ORIGIN ENERGY RESOURCES LIMITED

SAWPIT SANDSTONE

PROSPECTIVITY REVIEW

GEOLOGICAL ANALYSIS

OTWAY BASIN

SOUTH AUSTRALIA

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GEOLOGICAL ANALYSIS

1. Regional Geology

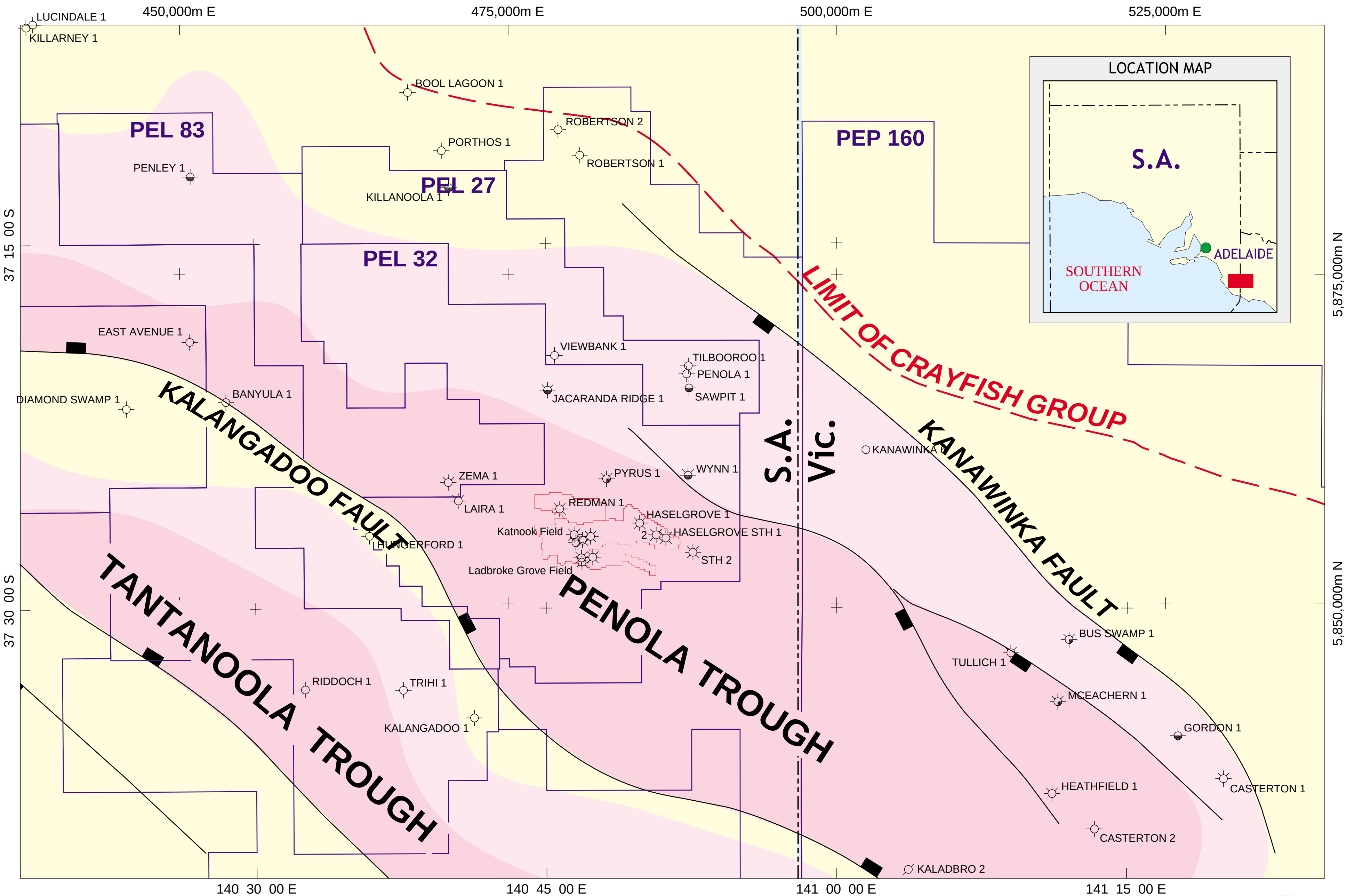
The regional geology of the onshore Otway Basin is described below with particular references to the Penola Trough flank. Current permits along the northeastern flank of the northwesterly trending Penola Trough, include PEL 27 & 32 in South Australia and PEP 160 in Victoria. (Figure 1).

The Otway Basin is one of a series of basins along the southern margin of Australia that was formed because of rifting between Australia and Antarctica in the Late Jurassic and Early Cretaceous (Lovibond *et al.,* 1993). The Penola Trough was formed as one of many half graben along the length of the Otway Basin (Morton and Drexel, 1995). Other major structural features in the region include the northwesterly trending Kalangadoo Fault and Tantanoola Trough. The Kalangadoo Fault bounds a basement high, which forms the southern boundary of the Penola Trough and the northern boundary of the Tantanoola Trough. This report focuses on the development of the Sawpit Sandstone in the Penola Trough. A similar facies may be present in the Tantanoola Trough as evidenced by seismic facies correlation but no well penetrations occur.

The generalised stratigraphy for the Penola Trough (figure 2) is described below using the stratigraphic nomenclature modified from Morton and Drexel 1995, incorporating the informal nomenclature for the Crayfish Group sequences described by Lovibond *et al.,* 1993. Palynological evidence suggests that further revision of the formal nomenclature, especially relating to the Sawpit Sandstone and associated units, within the Pretty Hill Formation, is required (P. Price 2000).

The Palaeozoic basement of the Otway Basin is comprised of low grade metamorphosed Cambrian to Lower Ordovician sedimentary rocks and Devonian granitic intrusives. Wells that have intersected Palaeozoic basement have encountered light greenish grey quartz-mica schist. The rocks are well foliated and intensely folded, and are more akin to the metamorphics of the Kanmantoo Fold Belt in western Victoria and South Australia than to the sedimentary rocks of the Lachlan Fold Belt of central Victoria (Abele *et al.,* 1995).

Sedimentation commenced in the Otway Basin during the Tithonian - Berriasian with the deposition of early rift sediments into newly formed half graben.



OTWAY BASIN - TECTONIC ELEMENTS

(After Constantine - VIMP 62 - 1999)

20932.042002 Fig.1

This non-marine sequence, which is formally named the Casterton Formation has been intersected along the Penola Flank in Sawpit 1 and Tilbooroo 1, in SA PEL27; Bus Swamp 1, Casterton 1 and McEachern 1 in VIC PEP160; but has not been intersected in SA PEL32 to date.

The deposition of the Casterton sequence was controlled primarily by the earliest east-west trending faults resulting from north-south extensional forces initiating the early rifting episode.

The Casterton Formation, which rests unconformably on the Palaeozoic basement, is interpreted as having been deposited in a low energy lacustrine environment (Abele *et al.,* 1995) with swamp and peat bog environments also active at this time (Price, 2000).

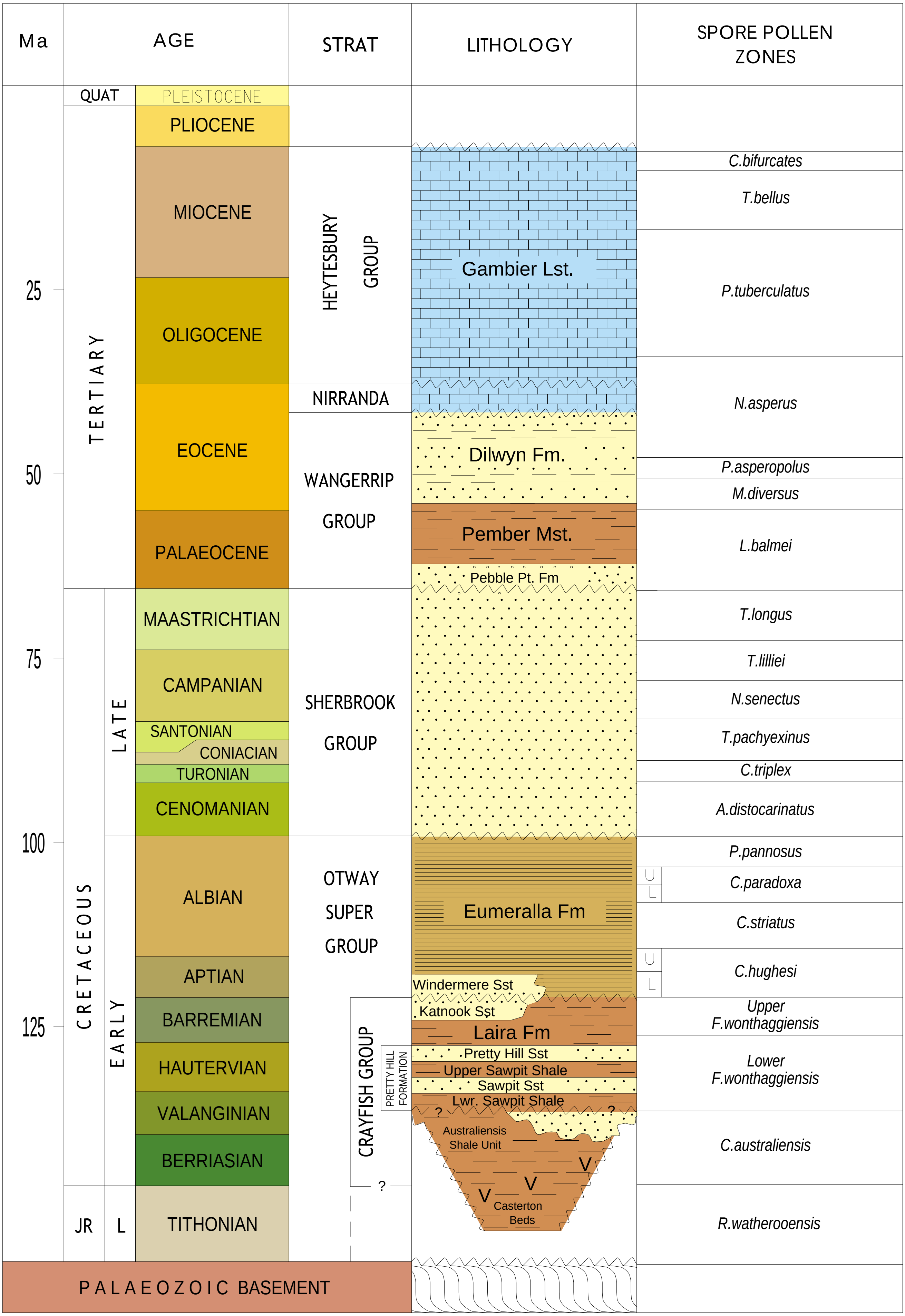
Lithologically the sequence comprises basalt, minor pyroclastics, lithic sandstone, siltstone and shales. The volcanic material indicates intensive structural reorganisation was in process at this time. (Lovibond *et al.,* 1993).

A phase of rapid subsidence of the half graben, in the Early to Middle Cretaceous (Valanginian to Albian), provided the accommodation space for the deposition of the Otway Supergroup, comprising the Crayfish Group and the overlying Eumeralla Group. As with the Casterton Fm, sedimentation of the lower Crayfish Group was strongly controlled by faulting, resulting in dramatic thickness changes in units (Morton and Drexel, 1995).

The Pretty Hill Formation, the basal unit of the Crayfish Group, rests conformably on the Casterton Formation in the Penola Trough and probably also in the Merino High area (Price, 2000). Palynological evidence suggests that the basal shale unit of the Pretty Hill Formation, informally known as the C. *australiensis* shale, may be regarded as the part of the upper Casterton Formation (Price, 2000). This unit is lithologically similar to the Casterton Formation but with less volcanic material (Lovibond *et al.,* 1993).

The Pretty Hill Formation unconformably overlies the Palaeozoic basement, where the Casterton Formation is not present, and represents an early syn-rift graben fill (Kopsen & Scholefield, 1990). The Pretty Hill Formation comprises sandstone, siltstone, mudstone and minor coal. The sandstone is generally medium to coarse grained, with a moderate to high porosity and permeability and is a proven reservoir in the western Otway Basin (Lovibond *et al.,* 1993).

OTWAY BASIN - PEL32
GENERAL STRATIGRAPHY



kayc

10802.052002 Fig.2

The basal unit, Lower Sawpit Shale, was deposited in a low energy, possibly lacustrine setting and together with the C. *australiensis* Shale Unit/Casterton formation is recognised as having oil generative potential and being the source of the oil in Sawpit 1 (Lovibond *et al.,* 1993). Recent palynological observations suggest that the McEachern Sandstone Member, intersected in Gordon 1, McEachern 1, Casterton 1 and Sawpit 1, along the eastern part of the Penola flank, may be a 'lower or basal' Lower Sawpit Shale equivalent (Price, 2000). This suggests that the direction of filling of the newly formed rift basin was from the east, with the McEachern Sandstone representing a sandstone wedge prograding into the trough over the C. *australiensis* Casterton Formation, with the lower Sawpit shale unit representing distal facies of this unit. The McEachern Sandstone is recognised as a distinctive blocky sandstone unit on wire-line logs and identified from cuttings and core examination as fine to very coarse grained to conglomeratic, with excellent reservoir properties, deposited within a high energy fluvial environment, possibly braided system is indicated.

The overlying Sawpit Sandstone comprises a thick succession of meandering fluvial and stacked braided stream sandstones sourced from local and fringing basement highs during fault reactivation, and subordinate floodplain and lacustrine mudstones.

The Sawpit Sandstone has been intersected in 13 wells along the Penola flank. An unpublished report by Davids and Doyle 1997 attempts to subdivide the Sawpit Sandstone into three inter-related sub-units, 'A', 'B', 'C' using data from four wells.

Resulting from Jacaranda Ridge 1 core and FMS interpretation, a sequence boundary may be interpreted near the top of the Sawpit Sandstone unit. This boundary may represent a break in deposition and/or change in provenance and is identified at the base of the channel sand cored in Jacaranda Ridge 1 and correlated with possible palaeosols and channel sands in other wells in the area, such as Sawpit 1, Wynn 1 and Pyrus 1. A change in apparent maturity profile in McEachern 1 (see figure 9 from McEachern 1 Well Completion Report 1990) may represent a change in organic facies and provenance that may provide the means to correlate across from the flank of the Victorian Penola Trough to the South Australian flank region. Price 2000, has identified assemblages, which indicate a degree of overall thickening of the lower Pretty Hill section from Casterton 1 to Gordon 1, which in turn supports the theory that the trough was being filled primarily from the east.

Oil has been recovered from the Sawpit Sandstone from Wynn 1, Killanoola 1 & DW1 and Jacaranda Ridge 1, with hydrocarbon shows observed in Penley 1, Pyrus 1, Porthos 1 and Viewbank 1. The Sawpit Sandstone is recognised as the principle play fairway for oil exploration along the flank of the Penola Trough.

The Sawpit Sandstone is overlain by the Upper Sawpit Shale. This unit is of variable thickness (in the order of 50-900 m) and provides vertical seal to potential accumulations in the underlying sands. The Upper Shale unit interpreted as being deposited in a lacustrine environment, is comprised principally of claystone and siltstone with minor hard siliceous interbeds. Interbeds of claystone and very fine siltstone within the Sawpit Sandstone unit may also provide intra-formational seal.

The upper Pretty Hill Formation, overlying the Upper Sawpit Shale unit, consists of interbedded sandstone and mudstone, interpreted as representing fluvial deposits (Abele *et al.,* 1995). The informally named Pretty Hill Sandstone comprise a thick succession of braided stream deposits, sourced from local and fringing basement highs during fault reactivation and subordinate floodplain or lacustrine shales (Lovibond *et al.,* 1993).

The overlying Laira Formation, identified in PEL 32 is interpreted as low energy fluvial to lacustrine deposit represents the return to tectonically quieter conditions with the deposition of siltstones and shales in a lacustrine environment (Morton, 1990). To the east, in the Victorian Penola Trough, the Laira becomes more arenaceous. A mid APK21 assemblage identified by Price 2000, in Mocamboro 11 and Digby 1 suggests the presence of a Laira Formation equivalent up onto the Merino High which appears similar to the upper Pretty Hill Formation. This indicates that the lower boundary of the Laira may be gradational and diachronous with the underlying Pretty Hill Formation. More studies are required to fully understand the relationships between the Laira and Pretty Hill and the overlying Katnook Sandstone / Windermere Sandstone member.

Uplift and erosion occurred, due to structural readjustment, with the axis of the rift shifting southwards beyond the Tartwaup Fault (see Figure 1) This lead to the termination of the deposition of the Crayfish Group, with erosion being most severe over the basement highs. This regional surface can be mapped and is known as the Crayfish Unconformity.

The Eumeralla Formation was deposited on a relatively low relief erosional surface, probably in an expansive system of shallow lakes. In the Victorian part of the trough, growth within the Eumeralla Formation has been recognised and occurred prior to C. *striatus* or lower Albian time with this period marked by the deposition of a thin channel and crevasse splay sand in some areas of the trough, informally named the Heathfield Sandstone. Morton and Drexel 1995 warn against using this name as it is difficult to correlate the sand unit successfully due to the nature of its depositional environment.

The area was tectonically stable until the end of the early Cretaceous when a thick sequence of fine grained clastics was deposited. The Windermere Sandstone Member is locally developed at the base of the Eumeralla Formation. Its environment of deposition is interpreted to be in low sinuosity meandering to sandy distally braided streams (Morton, 1990). Recent work by Price, 2000, has lead to an updating of how the Katnook Sandstone is viewed. Historically, the Katnook Sandstone, a medium grained cross-bedded sandstone of a meandering to distally braided fluvial origin, was regarded as the final unit deposited in the mid Cretaceous, Crayfish Group, prior to uplift and erosion. The Windermere was thought to be a reworked Katnook Sandstone. Price, (2000) suggests that the initiation of Eumeralla deposition began in the upper Hauterivian (APK22) which is earlier than first thought. If this revision is correct, then the Katnook Sandstone and the Windermere Sandstone are one and the same unit and may represent fluvial channel fills on the Crayfish Unconformity surface.

Following the deposition of the Eumeralla Formation widespread uplift and erosion occurred and this has been interpreted to be due to the onset of sea floor spreading. The Sherbrook Group was deposited on the resulting unconformity as a condensed sandstone sequence onshore, whilst offshore it can be subdivided into formations representing the various facies of a delta system (Morton, 1990). Marginal marine conditions prevailed with the Sherbrook Group thickening to the south.

The Tertiary sequence forms part of the Gambier Basin, which overlies the Otway Basin. The siliclastic sediments of the Wangerrip Group were probably deposited onshore in a fluvio-deltaic setting (Gravestock *et al.,* 1986), and fossiliferous limestones of the Heytesbury Group were deposited as a prograding marine sequence.

The Wangerrip Group rests unconformably on the Sherbrook Group and comprises the Pebble Point Formation, the Pember Mudstone and the Dilwyn Formation. The proposed South Australian subsurface reference section for the Pebble Point Formation is at Caroline 1, where it characteristically comprises dark green and brown oolitic grit with rounded fine grained to granule-sized quartz and carbonaceous material (Morton et al., 1996).

Conformably overlying the Pebble Point Formation (where present) are silty claystones with minor fine sands composing the Pember Mudstone. The Pember Mudstone has a gradational and interfingering contact with the overlying Dilwyn Formation. The Dilwyn Formation is the youngest unit of the Wangerrip Group. This unit consists of interbedded carbonaceous claystones and fine to medium grained sandstone. Overlying the Wangerrip Group are the Nirranda Group and Heytesbury Groups, which are essentially composed of limestones. The Tertiary sequence thickens to the south of PEL32.

2. Stratigraphy

2.1 Introduction

The Sawpit Sandstone is recognised as the principle play fairway for oil exploration along the flank of the Penola Trough. The focus of this study is to build on existing knowledge of the Sawpit Sandstone in this area by:

- Incorporating knowledge gained from wells drilled in South Australia after 1997, such as Killanoola 1 & DW1 (1998); Penley 1 (1999); Jacaranda Ridge 1 (1999) and Porthos 1 (2000)
- Extending the correlation of the Sawpit Sandstone and its associated units across into the Victorian part of the Penola flank.
- Attempting to understand the genesis and depositional history of the Sawpit, leading to possible breakdown of sub-units to assist in the correlation throughout the flank area.
- Updating and incorporating new palynological information to assist with the further understanding of the Stratigraphy

Peter Price (APG Consultants) was contracted by Origin Energy Resources Ltd. and Santos Ltd. to undertake a study to review the palynostratigraphy of the Penola Trough. This report builds on established studies previously undertaken by Roger Morgan (Morgan Palaeo & Associates) and draws interesting and challenging conclusions, including

- a close correlation of the Otway palynostratigraphy with that of the Eromanga Basin
- the conformable nature of the Katnook and Windermere Sandstone units at the base of the Eumeralla
- the possibility of the McEachern Sandstone being a time equivalent to the basal part of the Lower Sawpit Shale unit
- *Microfasta evansii* not being a definitive indicator at the top Crayfish Group as it persists into the lower Eumeralla Formation

Three cross-sections running along the northern flank of the Penola Trough, from northwest to southeast (looking in a northeasterly direction) have been prepared. Cross-section 1 (Enclosure 1) incorporates Victorian wells McEachern 1, Gordon 1 and Casterton 1 in the southern Penola flank area. Cross-section 2 (Enclosure 2), illustrating the stratigraphic relationships in a more deeper flank aspect, runs from Viewbank 1 to Jacaranda Ridge 1 to

Sawpit 1, Wynn 1 and then Pyrus 1. The third section (Enclosure 3) along the flank associates wells in the northern extent of the flank region, beginning with Penley 1, Killanoola 1DW1, Viewbank 1 to Sawpit 1.

The correlations have been interpreted with the benefit of the most recent palynological studies. A facies map showing the gamma ray log response for the entire Sawpit Sandstone sequence for the wells used in this Penola Flank study can be found in Enclosure 4. Formation tops in measured depth, for all wells utilised in the correlations are presented in Table 1, with a complete table of measured depth, sub-sea true vertical depth and measured true vertical depth found in Appendix 1.

The latest Jurassic to Early Cretaceous sequence is discussed in more detail below. It is understood that only the Pretty Hill Formation and Casterton Formation are recognised formally and that all other stratigraphic units, referred to in this study, are regarded as informal subdivisions of the Lower Cretaceous Pretty Hill Formation, of the Crayfish Group.

Resulting from the correlations, incorporating the recently drilled wells and the current palynological evidence, the stratigraphic chart for this area has been revised and is presented in Figure 3.

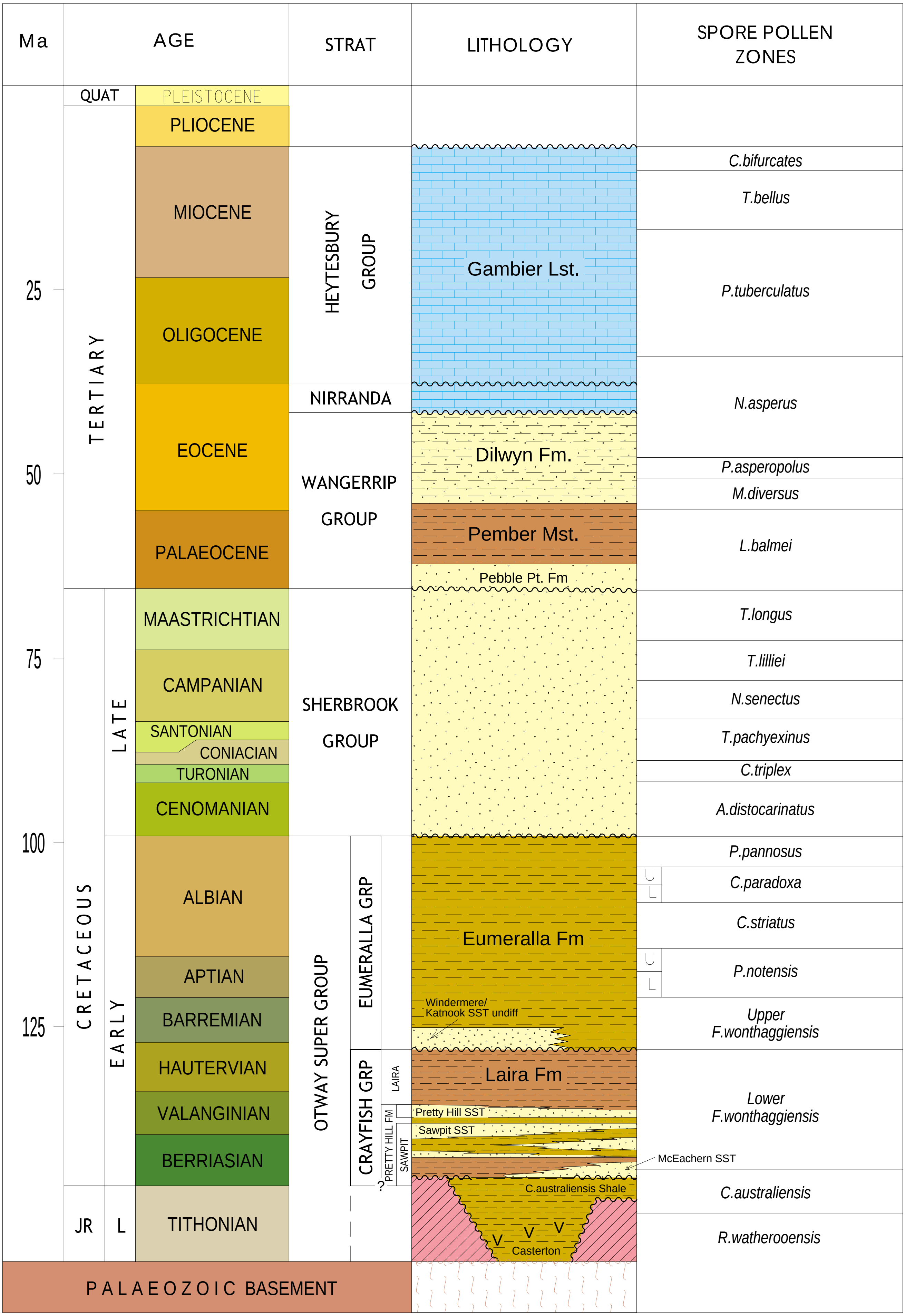
SAWPIT SANDSTONE FORMATION TOPS - Measured Depth Only

Well Name	Jacaranda Ridge Sand	Unit 4	Unit 3	Unit 2	Lower Sawpit Shale (Unit 1)				Casterton Formation
		Top Sawpit Sandstone			Sub-unit 1d	Sub-unit 1c	Sub-unit 1b	McEachern Sst (Sub-unit 1a)	
	MD (m)	MD (m)	MD (m)	MD (m)	MD (m)	MD (m)	MD (m)	MD (m)	MD (m)
BUS SWAMP 1	1427.3	1444.6	1550.6	1570.6					1798.8
CASTERTON 1	1417.6	1428.0	1554.2	1606.9	1711.0	1775.4	1954.4	1995.0	2219.7
GORDON 1	1413.9	1426.5	1582.4	1618.7	1736.1	1776.0	1870.7	1900.0	2119.1
JACARANDA RIDGE 1	2630.4	2640.2	2750.0	2783.6	2862.7	2867.8	2905.7		
KILLANOOLA 1DW1	819.2	823.3	910.9	915.8	968.2				
MCEACHERN 1	1424.0	1429.3	1706.5	1754.7	1877.0		2066.2	2118.0	2343.0
PENLEY 1	1517.3	1524.0	1615.0	1633.5	1650.5				
PYRUS 1	3159.3	3172.0	3278.8	3341.4	3407.5	3415.4	3442.5	3450.5	
SAWPIT 1	1825.9	1829.1	1937.5	1955.7	2024.1	2032.4	2054.8	2289.7	2449.3
VIEWBANK 1	2210.0	2220.9	2307.4	2326.8	2414.7	2425.3	2433.8		
WYNN 1	2753.0	2756.0	2811.4	2835.9	2908.9	2915.1	2943.5	2960.3	

Table 1

OTWAY BASIN

REVISED STRATIGRAPHY FOR THE PRETTY HILL FORMATION



(After Price 2000)

20933.042002 Fig.3

2.2 Casterton Formation and the C. *australiensis* Shale Unit

The Casterton Formation unconformably overlies Palaeozoic basement along the flank of the Penola Trough. It is identified as the earliest of the rift sediments into the newly formed half graben and is aged by palynological techniques as being of C. *australiensis* – R. *watherooensis* (Late Jurassic to very Early Cretaceous) age. This unit has been intersected in Casterton 1, Gordon 1, McEachern 1 and Bus Swamp 1 (in Victoria) and Sawpit 1, Penley 1 and Tilbooroo 1 (in SA). These sediments have been described in Sawpit 1, as dark grey, slightly silty, very carbonaceous, non-arenacous, non-calcareous, micromicaceous, hard and fissile. In Casterton 1 and McEachern 1, the Casterton Formation comprise interbedded shales and volcanoclastic material with minor amounts of siltstone, and is of C. *australiensis* – R. *watherooensis* age. The high concentration of volcanoclastic material is probably responsible for slightly higher than average gamma ray values (Lovibond *et al.* 1994). In Gordon 1 & Casterton 1 – coals are present within the formation and are probably the source rocks for the oil recovered from basement in Gordon 1.

2.3 Sawpit Sandstone – General Discussion

Resulting from the examination and reinterpretation of the lowest Crayfish Group intersected in wells drilled in PEL 27, 32, 83 & PEP 160, an updated description and correlation of the Sawpit Sandstone is presented. It is possible to dissect the Sawpit Sandstone sequence into four (4) units based on lateral facies associations interpreted in conjunction with recognised vertical profiles on the wire-line logs and lithological descriptions. It has been recognised by North (1994) that attempting to predict lateral facies can be less than successful when vertical profiles are used in isolation. Previous authors (as discussed in North 1994) have demonstrated the necessity to consider the lateral geometry of the facies, along with the vertical profile, to gain a full understanding of the fluvial depositional system.

The lateral facies packages (or sub-units) correlated across the northern flank of the Penola Trough have been accomplished whilst being mindful of the principles discussed above. Each sub-unit has been correlated and described in detail, using primarily log signatures and incorporating all available palynology, core and cuttings descriptions, hydrocarbon shows and recoveries, maturity information (Vr%) and FMS dip-meter interpretations, where available.

It is a recommendation of this report that the litho facies of the Sawpit Sandstone be formally defined as a member of the Pretty Hill Formation.

2.4 Sawpit Unit 1 (Lower Sawpit Shale Facies)

The Lower Sawpit Shale facies is shown to be a complex series of laterally and vertically inter-fingering sands and shales. It is possible to correlate the entire genetic unit along the flank of the Penola Trough and further sub-divide the facies into four (4) sub-units 1a, 1b, 1c and 1d, based on general lithotype. The deposition of unit 1 has been strongly controlled by active extensional tectonism in the early development of the rift basin.

Unit 1 (Lower Sawpit Shale) - Sub-unit 1a

Sub-unit 1a is otherwise known as the **McEachern Sandstone** Member of the Pretty Hill Formation. Sub-unit 1a is well developed in Victoria PEP 160 and has been intersected in Casterton 1, Gordon 1, McEachern 1 and Bus Swamp 1. This sand dominant unit is conformably overlain by shales and silts and has a shaley lateral facies equivalent intersected in two wells (Sawpit 1, Penley 1) in South Australia. It is described as a thick (approximately 200m) multistory channel conglomeratic sand unit of high energy braided fluvial origin with re-worked alluvial fan deposits sourced off the edge of the half graben (figure 4). It is considered to be a time equivalent of the Lower Sawpit Shale (Unit 1) and is a local sandy facies within this basal shale unit. Sub-units 1a and 1b have been deposited conformably on the Casterton Formation or unconformably on basement.

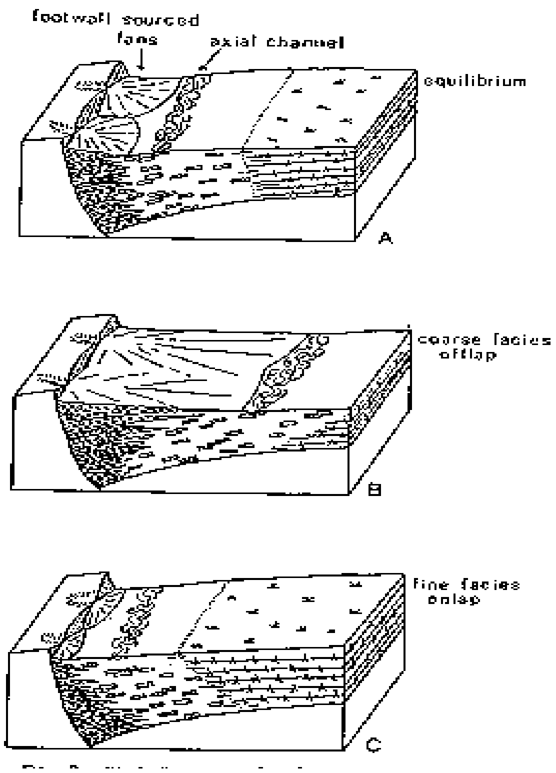


Figure 4: This figure illustrates a depositional model for the McEachern Sandstone (Sub-unit 1a), along the flank of the Victorian Penola Trough. (from Alexander and Leeder page 251). This shows the focusing effect of channel sand deposition by alluvial fan progradation on the edge of the half graben, such as those which occur along the Kanawinka fault terraces.

Log motifs for sub-unit 1a, typically indicate blocky coarse sands to conglomerates at the base of the unit overlain by upwardly fining channel sands with interbeds and interlaminations of silt and muds. Appendix 2 shows the log motif examples for sub-unit 1a (McEachern Sandstone) from Casterton 1, Gordon 1 and McEachern 1 wells, where this sandstone unit was first identified. Core from Casterton 1 is described as medium to very coarse grained, micaceous and carbonaceous, sandstone to conglomeratic sandstone consisting of pebbles (up to 2cm long) and granules of lithics comprised of reworked dark grey shale and phyllite, soft brown coal, garnets, greenish shale, yellowish ?tuffaceous material and serpentine. (see Appendix 3 for a complete core description for Casterton 1). In sidewall core sampling of sub-unit 1a (McEachern Sandstone) has identified fine to coarse grained, off white to medium grey, poor to moderately sorted sandstone with trace garnets. (see Appendix 4 for a complete sidewall core description for McEachern 1). In South Australia, lithological correlations suggest that both Pyrus 1 and Wynn 1 intersected sub-unit 1a (McEachern equivalent) at the base of the wells. Both wells passed through a shale at the base of the 'Sawpit proper' and then back into a good quality basal reservoir sand before the wells were abandoned.

