8	0.0	0.0
- Organic matter	0.0	0.0	0.0	1.2	0.0	0.0
Authigenic minerals						
- Glaucony	0.0	1.4	0.0	1.0	0.0	0.0
- Quartz	3.4	2.8	4.0	4.8	0.8	0.0
- Feldspar	0.0	0.0	0.0	0.0	0.0	0.0
- Kaolin -replace	0.4	2.4	0.4	1.4	1.8	0.8
- fill pores	0.0	0.2	0.0	0.6	0.4	0.0
- Illite - replace	0.0	0.6	0.0	0.0	0.2	0.0
- Chlorite - replace	0.0	1.0	0.0	0.0	0.6	0.6
- Oxide - replace	0.0	0.0	0.0	0.0	0.0	2.8
- Pyrite - replace	0.6	0.6	0.8	1.4	0.6	0.4
- fill pores	0.4	0.8	3.0	0.6	0.0	0.0
- Fe carbonate - replace	0.0	1.8	0.2	0.8	7.6	5.0
- fill pores	0.0	0.8	0.8	0.4	0.6	1.6
- Carbonate - replace	0.0	0.0	0.0	0.0	16.2	20.4
- fill pores	0.0	0.0	0.0	0.0	18.6	21.0
Porosity						
- Intergranular	22.8	10.2	16.4	16.6	0.0	0.0
- Dissolution	1.4	5.4	0.6	1.8	5.4	2.0
- Micropores	0.0	0.6	0.0	0.2	0.2	0.0
- Fractures	1.2	0.0	1.2	0.0	0.0	0.0

TABLE 2 continued VISUAL ESTIMATE DATA

WELL	CASINO-2				
Stratigraphic Unit	Ca	Ca	Ca	Ca	Ca
Depth (mRT)	1772.88	1810.00	1845.00	1857.00	1871.00
Sample	Cp 25	Swc 21	Swc 17	Swc 15	Swc 13
Lithology	quartzarenite	greywacke	sublitharenite	sublitharenite	sublitharenite
Avg GS (mm)	coarse sand (0.77)	v.fine sand (0.07)	medium sand (~0.31)	fine sand (0.23)	medium sand (0.28)
Sorting (phi)	poor (1.20)	poor (1.83)	mod well	poor (1.57)	well (0.48)
Shape	A-SA	A-SA	SA-SR	SA-SR	SR
Structures	laminae	laminae, ripples	-	laminae	none
	Volume percentage				
Framework grains					
- Quartz					
- monocrystalline	62	53	52	50	60
- polycrystalline	4	3	2	3	2
- Feldspar	1	3	5	7	5
- Lithics					
- sedimentary	tr	tr	2	1	2
- metamorphic	tr	2	4	5	7
- igneous	tr	-	3	2	5
- Mica	tr	5	1	1	1
- Accessory	tr	tr	tr	1	tr
Matrix					
- Clay	-	20	-	10	-
- Organic matter	-	5	-	2	-
Authigenic minerals					
- Glaucony	-	7	-	-	-
- Quartz	4	-	3	-	-
- Feldspar	-	-	tr	1	2
- Kaolin	1	-	4	3	5
- Illite	tr	-	-	-	-
- Pyrite	tr	1	tr	-	-
- Carbonate	-	3	8	5	4
Porosity					
- Intergranular	22	-	10	3	-
- Dissolution	2	-	5	5	5
- Micropores	-	tr	tr	tr	1
- Fractures	3		-	-	-

TABLE 2 continued VISUAL ESTIMATE DATA

WELL	CASINO-2		CASINO-1		
Stratigraphic Unit	A	A	Ca	Ca	Ca
Depth (mRT)	1901.00	1963.00	1751.00	1769.00	1783.00
Sample	Swc 8	Swc 3	Swc 18	Swc 15	Swc 12
Lithology	litharenite	silty mudstone	sublitharenite	sublitharenite	sublitharenite
Avg GS (mm)	medium sand (~0.40)	clay	fine sand (0.15)	medium sand (0.28)	fine sand (0.22)
Sorting (phi)	mod well	v poor	poor (1.03)	mod well (0.53)	well (0.43)
Shape	SA-SR	A-SR	SA-SR	SA-SR	SR
Structures	laminae	lenses	laminae	none	laminae
	Volume percentage				
Framework grains					
- Quartz					
- monocrystalline	56	20	60	65	58
- polycrystalline	2	tr	tr	tr	1
- Feldspar	3	3	2	3	3
- Lithics					
- sedimentary	1	-	1	1	2
- metamorphic	12	3	5	5	8
- igneous	10	2	tr	-	-
- Mica	-	5	3	tr	tr
- Accessory	tr	tr	tr	tr	tr
Matrix					
- Clay	4	60	1	-	-
- Organic matter	1	-	3	-	5
Authigenic minerals					
- Glaucony	-	2	?tr	?tr	tr
- Quartz	-	-	tr	1	-
- Feldspar	-	-	-	tr	-
- Kaolin	-	-	2	5	4
- Illite	-	-	tr	-	-
- Chlorite	-	tr	-	-	-
- Pyrite	tr	tr	1	tr	tr
- Oxide	-	4	-	-	-
- Carbonate	5	-	10	5	7
Porosity					
- Intergranular	?	-	5	10	6
- Dissolution	5	-	7	4	5
- Micropores	-	-	tr	tr	tr
- Fractures	-	-	-	-	-

4.1 Casino-2, Core plug 1, Depth 1763.18m

Thin section description

Rock classification: **Quartzarenite**

Texture:

Sedimentary structures:	vague cross lamination outlined by changes in grain size & sorting
Average grain size:	coarse - medium sand boundary (0.50mm)
Range in grain size:	very fine to coarse sand
Roundness / sphericity:	angular to subangular with low sphericity
Sorting:	moderately sorted (0.84 ϕ)
Texture:	grain supported
Packing / grain contacts:	open packing/ point & tangential grain contacts
Pore types:	primary intergranular pores dominant, rare honeycomb pores in corroded feldspars, minor grain fracturing, contamination by drilling mud & possible rock flour

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with dominantly straight crystal boundaries & rarely sutured, highly corroded K-feldspars that lack twinning, sericitised feldspars & relatively fresh microcline with tartan twinning, intergrowths of corroded K-feldspar & quartz may represent granitic lithics, rare lithics of micaceous schist & chert are apparent, highly altered & bent muscovite flakes, one grain of accessory tourmaline
Authigenic minerals:	pervasive prismatic quartz overgrowths, blocky & framboidal pyrite concentrates along grain margins & rarely partially replaces grains, replacement of micas by vermiform kaolin

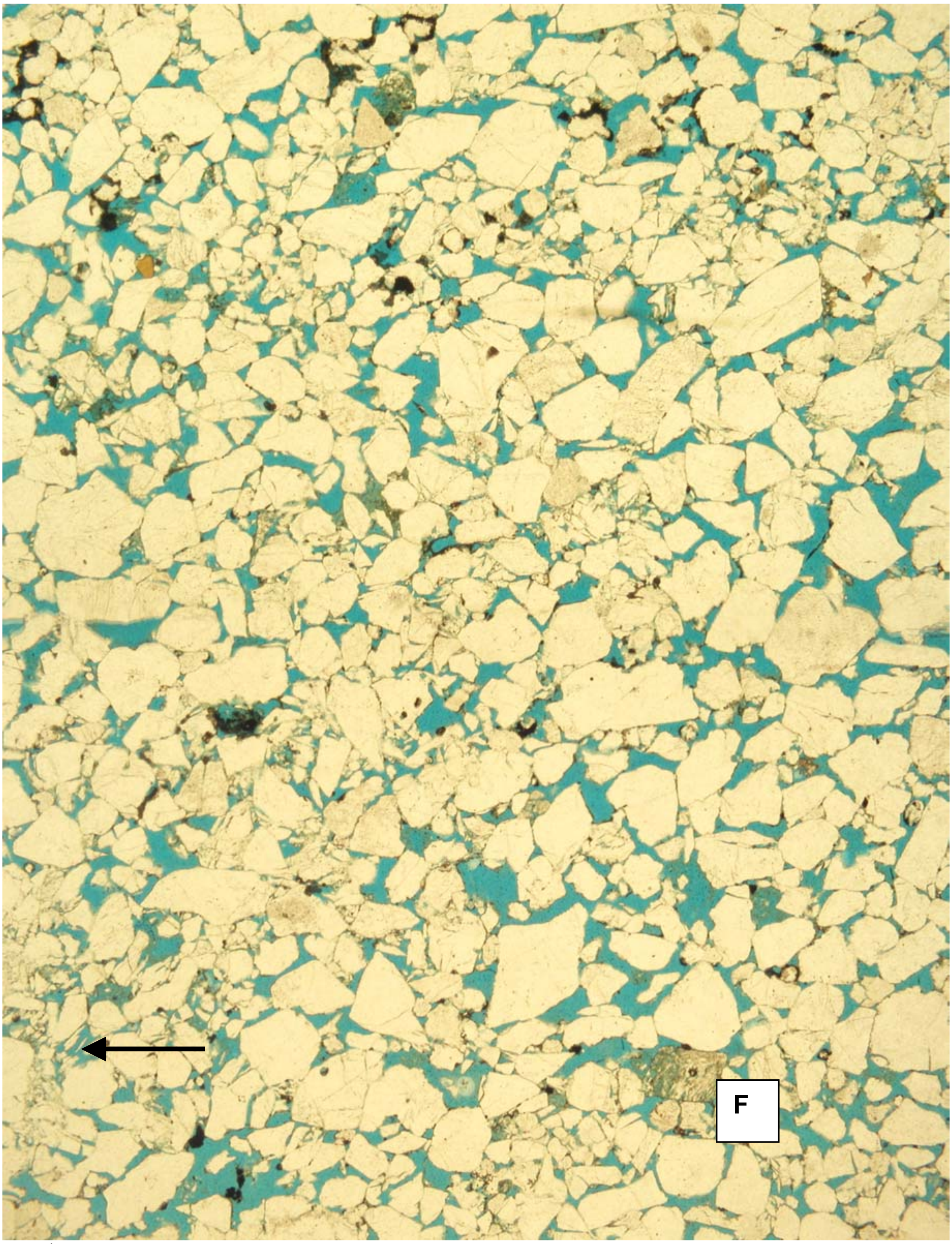


Figure 1

General view illustrating the excellent preservation of primary intergranular pores (blue) and coarse grain size. Note the dusty corroded feldspar (F) and very angular rock flour where grains appear to be crushed (arrow). Casino-2, Core plug 1, Depth 1763.18m. Plane light. Horizontal field of view 8.0 mm.

4.2 Casino-2, Core plug 10, Depth 1765.80m

Thin section description

Rock classification: **Sublitharenite**

Texture:

Sedimentary structures:	none apparent
Average grain size:	very fine sand (0.13mm)
Range in grain size:	clay to medium sand
Roundness / sphericity:	angular to subangular with low sphericity
Sorting:	moderately sorted (0.96 ϕ)
Texture:	grain supported
Packing / grain contacts:	moderately close / tangential & concavo-convex
Pore types:	primary intergranular pores, grain size dissolution pores, honeycomb pores & micropores. Deformed ductile grains could block pore throats.

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, fresh & highly corroded K-feldspars, lithics include micaceous schist, dusty chert, ?granite & numerous quartz grains with traces of illite suggestive of a metamorphic provenance, fresh & highly altered bent muscovite flakes, accessory tourmaline, rutile & zircon
Matrix:	discontinuous stringers of anhedral brown clay
Authigenic minerals:	micas & possibly other grains have been replaced by vermiform kaolin, traces of illite are associated with the kaolin, anhedral Fe rich carbonate (?siderite) spar has replaced deformed grains & single crystals are scattered throughout the section, blocky & framboidal pyrite concentrates where there are traces of detrital clay, very fine sand size green grains with a wormy texture typical of glaucony, rare euhedral terminations on quartz grains indicate syntaxial quartz overgrowths

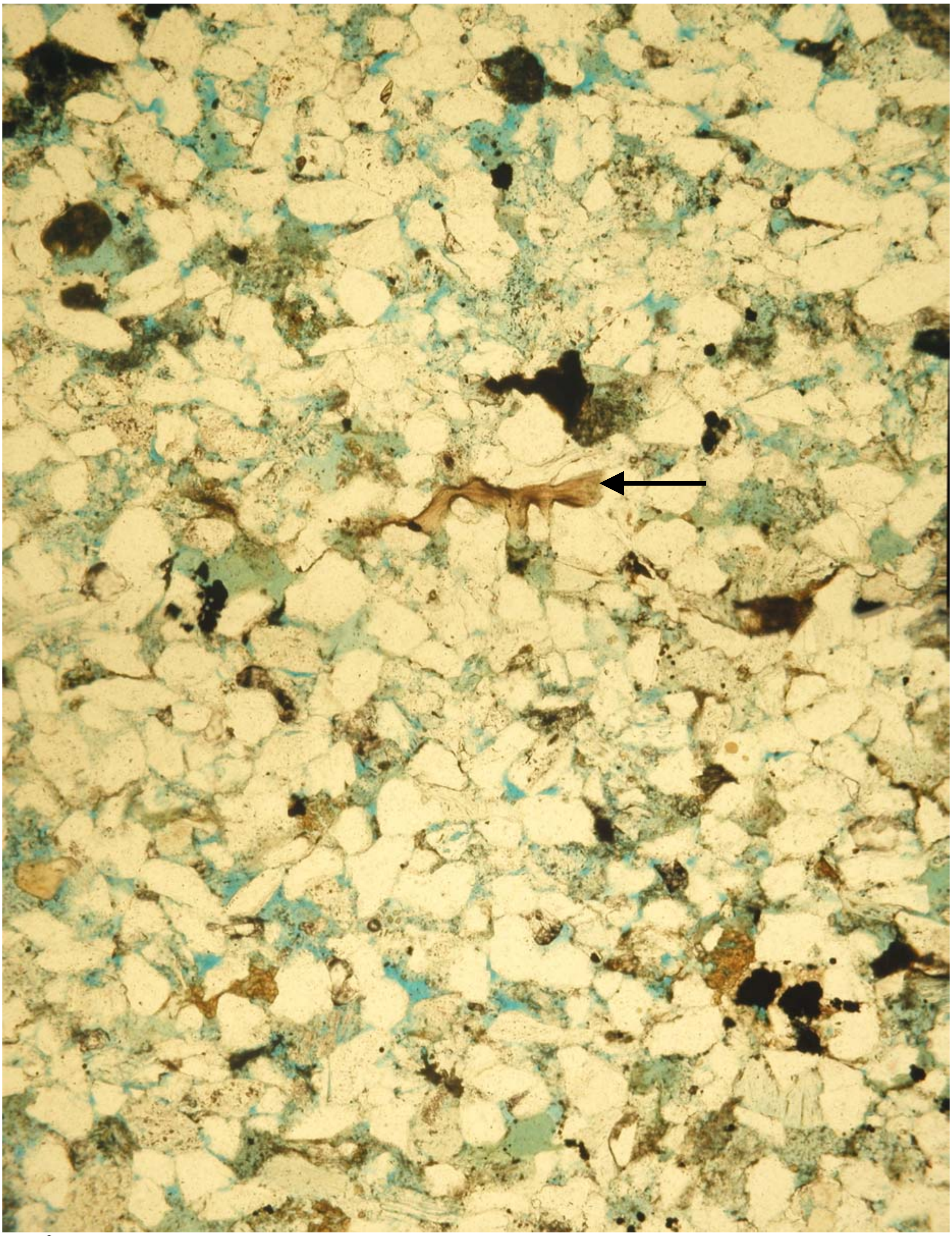


Figure 2
Porosity (blue) has been reduced by compaction and resultant deformation of ductile micas (arrow), plus patchy Fe rich microspar (orangey-brown) and pyrite (opaque) filling pores. Quartz overgrowths are evident as straight grain margins. Casino-2, Core plug 10, Depth 1765.80m. Plane light. Horizontal field of view 1.27mm.

4.3 Casino-2, Core plug 25, Depth 1772.88m

Thin section description

Rock classification: **Quartzarenite**

Texture:

Sedimentary structures:	bedding is apparent from a change in grain size and sorting, grain size is bimodal in the finer laminae, contact between beds is sharp and planar
Average grain size:	coarse sand (0.77mm)
Range in grain size:	very fine sand to granules
Roundness / sphericity:	angular to subangular with low sphericity
Sorting:	poor (1.20 phi)
Texture:	grain supported
Packing / grain contacts:	very open packing / point & tangential grain contacts
Pore types:	primary intergranular pores are dominant, honeycomb pores are evident where feldspars are corroded, intragranular pores where inclusions in quartz grains have been dissolved, minor grain fracturing

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz typically with straight crystal boundaries but rare examples have sutured crystal boundaries, highly corroded K-feldspars, rare lithics of chert, micaceous schist, granite and possibly other igneous origins, bent and altered micas, accessory zircon, rutile & tourmaline
Authigenic minerals:	grain replacing subhedral kaolin booklets are associated with traces of illite, vermiform kaolin has also replaced micas, fibrous chlorite has partially replaced an ?igneous lithic, syntaxial quartz overgrowths have a prismatic habit, rare framboidal pyrite on grain margins

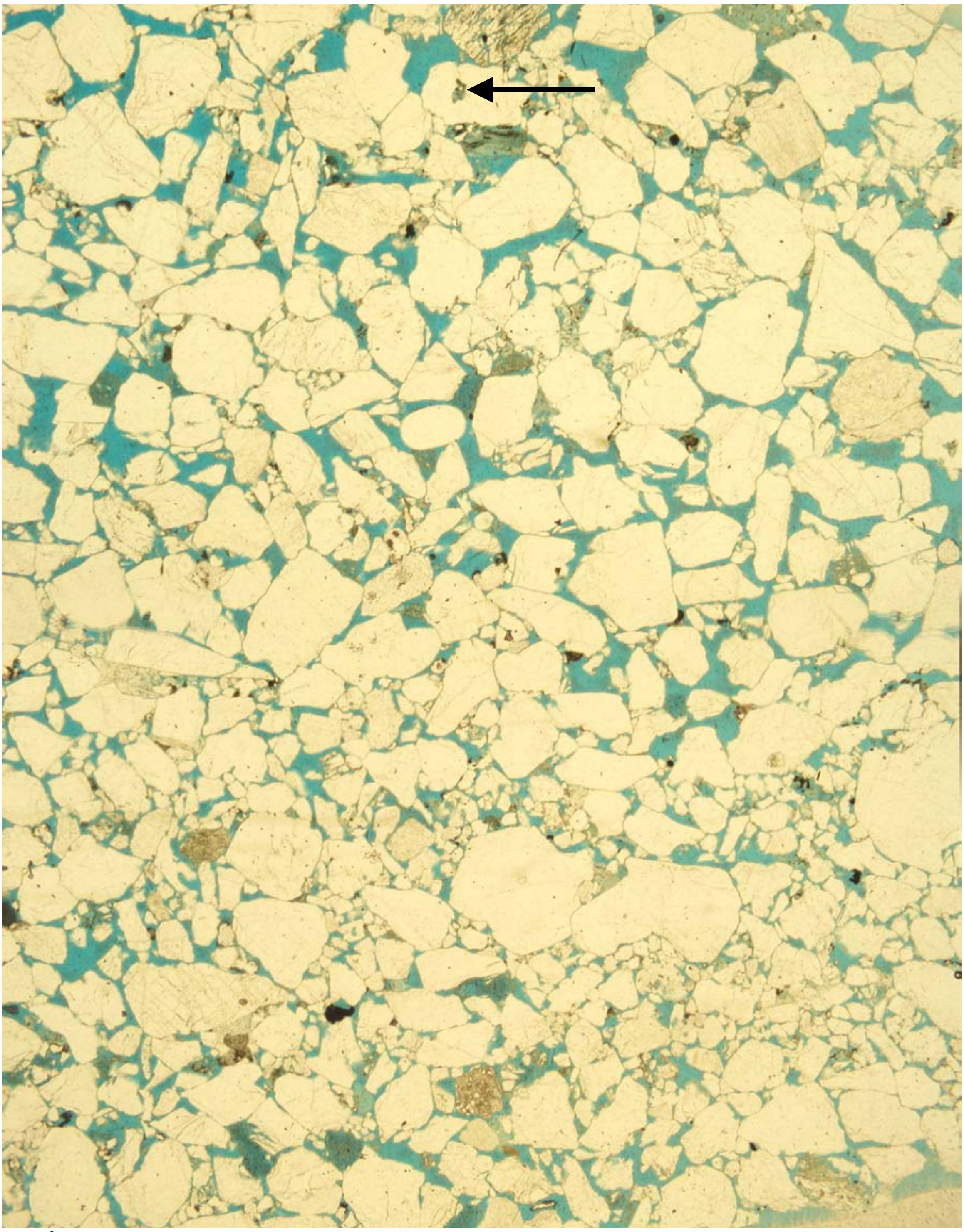


Figure 3

General field of view illustrating the contact between laminae due to a change in grain size and sorting. Note the abundance of primary intergranular pores (blue); rare intragranular pores (arrow) are also apparent. Casino-2, Core plug 25, Depth 1772.88m. Plane light. Horizontal field of view 8.00mm.

4.4 Casino-2, Core plug 30, Depth 1774.43m

Thin section description

Rock classification: **Quartzarenite**

Texture:

Sedimentary structures:	weakly defined planar laminae less than 2mm thick indicated by changes in grain size and sorting
Average grain size:	medium sand (0.49mm)
Range in grain size:	very fine to very coarse sand
Roundness / sphericity:	subangular with low to moderate sphericity
Sorting:	moderately well sorted (0.70 phi)
Texture:	grain supported
Packing / grain contacts:	open packing / point & tangential
Pore types:	dominantly primary intergranular pores, rare honeycomb pores & grain fracturing

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with dominantly straight crystal boundaries, highly corroded K-feldspars, rare lithics of chert, siltstone & possibly granite, altered muscovite flakes, accessory tourmaline & rutile
Authigenic minerals:	prismatic quartz overgrowths, blocky pore filling & grain replacing pyrite forms a localised cement, traces of micritic carbonate on grain margins & rarely filling pores, rare micas replaced by vermiform kaolin

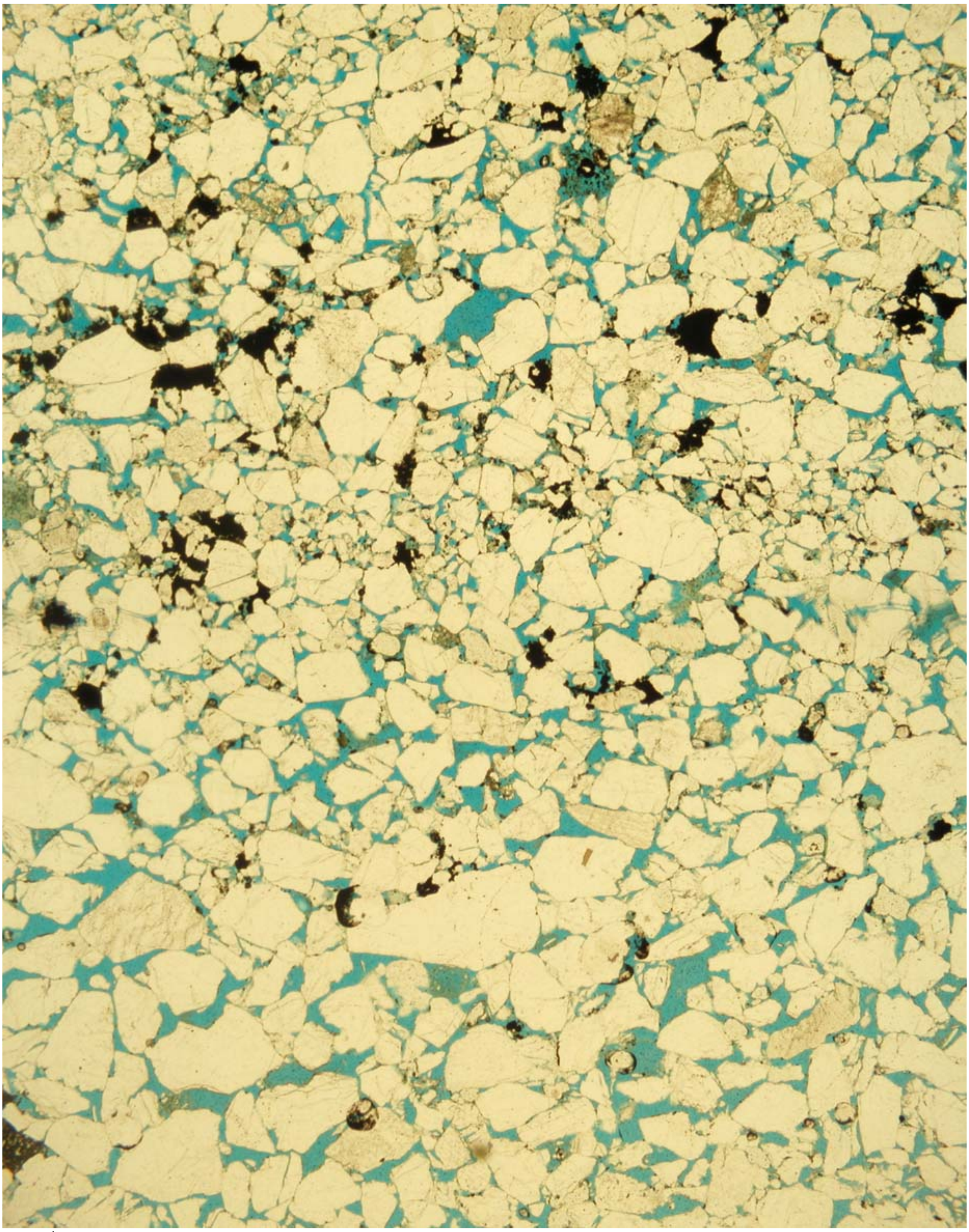


Figure 4

General field of view illustrating the presence of fine grained laminae in which there is a concentration of patchy pyrite cement (opaque). Contacts between laminae are graded and planar. Primary intergranular pores (blue) are well preserved. Casino-2, Core plug 30, Depth 1774.43m. Plane light. Horizontal field of view 8.0mm.

4.5 Casino-2, Core plug 50, Depth 1780.46m

Thin section description

Rock classification:	**Subarkose**
Texture:	
Sedimentary structures:	organic rich laminae & irregular patches of mud suggestive of bioturbation
Average grain size:	fine sand (0.21mm)
Range in grain size:	very fine to medium sand
Roundness / sphericity:	angular to subangular with low sphericity
Sorting:	well sorted (0.44 ϕ)
Texture:	grain supported
Packing / grain contacts:	open packing / point & tangential grain contacts
Pore types:	primary intergranular pores, honeycomb pores, micropores associated with kaolin
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, highly corroded K-feldspars, lithics of chert & siltstone, quartz grains with partial illitic rims probably represent metamorphic lithics, altered & bent mica flakes, accessory zircon, tourmaline & rutile
Matrix:	irregular patch of brown anhedral clay, elongate stringers of opaque & reddish (?liptinite) organic matter, minor opaque organic matter with a squashed cellular structure (?inertinite)
Authigenic minerals:	prismatic quartz overgrowths, blocky pore filling & grain replacing pyrite, pyrite has also replaced organic matter, grain replacing kaolin booklets & vermiform kaolin where micas have been replaced, patches of Fe rich micrite adjacent to the organic matter, rare green grains with wormy texture typical of glaucony

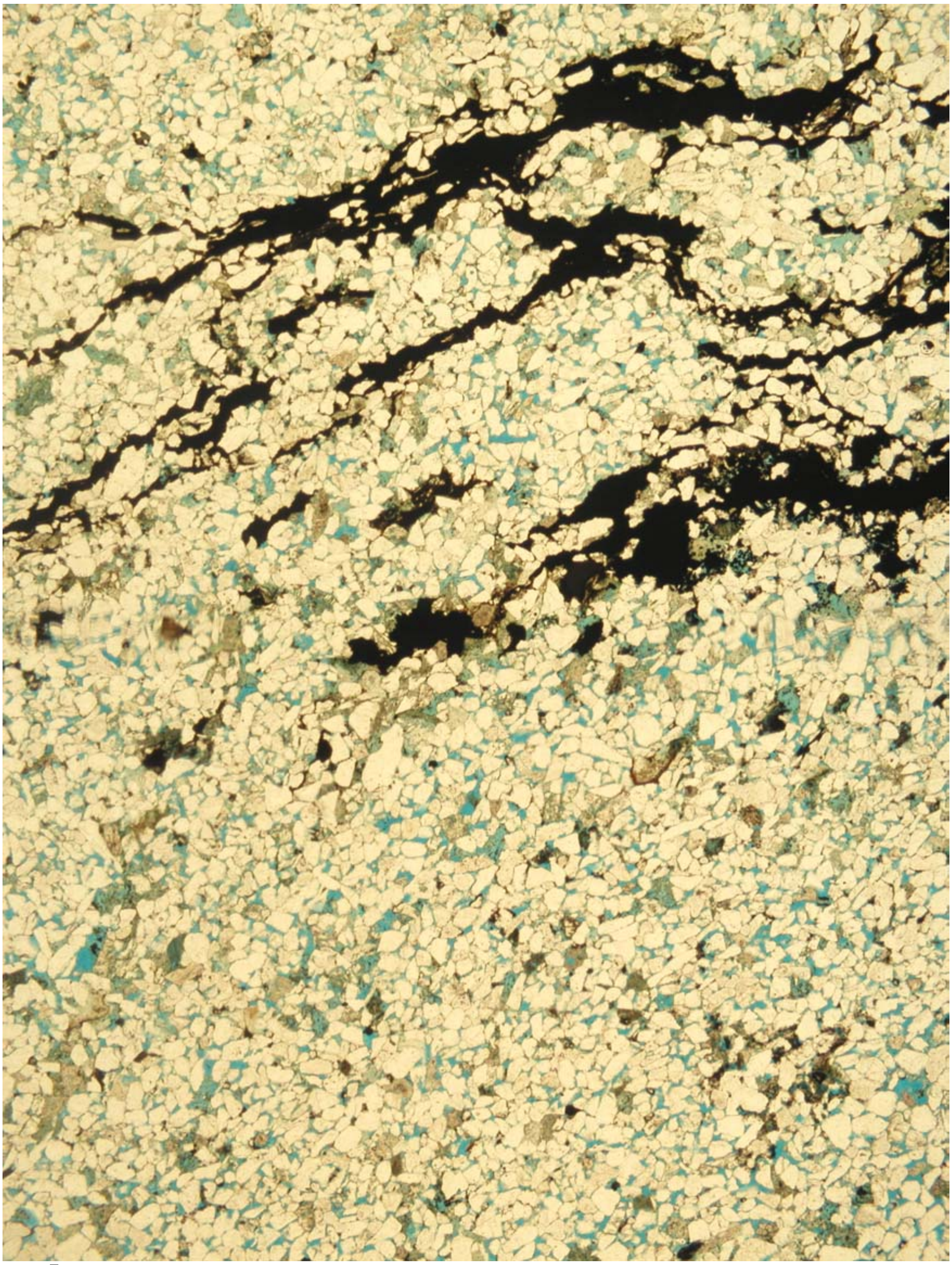


Figure 5

Discontinuous stringers of organic matter (opaque) have probably limited vertical permeability in this quartzarenite. Porosity (blue) is dominated by primary intergranular pores. Casino-2, Core plug 50, Depth 1780.46m. Plane light. Horizontal field of view 8.0mm.

4.6 Casino-2, Swc 21, Depth 1810.00m

Thin section description

Rock classification:	**Greywacke**
Texture:	
Sedimentary structures:	muddy sandstone is interbedded with mudstone, within the mudstone there are lenses of clean sand that might represent ripples or lenticular bedding, textures in the sandstone have been disrupted by sampling
Average grain size:	very fine sand (0.07mm)
Range in grain size:	clay to fine sand
Roundness / sphericity:	angular to subangular with low sphericity
Sorting:	poor (1.83 ϕ)
Texture:	grain supported sandstone/ matrix supported mudstone
Packing / grain contacts:	open packing / point contacts
Pore types:	disruption & the abundance of matrix make this assessment difficult, there could be micropores
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, fresh & altered feldspars, lithics of chert & micaceous schist, fresh & altered muscovite flakes, accessory rutile, tourmaline & zircon
Matrix:	brown anhedral clay with minor illitic laths, stringers of blocky opaque (?vitrinite/ inertinite) & reddish brown (?liptinite) organic matter
Authigenic minerals:	bright green & slightly altered grains of glaucony with a wormy texture typical of glauconite, anhedral Fe rich microspar has replaced selected grains, scattered framboidal pyrite

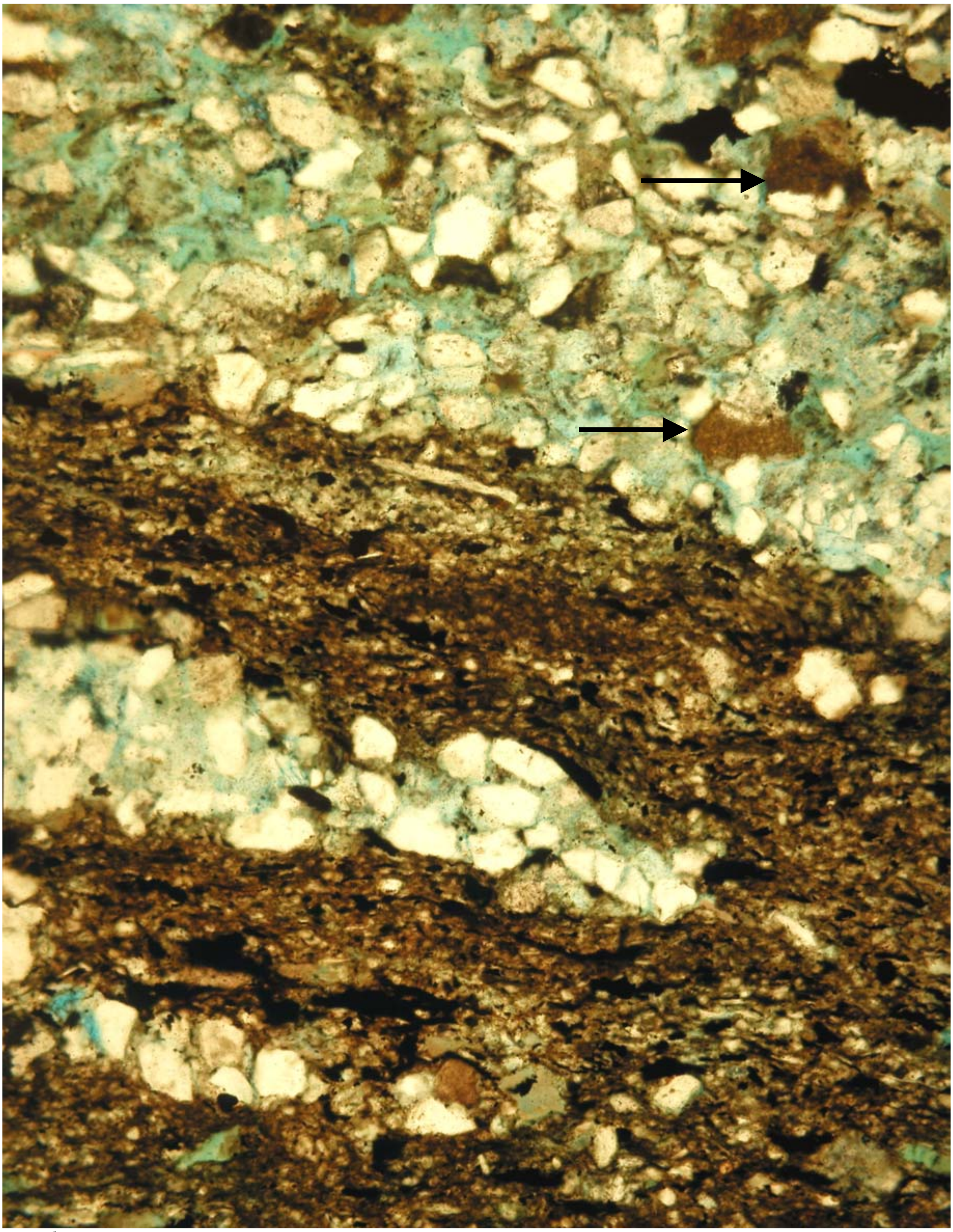


Figure 6

Contact between mudstone and muddy sandstone (greywacke) with a lens of clean sand in the mudstone. Texture in the sandstone has been disrupted and it is difficult to ascertain how much drilling mud has infiltrated into the sample. Note the grains replaced by anhedral Fe rich microspar (arrows). Casino-2, Swc 21, Depth 1810.00m. Plane light. Horizontal field of view 1.27mm.

4.7 Casino-2, Swc 17, Depth 1845.00m

Thin section description

Rock classification: **Sublitharenite**

Texture:

Sedimentary structures:	none apparent, extensive grain crushing & disruption during sampling
Average grain size:	medium sand (approx. 0.31mm)
Range in grain size:	fine to medium sand
Roundness / sphericity:	subangular to subrounded with low sphericity
Sorting:	moderately well sorted
Texture:	grain supported
Packing / grain contacts:	moderately close / tangential & concavo-convex
Pore types:	primary intergranular, honeycomb pores, grain size dissolution pores, micropores associated with kaolin

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, fresh, sericitised & highly corroded feldspars rarely with perthite & albite twinning, lithics of chalcedony, chert, micaceous schist, quartzite, silty mudstone & igneous lithics of plutonic (trachytic texture) & volcanic origin, bent & splayed altered muscovite flakes, accessory tourmaline
Authigenic minerals:	grain replacing & rimming Fe rich micrite formed prior to the spar & is trapped within quartz overgrowths, pore filling & grain replacing blocky rhombohedral carbonate spar forms a localised cement, rarely feldspars have overgrowths that lack twinning, grain replacing & pore filling subhedral kaolin booklets developed before the carbonate spar, rare framboidal pyrite

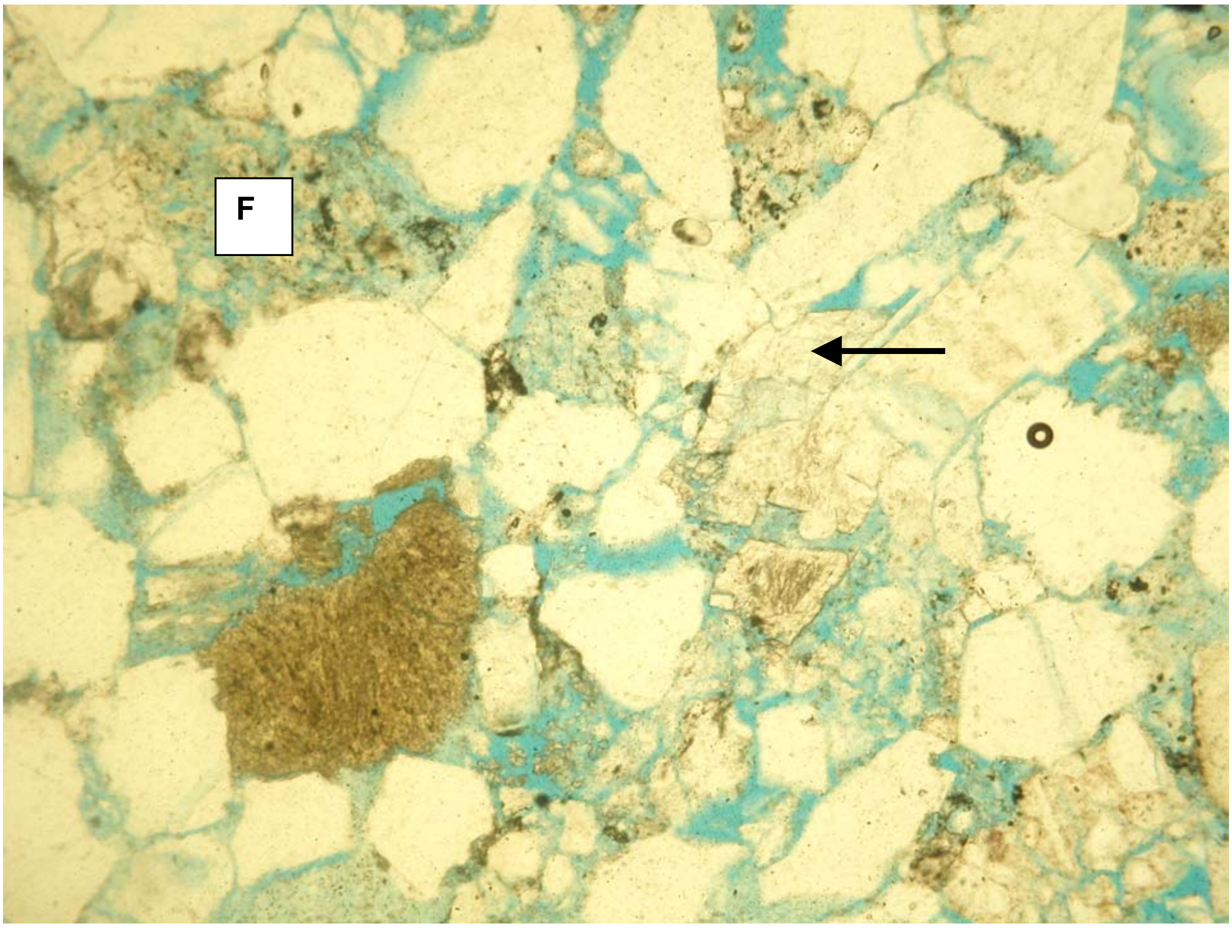


Figure 7
Grains replaced by micrite (brown) and blocky pore filling spar (arrow) are evident despite the textural disruption in this field of view. Remnants of corroded feldspar (F) are also apparent. Casino-2, Swc 17, Depth 1845m. Plane light. Horizontal field of view 1.27mm.

