Butress-1 Well Proposal Report (W1342)

Santos (BOL) Ltd
(A.C.N. 000 670 575)

909142 002

EXPLORATION & DEVELOPMENT - SA

BUTTRESS-1
WELL PROPOSAL

CHANGED FROM SCHOMBERG 1

SEAM Business Group

November 2001

CONTENTS

1. WELL DATA SUMMARY

909142 004

WELL NAME: BUTTRESS-1	WELL TYPE: GAS EXPLORATION
LICENCE: PEP 154 EQUITY: Voting (%) Santos Ltd 90% Beach Petroleum NL 10% TOTAL: 100%	Latitude: 38° 30' 59.4"S Longitude: 142° 48' 30.7"E Seismic Reference: Inline 2279 CDP 10211 Ground Level: 46m (preliminary) Rotary Table: 50.7m (preliminary) Proposed Total Depth: 1701m (-1650m) Rig: OD&E30 Nearest Facilities: Heytesbury (12 km)

Objectives/Fluid Contacts

Primary — Secondary

Waarre Sandstone (gas)

Stratigraphic Prognosis

Formation	Depth (m-RT)	Depth (m-SS)
Clifton	471	-420
Mepunga	576	-525*
Dilwyn	608	-557
Pember	892	-841*
Pebble Pt	945	-894*
Paaratte	1045	-994
Skull Creek	1386	-1335
Belfast	1478	-1427
Flaxmans	1578	-1527*
Waarre	1590	-1539
Eumeralla	1648	-1597
TD	1701	-1650

*Geological pick

Formation Evaluation

Wireline Logging:

GR-SDT	TD to surface casing (GR to surface) Semblance processing over Waarre
MSFL-DLL-CAL	TD to surface casing (MSFL to 100 m above top Pember approx. 800m RT)
LDL-CNL	TD to approx. 20m above top Flaxmans (approx. 1550m RT)

SWC's:
One gun 20 samples.

MDT's:
20 point pressure survey.

Velocity Survey:
No survey.

Mudlogging:
10m samples from surface to approx. 1000m.
3m samples thereafter to TD.
Samples as per well programme.

Formation Testing:
None programmed.

Coring:
None programmed.

REMARKS/RECOMMENDATIONS:
Boggy Creek-1 (2km ESE) encountered CO_2 in Waarre Sst.

Hole Design/Drilling Issues

Well Class: Down size monobore/exploration

Hole Type: Down size monobore

Hole Size:	Casing Depth:
9 7/8"	7 5/8" Surface to 475m
6¾"	3½" Surface to TD

Drill Fluid:
KCl/PHPA/Polymer

Deviation
Sub-Surface Targets:
Schomburg-1 is a vertical well. An accuracy of 25m radius from seismic reference at TD has been requested. The critical structural directions are north and south of the wellsite.

Other Information/Hazards:
No hazardous zone in offset wells.
No shallow gas expected.
Waarre Sandstones has excellent reservoir properties (Porosity 20%).
The Waarre may contain high CO_2 content.

Nearby Wells and Duration:

Naylor-1	10 days	(TD 2157m)
McIntee-1	14 days	(TD 1799m)

Approved by::	Project Leader:	Team Leader:	Operations Geology	Drilling Engineer:

ALL CO-ORDINATES WITHIN THIS DOCUMENT USE A GDA94 DATUM

2. EXECUTIVE SUMMARY

Buttress-1 is proposed as an Otway Basin near field gas exploration well in the PEP 154 licence. The proposed location lies approximately 12.0 km north west of the town of Peterborough, 1.8 km WNW of the Boggy Creek CO_2 gas field, 3.0 km south of the McIntee gas field and 1.5 km north of the Naylor gas field (Figure 1). The Buttress-1 prospect is situated within the productive Waarre Sandstone play fairway of the Port Campbell Embayment.

The PEP 154 Licence is held 90% Santos (Operator) and 10% Beach Petroleum N.L. The Buttress-1 prospect lies within an east-west trending horst block closure defined by the Curdievale 3D seismic dataset and the proposed location will test the western limb of the structure. The stratigraphic column for the Otway Basin is shown in Figure 2. The primary objective in the well is the Waarre Sandstone, with a prognosed mean average net pay of 29m across the structure. An amplitude anomaly is identified over the Buttress-1 prospect. **The critical risk of the prospect is hydrocarbon charge, in that the structure may contain CO_2 as observed in the Boggy Creek gas field.**

Buttress-1 is an attractive project with a mean prognosed success case of 5.89 BCF sales gas (11.43 BCF OGIP) and a Pc (probability of commercial success) of 50%, resulting in expected mean reserves of 2.9 BCF sales gas.

Proximity to Croft-Naylor pipeline (0.5 km to the east) will allow early connection and production.

A hydrocarbon success at Buttress-1 would probably lead to the drilling of Buttress-2 and Buttress-3 on the Buttress Complex, with mean success volumes of 7.2 & 6.3 BCF respectively.

3. GEOLOGICAL RISK ASSESSMENT

3.1 Play Analysis

The Buttress-1 prospect is mapped as an east-west aligned horst block closure with the primary reservoir of the Waarre Sandstone. Both vertical (100m thick) and cross-fault seal (300-600m) are provided by a thick Belfast Mudstone. The prospect is charged from mature source beds located within the underlying Eumeralla and/or Crayfish Group, with migration either directly into the reservoir or via fault conduits. The play has proven successful in the nearby Naylor and McIntee gas fields as well as the Boggy Creek $C0_2$ field. The Buttress-1 prospect exhibits a strong amplitude anomaly at the Waarre Sandstone horizon, which is interpreted as being indicative of a well-developed, gas saturated reservoir, as occurs at each of these fields.

3.2 Trap & Mapping (Pcl = 90%)

Interpretation and mapping of the Buttress-1 prospect was based on the Curdievale 3D survey, which was recorded in early 2000. The Curdievale 3D data quality is good over the prospect area. The Buttress-1 prospect is the western limb of an east-west trending horst block (Figures 3 & 4).

The greater Buttress structural closure area partially relies on downthrown side fault seal to the north, south and partially to the east where Waarre reservoir juxtaposes the Belfast Mudstone/Skull Creek Mudstone section. Similar seal potential has shown to be effective at Boggy Creek. Near and far-offset volumes were used to evaluate the AVO response over the Buttress-1 prospect, demonstrating amplitude increases with offset at the Waarre sandstone level. The full stack amplitudes show an anomaly that is coincident with the Buttress-1 prospect closure at ~1,300 msec. Figures 5 & 6 demonstrate the dip and strike seismic lines defining the prospect and Figure 7 is the full stack amplitude at the prospect location. The location for the proposed Buttress-1 well was selected on inline 2279 CDP 10211. This location is at a near crestal position, and about 200 metres away from significant faulting at the Waarre sand level. The data quality and reflector character are reflected in the 90% chance encountering a valid trap at the location.

The geophysical prognosis depth conversion utilised the Curdie-1 and Boggy Creek 1 velocities. The results of this conversion are presented in Attachment 1.

3.3 Reservoir (Prs = 95%)

In the Buttress prospect area the Waarre Sandstone is well developed being in the order of 60-80m thick. Both the Waarre "C" and "A" are expected to be present and gas saturated. The Waarre "C" unit tends to have the best sand development in terms of quality and quantity, for example Naylor-1 encountered 26m with 17.2% porosity and McIntee-1 16m at 23.1%. The total Waarre "C" plus "A" net sand development is in order of 70%, with average porosities in nearby wells ranging from 16% (Naylor-1), 19% (McIntee-1) and 25% (Boggy Creek-1). The Curdievale-1 well to the south of the area is less representative and has average porosities of 12%. Permeabilities in this region are good to excellent (Boggy Creek-1 core permeabilities average 4.5 Darcies). Representative well logs are shown as Figures 8, 9 and 10). The ubiquitous nature of the sandstone in the area is reflected in the risk of reservoir of 95%.

3.4 Seal (Psl = 90%)

A review of the cross-fault seal at the proposed Buttress-1 location suggests that leakage will not occur as the Belfast/Skull Creek shale package is juxtaposed against the Waarre on the major fault defining the south-side of the prospect and the Belfast Mudstone on the other controlling faults. Consequently reservoir is assessed at a 90% success level.

3.5 Charge (Pch = 65%)

The seismic amplitude response suggests the presence of gas within the targeted structure, but the critical risk of the Buttress-1 prospect is that of intersecting CO_2 gas, rather than hydrocarbons.

From the review of the aeromagnetic dataset an intrusive is not identified at nearby the Boggy Creek CO_2 gas field, but the field lies on a lineament (believed to be a deep-seated conduit for the CO_2 emplacement). No such feature is identified at the Buttress-1 location but given the proximity to Boggy Creek (1.8 km ESE) and the imprecision of the aeromagnetic tool, it is impossible to discount this risk. This has lead to the assessment of hydrocarbon charge of 65%.

4. RESOURCE DISTRIBUTION AND ECONOMIC EVALUATION

4.1 Resource Distribution

Distributions for the prospect are estimated primarily from nearby well control and fields, ie McIntee-1, Croft-1, Naylor-1 and Boggy Creek-1. Data from other wells contribute to the end members of the distributions. The resource calculation sheet shown in Table 1 summarises the results.

4.1.1 Area

The seismic mapping shows an maximum independent closure of 165 acres and this is used as the P_{10} area. A low side area of 100 acres forms the basis of the P_{90} estimation and corresponds to the extent of the highest amplitude anomaly associated with the prospect. The mean area (130 acres) corresponds to the area covered by the amplitude anomaly within structural conformance to ~1300 msec.

4.1.2 Net Pay

The Waarre Sandstone thicknesses and net pay/net sand thicknesses for control wells are shown below.