The general decrease in grain size from Casterton 1 to McEachern 1 in Victoria and Sawpit 1 in South Australia, may be explained by North (1994) where he describes a model for channel sand body deposition and alluvial architecture in a half graben. Figure 5 illustrates how the overall grain size of the sediment decreases, the further away from the maximum zone of subsidence (half graben edge). Turner *et al (1993)* also note that there is a preferential stacking of sand bodies in the proximity to the footwall of the main half graben fault, with mudstone more likely to be deposited away from the area of active channeling on the hanging wall slopes. Because of the structural complexity of the Penola Trough this tectonic control on deposition is probably encountered adjacent to many intra-trough early faults, rather than just the main half graben bounding fault.

North (1995) noted in his detailed examination of core from the Pretty Hill Formation that gamma ray log responses may not be a reliable indicator of mudstone. In this part of the section, gamma ray (GR) values are uncharacteristically high in the sandstones where there are bands or laminations high in mica and/or garnet. GR responses that appear 'spikey' are likely to be caused by concentrations of minerals such as mica and garnet. High frequency of thin laminae throughout the sandstone interval, results in the elevation of the overall GR response without the 'spikey' appearance. This 'spikey' appearance of the GR log response has been noted in the Victorian wells, Casterton 1, McEachern 1 and Gordon 1.

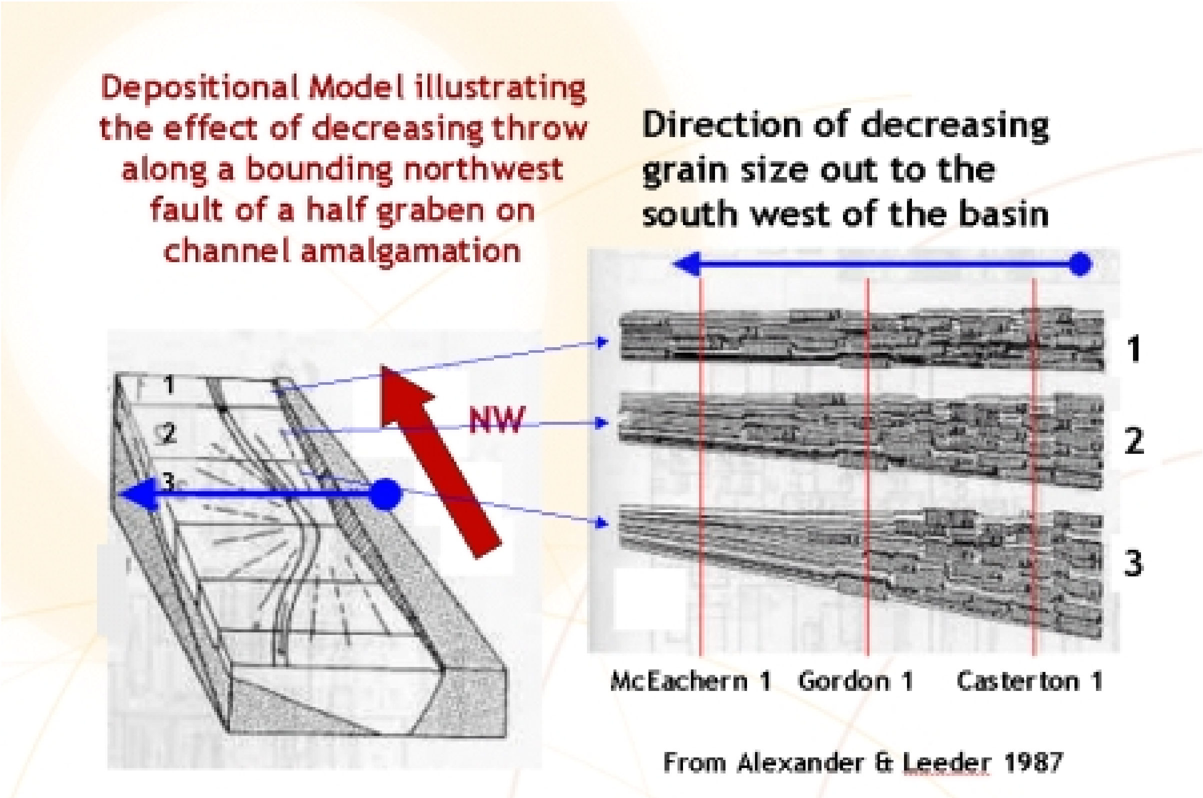


Figure 5: **Depositional Model illustrating the effect of decreasing throw along a bounding northwest fault of a half graben on channel amalgamation**

The McEachern 'equivalent' noted in South Australian wells, Pyrus 1, Wynn 1 and Sawpit 1, exhibit more blocky nature (see Appendix 2), however the overall GR values throughout the sands are slightly elevated to 55 –60 GAPI as compared with 50 GAPI in Victoria.

Correlative and palynological evidence suggest a diachronous boundary between sub-units 1a & 1b.

Unit 1 (Lower Sawpit Shale) - Sub-unit 1b

Sub-unit 1b overlies and/or is the more distal, shaley lateral facies equivalent of the sandy sub-unit 1a or the McEachern Sandstone. It has been intersected in Victoria in Casterton 1, Gordon 1 and McEachern 1. Pyrus 1, Wynn 1, Sawpit 1, Jacaranda Ridge 1, Viewbank 1 and Penley 1 have also intersected this shale facies in South Australia. The variability in thickness and lithology of this sub-unit is probably attributable to exactly where in the facies distribution the well has intersected, rather than due to erosion or faulting. In Victoria, sub-unit 1b is 30 to 50m thick and comprises interbedded sandstones, shales, siltstones and conglomerates in part. This unit is the lowest most part of the Lower F. *wonthaggiensis* zone, Morgan (1988), and APK 122 – APK2, probably APK122, Price (2000) and upper C. *australiensis* zone (Morgan 1990). This unit represents the lowering of the depositional energy from high energy braided (sub-unit 1a) to meandering and crevasse splay and overbank environment in Victoria with a lateral equivalent in South Australia being deposited in a low energy lacustrine, floodplain to swampy environment.

Log motifs for sub-unit 1b as intersected by Casterton 1 and McEachern 1 in Victoria and Jacaranda Ridge 1, Viewbank 1 and Sawpit 1 in South Australia, can be found in Appendix 2. The log motifs and lithological descriptions illustrate the change in depositional environments, during the Neocomian, along the flank areas of the Victorian and South Australian Penola Trough.

Unit 1 (Lower Sawpit Shale) - Sub-unit 1c

Sub-unit 1c is in many ways similar to sub-unit 1a or the McEachern Sandstone. In Casterton 1, the unit is characterized by a thick unit of 180m in thickness, comprised of interbedded conglomerates, medium to coarse sands and shales (generally less than 18cm thick). The conglomerates contain well rounded pebbles up to 8cm in diameter, consisting of quartz, greenish-medium grey shale, diorite and weathered sandstone. The sandstones are lithic (quartz, shale and phyllites) and are garnetiferous with coaly laminations. Contacts between the conglomerates and sandstones are sharp.

The lithology indicates a return to a high, energy depositional environment with this sub-unit representing a high, energy braided fluvial system active along the Penola Flank at this time. The classical blocky, cylindrical gamma ray log response of a braided, fluvial system is punctuated by high GR spikes. This is probably due to the high content of mica and volcanogenic lithics in the sands and concentrations along laminae and interbeds. The return to the high energy environment was most probably caused by active northwest – southeast fault movements along the flank of the Penola Trough. This sandstone-conglomerate sequence has its thickest intersection in Casterton 1, however it thins and becomes much more silty and shaley toward Gordon 1 and is indistinguishable from sub-unit 1d in McEachern 1. This indicates that the direction of the channels of the fluvial system is from the southeast toward the northwest and may involve some alluvial fan deposition from off the northeastern edge of the trough. The log motif of this sub-unit in Gordon 1 indicates high net to gross. Wells along the flank, intersect increasingly siltier and shalier section indicating that the main channel has either switched down into the deeper part of the trough, as a result of active tectonic control, or has been subjected to erosion. Evidence to support the switch of the main channel into deeper parts of the Penola Trough can be found in the Pyrus 1 and Wynn 1 wells, where a thinner (27m compared with 95 - 180m) section of poor to good quality reservoir was encountered at the same correlative level. Unfortunately, the palynology in this part of the section cannot be used for any decisive age assignments, as the zones are too broad. The sub-unit 1c intersected in Pyrus 1 is much deeper in the Penola Trough (3415-3442 m) as compared with Casterton 1 and Gordon 1 on the flank in Victorian PEP 160. Wynn 1 also intersected a possible sub-unit 1c between 2916 – 2943m with the overall grain size decreasing from coarse to predominantly medium, along with improved sorting suggests that the sands deposited at these locations are still being deposited in a high energy, possibly braided fluvial environment but are further from the source as compared with Casterton 1 and Gordon 1. A drill stem test over the interval 2918 – 2922m flowed gas at 1 MMscfd, 15.4 bbl condensate per day and 511 bbls water per day. This sub-unit intersected in Jacaranda Ridge 1 and Viewbank 1 indicates a lateral 'shaling out' of the sandy facies intersected in Wynn 1 and Pyrus 1. The log motifs show a typical floodplain, possibly swampy or lacustrine in part, type deposit with sandy overbank or crevasse splay deposits near the base with a decrease in depositional energy indicated by the fining upward sequence of fine sands to clays and silts. The sub-unit in Viewbank is very thin (only 7m thick) as compared with Jacaranda Ridge 1 (25m thick), which is probably due to Viewbank 1 being positioned higher on the flank of the basin. Oil fluorescence was noted in this section in Jacaranda Ridge 1 in the ditch cuttings. It was described as 50-70% dim, patchy to even, orange to yellow fluorescence, occasionally moderately bright yellowish white, weak pale diffuse crush cut only, trace ring residue. Palynology undertaken for Jacaranda Ridge 1 indicates a lower F. *wonthaggiensis* zone (Neocomian) age for this sub-unit. The report also states that the sub-unit is mature for sourcing oil and early mature for gas/condensate.

Unit 1 (Lower Sawpit Shale) - Sub-unit 1d

Sub-unit 1c is conformably overlain by sub-unit 1d, the top of which represents the top of the Lower Sawpit Shale unit of the Sawpit Sandstone Member. See Appendix 2 for log motifs for Casterton 1, Gordon 1, Wynn 1, Jacaranda Ridge 1 and Penley 1.

This relatively thin sub-unit is characterized by a dominantly shale and siltstone sequence with some fine to medium grained sandstone interbeds. This sub-unit indicates a return to tectonically quiet times along the flank of the Penola Trough, with lakes and swamps dominating the depositional environments. The sequence intersected midway through this unit in Casterton 1 indicates that a lake shore-line facies may have been intersected. In Gordon 1, slightly closer to the edge of the flank of the trough, the facies are sandier with fine to very coarse sands dominating and interbedded with silty claystone and shales. Price (2000) has aged sidewall cores at no older than middle APK122 (F. *wonthaggiensis*) or Berriasian. Thin (7m) sections of shale were intersected in Wynn 1 and Jacaranda Ridge 1, with a much thicker low energy, possibly lacustrine, deposit of shale was laid down in the Penley area. The variability in thickness of these shale beds is probably related to the placement of the lakes and swamps around the flank area at that time. Some erosion may have taken place prior to the deposition of the overlying sandy facies, which may account for thickness variations. Tectonically, north-south extension of the region resulted in northwest – southeast and east-west faulting in the Penola Trough at this time. Older faults were being re-activated and new ones forming as the rifting of the southern Australian margin progressed. This sequence is indicative of a relatively tectonically quiet time along the flank leading to the formation of lakes and swamps. The main channels may have been switched down deeper into the basin or it may indicate a shift in provenance and gradual change in channel direction from southeasterly to northwesterly. Sedimentological interpretation of the FMI data in Killanoola 1 and DW1, by Davids and Doyle 1998, concluded that insufficient data points existed to make a statistically meaningful conclusion with respect to current flow direction. However, it is suggested that the direction of flow of the channels within the lower Sawpit Sandstone may be either toward the northeast or southwest, if the bedding planes are lateral accretion surfaces or to the west-northwest, if the bedding planes are cross-bedding surfaces. Further sedimentological work is required on the FMI/FMS data existing in the area.

It is suggested here that the deposition of Unit 1 (Lower Sawpit Shale, including sub-units 1a, b, c and d) were highly influenced by the timing and orientation of tectonic activity in the early stages of rifting of the Otway Basin. Figure 6 shows a schematic diagram from Noll (unpublished) showing the influence that varying orientation of active faulting can have during the deposition of fluvial sediments. This diagram, the example being taken from the Early Cretaceous Skenes Creek – Wongarra fluvial system, shows that main channel systems are most likely controlled by the northeast – southwest faults, with east –west faults offering little influence on the orientation of the channels. A similar pattern may be present in the Penola Trough.

This analogue shows the possibility of the co-existence of high energy, braided fluvial systems and low energy lacustrine systems. A study by Chantraprasert *et al* 2001 of the Tilbooroo 3D seismic survey modelled the formation of raised or elevated features on the palaeo-topography, referred to as accommodation zones (TAZ for Tilbooroo Accommodation Zone). These zones are set up between areas of opposite fault dip domains, such as between east-west fault sets and northeast-southwest faults sets (figure 7). These elevated areas may provide separation of the higher energy channel and lower energy lacustrine / floodplain environment.

It is suggested that this model provides an explanation of the depositional relationship between all sub-units of Unit 1 (McEachern Sandstone and Lower Sawpit Shale) in the early formation of the Otway Basin rift system. McClay *et al* (2001) modeled the effect of extensional rifting and observed that as the faults are activated, the deposition of sands switch to the resulting different fault compartments. Regions that were once covered by high energy braided systems may then be subject to low energy swamp and lacustrine deposition. McEachern 1 appears to have intersected an area where depositional energy is reducing with time such that fine to coarse sands, of the meander channels and point bars at the base of sub-unit 1b, are progressively being overlain by overbank/floodplain and/or swampy deposits of muds and silts.

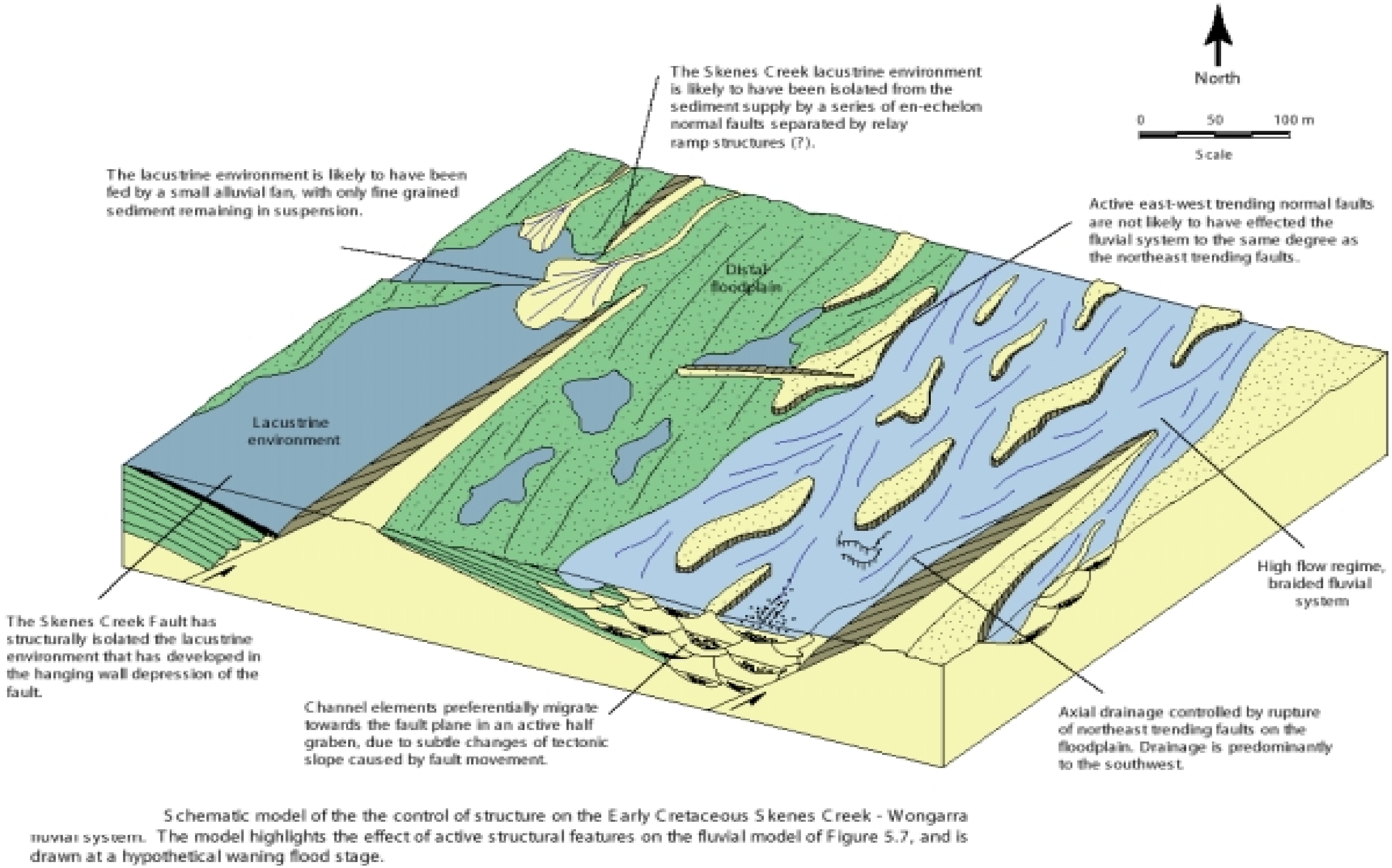


Figure 6: Diagram illustrating the effect of tectonic structural control on the deposition of fluvial facies in a half graben setting – from C. Noll (unpublished – pers. Comm.. P.J. Boult)

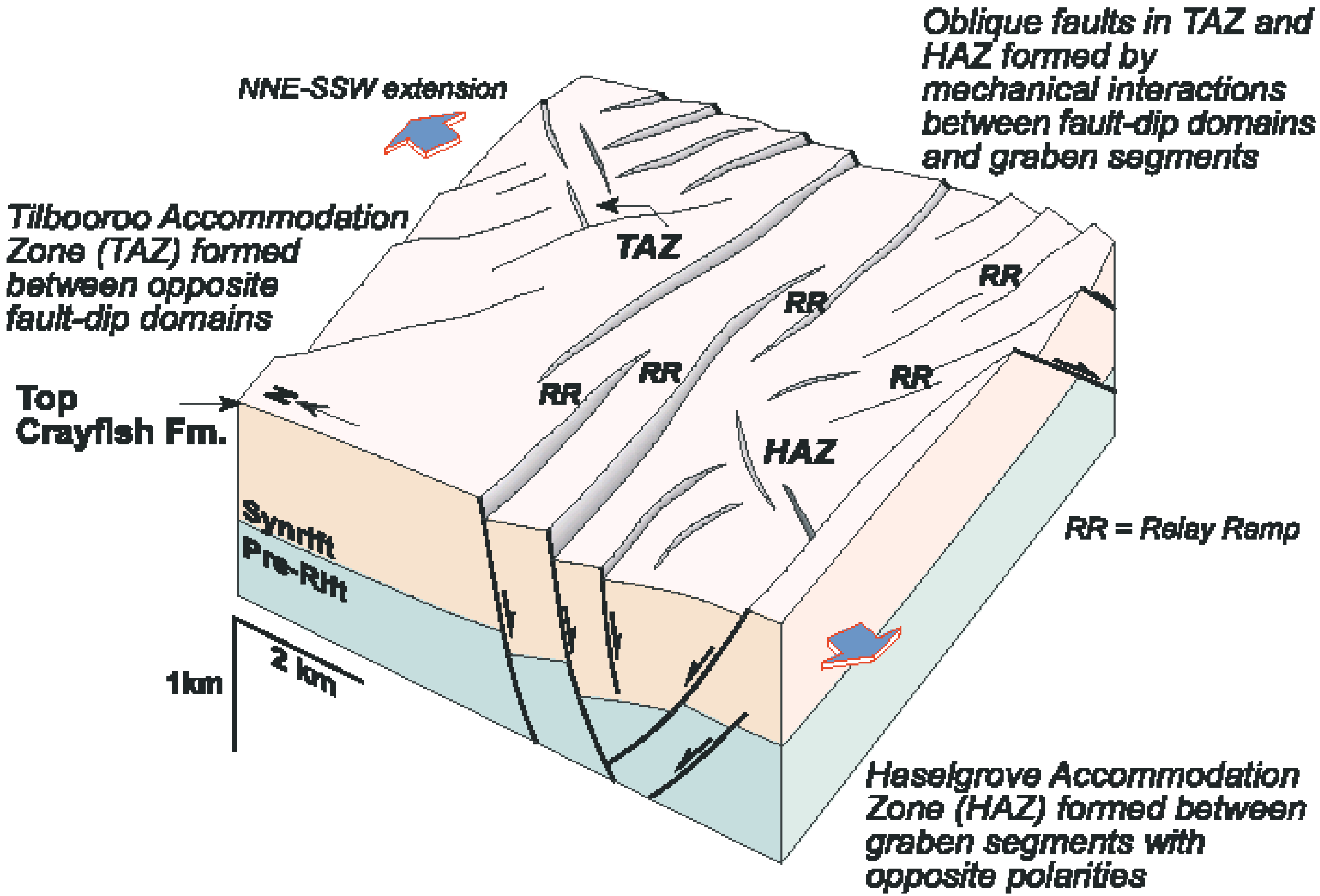


Figure 7: from Chantraprasert et al (2001) showing the formation of the TAZ (Tilbooroo Accommodation Zone) as a result of active faulting

2.5 Sawpit Unit 2 (Transition unit)

Unit 2 indicates a return to active re-structuring along the flank of the Penola Trough. The facies encountered at this level are predominantly fine to coarse, predominantly medium sands, interbedded with micaceous, silty shales and silts. In Casterton 1, the sequence is a thick series of upwardly fining and coarsening sand sequences indicating point bar and splay facies of a meandering fluvial depositional environment with multiple stacked channel with high ratio of sand to shale. This may indicate a lowering in the available accommodation space along the flank with subsequent reworking of channels, resulting in a thick, stacked sand sequence.

The log motif for this unit is typically concave in shape, indicating the unit is sandier at the top and base with silt and/or shale predominant in the mid section. Appendix 2, 3 and 4 include examples of log motifs, core and cutting descriptions, respectively.

The lateral extension of the sand dominated sequence at Casterton 1 and Gordon 1 was intersected in McEachern 1. This well is positioned deeper in the basin and has a much higher proportion of overbank/floodplain shales and silts with channels facies and crevasse splay deposits having a much lower frequency of occurrence than at the Gordon/Casterton location. Descriptions of sidewall cores taken in McEachern 1, describe the floodplain facies as dark to very dark grey claystone, soft to moderately hard, blocky in part. The sandstones are described as off-white to light grey, fine to coarse, subangular, poorly sorted, soft with lithics, trace coaly fragments and rare garnet. The cores are dated as F. *wonthaggiensis* (late Neocomian) by Roger Morgan (1990). Along the South Australian flank section of the Penola Trough; this sub-unit has been identified in Sawpit 1, Viewbank 1, Pyrus 1, Wynn 1, Jacaranda Ridge 1, Penley 1 and Killanoola 1DW1.

The main fluvial channel system appears to be positioned fairly close to the flank, depositing predominantly fine to medium, with some coarse grained quartz sands with shaley lateral equivalents in wells deeper in the basin. Sidewall cores taken in Jacaranda Ridge 1 show that the sandstones are fine to medium grained with common kaolinitic matrix, poor to fair visual porosity. Fluorescence noted throughout this interval is described as trace moderately bright, patchy, greenish yellow with moderately fast diffuse direct cut and thin ring residue. Penley 1 further to the north and deeper in the basin intersected a higher proportion of claystone interbedded with some significant channel sands.

2.6 Sawpit Unit 3 (Mid Sawpit Sandstone)

This unit marks a gradual return to lower energy deposition within the fluvial system. In wells such as Jacaranda Ridge 1 and Wynn 1, the sequence is predominantly fine-medium sand overlain by finer grained silt and mud of a floodplain or overbank sequence. In Casterton 1, this sub-unit is dominated by mud and silt, which may have been laid down in a swamp or lacustrine environment. Generally higher along the flank, finer grained sands were still being deposited at this time with overbank and floodplain deposits being more common deeper in the trough, as intersected in Wynn 1 and Pyrus 1. Along the flank into Victoria, the section intersected by Casterton 1 and McEachern 1 indicates a lacustrine event with sands intersected at Gordon being suggestive of pulses of higher energy clastic deposition, maybe in a fan, depositing coarser clastics into the swamp or lake. See Appendix 2 for log motifs of this sub-unit for Casterton 1, Wynn 1 and Jacaranda Ridge 1. Refer to the cross-section for further correlative information.

This scenario certainly indicates that the direction of fluvial flow is from the northwest rather than from the southeast.

2.7 Sawpit Unit 4 (Upper Sawpit Sandstone)

This sub-unit is the interval most commonly referred to as 'the Sawpit Sandstone' member of the Pretty Hill Formation. A very typical section is encountered in nearly every well along the flank of the Penola Trough. The entire sub-unit indicates a return to a lower energy depositional environment along the flank of the Penola Trough. The unit was initiated during a time of coarse clastic deposition in a reasonably high energy, probably braided fluvial system with some alluvial fan deposition over the edge of the basin. This sequence is conformably overlain by a lower energy meandering fluvial sequence as shown by an increase in shale deposition in floodplain environment along with fine to medium grained sands of meander channel belts, point bar and crevasse splays. Following this episode widespread swamps and lakes reformed, the facies of which have been intersected in Casterton 1, Gordon 1, Sawpit 1 and Jacaranda Ridge 1. Other wells such as Wynn 1 and Pyrus 1 have intersected a relatively thin shale/siltstone sequence at the top of this interval, which may also be lacustrine. It is this low porosity, low permeability and fine-grained sequence at the top of the Sawpit Sandstone sequence that may act as a waste zone for potential hydrocarbons accumulated within the better quality sandstone reservoirs beneath this zone. This potential waste zone is of variable thickness and ranges between 10 and 70m. The reservoir sands of the lower part of this unit have produced limited quantities of oil, condensate and gas in Jacaranda Ridge 1 and Wynn 1, where 408 BOPD and 107 BOPD and condensate were produced on drill stem test from these wells respectively. Wynn 1 flowed gas at 3.9 MMscfd and Jacaranda Ridge 1 at 0.8 MMscfd through 0.5" choke from the lower sands of sub-unit 7. Other significant shows include oil fluorescence in Pyrus 1 and Penley 1 (breached traps). Reservoir quality is compromised by increased kaolinisation of feldspars in the sands. The amount of kaolin matrix in the sands decreases with depth. This appears to be a widespread diagenetic effect and to be common along the flank region of the Penola Trough.

It is proposed here that the top of this unit represents an erosional surface and may be a major sequence boundary along the flank region. Evidence for this sequence boundary originates from core information acquired in the Jacaranda Ridge 1 well. Between 2630 and 2640m, a 10m sand has been deposited with a very sharp base over the shales and silts of the underlying sub-unit 7.

2.8 Jacaranda Ridge Sandstone

As stated above, the 10m sand intersected in Jacaranda Ridge 1 (2630 – 2640m) offered the best evidence to date on the presence of a sequence boundary at the top of sub-unit 7, or the conventional top pick of the Sawpit Sandstone member of the Pretty Hill Formation. A core was acquired over the interval 2635 – 2646m. The core was logged and described by sedimentologist Dr. Simon Lang from the NCPGG, the results of which can be found in Appendix 5. Essentially the core was described as medium grey, fine to medium grained, moderately sorted, moderately hard, massively bedded quartz sandstone, heavily cemented with silica and abundant kaolinitic matrix overlying with a sharp contact, olive grey, fine grained, well sorted, interlaminated siltstones and very fine grained sandstones. It is suggested by Lang in Jones *et al* (2000), that the sharp contact between the overlying sand and siltstone/sandstone interval may represent a sequence boundary. Resulting from this scenario, the top of this sand overlying the sequence boundary does not represent the top of the Sawpit Sandstone as picked previously but a new depositional unit overlying a disconformity at this location.

The presence of this sand unit is indicative of an increase in energy of clastic deposition, probably by a braided fluvial system. Palynology is unable to differentiate whether there is a time break at this point.

Other evidence to support the existence of a sequence boundary at this time can be found in Viewbank 1, Pyrus 1 and Penley 1 – with similar looking sands, on GR logs, intersected at the same level. Also of interest is the FMI interpretation at Killanoola 1DW1 by Davids and Doyle (1998) which shows a possible palaeosol at the top of sub-unit 7 (figure 8). This has been interpreted by Davids as the Crayfish Unconformity. Alternatively it may be additional evidence for the proposed sequence boundary at the top of the Sawpit Sandstone. Sawpit 1 and Wynn 1 also intersected thin, hard sands possibly indicative of palaeosols. It must be noted that care must be taken when isolating specific intervals as sequence boundaries in a fluvial depositional environment, as there may be many instances of preserved soil profiles.

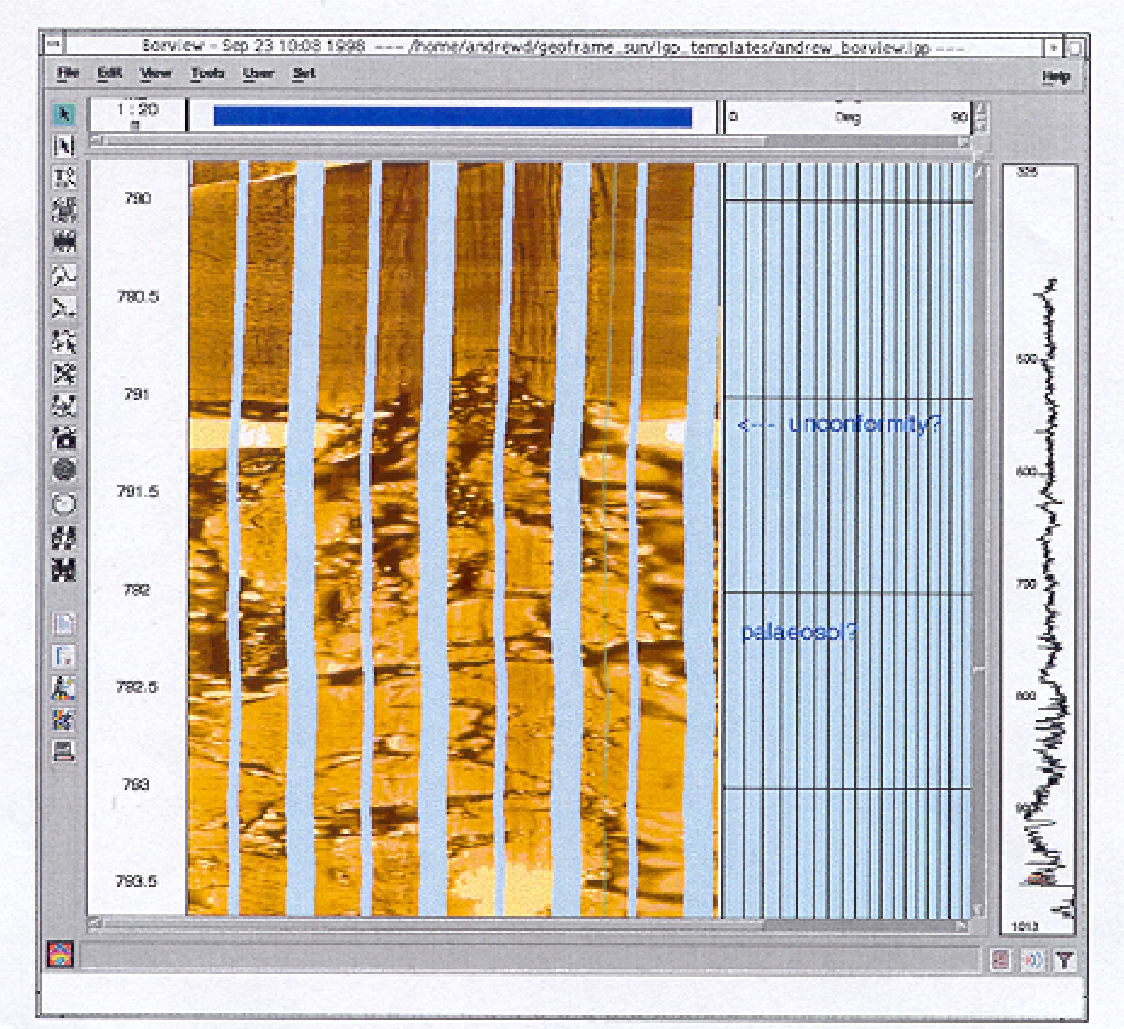


Figure 8: **Interpreted palaeosol at the top of the Sawpit Sandstone (sub-unit 7) in Killanoola 1DW1 - PEL 27**

In PEL 83, a truncation surface at the Sawpit level has been noticed around the Wetherall prospect to the northwest of the permit. This surface may be of interest in the identification of a widespread sequence boundary the top of the Sawpit and it is recommended that further interpretation over the area of interest be undertaken. Also of interest, is evidence of an on-lapping sequence onto a possible sequence boundary at the top Sawpit level which has been observed on the St. George 3D seismic survey (figure 9).

At McEachern 1, in Victoria, a change in the vitrinite reflectance profile has been observed at approximately 1400m, see figure 10. This change may reflect a disconformity at which a change in inorganic facies occurs and allow correlation of a sand above the disconformity to other wells along the flank.

This basal onlap sand was first recognised at Jacaranda Ridge 1, and for the purpose of this study is named the Jacaranda Ridge Sandstone. It may be of significant interest as a new fairway for oil and/or gas migration and entrapment along the flank of the Penola Trough. This sand could possibly have a depositional analogue with the Katnook Sandstone higher in the sequence, in PEL 32 in South Australia. The geometry of the Jacaranda Ridge Sandstone is such that it most likely to be sheet like with at least a 1:100 thickness:width ratio (Jones *et al* 2000), with a lateral extension likely to exceed 500m. This is greatly significant in the Jacaranda Ridge area where the first well intersected a fault zone at this level, resulting in permeability reduction of the reservoir and compartmentalization of the existing oil and gas accumulation. The presence of this sand provides reduced reservoir risk for the Jacaranda Ridge South prospect.

