

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

909014 001

EXPLORATION & DEVELOPMENT - SA

PENRYN 2
WELL PROPOSAL

G. Parsons / M. Majedi
June 2001

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

909014 002

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WELL PROPOSAL

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June 2001

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1. Geophysical Prognosis

WELL DATA SUMMARY

WELL NAME: Penryn 2				WELL TYPE: Gas Development														
				SURFACE LOCATION														
LICENCE: PEP 153 EQUITY: <table border="0"> <tr> <td colspan="2">Voting (%)</td> <td colspan="2">BUDGET STATUS: 2001 development</td> </tr> <tr> <td>Santos</td> <td>100%</td> <td>Santos</td> <td>\$1.277 mm</td> </tr> <tr> <td colspan="2">TOTAL 100.00%</td> <td colspan="2">TOTAL \$1.277 mm (P&A)</td> </tr> </table>				Voting (%)		BUDGET STATUS: 2001 development		Santos	100%	Santos	\$1.277 mm	TOTAL 100.00%		TOTAL \$1.277 mm (P&A)		Latitude: 38 31 20 S (surface) Longitude: 142 58 43 E (surface) Ground Level TARGET LOCATION (top Waarre Sand) Latitude: 38 31 21" S (target) Longitude: 142 58 43" E target Seismic Reference: line 3285 Heytesbury 3D CDP 10323 Ground Level: 128m Rotary Table: 132.7m Proposed Total Depth: 1733m RT (-1600m) Rig: OD&E 30 Nearby Facilities: Heytesbury		
				Voting (%)		BUDGET STATUS: 2001 development												
Santos	100%	Santos	\$1.277 mm															
TOTAL 100.00%		TOTAL \$1.277 mm (P&A)																
Resource Estimate (Recoverable)				Cost Estimates														
Mean Success Volume:		1.76 BCF		P&A: \$1.277 mm														
Mean Expected Volume:		1.34 BCF		C&S: \$1.406 mm														
				Cost Code: 8ED-83C890														
Objectives/Fluid Contacts				Stratigraphic Prognosis														
Primary		Secondary		Formation	Depth (m-KB)	Depth (m-SS)												
Waarre Sandstone (gas)				Clifton	297	-164												
				Mepunga	385	-252												
				Pebble Pt	723	-590												
				Paaratte	788	-655												
				Skull Ck	1172	-1039												
				Nullawarre	1348	-1215												
				Belfast	1471	-1338												
				Flaxmans	1587	-1454												
				WAARRE	1607	-1474												
				Eumeralla	1671	-1538												
				TD	1733	-1600												
Formation Evaluation				Hole Design/Drilling Issues														
Wireline Logging: PEX-HRS TD to Surface Casing to Surface SDT (WFT) TD to Surface Casing (WFT across Waarre Sst) MCFL-CALI TD to 10 m above top Pember PEX-LDL-CNL TD to 100' above Waarre Sst (dependent on shows and reservoir development)				Well Class: Conventional/Development Hole Type: Monobore Hole Size Casing Depth 9 7/8" 7 5/8" Surface to 380m 6 3/4" 3 1/2" Surface to TD														
SWC's: None Programmed				Drill Fluid: KCI														
MDT's: 20 point pressure survey				Deviation Sub-Surface Targets: Penryn 2 is a vertical well. An accuracy of 50m radius from seismic reference at TD has been Requested. The bounding fault is located to the SE of the well site.														
Velocity Survey: None Programmed				Other Information/Hazards: No hazardous zones in offset wells No shallow gas expected Waarre Sandstone has excellent reservoir properties (porosity 20%, permeability up to 20 darcies)														
Mudlogging: 10m Samples from Surface Casing to approx 1000m 3m samples thereafter to TD Samples as per well programme				Nearby Wells: Duration, TD, Distance: Mylor 1: 16.5 days 1922 m , 4.7kmSSW Fenton Ck 1: 15 days 1840m. 4.0km WNW Penryn 1: - 12 days, 1822m, 1.9km SSW														
Formation Testing: None Programmed																		
Coring: None programmed																		
REMARKS/RECOMMENDATIONS:																		

2. EXECUTIVE SUMMARY

Penryn 2 is proposed as an Otway Basin gas development well to be located in the PEP 153 licence, approximately 4 km south of the town of Timboon and 1.9 km ENE of Penryn 1 (see Figure 1). The Penryn 2 location will test a separate culmination within the greater Penryn structure.