Well	Gross Waarre	Net Pay/Net Sand*
Curdie-1	100m (328')	63m (208')*
Naylor-1	83.5m (274')	51m (168')
Boggy Creek-1	75m (246')	28m (93')
McIntee-1	62m (203')	27m (89')

At Buttress-1 53m (175') gross interval of Waarre is predicted.

The P_{10} net pay of 52m (172') and a P_{90} net pay of 22m (72') are applied and this is consistent with well observations. The mean net pay at the well is 36m (118') which is consistent with well results. A trap geometry factor of 0.80 is then used for the prospect to determine the average net pay.

4.1.3 Porosity

In the nearby McIntee-1, Naylor-1 and Boggy Creek-1 wells average porosities for the Waarre section of 19%, 16% and 25% are calculated. Spot core porosities of over 27% were measured in Boggy Creek-1. A range of 17% to 22% average porosity for P_{90} & P_{10} respectively is assumed, calculating a mean porosity of 19.3% for Buttress-1.

4.1.4 Gas Saturation

A gas saturation distribution of 65-85% (P_{90} & P_{10}) results in a mean of 74.7% which is consistent with outcomes of the discoveries in the Port Campbell Embayment.

4.1.5 Recovery Factor

The recovery factor for Buttress-1 is based on Santos experience in the area, and assumes a full water drive mechanism. This is estimated to be 60% and this is reflected in the prospect mean recovery factor. The P_{90} & P_{10} range is estimated as 45% and 77% respectively.

4.1.6 Gas Composition

The range of gas compositions utilised 2 bbl/mmcf and 8 bbls/mmcf (P_{90} and P_{10}) for Buttress are relatively narrow and reflect the variation between the McIntee-1 and Naylor-1 gas compositions. The mean is estimated to be 4.6 bbls/mmcf. The gas is assumed to be drier than the Santos fields to the east. The risk of CO_2 in Buttress-1 is accounted by a high low-side shrinkage factor of 80% and the geological chance of hydrocarbon charge of 65%.

4.1.7 Flow Rate

Flow rates are estimated to range between 5 mmcfd and 18 mmcfd (P_{90} & P_{10}). These estimates are based field analogues and recent production tests. Mylor-1 flowed at 25 mmcfd on a ¾" choke, Fenton Creek-1 flowed 17 mmcfd on a ½" choke and McIntee-1 flowed 14.5 mmcfd through a 1" choke.

Location

The proposed Buttress-1 is located about 12 km north west of the town of Peterborough. The site is located in intensive farming land (dairy cattle/sheep) and due to the proximity of remnant native bushland utmost attention needs to be given to environmental and landholder issues.

5. Port Campbell Embayment Waarre Sandstone Gas Play Geological Assessment

5.1 Play Description

In the Port Campbell Embayment the Waarre gas play is a proven, commercial play type with at least 12 discoveries in fields such as Mylor, Fenton Creek, Tregony, Naylor and McIntee. Gas is reservoired in the Waarre Sandstone in three way updip fault closures on the upthrown side of tilted fault blocks and horst blocks. Seal for the play consists of Belfast Mudstone as top seal and the Belfast Mudstone and/or Skull Creek Mudstone as cross-fault seal. Structures are charged from mature source beds located within the underlying Eumeralla and/or Crayfish Group with migration directly into the reservoir or via fault conduits.

Gas in the eastern half of the embayment tends to be wetter than in the western half. CO_2 is found in some reservoirs and this is deemed as a local charging effect related to magmatic source. A strong full stack amplitude anomaly at the Waarre Sandstone horizon is seen on most fields and this is related to well developed gas saturated reservoir. Amplitude anomalies therefore are a very effective exploration tool for thick Waarre sandstone targets.

5.2 Interpretation

The seismic interpretation of the area is based on the merged Curdievale and Nirranda 3D seismic data sets. Several migrated volumes, including migrated stacks with and without spectral whitening and both near and far offset migrated stacks were generated and used for interpretation. Due to better horizon continuity and amplitude preservation the migrated stack volume without spectral whitening was used for horizon interpretation. Far and near offset volumes were used for amplitude extraction and AVO analysis. A coherency cube (similarity volume) was generated and used in conjunction with other volumes for fault interpretation. Well ties were utilised throughout the 3D volume.

Mapping was carried out at near top Waarre Sandstone, which is the primary target reservoir. The Waarre sand package has a distinctive characteristic and therefore a high degree of consistency was maintained on mapping this unit. The top Belfast Mudstone was interpreted on a selected grid in order to evaluate adequately its seal efficiency over the prospects, as this is the critical cross-fault seal for these play types.

5.3 Reservoir

The Waarre Sandstone reservoir was deposited as the initial post-rift sequence at the commencement of the Turonian time under non-marine to marginal marine conditions. The section is sub-divided into three sub-units – Waarre "A", "B" & "C". The lower "A" unit represents a basal transgressive systems tract (TST) characterised by flooding of an incised valley with sediments deposited under marginal marine/estuarine conditions. The basal portion of Unit "A" is represented by either sand (as in Curdie-1) or shale (Boggy Creek-1 and Naylor-1). This section is overlain by the widespread predominantly argillaceous Unit "B", which was deposited under estuarine conditions. Unit "C" was then deposited and is characterised by initial estuarine/deltaic conditions succeeded by high-energy sands. As the transgression develops the valley system is flooded with the Flaxmans Formation and Belfast Mudstone. Main reservoir development is in Unit "C" but Units "A" and "B" also contain reservoir sands. Details of regional reservoir intersections for the total Waarre package are shown below.

Well	Gross Waarre (ft)	Net Sand (ft)	Net Pay (ft)
Tregony-1	374	254	153
Curdie-1	328	208	-
Croft-1	314	192	120
Mylor-1	308	218	80
Fenton Creek-1	302	216	113
Naylor-1	274	181	168
Penryn-1	266	130	58
Boggy Creek-1	246	150	93
Penryn-2	221	140	103
McIntee-1	203	158	89
Lavers-1	183	121	35
Rowans-1	167	100	-

5.4 Seal

All Otway Basin successes in the Port Campbell Embayment Waarre Sandstone play have been from high-side, tilted fault blocks or horst blocks. The ultimate top seal to Waarre reservoirs is the marine Belfast Mudstone. While a potential waste or "thief" zone (the Flaxmans Formation) exists between the Waarre sands and the Belfast seal, this unit was deposited under transitional marine conditions and generally acts as a seal. Valid traps tested and dry are generally interpreted to have throw of the fault large enough to juxtaposed the Waarre against other sandstones (ie the Nullawarre sandstone). Also, the Skull Creek shale has been demonstrated as a valid cross fault seal in the Lavers gas field.

5.5 Hydrocarbon Charge

Hydrocarbons are sourced in the Port Campbell Embayment from the Eumeralla Formation and/or the Crayfish Group. Analysis of the condensates and oils from the area suggest a non-marine origin with both algal and higher land plant components (Type III Kerogen). Maturation studies indicate that the top of the hydrocarbon window lies at about 2500m (subsea). Therefore the mature Eumeralla source units which directly underlie the local gas fields are most likely to charge the overlying structures through source-reservoir juxtaposition or via fault conduits. With many of the structures being present prior to the Belfast deposition, the timing of generation and migration does not appear to be a major issue. However drilling has shown that as well as the risk of hydrocarbon charge there can be a risk of CO_2 rather than hydrocarbon emplacement.