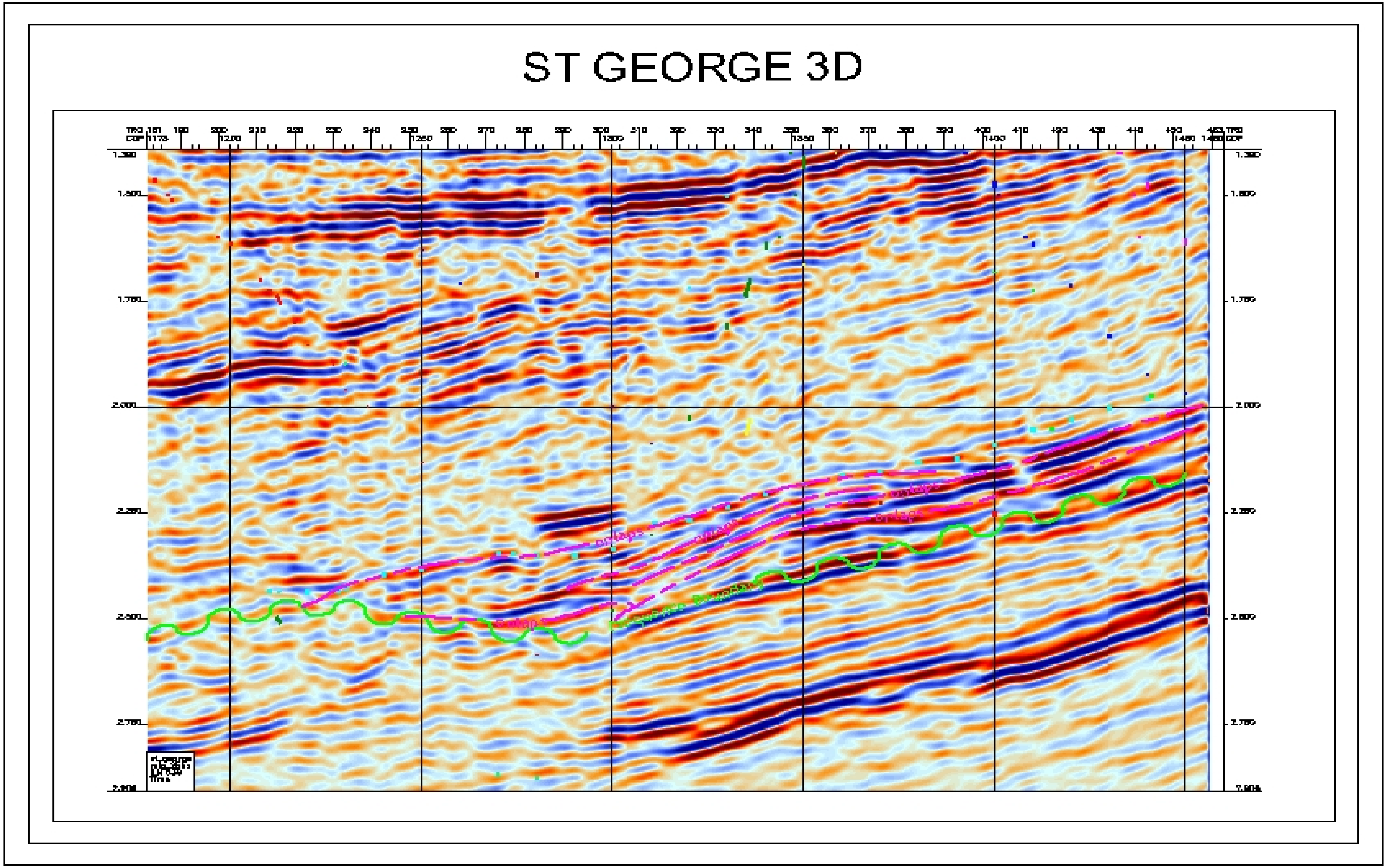


Figure 9: **St. George 3D (PEL 83) ILN 539**

Shows indications of sediment on-laps or progrades onto a possible sequence boundary

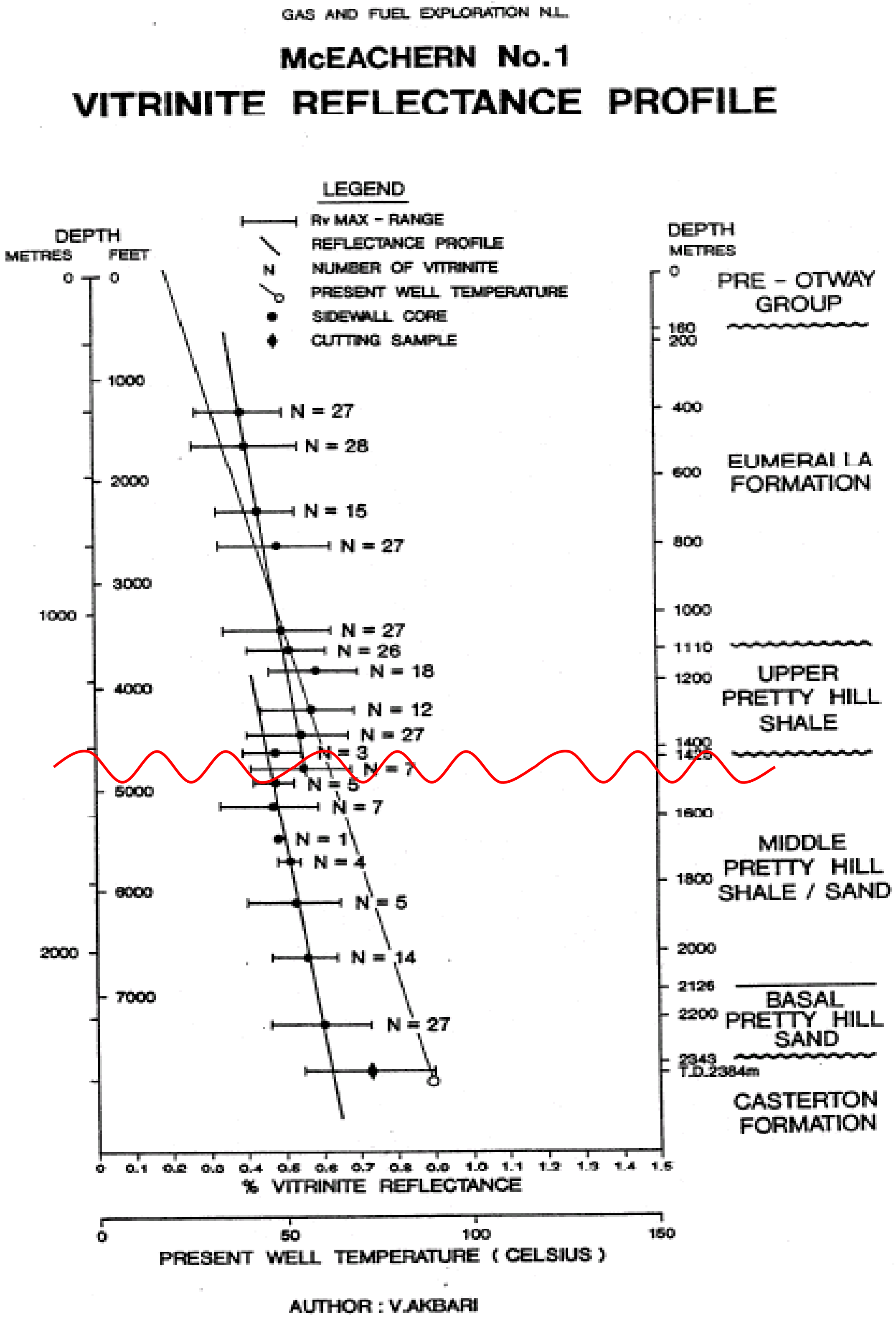


Figure 10: Vitrinite Reflectance Profile for McEachern 1 - evidence for a sequence boundary in Victoria?

3. Discussions and Conclusions

The aim of this study was to attempt to correlate the Sawpit Sandstone sequence of the Pretty Hill Formation along the flank of the Penola Trough in both South Australia and Victoria. The main outcome was to add to existing knowledge by incorporating new information from recent drilling results, palynological research and seismic interpretation to further understand the depositional history and stratigraphic correlations for reviewing the prospectivity of the oil fairway throughout this part of the Otway Basin.

This study and reinterpretation of the Jurassic and Early Cretaceous syn-rift sediments along the flank of the Penola Trough has taken into consideration pre-existing work in the South Australian PEL 27 area, undertaken by Davids and Doyle (1997) and Santos' correlative work in the Victorian permit PEP 160 (formerly 119). Drilling results from all wells drilled along the flank in PEL 32, 27, 83, PEP 160 was used along with new information gained particularly from Jacaranda Ridge 1 allowing a new approach to the stratigraphic correlation to be made. New palynological studies undertaken in the Penola Trough by Peter Price in 2000 were also incorporated into the studies along with the historical data provided by Roger Morgan and Nigel Hooker in the 1990's.

The main outcomes of this study are:

- The recognition of a sequence boundary at the base of the first sand intersected in Jacaranda Ridge 1 at the Sawpit level. This sequence boundary has been correlated across the basin identifying similar sands, possible palaeosols and changes in vitrinite reflectance profiles.

- The Sawpit Sandstone and underlying Casterton Formation has been correlated across the flank area, referring to recent palynology and seismic data where possible. The sequence is very complex, involving a high degree of tectonic control. It is important to note that this is an initial interpretation and new data will no doubt refine the model.

- The Sawpit Sandstone sequence has been sub-divided into four (4) genetically similar packages with lateral facies equivalents mapped. It is not possible to correlate individual channels as many are discontinuous due to the nature of the meandering and braided fluvial system active in the area.

- The McEachern Sandstone or sub-unit 1a is correlated as a lower sand facies within the Lower Sawpit Shale. Palynological evidence supports this theory.

- The direction of the main fluvial channels is coming from the southeast during the deposition of Unit 1 (sub-units 1a through to 1d). The palaeo-flow direction for Unit 2 is uncertain. It is possible that two separate depositional systems existed at this time, one sourced from the southeast depositing into the Victorian Penola Trough with the other from the northwest depositing into the South Australian part of the Penola Trough. For this reason it is named the 'transition' unit. Further data is required to unravel the palaeo-flow directions particularly for Unit 2.

  Possible explanations for the source of Unit 2 are:

  1. The channel direction in both South Australia and Victoria is from the southeast with high energy deposits in Victoria and a lowering of energy in South Australia.
  2. There is a change in channel direction so that the channels are coming from the northwest so that by the time the system reaches Vic there has been a reduction in accommodation space resulting in reworking of older channels into a thick sands sheet.
  3. The South Australian Penola flank and Victorian sections have separate depositional systems active at the same time.

  Explanation 3 is considered the most likely but more data is required to be sure.

- Units 3 and 4 record a return to meandering fluvial conditions with the top of Unit 4 being an erosional surface or sequence boundary

- Recognition of the Jacaranda Ridge Sandstone and its similarity in genesis to the 'Katnook Sandstone'. This sandstone is predicted to have good quality and lateral continuity away from fault zones. It is a primary objective in the Jacaranda Ridge South prospect.

- Casterton 1 well offers the most complete conformable Sawpit – Casterton Formation sequence intersected to date.

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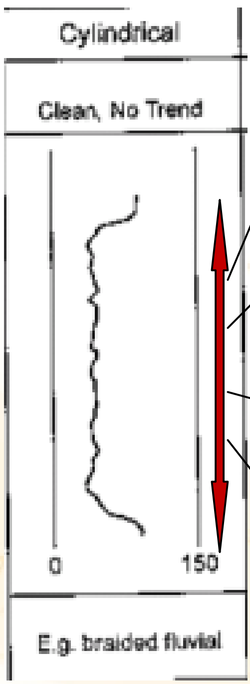
Well Completion Reports: Jacaranda Ridge 1, McEachern 1, Casterton 1, Gordon 1, Sawpit 1, Wynn 1, Viewbank 1, Killanoola 1DW1, Penley 1.

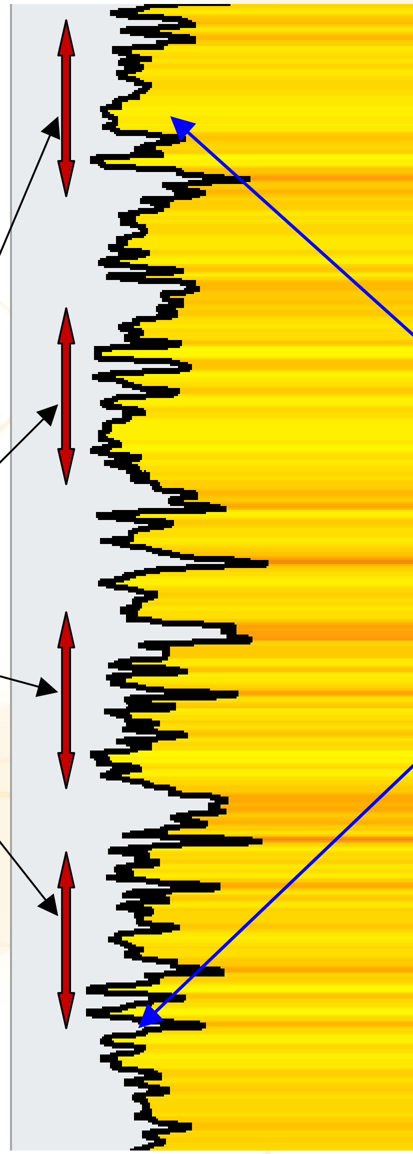
SAWPIT SANDSTONE FORMATION TOPS

Well Name	Jacaranda Ridge Sand			Top Sawpit Sandstone Unit 4			Unit 3			Unit 2			Lower Sawpit Shale (Unit 1)												Casterton Formation			Well Name
													Sub-unit 1d			Sub-unit 1c			Sub-unit 1b			McEachern Sandstone (Sub-unit 1a)						
	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	MD (m)	TVD (m)	TVDSS (m)	
BUS SWAMP 1	1427.3	1427.3	-1335.8	1444.6	1444.6	-1353.1	1550.6	1550.6	-1459.1	1570.6	1570.6	-1479.1													1798.8	1798.8	-1707.3	BUS SWAMP 1
CASTERTON 1	1417.6	1417.6	-1273.6	1428.0	1428.0	-1284.0	1554.2	1554.2	-1410.2	1606.9	1606.9	-1462.9	1711.0	1711.0	-1567.0	1775.4	1775.4	-1631.4	1954.4	1954.4	-1810.4	1995.0	1995.0	-1851.0	2219.7	2219.7	-2075.7	CASTERTON 1
GORDON 1	1413.9	1413.9	-1284.3	1426.5	1426.5	-1296.9	1582.4	1582.4	-1452.8	1618.7	1618.7	-1489.1	1736.1	1736.1	-1606.5	1776.0	1776.0	-1646.4	1870.7	1870.7	-1741.1	1900.0	1900.0	-1770.4	2119.1	2119.1	-1989.5	GORDON 1
JACARANDA RIDGE 1	2630.4	2624.5	-2563.5	2640.2	2634.3	-2573.3	2750.0	2743.9	-2682.9	2783.6	2777.4	-2716.4	2862.7	2856.3	-2795.3	2867.8	2861.5	-2800.5	2905.7	2899.3	-2838.3							JACARANDA RIDGE 1
KILLANOOLA 1DW1	819.2	803.7	-748.8	823.3	807.5	-752.7	910.9	890.4	-835.5	915.8	895.0	-840.1	968.2	944.4	-889.6													KILLANOOLA 1DW1
MCEACHERN 1	1424.0	1424.0	-1419.2	1429.3	1429.3	-1424.5	1706.5	1706.5	-1701.7	1754.7	1754.7	-1749.9	1877.0	1877.0	-1872.2				2066.2	2066.2	-2061.4	2118.0	2118.0	-2113.2	2343.0	2343.0	-2338.2	MCEACHERN 1
PENLEY 1	1517.3	1510.5	-1465.7	1524.0	1517.0	-1472.2	1615.0	1605.1	-1560.3	1633.5	1623.0	-1578.2	1650.5	1639.4	-1594.6													PENLEY 1
PYRUS 1	3159.3	2923.6	-2857.8	3172.0	2932.4	-2866.6	3278.8	3005.5	-2939.7	3341.4	3052.1	-2986.3	3407.5	3105.6	-3039.9	3415.4	3112.3	-3046.5	3442.5	3135.3	-3069.5	3450.5	3142.2	-3076.4				PYRUS 1
SAWPIT 1	1825.9	1825.9	-1759.8	1829.1	1829.1	-1763.0	1937.5	1937.5	-1871.4	1955.7	1955.7	-1889.6	2024.1	2024.1	-1958.0	2032.4	2032.4	-1966.3	2054.8	2054.8	-1988.7	2289.7	2289.7	-2223.7	2449.3	2449.3	-2383.2	SAWPIT 1
VIEWBANK 1	2210.0	2210.0	-2149.8	2220.9	2220.9	-2160.7	2307.4	2307.4	-2247.3	2326.8	2326.8	-2266.6	2414.7	2414.7	-2354.5	2425.3	2425.3	-2365.1	2433.8	2433.8	-2373.6							VIEWBANK 1
WYNN 1	2753.0	2753.0	-2683.3	2756.0	2756.0	-2686.2	2811.4	2811.4	-2741.7	2835.9	2835.9	-2766.2	2908.9	2908.9	-2839.1	2915.1	2915.1	-2845.3	2943.5	2943.5	-2873.8	2960.3	2960.3	-2890.5				WYNN 1

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone)
Casterton 1 Well

(1969.7-2219.7mKB)





Palynology: Morgan 1988

APK122-APK2, prob APK122

Sands average 50 GAPI

Motif through this section is spikey possibly due to the 'hot' sands (volcanic lithic component and mica / garnet laminae in the sands) - Colin North 1995 pg 14

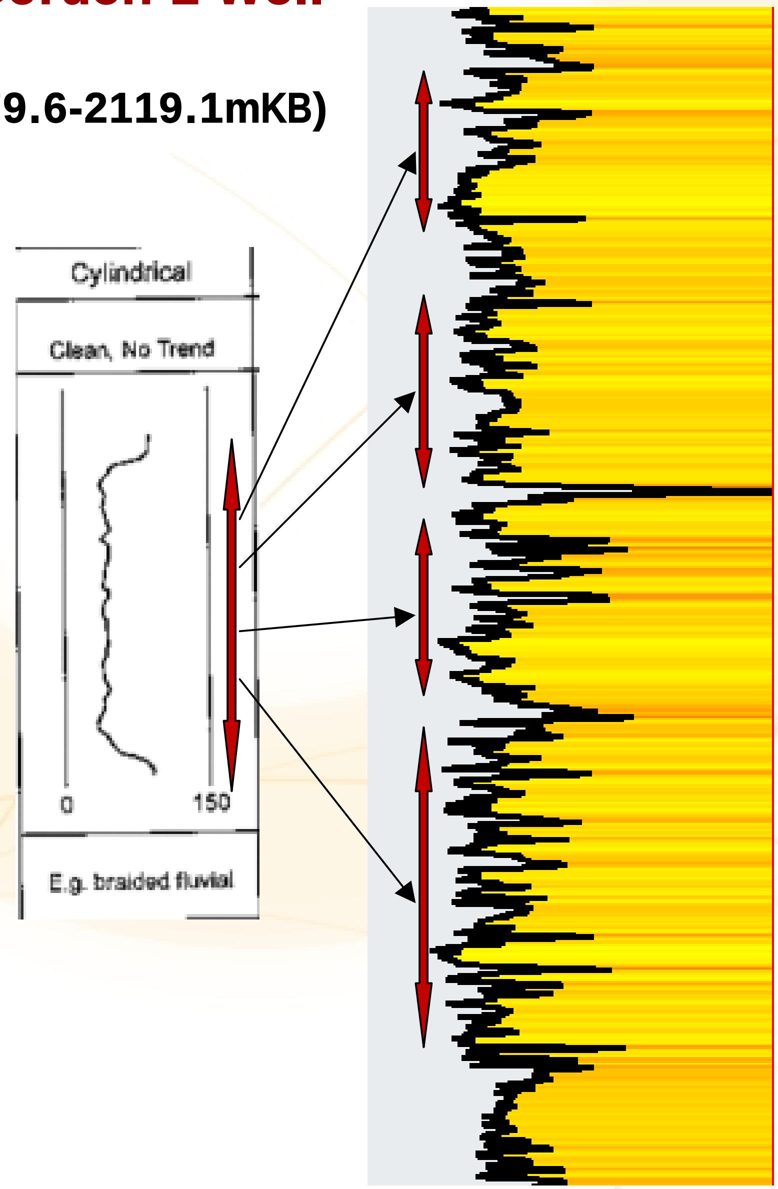
<u>From Core Description</u>

(2088.8-2090.6m) SANDSTONE: light grey, fine-med grained, hard, silicified qtz sst grading to orthoquartzite in places. Comprised of greenish grey lithics, mica, black carb flecks in silica or kaolinitic matrix. Sl-mod recrystallisation has taken place. Lower 13cm of core is med-coarse grained

(2210.7-2213.8m) CONGLOMERATIC SANDSTONE: med-coarse , hard, grey comprised of sub-ang fair sorted light grey-clear qtz, minor kaol feldspars, ab biotite, musc & chlorite. Some coaly grains and tr plant resin, ragged inclusions of soft, yellow clay ashy ?tuffaceous material, trace soft green shaly grains in clayey matrix. Flat pebbles up to 1.3x6.5cm, but generally <6mm are present in the sst with long axes aligned with the bedding. Dark lams present in SST due to conc of dk mica flakes.

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone) Gordon 1 Well

(1879.6-2119.1mKB)



Sands average 50 GAPI

Motif through this section is spikey possibly due to the 'hot' sands (volcanic lithic component and mica / garnet laminae in the sands) – Colin North 1995 pg 14

Sidewall Core Descriptions

SANDSTONE: off-white – light grey, clear-translucent quartz, sub-angular to sub-rounded, Moderately sorted, moderate silica cement, trace common white and brown argillaceous matrix, friable, fair visual porosity

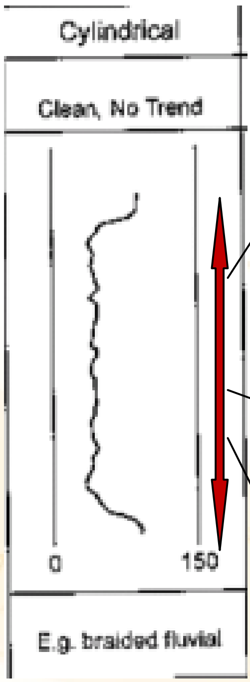
Cuttings Descriptions

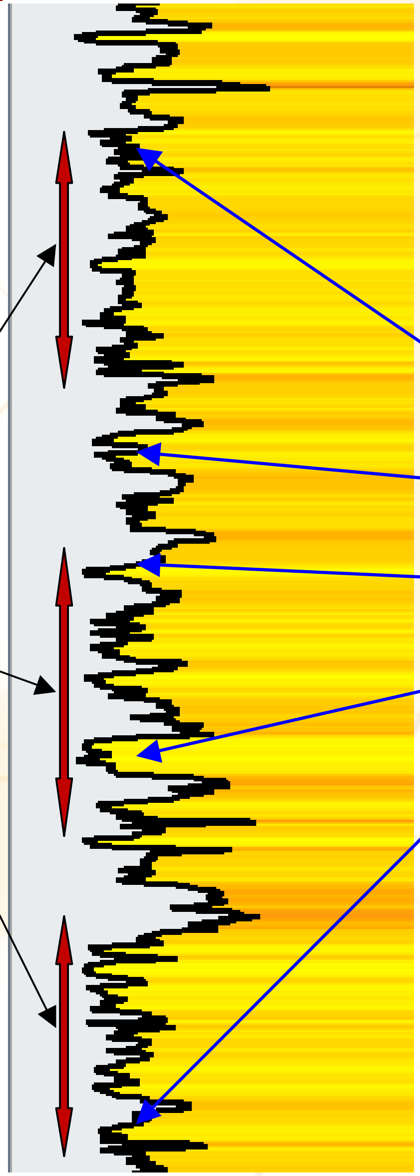
SANDSTONE: 95% off-white to light grey, very fine to very coarse grained, angular to subangular, poorly sorted, moderate to strong silica cement, weak calcareous cement, common white argillaceous matrix, trace to common pink garnet, common grey to green phyllitic and volcanogemic lithics (increasing with depth), trace black coaly detritus, moderately hard to hard, poor to fair visual porosity, no oil fluorescence; interbedded and interlaminated with:

SILTY CLAYSTONE: 5% medium brown to grey, occasionally dark grey and shaley, trace very fine off white partially altered feldspar grains in part, trace to common black carbonaceous flecks and coaly detritus, trace fine brown mica flakes, common micro-mica, moderately hard, very dispersive and sub-fissile

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone) McEachern 1 Well

(2118-2343mKB)





Sands average 60 GAPI

Motif through this section is spikey possibly due to the 'hot' sands (volcanic lithic component and mica / garnet laminae in the sands) - Colin North 1995 pg 14

From Sidewall Core Descriptions

(2149m) SST - sub-ang to sub-round, mod sorted, off white-light grey, fine-coarse.

(2203m) SST - sub-ang, poor sorted, light-med grey to grey brown, fine-coarse.

(2227m) SST - sub-ang, poor sorted, light-med grey, fine-coarse.

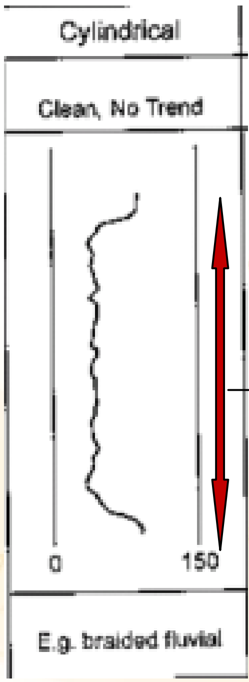
(2260m) SST - sub-ang, mod sorted, off white-grey, fine-coarse.

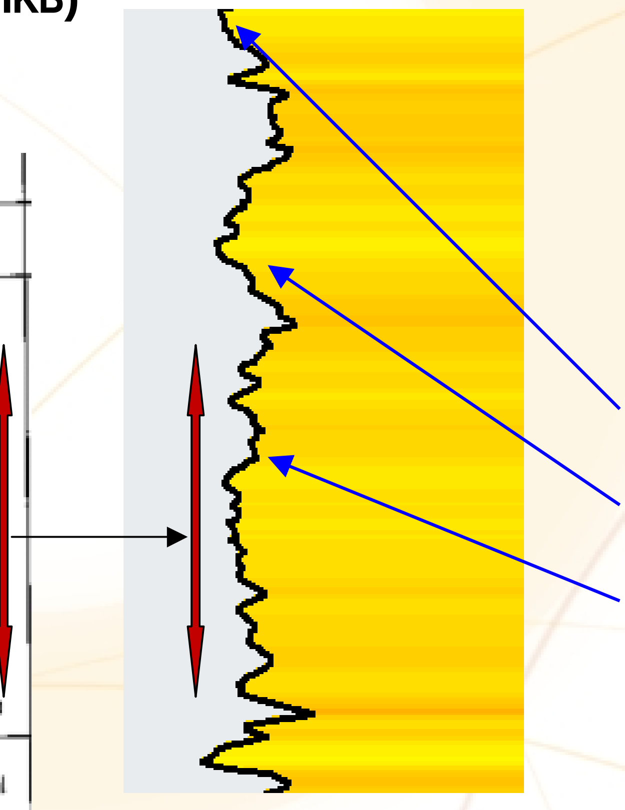
(2331m) SST - sub-ang, mod sorted, off white-grey, fine-coarse.

Trace garnets are described throughout all SWC over this interval

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone)
Wynn 1 Well

(2960.3-2990mKB)





No Palynology over this interval

Sands average 55 GAPI

Motif through this section is less spikey than the sands intersected in Victoria, possibly due to a lower percentage of mica / garnet laminae in the sands

<u>From Cuttings Descriptions</u>

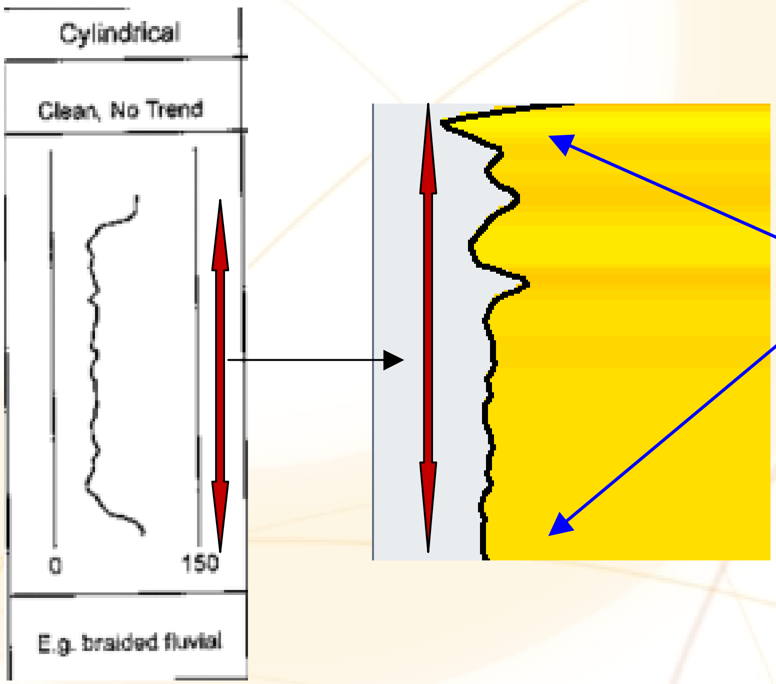
(2958-61m) Tr dull yellow patchy-spotty fluorescence. Weak cut, tr residual ring.

(2970-76m) SANDSTONE - sub-angular to rounded, well sorted, white-colourless, medium-coarse, loose with weak siliceous cement, some quartz overgrowths, tr siderite, tr grey chert, good porosity.

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone)
Pyrus 1 Well

(3450.5-3463mKB)

Sands average 60 GAPI



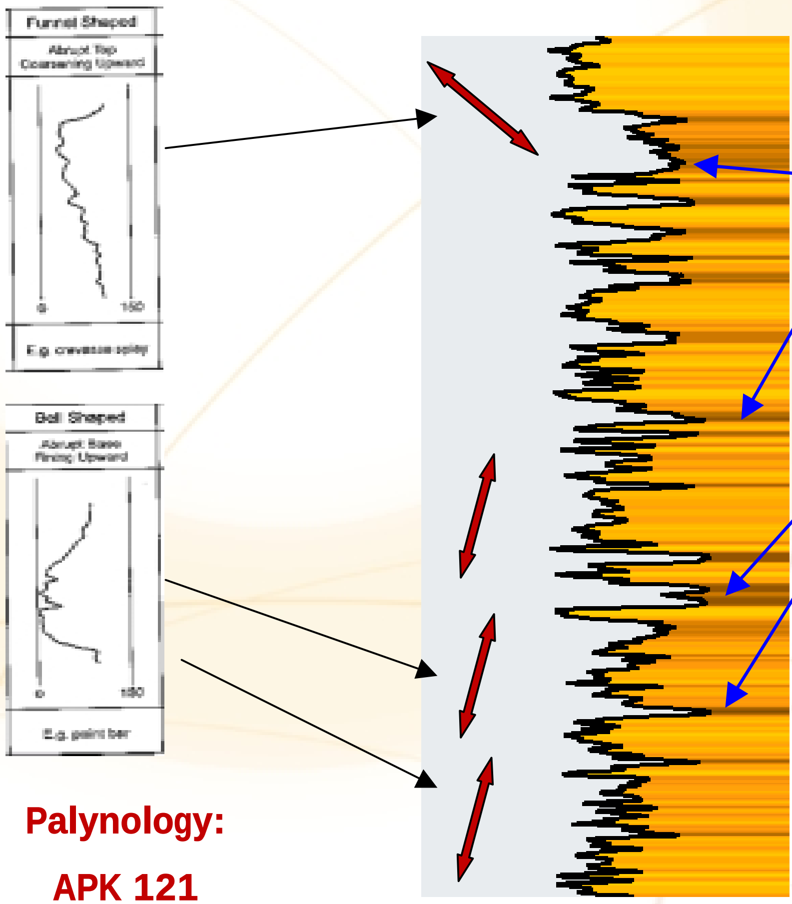
From Cuttings Descriptions

100% SANDSTONE: clear-translucent,fine-predominantly medium, occ. med-coarse, well sorted, subangular, trace weak calcitic, siliceous cement, kaolinitic matrix, predominantly clean loose grains, common moderately hard aggregates, fair inferred porosity.