The Penryn 2 structure is a tilted-fault block closure, defined by 3D seismic. The well is expected to intersect a thick Waarre Sandstone reservoir with mean net pay of about 24m.

The prognosed stratigraphy succession is summarised by Figure 2.

Penryn 2 is an attractive project with a mean prognosed success case of 1.76 BCF sales gas (3.1 BCF OGIP) and a Pc (probability of commercial success) of 76%, resulting in expected mean reserves of 1.34 BCF sales gas (1.6 PJ). The potential for oil at the Penryn 2 location is a distinct possibility, but has not been included in any economics. Spill from Penryn 1 is likely to be in the direction of Penryn 2.

3. GEOLOGICAL RISK ASSESSMENT

3.1 Play Analysis

The Penryn 2 structure is mapped as a tilted-fault block closure with the primary reservoir the Waarre Sandstone; both vertical and cross-fault seal is provided by a thick Belfast Mudstone. The Penryn 2 structure is charged from mature source beds located within the underlying Eumeralla and / or Crayfish Group with migration conduit directly into the reservoir or via fault conduits. The play has been proven successfully in the nearby Penryn, Mylor, Fenton Creek, North Paaratte, Wallaby Creek and Iona Fields.

3.2 Trap

The interpretation and mapping of the Penryn 2 Prospect was based on the Heytesbury 3D Survey which was recorded in 2001. The greater closure area of the Penryn Structural Complex however was defined by integration of the Waarre and Heytesbury 3D Surveys.

Mapping was carried out at top Waarre Sandstone, which is the primary target reservoir (Enclosure 1). The Waarre Sandstone has a distinctive character on both 3D volumes and therefore a high degree of accuracy was maintained on picking this event.

The Penryn 2 structural closure has been formed by a major-tilted fault block of similar style to the Mylor and Penryn gas fields. Penryn 1 and Penryn 2 closures are separated by a gentle saddle but if the downthrown side of the fault to the north of Penryn 2 closure seals the two closures may be in communication.

A strong amplitude event is present at the top Waarre reflector over the Penryn 2 structure (figures 3,4,5 and enclosure 2). A similar event over Mylor and Penryn gas fields suggest that the amplitude anomaly is likely related to presence of gas in these structures.

The target location for the proposed Penryn 2 was selected on inline 3285 at CDP 10323 Heytesbury 3D survey. This location is about 30 metre from the fault at the Waarre Sand level.

Depth conversion for the prognosis was performed using the Penryn 1 time depth pairs. A depth map at top Waarre Sand was also generated using average velocity at Penryn 1 . (Enclosure 3),

3.3 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 sands within the A & B units are generally shalier and more cemented and consequentially have lower porosity than the overlying Unit C (av 20%). In Mylor 1 however Unit A exhibited good porosity but proved water wet due to juxtaposition of the reservoir against the permeable Unit C. Thickness changes in the lower units imply that syn-depositional subsidence increased basinward to the southwest.

While the Waarre Sandstone thins to the north, the proximity to the Penryn and Mylor wells, where excellent reservoir is encountered, provides high confidence that similar good reservoir will be found in Penryn 2. Enclosure 4 shows a stratigraphic cross section between Fenton Creek, Mylor, Penryn and Namgib wells. Average core permeabilities of 4.1 Darcies are measured in Mylor 1 and production tests confirmed the potential of the reservoir with test rates of 17-25mmcf/d. Log displays for Penryn 1, Mylor 1 are presented in Figures 6 and 7.