5.6 $C0_2$ Issues

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

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

FIGURES

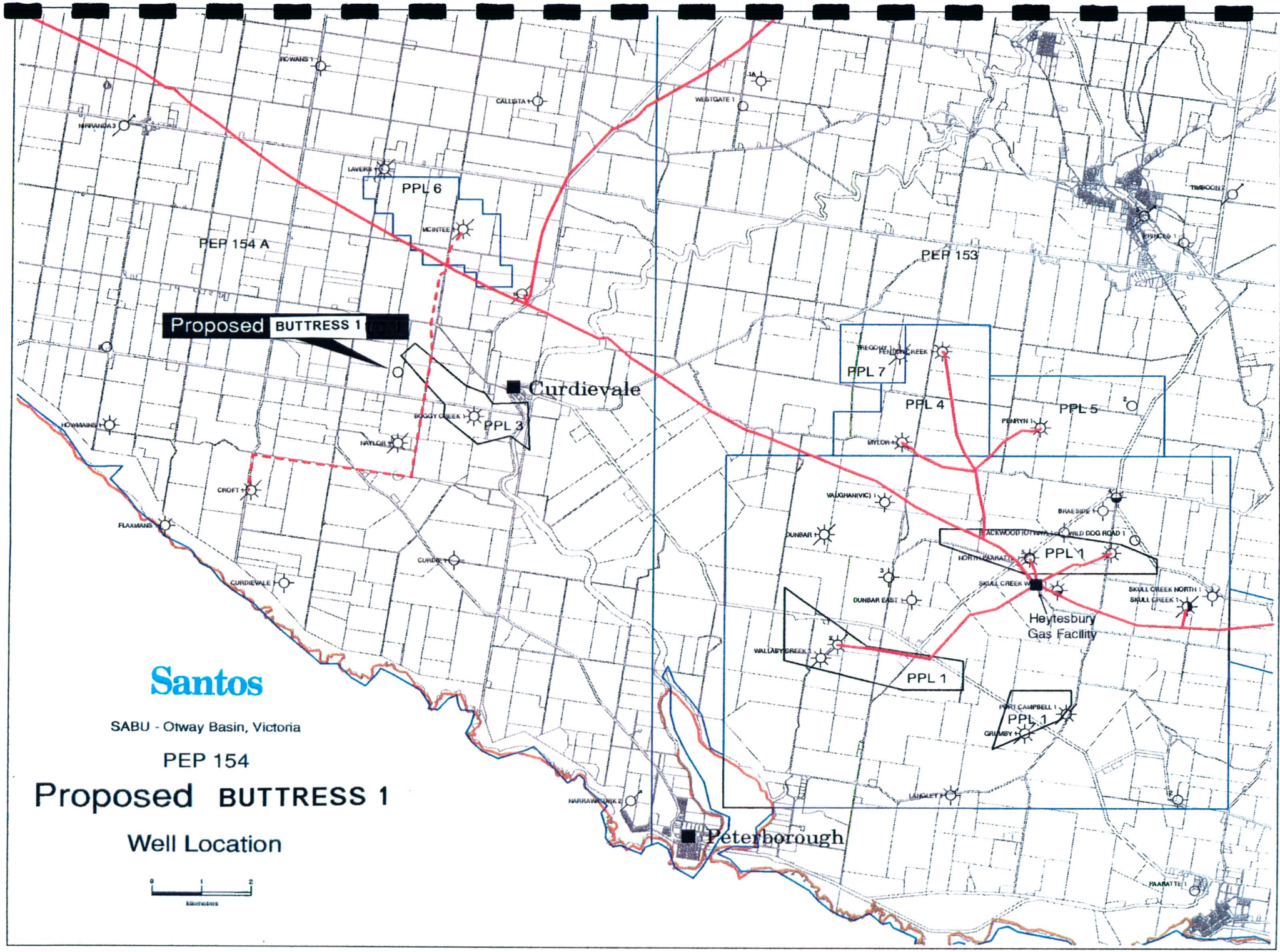


Figure 1

Pe909142 - colour Ø1

909142 013

Pe909142 – colour ØØ2

909142 014

OTWAY BASIN STRATIGRAPHIC COLUMN

Santos

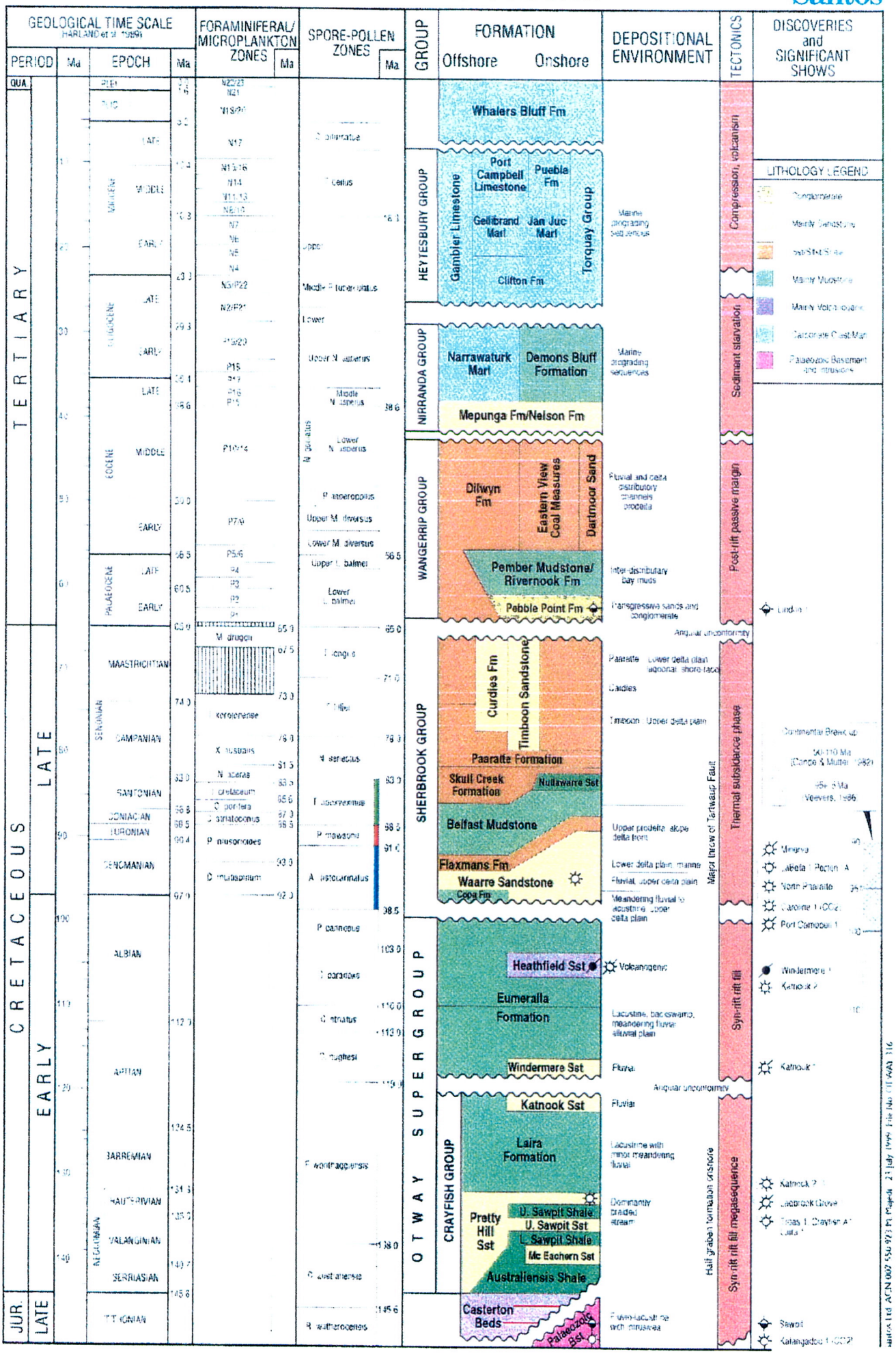
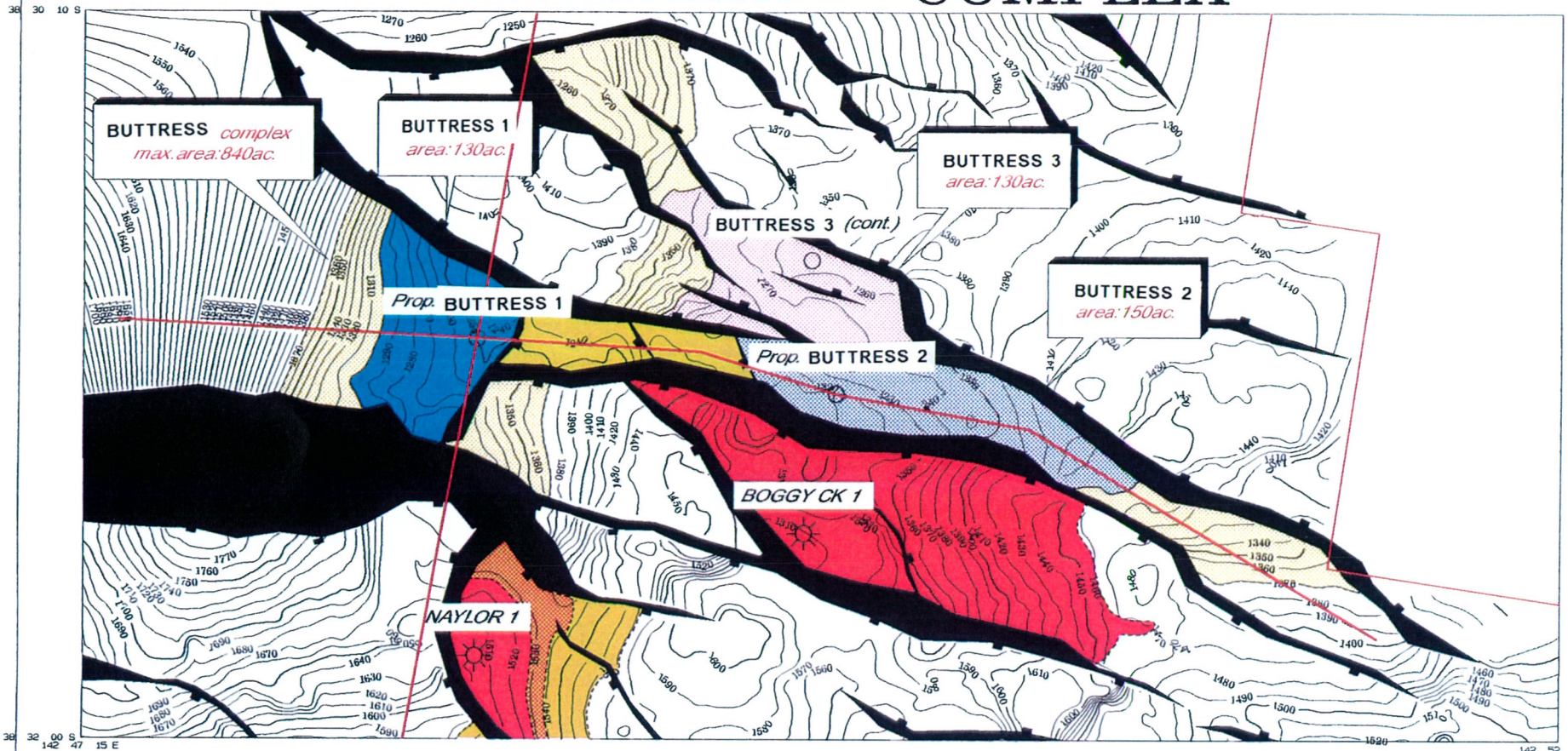


Figure 2

BUTTRESS COMPLEX



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KILOMETRES

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
G.R.S. 1980 SPHEROID
CENTRAL MERIDIAN 141 00 00 E
MAPSHEET DATUM: "GDA94"