No Palynology over this interval

Lower Sawpit Shale Sub-unit 1a (McEachern Sandstone)
Sawpit 1 Well

(2289.7 - 2449.3m)



Palynology:

APK 121

Price 1993

Sands average 80 GAPI

Sidewall Core Descriptions:

SILTSTONE: light grey to brownish grey, argillaceous, rare very fine arenaceous, moderately calcareous, soft to firm, massive, no oil fluorescence, weak milky white crush cut with rare micro-mica, lithics, partially altered feldspars and fine carbonaceous material

CLAYSTONE: medium to dark brown/grey, massive to sub-fissile, soft to moderately hard, non-calcareous with rare micro-mica

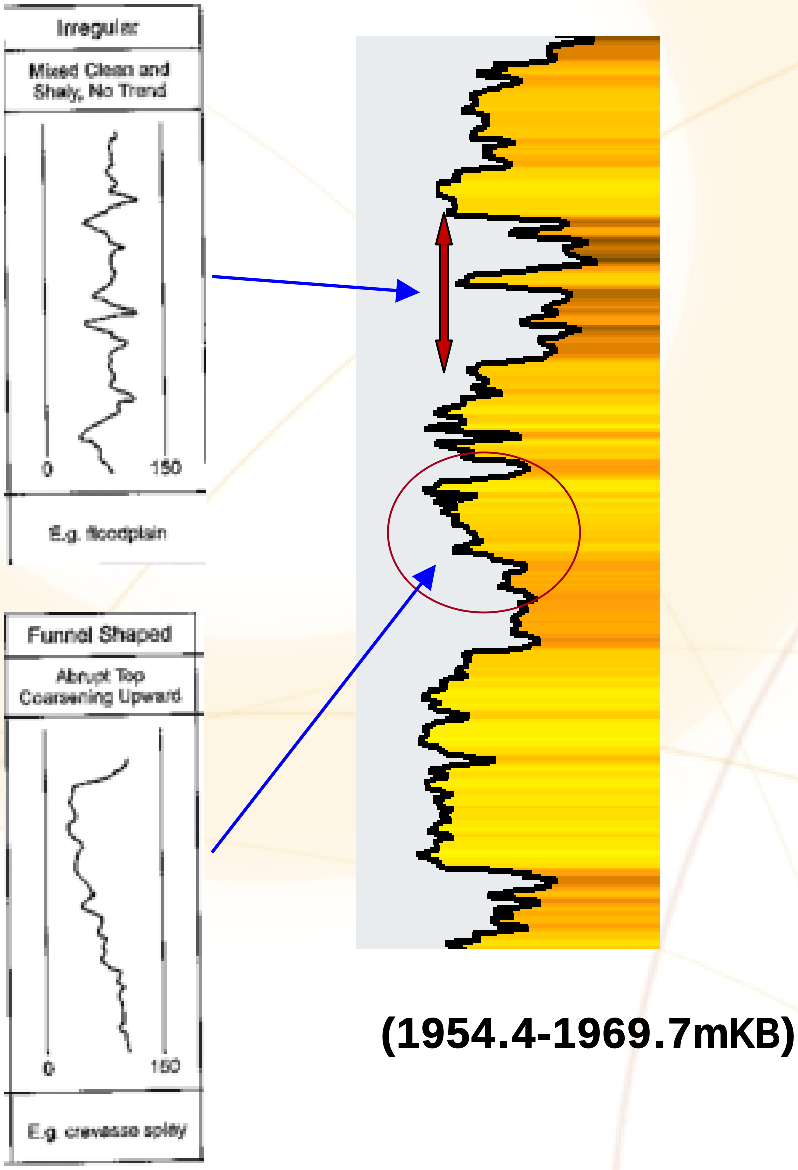
Cuttings Descriptions:

SANDSTONE: off-white, very fine to fine, occ. medium grained, subangular to sub-rounded, moderately sorted quartz, strong calcareous and moderately strong silica cement, abundant kaolinitic matrix, moderately hard, nil visual porosity, trace dull yellow to orange mineral fluorescence.

Average for the interval:

20% SANDSTONE; 70% CLAYSTONE; 10% SILTSTONE

Lower Sawpit Shale Sub-unit 1b Casterton 1 Well



(1954.4-1969.7mKB)

Sands average 42 GAPI

Muds: 120 GAPI

This unit in Vic is very sandy and conglomeratic in part.

From Cuttings Description

Conglomerate and Shale: WCR states that the conglomerate may be associated with a fault or unconformity surface or both.The conglomerates contain pebbles of siliceous sandstone, orthoquartzite and dark grey shale with graded bedding.

Shales are fractured and heavily slickensided - indicating the well has penetrated a shear zone.

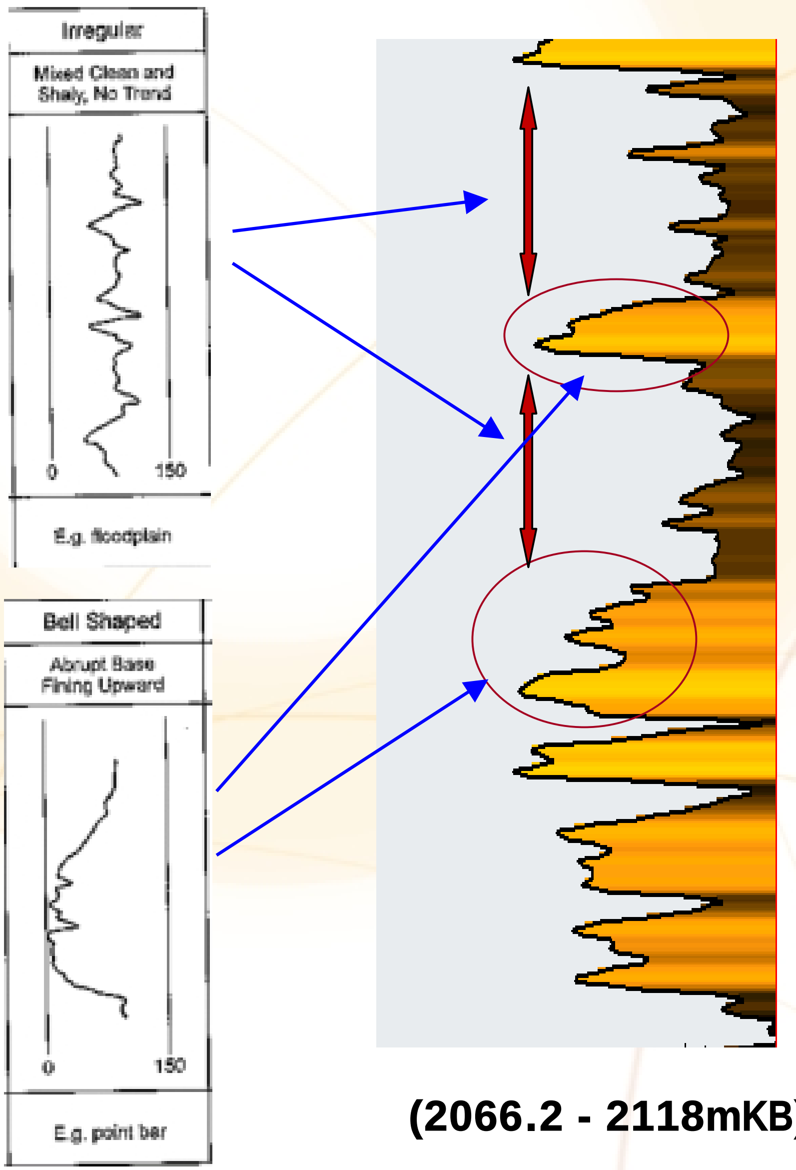
Palynology:

APK122-APK2,

prob. APK 122

Lower Sawpit Shale Sub-unit 1b
McEachern 1 Well

Meandering Fluvial / Swamp



(2066.2 - 2118mKB)

From Cuttings Description

50-70% SANDSTONE: off-white-light grey, medium grey, occasional loose -friable, firm in part, fine to medium grained, predom. medium, subangular - subrounded, mod. sorted, clear to frosty, quartzose, common-abundant kaolinitic matrix, tr-common calc. cement, med green to med grey lithics, alt feldspar, tr mica and tr-rare light-medium pink garnet, fair-good , occ. very good visual porosity

interbedded with

SILTSTONE: med-dark grey, medium-dark brown grey, firm, occ hard, blocky, sub-fissile in part, common mica, tr carbonaceous, abundant argillaceous, grading to very fine sandstone.

CLAYSTONE: medium to dark grey, med-dark brown, dom. firm, occasionally soft and dispersive, blocky and sub-fissile in part, common mica in part, moderately silty grading to siltstone.

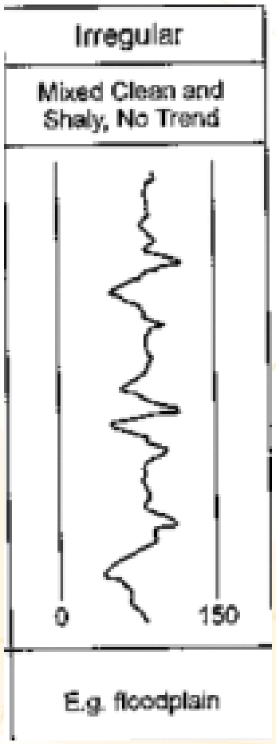
Palynology (cuttings):

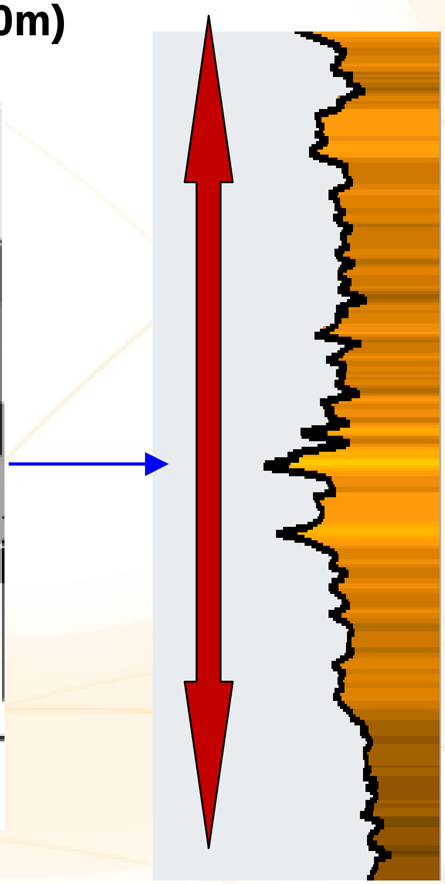
Upper C. australiensis zone (early Neocomian)

Morgan 1990

Lower Sawpit Shale Sub-unit 1b
Jacaranda Ridge 1 Well

(2905.7-2950m)





Palynology (SWC):

Lower F. wonthaggiensis (Neocomian)

Hooker 1999

<u>From SWC Descriptions:</u>

SILTSTONE: olive grey, argillaceous, moderately carbonaceous

<u>From Cuttings Descriptions:</u>

Predominantly SILTSTONE: dark grey to greyish black, non-calc, sl argillaceous, commonly arenaceous, micromicaceous, abundant fine carb material, hard, subfissile; interbedded with

CLAYSTONE: olive grey, non-calc, silty, common fine carb material, micromicaceous, dispersive, amorphous

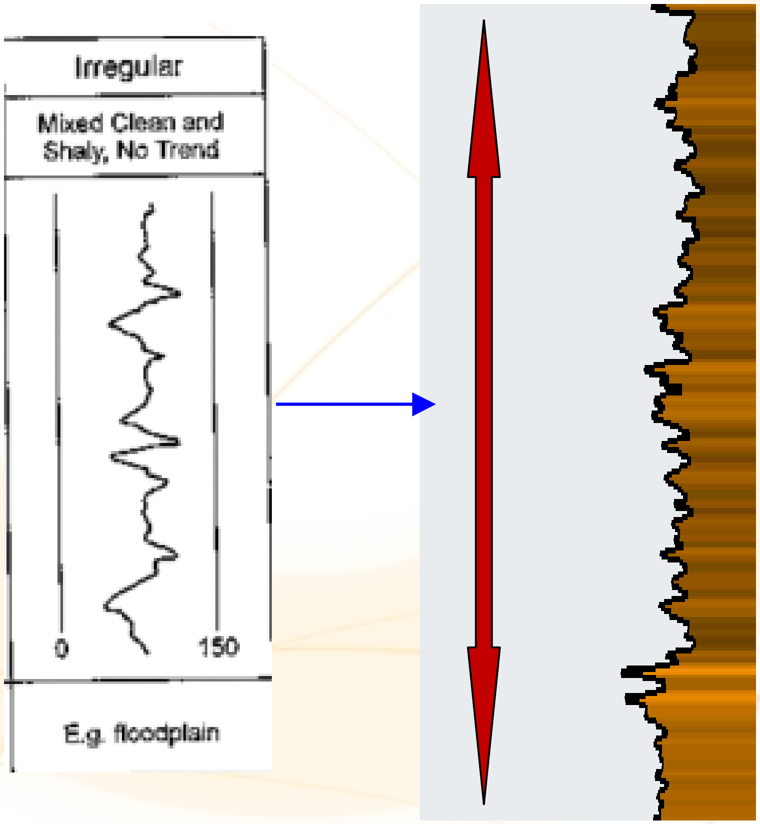
and

SANDSTONE: yellowish grey, fine to predom. Medium grained, mod sorted, subangular, weak-mod strong siliceous cement, common to ab. kaol matrix, quartzose, predom. hard aggregates and common loose grains, tight to poor visual porosity

40% dim, orange fluorescence, weak pale diffuse cut and trace ring residue.

Lower Sawpit Shale Sub-unit 1b
Viewbank 1 Well

(2433.8-2500mKB)



Palynology (SWC):

APK 122

Price 1997

<u>From SWC Descriptions:</u>

CLAYSTONE: medium grey, firm blocky, non-calc, micromicaceous, <1% very fine disseminated carbonaceous matter, silty, grading to siltstone:

<u>From Cuttings Descriptions:</u>

Predominantly CLAYSTONE: medium grey to greyish brown, moderately firm, blocky, occasionally sub-fissile, micromicaceous, very fine disseminated carbonaceous material

interbedded with

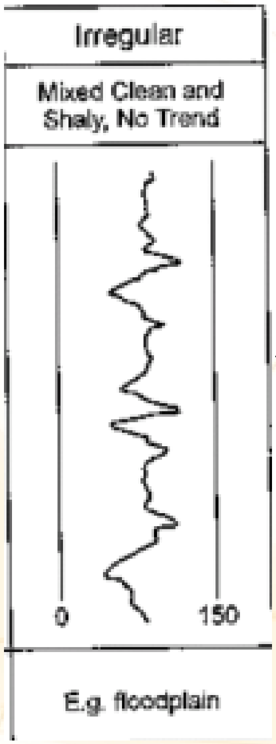
SILTSTONE: medium to dark grey, medium grey brown, non-calc, fine carbonaceous material, arenaceous, micromicaceous

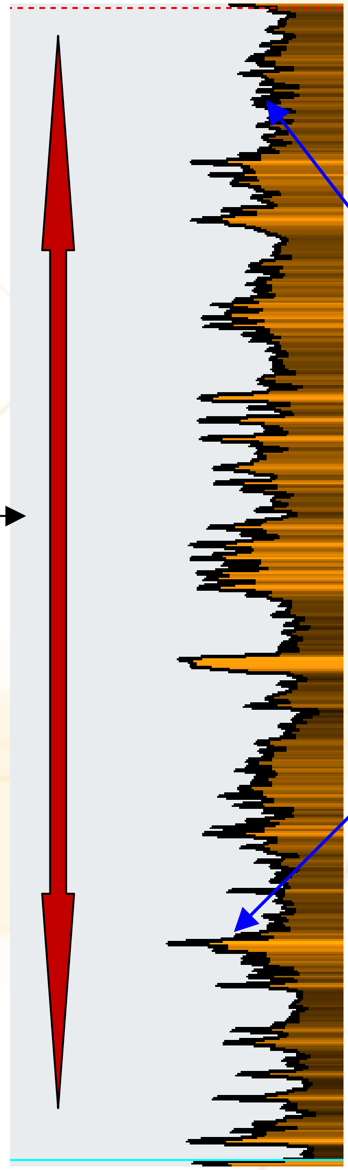
and

SANDSTONE: white to off-white, fine to medium grained, mod sorted, subangular, mod calcareous cement, <10%kaolinitic matrix, trace lithics, firm to loose, tight to poor visual porosity

Lower Sawpit Shale Sub-unit 1b
Sawpit 1 Well

(2054.8-2289.7mKB)





Palynology:

APK 122

Price 1993

<u>From Sidewall Core Description</u>

CLAYSTONE: medium to dark brown/grey, slightly silty, sub-fissile to massive, firm to hard, dispersive in part non-calcareous with moderate to rare micro-mica, trace carbonaceous and coaly detritus

<u>Cuttings Description</u>

CLAYSTONE: medium to dark brown/grey, sub-fissile, firm, dispersive in part slightly calcareous with rare micro-mica; interlaminated with

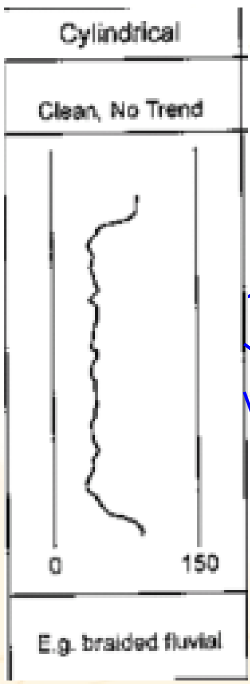
SANDSTONE: off-white, very fine to fine, subangular to sub-rounded, moderately sorted quartz, weak to strong calcareous and weak silica cement, abundant kaolinitic matrix, rare lithics, trace carbonaceous detritus, moderately hard, nil visual porosity, no oil fluorescence.

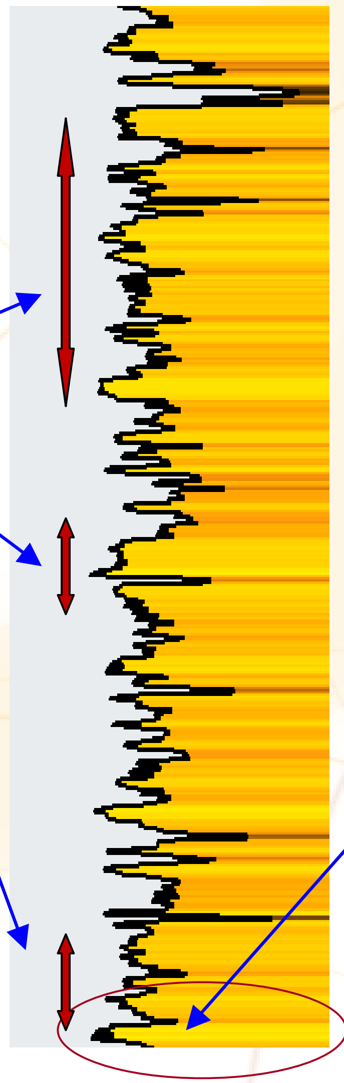
Average for the interval:

10% SANDSTONE; 90% CLAYSTONE

Lower Sawpit Shale Sub-unit 1c
Casterton 1

(1775.4 - 1954.4mKB 179m thick)





Palynology:

<u>Cuttings Description:</u>

Sandstone with minor interbeds of shale and siltstone.

The sands are loose, clear, frosted, milky, cloudy, brown, light grey, whitish and pink quartz with some rare yellow quartz. The sands are fine to very coarse, predominantly subangular with lithics consisting of phyllite, mica schist, grey and green shale, serpentine, green and grey quartzite, diorite, chlorite schist, slate and rare tuff.

SILTSTONE is light to medium grey, occ. whitish grey, micaceous, feldspathic, argillaceous, carbonaceous.

SHALE is medium to dark grey, fairly hard, carbonaceous and coaly in places.

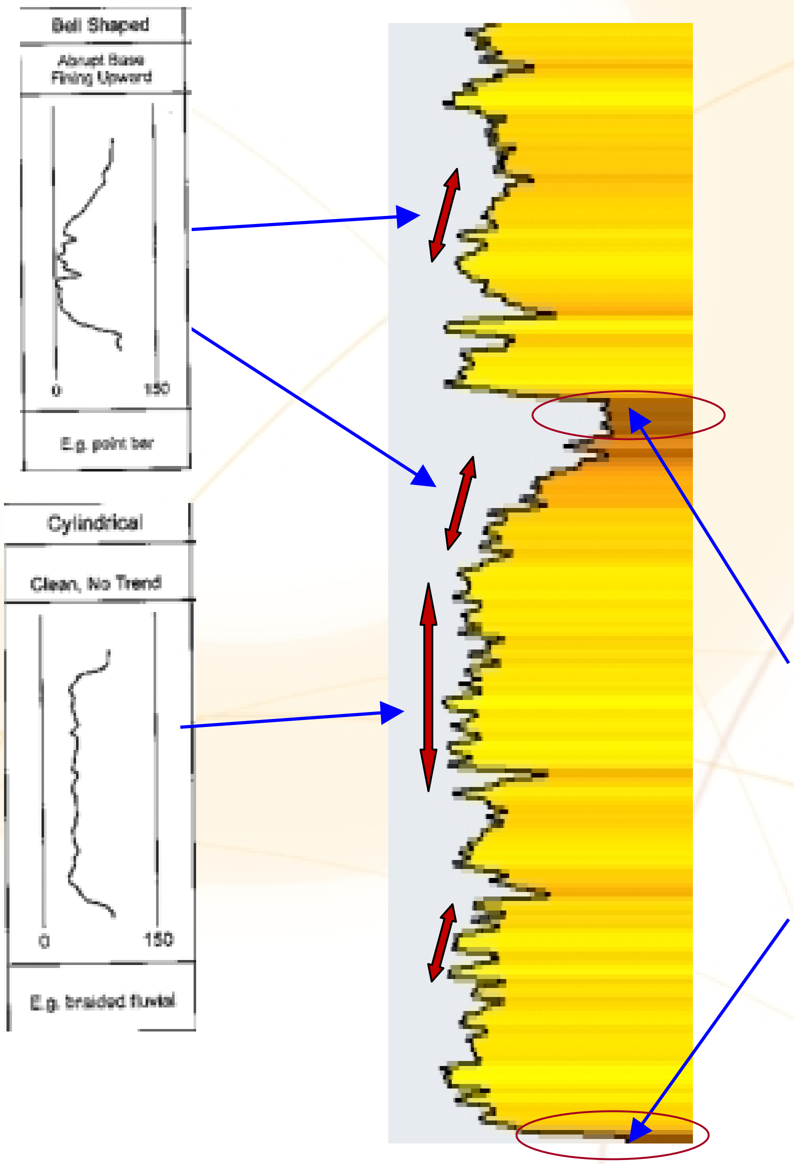
<u>From Core Description at base of sub-unit</u>

The conglomerates contain well rounded pebbles up to 8cm in diameter, consisting of quartz, greenish-medium grey shale, diorite and weathered sandstone. The sandstones are lithic (quartz, shale and phyllites) and are garnetiferous with coaly laminations. Contacts between the conglomerates and sandstones are sharp.

Lower Sawpit Shale Sub-unit 1c
Gordon 1

Sands average 55 GAPI

(1776 - 1870.7mKB 94.7m thick)



Cuttings Description:

Sandstone interbedded with silty claystone

The sands are off white to light grey, fine to very coarse, subangular to angular, poorly sorted with mod. calc. and siliceous cement with common white argill. matrix, with common pink to red garnet, trace to common grey green phyllitic and volcanogenic lithic grains, trace coaly detritus, mod hard with poor to fair visual porosity.

Silty Claystone is medium brown grey, occ. whitish grey, micaceous, feldspathic, carbonaceous and coaly, firm to mod. hard, very dispersive and subfissile.

From side wall core descriptions

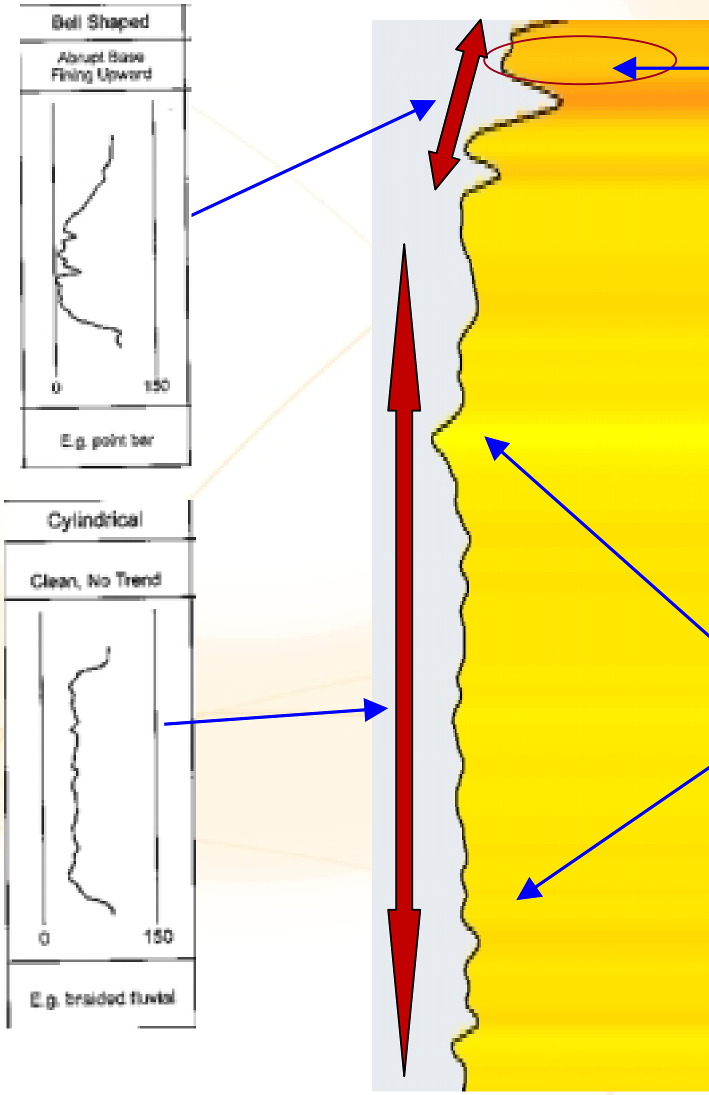
SANDSTONE: light-medium grey, very fine to coarse grained, sub-ang to sub-round, mod to well sorted, weak calc cement, mod sil cement, common white argill. matrix, abundant med brown grey argill. and silty matrix grading to claystone, friable, poor visible porosity.

SANDSTONE: light to med grey, very coarse to coarse, sub-ang to sub-round, mod to well sorted, weak calc. cement, mod. sil cement, common white argill. matrix, abundant med brown grey argill. and silty matrix, friable poor visible porosity

Lower Sawpit Shale Sub-unit 1c
Pyrus 1

Sands average 45 GAPI

(3415.4 - 3442.5m 27.1m thick)



Cuttings Description:

3417m Sandstone interbedded with silty claystone

SANDSTONE: 70-90% clear to translucent, fine - predom. medium, occasional medium to coarse, well sorted, subangular, trace weak calc/sil cement, kaol. matrix, predom. clean loose grains, fair inferred porosity

SILTSTONE: 10% med grey to light grey, argillaceous, predom. arenaceous, common to localised abundant mica, common carb matter, moderately hard, subfissile to fissile.

CLAYSTONE: 10-20% pred. brownish grey, silty, common very fine carb matter, common micromiceous, soft, pred. amorphous - sub blocky

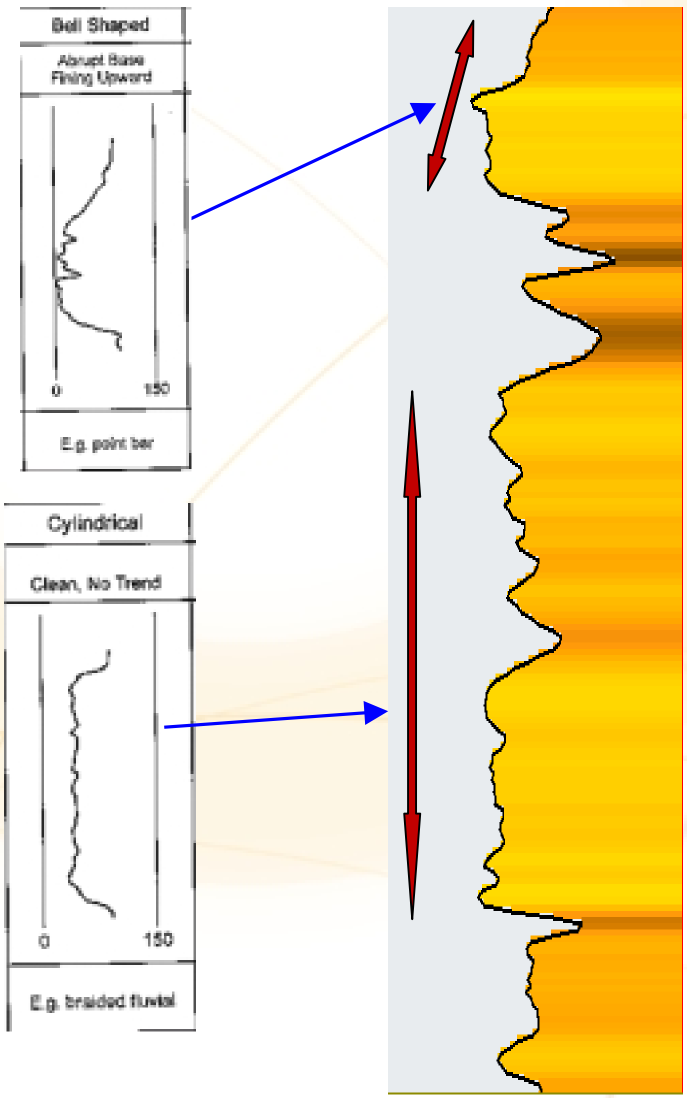
3426-3435m SANDSTONE: 100% clear to translucent, fine - predom. medium, occasional medium to coarse, well sorted, subangular, trace weak calc/sil cement, kaol. matrix, predom. clean loose grains, fair inferred porosity

Palynology:

Lower F. wonthaggiensis zone

(Hooker 1996)

Lower Sawpit Shale Sub-unit 1c
Wynn 1



Sands average 45 GAPI

(2915.1 - 2943.5mKB 28.4m thick)

<u>Cuttings Description:</u>

2915 - 2943m

Sandstone interbedded with silty claystone

SANDSTONE: 70-100% offwhite - colourless, friable to predom. Loose quartz, fine - predom. medium, mod. - well sorted, subangular- subrounded, weak calcitic cement, common grey and green chert fragments, fair - good inferred porosity

SILTSTONE: 10% grey brown, arenaceous, firm, micaceous, common carbonaceous laminations, trace feldspar.

CLAYSTONE: 10-30% light - dark grey, pale grey brown, firm, occ. silty with carbonaceous specks and mica flakes.

Palynology:

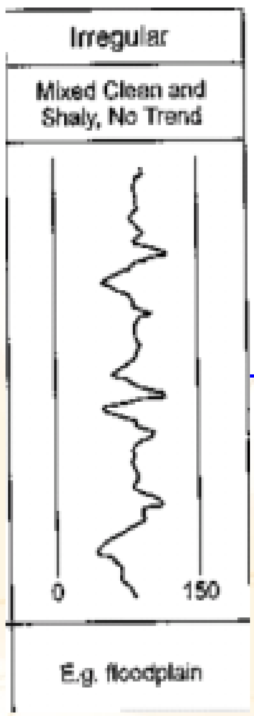
This interval not sampled

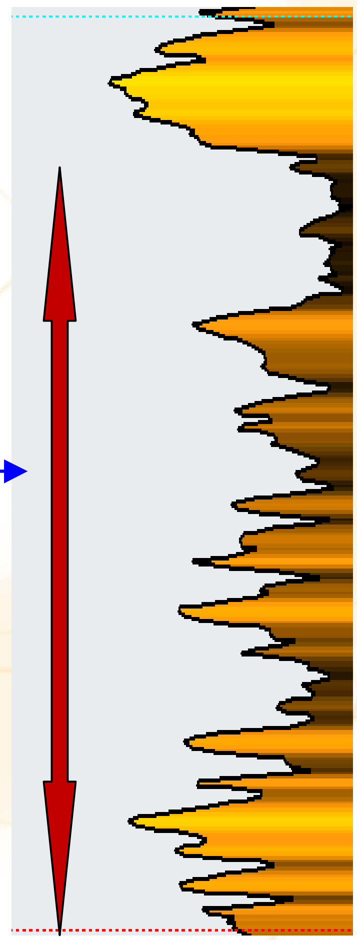
(Morgan 1994)

Lower Sawpit Shale Sub-unit 1c
Jacaranda Ridge 1

Sands average 74 GAPI

Muds average 130 GAPI





Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

(2867.8 - 2905.7mKB 37.9m thick)

Cuttings Description:

2880 - 2905m

Claystone interbedded with siltstone and sandstone

SANDSTONE: 10-80% yellowish grey aggregates and translucent to clear grains, fine to medium grained, mod.sorted, subangular, common dispersed kaol. matrix, moderately strong sil. cement, predominantly hard aggregates, tight inferred porosity

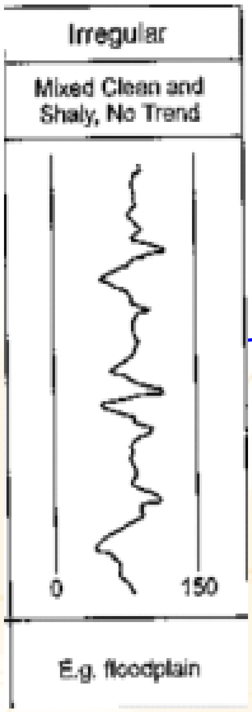
SILTSTONE: 10%-60%dark grey to greyish black, non-calcareous, sl. argillaceous, arenaceous, hard, micro-micaceous, abundant fine carbonaceous material, sub-fissile.

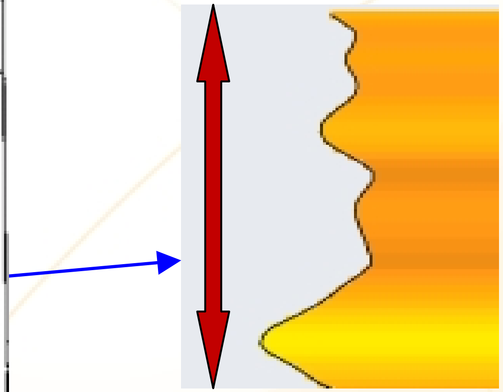
CLAYSTONE: 10-80% olive grey, non-calcareous, soft to dispersive, silty with common fine carbonaceous material and amorphous.

Fluorescence was noted in the sandstone cuttings and was described as 50-70% dim, patchy to even, orange to yellow fluorescence, occ. mod. bright yellowish white, weak pale diffuse crush cut only, trace ring residue.

Lower Sawpit Shale Sub-unit 1c Viewbank 1

(2425.3 - 2433.8mKB   7.5m thick)





Palynology:

This interval not sampled

(Morgan 1994)

Sands average 74 GAPI

Muds average 130 GAPI

Cuttings Description:

2426 - 2433m

Siltstone interbedded with claystone and sandstone

SANDSTONE: 20-60% white to off-white, very fine to medium, fair sort, subang to subrounded, trace weak quartz overgrowths, tr-20% kaol matrix, <1% lithics, tr k-felds & biot., loose to friable, fair to good inferred porosity.