4.8 Casino-2, Swc 15, Depth 1857.00m

Thin section description

Rock classification:	**Sublitharenite**
Texture:	
Sedimentary structures:	planar crenulated muddy laminae have sharp contacts with the sandstone
Average grain size:	fine sand (0.23mm)
Range in grain size:	clay to coarse sand
Roundness / sphericity:	subangular to subrounded with low to moderate sphericity
Sorting:	poor (1.57 ϕ)
Texture:	grain supported sandstone
Packing / grain contacts:	moderately close packing / tangential & concavo-convex grain contacts
Pore types:	primary intergranular pores, honeycomb & grain size dissolution pores
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with either straight or sutured crystal boundaries, highly corroded & sericitised feldspars & fresh microcline with tartan twinning & plagioclase with albite twinning, other fresh feldspars lack twinning, lithics of chert, dusty chalcedony, mudstone, micaceous schist, granite & volcanics, bent fresh & altered muscovite flakes, accessory rutile, tourmaline & zircon
Matrix:	anhedral dark brown clay, stringers of opaque to dark red organic matter, silt size grains concentrated in the muddy laminae
Authigenic minerals:	Fe rich micrite has replaced selected grains, single crystals of microspar are scattered along grain margins, pore filling & grain replacing kaolin booklets, feldspar overgrowths lack twinning

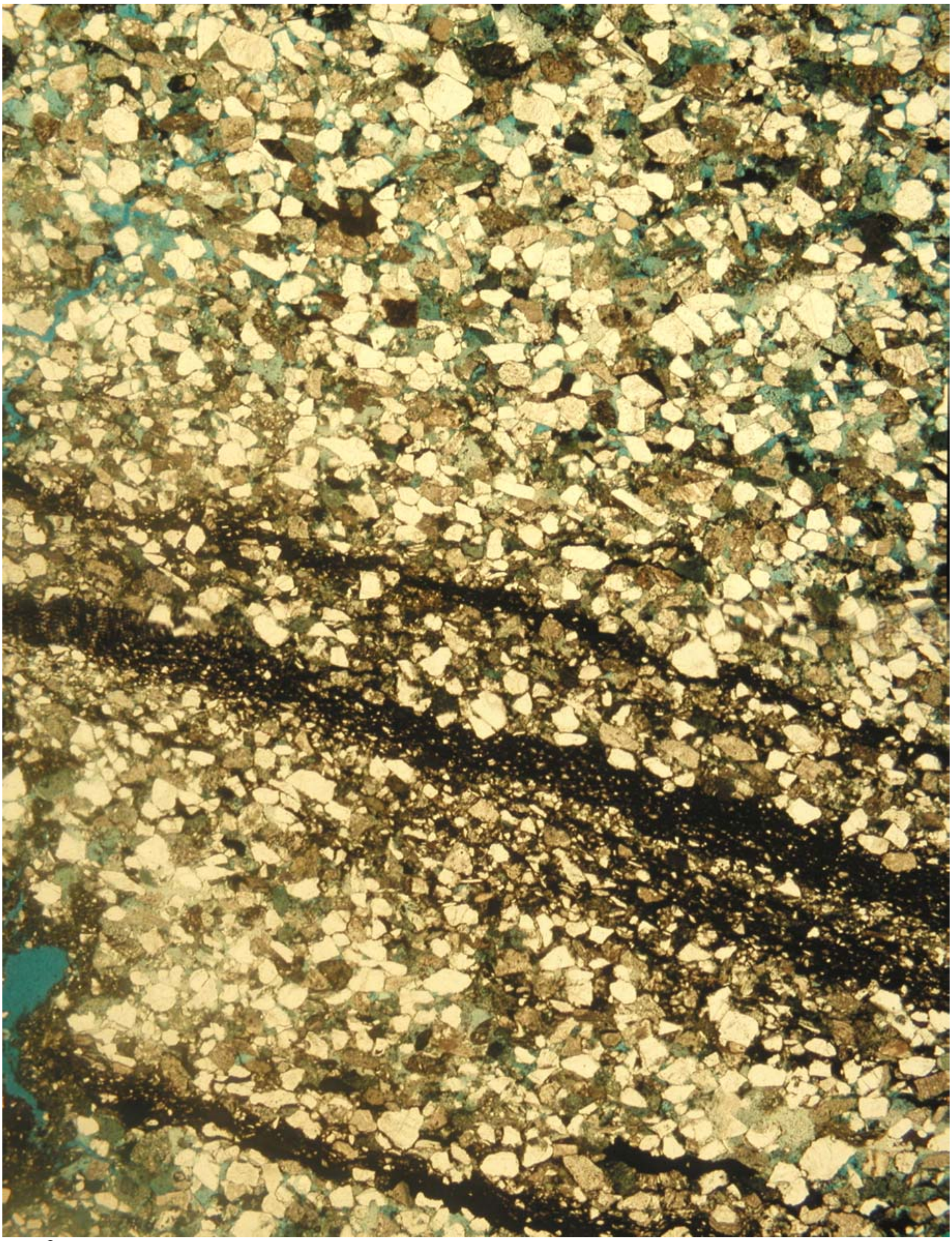


Figure 8

General view illustrating the presence of muddy laminae (dark brown) in the sublitharenite. Note the number of dusty grains which represent lithics and altered feldspars. Casino-2, Swc 15, Depth 1857.00m. Plane light. Horizontal field of view 8.00mm.

4.9 Casino-2, Swc 13, Depth 1871.00m

Thin section description

Rock classification: **Sublitharenite**

Texture:

Sedimentary structures:	none apparent, significant disruption during sampling
Average grain size:	medium sand (0.28mm)
Range in grain size:	very fine to medium sand
Roundness / sphericity:	subrounded with low to moderate sphericity
Sorting:	well sorted (0.48 ϕ)
Texture:	grain supported
Packing / grain contacts:	close packing / tangential & concavo-convex
Pore types:	honeycomb & grain size dissolution pores, micropores associated with kaolin

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz has either straight or sutured crystal boundaries, feldspars are either highly corroded or fresh & lack twinning, rare examples have perthite twins or granophyric texture, lithics of chalcedony, chert, mudstone, micaceous schist, quartzite, granite & volcanics, muscovite flakes are bent, accessory zircon, tourmaline, garnet & ?monazite
Authigenic minerals:	grain replacing & pore filling blocky Fe rich carbonate spar, clear pore filling spar suggests a second phase of carbonate, discontinuous feldspar overgrowths lack twinning & are rarely prismatic, grain replacing kaolin booklets have been squeezed into adjacent pores

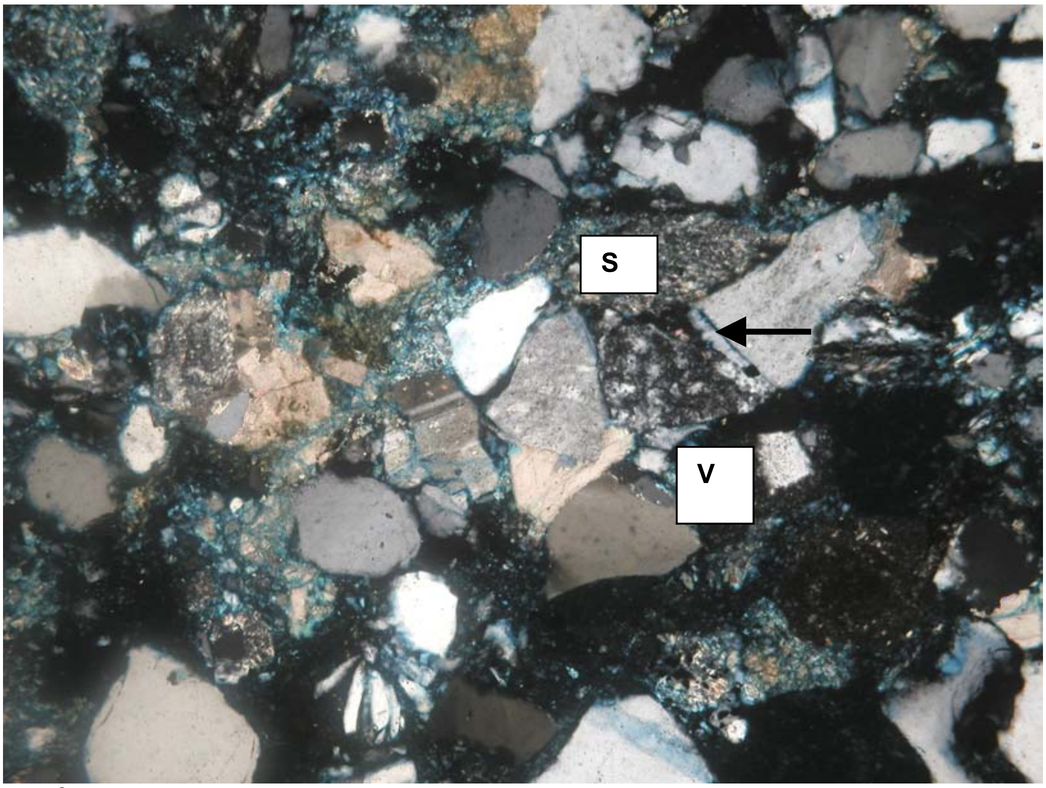


Figure 9a

A volcanic lithic (V) comprised of a feldspar phenocryst in a very fine groundmass, a fragment of micaceous schist (S) and other highly altered metamorphic lithics are evident in this field of view. In addition, there are feldspar overgrowths (arrow) and pore filling carbonate spar (cream) apparent. Casino-2, Swc 13, Depth 1871.00m. Crossed nicols. Horizontal field of view 1.27mm.

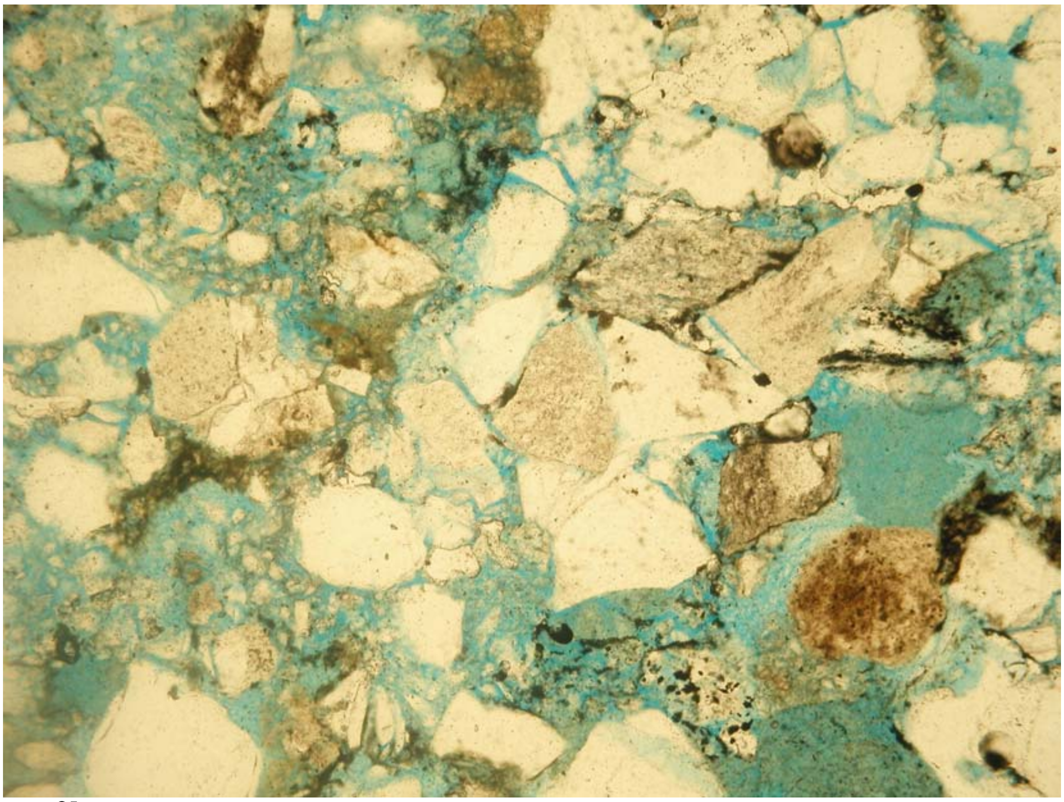


Figure 9b

Same field of view as Figure 9a illustrating the textural disruption during sampling. Casino-2, Swc 13, Depth 1871.00m. Plane light. Horizontal field of view 1.27mm.

4.10 Casino-2, Swc 12, Depth 1880.50m

Thin section description

Rock classification:	**Carbonate cemented litharenite**
Texture:	
Sedimentary structures:	weak grain alignment may indicate the orientation of bedding
Average grain size:	medium sand (0.27mm)
Range in grain size:	very fine to coarse sand
Roundness / sphericity:	subangular to subrounded / low to moderate sphericity
Sorting:	well sorted (0.42 ϕ)
Texture:	cement supported
Packing / grain contacts:	moderately open grain packing / point & tangential grain contacts
Pore types:	grain size & honeycomb dissolution pores, shrinkage associated with ?glaucony, micropores associated with kaolin
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with either straight or sutured crystal boundaries, feldspars are typically either relatively fresh & lack twinning, or highly corroded, rare examples with albite & tartan twinning are sericitised, lithics of chert, chalcedony, mudstone, shale, micaceous schist, quartzite & volcanics, muscovite flakes, accessory rutile
Authigenic minerals:	grain replacing & lesser amounts of pore filling Fe rich anhedral micrite & microspar has a patchy distribution, pervasive pore filling & grain replacing clear poikilotopic twinned carbonate spar, remnants of quartz overgrowths prior to spar, bright green grains with a fibrous habit, pore filling & grain replacing kaolin with traces of illite intermixed, rare pyrite framboids

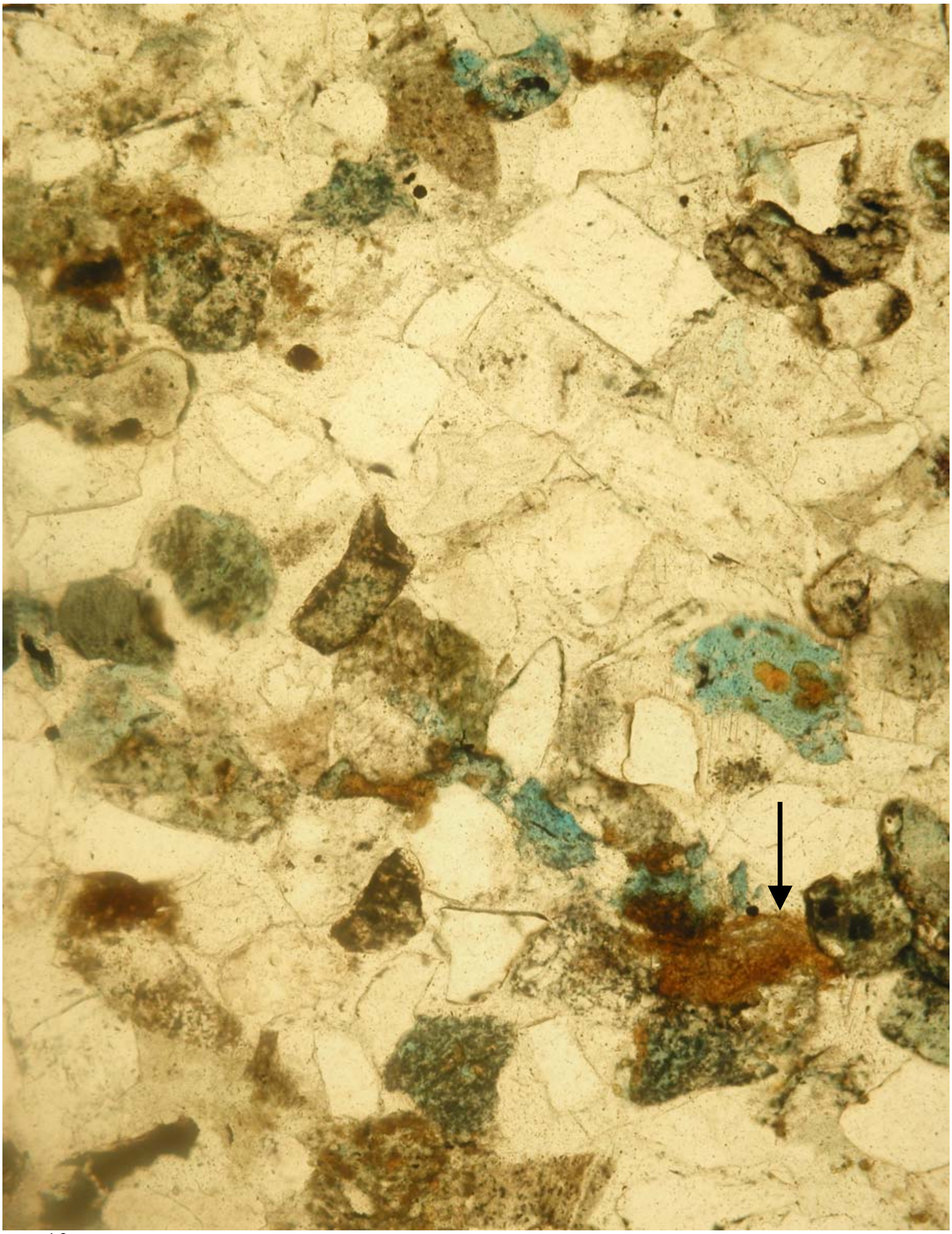


Figure 10
Secondary dissolution pores (blue) are the only type of macropores in this carbonate cemented sublitharenite. Dusty grains are comprised of lithics and feldspars, whilst the clear grains are quartz. Note the selective replacement of grains by Fe rich micrite (arrow). Casino-2, Swc 12, Depth 1880.50m. Plane light. Horizontal field of view 1.27mm.

4.11 Casino-2, Swc 8, Depth 1901.00m

Thin section description

Rock classification:	**Litharenite**
Texture:	
Sedimentary structures:	texture is highly disrupted but there are remnants of a crenulated muddy laminae
Average grain size:	medium sand (~ 0.40mm)
Range in grain size:	silt to coarse sand
Roundness / sphericity:	subangular to subrounded with low to moderate sphericity
Sorting:	moderately well
Texture:	grain supported
Packing / grain contacts:	?moderately close / tangential & concavo-convex grain contacts
Pore types:	honeycomb pores & possible grain size dissolution pores but other types are too disturbed to describe
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, feldspars are in various stages of alteration from highly corroded to sericitised, rare examples have albite twinning, lithics include chert, quartzite, shale, granite & volcanics, accessory tourmaline
Matrix:	muddy laminae are comprised of anhedral brown clay & illitic laths, silt size quartz grains & discontinuous stringers of opaque organic matter
Authigenic minerals:	traces of Fe rich micrite replacing grains & localised patches of Fe rich spar fill pores, blocky pyrite

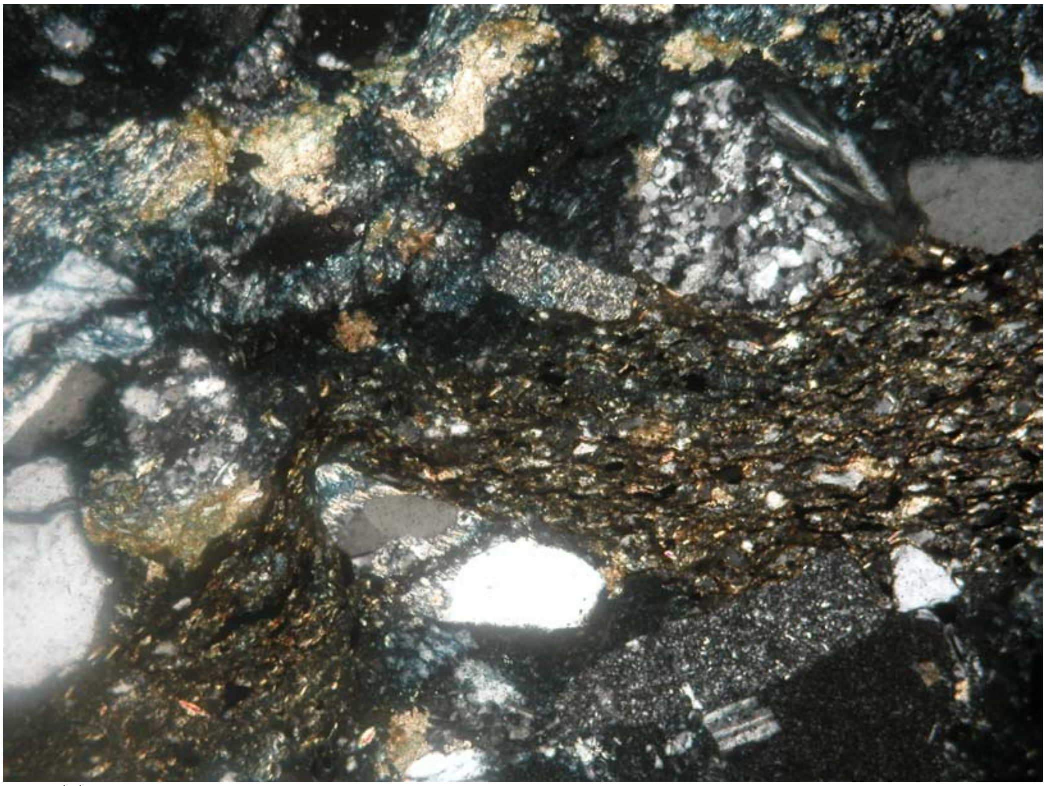


Figure 11a

Contact between muddy laminae & highly disrupted sublitharenite. Selected grains have been partially replaced by carbonate (cream), others are composed of polycrystalline quartz, micaceous schist & volcanics. Casino-2, Swc 8, Depth 1901.00m. Crossed nicols. Horizontal field of view 1.27mm.

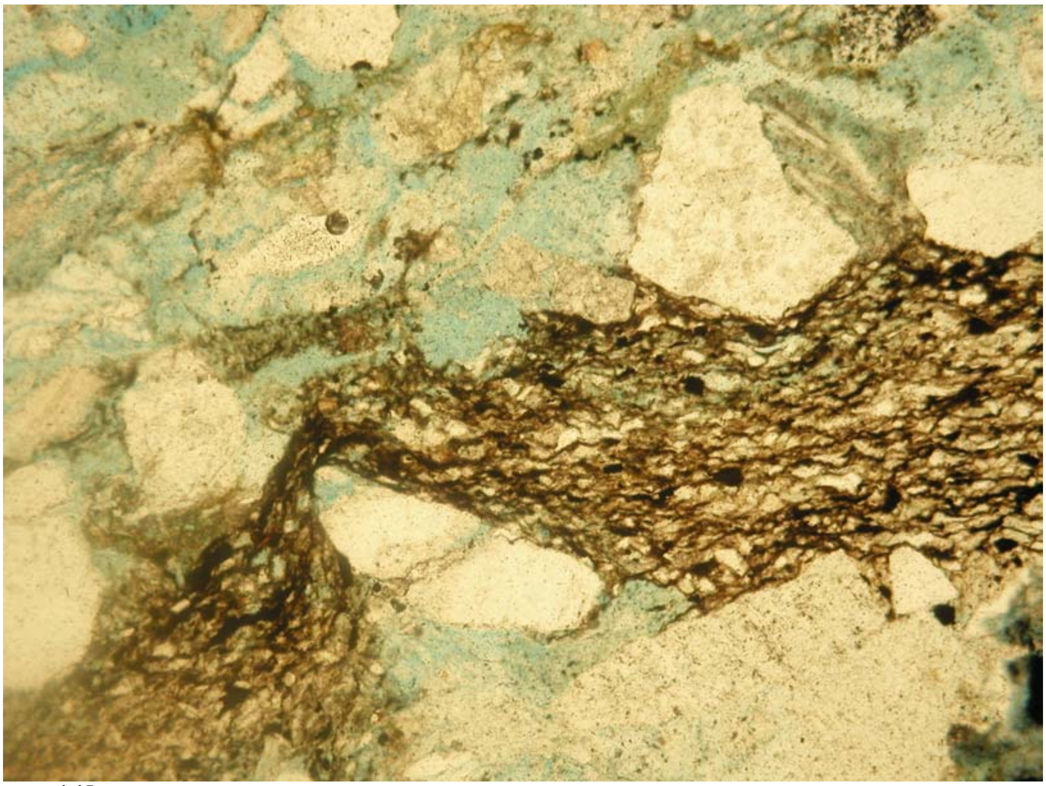


Figure 11b

Same field of view as Figure 11a showing the crenulated nature of the muddy laminae (brown) & the disrupted texture in the sublitharenite. Casino-2, Swc 8, Depth 1901.00m. Plane light. Horizontal field of view 1.27mm.

4.12 Casino-2, Swc 7, Depth 1917.00m

Thin section description

Rock classification: **Carbonate cemented litharenite**

Texture:

Sedimentary structures:	weak grain alignment indicates the orientation of bedding
Average grain size:	fine sand (0.22mm)
Range in grain size:	very fine to medium sand
Roundness / sphericity:	subrounded with low to moderate sphericity
Sorting:	well (0.44 ϕ)
Texture:	cement supported
Packing / grain contacts:	moderately open packing / point & tangential grain contacts
Pore types:	grain size dissolution pores & honeycomb pores

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with either straight or sutured crystal boundaries, fresh & highly corroded feldspars with tartan & albite twinning, lithics of chert, chalcedony, mudstone, micaceous schist, quartzite, shale & various types of volcanics, rare muscovite & biotite flakes, accessory opaques & rutile
Authigenic minerals:	grains replaced & partially rimmed by Fe rich anhedral micrite, rarely Fe rich carbonate is zoned & occurs as nodules up to 0.2mm in diameter, pervasive pore filling clear, twinned poikilotopic carbonate spar, this spar also partially replaces feldspars & lithics, grain replacing minute kaolin booklets, rare framboidal & blocky pyrite, rare partially oxidised very bright green grains of fibrous ?chlorite, many framework grains have thin oxidised rims & are partially replaced by oxide

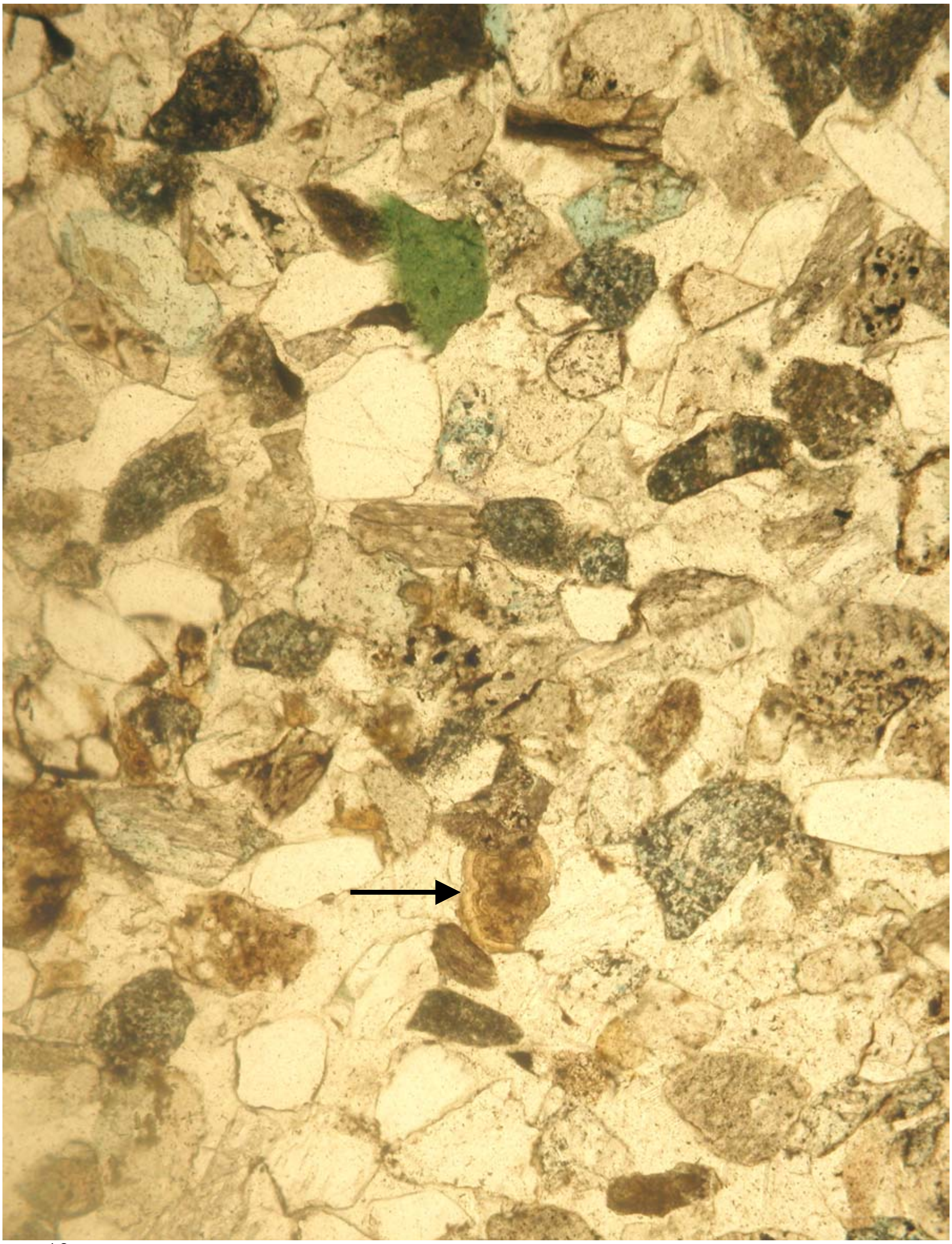


Figure 12
Zonation is apparent in the Fe rich carbonate ?nodule (arrow) in this field of view. Porosity is limited to secondary dissolution pores (blue). The very bright green grain has not been positively identified but it is thought to be chlorite. Casino-2, Swc 7, Depth 1917.00m. Plane light. Horizontal field of view 1.27mm.

4.13 Casino-2, Swc 3, Depth 1963.00m

Thin section description

Rock classification: **Silty mudstone**

Texture:

Sedimentary structures:	lenses of mudstone, texture disrupted during sampling
Average grain size:	clay
Range in grain size:	clay to fine sand
Roundness / sphericity:	angular to subrounded with low sphericity
Sorting:	very poor
Texture:	matrix supported
Packing / grain contacts:	open packing / rare point contacts
Pore types:	none apparent

Composition:

Framework grains:	monocrystalline quartz, rare polycrystalline quartz with straight crystal boundaries, zoned & twinned fresh feldspars, lithics of quartzite, micaceous schist & volcanics, muscovite flakes, oxidised & fresh biotite, accessory zircon, opaques & rutile
Matrix:	illitic pale brown to greenish clay
Authigenic minerals:	very bright green grains of ?glaucony, rare framboidal pyrite, rounded oxidised grains of unknown origin, rare grains replaced by spherules of fibrous chlorite

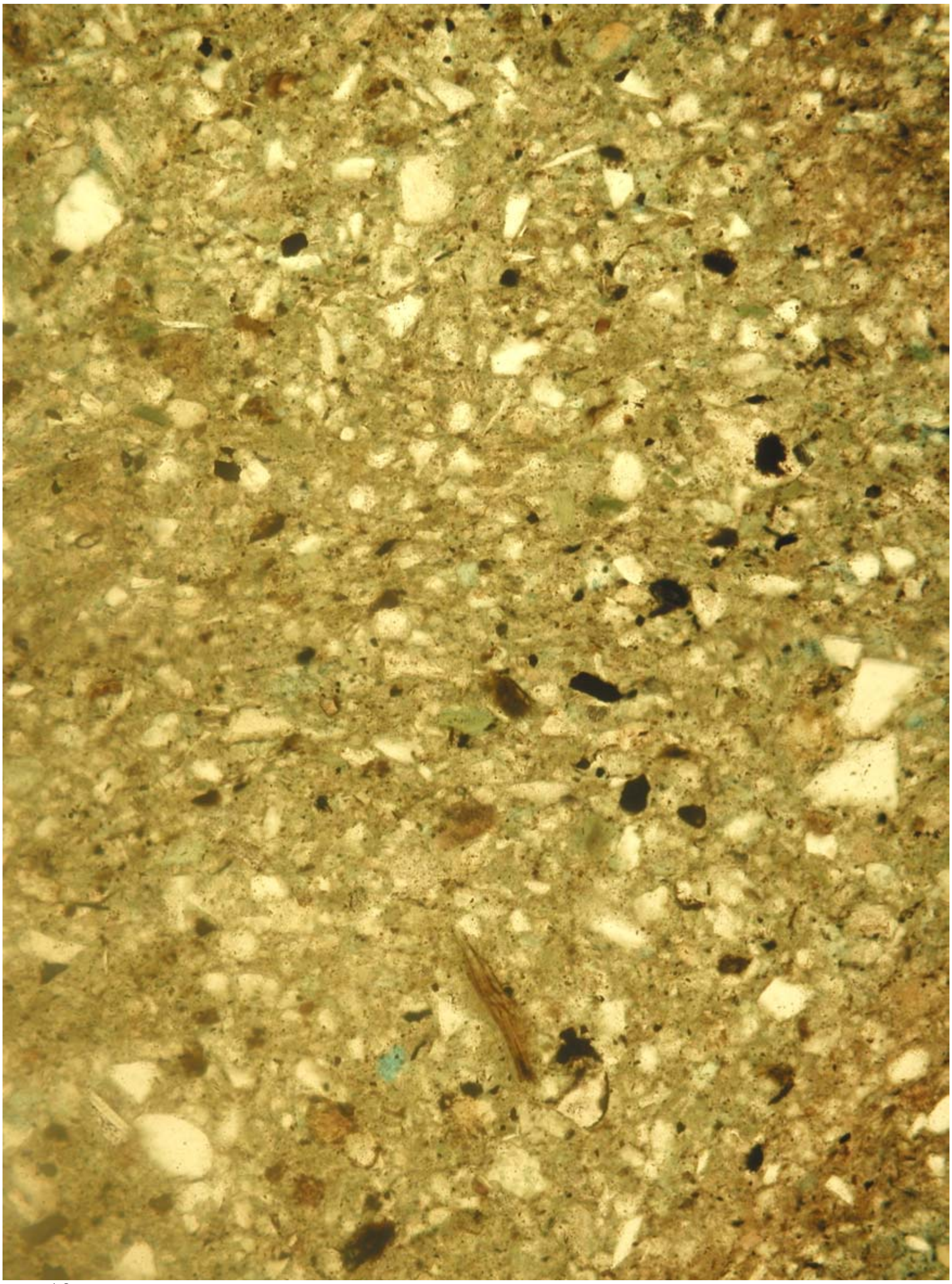


Figure 13

General field of view illustrating the silty nature of the mudstone. Note the elongate altered biotite flake, abundance of opaque grains & fine sand size grains of feldspar & quartz. Casino-2, Swc 3, Depth 1963.00m. Plane light. Horizontal field of view 1.27mm.

4.14 Casino-1, Swc 18, Depth 1751.00m

Thin section description

Rock classification:	**Sublitharenite**
Texture:	
Sedimentary structures:	laminae indicated by the concentration of organic matter & Fe rich carbonate, general texture disrupted
Average grain size:	fine sand (0.15mm)
Range in grain size:	clay to medium sand
Roundness / sphericity:	subangular to subrounded with low sphericity
Sorting:	poor (1.03 ϕ)
Texture:	grain supported
Packing / grain contacts:	?open packing / point & tangential grain contacts, but sutured adjacent to organic matter
Pore types:	primary intergranular pores, grain size dissolution pores, honeycomb pores, micropores associated with kaolin
Composition:	
Framework grains:	monocrystalline quartz, polycrystalline quartz with straight crystal boundaries, highly corroded feldspars lack twinning, lithics include chert, chalcedony, mudstone, micaceous schist, shale, quartzite & volcanics, fresh/altered bent & straight muscovite flakes, accessory minerals of zircon, tourmaline & rutile
Matrix:	large structureless fragments of opaque organic matter (?vitrinite), fragments in which the cell structure has been broken (?inertinite) & reddish stringers of organic matter (?liptinite), crenulated stringers of brown anhedral clay
Authigenic minerals:	rare framboidal pyrite, blocky pyrite forms a localised cement & appears to have replaced Fe rich carbonate, selected grains have been replaced by Fe rich micrite, rare subhedral microspar on pore margins has a dusty core, clear blocky spar has filled pores in localised patches, micas & other grains have been replaced by kaolin & traces of illite, very bright green grains of uncertain origin, rare quartz overgrowths

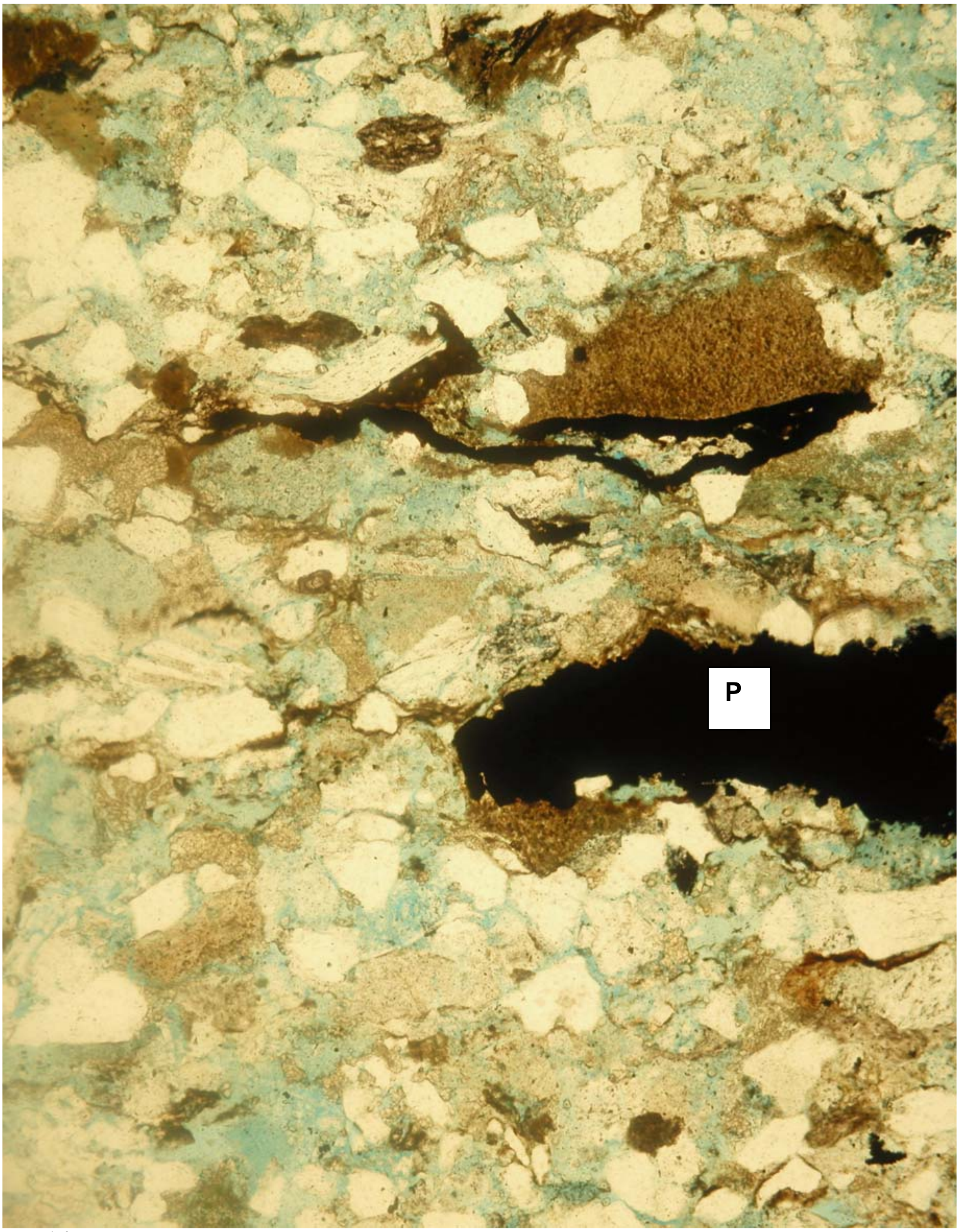


Figure 14
Blocky pyrite (P) cement postdates Fe rich micrite (reddish-brown) in this fine grained sublitharenite. Much of the apparent porosity(blue) in this field of view is due to disruption during sampling. Casino-1, Swc 18, Depth 1751.00m. Plane light. Horizontal field of view 1.27mm.