GDA

Santos

TWT

Near Top Waarre Sand

Oct.. 2001

M.Majedi

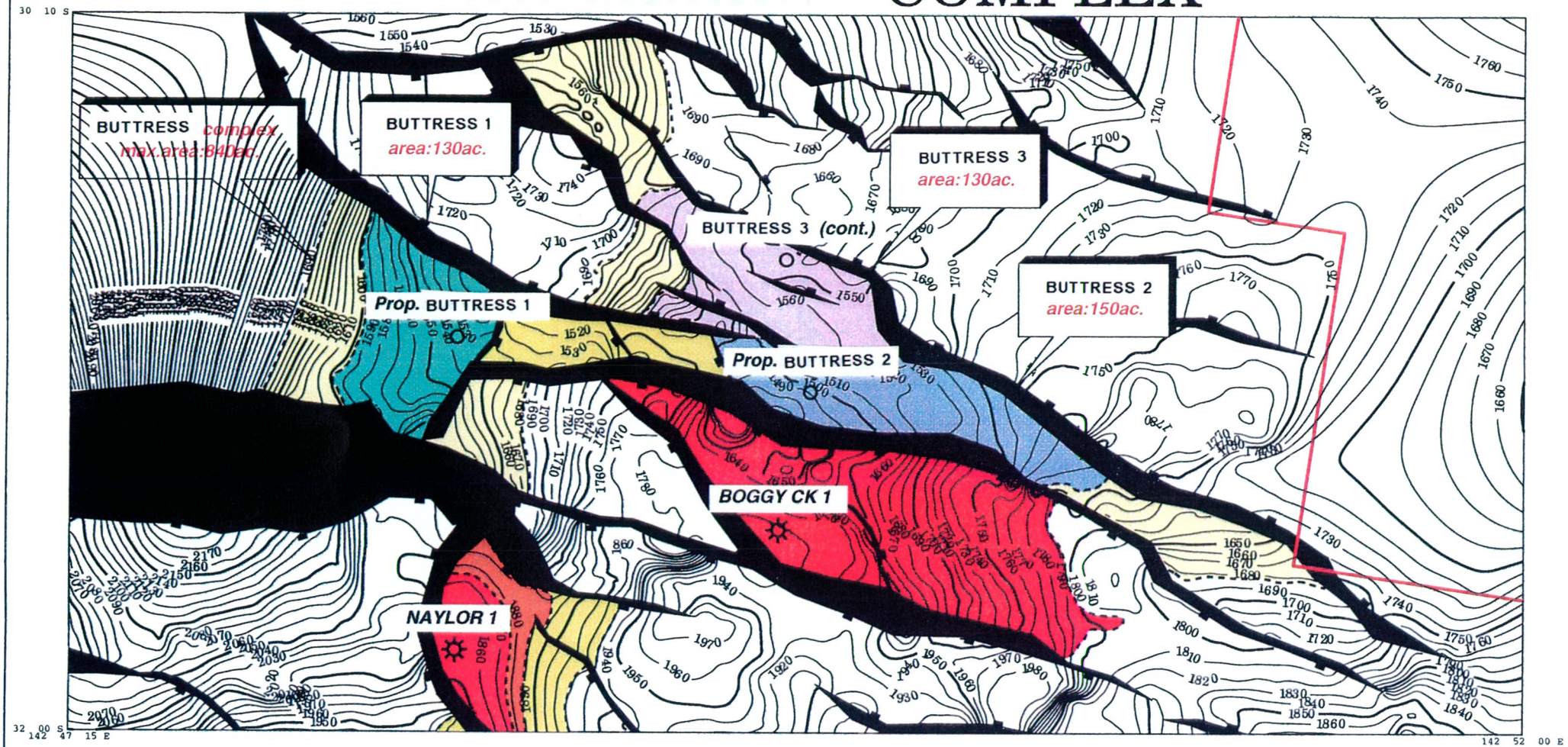
(Horizon : cv_war_pk)

Figure 3

Pe909142 – colour Ø03

909142 015

BUTTRESS COMPLEX



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0 1

KILOMETRES

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
G.R.S. 1980 SPHEROID
CENTRAL MERIDIAN 141 00 00 E
Mapsheet datum: "GDA94"

GDA

Santos

DEPTH

Near Top Waarre Sand

NOV. 2001

M.Majedi

(Horizon : cv_war_pk)

(based on avv.vel.of 2457m/s)

Date : October 30, 2001	Author :	ENCL
Contour Interval : 10	Drafted :	
Datum : G.R.S. 1980	File No. :	