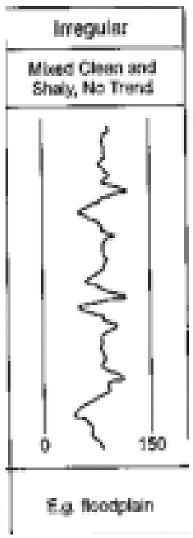
SILTSTONE: 20%-70% white - off-white, pale grey brown, soft, ab. very fine to medium matrix sand grading to argillaceous sandstone, <50% soft kaol. matrix.

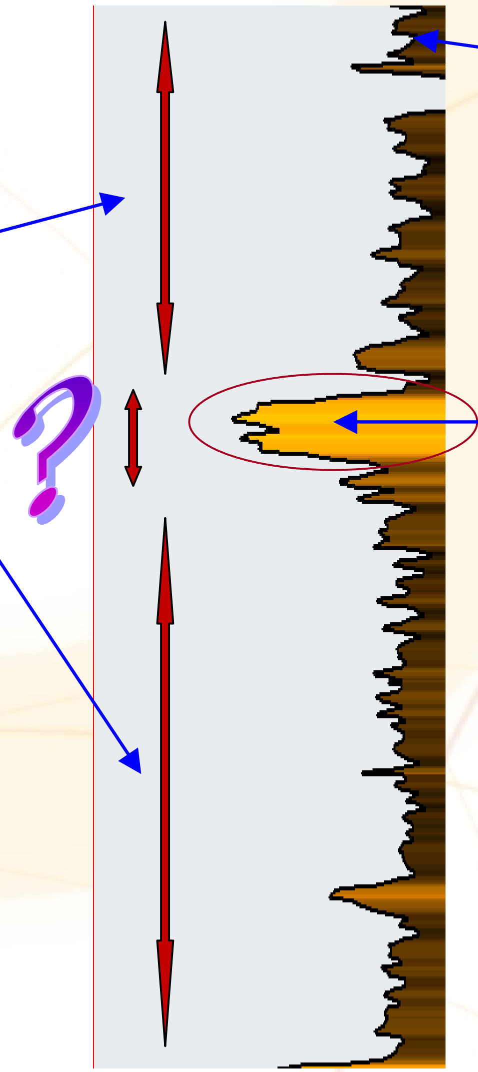
CLAYSTONE: 10-30% pale to med. grey brown, medium grey, mod. firm, blocky, occ. subfissile, micromicaeous, <20% quartz silt, tr. vf disseminated carbonaceous matter.

Fluorescence was noted in the sandstone cuttings and was described as 50-70% dim, patchy to even, orange to yellow fluorescence, occ. mod. bright yellowish white, weak pale diffuse crush cut only, trace ring residue.

Lower Sawpit Shale Sub-unit 1d
Casterton 1 Well

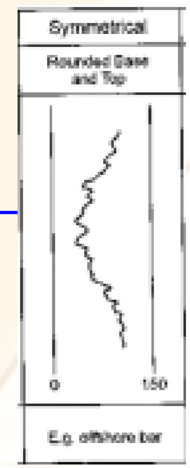
(1711 - 1775.4mKB 64.4m thick)





From Core Description at top of sub-unit

Shale: dk grey-black, micromicaceous, fairly hard, silty in places. A few plant & coaly fragments are present. Becomes more silty towards the base



Cuttings Description:

Sandstone: fine - medium grained subang, clear quartz with occ. frosted, predominantly loose, some aggregates with partly kaol feldspars, dark grey chert, grey-green schists and trace garnet in kaol. and calc. matrix.

Offshore bar or fan deposit??

Palynology:

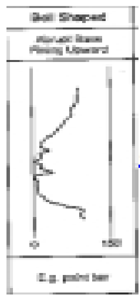
APK1-APK21, probably APK122 M. evansii notable (Price 2000)

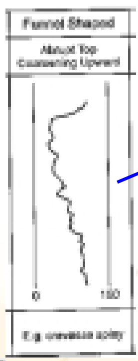
Cuttings Description:

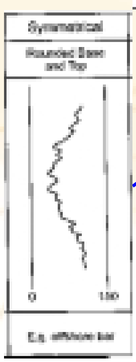
Shale: medium grey to dark grey, micaceous, carbonaceous, silty, sandy in part and mod. hard

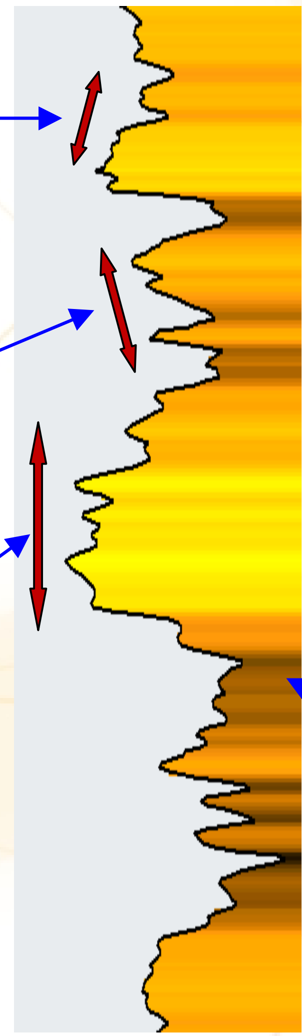
Lower Sawpit Shale Sub-unit 1d
Gordon 1 Well

(1736.1 - 1776mKB 39.9m thick)









Palynology:

Mid APK122

NOT Mid APK122

Price (2000)

Cuttings Description:

Sandstone interbedded with silty claystone

The sands are off white to light grey, fine to very coarse, subangular to angular, poorly sorted with mod. calc. and siliceous cement with common white argill. matrix, with common pink to red garnet, trace to common grey green phyllitic and volcanogenic lithic grains, trace coaly detritus, mod hard with poor to fair visual porosity.

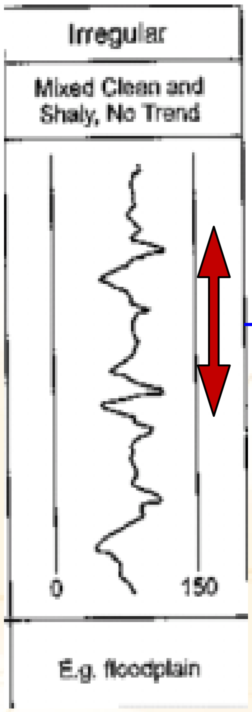
Silty Claystone is medium brown grey, occ. whitish grey, micaceous, feldspathic, carbonaceous and coaly, firm to mod. hard, very dispersive and subfissile.

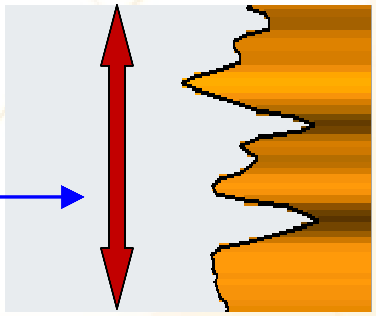
From side wall core descriptions

Siltstone/Sandstone: light-medium brown grey, clayey to very fine grained, grades to very fine sandstone, firm to hard, non-fissile.

Claystone: light to dark grey, very coarse to coarse, clayey to very fine grained, grades to very fine sandstone, firm to hard, non-fissile.

Lower Sawpit Shale Sub-unit 1d
Wynn 1 Well





(2908.9 – 2915.1mKB 6.2m thick)

<u>Cuttings Description:</u>

2909 - 2915m

SANDSTONE: 60-100% colourless – off-white, friable to predominantly loose quartz, very fine to occasional coarse, sub-rounded to sub-angular, moderately to well sorted, weak calcareous cement, abundant dispersive white matrix, clean in part with common white feldspar, poor to fair porosity

Trace bright, patchy yellow fluorescence, moderately strong, milky cut with thin ring residue.

CLAYSTONE: trace – 30%: grey-dark grey, greenish in part, silty with carbonaceous specks in part

SILTSTONE: 10% brown grey, firm, blocky, with feldspar, mica, argillaceous matrix and carbonaceous specks

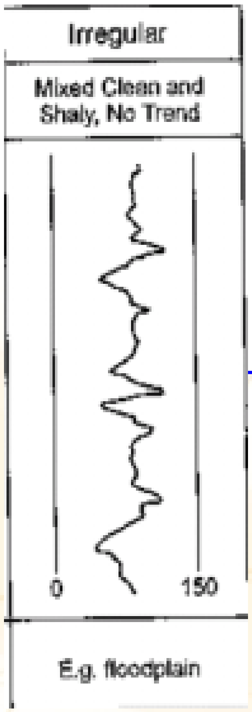
Palynology:

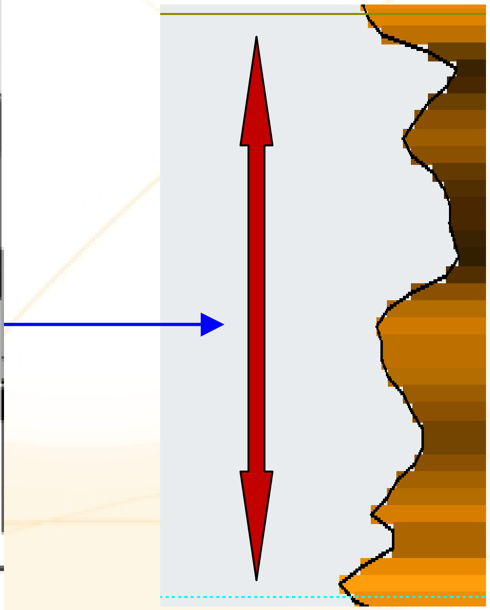
Not sampled

(Morgan 1994)

Lower Sawpit Shale Sub-unit 1d
Jacaranda Ridge 1 Well

(2862.7 - 2867.8mKB 5.1m thick)





Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

Cuttings Description:

2873 - 2880m

Claystone interbedded with siltstone

SILTSTONE: 10% dark grey to greyish black, non-calcareous, sl. argillaceous, arenaceous, hard, micro-micaceous, abundant fine carbonaceous material, sub-fissile.

CLAYSTONE: 90% olive grey, non-calcareous, soft to dispersive, silty, micromicaceous with common fine carbonaceous material and amorphous.

SWC Description:

2878m

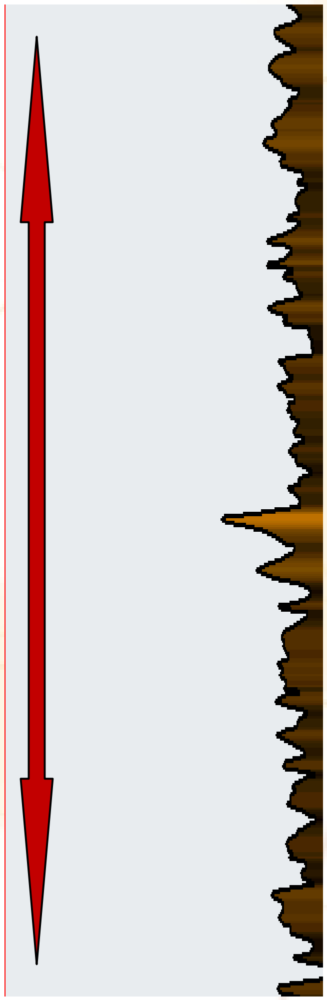
SILTSTONE: olive grey, argillaceous, moderately carbonaceous

Fluorescence was noted at the top of this unit and was described as trace dull to moderately bright, patchy yellow fluorescence, slow diffuse pale yellowish crush cut only, trace ring residue.

Lower Sawpit Shale Unit 1
Penley 1 Well

(1650.5 - 1712mKB 61.5m thick)

Depositional environment - lacustrine



Palynology:

This interval not sampled

(Morgan 1994)

Cuttings Description:

1650 - 1712m

Claystone interbedded with siltstone

CLAYSTONE: 90% medium grey to medium brown grey, trace mottled white, non-calcareous, soft to soluable, silty, micromicaceous, amorphous to sub-fissile.

SILTSTONE: 10% mid grey to dark grey brown, non-calcareous, arenaceous, moderately firm, micro-micaceous, blocky to sub-fissile.

SWC Description:

1670 and 1710m

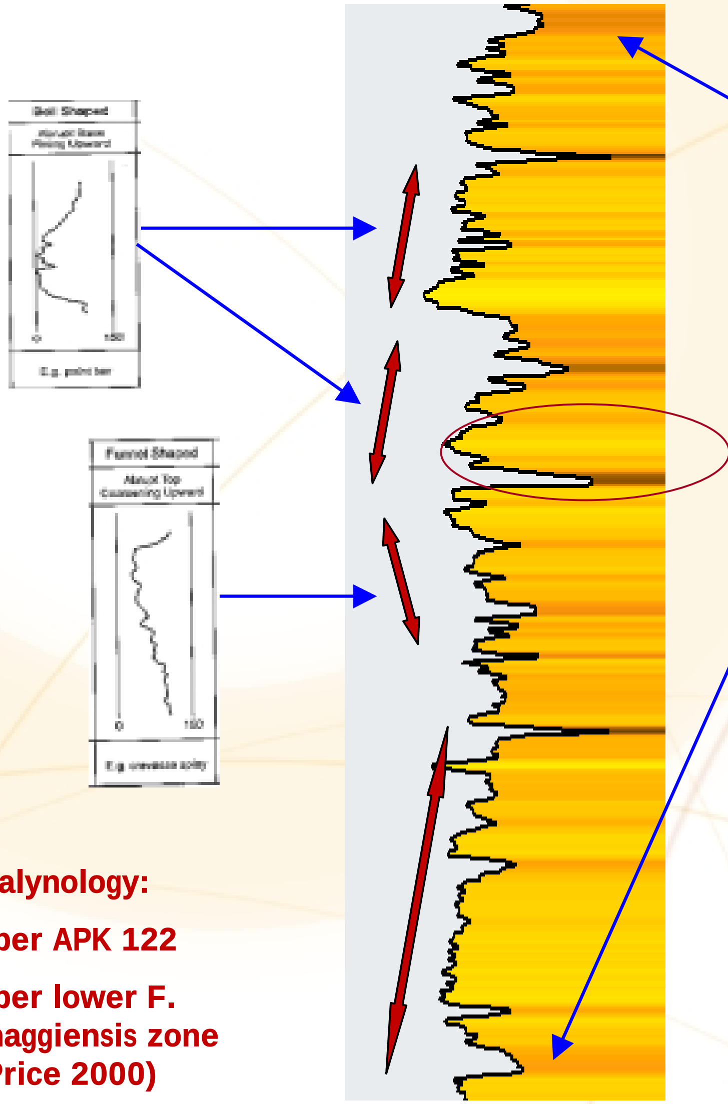
Silty CLAYSTONE: mid to dark brownish grey, moderately firm, blocky to sub-fissile, non-calcareous, micromicaceous, vf disseminated k feldspar, trace fine quartz sand, v finely disseminated carbonaceous matter.

Thin lenses of white, very fine grained, well sorted sandstone described from swc 9 (1670m).

No Fluorescence was noted in the sandstone cuttings or sidewall cores.

Sawpit Sandstone Unit 2
Casterton 1 Well

(1606.9 - 1711mKB 104.1m thick)



Palynology:

Upper APK 122

Upper lower F. wonthaggiensis zone (Price 2000)

From Core Description at top and base of sub-unit

SANDSTONE: v light grey, fine-med grained, friable comprised of well sorted, sub-ang light brown quartz, kaol white felds, scattered fine black soft carb shale, coaly grains & graphite, tr musc, chlorite & garnets in a kaolinitic matrix. Interbedded with SANDSTONE: with ab dark laminations containing coarse biot & musc, soft bn-bl coaly grains & tr plant resin. Finer grained than the sst above, less friable and more micaceous. Sst becomes more garnetiferous towards base of core.

SHALE: dk grey-black, micromicaceous, fairly hard, silty in places. A few plant & coaly fragments are present. Becomes more silty towards the base.

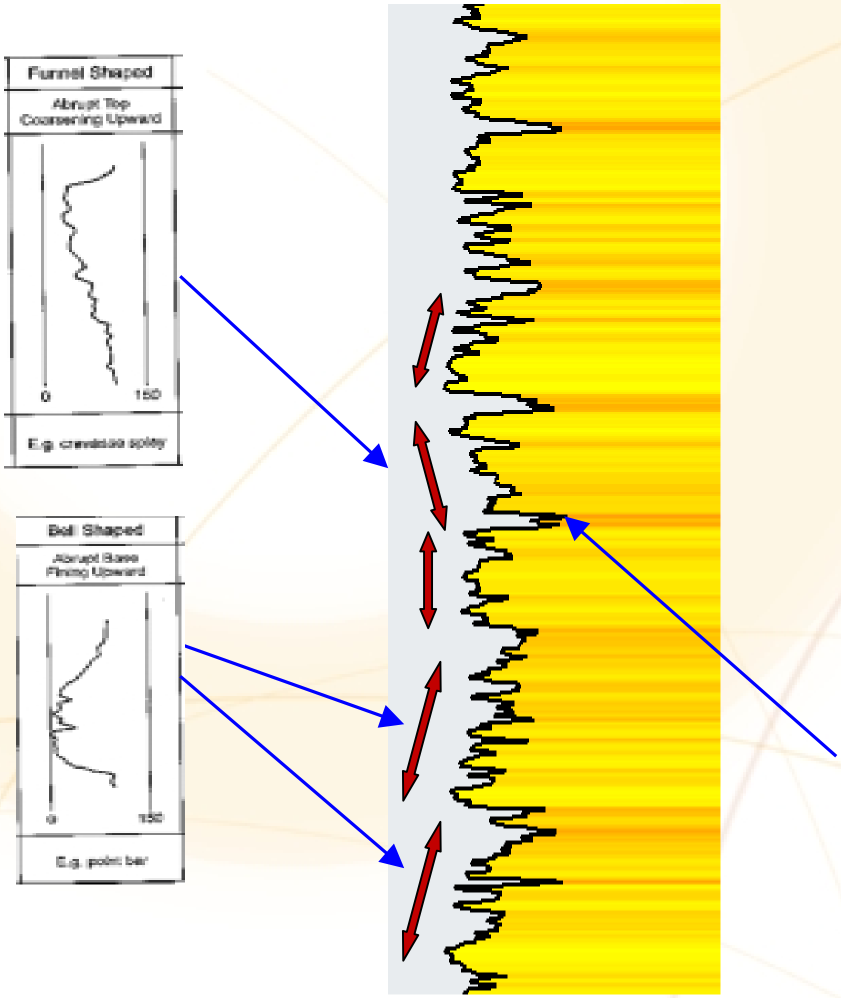
Cuttings Description:

SANDSTONE: light brown, fine - coarse grained, friable, occ. hard and calcareous in part, well sorted, ang to sub ang quartz, with feldspar (kaol) garnet, grey lthics, sideritic material, tr graphite, serpentine, phyllite in a kalonitic, siliceous or calc matrix; interbedded with minor:

SILTSTONE: lt to med grey, micaceous, occ. argillaceous and with carbonaceous specks.

Sawpit Sandstone Unit 2
Gordon 1 Well

(1618.7 - 1736.1m 117.4m thick)



Cuttings Description:

SANDSTONE: off-white to v light grey - light brown, v fine to coarse, dom. med, ang to subang, mod to strong silica cement, weak calc cement, occ mod dol cement. Common white to occ lt brown argill matrix, clear to opaque quartz grains, com pink to red garnet, tr green grey chert and volcanogenic lithics, tr black coal detritus, mod hard, poor to dom fair visible porosity, interbedded with med grey to brown grey, mod hard, dispersive, subfissile SILTSTONE: with micromica and tr carb flecks and med grey to med brown grey, mod to v silty, tr black carb, com micromica, mod hard, very dispersive, sub fissile Claystone.

From side wall core descriptions OLD

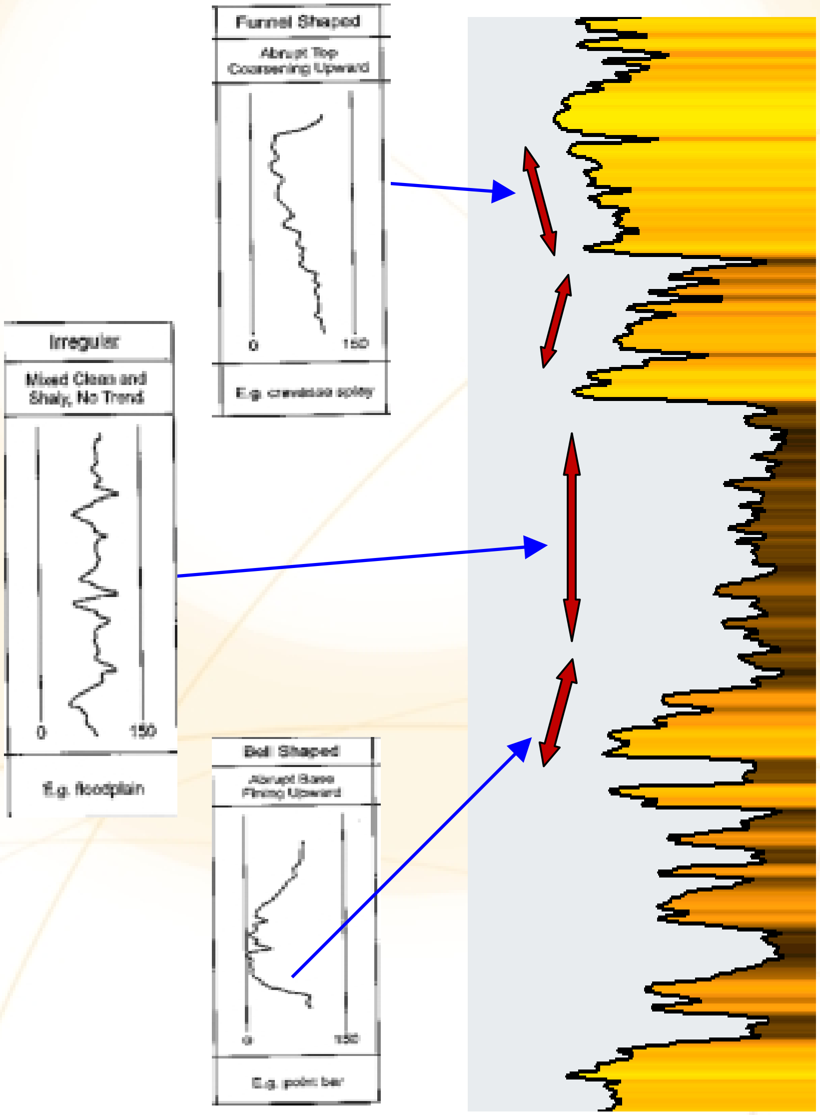
SANDSTONE: white - light grey, very fine to medium grained, subangular - subrounded, poorly sorted, mod sil cement, ab white argillaceous matrix, mod hard, very poor visual porosity.

Palynology:

APK122 Undiff.

Price (2000)

Sawpit Sandstone Unit 2
McEachern 1 Well



(1754.7 - 1877mKB 122.3m thick)

Sidewall Core Description:

SANDSTONE: off-white to light grey, fine to coarse, subangular, poorly sorted, soft with lithics, trace coaly fragments and rare garnet

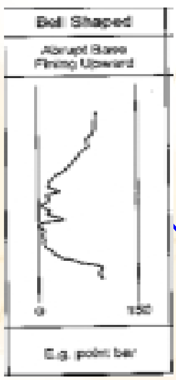
CLAYSTONE: dark to very dark grey, soft to moderately hard, blocky in part.

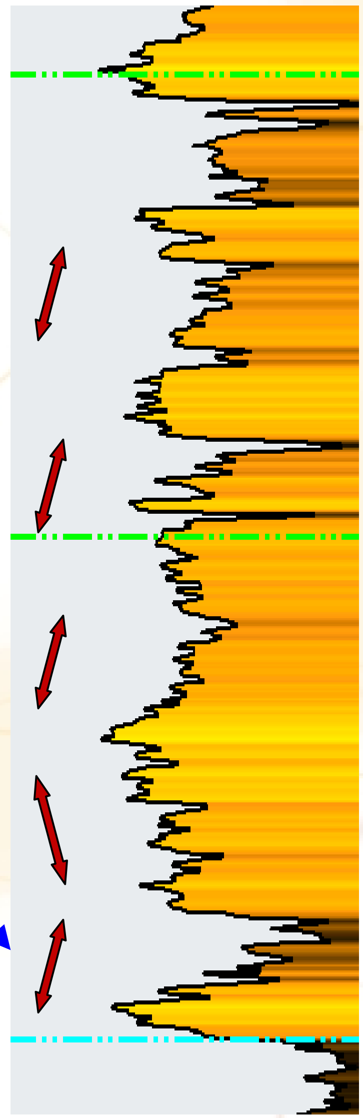
Palynology:

F. wonthaggiensis (lower Neocomian)

Morgan (1990)

Sawpit Sandstone Unit 2
Jacaranda Ridge 1 Well





(2783.6 – 2862.7mKB 79.1m thick)

<u>Sidewall Core Description:</u>

Sandstone interbedded with siltstone

SANDSTONE: fine to medium grained with common kaolinitic matrix, poor to fair visual porosity.

Fluorescence was noted throughout this interval is described as trace moderately bright, patchy, greenish yellow with moderately fast diffuse direct cut and thin ring residue.

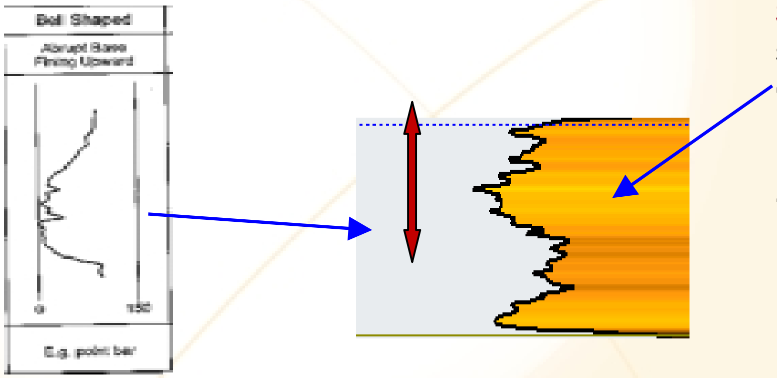
Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

Sawpit Sandstone Unit 2
Penley 1 Well

(1633.5 - 1650.5m 17m thick)



Cuttings Description:

SANDSTONE: white, fine to occ. medium, good sorting, subang to subround, tr weak calc cement, <10% weak quartz cement, <25% white kaolinitic matrix, with grey and dark brown lithics, biotite, rare garnet, tr graphite, loose to friable trace visual to occ. fair inferred porosity. No shows

Palynology:

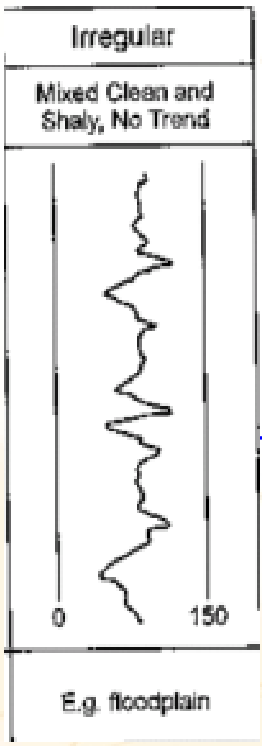
This interval not sampled

(Morgan 1994)

No Fluorescence was noted in the sandstone cuttings or sidewall cores.

Sawpit Sandstone Unit 3
Casterton 1 Well

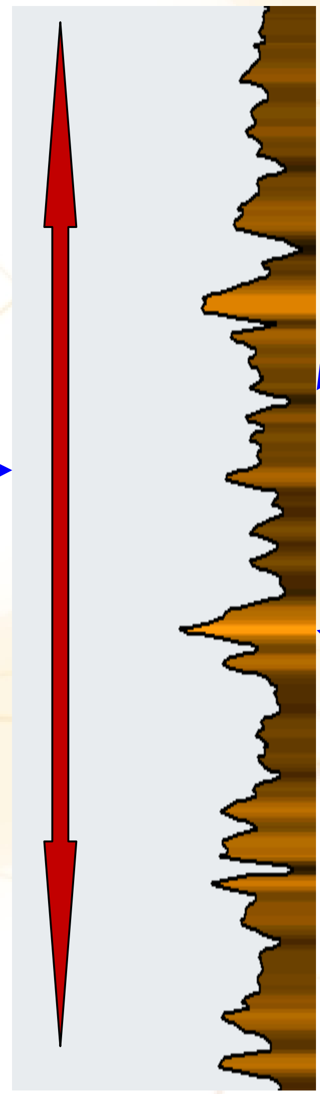
(1554.2 - 1606.9mKB 52.7m thick)



Palynology:

Upper APK 122

Upper lower F. wonthaggiensis zone (Price 2000)



Cuttings Description:

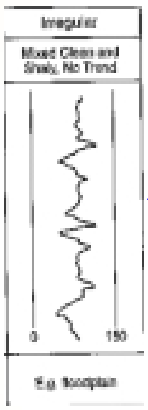
Shale with minor interbeds of siltstone and sandstone

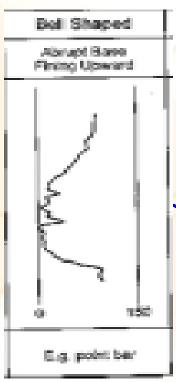
SHALE: predominantly medium grey to green grey, light and dark grey, micaceous, silty, chloritic in part with carbonaceous specks. Some shale is soft and carbonaceous and also hard, brown, ferruginous shale is also present along with black, brittle coal.

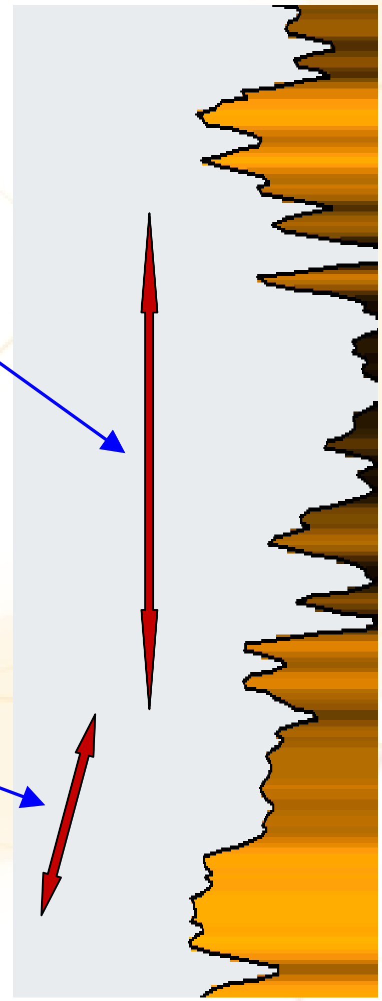
SILTSTONE: light grey with some green grey and white grey, micaceous, sandy, feldspathic, firm with common carbonaceous specks.

SANDSTONE: brownish grey, hard, ferruginous, fine to medium grained, clear quartz with lithics, siliceous and calcareous matrix.

Sawpit Sandstone Unit 3
Wynn 1 Well







Palynology:

Not sampled

Morgan 1994

(2811.4 - 2835.9mKB 24.5m thick)

Cuttings Description:

SANDSTONE: 50-100% white to greenish white, occasional greyish, hard to friable, very fine grained, subangular to subrounded, moderate to well sorted, moderately cemented with silica and calcite, trace common white - greenish kaloinitic matrix, dispersive and soft, abundant - 10% altered white feldspar, trace pale green and grey lithics, trace to fair porosity

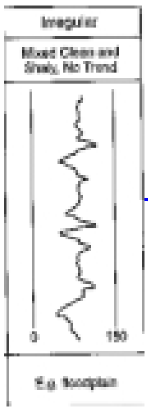
Trace to 80% dull patchy gold fluorescence with bright to dim yellow spots, weak crush cut, moderately thin colourless ring residue

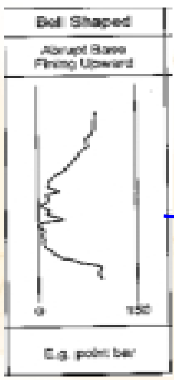
SILTSTONE: 10-40% dark grey to brown grey, firm to hard, micaceous, carbonaceous, with abundant off-white altered feldspar, blocky to sub-fissile.

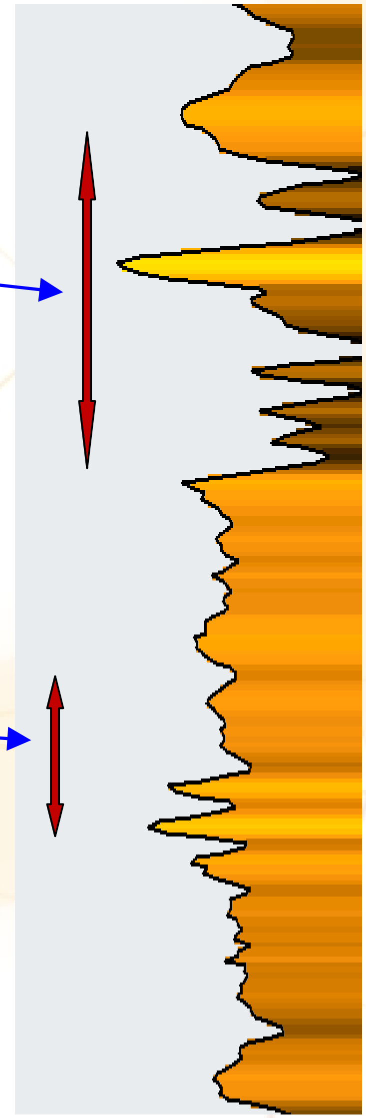
CLAYSTONE: 10-20% grey brown, firm to moderately hard, micro-micaceous, sub-fissile to fissile, grading to shale.

Sawpit Sandstone Unit 3
Jacaranda Ridge 1 Well

(2750 - 2783.6mKB 33.6m thick)







Cuttings Description:

Sandstone interbedded with claystone and siltstone

SANDSTONE: yellowish grey, fine to medium, well sorted, subangular, tr weak sil. cement, common to abundant white kaolinitic matrix, with poor inferred porosity.

SILTSTONE: dark grey, non-calcareous, sl argillaceous, abundant fine carbonaceous material, micromicaceous, hard, sub-fissile to sub-blocky.

CLAYSTONE: olive grey, non-calcareous, silty, common fine carbonaceous material, micromicaeous, dispersive, amorphous.