3.4 Seal

All Otway Basin successes in the Port Campbell Embayment area have been in high side, tilted fault and horst blocks. The ultimate top seal to Waarre reservoirs is the marine Belfast Mudstone. While a potential waste or “thief” zone exists between the Waarre sands and the Belfast seal, (the Flaxmans Formation) was deposited under transitional marginal marine conditions is most likely to act as a seal.

Cross fault seal is considered the major risk for prospects within the central Port Campbell Embayment area. For structures where the fault throw is greater than the thickness of the overlying Belfast Mudstone there is considerable risk that cross seal will leak due to Waarre sands being juxtaposed against sands of the Nullawarre Greensand. If the throw is great enough, the reservoir could however be juxtaposed against the Snake Creek Mudstone. Seismic interpretation suggests that leakage will not occur at Penryn 2 closure as the maximum fault displacement (120msec) is less than the thickness of the Belfast Mudstone (160msec) at the downthrown side of the fault.

A “greater” Penryn structure, which relies on downthrown fault seal against the Eumeralla Formation, allows the potential for a larger structure. The lack of strong amplitude support however suggests that this has a very low chance of success.

3.5 Charge

Hydrocarbons are produced in the Port Campbell Embayment with the Eumeralla Formation and/or the Crayfish Group being the source beds. Analysis of the condensates and oils from the area suggest a non-marine origin with both algal and higher land plant components. Mature source units underlie the gas fields and most likely charge directly into the overlying structures through source-reservoir juxtaposition or via fault conduits. This model is proposed for Penryn 2, which is positioned in a similar situation to the adjacent, existing gas fields.

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.

4. RESOURCE DISTRIBUTION AND ECONOMIC EVALUATION

4.1 Resource Distribution

Distributions for the local gas field parameters are estimated primarily from the Penryn Gas Field, with data from other nearby wells reviewed to provide details of the upper and lower limits. These results are set forth in Table 1 and are used in the resource calculation sheets.

4.1.1 **Area**

The seismic mapping shows a confident closure of around 62 acres (Enclosure 1). This area forms the basis of the mean estimation. The P90 and P10 area represents the distribution expected based on the distribution of amplitudes within the structure.

4.1.2 **Porosity**

The porosity in Penryn 1 averaged over 21% in the Waarre C and upper Waarre A units. In the nearby Mylor and Fenton Creek wells, average porosity of about 20% is calculated from the logs. Spot core porosities of over 30% were measured in Mylor 1. A range of 19% to 22.5% average porosity for P90 & P10 calculates a mean porosity 20.7% for the proposed Penryn 2.

4.1.3 **Hydrocarbon Saturation**

A hydrocarbon saturation range of 70%-80% would capture all of the discoveries in the Port Campbell Embayment. Based on a log-normal distribution this would calculate a mean of 74.9% which approximates to the Penryn, Mylor 1 and Fenton Creek 1 Sh average of 76.8%, 73.9% & 76.4% respectively.

4.1.4 **Net Pay**

Penryn 1 has net pay of 58 ft, Mylor 1 has net pay of 80 ft, Fenton Creek 1 has net pay of 113 ft. The mean net pay estimate for Penryn 2 is 72 ft. Gross closure for the Penryn 2 structure is over 180 ft (45ms TWT). Net / Gross ratios of 88.5%, 79.9% & 88.5% are recorded in Penryn, Mylor and Fenton Creek respectively.

4.1.5 **Recovery Factor**

The recovery factor for the Mylor and Fenton Creek fields is estimated to be about 60%, the mean recovery factor of 59.7% is calculated for Penryn 2 based on 50% and 70% P90 and P10 respectively. To date Mylor 1 has produced over 50% of its reserves, with Fenton Creek producing about 37% of its reserves; both wells are still in production. Penryn 1 however produced only 0.33 BCF of its 1.65 BCF 1P booked reserves (20% recovery) before the pressure dropped below the Heytesbury plant inlet pressure. A p/z plot of the production from Penryn indicates that an ultimate recovery using compression was likely to be about 1.5 BCF, which equates to about a 70% recovery factor. The 2P Penryn case, which included extension into the Penryn 2 structure, appears to be the high side case.