4.15 Casino-1, Swc 15, Depth 1769.00m

Thin section description

Rock classification: **Sublitharenite**

Texture:

Sedimentary structures:	none apparent
Average grain size:	medium (0.28mm)
Range in grain size:	very fine to very coarse sand
Roundness / sphericity:	subangular to subrounded with low to moderate sphericity
Sorting:	moderately well (0.53 ϕ)
Texture:	grain supported
Packing / grain contacts:	moderately open / point & tangential
Pore types:	primary intergranular pores, grain size dissolution pores, honeycomb pores & micropores associated with kaolin

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with either straight or sutured crystal boundaries, feldspars are corroded & typically lack twinning, very rare examples are fresh with tartan twinning, lithics of chert, mudstone, shale & micaceous schist, rare muscovite flakes, accessory tourmaline, zircon & rutile
Authigenic minerals:	very bright green deformed grains of ?glaucony, Fe rich carbonate has replaced selected grains & rarely fills pores, grain replacing kaolin booklets, prismatic quartz overgrowths, rare feldspar overgrowths lack twinning, blocky pore filling & grain replacing pyrite

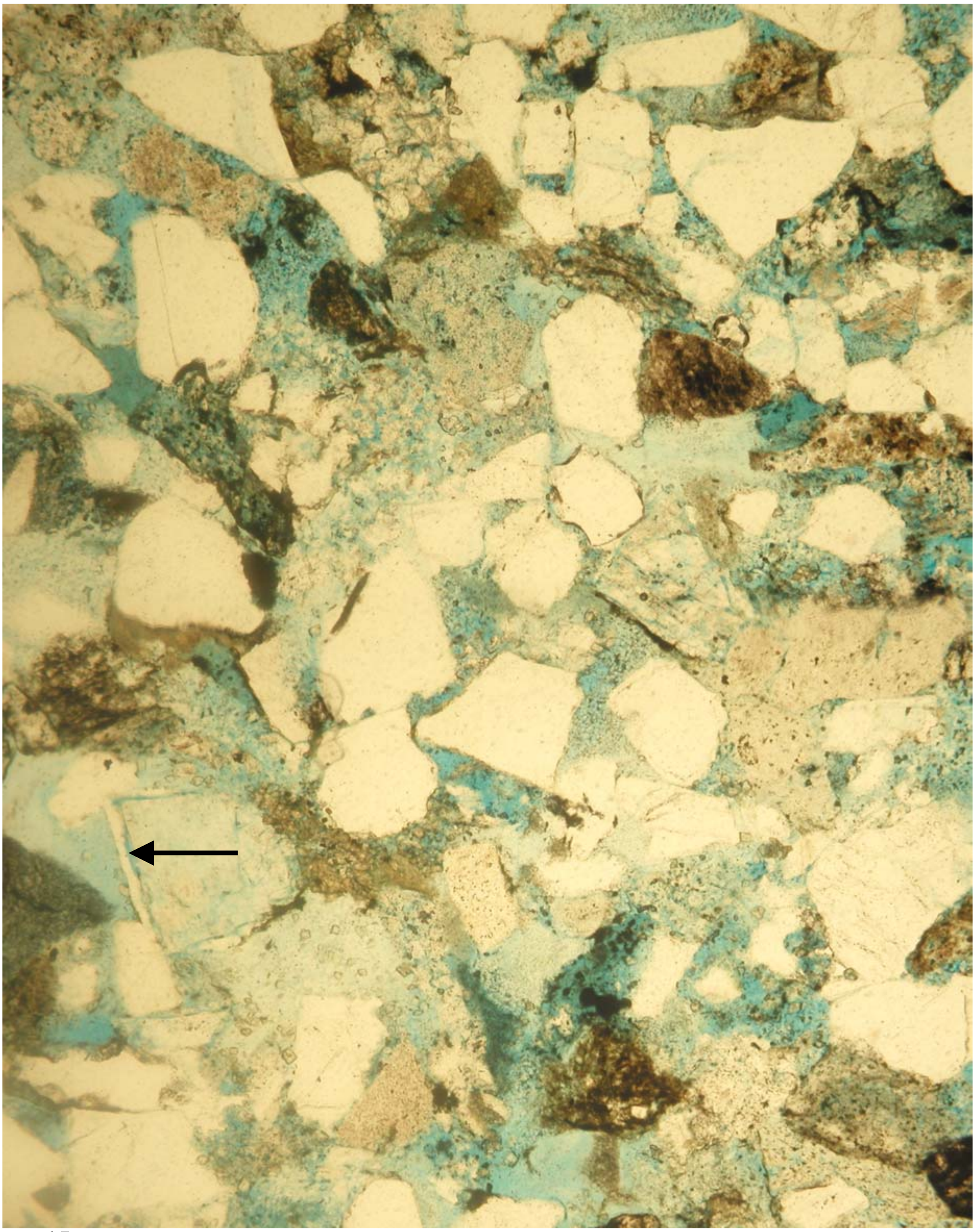


Figure 15

A feldspar overgrowth (arrow) is apparent in this field of view. Most of the other feldspars have been corroded to produce honeycomb pores. Minor pore filling carbonate microspar is evident on the RHS of the feldspar with an overgrowth. Casino-1, Swc 15, Depth 1769.00m. Plane light. Horizontal field of view 1.27mm.

4.16 Casino-1, Swc 12, Depth 1783.00m

Thin section description

Rock classification: **Sublitharenite**

Texture:

Sedimentary structures:	laminae outlined by organic matter
Average grain size:	fine sand (0.22mm)
Range in grain size:	very fine to medium sand
Roundness / sphericity:	subrounded with low to moderate sphericity
Sorting:	well sorted (0.43 ϕ)
Texture:	grain supported
Packing / grain contacts:	difficult to ascertain due to disruption, possibly moderately open
Pore types:	primary intergranular pores, honeycomb pores, micropores associated with kaolin

Composition:

Framework grains:	monocrystalline quartz, polycrystalline quartz with either straight or sutured crystal boundaries, corroded feldspars & fresh feldspars with tartan twinning, lithics include chert, mudstone, shale, micaceous schist & quartzite, fresh muscovite flakes, accessory zircon, tourmaline, rutile & ?monazite
Matrix:	organic matter is typically blocky & opaque (?vitrinite/inertinite), rarely cellular structures are retained & there is one example of serrated orangey-red cutinite
Authigenic minerals:	grain replacing & pore filling Fe rich micrite, traces of pore filling clear spar, grain replacing kaolin booklets & verms, rare very bright green grains with wormy texture typical of glaucony, framboidal pyrite

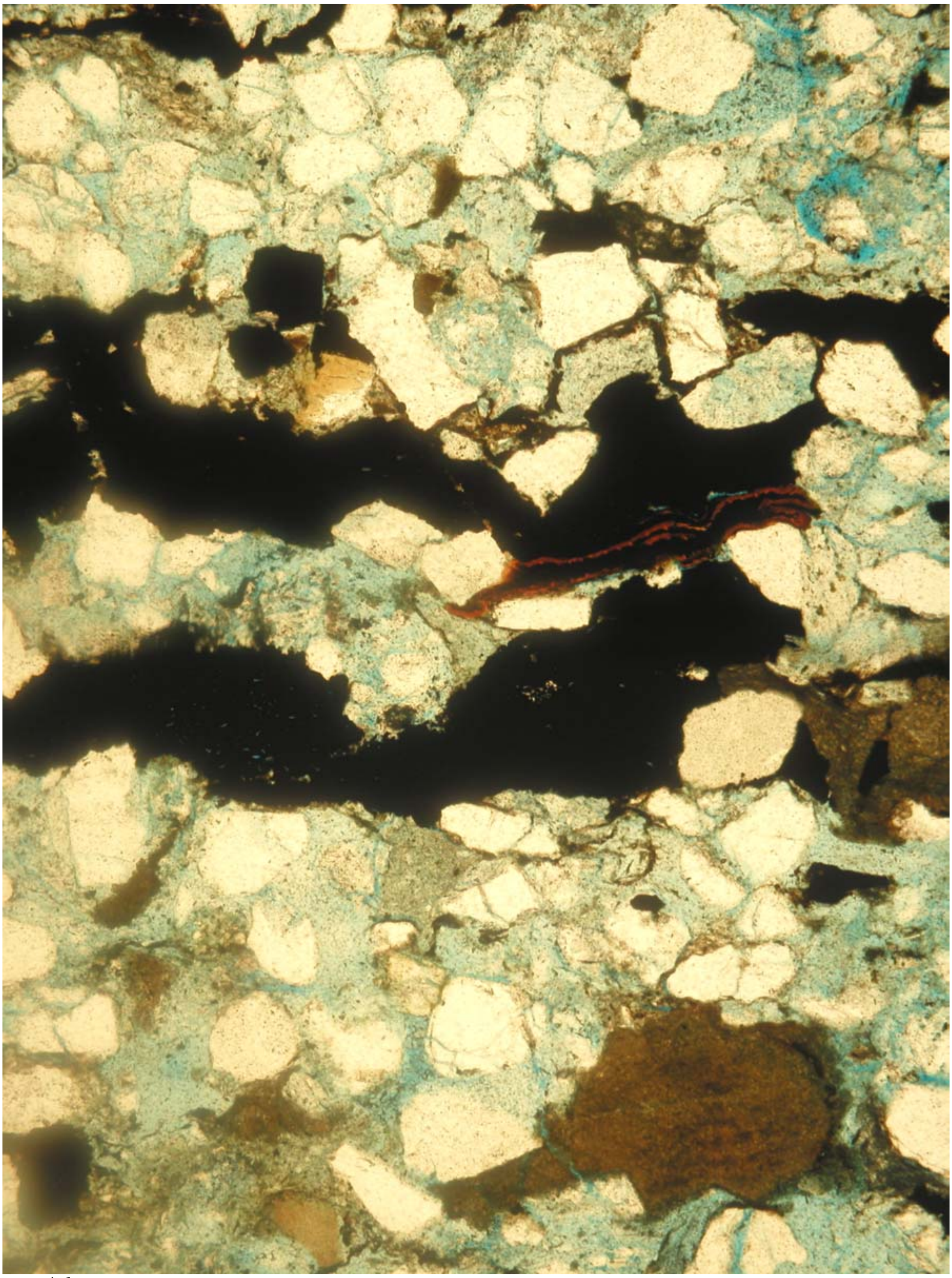


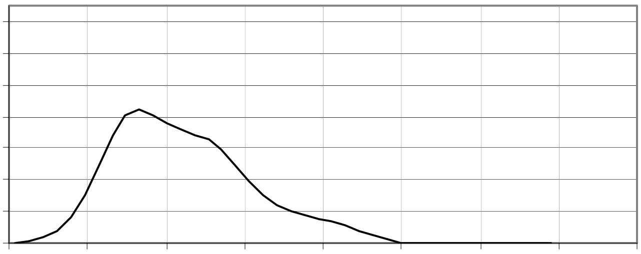
Figure 16

Dusty patches of Fe rich micrite are associated with the laminae in which organic matter (opaque) is concentrated. Note the serrated edge on the cutinite (reddish). Elsewhere texture has been disrupted during sampling. Casino-1, Swc 12, Depth 1783.00m. Plane light. Horizontal field of view 1.27mm.

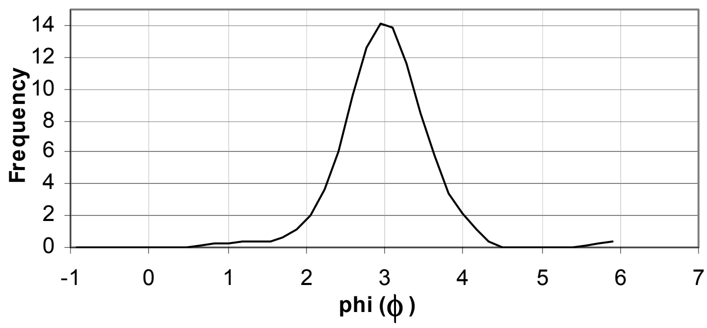
5. GRAIN SIZE ANALYSES

Thin Section Statistics / **Frequency Distribution**

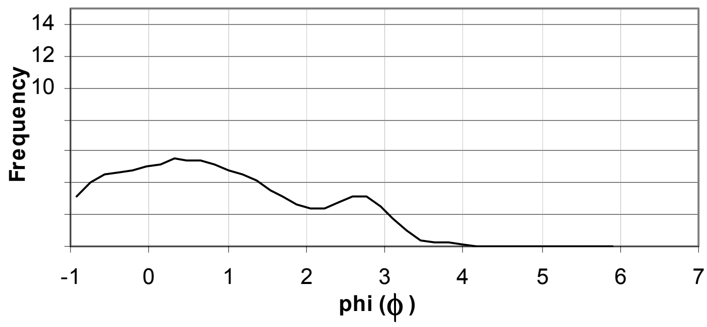
Casino-2:	**Cp 1**	
Depth (mRT)	**1763.18**	
Parameter	mm	ϕ
Mean	0.50 medium sand	1.22
Mode	0.62 coarse sand	0.68
Range: min	0.09	3.47
max	1.24	-0.31
Standard Deviation	0.25 moderately sorted	0.84



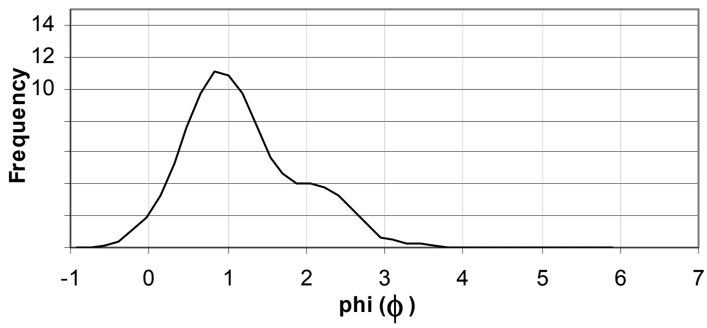
Casino-2:	**Cp 10**	
Depth (mRT)	**1765.80**	
Parameter	mm	ϕ
Mean	0.13 very fine sand	3.12
Mode	0.12 very fine sand	3.01
Range: min	0.002	8.97
max	0.50	1.00
Standard Deviation	0.06 moderately sorted	0.96



Casino-2:	**Cp 25**	
Depth (mRT)	**1772.88**	
Parameter	mm	ϕ
Mean	0.77 coarse sand	0.82
Mode	0.77 coarse sand	0.38
Range: min	0.08	3.64
max	3.15	-1.66
Standard Deviation	0.58 poorly sorted	1.20

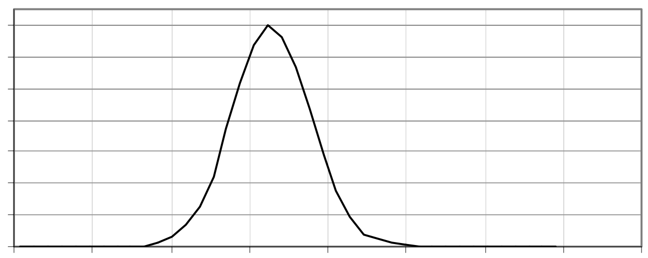


Casino-2:	**Cp 30**	
Depth (mRT)	**1774.43**	
Parameter	mm	ϕ
Mean	0.49 medium sand	1.19
Mode	0.53 coarse sand	0.91
Range: min	0.10	3.32
max	1.05	-0.07
Standard Deviation	0.21 moderately well sorted	0.70

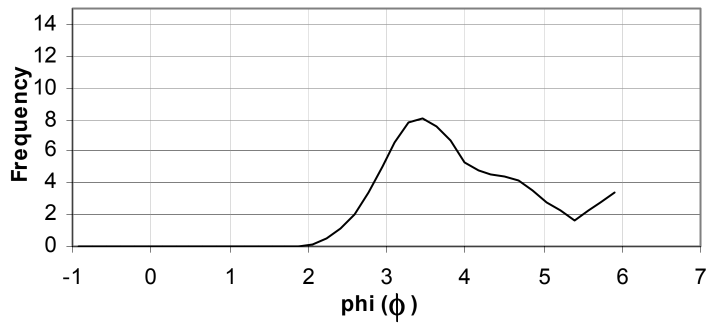


Thin Section Statistics		
Casino-2:	**Cp 50**	
Depth (mRT)	**1780.46**	
Parameter	mm	ϕ
Mean	0.21 fine sand	2.29
Mode	0.21 fine sand	2.27
Range: min	0.08	3.64
max	0.42	1.25
Standard Deviation	0.07 well sorted	0.44

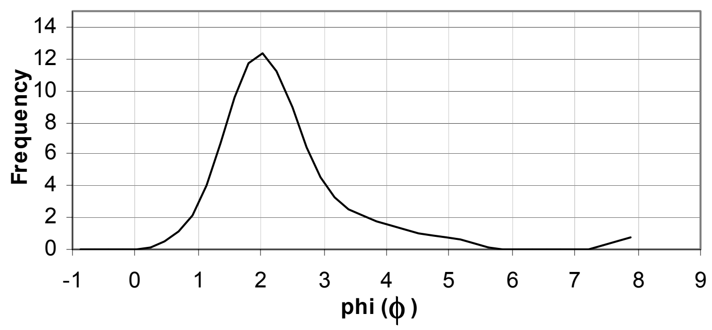
Frequency Distribution



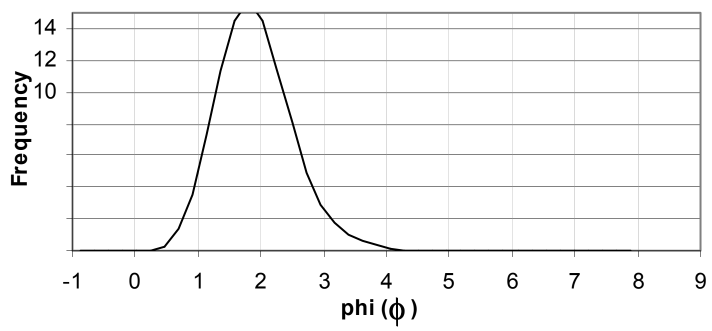
Casino-2:	**Swc 21**	
Depth (mRT)	**1810.00**	
Parameter	mm	ϕ
Mean	0.07 very fine sand	4.55
Mode	0.09 very fine sand	3.42
Range: min	0.002	8.97
max	0.19	2.40
Standard Deviation	0.04 poorly sorted	1.83



Casino-2:	**Swc 15**	
Depth (mRT)	**1857.00**	
Parameter	mm	ϕ
Mean	0.23 fine sand	2.56
Mode	0.25 medium sand	1.99
Range: min	0.00	8.97
max	0.56	0.84
Standard Deviation	0.12 poorly sorted	1.57



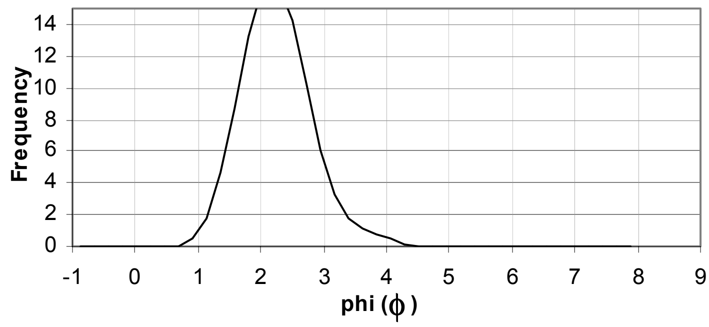
Casino-2:	**Swc 13**	
Depth (mRT)	**1871.00**	
Parameter	mm	ϕ
Mean	0.28 medium sand	1.91
Mode	0.28 medium sand	1.81
Range: min	0.09	3.47
max	0.48	1.06
Standard Deviation	0.08 well sorted	0.48



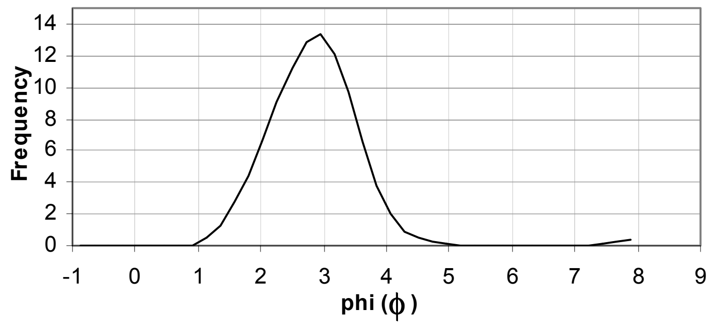
Thin Section Statistics | **Frequency Distribution**

Casino-2:	**Swc 12**	
Depth (mRT)	**1880.50**	
Parameter	mm	ϕ
Mean	0.27 medium sand	1.95
Mode	0.26 medium sand	1.96
Range: min	0.10	3.32
max	0.52	0.94
Standard Deviation	0.08 well sorted	0.42

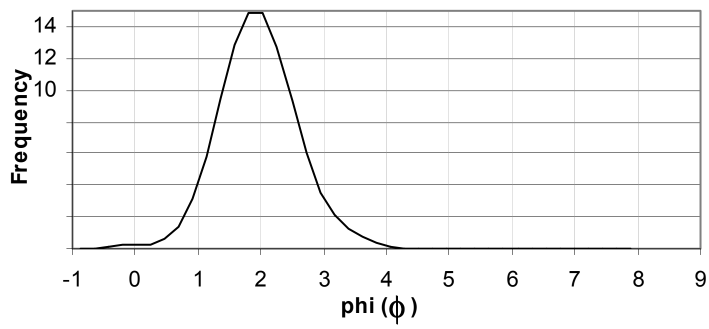
Casino-2:	**Swc 7**	
Depth (mRT)	**1917.00**	
Parameter	mm	ϕ
Mean	0.22 fine sand	2.24
Mode	0.22 fine sand	2.17
Range: min	0.07	3.84
max	0.38	1.40
Standard Deviation	0.06 well sorted	0.44



Casino-1:	**Swc 18**	
Depth (mRT)	**1751.00**	
Parameter	mm	ϕ
Mean	0.15 fine sand	2.93
Mode	0.14 fine sand	2.87
Range: min	0.002	8.97
max	0.35	1.51
Standard Deviation	0.06 poorly sorted	1.03

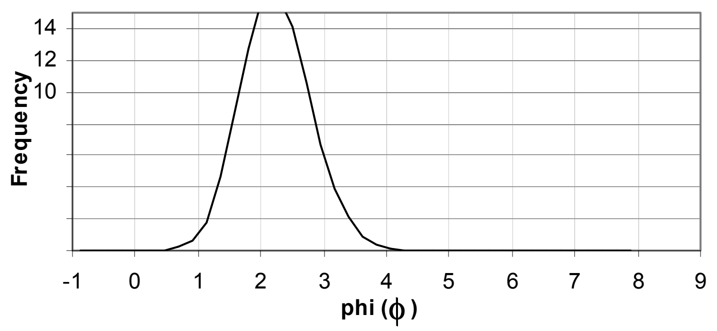


Casino-1:	**Swc 15**	
Depth (mRT)	**1769.00**	
Parameter	mm	ϕ
Mean	0.28 medium sand	1.94
Mode	0.26 medium sand	1.92
Range: min	0.10	3.32
max	1.00	0.00
Standard Deviation	0.11 moderately well sorted	0.53



Thin Section Statistics		
Casino-1:	**Swc 12**	
Depth (mRT)	**1783.00**	
Parameter	mm	ϕ
Mean	0.22 fine sand	2.23
Mode	0.22 fine sand	2.17
Range: min	0.08	3.64
max	0.42	1.25
Standard Deviation	0.06 well sorted	0.43

Frequency Distribution



6. X-RAY DIFFRACTION

All X-ray diffraction (XRD) results are summarised in the tables below and the traces from which these results were obtained are presented in Appendix A. Kaolinite is the dominant clay mineral in most samples, except Swc 3 (depth 1963.00m) in Casino-2 where chlorite-smectite is abundant. Peak shapes suggest the kaolinite is typically moderately crystalline consistent with SEM observations. Illite is present in all samples as a discrete mineral and only in core plug 10 is it interstratified with smectite to form rectorite. Interstratified chlorite-smectite is composed of authigenic chlorite-1A and 18Å montmorillonite. Where this clay is abundant in Casino-2 Swc 3 (depth 1963.00m) it may cause drilling problems because the smectite would be highly reactive to the presence of water. In those samples with relatively high percentages of chlorite, kaolin peak height may be slightly overestimated because the major peaks for kaolinite and chlorite overlap.

At least three phases of carbonate were identified from the bulk XRD traces. Siderite which is poorly crystalline is the most common carbonate and there is minor ankerite or dolomite in selected samples. Ankerite and dolomite could not be differentiated because the major peaks overlap and there is a continuous series between the two minerals. Where there are only small concentrations of ankerite/dolomite, as in these samples, secondary peaks are not strong enough to distinguish the two minerals. Highly crystalline calcite was the dominant carbonate mineral in Swc 12 (depth 1880.50m) from Casino-2. Identification of calcite in Swc 12 (depth 1783.00m) from Casino-1 was tentative because at this low concentration overlap from feldspar peaks can mask the presence of calcite.

Feldspars identified include both microcline and albite. In those samples containing both feldspars it is common for albite to be the dominant mineral. Samples from the shallowest depths in both Casino-1 and -2 only contain microcline, suggesting there may be some zonation in the distribution of these minerals.

Barite noted in the Swc 17 (depth 1845.00m) from Casino-2 is probably a contaminant from the drilling mud. Trace to minor amounts of pyrite were detected in selected samples and quartz is present in all samples.

TABLE 3. BULK XRD RESULTS

Sample	Depth (m)	C-S	I/M	Kaol	Bar	Qtz	Micr	Alb	Cal	A/D	Sid	Pyr
				Strongest peak height in counts								
CASINO-2												
CP 10	1765.80	-	110	456	-	8054	128	-	-	-	65	62
SWC 21	1810.00	-	168	314	-	2689	146	249	-	-	105	tr
SWC 17	1845.00	-	113	143	573	1174	95	105	-	89	474	-
SWC 15	1857.00	-	116	194	-	4232	116	246	-	65	124	81
SWC 12	1880.50	138	126	194	-	3856	184	227	1605	52	167	?
CASINO-1												
SWC 18	1751.00	-	147	496	-	4294	273	-	-	130	219	-
SWC 12	1783.00	175	142	655	-	5394	205	171	?76	84	118	?

C-S = interstratified chlorite-smectite, I/M = illite or muscovite, Kaol = kaolinite, Bar = barite, Qtz = quartz, Micr = microcline, Alb = albite, Cal = calcite, A/D = ankerite or dolomite, Sid = siderite & Pyr = pyrite

TABLE 4. CLAY XRD RESULTS

Sample	Depth (m)	C-S	Rec	Illite	Kaol	Qtz	Micr	Alb	Sid
				Strongest peak height in counts					
CASINO-2									
CP 10	1765.80	286	309	473	3509	706	162	-	-
SWC 21	1810.00	404	-	294	1246	807	-	-	196
SWC 15	1857.00	198	-	270	1231	1477	195	220	135
SWC 3	1963.00	1911	-	426	-	1057	-	267	-
CASINO-1									
SWC 12	1783.00	426	-	308	1775	1291	-	-	-

C-S = interstratified chlorite-smectite, Rec = rectorite (dioctahedral mica interstratified with dioctahedral smectite), Kaol = kaolinite, Qtz = quartz, Micr = microcline, Alb = albite, Sid = siderite

To facilitate between-sample comparisons of relative abundance for the same mineral, the results in each table are given in counts of peak height. These figures are based on the strongest line for each mineral detected. Caution should be used in assessing relative abundance from these figures since peak height is also significantly affected by factors such as crystal size and crystallinity. For these reasons the figures are even more unreliable when comparing different minerals in the same sample. For example, based on peak height alone carbonate minerals will always appear less abundant than similar proportions of quartz because of differences in crystallinity. Clay minerals will also appear to be less abundant than quartz in a bulk XRD trace because of differences in crystal size. Furthermore, comparison should not be made between peak heights given for bulk samples and those for the clay fractions because results have been influenced by the sampling and preparation methods. XRD will not detect minerals that represent less than approximately 5% of the total rock composition.

7. SCANNING ELECTRON MICROSCOPY

7.1 Casino-2, Core plug 1, Depth 1763.18m

Mineralogically this sandstone is dominated by quartz with rare K-feldspars. EDS analyses of the feldspars indicated a composition of Si, Al and K which could represent either orthoclase or microcline. Primary intergranular pores are well preserved (Fig. 17a) and there are examples of grain fracturing and honeycomb pores. Grain fracturing appears to postdate the development of quartz overgrowths (Fig. 17b) and has occurred in quartz grains regardless of their thickness.

Pore throats are partially blocked with drilling mud contaminants. The distribution of drilling mud is pervasive with both barite (Ba S) and sylvite (K Cl) recognised. Barite is typically present as blocky crystals (Fig. 17c) that concentrate within pore throats and fill micropores in corroded K-feldspars. Sylvite is more massive and has completely filled pores and pore throats (Fig. 17d). It is possible that the routine core analysis of this sample may have been adversely influenced by the extent of drilling mud contamination.

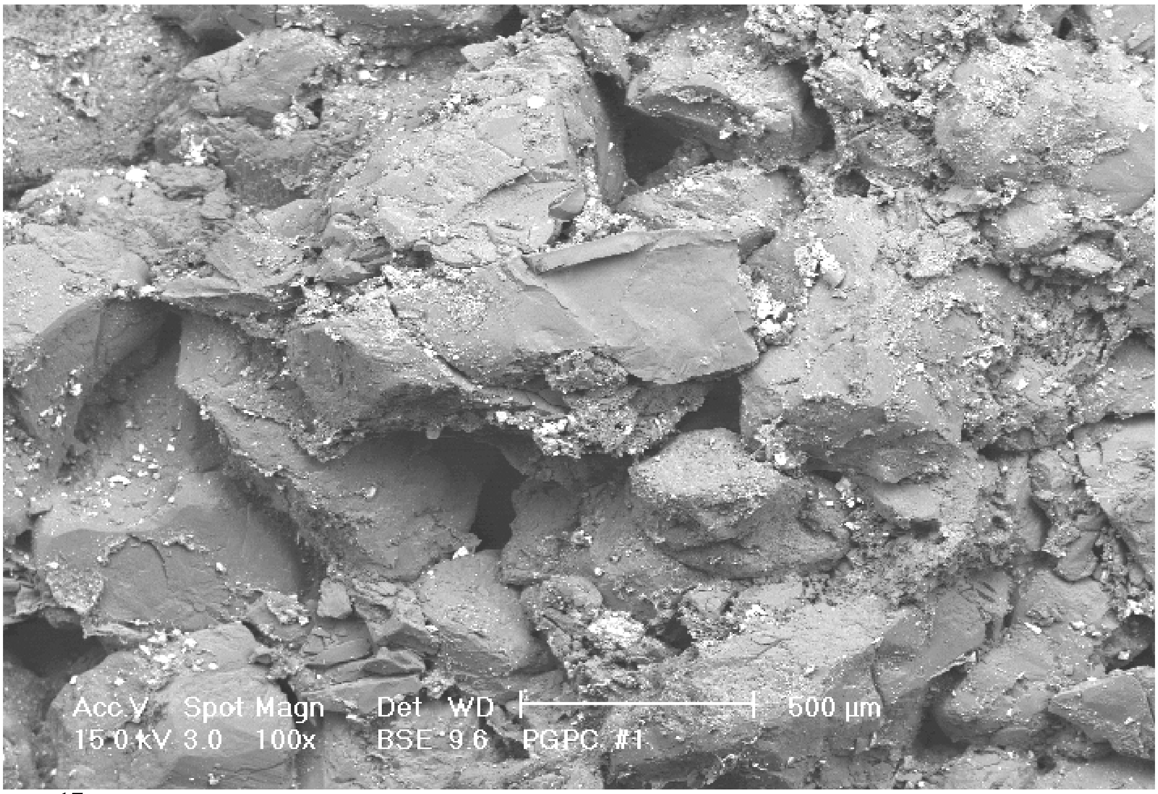


Figure 17a
General view illustrating the preservation of primary intergranular pores and the distribution of drilling mud contaminants. The latter is barite and appears as bright specks in this field of view because of the difference in elemental composition. Casino-2, Core plug 1, Depth 1763.18m. Backscattered electron photomicrograph. Bar scale 500 microns.

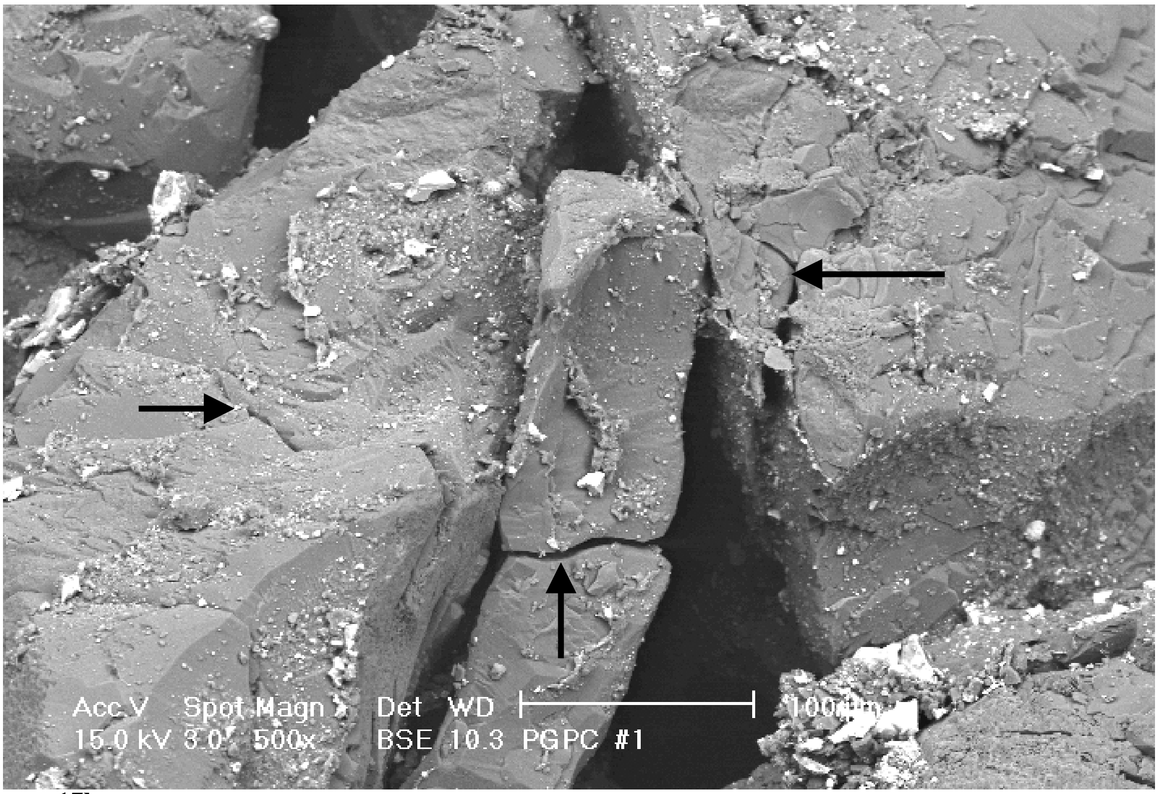


Figure 17b
There are several fractured grains (arrows) in this field of view similar to that seen in thin section. Fracturing is not related to grain thickness/size and does appear to postdate prismatic quartz overgrowths in the RHS grain. Casino-2, Core plug 1, Depth 1763.18m. Backscattered electron photomicrograph. Bar scale 100 microns.

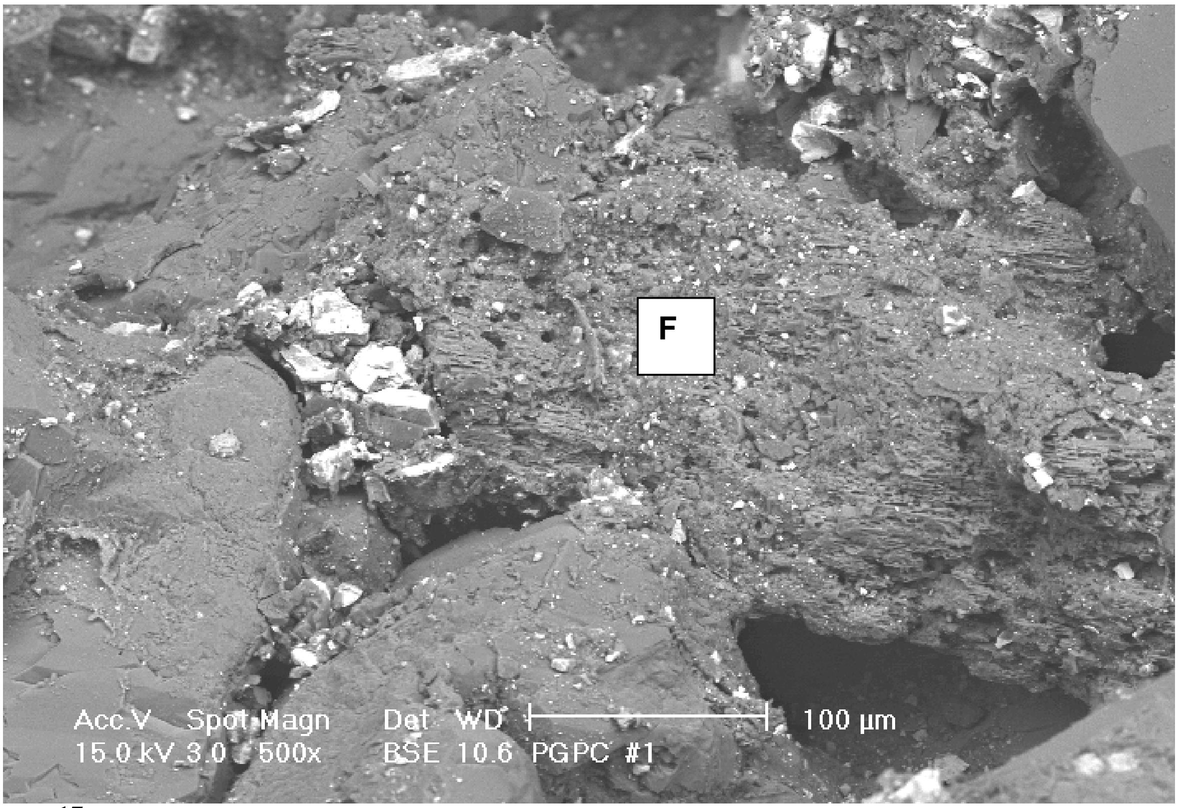


Figure 17c
Honeycomb porosity associated with this corroded K-feldspar (F) would not significantly contribute to effective porosity. Blocky crystals of barite (whiter) are evident partially filling a pore throat between intergranular pores. Casino-2, Core plug 1, Depth 1763.18m. Backscattered electron photomicrograph. Bar scale 100 microns.