Depositional environment -meandering fluvial with a return to floodplain / overbank environment with decreasing depth

Palynology:

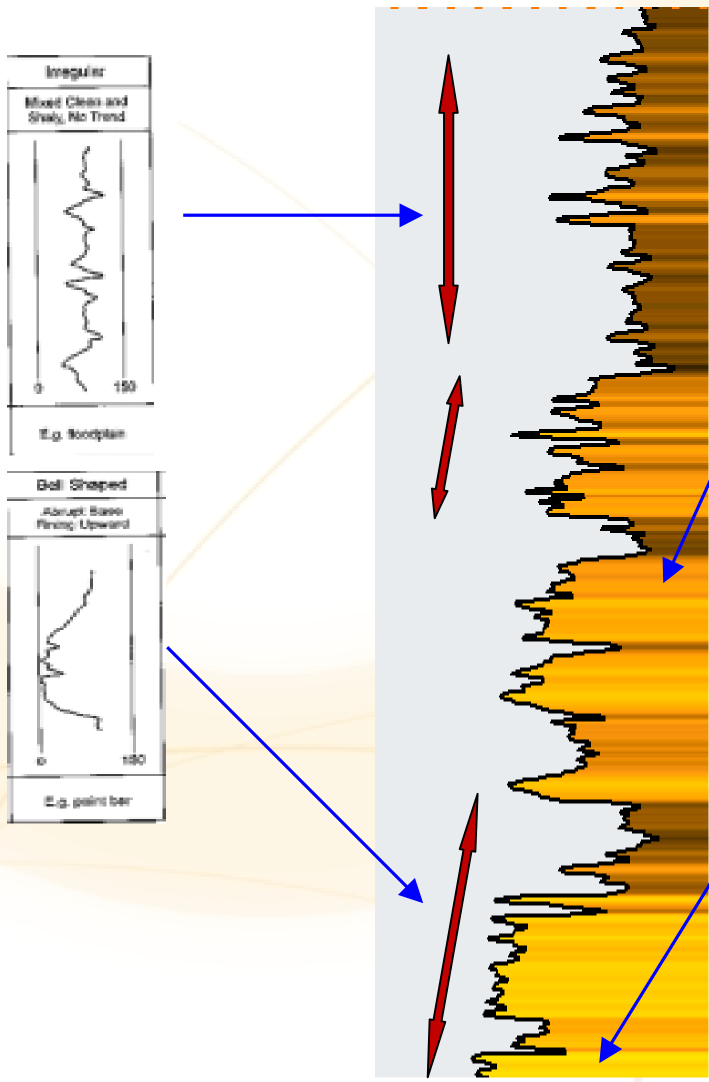
Lower F. wonthaggiensis

(Hooker 1999)

Fluorescence was noted throughout the section and comprises trace dim, patchy yellow to orange, weak diffuse cut and trace ring residue

Sawpit Sandstone Unit 4
Casterton 1 Well

(1428 - 1554.2mKB 126.2m thick)



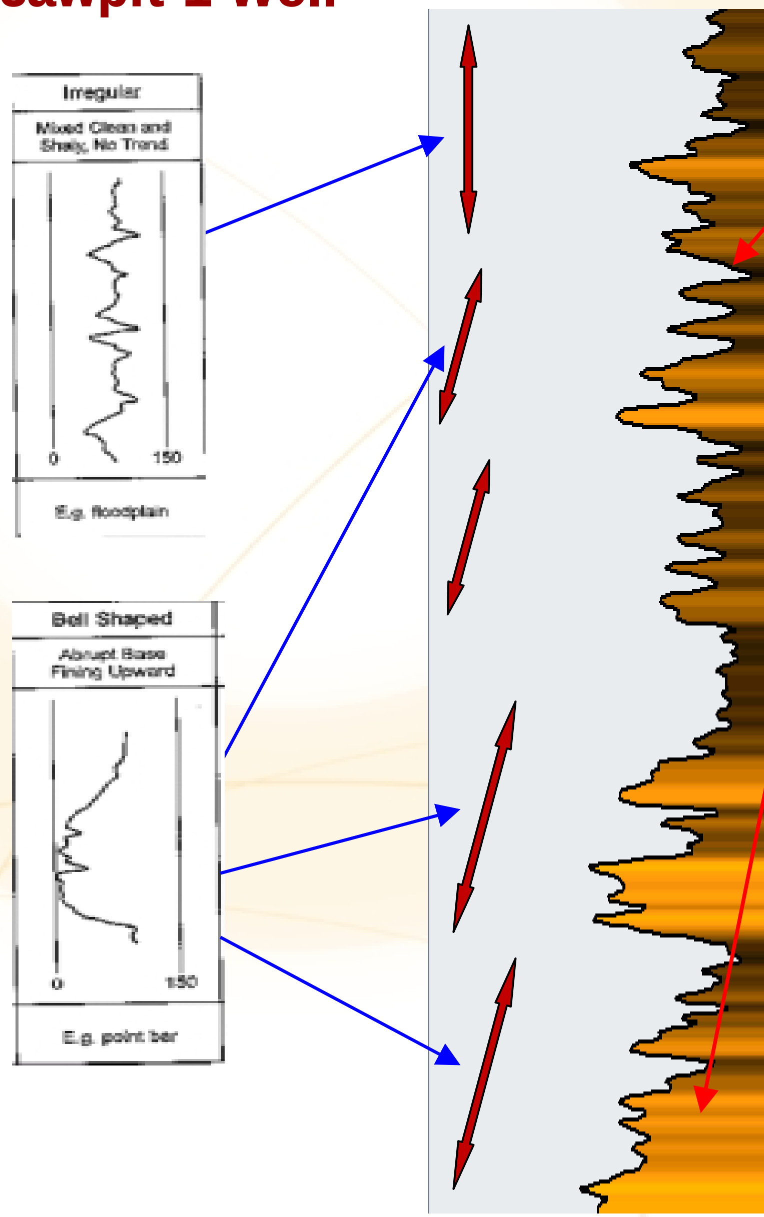
From Core Description

SANDSTONE: whitish grey, med grained, lithic, feldspathic, sl calc, sl mica, garnetiferous, friable. kaolinitic to sl calcareous matrix. Rare black, clean & bright coaly laminations and plant fragments & resin up to 3mm thick

SANDSTONE: light grey, med-coarse grained, lithic, partly kaolinised feldspathic, calc, garnetiferous, sl friable. Kaolinitic and calcareous matrix. Rare black, clean & bright coaly laminations and plant fragments & resin up to 3mm thick

Sawpit Sandstone Unit 4
Sawpit 1 Well

(1829.1 – 1937.5mKB 108.4m thick)



Sidewall Core Description:

1845 - 1870m

CLAYSTONE: medium to dark grey, moderately silty, common micro-mica, trace carbonaceous flecks, firm to moderately hard, massive to sub-fissile, no oil flu, very weak milky white crush cut.

Cuttings Description:

1895 - 1900m

SANDSTONE: 90%: offwhite to very light grey, very fine to fine, occ. medium, subangular to subrounded, moderate to well sorted quartz, weak to moderately strong silica cement, weak calcareous cement, common to abundant kaolinite matrix, common altered feldspars, lithics, rare biotite, trace carbonaceous detritus, friable to moderately hard, very poor to poor porosity, no oil fluorescence

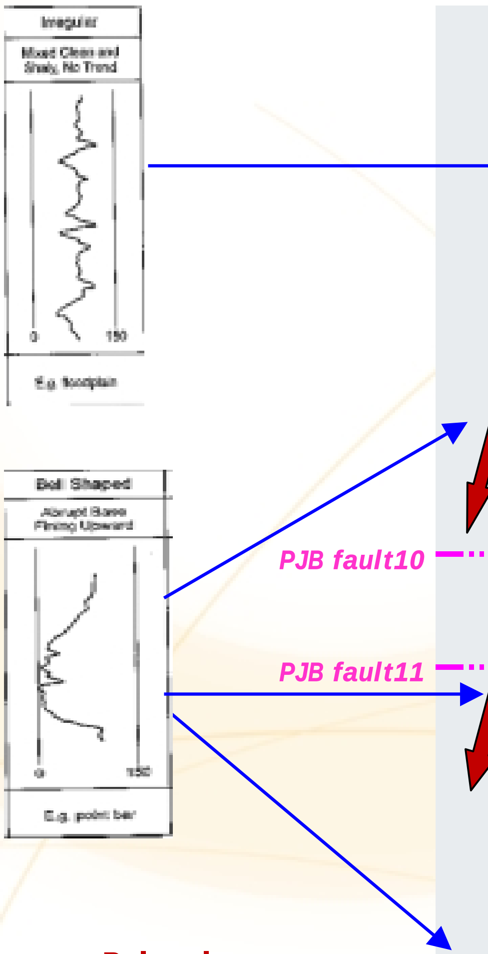
CLAYSTONE: 10%: as above

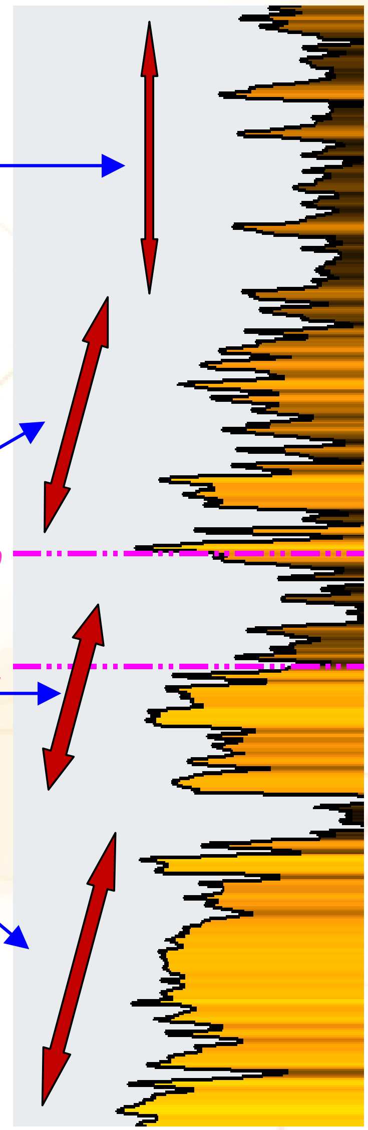
Palynology:

APK 122

Price (1993)

Sawpit Sandstone Unit 4
Jacaranda Ridge 1 Well





Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

(2640.2 - 2750mKB 109.8m thick)

<u>Cuttings Description:</u>

2705 - 2750m

SANDSTONE 100%: yellowish grey (agg), clear to trans (grains), predom. medium grained, well sorted, subangular, weak siliceous cement, minor kaol. matrix, fair inferred porosity

CLAYSTONE: olive grey, non-calc, silty, common fine carb material, micromicaceous, dispersive, amorphous

2640 - 2705m

Sandstone interbedded with siltstone and claystone

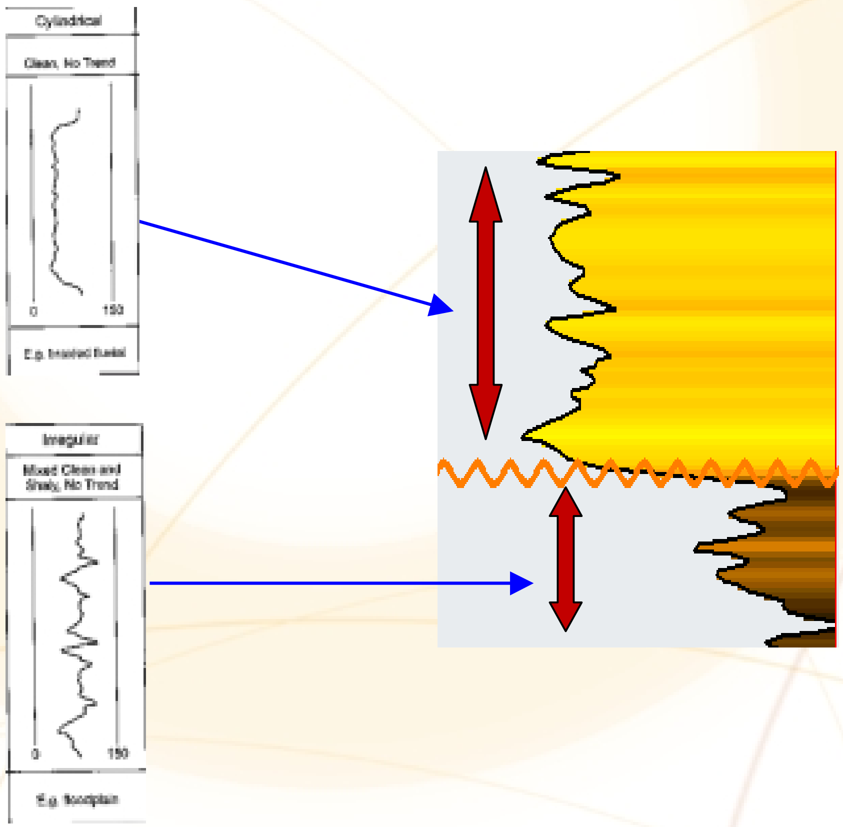
Sandstone and Claystone as above,

SILTSTONE: dark grey, non-calcareous, slightly argillaceous, arenaceous, abundant fine carbonaceous material, micro-micaceous, moderately hard, sub-fissile.

Fluorescence was noted throughout this interval is described as trace to 50% dim to moderately bright, patchy, greenish yellow with moderately fast diffuse direct cut and thin ring residue.

Jacaranda Ridge Sandstone
Jacaranda Ridge 1 Well

(2630.4 - 2640.2m 10m thick)



Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

Cuttings Description:

2705 - 2750m

SANDSTONE 100%: yellowish grey (agg), clear to trans (grains), predominantly medium grained, well sorted, subangular, weak siliceous cement, minor kaolinitic matrix, fair inferred porosity

CLAYSTONE: olive grey, non-calc, silty, common fine carbonaceous material, micromicaceous, dispersive, amorphous

2640 - 2705m

Sandstone interbedded with siltstone and claystone

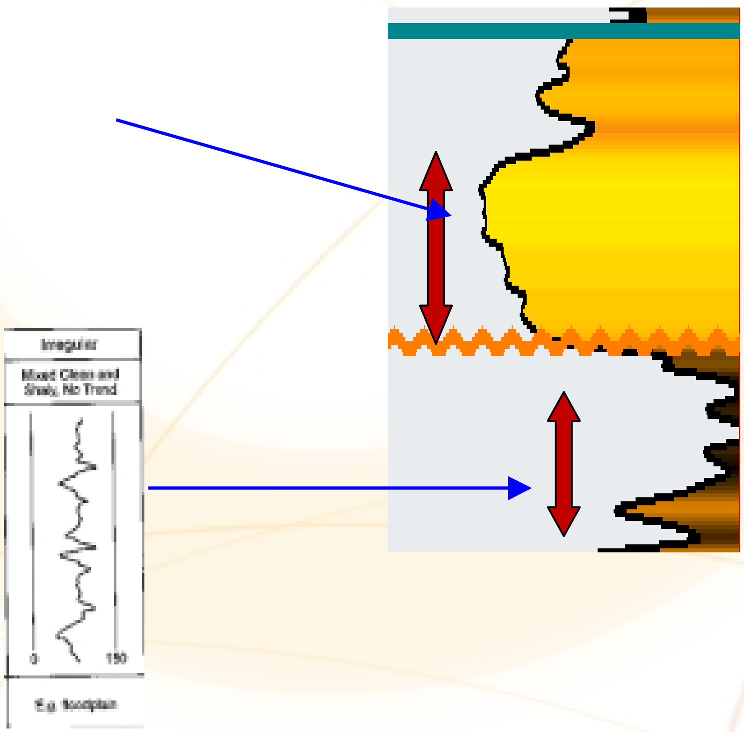
Sandstone and Claystone as above,

SILTSTONE: dark grey, non-calcareous, slightly argillaceous, arenaceous, abundant fine carbonaceous material, micromicaceous, moderately hard, sub-fissile.

Fluorescence was noted throughout this interval is described as trace to 50% dim to moderately bright, patchy, greenish yellow with moderately fast diffuse direct cut and thin ring residue.

Jacaranda Ridge Sandstone
Pyrus 1 Well

(3159 - 3172m 13m thick)



Palynology:

Lower F. wonthaggiensis

(Hooker 1999)

<u>Cuttings Description:</u>

2705 - 2750m

SANDSTONE 100%: yellowish grey (agg), clear to trans (grains), predom. medium grained, well sorted, subang., weak sil cement, minor kaol. matrix, fair inferred porosity

CLAYSTONE: olive grey, non-calc, silty, common fine carb material, micromicaeous, dispersive, amorphous

2640 - 2705m

Sandstone interbedded with siltstone and claystone

Sandstone and Claystone as above,

SILTSTONE: dark grey, non-calcareous, slightly argillaceous, arenaceous, abundant fine carbonaceous material, micromicaeous, moderately hard, subfissile.

Fluorescence was noted throughout this interval is described as trace to 50% dim to moderately bright, patchy, greenish yellow with moderately fast diffuse direct cut and thin ring residue.

Core Intervals for Casterton 1

No	Top (m)	Base (m)	Rec. %	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv%
1	614.5	617.8	75	**SILTSTONE:** light green grey, sl sandy, arg, mica, carb **MUDSTONE:** dark grey-black, v. carb	no shows **tight**	Interlaminated - laminations <0.5-20mm thick. Core dip flat		APK4-APK5 (Morgan 1988)			0.95	0.79
2	737.6	740.7	100	**MUDSTONE:** dark grey-black, sl silty & argill., mica, occ carb specks & lignite **SILTSTONE:** light grey, green-grey, sl sandy, arg, mica, carb, grading to v fine grained **SANDSTONE**, light grey, arg, mic,carb, tight Bottom 25cm of core is very dark grey-black MUDSTONE, v sl silty with occ plant remains - no app bedding	no shows **tight**	Interlaminated - laminations very thin with occ interbeds 1cm thick Good bedding, X-bedding, lensing, structures. Core dip 0.3deg to flat		APK31-APK321 (Morgan 1988)			1.6	
3	957.7	960.7	3	**MUDSTONE:** med grey, soft, calc,mica, carb, fossiliferous, massive, brittle	no shows **tight**	ROP 20 min/ft very low recovery. Subconchoidal fracture						
4	1096.1	1099.1	72	**SANDSTONE:** v. coarse at base to fine **SST - SILTST** at top of core, light grey with thin brown **MUDSTONE** bands at base grading to interbeds of grey brown **MUDST** up to 2cm thick with well preserved plant leaf near top. **SST** is typically comprised of sub-ang frag lithics (see right) in a light grey to white kaolinitic & calcareous matrix	shows? None described in the log **tight**	All sandstones are tight. All beds are carbonaceous with ab plant & wood remains throughout entire core(= (inc v coarse sands at base). Bedding flat - Xbeds minor and is about 10 deg max. Core is coarsest (fragments up to 1cm long) at base with most ab carbonaceous matter at top.	**LITHICS:** sub-ang frag of clear-grey qtz, white v kaol feldspar, dk grey & blue-green waxy clayst, brown & grey schist, green grey phyllite, light grey siltst, shiny black coal, brown mudst	1096.1m APK31-APK321 (Morgan 1988) M.*evansii* common 1096.67m lower APK321 (Price 2000) 1097.58m APK321-APK32 lower APK321 M.evansii scarce		Fluvial-lacustrine (lower Eumeralla)		0.44
5	1276.8	1278.3	0			no recovery						
6	1278.3	1280.2	2	**MUDSTONE:** medium grey, firm, silty, sl mica, carb inclusions & plant fragments		minimal recovery (2.5cm only)						
7	1370.7	1373.7	0			no recovery					15.1	0.54
8	1373.7	1375.3	100	Top 60cm comprises i/b **MUDSTONE** & carbonaceous **SHALE**. **MUDST** is med grey, silty, mica with a few finely macerated plant frag. **SHALE** occurs as interbeds 5-8cm thick, black, fissile, carb with ab fine lams of bright clean coal with com plant frags. Next 137cm comprises med grey **MUDSTONE**, mic, few fine green lithics, carb, yell specks, small plant frags. This Mudstone is silty and grades to **SILTSTONE**: which is light grey and slightly calcalcareous.		Overall dip of core 0-5deg.		APK12-APK31 probably Upper APK122-Lower APK21, tentatively Upper APK122 *M.evansii* common (Price 2000)		Fluvial-lacustrine (basal Laira or upper Pretty Hill Sst)	3	
9	1496.0	1499.3	100	**SANDSTONE:** whitish grey, med grained, lithic (see right), feldspathic, sl calc, sl mica, garnetiferous, friable. Kaolinitic to sl calcareous matrix. Rare black, clean & bright coaly laminations and plant frags & resin up to 3mm thick	Traces of poor porosity in places	Some dips 5-10 deg present, possibly due to X-bedding	**LITHICS:** sub-ang frag of light grey qtz, white kaol feldspar, soft light grey & greenish grey reworked shale, dk grey carb shale, mica & chlorite schist, dark grey chert					
10	1549.6	1551.4	37	**SANDSTONE:** light grey, med-coarse grained, lithic (see right), partly kaolinised feldspathic, calc, garnetiferous, sl friable. Kaolinitic and calcareous matrix. Rare black, clean & bright coaly laminations and plant frags & resin up to 3mm thick	Traces of poor porosity in places	Darker laminations in the sandstones indicate dips of 10-20 deg	**LITHICS:** sub-ang frag of light grey qtz, white kaol feldspar, pale grey & pale brown phyllites, grey mica schists, green serpentines and chlorite schists, abundant garnets, black & brownish black carbonaceous shale & coaly shale.					

Core Intervals for Casterton 1

No	Top (m)	Base (m)	Rec. %	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv%
11	1606.3	1609.3	100	**SANDSTONE:** v light grey, fine-med grained, friable comprised of well sorted, sub-ang light brown quartz, kaol white felds, scattered fine black soft carb shale, coaly grains & graphite, tr musc, chlorite & garnets in a kaolinitic matrix. Interbedded with **SANDSTONE:** with ab dark laminations containing coarse biot & musc, soft bn-bl coaly grains & tr plant resin. Finer grained than the sst above, less friable and more micaceous. **Sst** becomes more garnetiferous towards base of core.	**Tight** No Flu	Darker laminations in the sandstones indicate dips of 5-10 deg - probably X-bedding						
12	1709.6	1712.4	56	**SHALE:** dk grey-black, micromicaceous, fairly hard, silty in places. A few plant & coaly fragments are present. Becomes more silty towards the base.				APK1-APK21, probably APK122 M. evansii notable (Price 2000)		Fluvial-lacustrine (basal Laira or upper Pretty Hill Sst)	1.35	
13	1816.0	1819.0	100	**SANDSTONE:** v light grey, v.coarse grained, v. friable comprised of well sorted, sub-ang clear-light grey quartz with overgrowths, kaol white felds, scattered dk grey chert with minor lithics and locally ab garnets cemented with silica or kaolinite. Sorting & porosity improves when assoc with the silicous cement. A few v coarse (2-15mm long) coaly plant frag occur in the plane of the bedding. The sand becomes harder, less friable, less porous, finer grained, inc. coal frags and silty micaceous laminations, near the base of the core with almost all kaolinitic matrix.	Porosity ranges from poor to fair to occ. Good	Strongly X-bedded with dips 5-30deg	**LITHICS:** reworked dk grey shale, soft brown coal, garnets with quartz pebbles up to 2cm long.	APK122-APK21, probably APK122 (Morgan 1988)				
14	1949.5	1952.5	40	Interbedded **CONGLOMERATE:** (top 5.5cm and 3rd bed 8cm thick) well rounded 0.6 - 8cm pebbles (see right) in a calc, tight med-crs sst matrix. **SANDSTONE:** (2nd & 5th beds both 46cm thick) med-coarse gnd, lithics, garnets, laminations of coaly material, coarsening downwards becoming more friable near base. **SHALE:** (4th bed 18cm thick) med dk grey, micaceous, with silty lams.	Porosity improves towards base of coarsening downward ssts.	Sharp contact between top cong and underlying sandstone (porosity improves towards base) - Upper boundary of shale irregular due to load casting. Otherwise bedding is horizontal.	**PEBBLES:** quartz, greenish - med grey shale, diorite & weathered sst. **LITHICS:** sub-ang qtz, granules of reworked shale & phyllites	APK121-APK21, tentatively APK12		Fluvial (?Sawpit Sst)	1.6	
15	2061.4	2063.2	100	Interbedded Shale, Sandstone and Conglomerate: (2061.4-2062.6m) **SHALE:** dk dk grey, dense, fractured from intersecting fault (heavily slickensided - presence of talc & chlorite on fault planes. Shale grades down to dk greenish grey **SANDSTONE** comprised of lithics (see right) minor qtz in a chloritic matrix. Grain size increases gradually downward as the lithology changes to a **CONGLOMERATE**. Near the base the pebbles (desc. see right) are 2.5 to 3cm in diam and elongated in direction of bedding dip of 25-40 deg. Matrix is greenish grey -med grey sst consisting of predom. reworked shale grains. (2062.6-2063.2m) **CONGLOMERATE:** sst grading down to conglomerate - similar to above.		2 fault planes identified in core (2061.4-2062.1m), one subvertical and the other dipping at 40-60deg. Maybe other faults but cannot be determined as the core is highly fractured. Graded bedding is present (fine at top) Another fracture plane indicated in core (2062.6-2063.2m)	**PEBBLES:** 70% dk grey shale, 10% quartz & qtzite, light grey shale, greenish shale & serpentine. **LITHICS:** dk grey shale	APK122-APK2, prob APK122		Fluvial (McEachern Sst)		
16	2088.8	2090.6	100	**SANDSTONE:** light grey, fine-med grained, hard, silicified qtz sst grading to orthoquartzite in places. Comprised of greenish grey lithics (see right), mica, black carb flecks in silica or kaolinitic matrix. Sl-mod rextallisation has taken place. Lower 13cm of core is med-coarse grained	No porosity	Undulose bedding planes are evident due to conc of mica and carb matter along bedding planes. Dips range from 20-35 deg. Slickensided surfaces (mineralised with mica & mica talc) are present, dipping between 30-40 deg, and are not consistently parallel to bedding.	**LITHICS:** qtz, kaol feldspars, pink garnets, reworked hard, dk grey shale, soft light grey & light greenish grey shale and qtz pebbles up to 2cm long					

Core Intervals for Casterton 1

No	Top (m)	Base (m)	Rec. %	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv%
17	2210.7	2213.8	60	**CONGLOMERATIC SANDSTONE:** med-coarse , hard, grey comprised of sub-ang fair sorted light grey-clear qtz, minor kaol feldspars, ab biotite, musc & chlorite. Some coaly grains and tr plant resin, ragged inclusions of soft, yellow clay ashy ?tuffaceous material, trace soft green shaly grains in clayey matrix. Flat pebbles up to 1.3x6.5cm, but generally <6mm are presnt in the sst with long axes aligned with the bedding. Dark lams present in SST due to conc of dk mica flakes.	Tight	Lower contact of upper unit (2210.7-2211m) is undulose.	**LITHICS:** soft, yellow clay ashy ?tuffaceous material, reworked phylitte, serpentine, light greenish grey soapy textured shale, coarse bitoite, musc & chlorite. **PEBBLES:** dk grey, micaceous slaty shale.				16.4	0.67 0.82
				Underlain by very coarse grained **SANDSTONE** (2211-2211.7m) comprised of lithics, abundant flat pebbles of slatey shale, some containing finely desseminated pyrite. Not laminated.	Tight	Pebble direction indicates bedding dip of 10deg.						
				Underlain by sl pebbly, med-coarse grained **SANDSTONE** (2211.7-2212.1m) with similar lithology to above except with dark laminations and scarcity of pebbles. Laminations due to dk mica and coalified plant fragments conc along bedding planes.	Tight	Xbedding dip 0-20 deg.						
				From (2212.1-2212.5m) a very coarse grained conglomeratic **SANDSTONE** similar to the second unit in this core, is present.	Tight							
18	2250.9	2254.0	100	**SHALE:** dense, hard, med grey, slatey, micaceous shale with carbonised plant fragments in the bedding plane. Silty bands (5-15cm thick) apparent. Non fissile - no cleavage.		Bedding plane dip 5-10 deg		APJ6-APK2, tent. APK11		Fluvial-Lacustrine (Castrerton Fm)	2.95 / 2.3 / 1.5	
19	2358.8	2361.9	100	**SANDSTONE:** (2358.8-2358.88m) light-med grey, lithic, v dirty, fine-med grnd, poorly sorted in brown grey clayey, micaceous, silty matrix.	Tight	Xbedding dip 20 deg.	**LITHICS:** reworked dk grey, hard, micaceous shale grains, sub-rnd-ang, med-coarse glassy qtz grains, carbonaceous and coaly grains, silvergrey mica schist grians, yellowish ashy ?tuffaceous grains, tr serpentine and dark grey dolerite, occ soft green shaley grains	Indeterminate		Indeterminate		
				SILTSTONE: (2358.88-2361.44m) brown grey, argill, qtz, lithics,carbonaceous and coaly, common biotite & yellowish - white specks. Contains common dark laminations and thin interbeds of more arg siltst and conc. Of macreated plant frags. Scattered v coarse poorly preserved coalified leaf frags present. A few soft blue grey flat pebbles of shale up to 0.3x1.25cm are present along with thin laminations of coarse pebbly sst.		small scale current bedding and lensing apparent. Overall dip about 15 deg						
				SHALE: (2361.44-2361.57m) dk grey to black, carbonaceous, v micaceous with some coaly laminations and one coal seam 1cm thick)of black, brittle, shaley, laminated coal.								
				SILTSTONE (2361.57-2361.9m) as above except it is more argillaceous with sl more carbonaceous and coaly material.								
20	2395.1	2396.3	38	**PORHYRITIC ANDESINE-BASALT:** with occ gns of olivine, <0.5mm flakes of unidentified white material and larger 1-2mm pale green soft waxy, transparent flakes of ??zeolite??. Abundant v dk grey ang frag 1mm which are soft, have a white streak and appear to be altering to a reddish-brown material, possibly devitrified glass shardo. Occ. vesicles lined with red-jasperlike material and filled with calcite or quartz. The wall rock shows slight evidence of alteration. Entire core is highly fractured and are slickensided when they have undergone movement and the fracture is filled with chloritic calcite. Vertical, horizontal & irregular fractures are present.					120 =/- 10 ma (regarded as a reliable minimum age. Described as an olivine basalt (ANU) 153 =/- 5 ma (Geochron Labs)			

Core Intervals for Casterton 1												
No	**Top (m)**	**Base (m)**	**Rec. %**	**Description**	**Shows**	**Comments**	**Lithic Composition**	**Palynology**	**K-Ar Age Data**	**Depositional Environment**	**TOC%**	**Rv%**
21	2406.4	2409.4	100	**PORHYRITIC ANDESINE-BASALT:** dk greenish grey, fine, crustalline, hard - slightly coarser than in core 20. Dk plagioclase are visible and pyroxenes under binocular microscope. Occ greenish-yell olivine is also present. Alteration has proceeded outward from the fractures imparting a green colour to the affected rock. The fractures are filled with calcite haematite and chlorite.		3 main directions of fractures appear to be present. Sub-vertical, dipping 45-60 deg and sub-horizontal. Subsequent movement to the fracture development is evidenced by slickensides and the presence of calcite & haematite.						
22	2422.2	2425.3	90	**SHALE:** black massive, brittle and fractured clean shale, **slightly?** carbonaceous with plant fragments.		Bedding dip is variable, averaging between 10-15 deg					5.05 / 1.35	
				SHALE: Med-dark grey silty shale is hard, brittle, mod blocky - mod fissile, micaceous, carbonaceous and shaley. Silty layers have scattered thin layers of shale pebbles, brown-grey-green shale in sub-ang-sub-rounded pellets up to grit size in silty matrix.								
23	2447.2	2450.3	85	**SHALE:** (2447.2-2447.7m) light grey and brown green, hard dense, massive, brittle, tr white mica, dk green flecks and frags of shaley material. Possibly a **tuffaceous altered shale.**		No plant remains, no bedding						
				SHALE: (2447.7-2450.3m) med dk grey, hard, brittle, dense, fissile, v micaceous with foliated v fine white mica and agg. Of brown, mica pyrite, ?feldspars and dark indeterminate mineral aggs in dk grey slatey & pyritic matrix.		Bedding dips at 50-55 deg with prominent parting. Joints are slickensided with chlorite & mica.						
24	2492.0	2494.2	100	**SLATEY SHALE:** dark grey, hard, brittle, fissile with good cleavage parallel to bedding.		Bedding dip at 60-65 deg						

Side Wall Core Intervals for McEachern 1

No	Top (m)	Rec. (cm)	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv max%
											KK
											AMDEL
1	2378.0	0									
2	2366.6	0									
3	2354.6	0									
4	2344.6	0									
5	2330.6	2.7	SST - sub-ang, mod sorted, off white-grey, fine-coarse.	nil	trace garnets						
6	2259.6	1	SST - sub-ang, mod sorted, off white-grey, fine-coarse.	nil							
7	2226.6	1.7	SST - sub-ang, poor sorted, light-med grey, fine-coarse.	nil	trace garnets. 5% qtz cement					0.34	0.58
8	2202.6	1	SST - sub-ang, poor sorted, light-med grey to grey brown, fine-coarse.	nil	trace garnets.						
9	2148.6	2	SST - sub-ang to sub-round, mod sorted, off white-light grey, fine-coarse.	nil	trace garnets						
10	2116.6	0									
11	2076.1	0									
12	2041.6	0									
13	2023.6	0.7	SST - sub-round, well sorted, dark grey, very fine. Tr lithics	nil	rare garnets					0.36	0.59
14	1992.6	0									
15	1946.1	0.5	CLAYST: dark grey, tr lithics	nil	blocky in part					0.58	
16	1924.6	0									
17	1895.6	0									
18	1857.6	3	CLAYST: very dark grey, tr lithics	nil	blocky and subfissile. Very hard					0.48 0.45	0.52
19	1824.6	0									
20	1801.6	1.5	CLAYST: dark to very dark grey, tr lithics	nil	blocky in part. Soft-moderate hardness						