Figure 4

Pe909142 - colour Ø4

909142 016

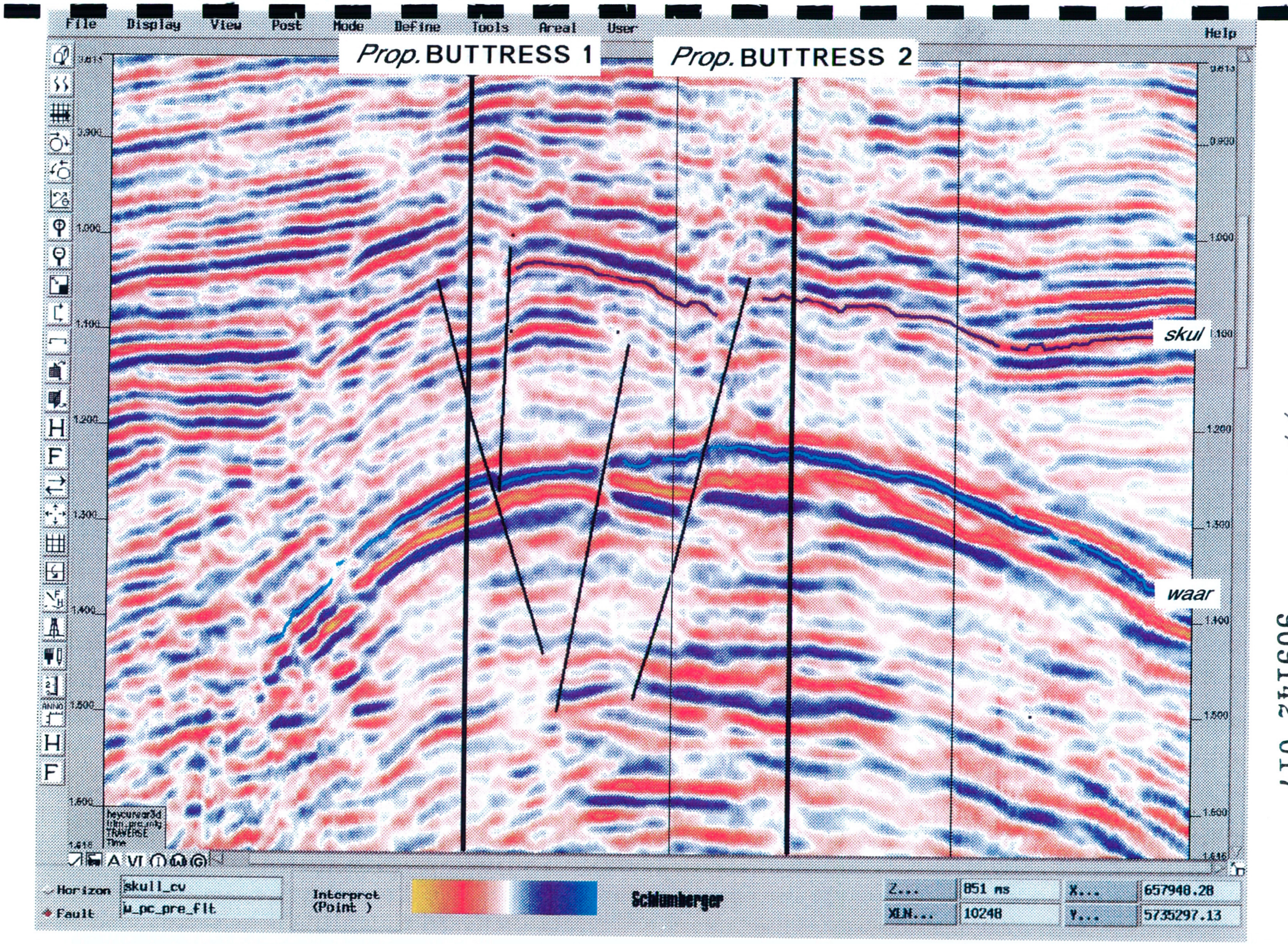

Figure 5

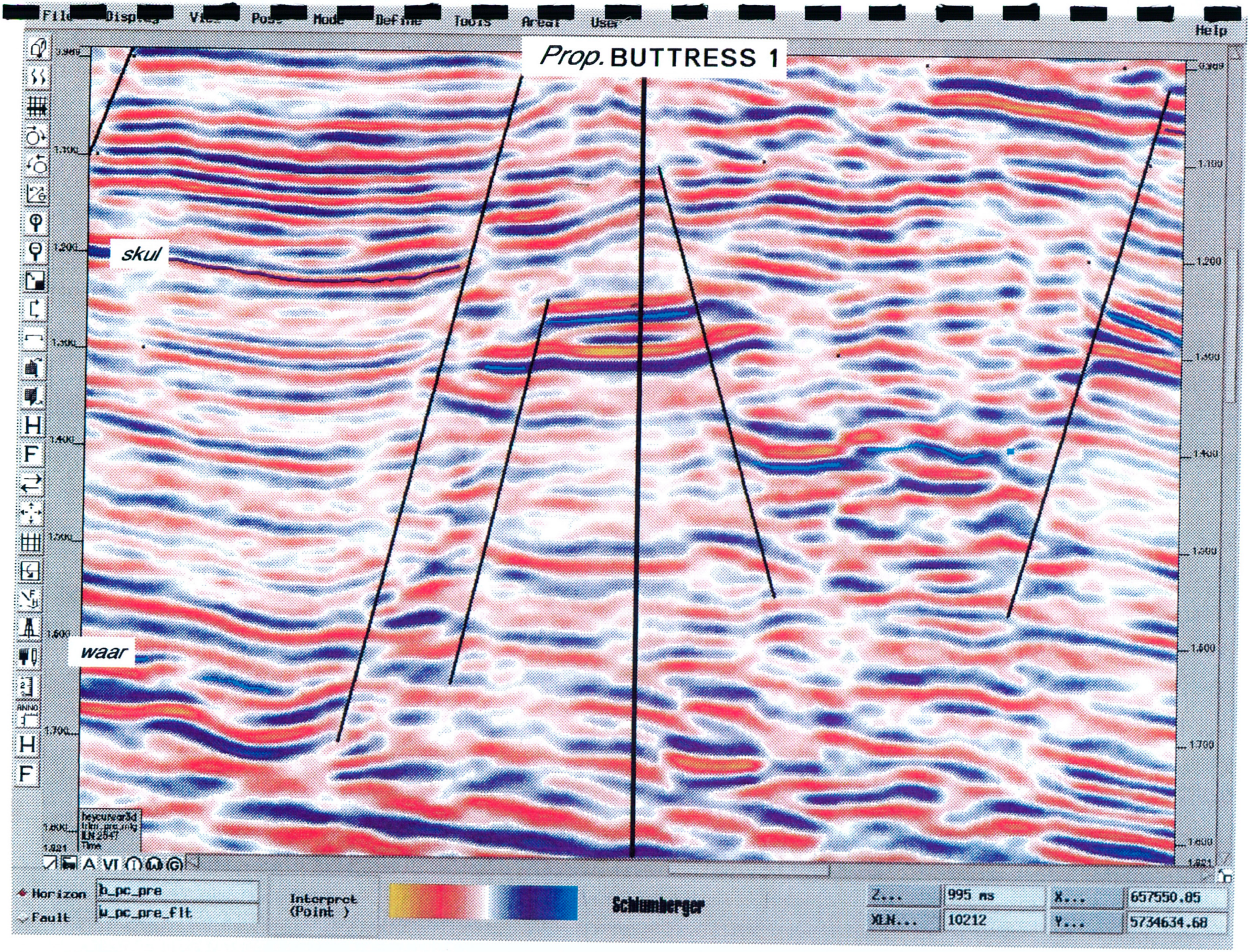

Figure 6

Pe909142 - colour Ø6

909142 018

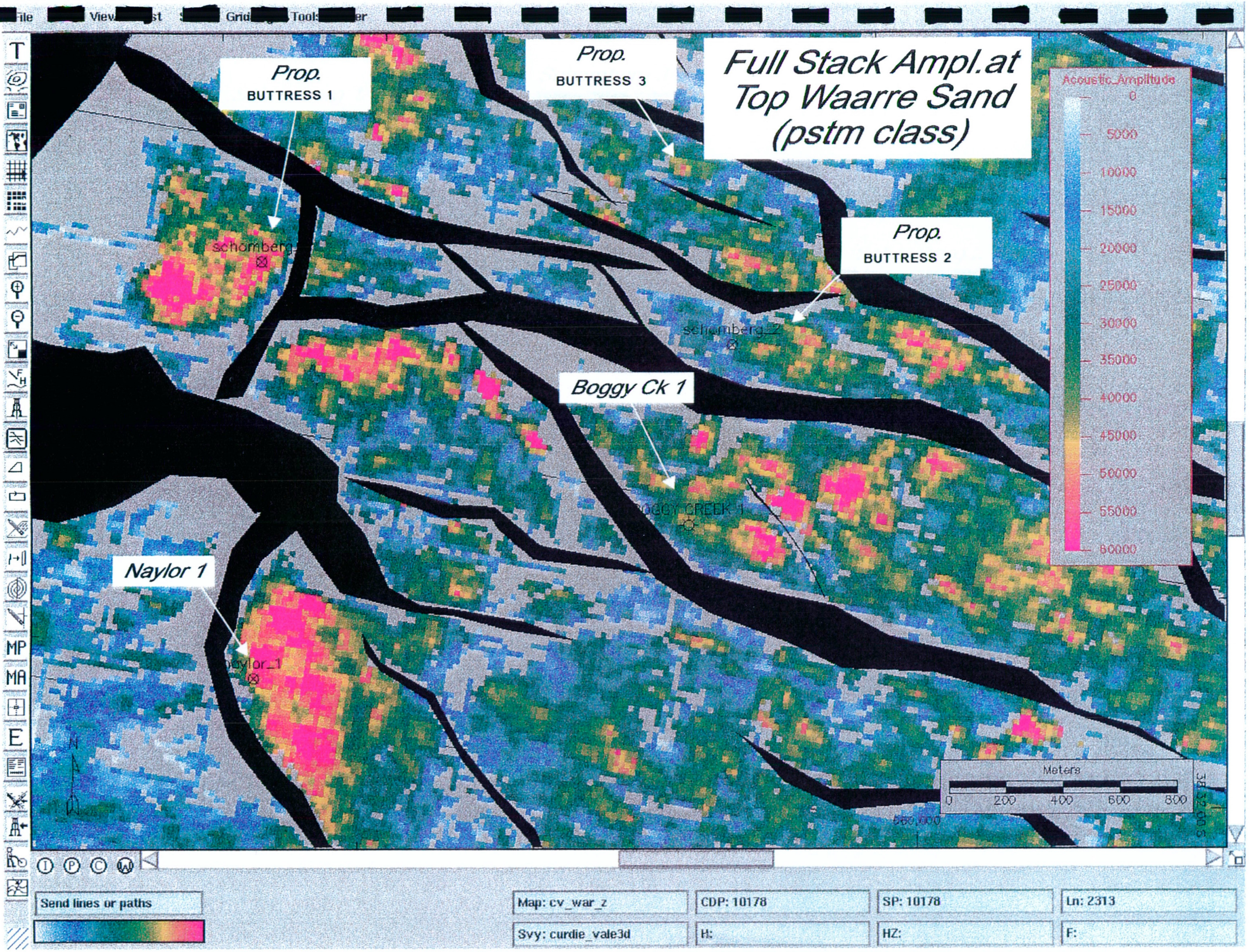

Figure 7

PE909142 - colour 007

909142 019

Pe 909142 _ colour ØØ 8

BOGGY CREEK 1

909142 020

KB : 35 METRES
TD : 1900 METRES

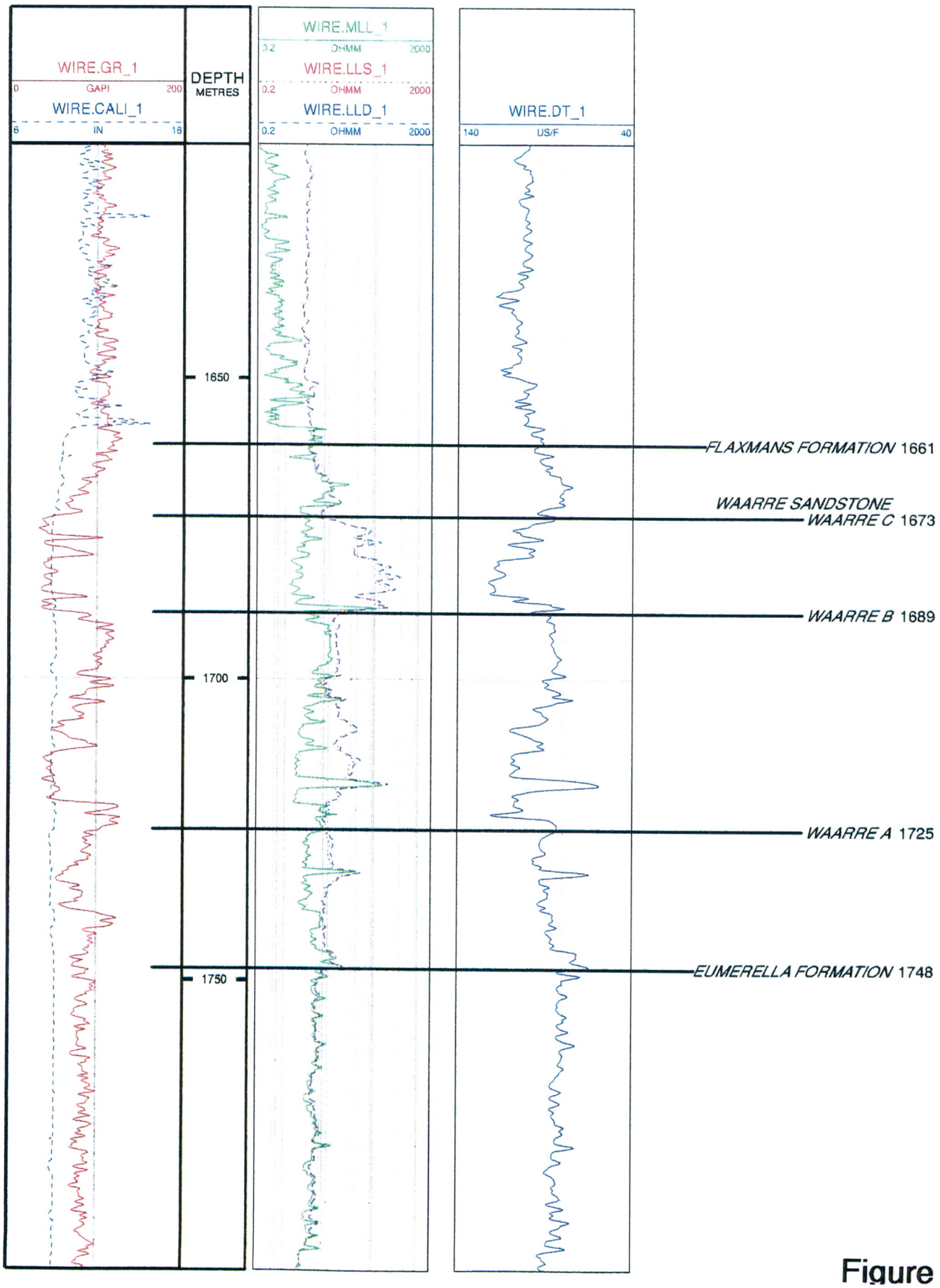

Figure 8

Pe909142 - colour ØØ9

NAYLOR 1

909142 021

KB : 51.09 METRES

TD : 2143 METRES

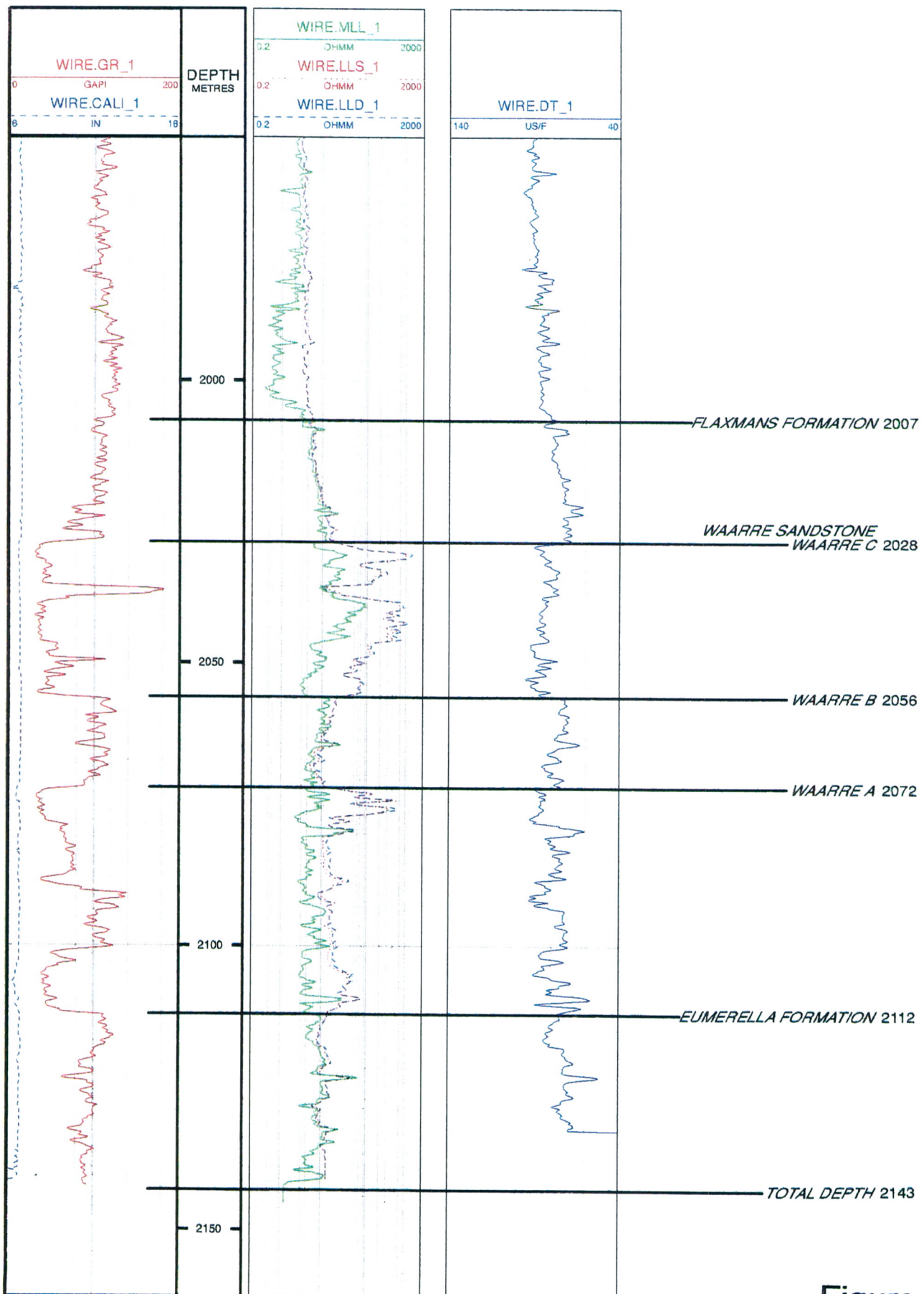

Figure 9

ATTACHMENTS

ATTACHMENT 1
BUTTRESS-1

GEOPHYSICAL PROGNOSIS

	CURDIE-1					PROP. Schomberg-1						BOGGY CK-1				
	TWT (ms)	DEPTH (m-ss)	Isopach (m)	VAV (m/s)	VINT* (m/s)	TWT (ms)	DEPTH (m-ss)	ERROR (+/-m)	Isopach (m)	VAV (m/s)	VINT* (m/s)	TWT (ms)	DEPTH (m-ss)	Isopach (m)	VAV (m/s)	VINT* (m/s)
CLIFF	458	428		1869		440	420			1911		435	406		1867	
			531		2642				136		2096			464		2529
PEB.P	860	959		2230		570	557			1953		802	870		2170	
			136		2519				438		2669			98		2800
PAAR	968	1095		2262		898	994			2215		872	968		2220	
			577		3476				340		3067			480		2927
SKUL	1300	1672		2572		1120	1335			2384		1200	1448		2413	
			180		3273				92		2677			83		3609
BELF	1410	1852		2627		1189	1427			2401		1246	1531		2457	
			558		3331				112		3508			107		3194
WAAR	1745	2410		2762		1253	1539	+/- 20m		2457		1313	1638		2495	
			103		3745				58		2233			77		2567
EUME	1800	2513		2792		1305	1597			2448		1373	1715		2498	
			44						53					150		
(TD)		2557					1650						1865			

DRILLING SERVICES

WELL SPECIFICATIONS

PROJECT NAME: Buttress 1

DATE: December 2001

REVISION: 0

PLEASE SIGN AND PASS ON TO THE NEXT PERSON URGENTLY

DO NOT SEND VIA INTERNAL MAIL

CIRCULATION

POSITION	NAME	PHONE	SIGNATURE	DATE
Drilling Engineer	Justine Bevern	8224 7618 (W) 8357 3098 (H) Mob: 0411 101 206	JNBevern	31st Dec 2001.
Team Leader Drilling	Mike Bill	8224 7150 (W) 8358 6053 (H) Mob: 0419 169 249		31/12/01
Project Leader	Maris Zwigulis	08 8224 7916 (W)	Not Required.	
Drilling Superintendent (Moomba)	Geoff Atherton / Bob Goosem	8224 7406 (W)		
Technical Assistant	Trish Robertson	8224 7331(W)	For Distribution	

General Drilling Procedures

This Well Specifications Program is not a full drilling program.
It contains information specific only to **Buttress 1** and is to be read in conjunction with the Generic Drilling Program for the Otway Basin and the Santos DOM, Drilling Operations Manual. Copies of this should be on Rig 30, if not please contact the Drilling Engineer for further copies.