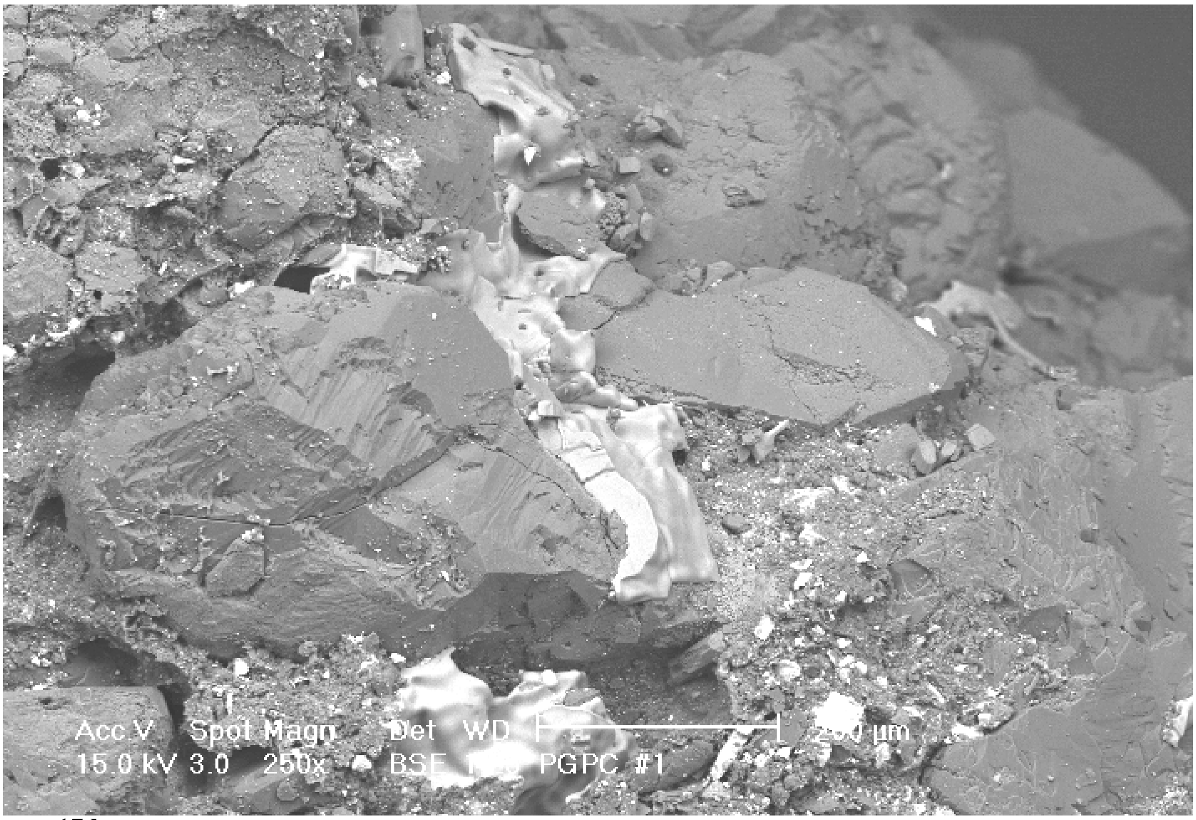


Figure 17d
Where sylvite (white) precipitated from the drilling mud it has completely filled pores and pore throats. Casino-2, Core plug 1, Depth 1763.18m. Backscattered electron photomicrograph. Bar scale 200 microns.

7.2 Casino-2, Core plug 10, Depth 1765.80m

Framework grains include quartz, K-feldspars, muscovite and highly altered grains. K-feldspars are either fresh or corroded and in all instances the composition was Si, Al and K characteristic of either orthoclase or microcline. Primary intergranular pores are preserved where pores are rimmed by quartz overgrowths (Fig. 18a). Elsewhere pore throats are blocked by authigenic minerals and deformed ductile framework grains. Highly ductile grains (Figs 18 b) are composed of illite (Si, Al, K and traces of Fe) and these grains may represent altered micas that have been deformed during mechanical compaction.

Authigenic minerals include pseudohexagonal booklets and verms of kaolin (Fig. 18c) which range in diameter from 5 to 15 microns. Kaolin is commonly engulfed by prismatic quartz overgrowths and has precipitated in pores and replaced grains. Microporosity associated with the kaolin may not be maximised because of the variation in crystal size. This variation would effectively reduce the size of some micropores. Framboids of pyrite (Fig. 18d) also block pore throats and single crystals of Fe rich carbonate (Fig. 18e) postdate the kaolin and quartz overgrowths. The final authigenic minerals are thought to be contaminants from the drilling mud. Sylvite has a similar habit to that seen in other samples but it is not as abundant. In addition, there are rare needle-like crystals (Fig. 18f) which are composed of Sr, K, S and Ca (Fig. 18g). These needles could be composed of either celestine (Sr SO_4) and/or gypsum (Ca S) and the K has substituted into the lattice from the sylvite (K Cl).

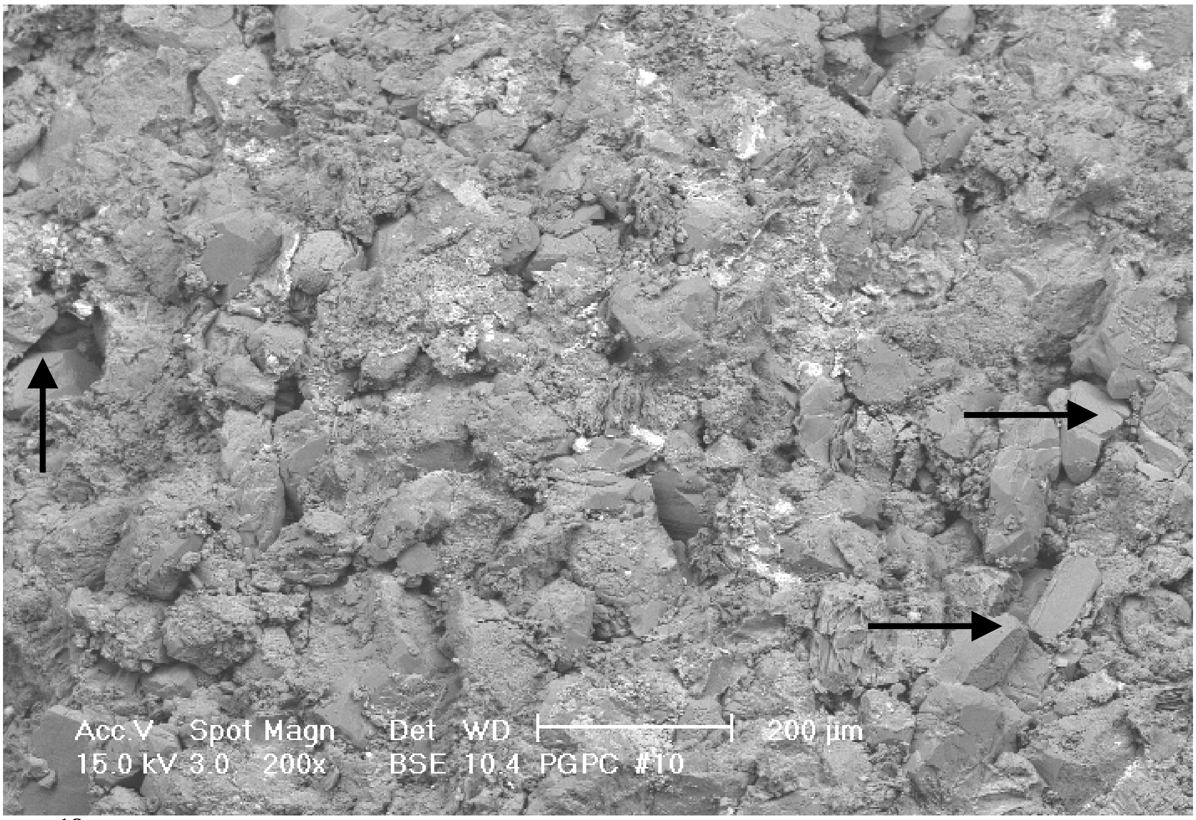


Figure 18a
General field of view illustrating the distribution of macropores. Primary intergranular pores are preserved where quartz overgrowths are well developed (arrows). The well rounded grain is composed of K-feldspar. Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 200 microns.

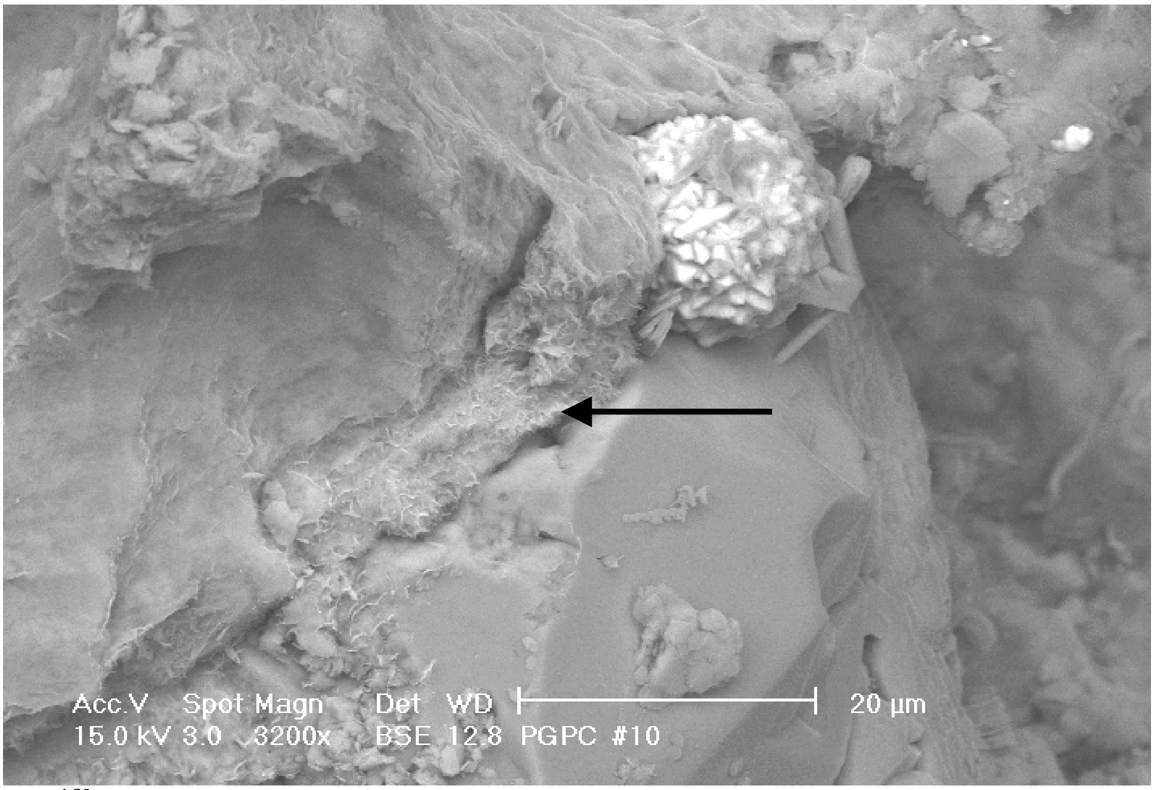


Figure 18b

Quartz overgrowths are clearly apparent in this field of view. The bright material is composed of a pyrite framboid. Note the highly deformed grain (arrow) which has an illitic composition and traces of illite imbedded in the quartz overgrowth. Rare kaolin booklets are associated with the pyrite framboid. Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 20 microns.

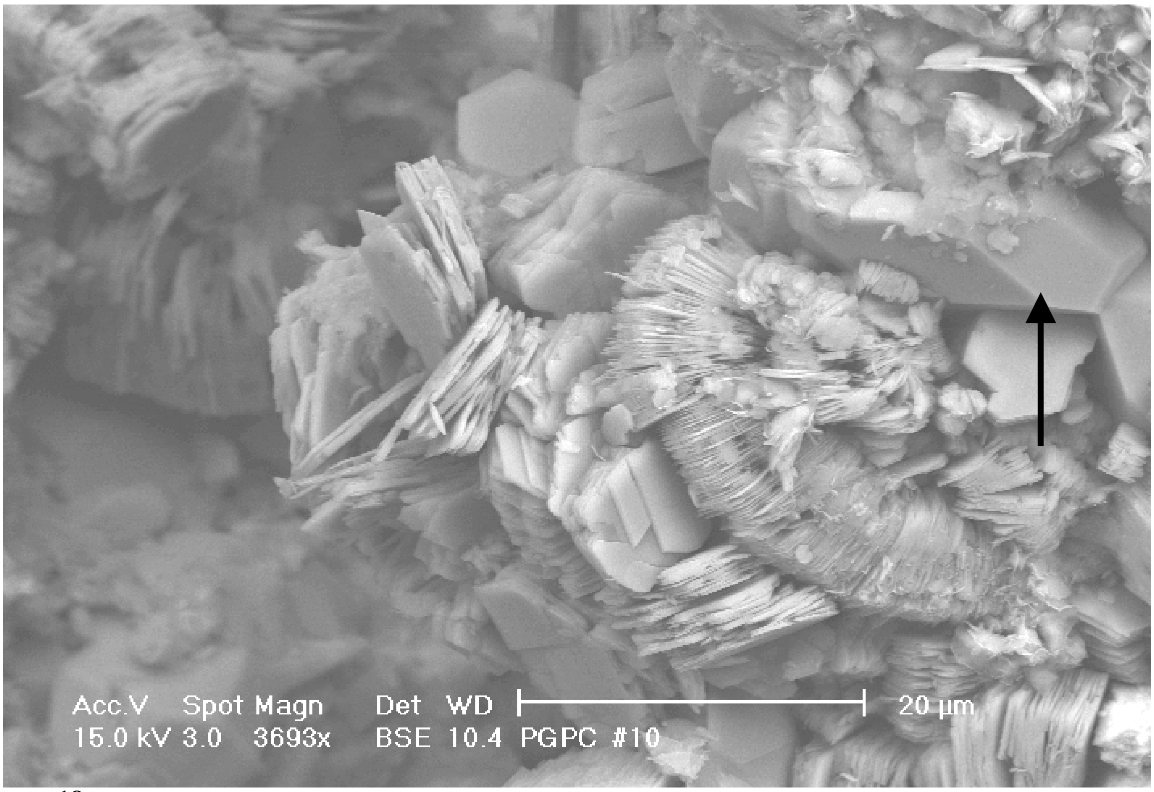


Figure 18c

Booklets and verms of kaolin display various sizes and are engulfed by a prismatic quartz overgrowth (arrow). Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 20 microns.

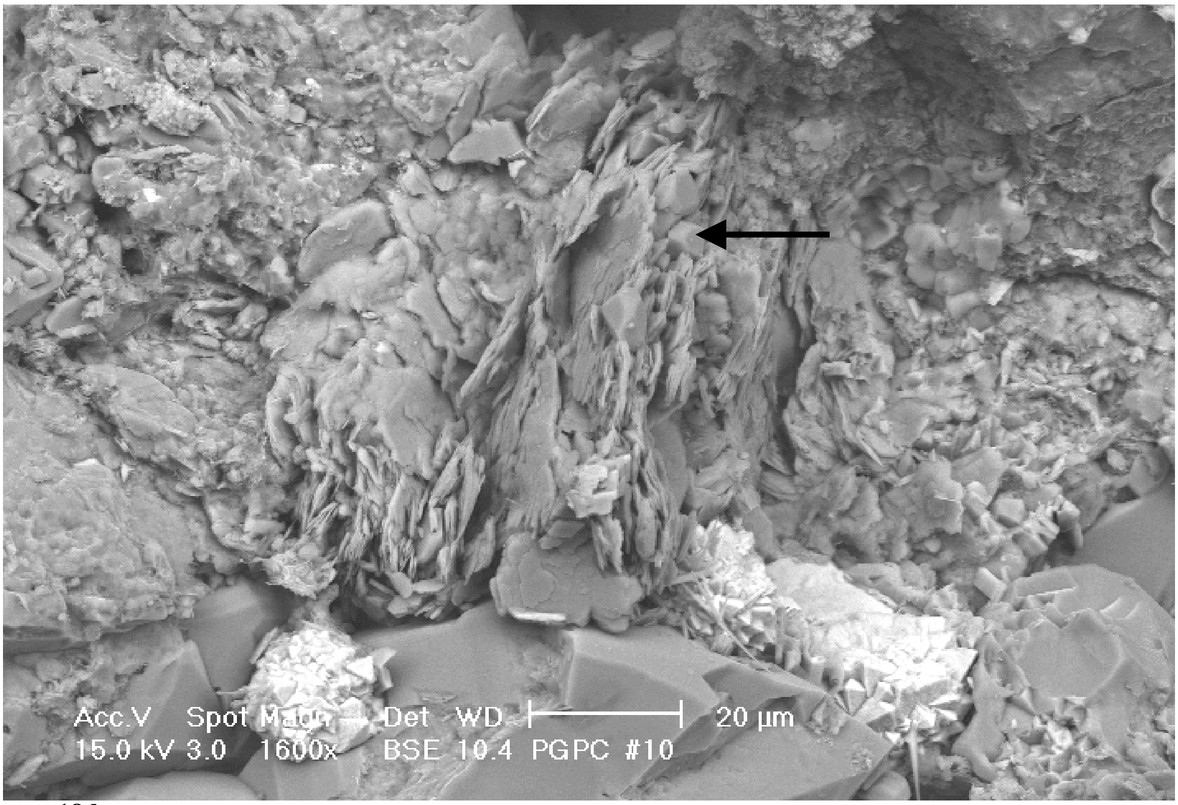


Figure 18d
Framboidal pyrite (bright colour) is concentrated in pore throats. Cleavage in the muscovite flake has been disrupted by alteration to kaolin and precipitation of rare authigenic quartz (arrow). Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 20 microns.

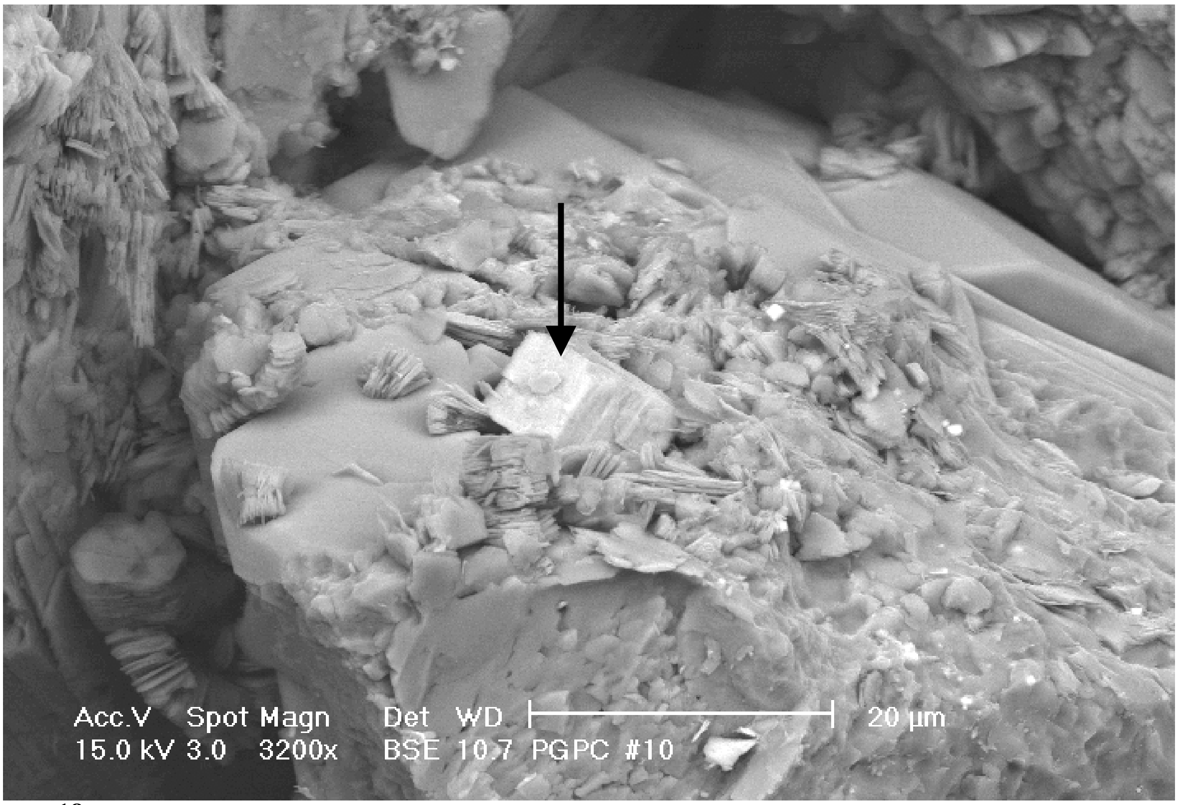


Figure 18e
A euhedral rhomb of carbonate spar (arrow) is very Fe rich indicating a sideritic composition. Surrounding booklets of kaolin up to 5 microns in diameter are engulfed by quartz overgrowths. Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 20 microns.

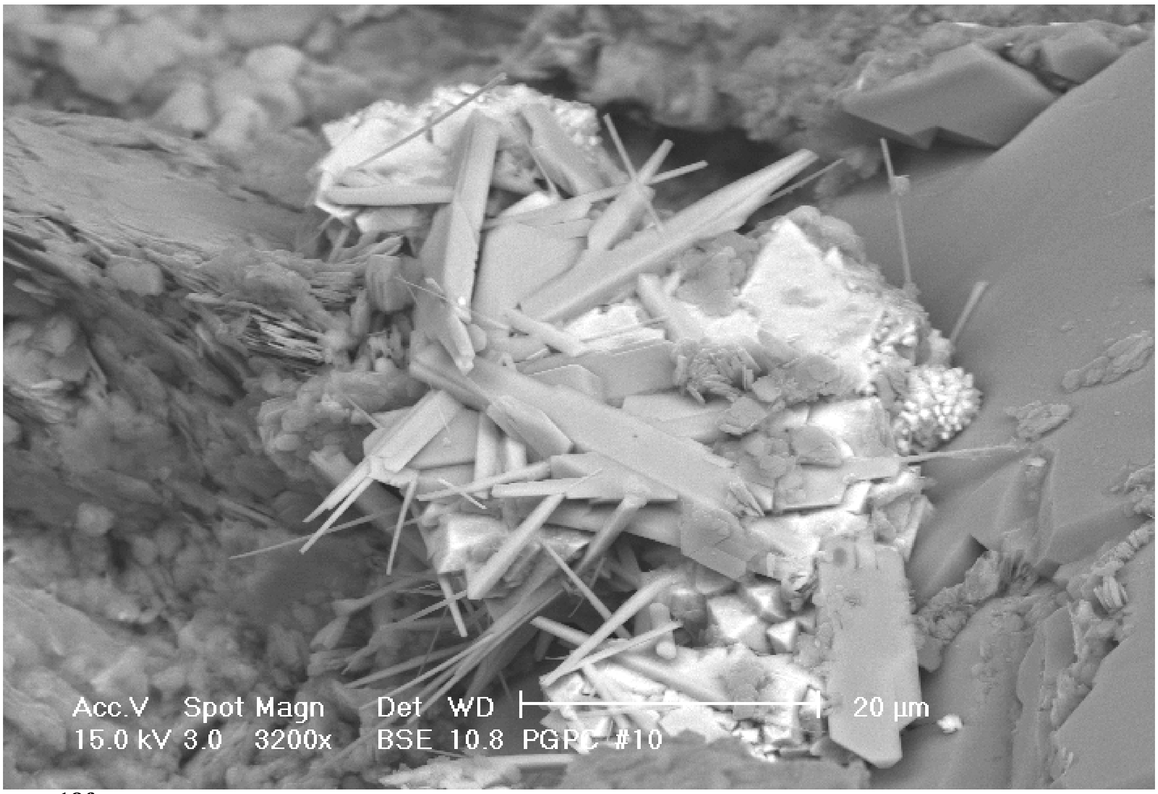


Figure 18f
Bladed crystals that postdate framboidal pyrite (bright colour) have probably precipitated from the drilling mud. Casino-2, Core plug 10, Depth 1765.80m. Backscattered electron photomicrograph. Bar scale 20 microns.

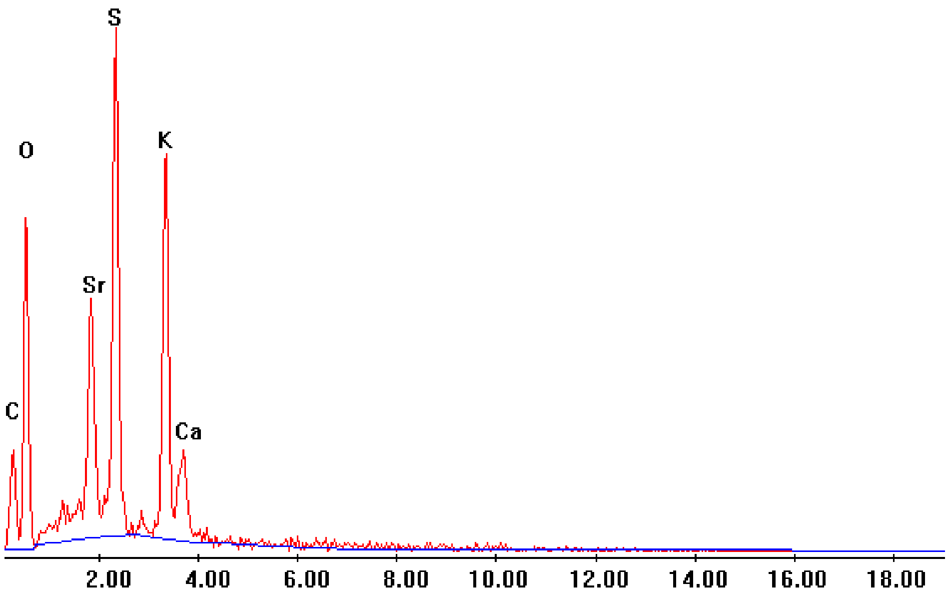


Figure 18g
EDS trace of the bladed crystals illustrated in Figure 18f indicates the presence of Sr, K, S and Ca. Carbon and oxygen peaks are also evident. Casino-2, Core plug 10, Depth 1765.80m.

7.3 Casino-2, Core plug 30, Depth 1774.43m

Primary intergranular pores are well preserved in this quartzarenite (Fig. 19a). Framework grains are dominated by quartz with rare examples of corroded feldspars, micas and highly altered grains. The latter are composed of a mixture of minute subhedral kaolin booklets and authigenic quartz (Fig. 19b). In addition, muscovite flakes appear to be partially altered to kaolin. Feldspars are commonly highly corroded to produce honeycomb pores (Fig. 19c). The remaining skeleton of these grains is composed of Si, Al, and K suggesting the composition was that of either orthoclase or microcline.

Quartz overgrowths are present but typically these are incipient and prismatic in habit. Rarely prisms extend up to 60 microns into intergranular pores but do not fill pores. Where prisms have merged laterally the overgrowths are more rhombohedral (Fig. 19b) in habit. Grain fracturing appears to have developed after the quartz overgrowths since fractures are clean and not lined by quartz prisms. Grains have been partially replaced by blocky pyrite crystals (Fig. 19d & e) which contrast in habit with framboidal pyrite that occurs on grain margins (Fig. 19a). Blocky pyrite also partially fills pores and blocks pore throats.

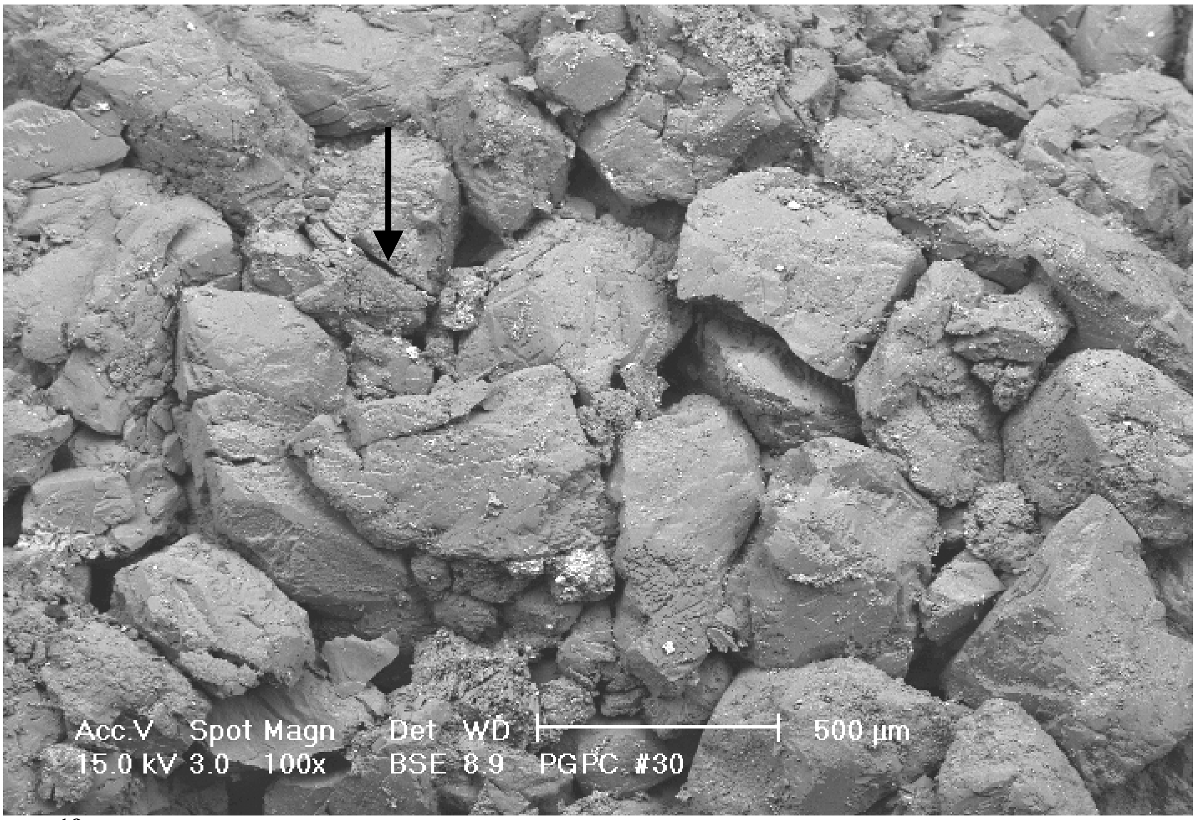


Figure 19a

General view illustrating the good preservation of primary intergranular pores. Minor grain fracturing is apparent (arrow) and framboidal pyrite (light colour) is evident just below the centre of the field of view. Other bright specks in this view are typically composed of sylvite. Casino-2, Core plug 30, Depth 1774.43m. Backscattered electron photomicrograph. Bar scale 500 microns.

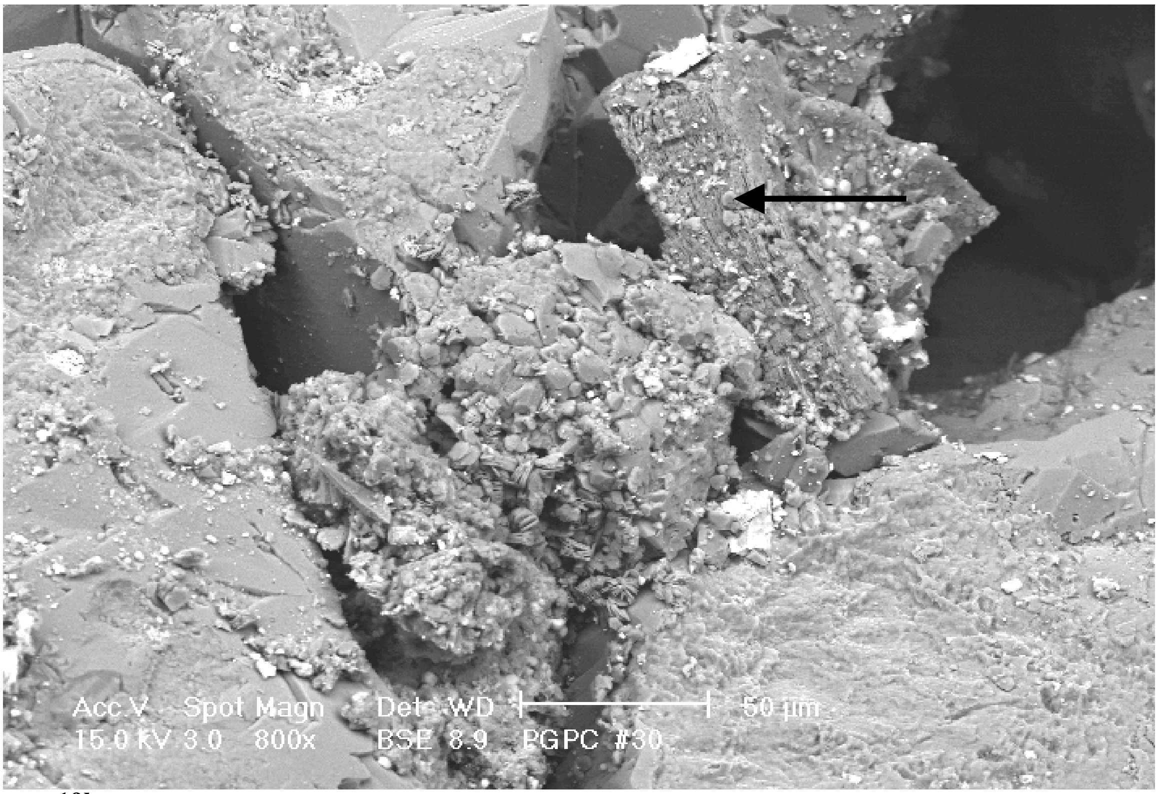


Figure 19b
Closer view of the centre of Figure 19a. The central grain has been replaced by minute kaolin booklets and authigenic quartz. Cleavage is poorly preserved in the adjacent mica (arrow) because it is partially altered to kaolin. Note the quartz overgrowths on the adjacent framework grains. Casino-2, Core plug 30, Depth 1774.43m. Backscattered electron photomicrograph. Bar scale 50 microns.

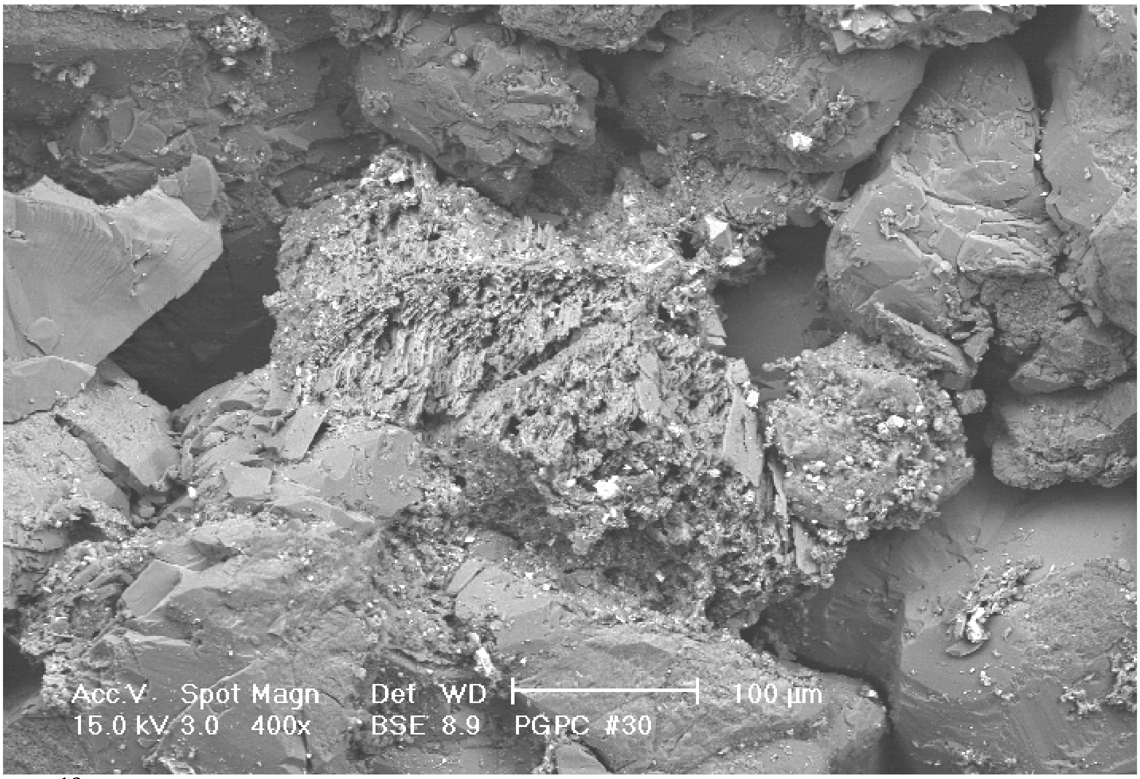


Figure 19c
This highly corroded K-feldspar has produced minute secondary pores. These dissolution pores contribute to total porosity but not necessarily effective porosity except immediately adjacent to the primary intergranular pores. Casino-2, Core plug 30, Depth 1774.43m. Backscattered electron photomicrograph. Bar scale 100 microns.

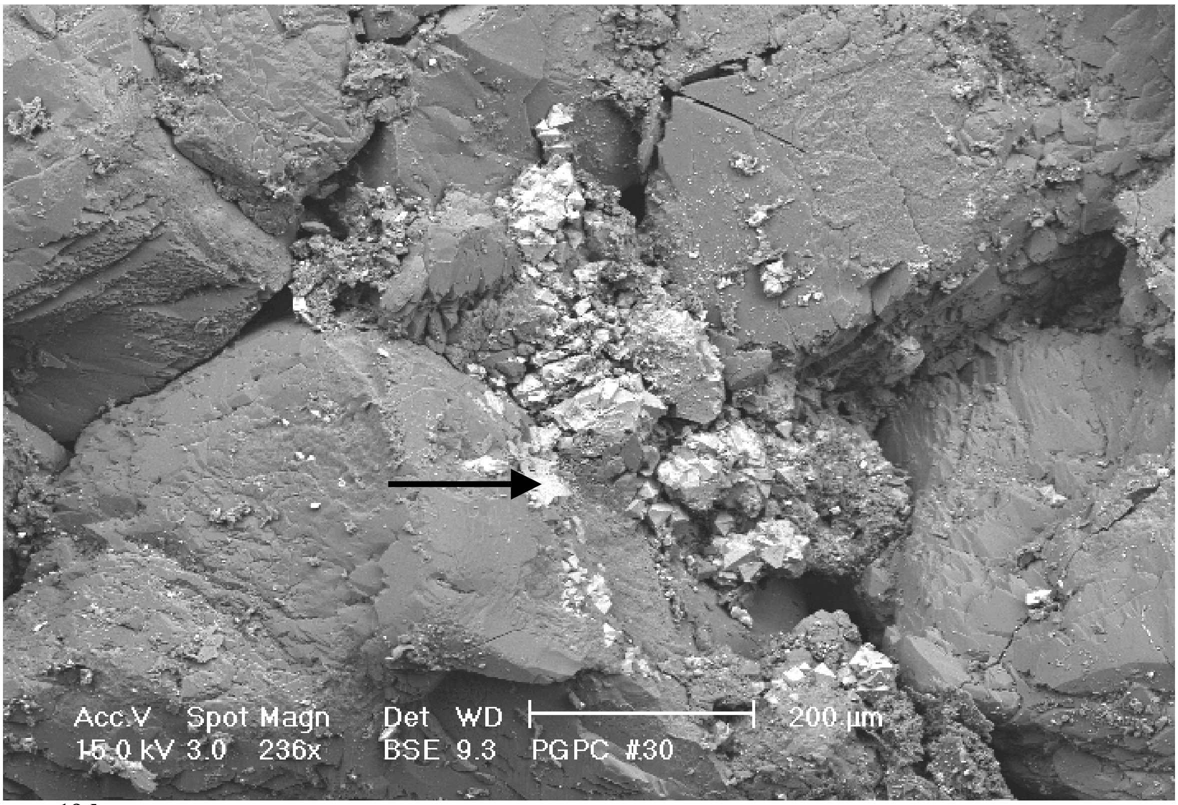


Figure 19d
General view illustrating a grain that is partially replaced by pyrite (light colour). Note that pyrite is also imbedded within the quartz overgrowth on an adjacent grain (arrow) and that fracturing in grains developed after quartz overgrowths. Casino-2, Core plug 30, Depth 1774.43m. Backscattered electron photomicrograph. Bar scale 200 microns.