4.1.6 **Gas Composition**

The ranges of gas compositions utilised for Penryn 2 is relatively narrow and reflect the limited variation between the Penryn 1, Mylor 1 and Fenton Creek 1 gas compositions. No detailed information from other nearby fields is available, although there is potential for the gas to be drier.

4.1.7 **Flow Rate**

Flow rates used range between 3 MMCFD and 20 MMCFD. Online rate will greatly depend on the length of section perforated. Extended production tests at Mylor and Fenton Creek flowed at 25mmcf/d on a 3/4" choke and 17mmcf/d on a 1/2" choke respectively. Penryn 1 came online at about 15TJ/day.

4.2 Location

The proposed Penryn 2 is located about 1.9km east of the Penryn 1 well head. The site is located within an intensive dairy area and utmost attention needs to be given to environmental and landholder issues

WELL NAME: PENRYN 2

LOCATION: 4 km S of the Timboon township and 1.9km ENE of Penryn
Latitude: 38° 31'20" S (surface location)
Easting: 672488 E
Longitude: 142° 58' 43" E (surface location)
Northing: 5734382N
Seismic Reference: Line 3285 Heytesbury 3D Survey
CDP 10323 for target location
Easting: 672484.39 m E (target location)
Northing: 5734330.90m N (target location)

LICENCE: PL 5

COST ESTIMATE: P&A \$1.277k
C&S \$1.406k

**INPUT and APPROVED
BY PROJECT TEAM:**

_____ DATE: / /
Project Leader/Team Leader

APPROVED BY:

_____ DATE: / /
Manager, Field Production & Development - SA

_____ DATE: / /
Manager, Exploration & Development - SA

_____ DATE: / /
Staff Petroleum Engineer

RETURN TO EXPLORATION & DEVELOPMENT - SA WHEN SIGNED

ATTACHMENT 1

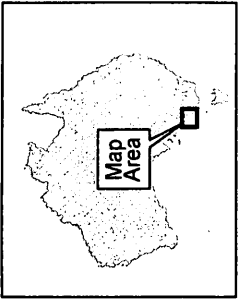
GEOPHYSICAL PROGNOSIS

ATTACHMENT 1

GEOPHYSICAL PROGNOSIS

Formation	Mylor 1					Proposed Penryn 2					Iona 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)
Mepunga Fm	382	357		1869		314	293			1869		169	147		1740	
			259		2398			260		2398				249		2092
Pember Mudst	598	616		2060		531	554			2085		407	396		1946	
			69		1624			81		1624				90		2951
Pebble Pt Fm	683	685		2006		631	635			2012		468	486		2077	
			51		2757			48		2757				52		3467
Paaratte Fm	720	736		2044		666	683			2051		498	538		2161	
			403		2732			411		2732				360		2441
Skull Ck Mudst	1015	1139		2244		967	1094			2263		793	898		2265	
			147		3459			175		3459				131		2944
Nullawarre GrnSd	1100	1286		2338		1068	1269			2376		882	1029		2333	
			125		3731			134		3731				95		2794
Belfast Mudst	1167	1411		2418		1140	1403			2462		950	1124		2366	
			158		3010			170		3010				58		2578
Waarre Sst	1272	1569		2467		1253	1573		+/- 20m	2511		995	1182		2376	
			90		2813			91		2813				85		2982
Eumeralla Fm	1336	1659		2484		1318	1665			2526		1052	1267		2409	
			160					100						249+		
TD (m)		1819					1765						1516			