Note: Where information in this specifications program differs from the Generic Drilling Program for the Otway Basin, adhere to the information in this Specifications Program.

This well is vertical it is not anticipated that a correction run will be required. However some controlled drilling may be required to keep within the 25 m target tolerance.

9-7/8"Surface Hole

- Spud well with 9 7/8" bit dressed with 3 x 18 nozzles.
- Drill in rotary with spud mud at reduced flow rate (under 300 gpm) and parameters until 6 1/2" drill collars buried. Then increase to full drilling flowrate and drilling parameters for optimum ROP. Ensure viscosity at least 50 sec/qrt in the surface limestone prior to reaching the marl formations. If mud rings become a problem in the clay-rich formations then dilute with drill water as a first recourse. If required then switch over to 4% KCl.
- Take a MSS survey at approx 30m. Marl is expected from approx 150m. Then survey every 60m or as seen appropriate.
- Drill ahead surface hole in rotary to approx 380 m.
- Check bottoms up sample to confirm competent casing seat.

Please note the Shallow Hole Contingency steps in the Generic Drilling Program for the Otway Basin. It is expected that Buttress 1 will have up to 150m of limestone in the surface hole, so caution will be required in this section.

The kick tolerance for this well has been based on 12.4 bbl tolerance if the LOT is 15.5 ppg. A minimum of 14.7 ppg would give a kick tolerance of 10 bbls.

6-3/4"Production Hole

- Make up and run a packed assembly as in BHA number 2.
- Drill ahead 6-3/4"hole in rotary with MSS surveys every 150m or as required.
- A 6.75" hole packed assembly, such as BHA 2, should drop angle at low WOB and high RPM, and hold or build slightly at higher WOB and lower RPM. A 6.75" hole short pendulum assembly, such as the third BHA should drop angle.
- Drill the well in rotary as long as possible, however if there are indications that the target may be missed, then drill no further than will allow for a motor run. The motor run is to be no more than 30 degrees inclination and 6 degrees / 30 m dogleg severity.
- If there is a need for a correction run with a motor, then survey with MWD as appropriate.

- Drill to TD at approx 45 - 60 m into the Eumeralla formation (1701 m TVD).

Wait for advice from Operations Geology after logging runs to confirm whether the well will be cased or not.