Figure 19e
Closer view of the central grain in Figure 19d showing the blocky habit of the pyrite (lighter colour). Casino-2, Core plug 30, Depth 1774.43m. Backscattered electron photomicrograph. Bar scale 50 microns.

7.4 Casino-2, Core plug 50, Depth 1780.46m

Framework grains are dominated by quartz with rare K-feldspars in this quartzarenite. Silicification (Fig. 20a) would appear to be more extensive than for previous samples and this has resulted in the preservation of primary intergranular pores with angular outlines. Overgrowths have formed by the merging of quartz prisms (Fig. 20b). Imbedded within or engulfed by quartz overgrowths there are minute kaolin booklets (Fig. 20c). Booklets are typically subhedral and 4 to 10 microns in diameter. Kaolin has precipitated within pores and replaced feldspars (Figs 20d & e). Where only part of a feldspar has been replaced there may have been chemical zonation within the original feldspar that favoured kaolinisation. Pyrite was the only other authigenic mineral identified. It occurs as single octahedral crystals and as framboids.

Drilling mud (Fig. 20f) has contaminated large areas within this sample. Sylvite forms a coating on kaolin booklets and verms thus blocking micropores. This contaminant would be especially damaging to permeability where the kaolin occurs within pores.

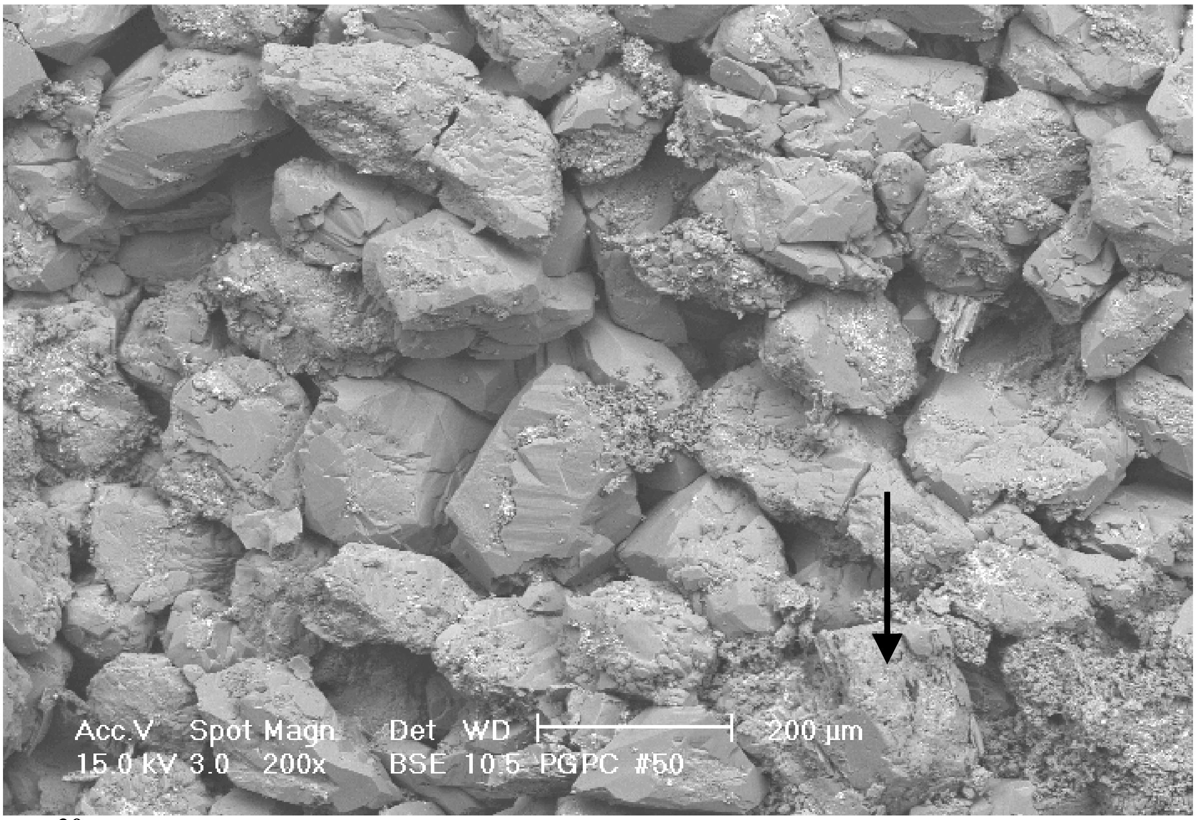


Figure 20a
General view illustrating the angular outline of primary intergranular pores due to the presence of quartz overgrowths. Note the relatively fresh K-feldspar (arrow) and other areas where grains have been replaced by kaolin. Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 200 microns.

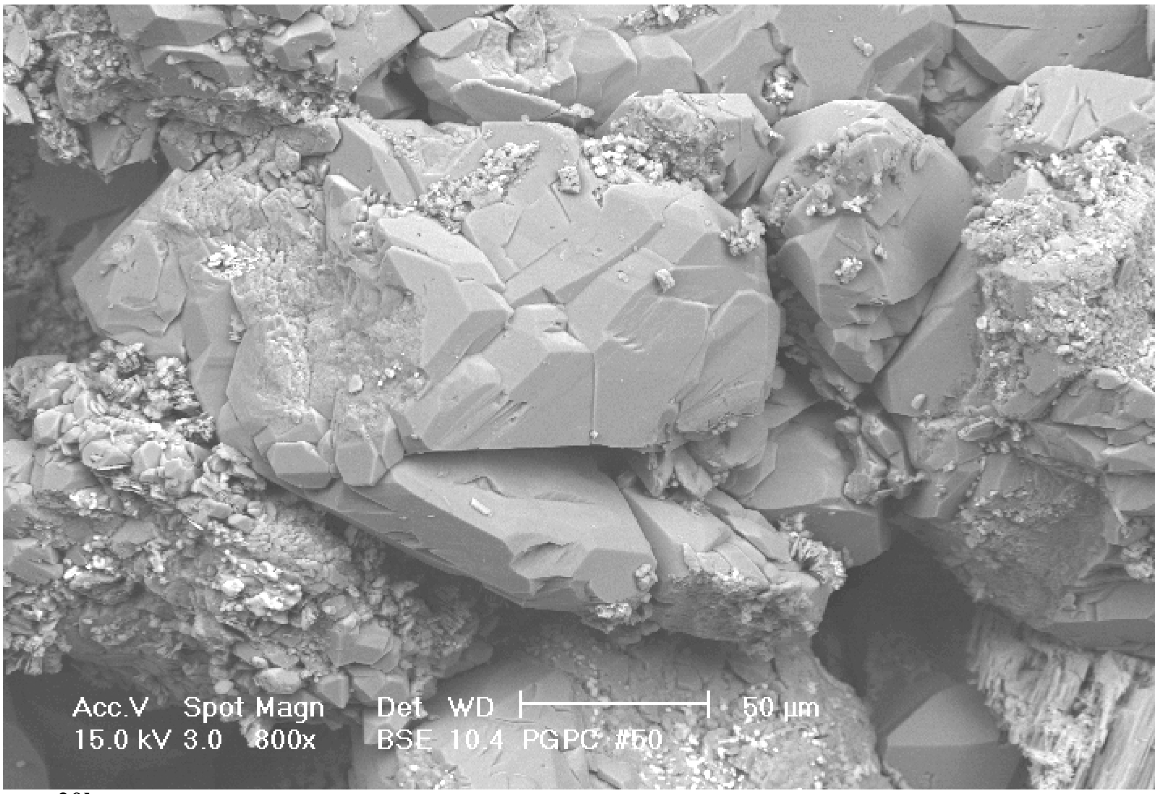


Figure 20b
Closer view of prismatic quartz overgrowths on upper RHS of Figure 20a. Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 50 microns.

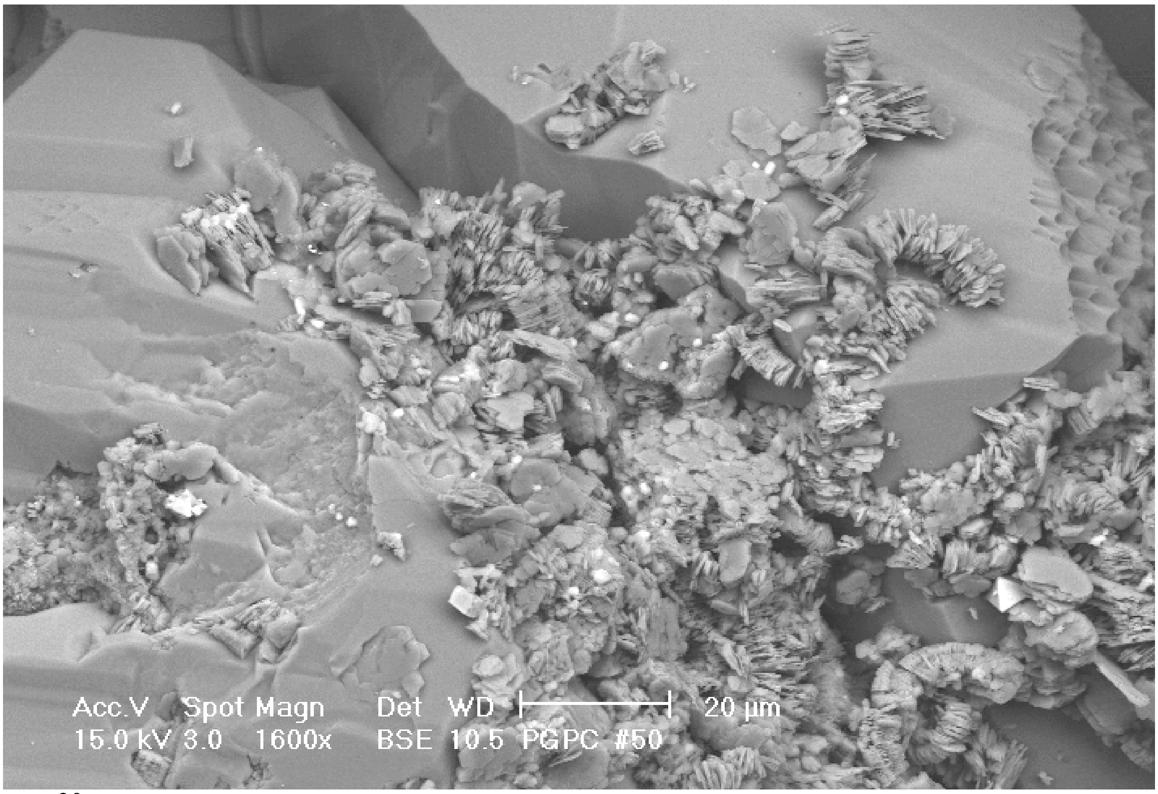


Figure 20c
Subhedral kaolin booklets and verms engulfed by quartz overgrowths located in centre of Figure 20a. Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 20 microns.

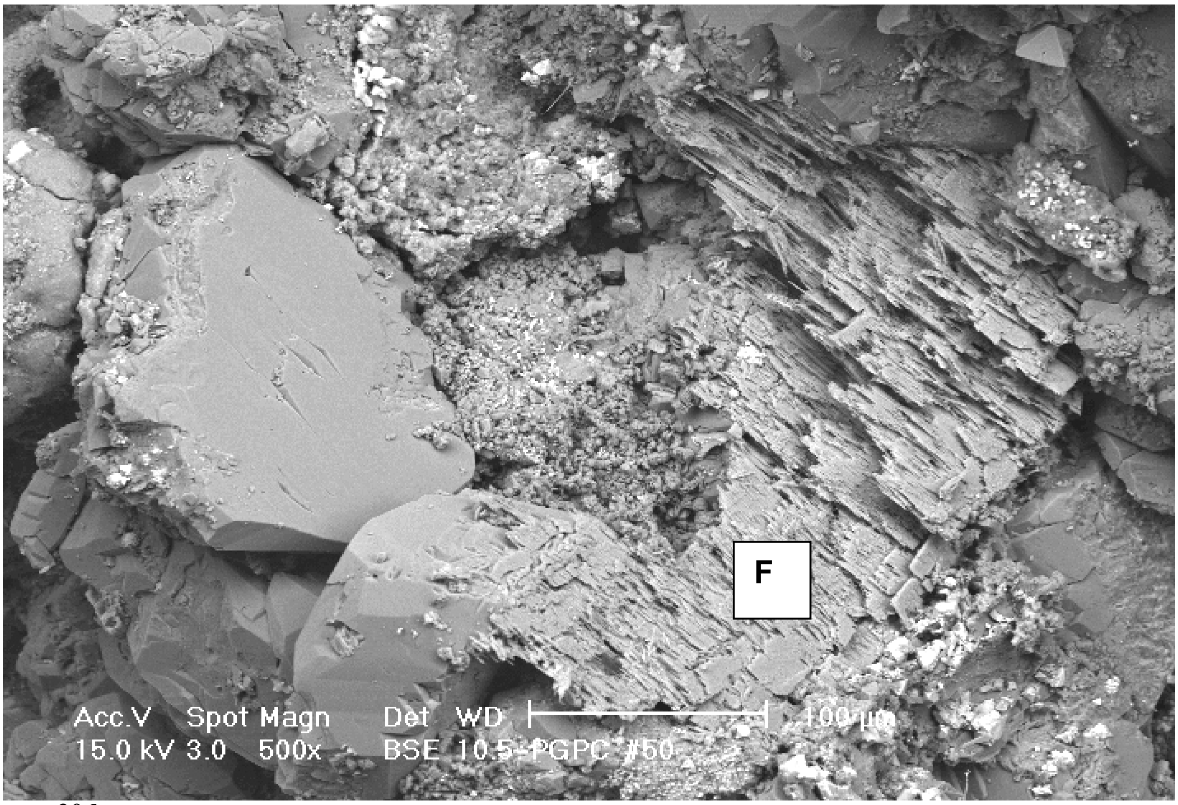


Figure 20d
This K-feldspar (F) has not only been corroded but it was partially replaced by kaolin. Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 100 microns.

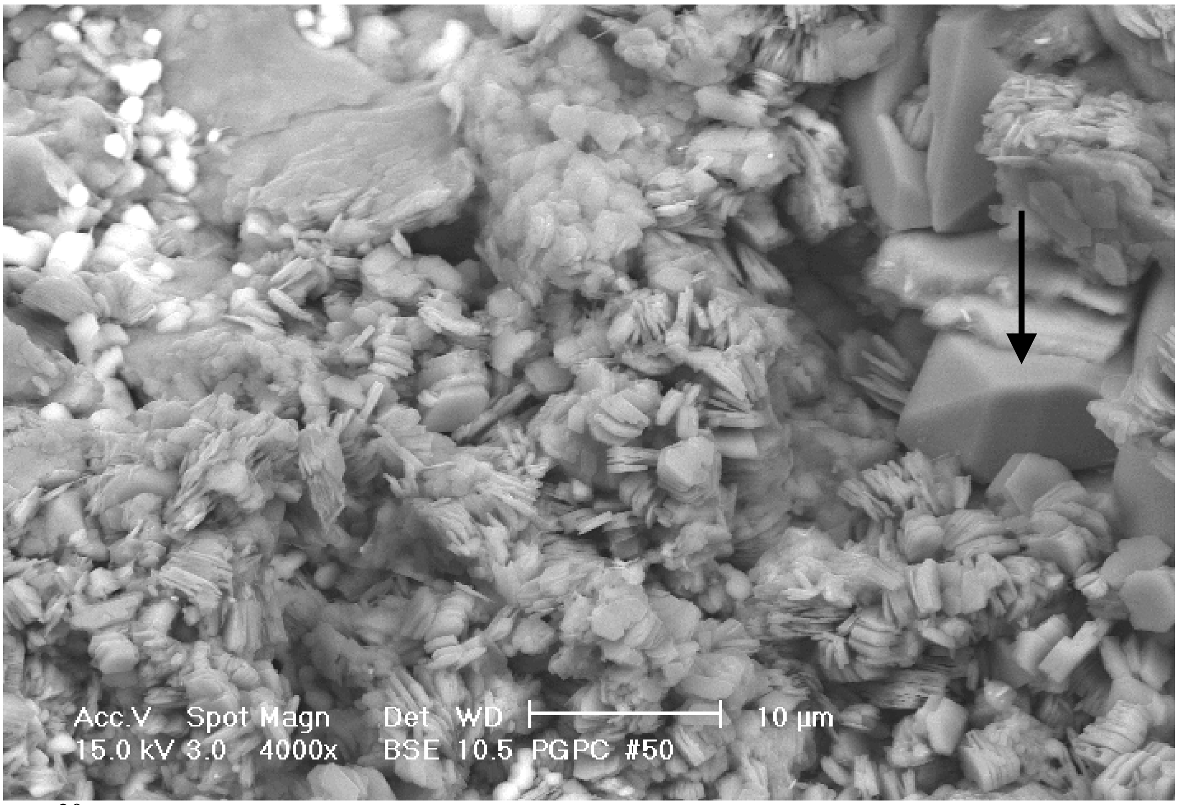


Figure 20e
Closer view of kaolin booklets replacing the K-feldspar in Figure 20d. Prismatic quartz overgrowths project into the kaolin (arrow) and there is minor contamination from sylvite (light colour). Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 10 microns.

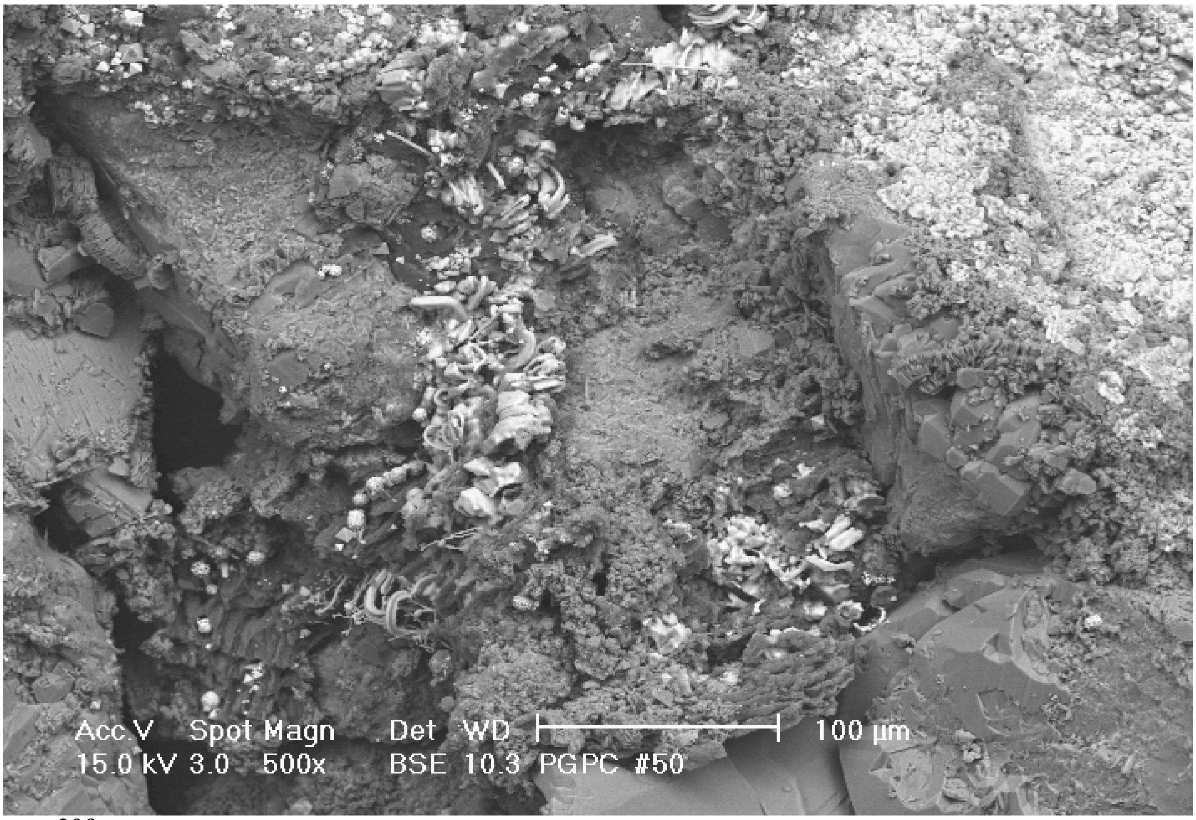


Figure 20f
The extent of contamination by sylvite (light colour) and relative abundance of kaolin is apparent in this field of view. Sylvite has molded itself over the kaolin crystals especially in the central area. Quartz overgrowths are evident on the lower RHS and minute single pyrite octahedra on the lower LHS. Casino-2, Core plug 50, Depth 1780.46m. Backscattered electron photomicrograph. Bar scale 100 microns.

8. DISCUSSION

a. Lithology

Unit A, Casino-2

Waarre Formation sandstones studied from Unit A are comprised of fine to medium grained, moderately well to well sorted, mineralogically immature litharenites (Swcs 7 & 8, depths 1917.00m & 1901.00m). Bedding is apparent from grain alignment and the presence of muddy laminae. Framework grains are typically subangular to subrounded with low sphericity.

Mudstones in Unit A include silty mudstone (Swc 3, depth 1963.00m) which contains up to fine sand size grains. Grains are angular to subrounded in shape with low sphericity.

Unit Ca, Casino-2

Below the muddy section in the middle of this unit sandstones are comprised of fine to medium grained, poor to well sorted sublitharenites (Swcs 13, 15 & 17; depths 1871.00m, 1857.00m & 1845.00m) and a carbonate cemented, medium grained, well sorted litharenite (Swc 12, depth 1880.50m). The latter sample was probably a sublitharenite before the introduction of pervasive carbonate which has partially replaced framework grains. In all these sandstones, framework grains are subangular to subrounded with low sphericity. Rare muddy laminae and organic matter are preserved in sidewall core 15 (depth 1857m), but texture was too disrupted in the other sublitharenites to ascertain the presence of sedimentary structures.

More sandy intervals of the muddy section in the middle of this unit are comprised of very fine grained, poorly sorted greywacke interbedded with mudstone (Swc 21, depth 1810.00m). Framework grains are angular to subangular and there are laminae and ripples apparent.

Above the muddy section, sandstones of Unit Ca show considerable lithological variation. The coarsest grained sediments consist of medium to coarse grained, poor to moderately well sorted quartzarenites (Cps 25 & 30, depths 1772.88m & 1774.43m). In addition, there is a very fine grained, moderately sorted sublitharenite (Cp 10, depth 1765.80m) and a fine grained, well sorted subarkose (Cp 50, depth 1780.46m).

Unit Ca, Casino-1

Below the muddy interval in Unit Ca of Casino-1 the sandstones are fine to medium grained, moderately well to well sorted sublitharenites (Swcs 12 & 15; depths 1783.00m & 1769.00m). Framework grains are subangular to subrounded and there are laminae preserved which include significant amounts of organic matter. Above the muddy interval the sandstone is very similar and is composed of a fine grained, poorly sorted sublitharenite (Swc 18, depth 1751.00m). Again laminae are outlined by a concentration of organic matter.

Unit Cb, Casino-2

Only one sample was studied from Unit Cb. It is comprised of a medium to coarse grained, moderately sorted, mineralogically mature quartzarenite (Cp 1, depth 1763.18m). Framework grains are angular to subangular similar to that of coarse sediments in quartzarenites from Unit Ca.

b. Detrital mineralogy & sediment provenance

Variations in detrital mineralogy are evident between the different units of the Waarre Formation. These changes might in part reflect a variation in sediment provenance and/or a change in hydraulic regime associated with the depositional environments. Detrital minerals are comprised of quartz, feldspars, lithics, mica and accessory minerals in all sandstones. Matrix comprised of clay rich laminae and organic matter are also detrital in origin.

Unit A, Casino-2

The most significant difference between Unit A and C is the presence of biotite and accessory opaques in Unit A. Both these minerals could have an igneous or metamorphic provenance but biotite may also be retained because there was less weathering in Unit A. Polycrystalline quartz typically has straight crystal boundaries characteristic of an igneous source in Unit A. Feldspars include both K-feldspar (microcline) and plagioclase (albite). Lithics are dominated (3-14%) by fragments from a metamorphic provenance (quartzite, micaceous schist and shale) with similar amounts (2-13%) of igneous lithics (both volcanic and rare plutonic). Lithics of unknown affinity (chert and chalcedony), and sedimentary mudstone comprise only a small portion (0-1%) of the lithic fraction.

Identification of abundant interstratified chlorite-smectite in the clay fraction of Swc 3 (depth 1963.0m) just above the boundary with the Eumerella Formation may be significant. Elsewhere, volcanism is considered contemporaneous with the Eumerella Formation (Duddy, 1997) and weathering of volcaniclastics may have produced this high concentration of smectite (montmorillonite) in the Waarre Formation.

Unit Ca, Casino-2

There are differences in detrital mineralogy above and below the muddy interval within Unit Ca. Below the muddy interval feldspars include both K-feldspars (microcline) and plagioclase (albite), but above the muddy interval there are only K-feldspars. Lack of plagioclase may be attributed to more intense weathering rather than a difference in sediment provenance. However, in the lithic fraction below the muddy interval there are fragments of chalcedony, mudstone, quartzite and volcanics which are not evident above the mudstone. These lithics suggest a stronger influence at this time from a diverse range of rock types including metamorphic and volcanic terranes. Therefore, distribution of plagioclase may also reflect this difference in sediment provenance.

Accessory zircon, tourmaline and rutile have a relatively uniform distribution within Unit Ca. These minerals are the most resistant to weathering and therefore may not be diagnostic of sediment provenance. All three minerals can be derived from granites. Identification of garnet and possibly monazite in Swc 13 (1871.00m) would be consistent with either a granitic or pegmatite source.

Detrital clay matrix may display zonation related to the muddy interval that subdivides Unit Ca. X-ray diffraction results indicate the greywacke in the muddy interval contains a high percentage of kaolinite and illite in the clay fraction (Swc 21, depth 1810.00m). Kaolinite is interpreted as detrital in this sample because there were no booklets observed in thin section. Minor chlorite-smectite was also detected from XRD but this clay may be associated with glaucony grains in the greywacke. Detrital clay matrix in Cp 10 (depth 1765.80m) above the muddy interval is also thought to be dominantly kaolinite. Most of the illite in this sublitharenite would be associated with altered lithics. In contrast, below the muddy interval where authigenic kaolinite (3%) is apparent (Swc 15, 1857.00m) the detrital clay could be dominated by both kaolinite and illite with traces of chlorite-smectite. An explanation for this apparent zonation in detrital clay mineralogy has not be ascertained but it could be related to later diagenetic alteration of kaolinite to illite as a function of depth.

Unit Ca, Casino-1

Sublitharenites from Casino-1 are almost devoid of igneous lithics when compared to Casino-2. This may be a function of a number of factors including:

- greater distance from the igneous source,
- a different sediment source, and/or
- higher rates of weathering because of the nature of the depositional environment

Other lithics of both metamorphic and sedimentary origin are comprised of lithologies that are very similar to those in Casino-2 from below the muddy interval.

Feldspars in the shallowest two samples from Casino-1 (Swc 18 & 15; depths 1751.00m & 1769.00m) are only composed of mineralogically more stable microcline. Similarly the shallowest samples in Casino-2 above the muddy interval only contain microcline. The basal sample from Casino-1 (Swc 12, depth 1783.00m) contains both microcline and albite.

The accessory mineral assemblage is also similar to Casino-2 because zircon, tourmaline and rutile are dominant. In addition, monazite was tentatively identified in the basal sample of Casino-1. Again the sediment source could have been a granite or pegmatite for these accessory minerals.

Unit Cb, Casino-2

There is nothing in the detrital mineralogy of Cp 1 (depth 1763.18m) to suggest that sediment provenance was any different to other quartzarenites above the muddy interval in Unit Ca. Feldspars are restricted to microcline and lithics lack volcanic fragments, quartzite, chalcedony and mudstone.

Possible sediment sources for the Waarre Formation

Based on the petrology observations it would appear that at the time when Unit A was deposited at Casino-2, there was both an igneous and metamorphic terrane from which sediment was derived. Both these sources continued to be important during deposition of the basal part of Unit Ca in Casino-2 but not at Casino-1 where the igneous source had little influence. In the upper part of Unit Ca at Casino-2 lithics are concentrated in the finest grained sands suggesting a hydraulic control on distribution and the metamorphic source is dominant.

It is possible that rifting and tectonic movements within the Otway Basin during the Turonian controlled the variations in sediment provenance noted in the Waarre Formation. Igneous and metamorphic terranes adjacent to the Otway Basin occur towards the southeast in the King Island High and to the northeast in the Kanmantoo Fold Belt (Moore *et al*, 2000). Edwards *et al* (1999) suggested that in approximately the Turonian there was major uplift of the Eastern Australian highlands which had a major impact on drainage patterns along the southern Australian margin. They interpreted major river systems flowing from the eastern highlands towards the southwest. Minor uplift in the eastern Otway Basin during the Cenomanian-Turoanian (Cooper, 1995) may have increased the erosion of sediments from the Kanmantoo Fold Belt. Included within the Early to Middle Cambrian Kanmantoo Group metasediments is the Glenelg River Complex which underwent low grade metamorphism and was intruded by granitic plutons, sills and dykes (Morton *et al*, 1995). This mixed igneous and metamorphic terrane could have sourced almost all the sediment identified in the Waarre Formation in Casino-1 and Casino-2.

Precambrian granites, quartzites and schists, and Devonian granites are reported from the King Island High (Christ *et al*, 2001) and this could also have been a major source of granitic and metamorphic sediments in Unit A and the basal parts of Unit Ca. Volcanic lithics could have been reworked from exposures of Late Jurassic Coleraine Volcanics somewhere along this path. Further to the south on the edge of Tasmania there are Neo-proterozoic dolomites and cherts that may also have provided a source for dusty chert and chalcedonic lithics noted throughout the Waarre Formation. Therefore, sediments in the Waarre Formation may have been derived from either the Kanmantoo Fold Belt, or the

King Island High. If the latter interpretation is correct then sediment transport may have been dominantly from the southeast.

c. Depositional environments

Previous workers on the Waarre Formation have interpreted it as possibly:

- A (transgressive) barrier-island sequence (Buffin, 1989) in the Upper Waarre Formation of the Port Campbell Embayment
- Upper delta plain to low sinuosity fluvial (Morton *et al*, 1995)
- A basal transgressive unit which flooded the Otway Basin from west to east overlain by an upper more regressive unit in which deposition of the best reservoirs occurred in lower coastal plain and delta front environments (Partridge, 1997)
- Fluvial, deltaic and marine environments (Edwards *et al*, 1999)
- Shallow marine to upper delta plain (Moore *et al,* 2000)

Unit A, Casino-2
On the wireline logs it would appear that Unit A in Casino-2 is comprised of a basal thick relatively uniform muddy interval overlain by at least two major fining upwards units. Sidewall core 3 (depth 1963.00m) was selected from the uniform muddy interval. It is comprised of very poorly sorted, silty mudstone with lenses of mudstone. The latter may represent either ripples (?flaser bedding) or horizontal burrows filled with mud. Fresh grains of green glaucony (2%) combined with the presence of framboidal pyrite indicate this was a marine depositional environment, possibly the continental shelf. Low rates of sedimentation would favour the formation of both glaucony and horizontal burrows. Oxidised grains could have been reworked from shallower water depths. Sidewall core 7 (depth 1917.00m) was taken at the base of a fining upwards sequence. This fine grained, well sorted litharenite contains grains which appear to have been oxidised and rarely grains are rimmed by oxidised material. It is possible that oxidation was either a function of exposure, or flushing by meteoric waters after burial. Framboidal pyrite could indicate the depositional environment was marine but there is no glaucony to confirm this hypothesis. It is possible that this fine grained well sorted litharenite accumulated as a channel fill, perhaps on a lower delta plain where there was periodic exposure. There is nothing in sidewall core 8 (1901.00m) to provide any information re the depositional environment except the presence of muddy laminae that indicate variations in hydraulic energy.

Units Ca & Cb, Casino-1 and Casino-2
Sidewall cores from within and below the muddy interval in Unit Ca of Casino-2 have been extensively disrupted making identification of sedimentary structures difficult. Sidewall core 21 (1810.00m), which is a very fine grained greywacke within the muddy interval, does have laminae and possibly lenticular bedding. The latter may suggest deposition on a tidal flat, delta front or prodelta. Sedimentation rates were low during deposition of this sample because there is also 7% glaucony present, confirming the marine depositional environment and possibly the prodelta location. The presence of ripples indicates low energy currents operated. Sublitharenites below the muddy interval contain up to coarse sand size grains and rare muddy laminae. It would appear that these sandstones were deposited in a much higher energy environment perhaps in distributary channels or as mouth bars of a delta.

The equivalent interval of Unit Ca in Casino-1 is fining upwards and also contains fine to medium grained sublitharenites. Laminae in the sandstones are outlined by organic matter. Preservation of cutinite in sidewall core 12 (1783.00m) suggests a depositional environment close to the coast where land plants grew. The cutinite is relatively thick and would have been derived from a plant that could survive periods of aridity.

Core logged from near the top of the Waarre Formation in Casino-2 has been interpreted by Lemon (2002) as a regressive sequence from shallow marine shelf, tide influenced shoreline, beach barrier, lagoon to possibly fluvial facies. Ichnofacies identified in the core are consistent with an overall change from dominantly Cruziana bathymetry at the base to alternating zones of mixed Cruziana plus Skolithos, just Cruziana or Skolithos at the top of the core.

Core plugs used in the petrology study were taken from the cored sequence. Core plug 50 (depth 1780.46m) at the base of the sequence occurs within the interval that Lemon (2002) assigned to a shallow marine shelf. The subarkose is fine grained, well sorted and displays laminae outlined by organic matter (1.2%) and irregular patches of mud suggestive of bioturbation. There are approximately 1% glaucony grains in the subarkose which are interpreted as indicative of the marine depositional setting. Glaucony typically forms on continental shelves at the sediment-water interface by the replacement of other grains when pH is near 8, Eh is slightly reducing and sedimentation rates are low. It is possible that the glaucony is not *in situ* but has been incorporated into these sands (?storm deposits) during bioturbation from a overlying quieter facies deposited during fair-weather.

Three poor to moderately well sorted, medium to coarse grained quartzarenites were sampled from channel lithofacies. Core plugs 30 and 25 (depths 1774.43m and 1772.88m) are both thought to represent tidal channels because their grain size distribution is almost bimodal. Grain size differences are evident in selected laminae and are thought to reflect variations in the strength of ebb and flood tidal currents. In contrast, the channel deposit at the top of the core (core plug 1, depth 1763.18m) has a unimodal and positively skewed grain size distribution which may be characteristic of a fluvial channel. Tucker (2001) suggested that positive skewness is a result of finer grain sizes trapped between coarser grains where currents are not sufficient to rework the sediment and remove fine grained sediment.

The final sample from the core (core plug 10, depth 1765.80m) is a very fine grained, moderately sorted sublitharenite. A relatively high percentage of mica (2.2%) and stringers of brown anhedral clay in this sample may reflect a low energy hydraulic regime. Lemon (2002) suggested this was a lagoon based on the grain size and ichnofacies. However, there are very fine sand size grains of fresh glaucony (1.4%) in this sample, similar to that seen in the subarkose assigned to a shelfal depositional environment.

It may be possible with the additional information from the petrology to reinterpret some lithofacies from the core. Cruziana ichnofacies characterise moderately to intensely bioturbated facies below daily wave base but not storm wave base where the hydraulic regime is moderate to relatively low energy (Frey & Pemberton, 1984). Depositional environments such as estuaries, bays, lagoons, tidal flats and continental shelves are possible in the Cruziana ichnofacies. Of these facies, estuaries, bays and lagoons are mainly associated with transgression rather than regression (Reading & Collinson, 1996). Similarly beach-barriers are normally associated with transgression. Therefore the Cruziana ichnofacies in Casino-2 could be interpreted as either tidal flat and/or continental shelf since these facies characterise regression. Skolithos ichnofacies represent moderate to relatively high energy hydraulic regimes where the substrate is shifting such as along sandy shorelines. Therefore the ?beach identified in core could be a beach-ridge strandplain rather than a beach-barrier deposit. In addition to bioturbation, two of the most striking features of the Casino-2 core are the relatively clean nature of the sands and the high percentage of organic matter that has been preserved. Any facies interpretation must account for these features. Shoreface to shelf facies overlain by sand-dominated tidal flats with tidal channels and a beach-ridge would be a possible interpretation for a regressive sequence in the Casino-2 core. Intense bioturbation would be associated with the tidal flats and mangroves growing on the flat may have contributed the organic matter. Preservation of organic matter requires anoxic conditions therefore rates of burial on the tidal flat must have been very rapid.

d. Authigenic mineralogy & diagenetic alteration

Unit A, Casino-2

Unit A in Casino-2 contains rare grains of glaucony in the mudstone, and pyrite framboids that are thought to have formed as a response to the marine depositional environment. Glaucony forms at the sediment-water interface by the replaced of other grains when pH is near 8, Eh is slightly reducing and Fe is available. Pyrite forms when sulphide from the bacterial reduction of sulphate in marine pore waters and Fe^{2+} from detrital clays and organic matter is present. Typically these conditions develop soon after burial within the sediment.

Micritic siderite which has replaced grains and rarely fills pores probably formed under similar conditions to the pyrite except that sulphide activity was low. In a marine environment this can result from flushing by meteoric waters during storms and floods when plumes of relatively fresh water move offshore. Therefore the litharenites (Swcs 7 & 8, depths 1917.00m & 1901.00m) may have been aquifers at this time. Zonation within the pore filling siderite spar noted in sidewall core 7 (depth 1917.00m) indicates that there were probably multiple pulses of relatively freshwater. It is possible that isolated feldspars in this same sample were converted to kaolinite during one of these freshwater pulses, when pore fluids were slightly acidic (pH 4-7) and K^+ activity was low. As the pore fluids became more alkaline and K^+ activity remained low, igneous lithics containing ferromagnesium minerals could have been replaced by chlorite.

Poikilotopic, twinned calcite spar that filled pores and replaced grains in the fine grained litharenite (Swc 7, depth 1917.00m) is thought to be a late diagenetic burial cement. Grain packing was described as moderately open in this sample, but this appearance is partially the result of grain replacement by the calcite. The original packing was probably moderately close indicating the introduction of the cement after initial mechanical compaction. CO_2 necessary for the precipitation of calcite was probably released from organic matter in the sediments during maturation and the source of Ca may have been provided by the corrosion of plagioclase feldspars. Lack of calcite cement in sidewall core 8 (depth 1901.00m) may be explained by reduced initial permeability in this litharenite caused by muddy laminae. Lower permeability may have limited the flow of pore fluids into this zone.