Side Wall Core Intervals for McEachern 1

No	Top (m)	Rec. (cm)	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv max%
											KK
											AMDEL
21	1796.6	1	SST - sub-ang, poorly sorted, off white-light grey, fine-coarse.	nil	rare garnets Por: 15% (drill m	LITHICS: coal frags, heavy minerals, other lithics (not described)					
22	1766.6	1	SST - sub-ang, poorly sorted, off white-light grey, fine-coarse.	nil	rare garnets	LITHICS: coal frags, heavy minerals, other lithics (not described)					
23	1741.1	0.5	CLAYST: dark grey, tr lithics	nil	very rare garnets. Mod. Carbonaceous	LITHICS: mica, heavy minerals, other lithics (not described)				0.53	0.51
24	1674.6	2.5	CLAYST: dark grey, tr lithics	nil	tr. Carb, blocky in part	LITHICS: mica, other lithics (not described)				0.46	0.48
25	1649.1	1.5	CLAYST: dark grey to dark brown grey, tr carb	nil	tr. Carb, blocky in part	LITHICS: mica.				1.38	
26	1607.6	2	CLAYST: dark to very dark grey	nil	tr. Carb, blocky in part	LITHICS: mica, other lithics (not described)					
27	1593.6	1.5	SST - sub-ang, poorly sorted, off white-light grey, fine-coarse.	nil	tr. Carb, blocky in part	LITHICS: heavy minerals, other lithics (not described)					
28	1573.6	3	CLAYST: dark grey to dark brown grey, tr carb	nil	tr. Carb, blocky in part	LITHICS: mica, coal frags				1.2	0.44
29	1545.6	2	SST - sub-ang, poorly sorted, off white-light grey, very fine-coarse.	nil	tr. Garnet	LITHICS: heavy minerals, other lithics (not described), coal frags.					
30	1523.6	2.5	CLAYST: dark grey to brown grey	nil	very Carb, fissile, hard					0.93	

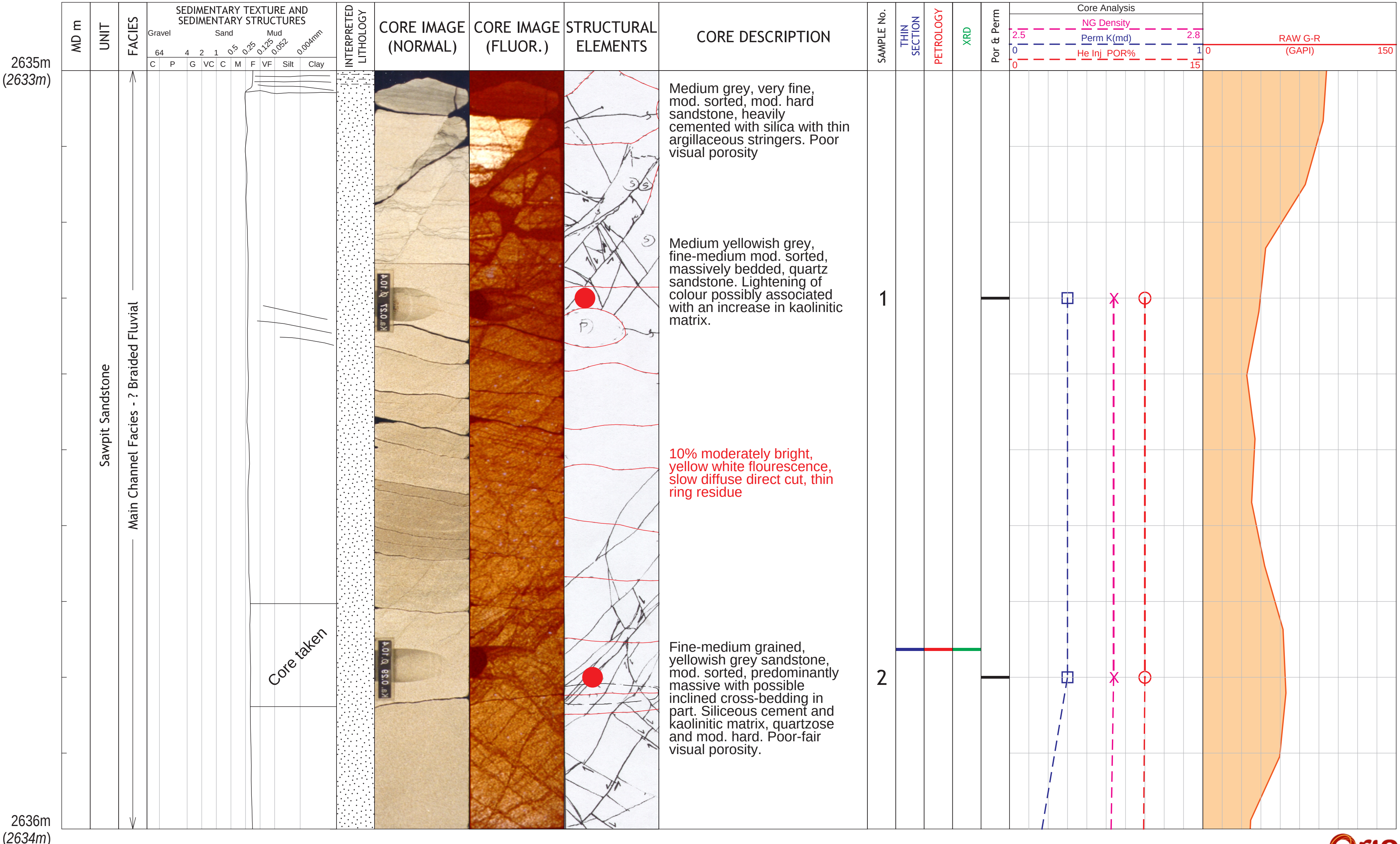
Side Wall Core Intervals for McEachern 1

No	Top (m)	Rec. (cm)	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv max%
											KK
											AMDEL
31	1504.6	3	CLAYST: dark grey, tr lithics	nil	mod. Carb, blocky, mod hard					0.35 0.31	0.47
32	1461.6	3	CLAYST: dark grey, tr lithics	nil	mod. Carb, blocky, mod hard					0.38 0.34	0.58
33	1435.1	0									
34	1414.1	3	CLAYST: dark grey, tr lithics	nil	mod. Carb, blocky, mod hard					0.82 0.67	0.45
35	1384.1	0									
36	1364.6	2.5	CLAYST: 50% med brown. COAL: 50% black-v dark brown	nil	coal is soft-firm, blocky in part, argillaceous in part, rare sub.conchoidal fracture					14.6 16.1	0.49
37	1293.6	0									
38	1289.5	3	CLAYST: med-dark grey	nil	tr. Carb, blocky in part	tr. Mica				0.6 0.56	0.55
39	1174.5	3.5	CLAYST: med grey, med green grey	nil	tr. Carb, blocky in part	tr. Mica				0.53 0.63	0.54
40	1146.6	3.5	CLAYST/Carb. CLAYST:, soft-medium, coal	nil	blocky-sub fissile, dominant carbonaceous clay	10% coal					
41	1113.6	2	SILTST/SST: med grey to medium green grey, very fine, sub-round, soft, lithics and mica	nil	Siltst interlaminated with sandstone	tr. Mica; tr. Lithics				0.4	0.49
42	1048.6	1.5	SILTST/SST: med grey to medium green grey, very fine, sub-round, soft, lithics and mica	nil	Siltst interlaminated with sandstone	tr. Mica; tr. Lithics				0.32 0.4	0.5
43	905.6	1.5	CLAYST: med grey, med green grey, soft-medium.	nil	blocky in part, medium carb.	tr. Mica; tr. Lithics				1.06	
44	793.1	2	SST: med grey, speckled med green grey, very fine, sub-round, very well sorted, soft, quartzose with trace lithics	nil		LITHICS: volcanogenic trace mica, rare coal frags				0.48	0.45

Side Wall Core Intervals for McEachern 1

No	Top (m)	Rec. (cm)	Description	Shows	Comments	Lithic Composition	Palynology	K-Ar Age Data	Depositional Environment	TOC%	Rv max%
											KK
											AMDEL
45	699.6	2.5	SST: med green grey, very fine, sub-round, very well sorted, soft, quartzose with trace lithics	nil		LITHICS: volcanogenic trace mica, rare coal frags				0.26 0.16	0.42
46	594.6	2	CLAYST: med green grey, soft-med, trace lithics and mica	nil	disp in part, blocky in part, moderately carbonaceous						
47	504.6	3.2	CLAYST: med grey, soft-med, trace lithics and rare mica	nil	disp in part, moderately carbonaceous					0.58 0.53	0.38
48	402.6	3.2	SST: light to medium green grey, quartzose, very fine to fine, sub-round, well sorted with 5% lithics, tr mica	nil		LITHICS: volcanogenic trace mica				0.32	0.41

Jacaranda Ridge 1 - 2635 - 2636m Logger - (*2633 - 2634m Core Depth*)

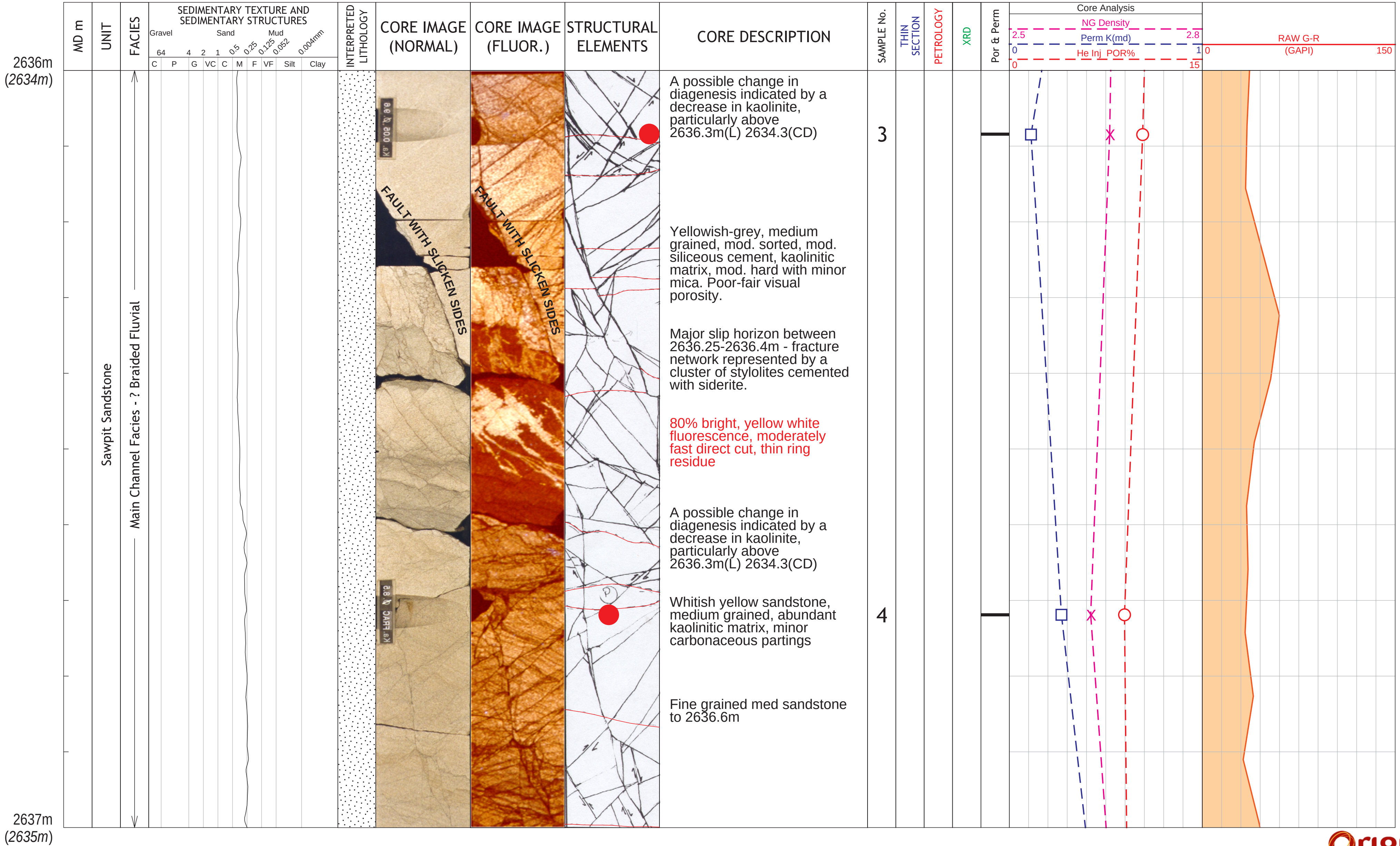


CPK

16260.062000

Origin energy

Jacaranda Ridge 1 - 2636 - 2637m Logger - (*2634 - 2635m Core Depth*)

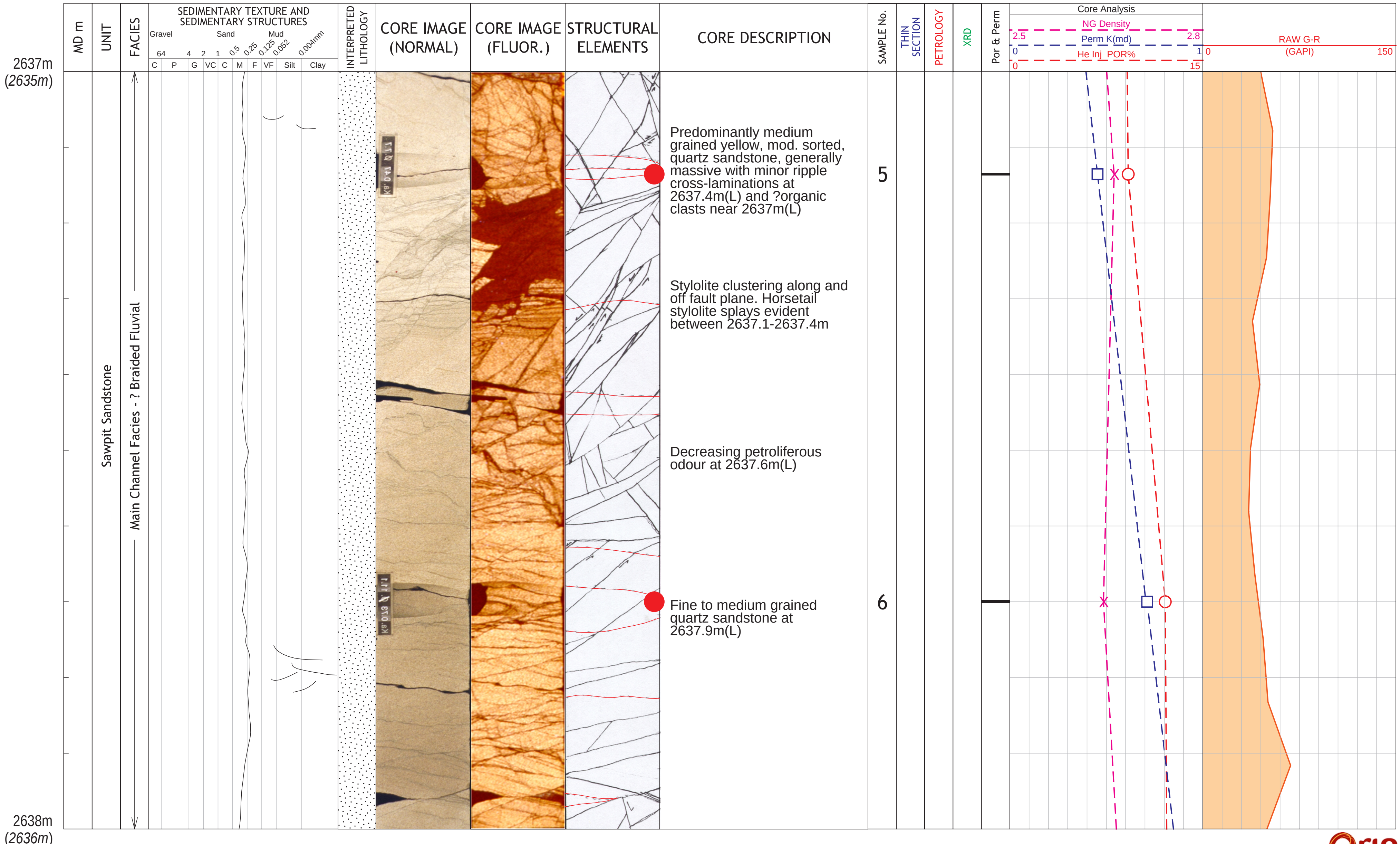


CPK

16261.062000

Origin energy

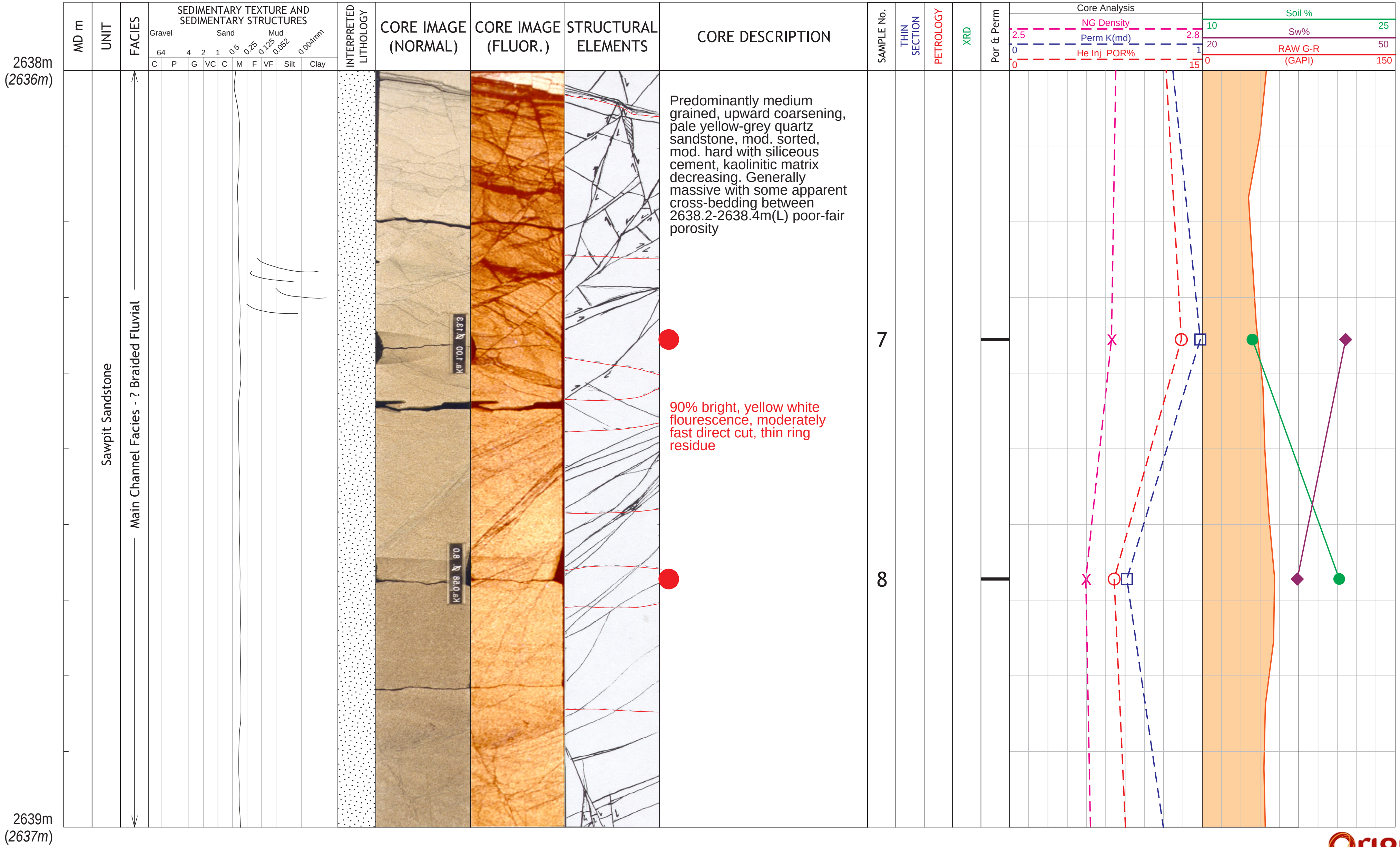
Jacaranda Ridge 1 - 2637 - 2638m Logger - (*2635 - 2636m Core Depth*)



CPK

16262.062000

Jacaranda Ridge 1 - 2638 - 2639m Logger - (*2636 - 2637m Core Depth*)

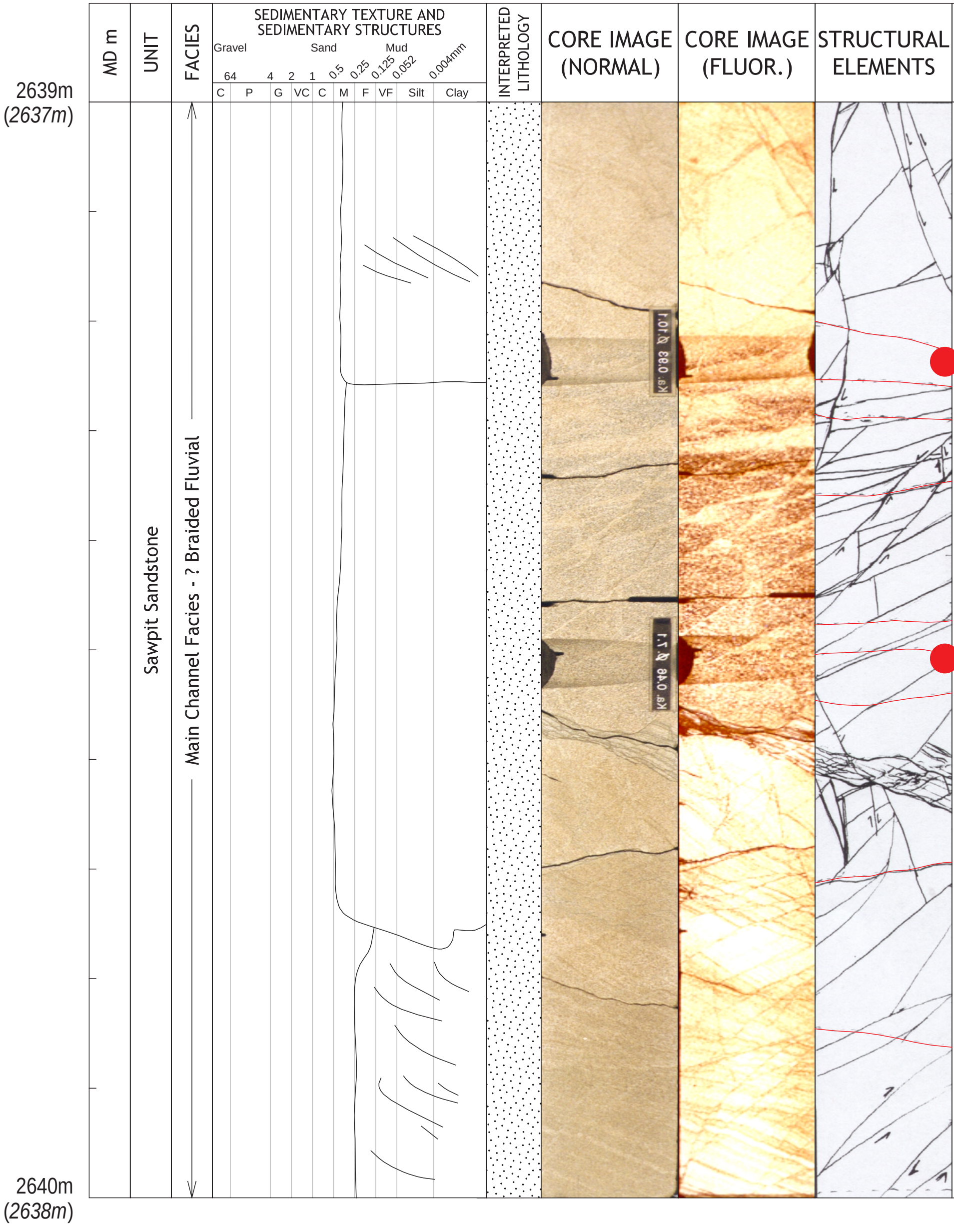


CPK

16263.062000

Origin energy

Jacaranda Ridge 1 - 2639 - 2640m Logger - (*2637 - 2638m Core Depth*)



CORE DESCRIPTION

Yellow-grey, medium coarse, mod. sorted, siliceous cement, kaolinitic matrix, common weath. feldspar, mod. hard. Fair visual porosity.

Minor cross-beds at 2639.15m(L)

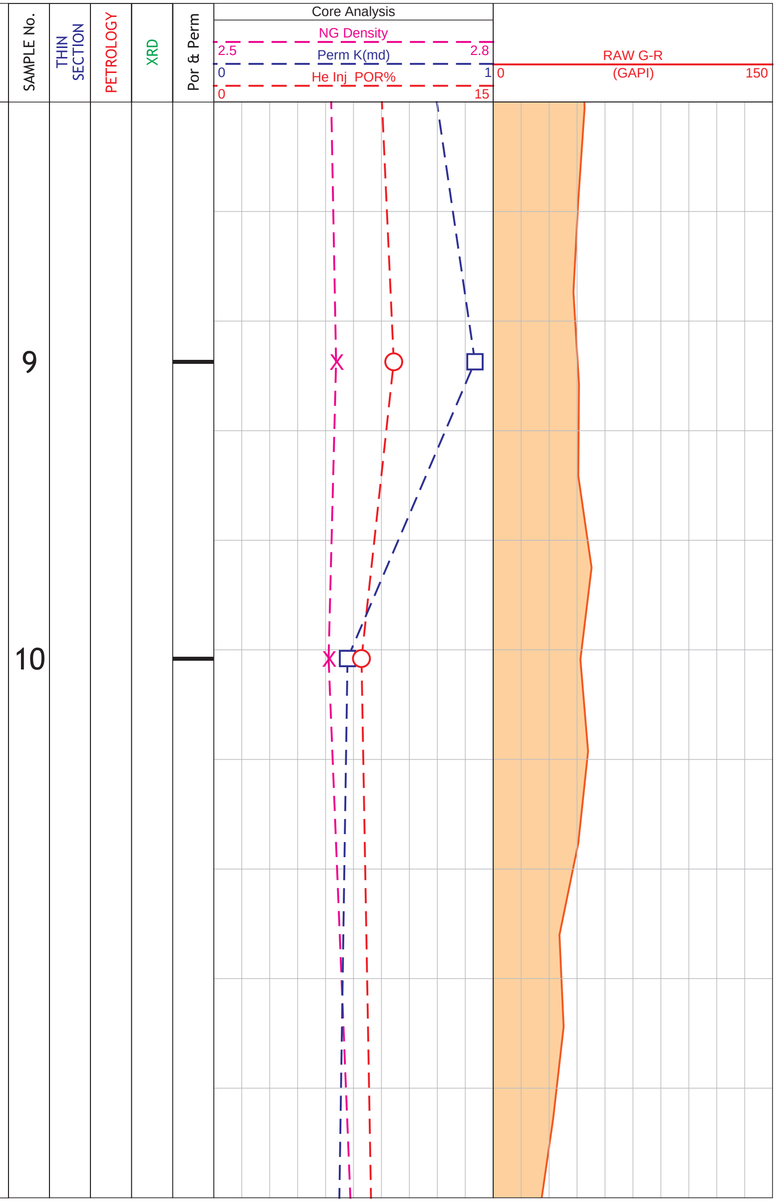
Colour change at 2639.2m(L) from dark grey to yellowish grey. Dark colour in sandstone either due to bitumen staining, associated with petroliferous odour, or mineralogical changes-ie. increase in dark mineral/lithic matrix.

Darkish grey, medium-coarse grained sandstone with strong petroliferous odour. Massive upward fining sandstone.

80% bright, yellow white fluorescence, moderately fast direct cut, thin ring residue.

Sub horizontal contacts between black and pale sand are apparent in the core between 2639.58-2639.75m(L) (suggestive of fault based compartmentilisation -possible GWC app in a micro-scale or possibly due to a mineralogical change in the rock type and subsequent deformation).

Medium grained quartz sandstone, grading to fine at top (2639.75-2639.8m(L)).



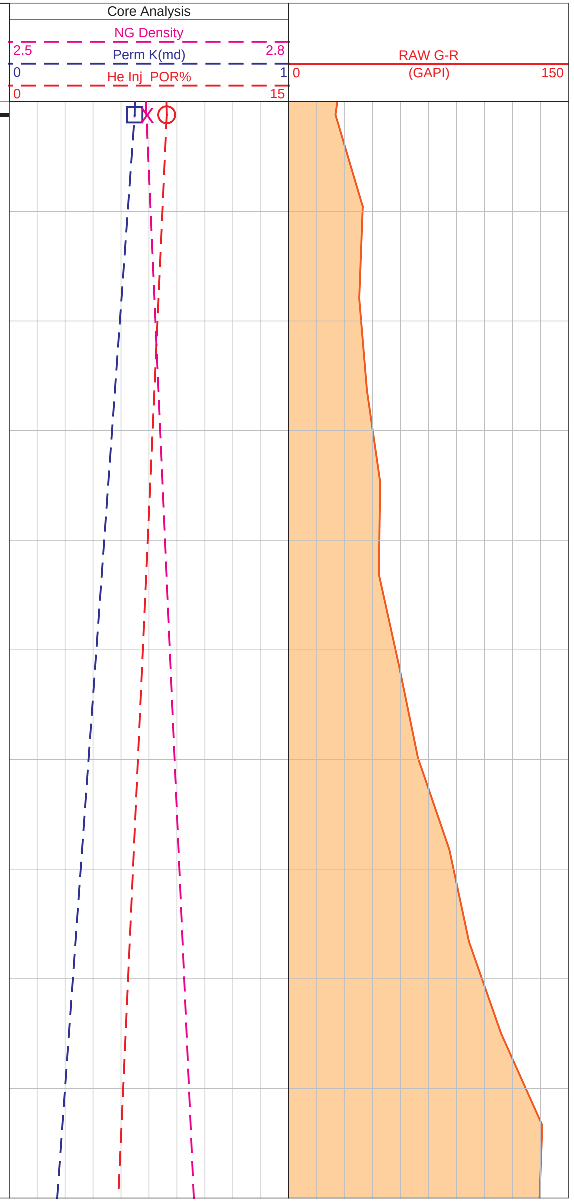
CPK

16264.062000

Origin energy

Jacaranda Ridge 1 - 2640 - 2641m Logger - (*2638 - 2639m Core Depth*)

MD m	UNIT	FACIES	SEDIMENTARY TEXTURE AND SEDIMENTARY STRUCTURES	INTERPRETED LITHOLOGY	CORE IMAGE (NORMAL)	CORE IMAGE (FLUOR.)	STRUCTURAL ELEMENTS	CORE DESCRIPTION	SAMPLE No.	THIN SECTION	PETROLOGY	XRD	Por & Perm	Core Analysis	RAW G-R (GAPI)
2640m (*2638m*) – 2641m (*2639m*)	Sawpit Sandstone	Main Channel Facies - ? Braided Fluvial; Distal Crevasse Splay; Flood Basin/overbank						Predominantaly medium grained quartz sandstone, grading to fine at 2640.25m(L), yellowish grey, well sorted, siliceous cement, common argillaceous/kaolinitic matrix. Very poor visual porosity. Cross-bedding apparent at 2640m(L) with ripple cross-lamination and associated climbing ripples evident at 2640.2-2640.3m(L). Stylolite clustering at 2640.1m(L). 60% dull moderately bright, greenish yellow fluorescence, slow and diffuse direct cut, thin ring residue. Fine-medium grained sandstone, ripple laminated, overlying sharp sedimentary contact at 2640.5m(L) with a strong petroliferous odour. ?SEQUENCE BOUNDARY? Olive grey, very fine grained, well sorted, siliceous cement, interlaminated siltstone and very fine sandstone. Ripple cross-lamintaion evident between 2640.5-2640.7m(L). Very fine sandstone interlaminated with siltone.	11						

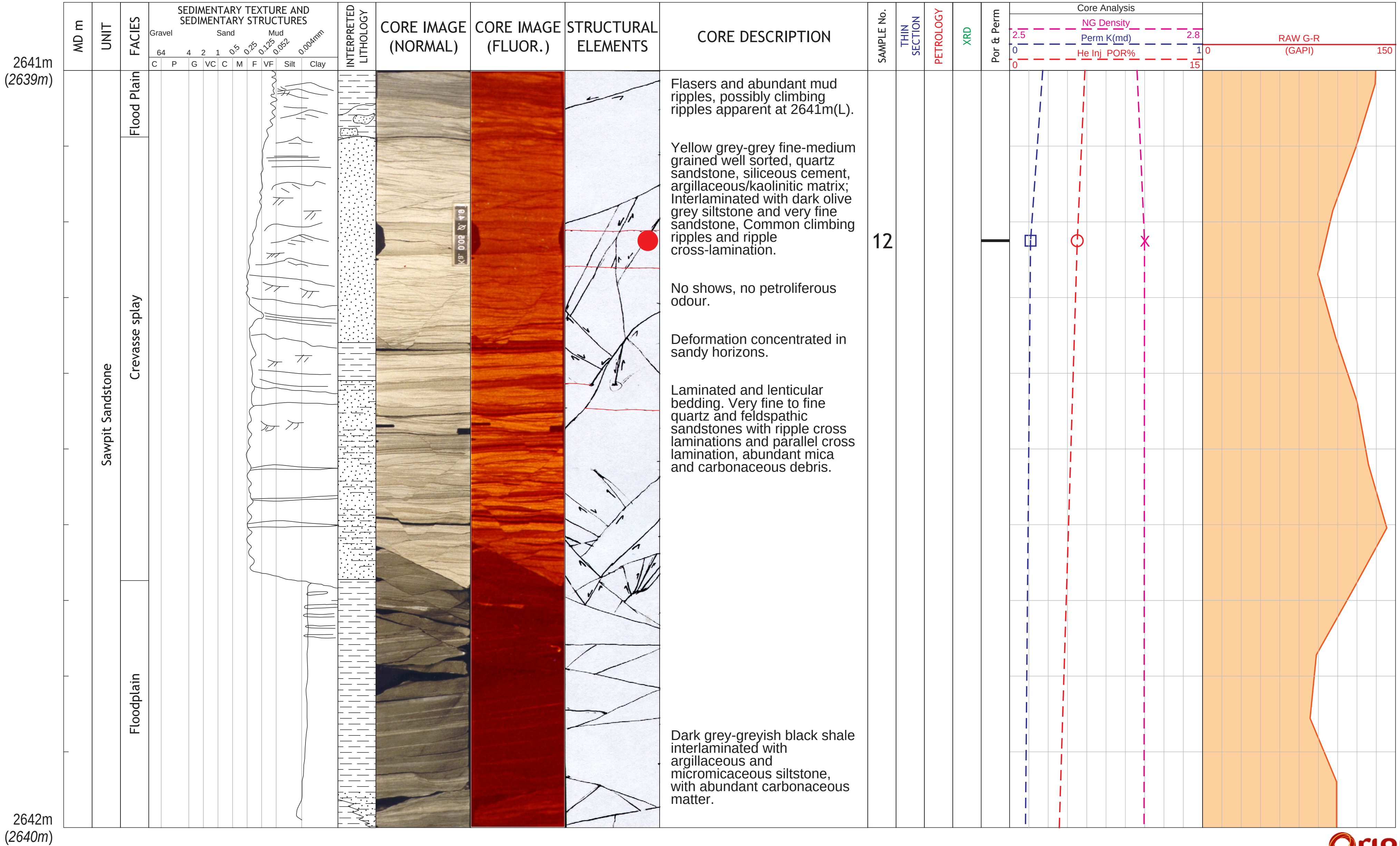


CPK

16265.062000

Origin energy

Jacaranda Ridge 1 - 2641 - 2642m Logger - (*2639 - 2640m Core Depth*)



Flasers and abundant mud ripples, possibly climbing ripples apparent at 2641m(L).