Bit & Hydraulics Recommendations

Bit No.		# 1	# 2	Correction Run
Bit Size	In	9 7/8"	6 ¾"	6 ¾"
IADC Code		116	PDC	PDC or TCI
Bit Type		FGSS+2	S98 Rebuild	S75 or STR09D
Manufacture		Smith	Smith	Smith or Hughes
Depth In	MD m	0	380	
Depth Out	MD m	380	1701	2152
Metre-age	MD m	380	1321	
Cumulative hrs (IADC)		38	40	
ROP (IADC)	m/hr	20	33	
RPM		100 / 140	100 / 140	300
WOB	k lbs	5 / 15	4 / 15	5 / 10
Nozzles		3 x 18	4 x 11	4 x 11 or 3 x 12
Jet Velocity	Fps	260	330	
Pump Output	Gpm	600	380	250
Pump Pressure	Psi	1350	2350	
SPM		235	148	104
Ann. Velocity	ft/min			
3 ½" DP and HWDP to casing			280	
3 ½" DP and HWDP to hole		174	257	
6 1/2" DC to hole		253		
4 ¾" DC and hole			405	
Pressure @ bit	%	34	34	
Bit HSI	Hhp/in^2	2.5	5.4	

NOTE: Attempt to keep pump rates for the production hole to the top Flaxmans formation above 300 gpm as it has been seen to increase ROP. However, keep in mind it is more important to hit the target than increase ROP, so if control drilling is required, this is the main objective.

BHA Recommendations

BHA No.	1	2	3*	4*
Objective	Surface Hole	Production Hole Rotary angle hold / build	Production Hole Contingency rotary angle drop	Production Hole Motor Run
Bit Size	9 7/8"	6 ¾"	6 ¾"	6 ¾"
BHA	Bit Sub (with ported float)	6 ¾" Near Bit Stabiliser (with ported float)	Bit Sub	4/5 PDM 6 ½" motor stab 1.15 deg bent housing
	X Over	1 x 4 ¾" Pony Drill Collar	1 x 4 ¾" Pony Drill Collar	6 ½" String Stab
	1 x 6 ½" NMDC	6 ¾" String Stab	6 ¾" String Stab	4 ¾" NMDC with MWD
	X Over	1 x 4 ¾" NMDC	1 x 4 ¾" NMDC	6 ¼" string stab
	9 7/8" string stab	6 3/4" String Stab	16 x 4 ¾" DC	16 x 4 ¾" DC
	10 x 6 ½" DC	16 x 4 ¾" DC	4 ¾" Jars	4 ¾" Jars
	X Over	4 ¾" Jars	3 x 4 ¾" DC	3 x 4 ¾" DC
	6 x 3½" HWDP	3 x 4 ¾" DC	6 x 3 ½" HWDP	6 x 3 ½" HWDP
	3 ½" DP	6 x 3 ½" HWDP	3 ½" DP	3 ½" DP
		3 ½" DP		
Approx. Buoyed DC Weight Below Jars	24 kbl	22 klb	22 klb	23 klbs
Mud Weight	9.0 ppg (to 9.2)	9.4 ppg at TD	9.4 ppg at TD	9.4 ppg at TD

* **NOTE** – BHA's 3 and 4 are contingent only. These may not need to be run.

Casing Design

CASING STRING		Surface Casing	Production Casing
Shoe Depth		380 m	1701 m
Casing size (in)		7-5/8	3 1/2"
Grade		L80	J55
Weight (lb/ft)		26.4	9.3
Burst rating (psi)		6020	6980
Collapse rating (psi)		3400	7400
Tensile rating (klb)		602	142
Connection		BTC	Fox
Nominal Wall (in)		0.328	0.254
Inside diameter (in)		6.969	2.992
Drift Diameter (in)		6.844	2.867
Capacity (bbl/ft)		0.0472	.0087
Coupling OD (in)		8.5	4.5
Make-Up Torque (ft/lbs)	Minimum	To bottom	2150
	Optimum	Of triangle	2310
	Maximum		2470
FLOAT EQUIPMENT			
Float Shoe		Non-Rotating	
Float Collar		Non-Rotating	
Shoe Track Length		2 Joints	1 Joint
Threadlock		Shoe Track	Shoe Track
SAFETY FACTORS			
Burst		2.99	3.50
Collapse		7.22	3.51
Tension	- Running	5.34	1.91
	- Pressure Test	5.76	2.30

Pressure Testing Schedule

Component	Pressure Test
7 5/8" Surface casing	2000 psi
Pipe rams, K&C lines, choke manifold, Standpipe, kelly & safety valves	2000 psi
Annular	1500 psi
Bradenhead – casing connection	2000 psi
3 ½" Production casing	2000 psi
Packoff and Seal Assembly	5000 psi
7 5/8" x 3 ½" annulus	2000 psi
Xmas tree valves	5000 psi
LOT	Minimum allowable 14.7ppg EMW (to fracture propagation or max allowable surface pressure)

NOTE: Pressure tests will be a 5 minute low pressure test to 200psi and a 10 minute high pressure test as above. Retest BOPs after 14 days of operations since last test, or nearest operational opportunity thereafter.

Drilling Fluid Program

Prepared by: Mark Scheide
Approval by: Justine Bevern
Date: 11/12/2001
Operator: Santos
Block:
Location: Otway Basin

Well Name: Buttress #1

Interval 3119 **To:** 5613 **Main Production Hole** **4% KCl Polymer** **Hole Size:** 6.75 **Casing:** 7.625" **WorkType:** Drilling

After reaching the Pebble Point formation cease additions of JK-261 as the encapsulating properties of the PHPA will no longer be required.
Fit the finest possible screens on the shakers from the onset of this section once the PHPA is depleted.
Commence additions of Pac R to reduce the fluid loss and increase the Yield Point to min 7-11 lbs/100ft2. The mud weight should be allowed to increase to minimum 8.9 ppg by the Eumaralla formation. The yield point will need to be increased to ~10lbs/100ft2 if barite is added to weight up.
Commence additions of Idcide 20 (0.4ppb) and Sodium Sulphite (120ppm) in order to prevent bacterial contamination and reduce downhole oxygen respectively.
If downhole losses become apparent add Sandseal fine via 10-20ppb sweeps or directly into the active system to stem losses as required.
KCl is to be maintained at a minimum level of 4% excess until TD.
If the filter cake quality is poor and MBC's low, add 1-5ppb Bentonite via premixes to improve integrity and rheology.
To save on chemical consumption levels, recycle the sump water when the level allows and report properties on a daily basis. Cease using sump water if biological activity is evident.
Pump high viscosity Xanthan Gum sweeps to surface prior to pulling out of the hole to ensure that the hole is clean of cuttings.

Mud Properties		
Mud Weight	ppg	8.8 - 9.4
Funnel Viscosity	sec / qt	34 - 39
Yield Point	lbs/100 sq ft	7 - 11
API Fluid Loss	cc's	<10
KCl	%wt	>4
Hardness	mg/l	<200
Drill Solids	%	< 4
Shaker Screen Size		200/250

Products	Unit:	Size	*Usage*
Barite	Kg	25	55
Caustic Soda	Kg	25	3
Soda Ash	Kg	25	21
KCl (fine)	Kg	25	191
Idcide-20	Ltr	20	7
IDPAC-R	Kg	25	15
Sodium Sulphite	Kg	25	14
Xanthan Gum (P)	Kg	25	5

Pipe Out	*Volume*
Dilution Volume	748.2
Total Volume:	748

Interval 5613 **To:** 5613 **Post TD Treatment** **4% KCl Polymer** **Hole Size:** 6.75 **Casing:** 3.5" **WorkType:** Post TD

Ensure that all mud that is left for extended periods of time whilst logging or testing are treated with Idcide and caustic soda (pH 10min) to prevent bacterial degradation of viscosifying polymers.
Ensure that Cronox 2100 does not come into contact with the reservoir.
Displacement fluid recipe will be as per Santos cementing program.
Ensure that two full mud checks are conducted daily and that the sump water analysis is reported daily during usage.
Ensure that all products are protected from the elements and are ready for transport.

Products	Unit:	Size	*Usage*
Salt	Kg	25	26
KCl (fine)	Kg	25	46
SAPP	Kg	25	8

Pipe Out	*Volume*
Displacement Volume	50
Pre Flush Volume	40
Total Volume:	90

Drilling Fluid Program

Prepared by: Mark Scheide
Approval by: Justine Bevern
Date: 11/12/2001
Operator: Santos
Block:
Location: Otway Basin

Well Name: Buttress #1

Interval 0 **To:** 1254 **Surface Hole** **Spud Mud** **Hole Size:** 9.875 **Casing:** 7.625" **WorkType:** Drilling

After arriving on location, test the water source and record its properties on the first mud report. The water source is expected to be of reasonable quality to hydrate bentonite. Also record the shaker screen inventory on the first report. Highlight any damaged stock during transit.
Using the short system treat out the hardness and prehydrate 25ppb Bentonite. This should be extended with lime if extra viscosity is required prior to spudding.
Spud the well with the high viscosity bentonite spud mud. Keep a 4% KCl brine as stand by in one of the tanks for use if reactive clays are encountered. There should be no requirement to maintain a particular [K+] until TD however if downhole conditions dictate add 2% KCl. Maintaining sufficient Gel concentrations should minimise downhole losses, however If whole mud loss becomes apparent, Enerseal Fine and Coarse are the preferred LCM to be added either directly to the active system or via sweeps containing a minimum 10ppb. The solids control equipment should be run to keep the mud weight and solids to a minimum. Check the flowline and sand trap regularly for solids build up and clean as required.