Litharenites from Unit A do not contain either quartz, or feldspar overgrowths that are evident in Unit Ca.

Unit Ca, Casino-2

Below the thick muddy interval in Unit Ca there are feldspar and quartz overgrowths but above the muddy interval there are only quartz overgrowths. This zonation may correspond to the detrital feldspar and lithic mineralogy. Both plagioclase and K-feldspars were noted below the muddy interval but only K-feldspar above, and volcanic lithics only occur below the muddy interval. Dissolution/alteration of detrital plagioclase or volcanic lithics may have been the source of elements necessary for the precipitation of feldspar overgrowths. Alkaline pore waters rich in K^+, Si and Al would have resulted in K-feldspar overgrowths that lacked twinning.

Furthermore, higher total percentages of detrital feldspars occur below the muddy interval and these may explain why there is more kaolin in this zone. Kaolin forms when feldspars are altered thus liberating Si and Al. The excess Si that results from the replacement of feldspars by kaolin is one possible source for the Si required for the precipitation of quartz overgrowths. Quartz overgrowths formed prior to pore filling carbonate spar and may have provided a rigid framework to reduce mechanical compaction. Typically the overgrowths in this Unit are prismatic suggesting that silicification was limited and the more typical rhombohedral overgrowths did not form.

Carbonate cements below the muddy interval are comprised of a relatively early micritic siderite that replaced selected grains and probably formed when conditions were reducing but sulphide activity was low. Similar conditions to those described from Unit A where there was flushing by pulses of freshwater probably prevailed. Micritic siderite occurred prior to the development of quartz overgrowths. Later sparry cements that have replaced grains and filled pores are late diagenetic calcite and ankerite/dolomite. It is possible that the ankerite/dolomite spar is equivalent to the zoned siderite in Unit A since both may contain Fe. Mg may have been derived from volcanic lithics for the ankerite/dolomite. These two minerals could not be differentiated from the XRD traces because the secondary peaks were too small. Dolomite is preferred as the possible late cement because the spar does not show Fe staining in thin section. Pervasive calcite spar appears to be restricted to the base of Unit Ca where it was noted in sidewall core 12 (depth 1880.50m). This distribution of calcite may be related to an inherent zonation in the detrital feldspar mineralogy.

Above the muddy interval in Unit Ca there are traces of micritic siderite replacing grains and filling pores but neither calcite nor ankerite/dolomite were identified in the petrology samples. However, Lemon (2002) did note a zone of poikilotopic dolomite or dolomitic calcite cement at 1765.3m. Lack of detrital plagioclase above the muddy interval suggests that Ca may not have been available to form a calcite cement at this depth.

The only other authigenic minerals above the muddy interval that were not recognised elsewhere were trace amounts of illite associated with grain replacing kaolin and rectorite. Typically kaolin is thought to convert to illite with increasing depth of burial. However, in this instance it is the shallowest samples that contain the illite. An alternative hypothesis to explain the illite is that there were zoned detrital feldspars in the sequence and these have produced the variation. Part of the feldspar converted to kaolin and the other to illite. Rectorite is an illite-smectite detected by XRD in core plug 10 (depth 1765.80m) that may correspond to highly deformed illitic grains identified in the SEM study. Distribution of this mineral is thought to be related to the detrital mineralogy (altered micas) and the hydraulic regime, therefore it should not adversely influence reservoir quality. Rectorite probably formed prior to quartz overgrowths because there are traces trapped as dust rims.

Unit Ca, Casino-1

Diagenetic alteration in Unit Ca from Casino-1 is similar to that below the muddy interval in Casino-2. There are examples of both quartz and feldspar overgrowths and kaolin is relatively abundant. Furthermore, carbonate cements include micritic siderite and a later phase of clear spar (probably dolomite) but no calcite was noted from petrology samples at the base of Unit Ca.

Unit Cb, Casino-2

The medium to coarse grained quartzarenite (Cp 1, depth 1763.18m) from this unit contains three authigenic minerals. There are prismatic quartz overgrowths, rare vermiform kaolin that has replaced micas rather than feldspars and both framboidal and blocky pyrite. The presence of framboidal pyrite, which typically forms in association with marine pore waters may be evidence that there was a relative sea level rise which influenced this fluvial channel fill. Blocky pyrite was noted as a localised cement and replacing grains in all the other Units of the Waarre Formation. It is commonly interpreted as a late diagenetic mineral associated with bacterial reduction of reservoir bitumen.

Paragenetic sequence

All sandstones studied from the Waarre Formation have followed a similar diagenetic path. Variations between the units appear to be related to differences in the depositional environments and detrital mineralogy. The general sequence is summarised in Table 5 below but not all samples contain each phase identified in this table. The relative timing of events is based on relationships noted in thin section and from the SEM study but this sequence should not be considered inviolate. For example, there was no evidence re the timing of chlorite replacing lithics, feldspar overgrowths nor when hydrocarbons migrated.

TABLE 5. PARAGENETIC SEQUENCE

Event	Diagenetic Stage Early	Middle	Late
Glaucony	----		
Pyrite	----		----
Siderite	------		
Oxidation	--------		
Compaction	----------------------		
Dissolution	--------		
Kaolin	-------		
Illite		------	
Quartz		------	
Feldspar	?-------		
Chlorite		?------	
Calcite			--------
Ankerite/dolomite			-----
Hydrocarbons			?-----

e. Reservoir quality

Unit A, Casino-2

The distribution of calcite cement would be a major control of reservoir quality in Unit A. Where calcite is abundant porosity is restricted to minor dissolution pores (2%) and permeability would be extremely poor. These secondary pores are the result of partial feldspar corrosion and the complete dissolution of labile grains. Calcite cement may have been concentrated in those sands which had high initial permeability and thus acted as aquifers for carbonate saturated fluids. Therefore the primary control of reservoir quality was facies, but it is now the distribution of carbonate cement.

Estimation of reservoir quality in sidewall core 8 (depth 1901.00m) from this Unit was very difficult because of extensive crushing during sampling. The fact that it is so disrupted may indicate there was minimal cement and reservoir quality may have been retained. However, muddy laminae would have reduced permeability even if porosity were retained. The prime control of reservoir quality in this sample was probably depositional facies.

Unit Ca, Casino-2

Below the muddy interval, sidewall cores have retained variable reservoir quality. As for Unit A it is possible that the distribution of calcite cements and facies were the prime controls. Where calcite cements are abundant (eg Swc 12, 1880.50m) only secondary porosity (5.4%) has been retained and these pores are unlikely to be interconnected. Similarly where muddy laminae are recognised (Swc 15, depth 1857.00m) or there are high percentages of ductile lithics (Swc 13, depth 1871.00m) it is anticipated that reservoir quality is limited.

In the relatively clean sublitharenites where there are quartz overgrowths present then a rigid structure was provided to preserve primary intergranular pores (eg Swc 17, depth 1845.00m). Retention of approximately 10% intergranular porosity should mean that permeability is moderate especially when there are secondary pores (5%) to aid the interconnection. Quartz overgrowths are most apparent where there are the least number of lithics because there are more sites for silica precipitation. Higher percentages of lithics (eg Swc 13, depth 1871.00m) occur in those sandstones where compaction has resulted in close packing. This relationship can be attributed to the ductile nature of some lithics causing them to fill pores and block pore throats. Reservoir quality is probably limited in these samples.

Above the muddy interval in the core there are significantly less lithics and more quartz overgrowths allowing the retention of better reservoir quality. Observation of the core reveals that reservoir quality is reduced in those intervals with significant amounts of organic matter and trace fossils. Organic matter would have inhibited the precipitation of quartz overgrowths and thus allowed more mechanical compaction reducing both porosity and especially permeability. For example in core plug 50 (depth 1780.46m) where there is 1.2% organic matter, routine core analysis indicates high porosity (24.3%) but only 670.01mD permeability. Therefore the major control of reservoir quality was sedimentary facies.

The petrology study was deliberately concentrated on relatively clean sandstones where the impact from organic matter and trace fossils was minimised. The most obvious relationship from the petrology study is between grain fracturing and enhanced permeability. In those samples (Cp 30, depth 1774.43m & Cp 25, depth 1772.88m) where fracture porosity represents 1.2 to 3%, permeability ranges from 2696.4 to 4628.38mD respectively. Where fractures are absent (Cp 10, depth 1765.80m & Cp 50, 1780.46m) the permeability is 43.1 to 670.01mD. Fracturing is considered an artifact of problems during coring because there is no evidence of any diagenetic events which postdate these features. Drilling mud infiltrated the core and contaminants such as barite and sylvite have precipitated in pores from the drilling mud.

All sandstones above the muddy interval have high percentages of primary intergranular pores (10.2 to 22%) and the lowest value is associated with a sample (Cp 10, depth 1765.80m) that has a relatively high percentage of ductile altered micas (2.2%) and metamorphic lithics (5.6%). These ductile grains have probably blocked pore throats and reduced pore space. Because average grain size is only very fine sand in this sample the slightest amount of deformation would have considerable impact on porosity. The percentage of primary intergranular pores is also reduced, where there are localised pore filling blocky pyrite cements (Cp 30, depth 1774.43m).

Secondary porosity (0.6 to 5.4%) has resulted from the partial corrosion of feldspars and rarely the complete dissolution of labile grains. Dissolution is most abundant in the sublitharenite (Cp 10, depth 1765.80m) which has the highest percentage of ductile grains suggesting that there were also more labile grains in this sample. It would appear that the impact of sediment provenance and facies are still the major controls of reservoir quality in the upper part of Unit Ca. Microporosity is preserved between kaolin booklets (0-0.6%) but this is unlikely to have a significant impact on effective porosity.

Unit Ca, Casino-1

Again the prime control of reservoir quality appears to be related to depositional environments and facies. Sidewall core 15 (depth 1769.00m) which lacks evidence of sedimentary structures and laminae of organic matter has retained the highest percentage of primary intergranular pores (10%). Where laminae of organic matter are evident the proportion of intergranular pores is reduced to 5-6% because of mechanical compaction and development of sutured grain contacts. These laminae are likely to significantly reduce vertical permeability.

Secondary pores due to corrosion of feldspars and dissolution of labile grains represent 4-7% of total porosity in the sublitharenites. The highest percentage occurs in the finest grained sample (Swc 18, depth 1751.00m) just as it did in Casino-2. This indicates that more labile grains were concentrated in the finest grain sizes due to sorting by the hydraulic energy of the depositional environment.

Microporosity is associated with grain replacing kaolin booklets but is unlikely to significantly contribute to total porosity because there is only 2-5% kaolin present. Some of this kaolin may actually limit permeability because the booklets are squeezed into intergranular pores surrounding the grain that has been replaced.

Unit Cb, Casino-2

The quartzarenite from this unit (Cp 1, depth 1763.18m) lacks sedimentary structures and laminae of organic matter, therefore it is not surprising that reservoir quality is good. However, this sample has 1.2% fractures and high permeability (3525.79mD) which is probably partially an artifact of coring. Primary intergranular pores (22.8%) are well preserved and this suggests that despite the fracturing there should be good reservoir quality.

9. CONCLUSIONS

1. Lithics decrease in abundance from Unit A to Unit Ca/Cb in the Waarre Formation causing a change in lithology from litharenites to sublitharenites and then minor quartzarenites at the top of the sequence.

2. Sediment provenance varied during deposition of the Waarre Formation and may be related to rifting and tectonic movements on the King Island High and/or the Kanmantoo Fold Belt. Metamorphic lithics are most abundant in all Units with decreasing proportions of rock fragments derived from igneous and sedimentary terranes. At the base of Unit A the thick mudstone has a very high percentage of chlorite-smectite that probably weathered from a volcanic source (?Eumerella Formation). Unit A litharenites contain biotite and opaques that are not apparent in shallower units. Unit Ca in Casino-2 has a thick muddy interval in the middle which is comprised of both kaolinite and illite. Below the muddy interval there are more lithics (including volcanics), and both plagioclase and K-feldspar. Above the muddy interval lithics are less abundant, volcanics are absent and there is no plagioclase. In Casino-1 Unit Ca is almost devoid of all igneous lithics and only the deepest sample contains both plagioclase and K-feldspar. Unit Cb in Casino-2 had a similar provenance to the upper part of Unit Ca above the muddy interval.

3. Depositional environments in the Waarre Formation were dominantly marine but do show a range in hydraulic energy. Unit A may vary from continental shelf to channel fill on a lower delta plain with minor exposure. Unit Ca below the muddy interval may also represent distributary channels or mouth bars but was not exposed. Cutinite from Casino-1 indicates vegetation was adapted to periods of aridity during deposition of Unit Ca. Above the muddy interval the core is thought to represent a slow regressive sequence (possibly aggradation) from shoreface/shelf with Cruziana ichnofacies, through a strandplain and sandy tidal flat (Skolithos ichnofacies) to a fluvial channel.

4. Distribution of early diagenetic glaucony, pyrite and siderite were related to the depositional environments. Other authigenic minerals display zonation that in part may be related to differences in detrital mineralogy. Prismatic quartz overgrowths are absent from Unit A possibly because of the high percentage of lithics. Quartz and feldspar overgrowths occur in Unit Ca below the muddy interval but only quartz above. Plagioclase feldspars and volcanic lithics may have provided the elements necessary for feldspar overgrowths and calcite spar cements. Calcite spar has cemented permeable sands below the muddy interval in Unit Ca and in Unit A but not in the upper cleaner sands. Other authigenic minerals include kaolinite, illite, chlorite and traces of ankerite/dolomite.

5. Reservoir quality was primarily controlled by facies and sediment provenance. Reservoir quality has been reduced where there are high percentages of ductile grains, abundant organic matter and/or extensive bioturbation. These controls are overprinted by the distribution of calcite spar and on a minor scale localised pore filling pyrite cement. Abundant calcite has occluded primary intergranular pores. Good reservoir quality is associated with channel facies (tidal and fluvial) in the regressive sequence at the top of Unit Ca.

10. GLOSSARY OF TERMS

Framboid
A cluster of pyrite crystals with a spheroidal outline.

Glaucony
A term used to describe green minerals without any genetic connotations. If the green minerals can be identified, a specific mineral name is given.

Glauconite
An Fe-rich dioctahedral illite. The term is also used to refer to a family of Fe-rich dioctahedral clays with varying ratios of expanded (smectite) and non-expanded layers.

Granophyric Texture
A variety of micrographic intergrowth of quartz and alkali feldspar that is either crudely radiate or is less regular than micrographic texture.

Honeycomb Porosity
Secondary porosity produced by the corrosion (etching) of detrital grains.

Micrographic Intergrowth
A regular intergrowth of two minerals.

Microporosity
Porosity directly associated with clay minerals.

Neomorphism
All transformations between a mineral and the same mineral, or another of the same general composition.

Poikilotopic
A sedimentary textural term denoting a single crystal of carbonate enclosing more than one framework grain.

Trachytic
A textural term for igneous rocks in which there is a subparallel arrangement of microcrystalline, lath shaped feldspars. The term is not restricted in use to rocks of trachyte composition.

Vacuole
Gas or liquid filled inclusion.

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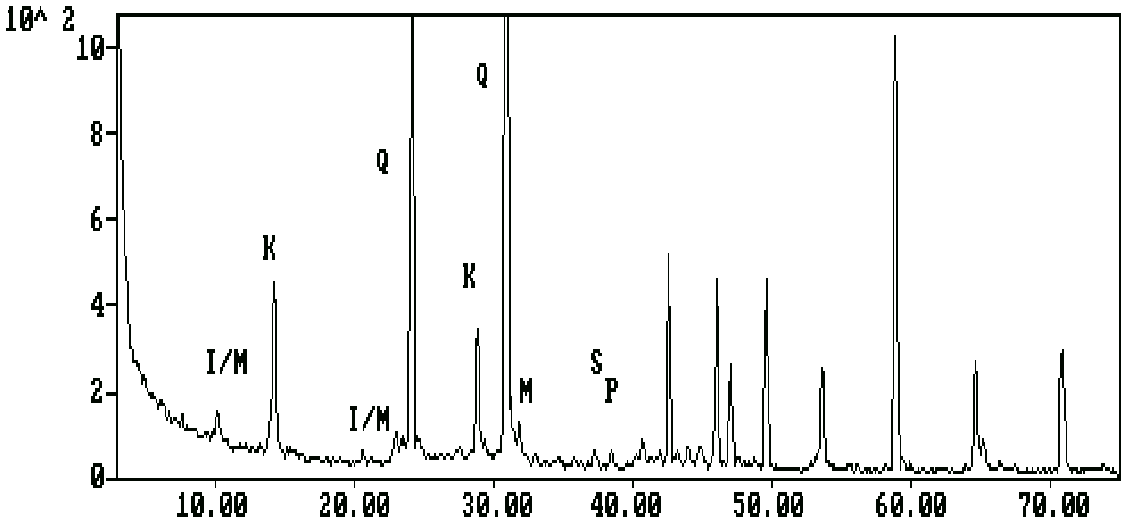
12. APPENDIX A

XRD TRACES

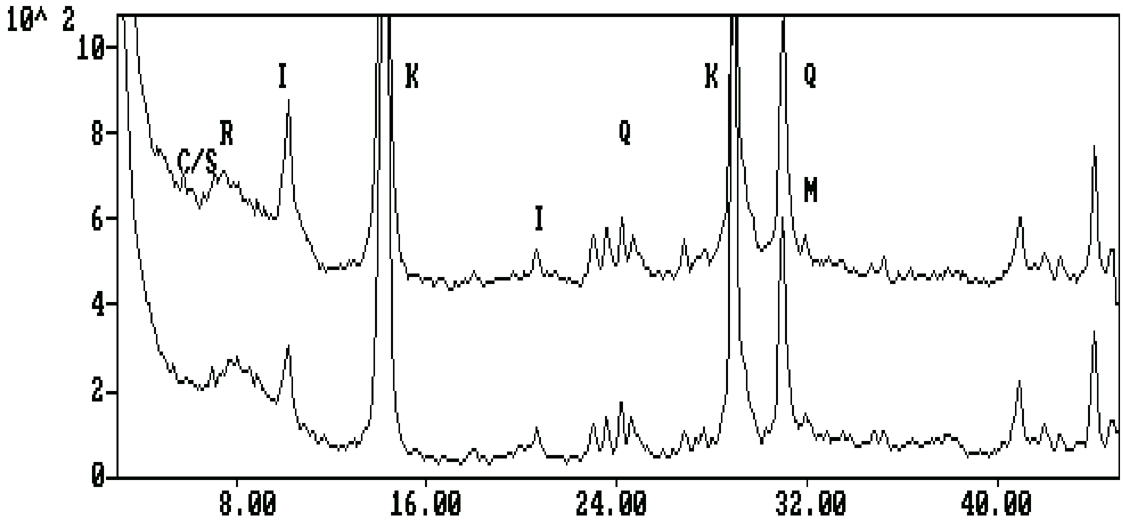
Only the strongest peaks for each mineral identified have been labeled on the XRD traces. The horizontal axis on each trace is in degrees two theta and the vertical axis is in counts of peak height. For the clay fraction both Mg saturated and Mg plus glycerol traces have been included to demonstrate movements in the peaks that aided identification of smectite. The following abbreviations have been used on the XRD traces:

A = albite
B = barite
C = calcite
C/S = interstratified chlorite-smectite
D = dolomite or ankerite
I/M = illite or muscovite
K = kaolinite
M = microcline
P = pyrite
Q = quartz
R = rectorite
S = siderite

Sample: CASINO-2, Core plug 10, depth 1765.80m.

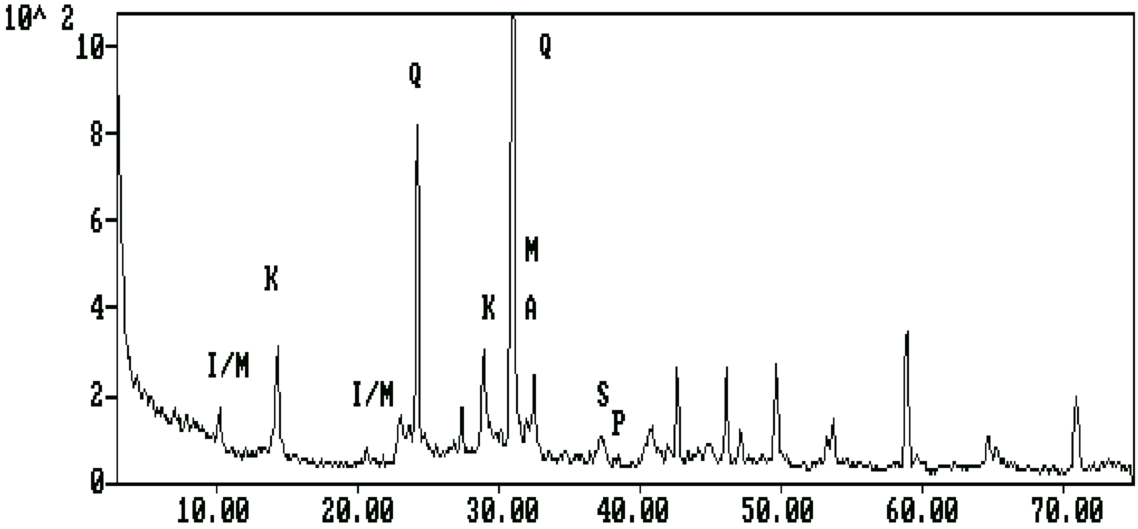


Bulk XRD trace.

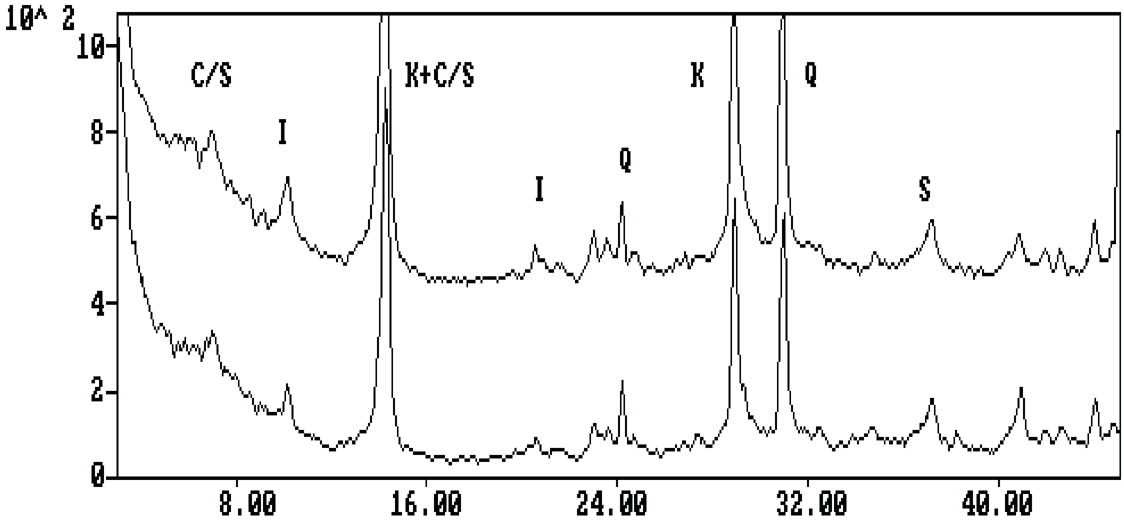


Clay XRD traces. (Lower trace is Mg saturated and air dried. Upper trace is Mg and glycerol saturated and air dried.)

Sample: CASINO-2, Swc 21, depth 1810.00m.

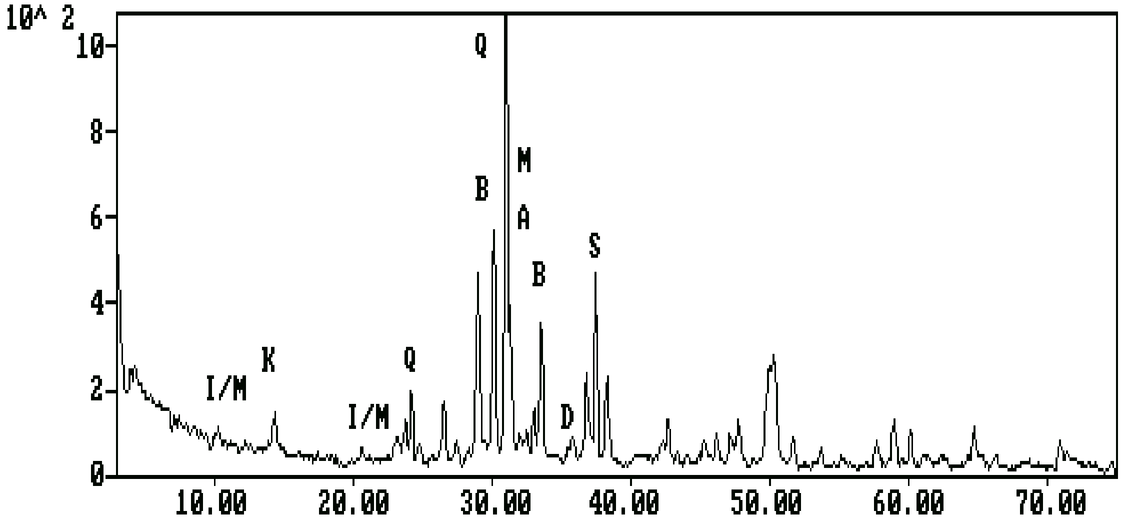


Bulk XRD trace.



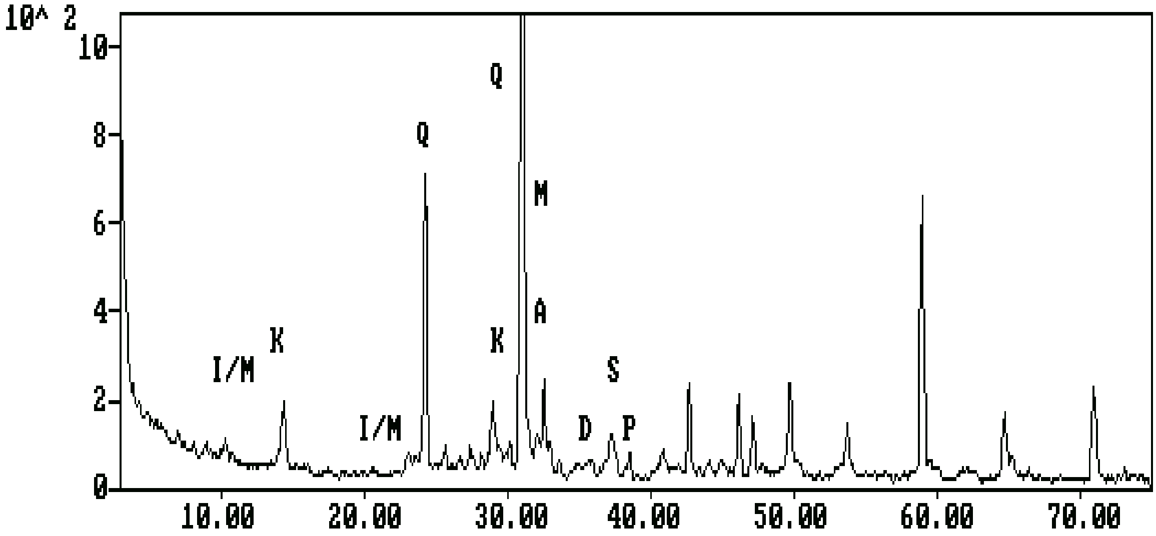
Clay XRD traces. (Lower trace is Mg saturated and air dried. Upper trace is Mg and glycerol saturated and air dried.)

Sample: CASINO-2, Swc 17, depth 1845.00m.



Bulk XRD trace.

Sample: CASINO-2, Swc 15, depth 1857.00m.



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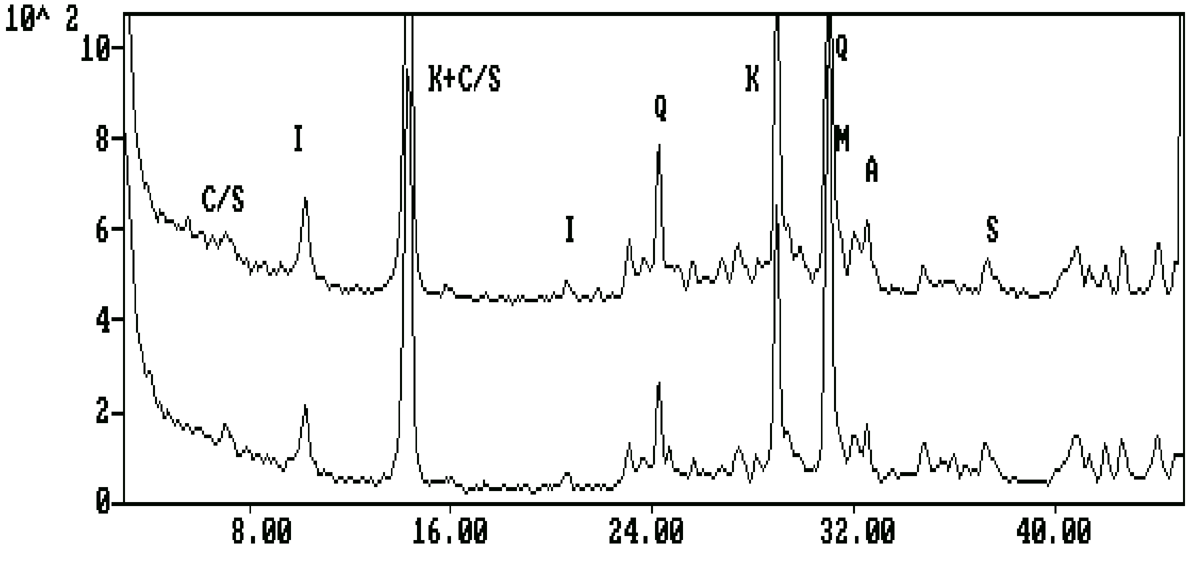
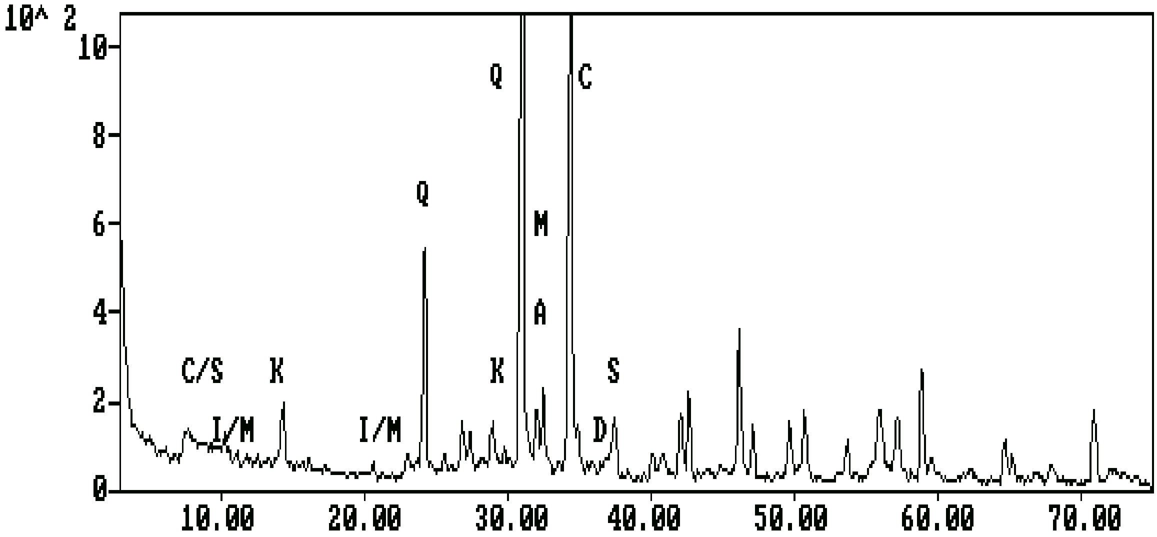


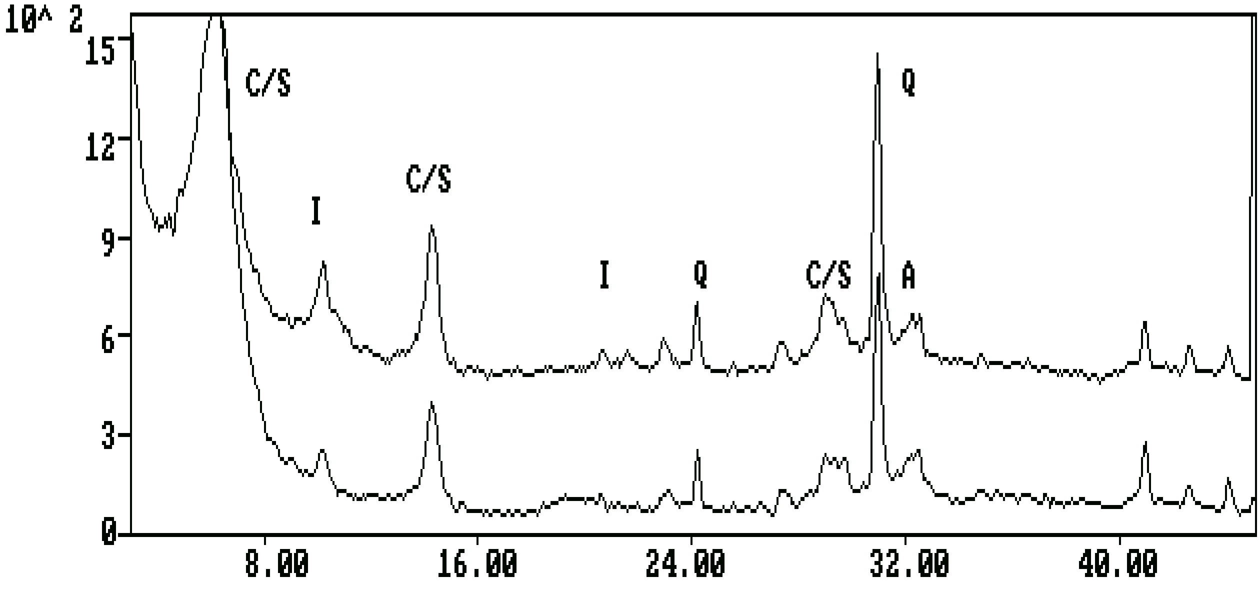
Clay XRD traces. (Lower trace is Mg saturated and air dried. Upper trace is Mg and glycerol saturated and air dried.)

Sample: CASINO-2, Swc 12, depth 1880.50m.



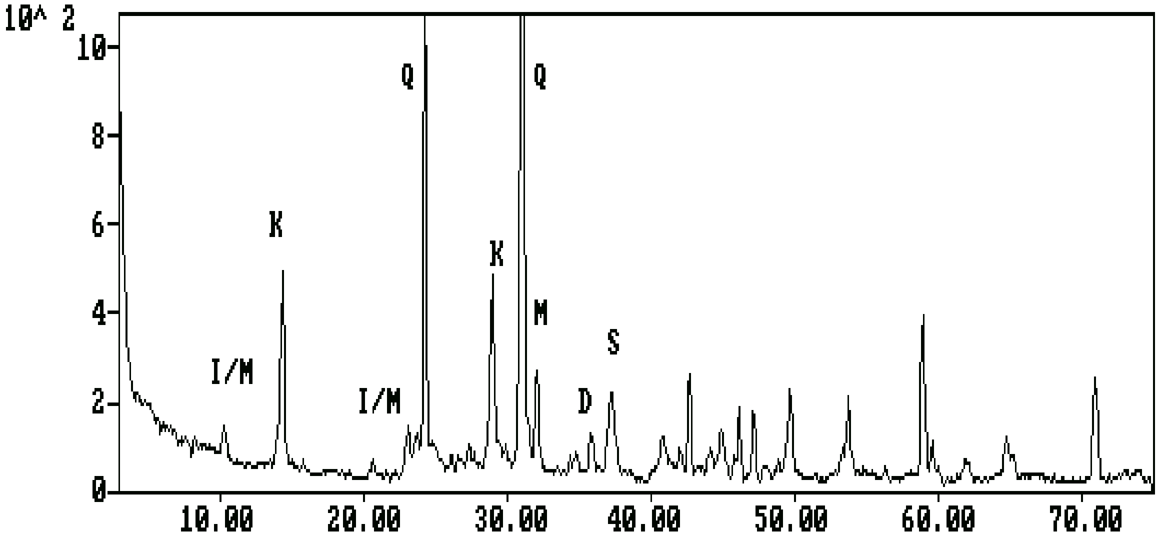
Bulk XRD trace.

Sample: CASINO-2, Swc 3, depth 1963.00m.



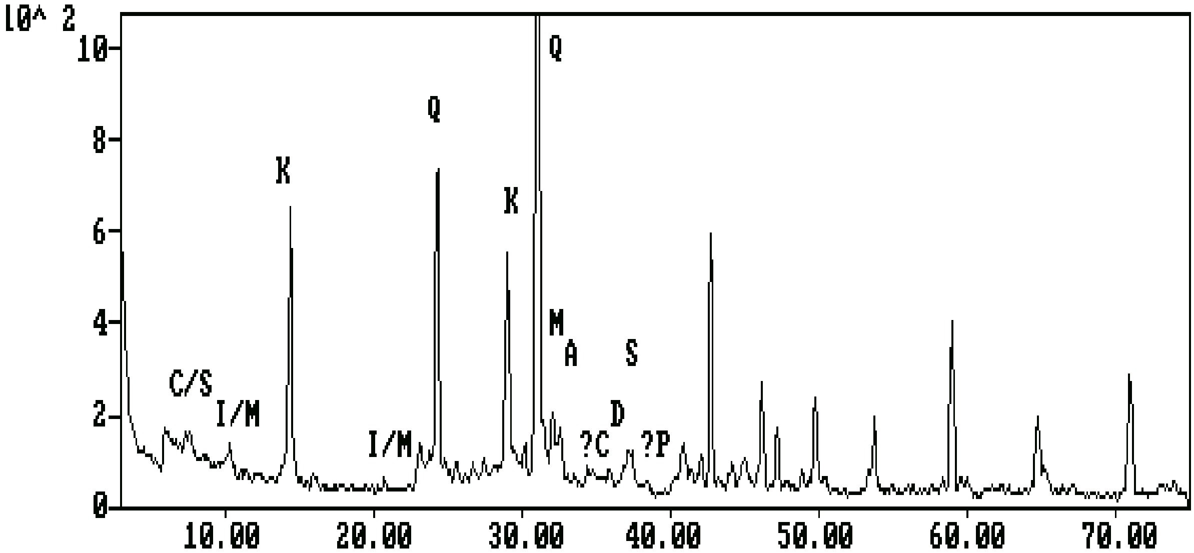
Clay XRD traces. (Lower trace is Mg saturated and air dried. Upper trace is Mg and glycerol saturated and air dried.) Note the change of scale on the vertical axis when compared to other samples. This was necessary to illustrate the height of the smectite peak.

Sample: CASINO-1, Swc 18, depth 1751.00m.