Yellow grey-grey fine-medium grained well sorted, quartz sandstone, siliceous cement, argillaceous/kaolinitic matrix; Interlaminated with dark olive grey siltstone and very fine sandstone, Common climbing ripples and ripple cross-lamination.

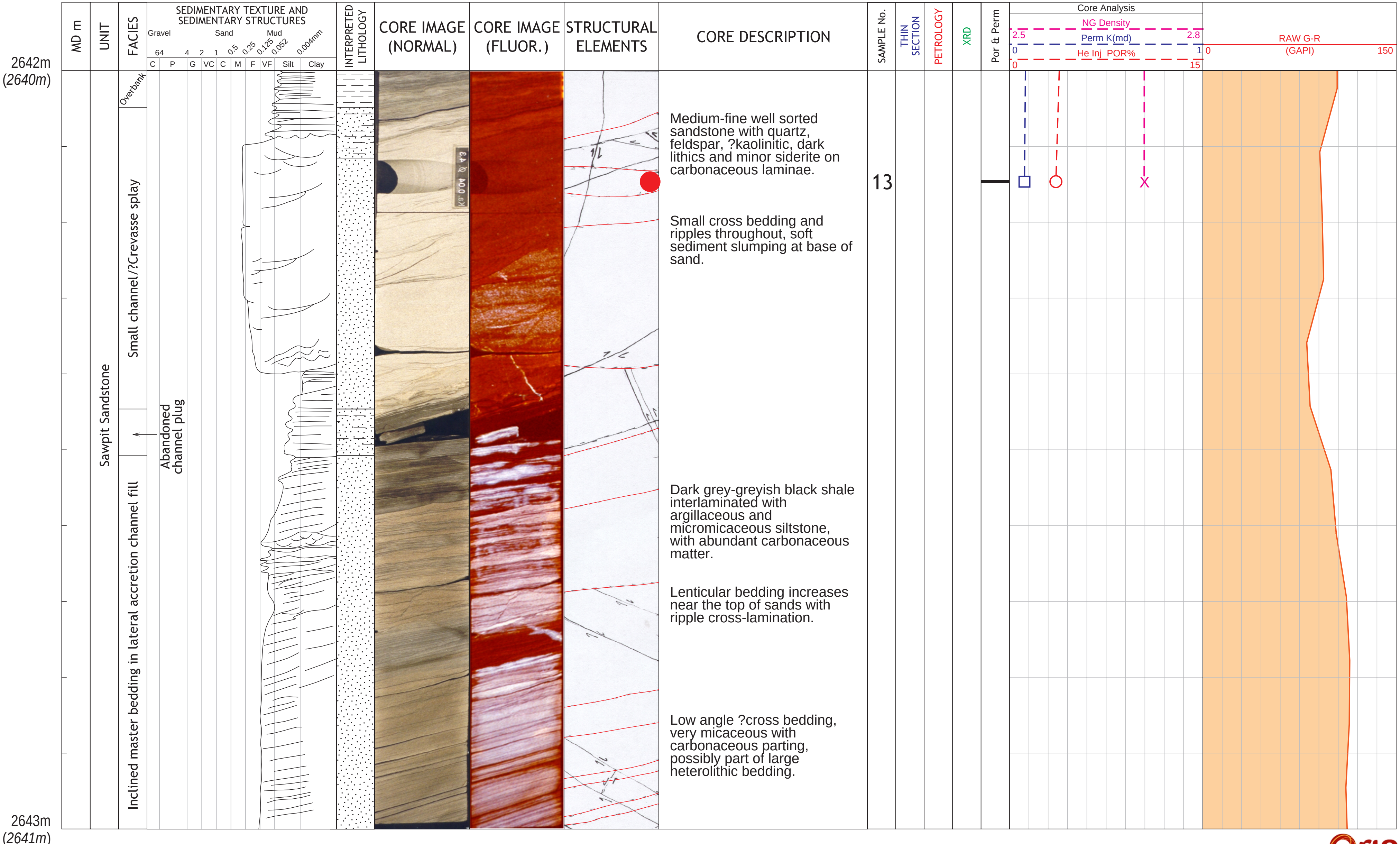
No shows, no petroliferous odour.

Deformation concentrated in sandy horizons.

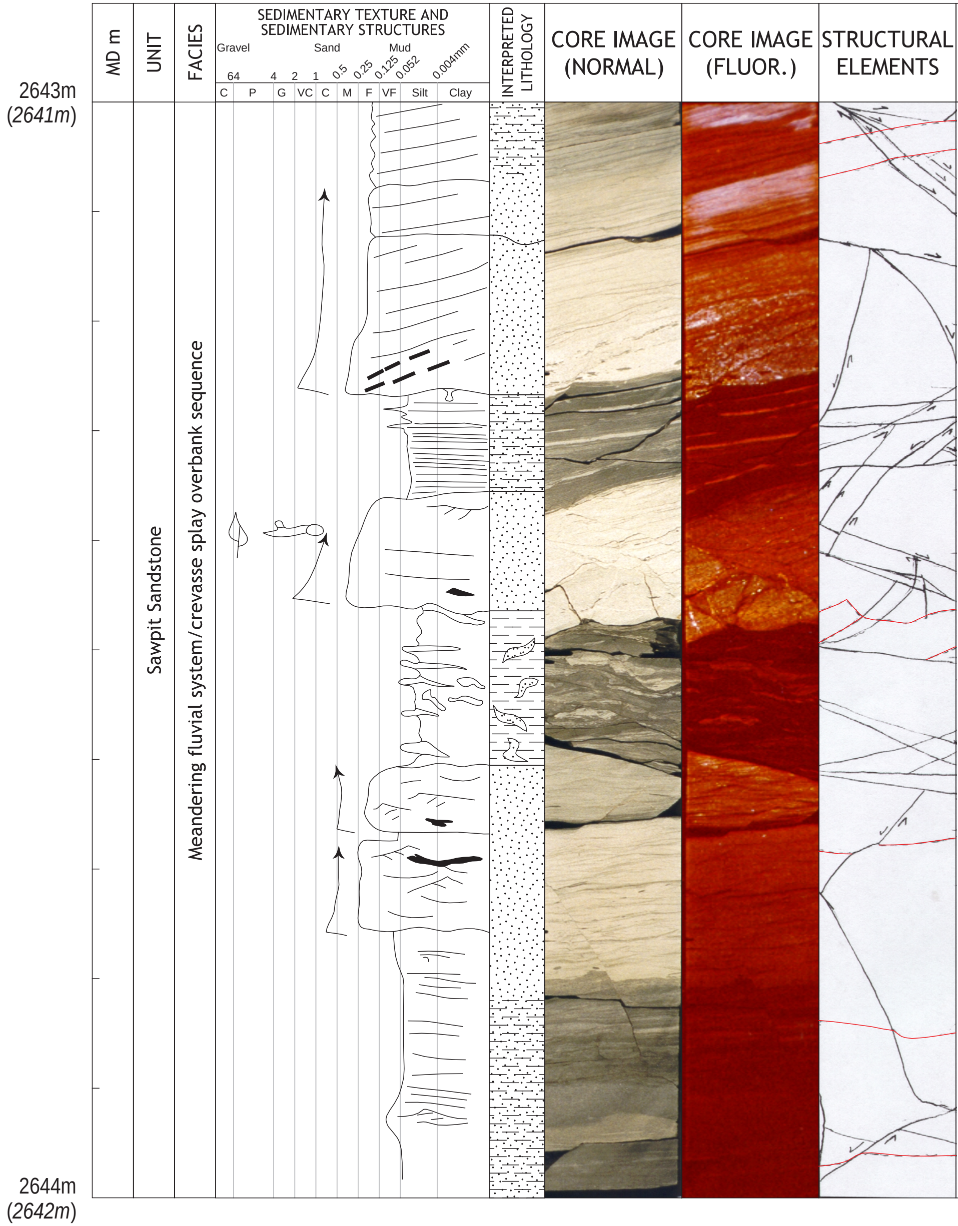
Laminated and lenticular bedding. Very fine to fine quartz and feldspathic sandstones with ripple cross laminations and parallel cross lamination, abundant mica and carbonaceous debris.

Dark grey-greyish black shale interlaminated with argillaceous and micromicaceous siltstone, with abundant carbonaceous matter.

Jacaranda Ridge 1 - 2642 - 2643m Logger - (*2640 - 2641m Core Depth*)



Jacaranda Ridge 1 - 2643 - 2644m Logger - (*2641 - 2642m Core Depth*)



CORE DESCRIPTION

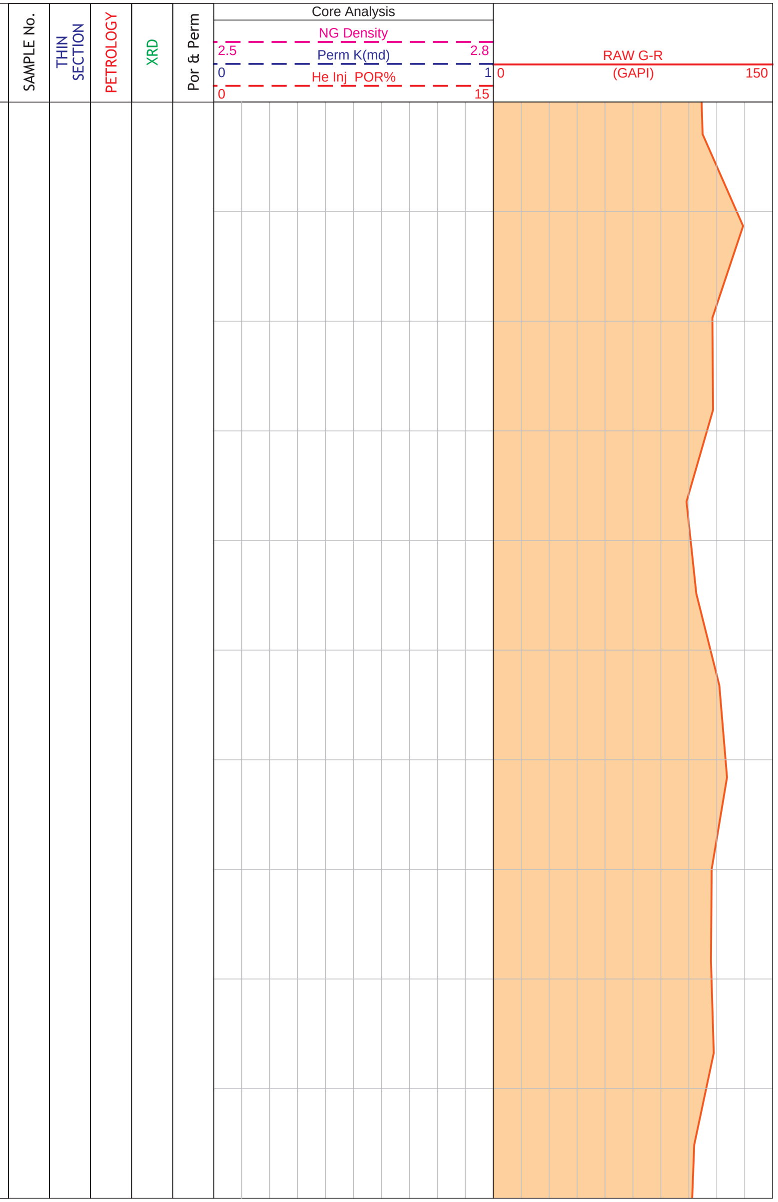
Medium-coarse, micaceous and carbonaceous sandstone with quartz, feldspar, kaolinite, dark lithics exhibiting low angle cross-bedding and load casts and rip up clasts on foresets.

Interbedded with dark grey-greyish black shale interlaminated with argillaceous and micromicaceous siltstone, with abundant carbonaceous matter.

Sharp depositional contact between the dark grey silts and sands, soft sediment deformation structures evident within the siltstones.

Pale grey ripple lamination fine sandstone with quartz, feldspar and mica.

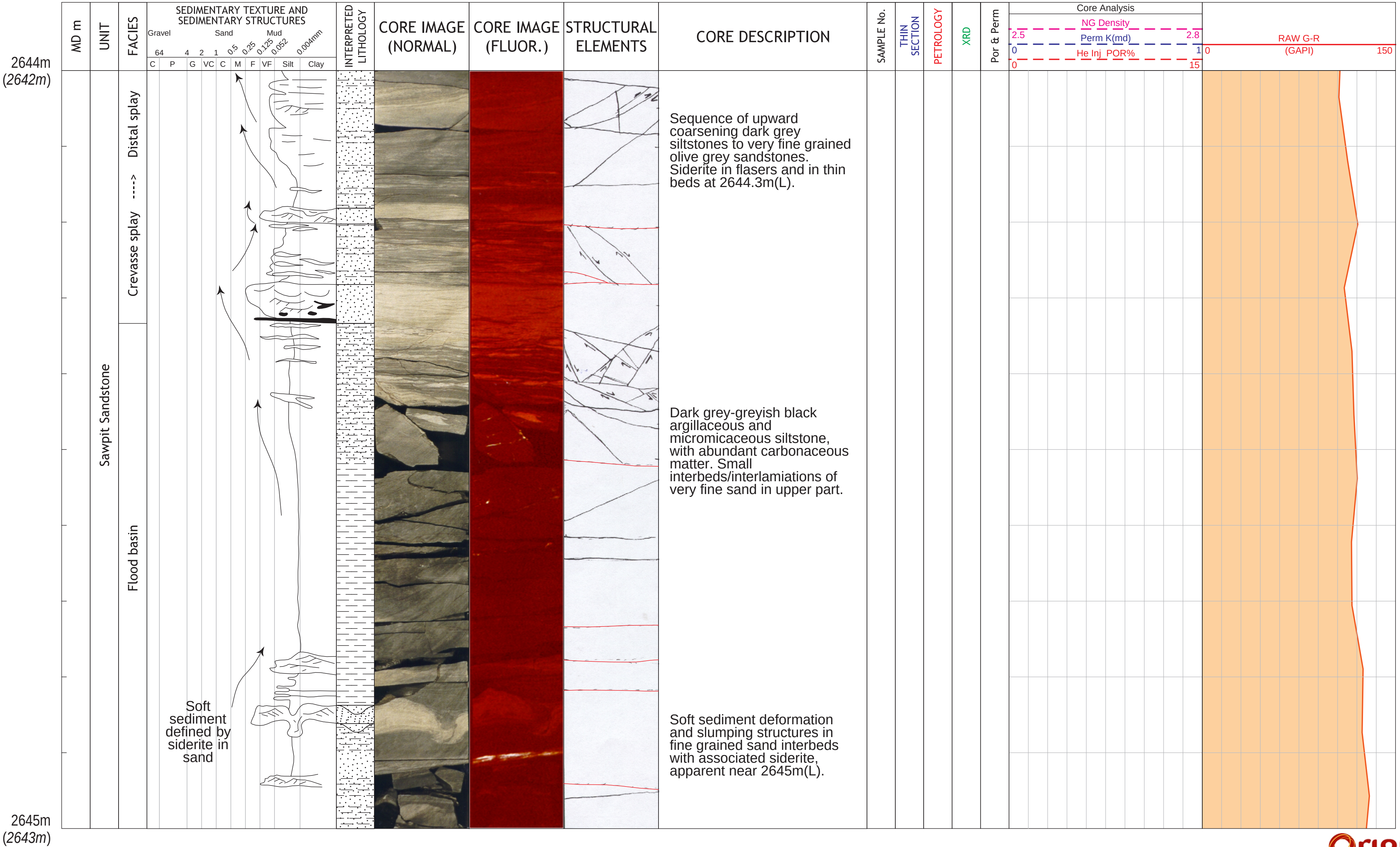
Tight visual porosity.



CPK

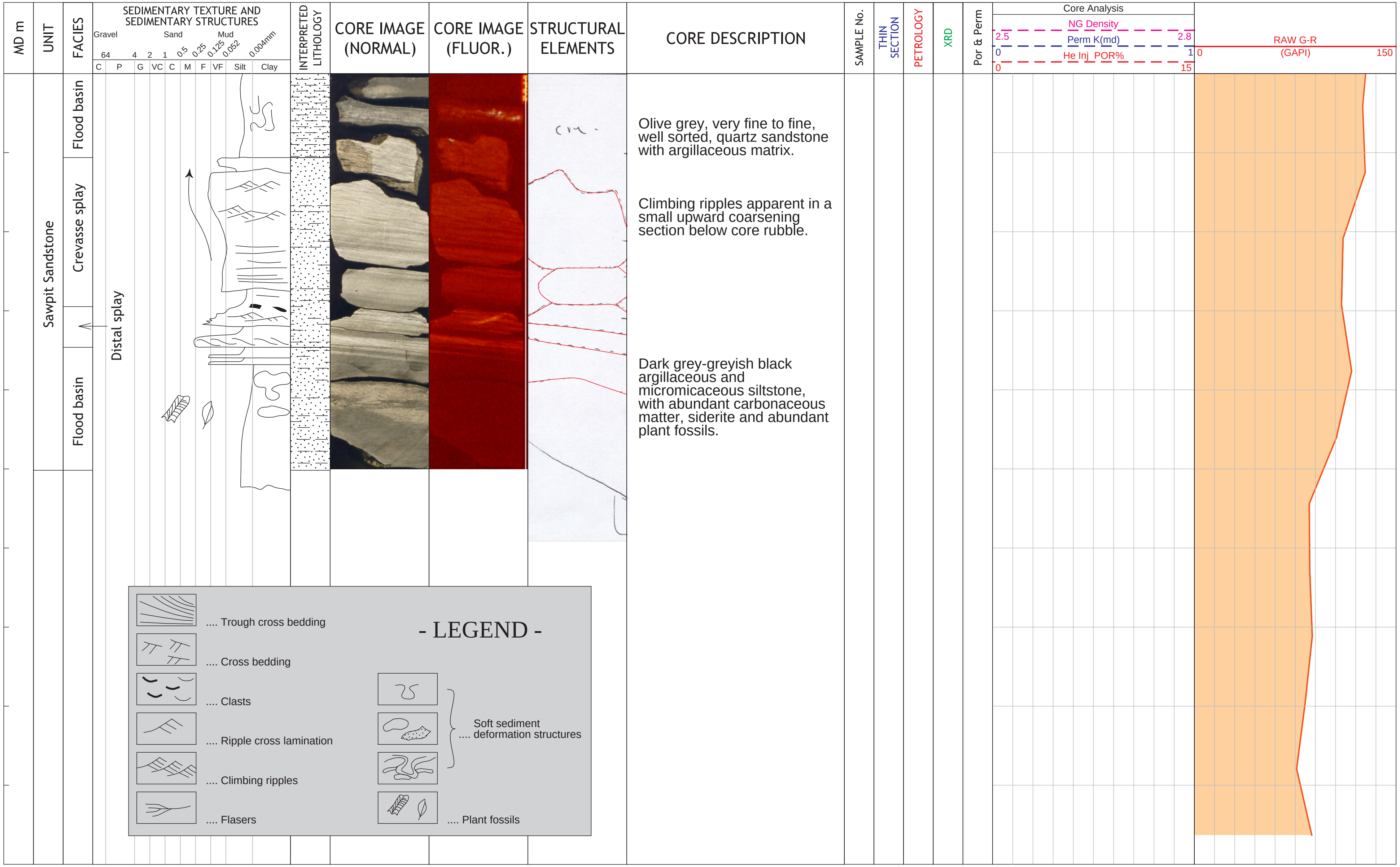
16268.062000

Jacaranda Ridge 1 - 2644 - 2645m Logger - (*2642 - 2643m Core Depth*)



Jacaranda Ridge 1 - 2645 - 2646m Logger - (*2643 - 2644m Core Depth*)

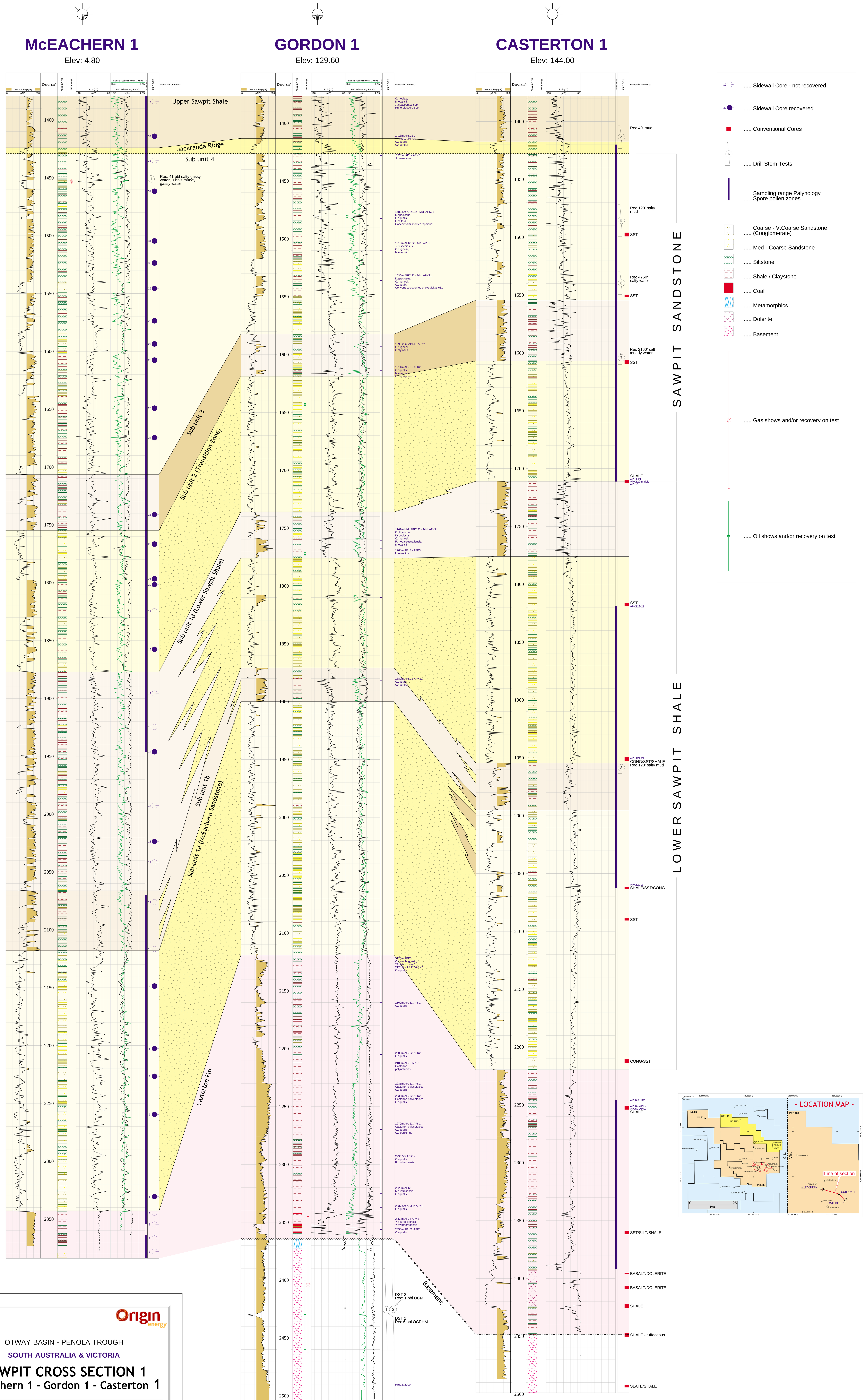
2645m
(*2643m*)



2646m
(*2644m*)

CPK

16270.062000



OTWAY BASIN - PENOLA TROUGH

SOUTH AUSTRALIA & VICTORIA

SAWPIT CROSS SECTION 1
McEachern 1 - Gordon 1 - Casterton 1

AUTHOR : Bronwyn Camac	DATE : May 2002	No : 21032.052002
DRAWN : Chris Kay	DATUM :	
SCALE : As Shown	CONTOUR INTERVAL :	Enclosure 1

PH. 8217 5777 Fax 8217 5799 Interstate prefix (08) International prefix (618) A.C.N. 007 845 338

Origin energy

OTWAY BASIN - PENOLA TROUGH

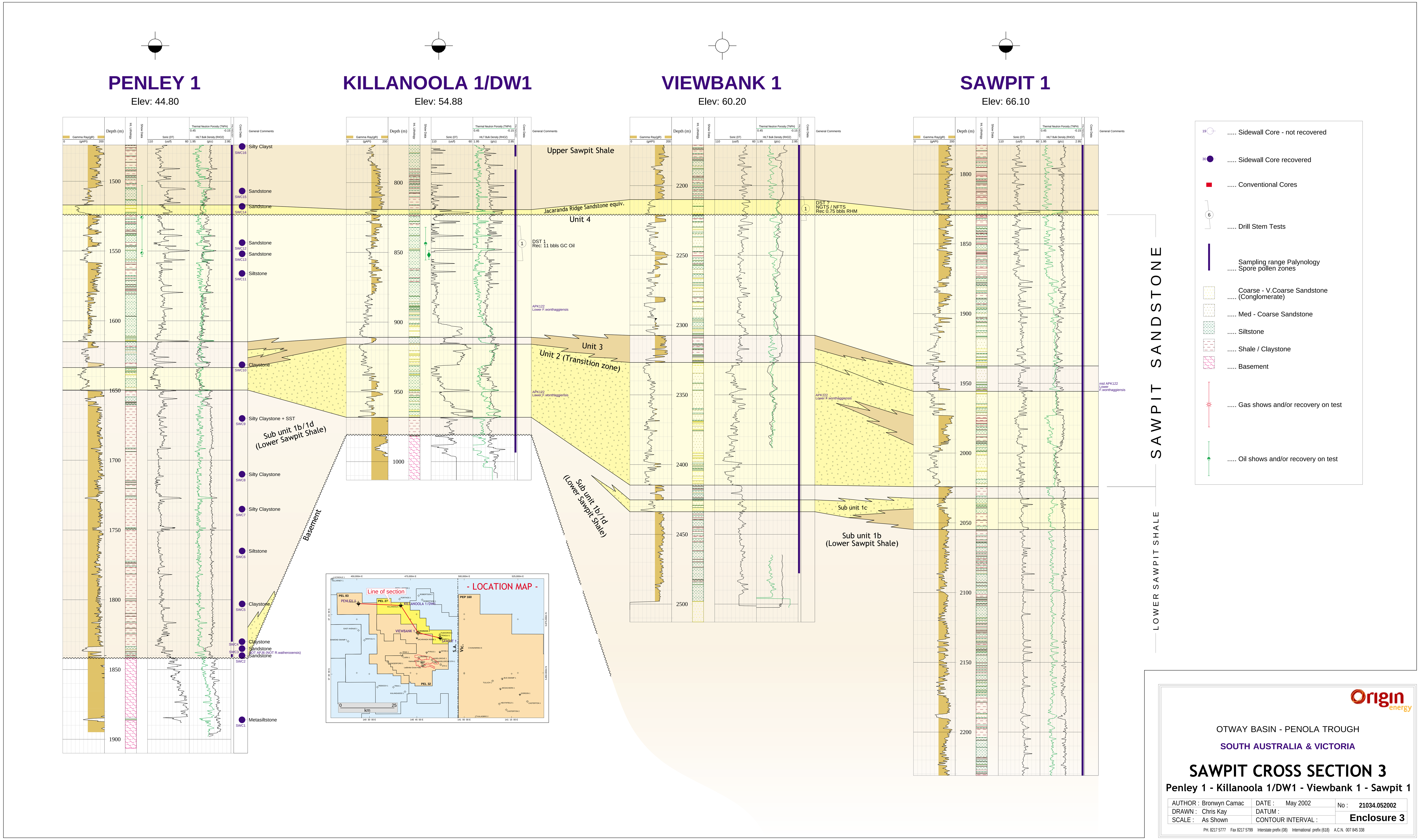
SOUTH AUSTRALIA & VICTORIA

SAWPIT CROSS SECTION 2

Viewbank 1 - Jacaranda Ridge 1 - Sawpit 1 - Wynn 1 - Pyrus 1

AUTHOR : Bronwyn Camac	DATE : May 2002	No : 21033.052002
DRAWN : Chris Kay	DATUM :	Enclosure 2
SCALE : As Shown	CONTOUR INTERVAL :	

PH. 8217 5777 Fax 8217 5799 Interstate prefix (08) International prefix (618) A.C.N. 007 845 338



OTWAY BASIN - PENOLA TROUGH

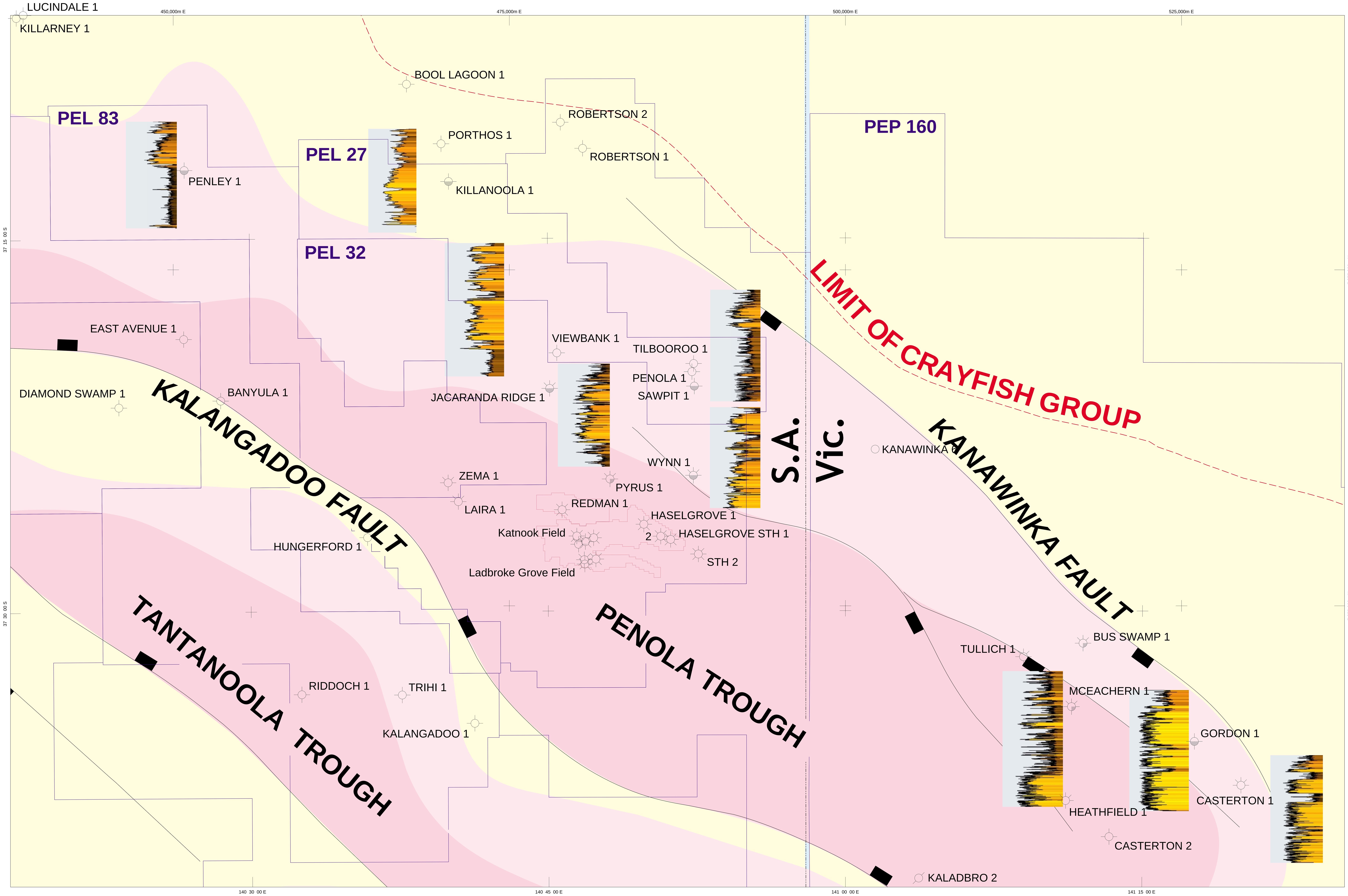
SOUTH AUSTRALIA & VICTORIA

SAWPIT CROSS SECTION 3

Penley 1 - Killanoola 1/DW1 - Viewbank 1 - Sawpit 1

AUTHOR : Bronwyn Camac	DATE : May 2002	No : 21034.052002
DRAWN : Chris Kay	DATUM :	Enclosure 3
SCALE : As Shown	CONTOUR INTERVAL :	

PH. 8217 5777 Fax 8217 5799 Interstate prefix (08) International prefix (618) A.C.N. 007 845 338



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0 2 4 6 8 10

KILOMETRES

0 1 2 3 4 5

MILES

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 141 00 00 E
Mapsheet datum: "AGD84"

SAWPIT SANDSTONE

FACIES MAP

Northern Flank

PENOLA TROUGH

MapSheet: PENOLA FLANK	Mapping Date: 8-April-2002	Grid Size :	Drafted By : Bronwyn Camac
Generated By : camacb	Datum: M.S.L.	Smoothing:	Checked By :
Author : Bronwyn Camac	Contour Int.:	Scale: 1:100000	Plan No.:
Date : 7-JUN-2002 15:15:25	Grid File :	Revised :	21072.262002

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