Mud Properties			Products	Unit:	Size	Usage	Pipe Out	Volume
Mud Weight	ppg	9.2 (TD)	Caustic Soda	Kg	25	5		
Funnel Viscosity	sec / qt	> 40	Trugel 13A	Kg	25	131		
pH		9 - 10	KCl (fine)	Kg	25	8	Dilution Volume	438.9
MBT	ppb	15 - 25	IDPAC-R	Kg	25	1	Initial Pre Mix	200
Shaker Screen Size		84/110		Total Cost:			Total Volume:	639

Interval 1427 **To:** 3119 **Top Production Hole** **4%KCl PHPA** **Hole Size:** 6.75 **Casing:** 3.5" **WorkType:** Drilling

After filling the pill tank with spud mud, dump and clean all other tanks in preparation for the next section. Ensure that all gates are sufficiently gelled to prevent cement contamination to the PHPA mud system whilst drilling the cement, shoe and track.
After treating out the hardness of all surface tank water, add 0.6ppb JK-261 and apply shear. Just prior to spudding this section add 4% KCl.
Once the FIT has been performed swap the circulating system over to the PHPA / KCl fluid and commence direct additions of JK-261 to increase the PHPA between 1-1.5ppb as soon as possible. Ensure that all solids control equipment are put on line at the commencement of this section. The integrity of the cuttings at the shakers should be monitored and the concentration of PHPA adjusted to ensure sufficient inhibition at all times. Reduce fluid loss through the interval by IDPAC-R additions while the yield point should be allowed to remain on the lower side of programmed specifications.

Mud Properties			Products	Unit:	Size	Usage	Pipe Out	Volume
Mud Weight	ppg	8.5 - 8.7	Caustic Soda	Kg	25	1		
Funnel Viscosity	sec / qt	34 - 37	Soda Ash	Kg	25	3		
Yield Point	lbs/100 sq ft	5 - 7	KCl (fine)	Kg	25	130	Dilution Volume	507.6
pH		8 - 9	JK-261	Kg	25	19	Initial Pre Mix	450
KCl	%wt	>3	KCL (fine)	Kg	1000	3	Total Volume:	958
PHPA	ppb	1 - 1.5	IDPAC-R	Kg	25	5		
Hardness	mg/l	< 200	Sodium Sulphite	Kg	25	4		
Shaker Screen Size		84/110						

WELL NAME:	Buttress 1	SEISMIC REF:	Inline 2279 CDP 10211
WELL TYPE:	Gas Exploration	ELEVATION:	GL - 45.8m RT - 50.5m
WELL AREA:	PEP 154	LATITUDE:	38 deg 31' 00.10" (N 5735304.6)
RIG	ODE&E 30	LONGITUDE:	142 deg 48' 30.08" (E 657654.2)

SANTOS Limited

FT MD (RT)	LITHOLOGY	FORMATION TOPS Metres RT	P & A	WELL SCHEMATIC	CASING WELLHEAD	CEMENTATION	DRILLING FLUID	EVALUATION	WELL DATA	OFFSET WELL INFO.
250	Limestone to 150 m Gellibrand Marl to 470 m			9-7/8" 270 m 7-5/8" 210 m 380 m	**SURFACE CASING** If necessary, make wiper trip with bit to conductor. 7 5/8" 31 joints 26.4 ppf L80 BT&C 2 jnt shoe track Connection to be torqued to triangle Set Shoe @ +/- 380 m Centralisers Mid 1st & 2nd jnts 4th, 6th couplings 1st coupling below cellar	**SURFACE CASING** Lead to surface Tail slurry 90 m rise. Calculate mud and cement returns to surface. Perform Top Fill Job using 1" stinger regardless of cement returns. Displace cement with old mud. Use 50% excess for lead and 30% excess for tail. Use Mains water (hauled 3 km) for cementing.	**SURFACE HOLE** 9-7/8" to 380 m Spud Mud with Gel Spud mud Run solids control equipment to keep mud weight and solids content to a minimum. Funnel Viscosity 35 - 40 sec/qrt YP 20 - 25 Use 84 mesh shaker screens	**SURFACE HOLE** Mudlogging - As Directed by Ops Geology	20" Conductor set at +/- 10 m MSS Survey at 30 m then every 60 m Test casing 2000 psi when bump plug	Assumed Temp Grad 1.86 deg F / 100 ft BHT approx 167 deg F Offsets include: Naylor South 1 - 15 days to drill - 2243 m Naylor 1 - 10 days to drill - 2157 m McIntee 1 - 14 days to drill - 1799 m 1100 - 1300 m Trace Gas on Naylor 1 1100 - 1600 m 100% C1 on Naylor 1 Potential for lost circulation in shallow surface hole and for mud rings in deeper Marls.
500	Clifton Mepunga Dilwyn	471 576 608								
750	Pember Mudstone	892		6-3/4" 3-1/2"	**PRODUCTION CASING** 3 1/2" 9.3 lb J55 Fox Surface to TD Make up single jnt shoe track. Run Dowell float equipment. Make up connections to optimum torque Centralisers 3 1/2" x 6 3/4" type 3m above shoe. Next 2 couplings. Every 2nd coupling from 15m above Flaxmans to 15m below Eumeralla 1st & 3rd coupling above 7 5/8" shoe. Marker Joints 15m above Waarre top. 15m above any other pay zone encountered.	**PRODUCTION CASING** Top of Lead 170m inside surface casing shoe. Top of tail to go to 100m above top Waarre Approx 1490m Use 10% excess over caliper or 20% over gauge hole (lead & tail) Pump NaCl/SAPP preflush & water as per schedule Use Dowell unit for mixing & pumping cement and displacing with 2% KCl (8.5 ppg) brine Hold safety meeting prior to pressure testing to minimise delays. Reciprocate the production casing string during job. Use Mains water (hauled 3km) for cementing	**MAIN HOLE** 6-3/4" to 1701 m 3% KCl/PHPA/Polymer MW: 8.6 - 9.4 ppg PV: ALAP YP: > 4 - 10 6 rpm: 1 - 4 Shoe to 950 m 4% KCl minimum MW: 8.5 - 8.7 ppg API fluid loss 10 cc PHPA 1.5 ppb 950 - 1390 m Allow PHPA to deplete MW: 8.6 - 8.7 ppg API fluid loss 7 - 8 cc YP 8 - 12 1390 - 1701 m 3-4% KCl MW: 9.0 - 9.4 ppg Ensure that MW is 9.0 ppg prior to Waarre May need to weight up to 9.4 ppg in the Eumeralla for pore pressure control. Up to 8.9 ppg pore pressure in Eumeralla has been observed. Use finest possible shaker screens as possible, ie 250 mesh. Ensure YP is 7 - 9 prior to first trip.	**MAIN HOLE** Mudlogging - Samples every 10 m to approx 1000 m 3 m samples 1000 m to TD Coring None Wireline Logs GR TD to Surface SDT Over Waarre MSFL TD to 100 m above Pember DLL - CAL TD to Surface Casing LDL - CNL TD to approx 20 m above Flaxmans MDT Points 20 points SWC's One run, 20 samples	**MAIN SECTION** Install 5K x 11" Bradenhead with with wear bushing bushing and BOP's Pressure test BOPs to 200/2000 psi. Hydril to 200/1500 psi 5 mins / 10 mins LOT allow 14.5 ppg EMW (min) Note: Clamp lock system to be used Target Tolerance 25m radius at top Waarre Survey with MSS in rotary 150 m minimum frequency MWD for correction runs Test casing to 2000 psi. when bump plug	LOT Data: 18.0 ppg @ 487 m Naylor 1 15.9 ppg @ 436 m Naylor South 1 15.7 ppg @ 426 m McIntee 1 15.9 ppg @ 670 m Penryn 1 17.2 ppg @ 360 m Penryn 2 13.6 ppg @ 303 m Fenton Creek 1 16.2 ppg @ 471 m Croft 1 16.2 ppg @ 378 m Tregony 1 18.9 ppg @ 424 m Lavers 1 16.5 ppg @ 293 m Mylor 1 Directional Tendency: Naylor 1 - Slightly down dip. East from surface, turning full circle to south-east main hole. McIntee 1 - Updip. Jetted surface hole to N 1.6 deg at SH TD. Rotary main hole to NE to N direction. Tregony 1 - Updip. Jetted surface hole south 7 degrees. Rotary main hole, went S to SW, pick up motor. Lavers 1 - Updip. Surface hole went NE then main hole turned south and TD at 2.2 deg. Naylor South 1 - Down dip. Reservoir Pressures: Waarre expected reservoir pressure at 1590 m is 2250 psi (equates to 8.3 ppg MW) Max surface pressure with gas filled pipe is 1700 psi Potential for 8.9 ppg pore pressure in the Eumeralla formation Notes: Naylor South had tight hole on wiper trips pulling 10-20 klb over. Also had to back ream some sections especially those that had some sort of dog leg.
1000	Pebble Point Paaralie	945 1045								
1250	Skull Creek	1386								
1500	Belfast Flaxmans Waarre Eumeralla TD	1478 1578 ● 1590 1648 1701		1490 m						
2000				Well TD at 1701 m						

TARGETS:
Primary ●
Secondary O

P & A PLUGS (if required) Minimum 90 m in length. Tag plug across shoe and pressure test 500 psi above leak off

No changes to the drilling program can be made without the Program Change Control form (DOMS-F207) first being signed and sent to the rig.

Prepared by: Justine N. Bevern

Well Objectives: Waarre
Water Source: Hauled water from Mains approx 3 km

DRILLING HAZARDS: Possible lost circulation at very shallow depths and mud rings in surface hole. Swelling clays in the Skull crk and Belfast may cause tight hole. Hard stringers in Croft 1 1406-1513m and 1900-2000m drilled with a pendulum assy caused ledges and troublesome logging.

Signed by:

Date:

VERSION 0
REVISION 0

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