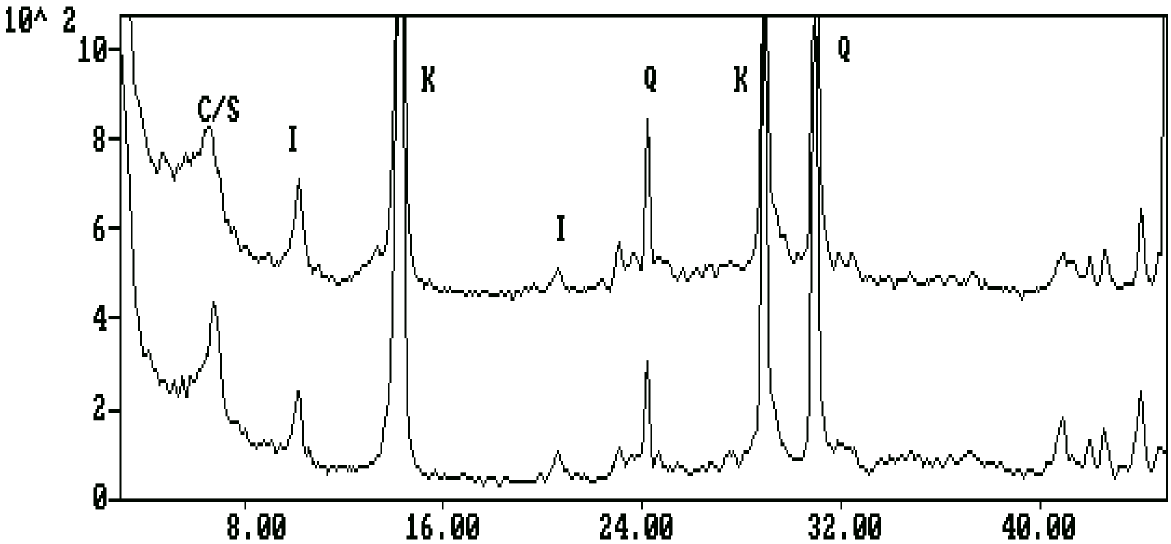


Bulk XRD trace.

Sample: CASINO-1, Swc 12, depth 1783.00m.



Bulk XRD trace.



Clay XRD traces. (Lower trace is Mg saturated and air dried. Upper trace is Mg and glycerol saturated and air dried.)

APPENDIX VI : PALYNOLOGY REPORT

The Palynology Report is presented overleaf.

SANTOS STRATIGRAPHIC SERVICES
EXPLORATION SERVICES DEPARTMENT

Palynology Report No. 2002/39

Author: R. HELBY
Approved by: G.R. WOOD
Date: 20/01/2003

PALYNOLOGICAL REPORT NO. 2002/39
PALYNOSTRATIGRAPHICAL ANALYSIS
CASINO NO. 2

Santos Ltd
A.C.N. 007 550 923

Circulation: Geology Operations,Team Leader, EIC, Palynology Files

Introduction

Twenty nine samples including sixteen sidewall cores, six conventional core samples and seven ditch cuttings samples from Casino No., 2 located in VIC/P44, were examined palynologically to assess their palynostratigraphic position and palaeoenvironment.

The palynostratigraphic results are presented in more detail on Table 1. A range chart of the palynomorphs identified in this study is presented in Appendix 1.

Biostratigraphic Framework

During the 1980's most of the palynology undertaken in the Otway Basin was expressed either in terms of the eastern Australian Mesozoic zonation developed by the Minad/APG group (Peter Price and co-workers) or the pan-Australian HMP scheme (Helby, Morgan & Partridge, 1987). Both of these schemes relied on classical interval zone concepts and lacked resolution in the predominantly non-marine to marginal marine Waarre Sandstone and to a certain extent the underlying Eumeralla Formation. By the mid 1990's the Morgan group had begun to develop an event stratigraphy (Morgan& Hooker *in* LaBella WCR) and Partridge (2001 Fig.2)

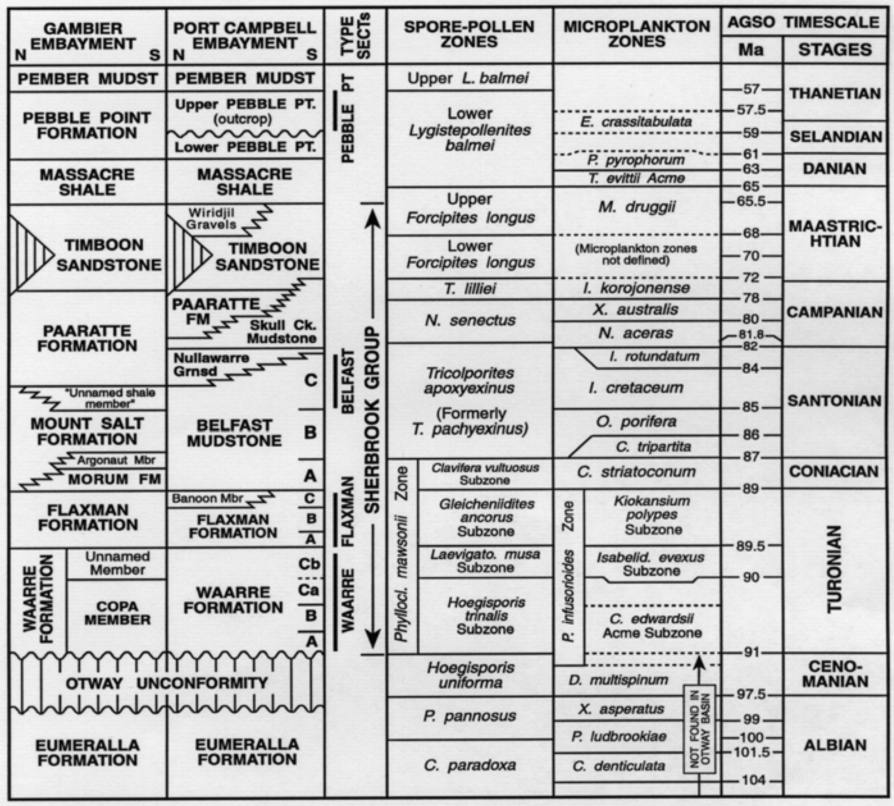


FIG 2 - Revised Sherbrook Group stratigraphy, palynological biostratigraphy and proposed correlation to international stages and AGSO chronometric timescale of Young & Laurie (1996).

Figure 1: From Partridge 2001, p. 456.

published a review and substantial up-date of the Late Cretaceous part of the HMP scheme, introducing a number of subzones based on both interval zone criteria and event features (acmes). The Partridge (2001) Waarre subdivision was based primarily on Port Campbell Embayment on-shore sequences. We have adopted the Partridge scheme but require more precision to satisfactorily label the sands in and below the Waarre "Ca" interval (i.e. below the base of *I. evexus*) in the offshore Otway sequences with expanded Waarre A to Ca sections. Development of an event stratigraphy is in progress to provide more sequence precision for the off-shore Waarre A to Ca interval. The events documented in Casino 2 are shown in Figure 2.

POINTS OF SIGNIFICANCE

1. The age of the seal (lowest sample at 1700m) is late Santonian *I. rotundatum* Zone which suggests that it is assignable to the upper Belfast Mudstone (unit C), possibly equivalent to the Nullawarre Greensand Member.
2. There is a substantial unconformity below this shale. The missing sequence encompasses the mid and lower Belfast Mudstone, the Flaxman Formation and the upper Waarre Formation, representing a period which may be as long as 5 million years.
3. The palynofloras immediately below the shale suggest a correlation with lower Waarre Ca or older (below 1987m in Minerva-2A). Marked by a relative acme of *Heterosphaeridium* and apparent absence of *Isabelidinium evexus*.
4. A distinctive dinocyst (*I. waarrense*) occurs between 1810-1838m. This is regarded as a marker ("Event 3") for the shale which is tentatively correlated with the Waarre B. This event is not represented in Casino-1 (removed by the unconformity).
5. The lowest occurrence of *Cyclonephelium compactum* ("Event 4") is recorded in ditch cuttings at 1844m.
6. A relative acme of *Rouseisporites* spp. ("Event 5") is recorded at 1890m.
7. *Hoegisporis trinalis* is recorded at 1890m and *Phyllocladidites* sp. at 1894m (deepest sample examined) suggesting that the spore-pollen suite is no older than *P. mawsonii* spore-pollen zone and thus probably no older than Waarre Sandstone.

Robin Helby

CASINO-2 PALYNOLOGY EVENTS

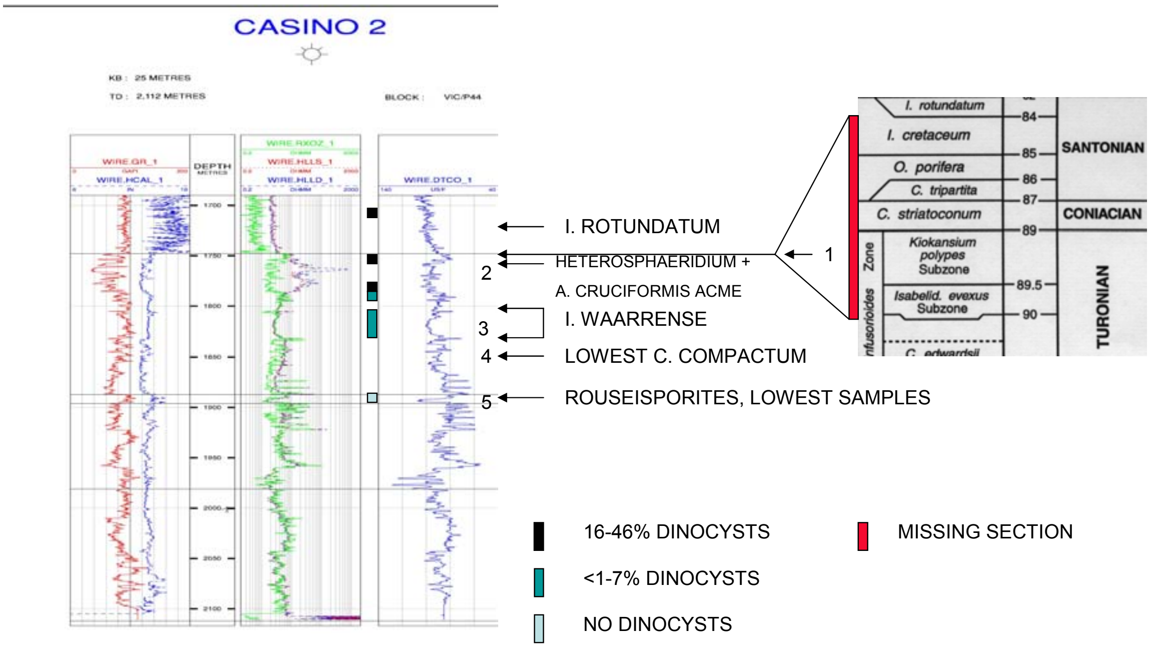


Figure 2: Waarre Formation Palynological Events – Casino-2

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
SWC30	1016.0	*D. heterophlycta* to *P. comatum* (dinocysts) upper mid to late Eocene	Dilwyn Formation	-	-	F-G	Mod.	High	Relatively diverse spore/pollen suite with *M. diversus, C. orthoteichus, S. prominatus* and relatively prominent *H. harrisii* and *Proteacidites* spp. Dinocyst suite (14%) with *Cooksonidium* (*Areosphaeridium*) *capricornum*. Shelfal marine.
SWC29	1060.0	*Lygistepollenites balmei* (spore-pollen) *A. reburrus* (dinocyst) Late Paleocene	Pember Mudstone	-	-	F-G	Mod.	High	Relatively diverse spore/pollen suite with *L. balmei, A. obscures, H. harrisii, M. subtilis* and *P. reticulosaccatus*. Moderately diverse microplankton suite (27%) with 4% *Apectodinium* (*reburrus*) *homomorphum*. Shelfal marine.
SWC28	1101.0	*Lygistepollenites balmei* (spore-pollen) Paleocene (undiff.)	Pebble Point Fm	<1	Perm	F-G	Low	Mod.	Moderately diverse spore/pollen suite with *T. longus, A. obscurus*, *L. balmei* and relatively prominent *G. rudata* (4%). Microplankton suite lacks diagnostic species. Shelfal marine.
SWC27	1152	*Lygistepollenites balmei* (spore-pollen) *P. pyrophorum* to *E. crassitabulata* (dinocyst) Paleocene	Massacre Shale	<1	Perm	F-G	Mod.	High	Relatively diverse spore/pollen suite with *T. longus*, *L. balmei* and prominent *G. rudata* (12%). Dinocyst suite (12%) dominated by *Areoligera* sp. and includes *I. bakeri.* Shelfal marine.
SWC26	1303.0	Upper *Tricolporites lilliei* *Campanian-Maastrichtian*	Skull Ck Mudstone	1	Perm	P-F	Mod.	Mod.	Relatively diverse spore/pollen suite with *G. edwardsii, L. balmei, N. senectus, T. longus* and prominent *Proteacidites* spp. (16%). Restricted dinocyst suite includes *Isabelidinium pellucidum.* Shelfal marine.

PALYNOSTRATIGRAPHICAL DATA

Table 1

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
SWC25	1500.0	*Xenikoon australis to Isabelidinium pellucidum* Upper early to late Campanian	Skull Ck Mudstone	1	Perm	P-F	Mod.	Mod.	Moderately diverse spore/pollen suite with *T. lilliei*, *A. obscurus* (5%), *D. granulatus* (14%), *N. senectus* and *Proteacidites* spp. (4%). Dinocyst suite not well defined but includes *O. porifera, P. infusorioides* and *Xenascus* sp., suggesting that it is no younger than Campanian. Shelfal marine.
SWC25	1500.0	*Xenikoon australis to Isabelidinium pellucidum* Upper early to late Campanian	Skull Ck Mudstone	1	Perm	P-F	Mod.	Mod.	Moderately diverse spore/pollen suite with *T. lilliei*, *A. obscurus* (5%), *D. granulatus* (14%), *N. senectus* and *Proteacidites* spp. (4%). Dinocyst suite not well defined but includes *O. porifera, P. infusorioides* and *Xenascus* sp., suggesting that it is no younger than Campanian. Shelfal marine.
SWC24	1555.0	Lower *Xenikoon australis* Upper early Campanian	Skull Ck Mudstone	-	-	VP-F	Mod.	Mod.	Relatively abundant (33% total palynomorphs), moderate diversity dinocyst suite, with *Heterosphaeridium* (11%), *N. aceras* and *X. australis*. Shelfal marine.
SWC23	1700.0	*I. kaikourense* (= *I rotundatum* of Partridge) Late Santonian	Belfast “C” equivalent	<1	Perm	P-F	Mod.	Mod.	Relatively abundant (35%), moderate diversity dinocyst suite, dominated by *Heterosphaeridium* (26% total palynomorphs) with *I. kaikourense*. Shelfal marine.
CUTT	1751	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm with Belfast “C” caving	-	-	P-F	Mod.	Mod.	Rich (67%), moderate diversity dinocyst suite dominated by caved *Heterosphaeridium* and *Odontochitina* spp. *K. polypes* present (4%) but lacking *V. griphus*. Shallow marine.

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
SWC22	1751.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	VP-G	Mod.	Mod.	Low diversity dinocyst suite dominated by *Heterosphaeridium* (30% = Event 2) with prominent *A. cruciformis* (11%). *Cribroperidinium* spp., *K. polypes* and *P. infusorioides* recorded. Shelfal marine.
CUTT	1754	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm with Belfast "C" caving	<1	-	P-F	Mod.	Mod.	Rich (71%), moderate diversity dinocyst suite totally dominated by caved *Heterosphaeridium* and *Odontochitina* spp. *K. polypes* present (4%+) but lacking *V. griphus*. Shallow marine.
CUTT	1760	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm with Belfast "C" caving	<1	-	P-F	Mod.	Mod.	Prominent (23%), low diversity dinocyst suite dominated by caved *Heterosphaeridium* and *Odontochitina* spp. *K. polypes, P. cretaceum* present but lacking *V. griphus*. Shallow marine.
FHC	1763.5	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	<1	-	P-F	Mod.	Mod.	Restricted (5%), low diversity dinocyst suite with *C. compactum*, *Heterosphaeridium, Oligosphaeridium* and *Spiniferites,* but lacking *V. griphus and K. polypes*. Fringing marine to lagoonal.
FHC	1767.65	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	<1	-	P-F	Mod.	Mod.	Restricted (6%), low diversity dinocyst suite with *C. compactum*, *Heterosphaeridium, K. polypes* and *P. cretaceum,* but lacking *V. griphus.* Fringing marine to lagoonal.
FHC	1768.7	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	<1	-	P-F	Mod.	Mod.	Very restricted (3%), low diversity dinocyst suite with *C. compactum*, *Heterosphaeridium* and *Spiniferites,* but lacking *K. polypes* and *V. griphus.* Fringing marine to lagoonal.

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS %	REWORKED ELEMENTS AGE	PRESER VATION	YIELD	DIVER SITY	REMARKS
FHC	1772.7	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	<1	-	P-F	Mod.	Low	Prominent (40%+), low diversity dinocyst suite in very lean sample with *C. compactum*, prominent *Heterosphaeridium and K. polypes. V. griphus* not recorded. Shallow to fringing marine.
FHC	1778.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Low	Mod.	Moderately prominent (19%), moderately diverse dinocyst suite with *C. compactum*, common *Heterosphaeridium* (12%) *and K. polypes. V. griphus* not recorded. Shallow to fringing marine.
FHC	1781.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Mod.	Mod.	Moderately prominent (18%), moderately diverse dinocyst suite with *C. compactum*, common *Heterosphaeridium* (12%) *and K. polypes. V. griphus* not recorded. Shallow shelf.
SWC21	1810.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Mod.	Mod.	Moderately rich (20% total palynomorphs), moderately diverse dinocyst suite with *Heterosphaeridium* (8%), *Isabelidinium waarrense* (3% = Event 3 top), *K. polypes, C. edwardsii* (2%) and *P. cretaceum*. Spore-pollen suite contains *H. trinalis*. Shallow shelf.
CUTT	1817	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	1	-	P-F	Mod.	Mod.	Relatively lean recovery with prominent (23%), low diversity dinocyst suite dominated by caved *Heterosphaeridium* and *Odontochitina* spp. *K. polypes, P. cretaceum* present but lacking *V. griphus*. Shallow marine.

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
SWC20	1823.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	1	Perm	P-F	Mod.	High	Low numbers (7% total palynomorphs), but high diversity dinocyst suite with *Heterosphaeridium* (3%), *Isabelidinium waarrense* (1% = Event 3), *K. polypes* (1%) and *P. cretaceum* (1%). Spore-pollen suite contains both *H. trinalis* and *L. musa*. Fringing marine.
SWC18	1838.0	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Low.	Low	Restricted, low diversity dinocyst suite with *Heterosphaeridium* (1%), *I. waarrense* (1% = base Event 3) and *P. cretaceum*. Spore-pollen suite contains *H. trinalis*. Fringing marine to lagoonal.
CUTT	1844	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Low	Mod.	Relatively lean recovery with prominent (34%), moderately diverse (but probably inflated by caving), dinocyst suite. Includes relatively common *C. compactum* (5% = Event 4), *K. polypes* (2%) and *P. cretaceum* (5%). Shallow marine.
SWC16	1854.0	*P. mawsonii* (spore-pollen) *H. trinalis* Sz. Turonian	Waarre Fm	3 1	Perm Trias	P-F	Low	Mod.	Moderately diverse spore-pollen suite with *A. distocarinatus* and *Hoegisporis trinalis*, but lacking *Laevigatosporites musa and Gleicheniidites ancorus*. Microplankton very restricted (<1%) and include *C. edwardsii, Spiniferites* and *Veryhachium*. Estuarine ?
CUTT	1862	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	1	Perm	P-F	V. low	Mod.	Very low recovery with moderate (17%), low diversity dinocyst component including relatively common *K. polypes* (5%) with *C. nyei, Cribroperidinium* and *Heterosphaeridium*. Spore-pollen suite not particularly diagnostic. Shallow marine.

PALYNOSTRATIGRAPHICAL DATA

Table 1

SAMPLE	DEPTH	PALYNOSTRATIGRAPHICAL UNIT (Age)	INFERRED STRATIGRAPHICAL UNIT	REWORKED ELEMENTS		PRESER VATION	YIELD	DIVER SITY	REMARKS
				%	AGE				
CUTT	1866	*P. infusorioides* Older than *I. evexus* subzone Turonian	Waarre Fm	-	-	P-F	Low	Mod.	Very low recovery with moderate (14%), low diversity dinocyst component including *C. edwardsii, Heterosphaeridium, K. polypes* (2%) and *Oligosphaeridium*. Spore-pollen suite includes *A. distocarinatus* and *H. trinalis*. Shallow marine.
SWC10	1890.0	*P. mawsonii* (spore-pollen) *H. trinalis* Sz. Turonian	Waarre Fm	- <1	Perm	P-F	V. low	Mod.	Moderate diversity spore-pollen assemblage including *A. distocarinatus* and *H. trinalis* with prominent *Corollina* spp. (12%) and a relative acme of *Rouseisporites* (Event 5). *Micrhystridium* recorded. Lagoonal to lower delta plain.
SWC9	1894.0	*P. mawsonii* (spore-pollen) *H. trinalis* Sz. Turonian	Waarre Fm	-	-	P-G	Mod.	High	Rich, diverse spore-pollen assemblage with *A. distocarinatus* and *H. trinalis.* Assemblage dominated by *Cyathidites* (20%), bisaccate (22%) and trisaccate pollen (16%). No unequivocal dinocysts recorded although a low diversity acritarch suite (dominated by *Micrhystridium*) was encountered. *Amosopollis cruciformis* present. Lagoonal to lower delta plain.

APPENDIX VII : SAMPLE ANALYSES

TABLE 1 - WATER ANALYSIS **JOB NUMBER: LQ12136**

WELL / ID:	CASINO-2	FORMATION:	
SAMPLE TYPE:	Mud Filtrate	INTERVAL:	
SAMPLE POINT:	1350 m	COLLECTED BY:	Client
DATE COLLECTED:	29/09/02		
DATE RECEIVED:	09/10/2002		

PROPERTIES:

pH (measured) = 7.3
Resistivity (Ohm.M @ 25°C) = 0.16
Electrical Conductivity (µS/cm @ 25°C) = 63700
Specific Gravity (S.G. @ 20°C) = na
Measured Total Dissolved Solids(Evap@180°C) mg/L = na
Measured Total Suspended Solids mg/L = na

CHEMICAL COMPOSITION

CATIONS		**mg/L**	**meq/L**	**ANIONS**		**mg/L**	**meq/L**
Ammonium	as NH4	na	na	Bromide	as Br	na	na
Potassium	as K	18780	480.31	Chloride	as Cl	21104	594.47
Sodium	as Na	3865	168.12	Fluoride	as F	na	na
Barium	as Ba	nd	nd	Hydroxide	as OH	nd	nd
Calcium	as Ca	200	9.98	Nitrite	as NO2	na	na
Iron	as Fe	nd	nd	Nitrate	as NO3	nd	nd
Magnesium	as Mg	50	4.12	Sulphide	as S	na	na
Strontium	as Sr	nd	nd	Bicarbonate	as HCO3	1079	17.69
Boron	as B	na	na	Carbonate	as CO3	nd	nd
Aluminium	as Al	nd	nd	Sulphite	as SO3	na	na
				Sulphate	as SO4	558	11.61
Total Cations		22895	662.52	**Total Anions**		22740.4	623.77

DERIVED PARAMETERS

a) Ion Balance (Diff*100/Sum) (%) = 3.01
b) Total Alkalinity (calc as CaCO3) (mg/L) = 885
c) Total of Cations + Anions = 45635
(calculated dissolved salts)
d) Hardness (calc as CaCO3) (mg/L) = 705

e) Theoretical Total dissolved salts = 40768
(From Electrical Conductivity)

QUALITY CONTROL COMMENTS

Item	Actual Value	Acceptance Criteria	Satisfactory? (Yes/No)
Ion Balance (%) =	3.01	5%	Yes
Undetected ions % =	-11.94	10%	Yes
(from comparison of calculated vs theoretical salts derived from measured conductivity)			
Expected pH range		< 8.3	Yes
% difference between measured total dissolved solids and calc total dissolved salts (from ionic comp) =	na	5%	na

na = not analysed
nd = not detected
is = insufficent sample

If No - what action is recommended by Amdel

TABLE 1 - WATER ANALYSIS **JOB NUMBER: LQ12136**

WELL / ID:	CASINO-2	FORMATION:	
SAMPLE TYPE:	Mud Filtrate	INTERVAL:	
SAMPLE POINT:	1500 -1650 m	COLLECTED BY:	Client
DATE COLLECTED:	29/09/02		
DATE RECEIVED:	09/10/2002		

PROPERTIES:

pH (measured) = 7.4
Resistivity (Ohm.M @ 25°C) = 0.15
Electrical Conductivity (µS/cm @ 25°C) = 65400
Specific Gravity (S.G. @ 20°C) = na
Measured Total Dissolved Solids(Evap@180°C) mg/L = na
Measured Total Suspended Solids mg/L = na

CHEMICAL COMPOSITION

CATIONS		**mg/L**	**meq/L**	**ANIONS**		**mg/L**	**meq/L**
Ammonium	as NH4	na	na	Bromide	as Br	na	na
Potassium	as K	18280	467.52	Chloride	as Cl	22241	626.50
Sodium	as Na	5205	226.40	Fluoride	as F	na	na
Barium	as Ba	nd	nd	Hydroxide	as OH	nd	nd
Calcium	as Ca	200	9.98	Nitrite	as NO2	na	na
Iron	as Fe	nd	nd	Nitrate	as NO3	5	0.07
Magnesium	as Mg	50	4.12	Sulphide	as S	na	na
Strontium	as Sr	nd	nd	Bicarbonate	as HCO3	480	7.87
Boron	as B	na	na	Carbonate	as CO3	nd	nd
Aluminium	as Al	nd	nd	Sulphite	as SO3	na	na
				Sulphate	as SO4	961	20.00
Total Cations		23735	708.02	**Total Anions**		23686	654.44

DERIVED PARAMETERS

a) Ion Balance (Diff*100/Sum) (%) = 3.93
b) Total Alkalinity (calc as CaCO3) (mg/L) = 393
c) Total of Cations + Anions = 47421
(calculated dissolved salts)
d) Hardness (calc as CaCO3) (mg/L) = 705

e) Theoretical Total dissolved salts = 41856
(From Electrical Conductivity)

QUALITY CONTROL COMMENTS

Item	Actual Value	Acceptance Criteria	Satisfactory? (Yes/No)
Ion Balance (%) =	3.93	5%	Yes
Undetected ions % =	-13.30	10%	Yes
(from comparison of calculated vs theoretical salts derived from measured conductivity)			
Expected pH range		< 8.3	Yes
% difference between measured total dissolved solids and calc total dissolved salts (from ionic comp) =	na	5%	na

na = not analysed
nd = not detected
is = insufficent sample

If No - what action is recommended by Amdel

TABLE 1 - WATER ANALYSIS **JOB NUMBER: LQ12136**

WELL / ID:	CASINO-2	FORMATION:	
SAMPLE TYPE:	Mud Filtrate	INTERVAL:	
SAMPLE POINT:	1700 -2112 m	COLLECTED BY:	Client
DATE COLLECTED:	29/09/02		
DATE RECEIVED:	09/10/2002		

PROPERTIES:

pH (measured) = 9.5
Resistivity (Ohm.M @ 25°C) = 0.11
Electrical Conductivity (µS/cm @ 25°C) = 88500
Specific Gravity (S.G. @ 20°C) = na
Measured Total Dissolved Solids(Evap@180°C) mg/L = na
Measured Total Suspended Solids mg/L = na

CHEMICAL COMPOSITION

CATIONS		**mg/L**	**meq/L**	**ANIONS**		**mg/L**	**meq/L**
Ammonium	as NH4	na	na	Bromide	as Br	na	na
Potassium	as K	26470	676.98	Chloride	as Cl	35939	1012.37
Sodium	as Na	6635	288.60	Fluoride	as F	na	na
Barium	as Ba	nd	nd	Hydroxide	as OH	nd	nd
Calcium	as Ca	50	2.50	Nitrite	as NO2	na	na
Iron	as Fe	nd	nd	Nitrate	as NO3	3	0.05
Magnesium	as Mg	nd	nd	Sulphide	as S	na	na
Strontium	as Sr	nd	nd	Bicarbonate	as HCO3	480	7.86
Boron	as B	na	na	Carbonate	as CO3	354	11.79
Aluminium	as Al	25	2.78	Sulphite	as SO3	na	na
				Sulphate	as SO4	1383	28.80
Total Cations		33180	970.86	**Total Anions**		38158.3	1060.86

DERIVED PARAMETERS

a) Ion Balance (Diff*100/Sum) (%) = 4.43
b) Total Alkalinity (calc as CaCO3) (mg/L) = 983
c) Total of Cations + Anions = 71338
(calculated dissolved salts)
d) Hardness (calc as CaCO3) (mg/L) = 125

e) Theoretical Total dissolved salts = 56640
(From Electrical Conductivity)

QUALITY CONTROL COMMENTS

Item	Actual Value	Acceptance Criteria	Satisfactory? (Yes/No)
Ion Balance (%) =	4.43	5%	Yes
Undetected ions % =	-25.95	10%	Yes
(from comparison of calculated vs theoretical salts derived from measured conductivity)			
Expected pH range		< 8.3	Yes
% difference between measured total dissolved solids and calc total dissolved salts (from ionic comp) =	na	5%	na

na = not analysed
nd = not detected
is = insufficent sample

If No - what action is recommended by Amdel

TABLE 1 - WATER ANALYSIS **JOB NUMBER: LQ12136**

WELL / ID:	CASINO-2	FORMATION:	
SAMPLE TYPE:	MDT Sample Chamber Fluid	INTERVAL:	
SAMPLE POINT:	Sample Chamber, Pressure: 4125 psi	COLLECTED BY:	Client
DATE COLLECTED:	29/09/02		
DATE RECEIVED:	09/10/2002		

PROPERTIES:

pH (measured) = 6.9
Resistivity (Ohm.M @ 25°C) = 0.65
Electrical Conductivity (µS/cm @ 25°C) = 15500
Specific Gravity (S.G. @ 20°C) = na
Measured Total Dissolved Solids(Evap@180°C) mg/L = na
Measured Total Suspended Solids mg/L = na

CHEMICAL COMPOSITION

CATIONS		**mg/L**	**meq/L**	**ANIONS**		**mg/L**	**meq/L**
Ammonium	as NH4	na	na	Bromide	as Br	na	na
Potassium	as K	3158	80.77	Chloride	as Cl	5233	147.40
Sodium	as Na	1706	74.21	Fluoride	as F	na	na
Barium	as Ba	1	0.01	Hydroxide	as OH	nd	nd
Calcium	as Ca	188	9.38	Nitrite	as NO2	na	na
Iron	as Fe	nd	nd	Nitrate	as NO3	213	3.44
Magnesium	as Mg	50	4.12	Sulphide	as S	na	na
Strontium	as Sr	nd	nd	Bicarbonate	as HCO3	1079	17.69
Boron	as B	na	na	Carbonate	as CO3	nd	nd
Aluminium	as Al	1	0.11	Sulphite	as SO3	na	na
				Sulphate	as SO4	386	8.05
Total Cations		5104	168.60	**Total Anions**		6911.1	176.57

DERIVED PARAMETERS

a) Ion Balance (Diff*100/Sum) (%) = 2.31
b) Total Alkalinity (calc as CaCO3) (mg/L) = 884.7
c) Total of Cations + Anions = 12015
(calculated dissolved salts)
d) Hardness (calc as CaCO3) (mg/L) = 675

e) Theoretical Total dissolved salts = 9920
(From Electrical Conductivity)

QUALITY CONTROL COMMENTS

Item	Actual Value	Acceptance Criteria	Satisfactory? (Yes/No)
Ion Balance (%) =	2.31	5%	Yes
Undetected ions % =	-21.12	10%	Yes
(from comparison of calculated vs theoretical salts derived from measured conductivity)			
Expected pH range		< 8.3	Yes
% difference between measured total dissolved solids and calc total dissolved salts (from ionic comp) =	na	5%	na

na = not analysed
nd = not detected
is = insufficent sample

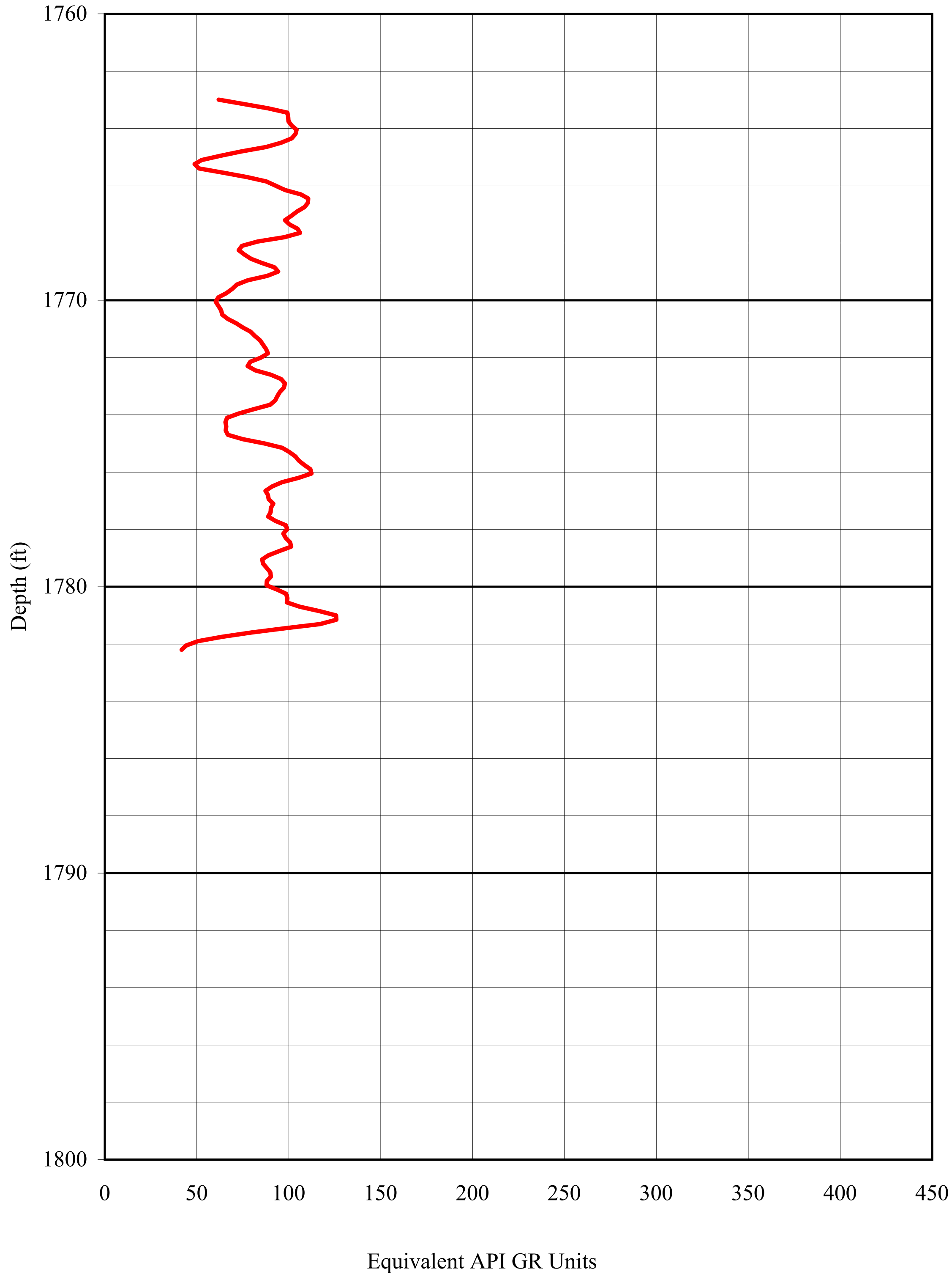
If No - what action is recommended by Amdel

APPENDIX VIII : CORE DATA

Casino 2 Core Data

Casino 2

Gamma Ray



Well:	Casino	Formation:					
No:	2	Amdel No:	LQ12122				
DEPTH	POROSITY	PERM	GRAIN	PERM	REMARKS		
ROUNDED	HE	KA	DENSITY	KV			
1763.08	21.5	3525.79	2.64				
1763.42	25.2	159.37	2.65				
1763.78	20.3	21.48	2.75				
1764.03	19.6	22.92	2.64				
1764.3	14.8	1.64	2.64	1.91			
1764.61	19.6	29.23	2.66				
1764.91	23.4	372.86	2.65				
1765.13	21.2	2227.96	2.65				
1765.48	6.4	0.42	3.07				
1765.8	22.1	43.10	2.67	15.11			
1766.1	10.3	1.05	2.64				
1766.4	23.8	91.12	2.67				
1766.7	25.2	322.40	2.67				
1767.05	9.0	0.62	2.66				
1767.36	20.8	87.41	2.67	1.80			
1767.97	18.2	1308.55	2.65				
1768.2	19.2	97.97	2.67				
1768.47	19.8	3857.16	2.64				
1768.8	20.5	46.38	2.64				
1769.14	11.6	1.35	2.62	0.26			
1769.4	14.1	3.18	2.65		Lighter densities represent varying carbonaceous material in sample		
1769.7	15.0	6.85	2.65				
1770.03	27.8	2069.17	2.65				
1770.35	26.8	894.23	2.66				
1772.88	19.8	4628.38	2.67	11.63	Plug fragile not a perfect cylinder		
1773.2	22.9	459.83	2.74				
1773.5	24.7	896.89	2.66				
1773.85	19.2	925.10	2.64				
1774.1	19.7	2627.05	2.63		Lighter densities represent varying carbonaceous material in sample		
1774.43	20.0	2696.40	2.67	0.73			
1774.75	21.5	1398.05	2.68				
1774.97	19.4	69.18	2.72				
1775.3	17.9	18.37	2.69				
1775.62	23.1	275.97	2.70				
1775.9	24.9	460.06	2.66	118.94			
1776.18	24.3	263.79	2.66				
1776.51	22.8	143.86	2.71				
1776.78	25.5	724.87	2.65				
1777.14	27.2	913.98	2.65				
1777.43	27.1	1004.45	2.66	409.39			
1777.7	17.5	963.32	2.65				
1778.04	22	158.25	2.66				
1778.3	21.1	56.38	2.65				
1778.6	12.3	1.23	2.62		Argill. & slightly carbonaceous varying laminations		
1778.9	25.2	475.14	2.66	6.63			
1779.2	25.3	989.03	2.66				
1779.48	24.7	654.44	2.66				
1779.8	16	48	2.67				
1780.13	18.4	24.54	2.69				
1780.46	24.3	670.01	2.61	1.75	Carbonaceous filaments and particles		
1780.7	25	991.17	2.67				
1781.35	27.1	495.56	2.72				
1781.62	25	445.92	2.74				
					High densities probably siderite		

PRELIMINARY PROFILE PERMEAMETRY

SAMPLE POINT	DEPTH (m)	PERMEABILITY Ka (md)	PERMEABILITY Kinf (md)	COMMENTS
1	1762.92	3250	3180	
2	1763.00	4580	4500	
4	1763.09	8210	8100	
5	1763.20	14.9	12.8	
6	1763.30	101	93.9	
7	1763.50	2.33	1.77	
8	1763.60	1.69	1.25	
9	1763.70	42.6	38.4	
10	1763.80	15.9	13.7	
11	1763.90	3.85	3.04	
12	1764.00	4.63	3.67	
13	1764.10	2.16	1.63	
14	1764.20	4.06	3.20	
15	1764.30	6.62	5.40	
16	1764.40	91.2	84.6	
17	1764.50	99.0	92.1	
18	1764.60	32.5	29.1	
19	1764.70	8.24	6.83	
20	1764.80	35.3	31.7	
21	1764.90	142	133	
22	1765.00	2650	2590	
23	1765.10	1020	990	
24	1765.20	0.025	0.008	
25	1765.30	0.046	0.017	
26	1765.40	0.135	0.068	
27	1765.49	0.045	0.017	
28	1765.60	1.01	0.706	
29	1765.70	17.9	15.6	
30	1765.80	23.0	20.3	
31	1765.88	33.4	29.9	
32	1766.00	1.70	1.25	
33	1766.10	0.245	0.138	
34	1766.19	0.305	0.178	
35	1766.30	60.4	55.3	
36	1766.40	30.4	27.1	
37	1766.50	47.9	43.5	
38	1766.60	78.4	72.4	
39	1766.70	128	120	
40	1766.80	49.6	45.0	
41	1766.90	1.23	0.884	
42	1767.00	1.49	1.09	
43	1767.11	4.43	3.52	
44	1767.20	16.1	13.9	
45	1767.30	2.92	2.26	
46	1767.40	33.6	30.1	
47	1767.49	8.980	7.500	
48	1767.62	1.43	1.04	
49	1767.70	0.470	0.299	
50	1767.80	84.6	78.4	
51	1767.91	131	123	

PRELIMINARY PROFILE PERMEAMETRY

SAMPLE POINT	DEPTH (m)	PERMEABILITY Ka (md)	PERMEABILITY Kinf (md)	COMMENTS
52	1767.99	328	313	
53	1768.10	23.7	20.9	
54	1768.20	75.2	69.3	
55	1768.30	19.7	17.2	
56	1768.40	7300	7200	
58	1768.52	11700	11500	
59	1768.60	938	910	
60	1768.66	9710	9590	
61	1768.80	53.2	48.5	
62	1768.90	0.620	0.411	
63	1769.00	0.064	0.027	
64	1769.10	9.89	8.31	
65	1769.20	2.11	1.58	
66	1769.30	2.21	1.67	
67	1769.40	53.6	48.9	
68	1769.50	16.1	14.0	
69	1769.60	2.42	1.84	
70	1769.70	4.15	3.28	
71	1769.80	44.3	40.2	
72	1769.90	1270	1240	
73	1770.01	836	809	
74	1770.11	2190	2140	
75	1770.20	168	159	
76	1770.31	878	850	
77	1770.39	1130	1100	
78	1770.50	1470	1430	
79	1770.60	246	234	
80	1770.70	318	302	
81	1770.80	1100	1070	
82	1770.90	412	395	
83	1771.00	2250	2200	
84	1771.10	136	128	
85	1771.21	519	499	
86	1771.30	424	406	
87	1771.40	476	457	
88	1771.52	229	217	
89	1771.61	331	316	
90	1771.70	237	225	
91	1771.85	219	207	
92	1772.07	154	145	
93	1772.20	57.7	52.7	
94	1772.30	33.1	29.7	
95	1772.40	146	138	
96	1772.53	192	182	
97	1772.61	1.30	0.933	
99	1772.80	315	300	
100	1772.90	5410	5330	
102	1772.99	1530	1490	
103	1773.10	251	238	
104	1773.20	430	413	
105	1773.30	218	206	

PRELIMINARY PROFILE PERMEAMETRY

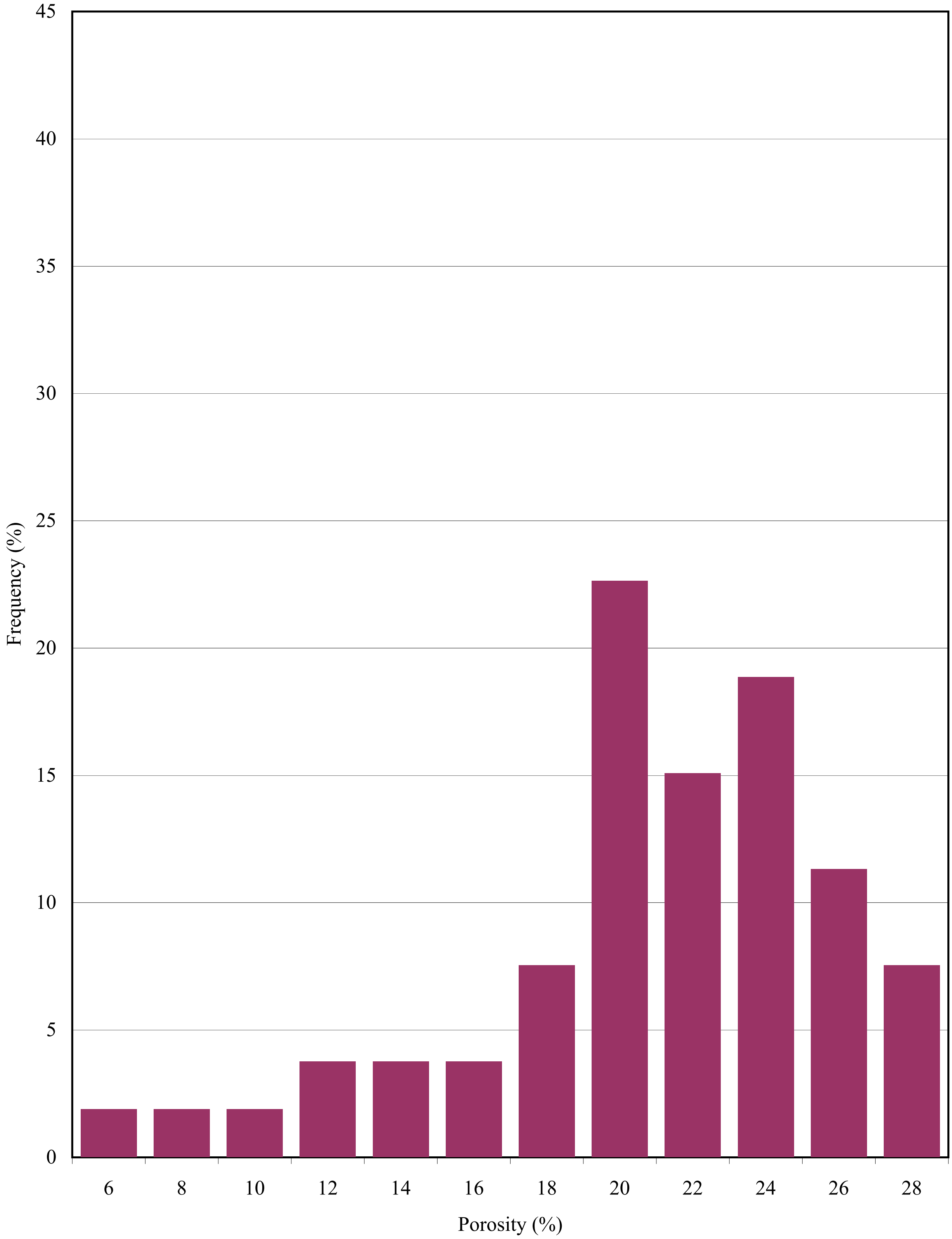
SAMPLE POINT	DEPTH (m)	PERMEABILITY Ka (md)	PERMEABILITY Kinf (md)	COMMENTS
106	1773.40	673	650	
107	1773.50	286	273	
108	1773.60	293	279	
109	1773.70	820	793	
110	1773.80	985	956	
111	1773.90	2890	2830	
112	1773.99	2580	2520	
113	1774.09	7620	7520	
115	1774.20	9510	9380	
116	1774.30	4720	4640	
117	1774.40	4280	4200	
118	1774.52	1510	1470	
119	1774.60	1070	1040	
120	1774.70	128	121	
121	1774.80	623	602	
122	1774.90	146	138	
123	1775.00	32.1	29.2	
124	1775.10	3.070	2.440	
125	1775.20	37.3	34.1	
126	1775.30	23.5	21.2	
127	1775.39	1070	1030	
128	1775.50	52.4	48.4	
129	1775.60	152	144	
130	1775.70	2.40	1.87	
131	1775.80	357	342	
132	1775.90	258	246	
133	1776.00	386	371	
134	1776.10	556	536	
135	1776.20	48.1	44.3	
136	1776.29	541	521	
137	1776.40	198	188	
138	1776.50	93.6	87.7	
139	1776.60	274	262	
140	1776.70	80.4	75.1	
141	1776.79	109	102	
142	1776.90	44.5	40.9	
143	1777.01	596	576	
144	1777.10	568	548	
145	1777.20	155	147	
146	1777.30	56	52	
147	1777.41	234	223	
148	1777.50	545	526	
149	1777.60	534	515	
150	1777.70	2210	2160	
151	1777.80	4.880	4.050	
152	1777.90	1.58	1.19	
153	1778.00	21.4	19.2	
154	1778.10	398	382	
155	1778.20	194	185	
156	1778.30	2.11	1.63	
157	1778.40	649	627	

PRELIMINARY PROFILE PERMEAMETRY

SAMPLE POINT	DEPTH (m)	PERMEABILITY Ka (md)	PERMEABILITY Kinf (md)	COMMENTS
158	1778.50	17.4	15.5	
159	1778.60	0.357	0.219	
160	1778.70	37.2	34.0	
161	1778.80	257	245	
162	1778.90	216	205	
163	1779.01	1.91	1.46	
164	1779.10	8.14	6.97	
165	1779.20	618	596	
166	1779.29	6.50	5.49	
167	1779.40	500	481	
168	1779.50	215	205	
169	1779.60	1.28	0.938	
170	1779.70	35.6	32.5	
171	1779.80	5.02	4.17	
172	1779.90	1830	1790	
173	1780.00	1090	1060	
174	1780.10	108	101	
175	1780.20	40.8	37.4	
176	1780.30	58.6	54.3	
177	1780.39	111	104	
178	1780.50	29.2	26.5	
179	1780.60	119	112	
180	1780.70	49.1	45.3	
181	1780.80	30.1	27.3	
182	1780.90	1.50	1.13	
183	1781.00	20.3	18.2	
184	1781.10	1.05	0.757	
185	1781.20	80.0	74.7	
186	1781.30	215	205	
187	1781.40	90.7	84.9	
188	1781.50	382	367	
189	1781.60	115	108	
190	1781.70	72.5	67.5	
191	1781.78	1.84	1.40	
192	1781.86	493	475	

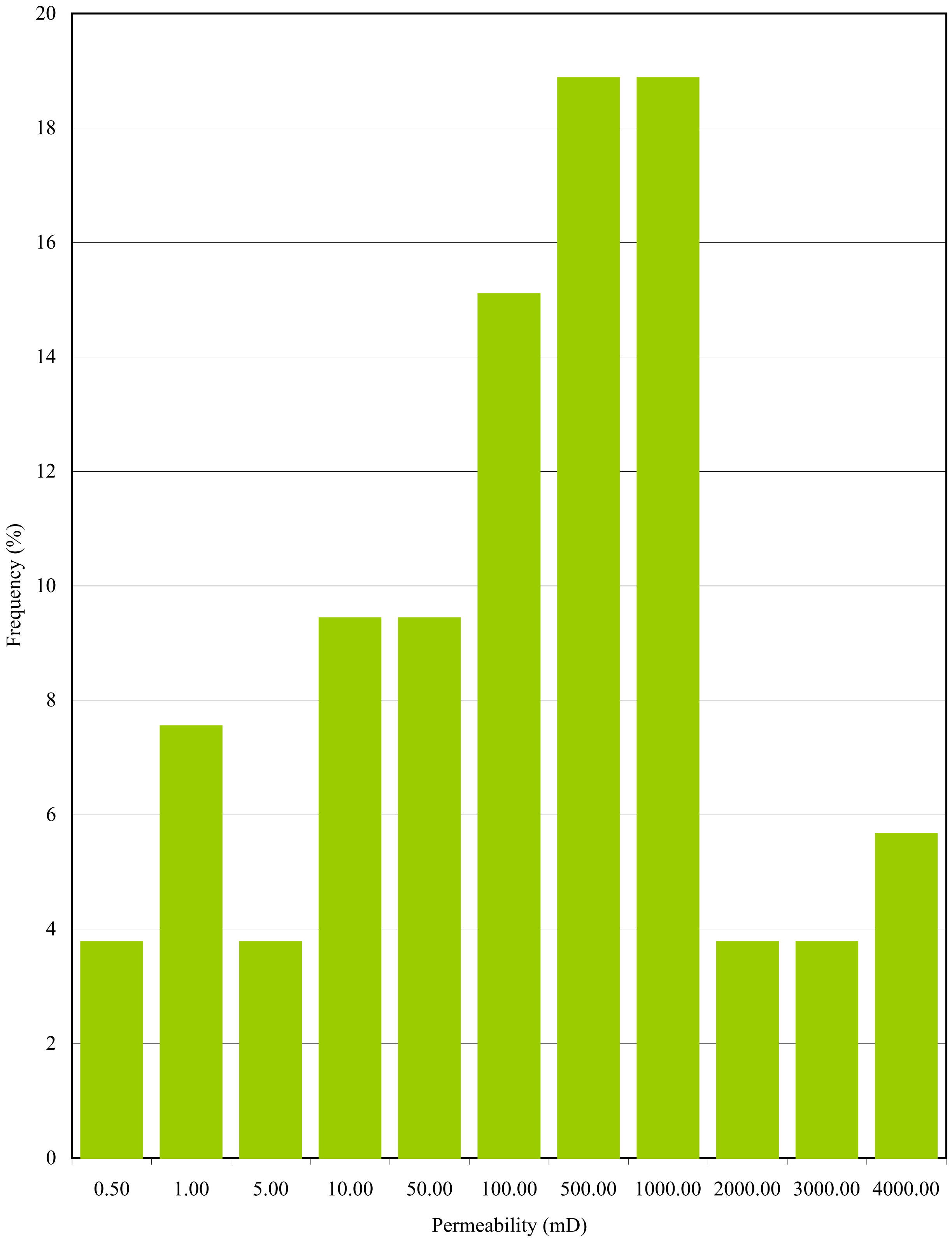
Casino No. 2

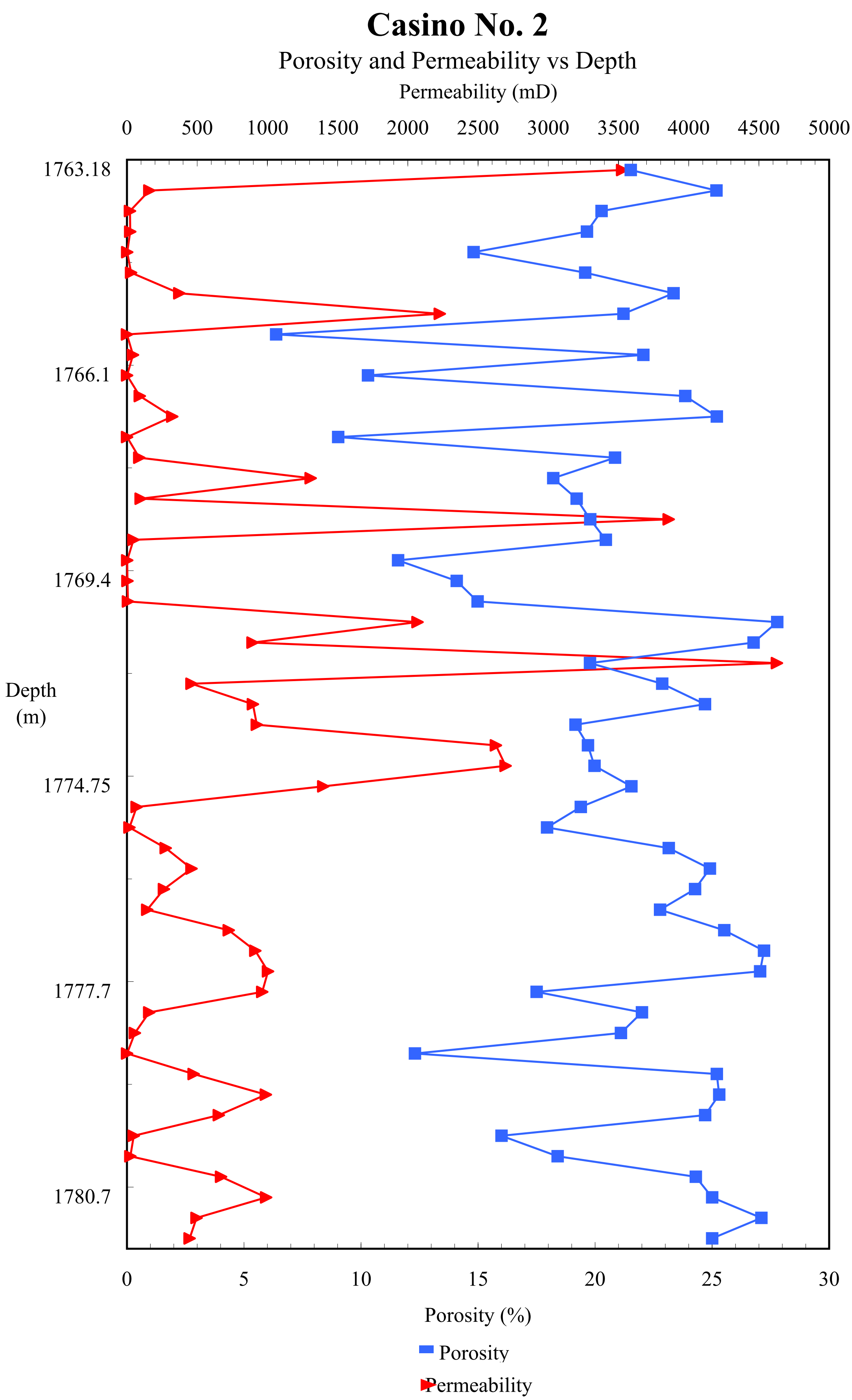
Porosity Histogram



Casino No. 2

Permeability Histogram

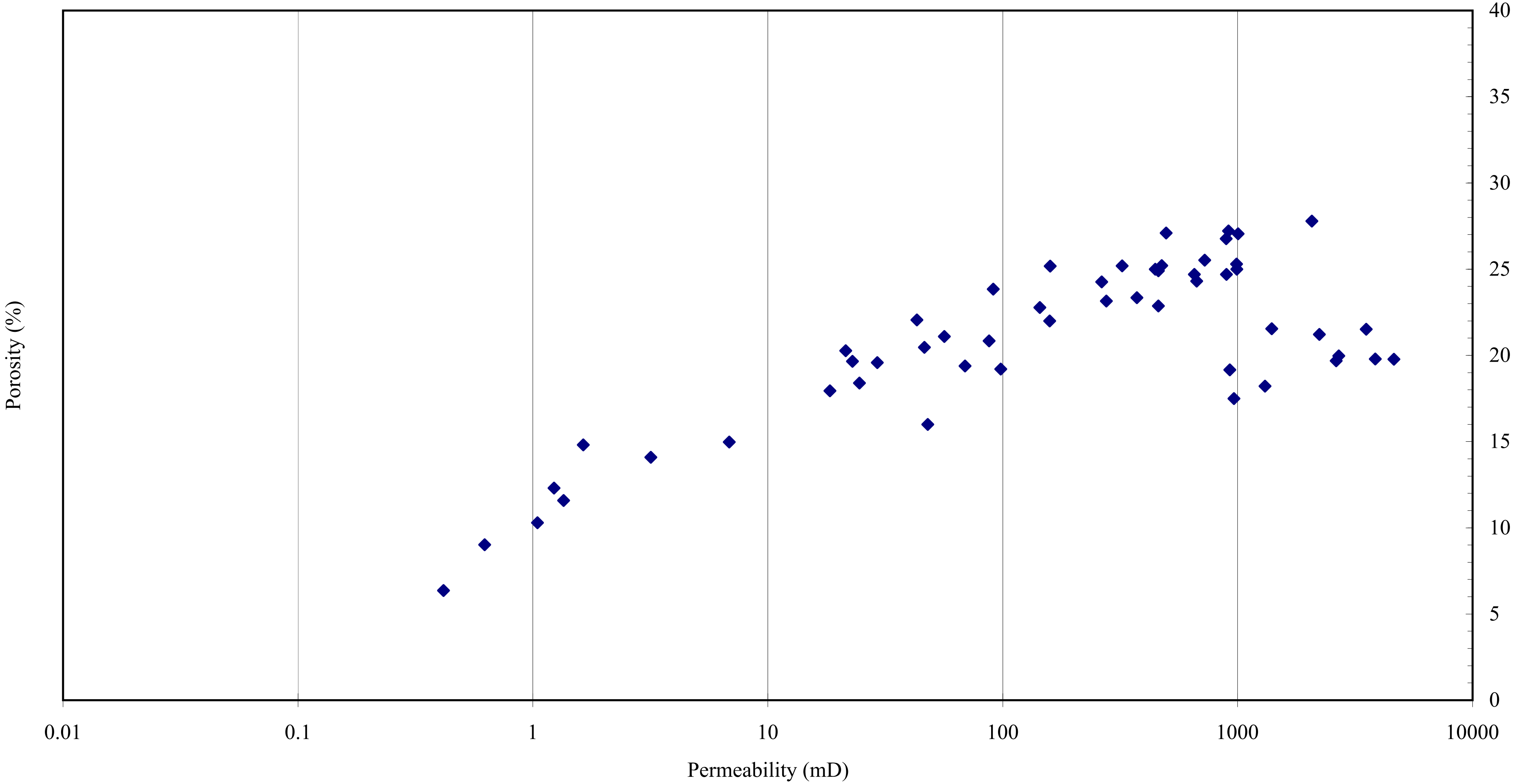




Casino No. 2
Porosity and Permeability vs Depth
Permeability (mD)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
1763.18
1766.1
1769.4
Depth (m)
1774.75
1777.7
1780.7
0
5
10
15
20
25
30
Porosity (%)
Porosity
Permeability

Casino No. 2

Porosity/Permeability Crossplot



From: Darren Matthews [DMatthews@amdel.com]
Sent: Friday, 24 January 2003 15:17
To: Pignetti, Anna
Subject: Latest Casino-2 results

Anna,

Please find on the table below vertical and horizontal permeabilities for the depths requested. Unfortunately the plugs cut at 1768.90 vertical and 1775.15 horizontal disintegrated during cutting and insufficient core was left to cut another.

Depth	Orientation	Permeability Ka (mD)
1763.60	Vertical	2.84
1763.60	Horizontal	0.99
1765.65	Vertical	1.45
1765.65	Horizontal	1.29
1766.20	Vertical	0.53
1766.20	Horizontal	0.40
1767.30	Vertical	0.95
1767.30	Horizontal	0.67
1768.90	Horizontal	1.45
1775.15	Vertical	8.55

Kind Regards

Darren Matthews
Petroleum Chemist
Amdel Ltd.

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Mob: 0408812763
Fax: +61 8 8234 2933
Web: www.amdel.com


SANTOS.
CASINO # 2.
1763 TO 1782·3 M
WAARRE fm
EXP. 1
LAB USE ONLY
5 Y 8/1
5 Y 6/1
5 Y 7/2
10 YR 7/4
10 YR 4/2
5 YR 3/4
10 R 2/2
5 YR 4/1
CORE. 1
1763
Ka. 21.48 Ø. 20.3
Ka. 159 Ø. 25.2
Ka. 3525 Ø. 21.5
1764
Ka. 372 Ø. 23.4
Ka. 29.23 Ø. 19.6
Ka. 1.64 Ø. 14.8
Ka. 22.92 Ø. 19.6
1765
Ka. 43.1 Ø. 22.1
Ka. 0.42 Ø. 6.4
Ka. 2227 Ø. 21.2
1766
Ka. 322 Ø. 25.2
Ka. 91.12 Ø. 23.8
Ka. 1.05 Ø. 10.3


SANTOS. CASINO # 2. 1763 TO 1782·3 M
WAARRE fm
CHALLENGER GEOLOGICAL SERVICES
EXP. 2
LAB USE ONLY
5 Y 8/1
5 Y 6/1
5 Y 7/2
10 YR 7/4
10 YR 4/2
5 YR 3/4
10 R 2/2
5 YR 4/1
CORE. 1
Ka. 1308 Ø. 18.2
Ka. 87.41 Ø. 20.8
Ka. 0.62 Ø. 9.0
1767
Ka. 46.38 Ø. 20.5
Ka. 3857 Ø. 19.8
Ka. 97.97 Ø. 19.2
1768
Ka. 6.85 Ø. 15.0
Ka. 3.18 Ø. 14.1
Ka. 1.35 Ø. 11.6
1769
Ka. 894 Ø. 26.8
Ka. 2069 Ø. 27.8
1770


SANTOS.
CASINO # 2.
1763 TO 1782·3 M
WAARRE fm
CHALLENGER GEOLOGICAL SERVICES
EXP.
3
LAB USE ONLY
5 Y 8/1
5 Y 6/1
5 Y 7/2
10 YR 7/4
10 YR 4/2
5 YR 3/4
10 R 2/2
5 YR 4/1
CORE. 1
1771
1772
Ka. 4628 Ø. 19.8
1773
Ka. 925 Ø. 19.2
Ka. 896 Ø. 24.7
Ka. 459 Ø. 22.9
1774
Ka. 69.18 Ø. 19.4
Ka. 1398 Ø. 21.5
Ka. 2696 Ø. 20.0
Ka. 2627 Ø. 19.7


SANTOS.
CASINO # 2.
1763 TO 1782·3 M
WAARRE fm
CHALLENGER GEOLOGICAL SERVICES
EXP. 4
CORE. 1
LAB USE ONLY
5 Y 8/1
5 Y 6/1
5 Y 7/2
10 YR 7/4
10 YR 4/2
5 YR 3/4
10 R 2/2
5 YR 4/1
1775
Ka. 460 Ø. 24.9
Ka. 275 Ø. 23.1
Ka. 18.37Ø. 17.9
1776
Ka. 724 Ø. 22.5
Ka. 143 Ø. 22.8
Ka. 263 Ø. 24.3
1777
Ka. 963 Ø. 17.5
Ka. 1004 Ø. 27.1
Ka. 913 Ø. 27.2
1778
Ka. 475 Ø. 25.2
Ka. 1.23 Ø. 12.3
Ka. 56.38Ø. 21.1
Ka. 158 Ø. 22.0


SANTOS.
CASINO # 2.
1763 TO 1782·3 M
WAARRE fm
EXP. 5
CORE. 1
LAB USE ONLY
5 Y 8/1
5 Y 6/1
5 Y 7/2
10 YR 7/4
10 YR 4/2
5 YR 3/4
10 R 2/2
5 YR 4/1
Ka. 48 Ø.16.0
Ka. 654 Ø.24.7
Ka. 989 Ø.25.3
1779
Ka. 991 Ø.25.0
Ka. 670 Ø.24.3
Ka. 24.54 Ø.18.4
1780
Ka. 445 Ø. 25.0
Ka. 495 Ø. 27.1
1781
1783
1782


INCH
DEAN
MADE IN
ENGLAND
FIBREGLASS
TAPE
CM
BOT.
WAARRE fm
TOP
CHALLENGER
GEOLOGICAL SERVICES
GRAIN SIZE
v. coarse sand 2.0—1.0
coarse sand 1.0—0.5
medium sand 0.5—0.25
fine sand 0.25—0.125
v. fine sand 0.125—0.063
SANTOS CASINO#2.
CORE 1
1763.0 to 1763.3m


DEAN MADE IN ENGLAND FIBREGLASS TAPE
INCH
CM
BOT.
WAARRE fm
TOP
CHALLENGER GEOLOGICAL SERVICES
GRAIN SIZE
v. coarse sand 2.0—1.0
coarse sand 1.0—0.5
medium sand 0.5—0.25
fine sand 0.25—0.125
v. fine sand 0.125—0.063
SANTOS CASINO#2. CORE 1 1766.6 to 1766.9m

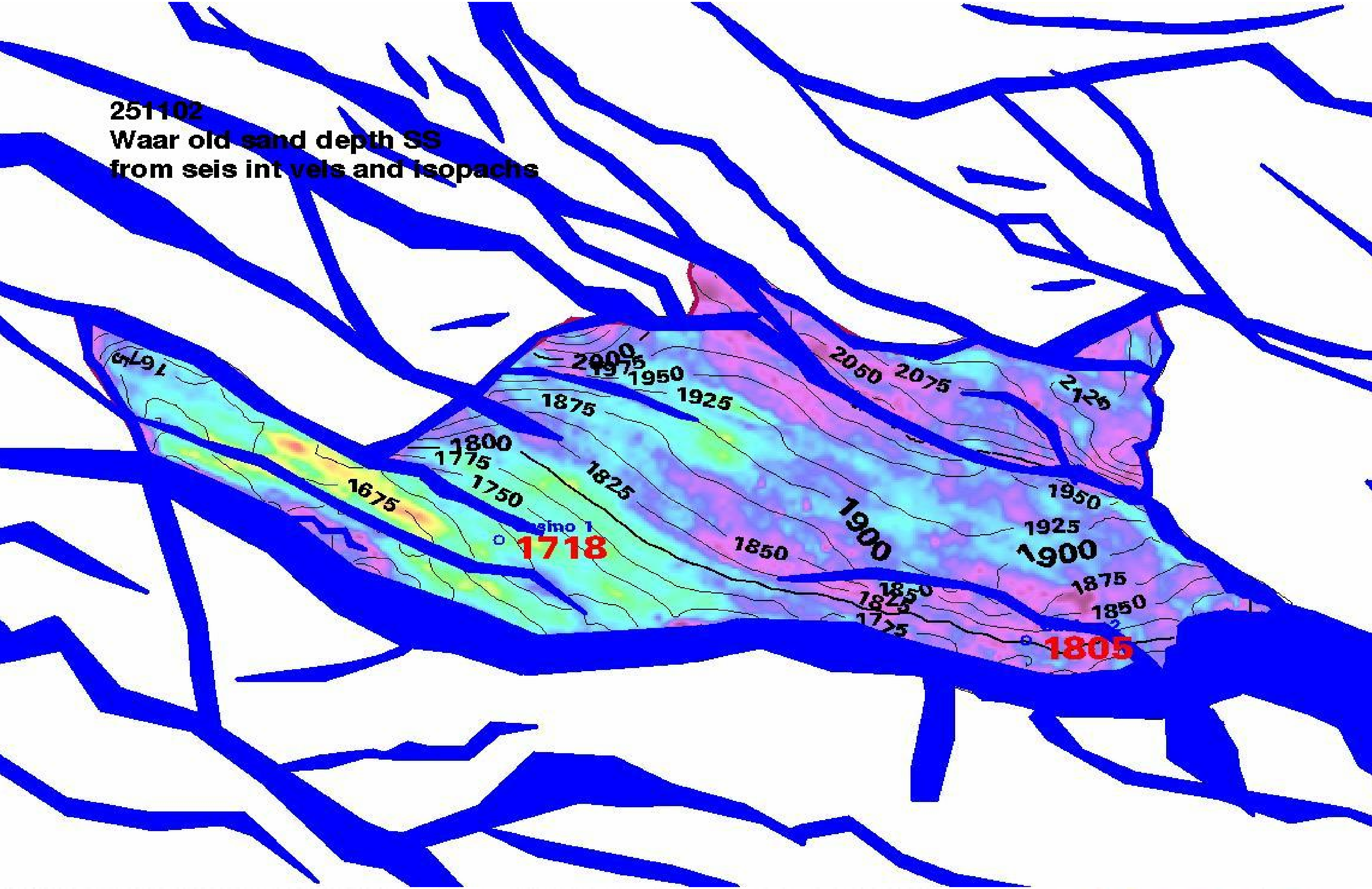

BOT.
WAARRE fm
TOP
CHALLENGER
GEOLOGICAL SERVICES
GRAIN SIZE
v. coarse sand 2.0—1.0
coarse sand 1.0—0.5
medium sand 0.5—0.25
fine sand 0.25—0.125
v. fine sand 0.125—0.063
SANTOS CASINO#2. CORE 1 1768.38 to 1768.68m


DEAN INCH MADE IN ENGLAND FIBREGLASS TAPE
BOT.
WAARRE fm
TOP
CHALLENGER
GEOLOGICAL SERVICES
GRAIN SIZE
v. coarse sand 2.0—1.0
coarse sand 1.0—0.5
medium sand 0.5—0.25
fine sand 0.25—0.125
v. fine sand 0.125—0.063
SANTOS CASINO#2. CORE 1 1773.23 to 1773.53m

ENCLOSURE I : COMPOSITE LOG (1:500 SCALE)

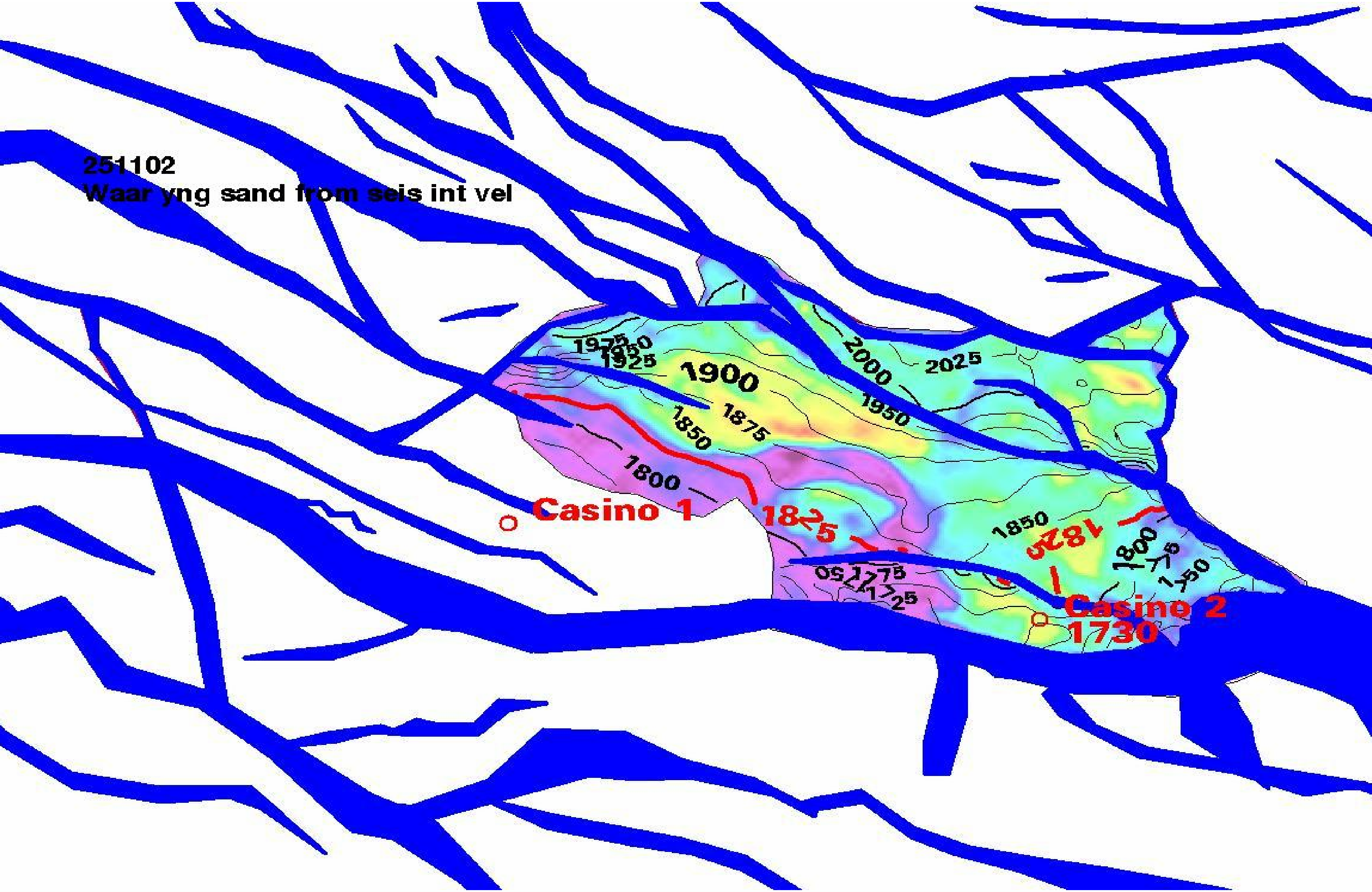
ENCLOSURE II : DEPTH STRUCTURE MAP

Casino – Depth Map Top "Older Sand" C.I. 20m

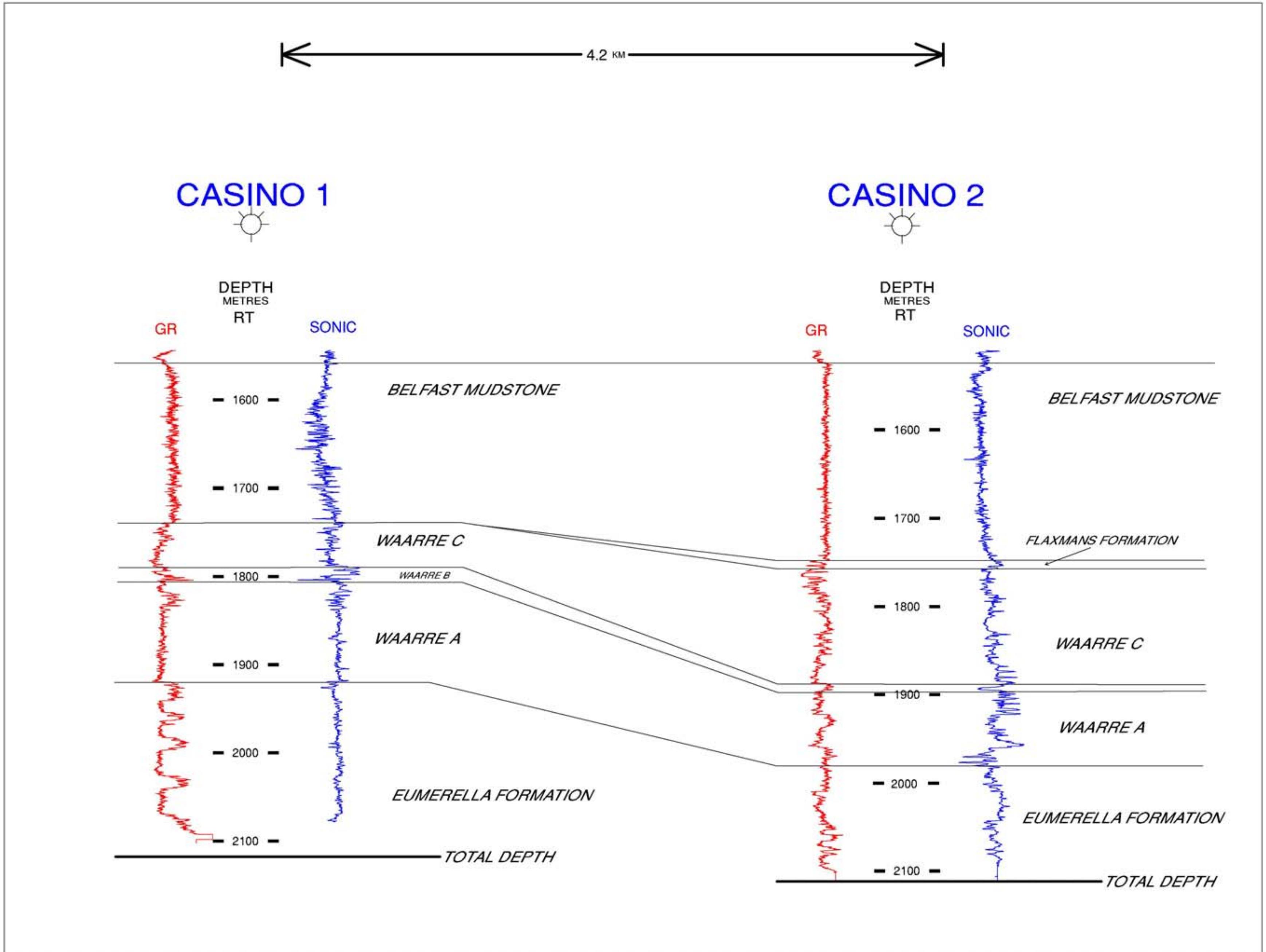


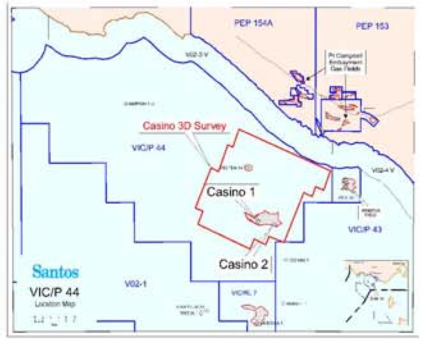
Santos

Casino – Depth Map Top “Younger Sand” C.I. 20m



ENCLOSURE III : STRATIGRAPHIC CROSS SECTION





Santos
Southern Business Unit

Stratigraphic Cross Section
Casino 1 - Casino 2

Datum: Belfast Formation

Date : March 19, 2003	Author : Maris Zwigulis	ENCL.
Drafted: Justin Clayton	File(cgm) : :/plots/maris_casino.cgm	

ENCLOSURE IV : PRELIMINARY LOG INTERPRETATION ANALOGUE PLOT