Santos Otway Basin - Victoria PL 5 Penryn 2 Location Map



Proposed
Penryn 2

PL 7
Fenton Creek

Tregony
Tregony Creek 1

PL 4
Mylor

Mylor 1

PL 5
Penryn

Penryn 2

Braeside 1

Wild Dog Road 1

Blackwood 1

North Paaratte 1

5

2

Vogel 1

Waarre 1

Namgib 1

3

Iona

Heytesbury Gas
Facility

Prof Campbell 1

Grumbly 1

Vaughan 1

Dunbar 1

3

Dunbar East 1

Wallaby Creek
2

Wallaby Creek

Langley 1

2

Paaratte 1

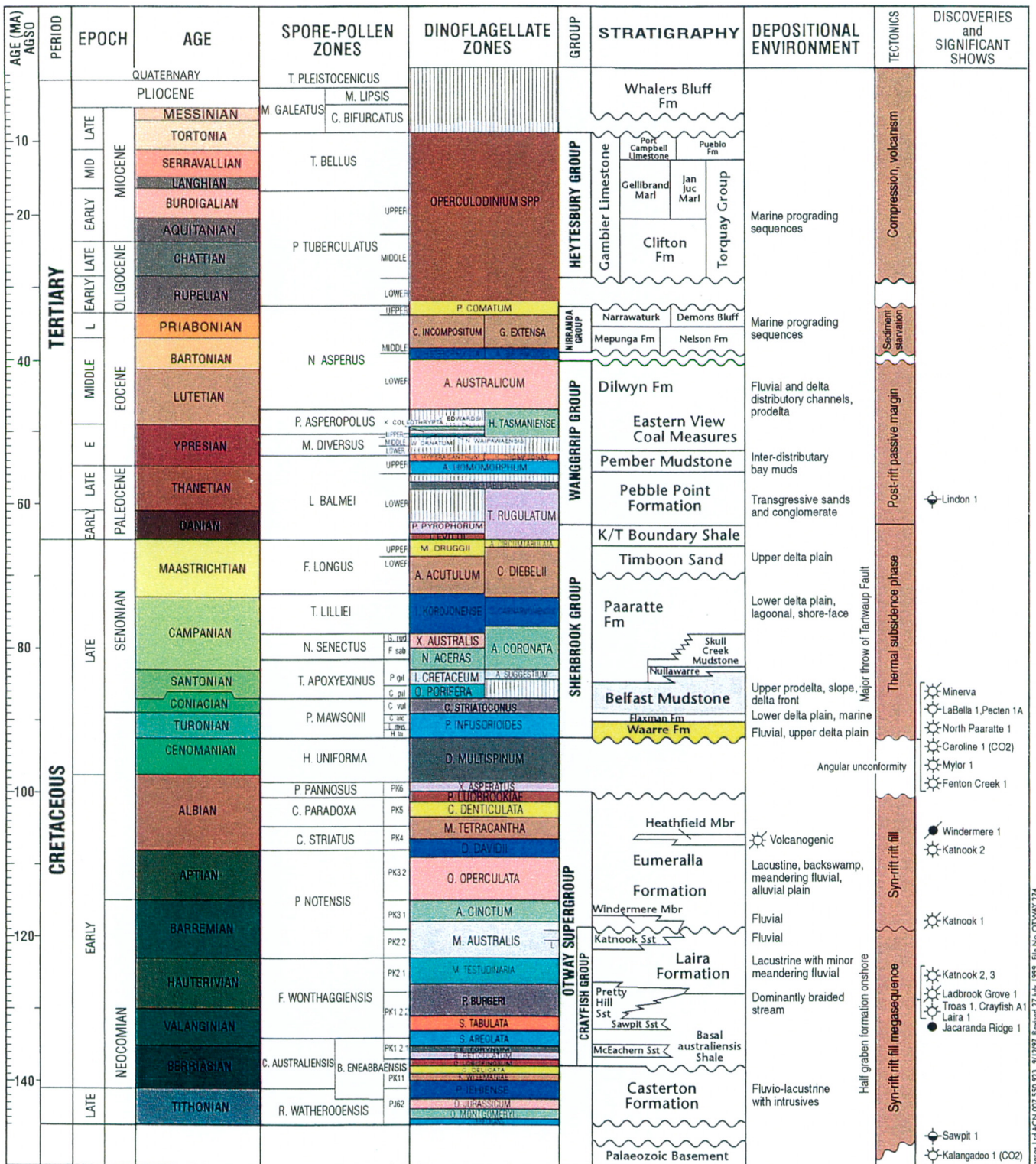
PEP 153

PEP 154 A

Figure 1

OTWAY BASIN STRATIGRAPHIC COLUMN

Santos



*Penryn 2 Structure Top Waarre Sand
Full Offset Amplitude on
TWT Contour Map*

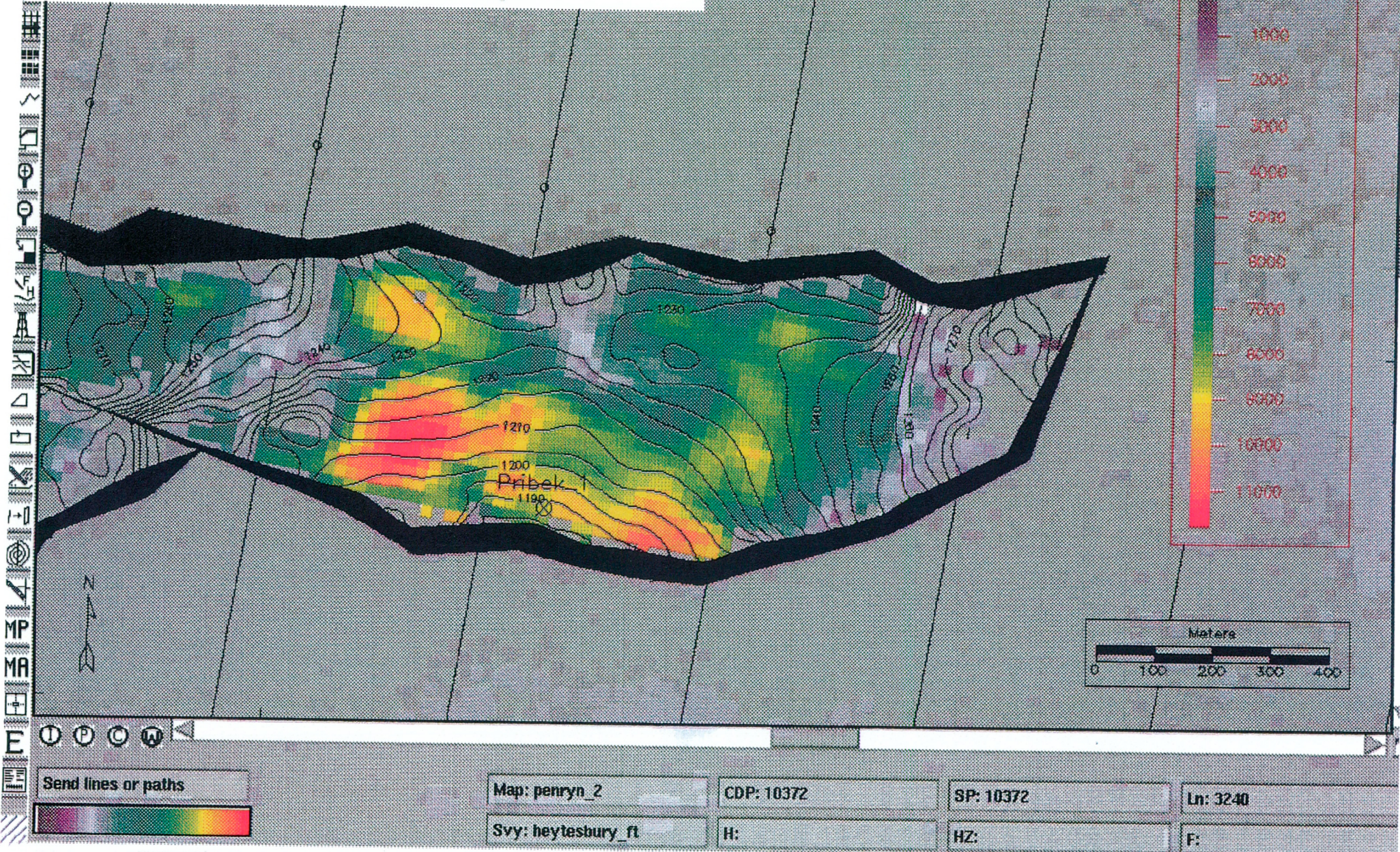
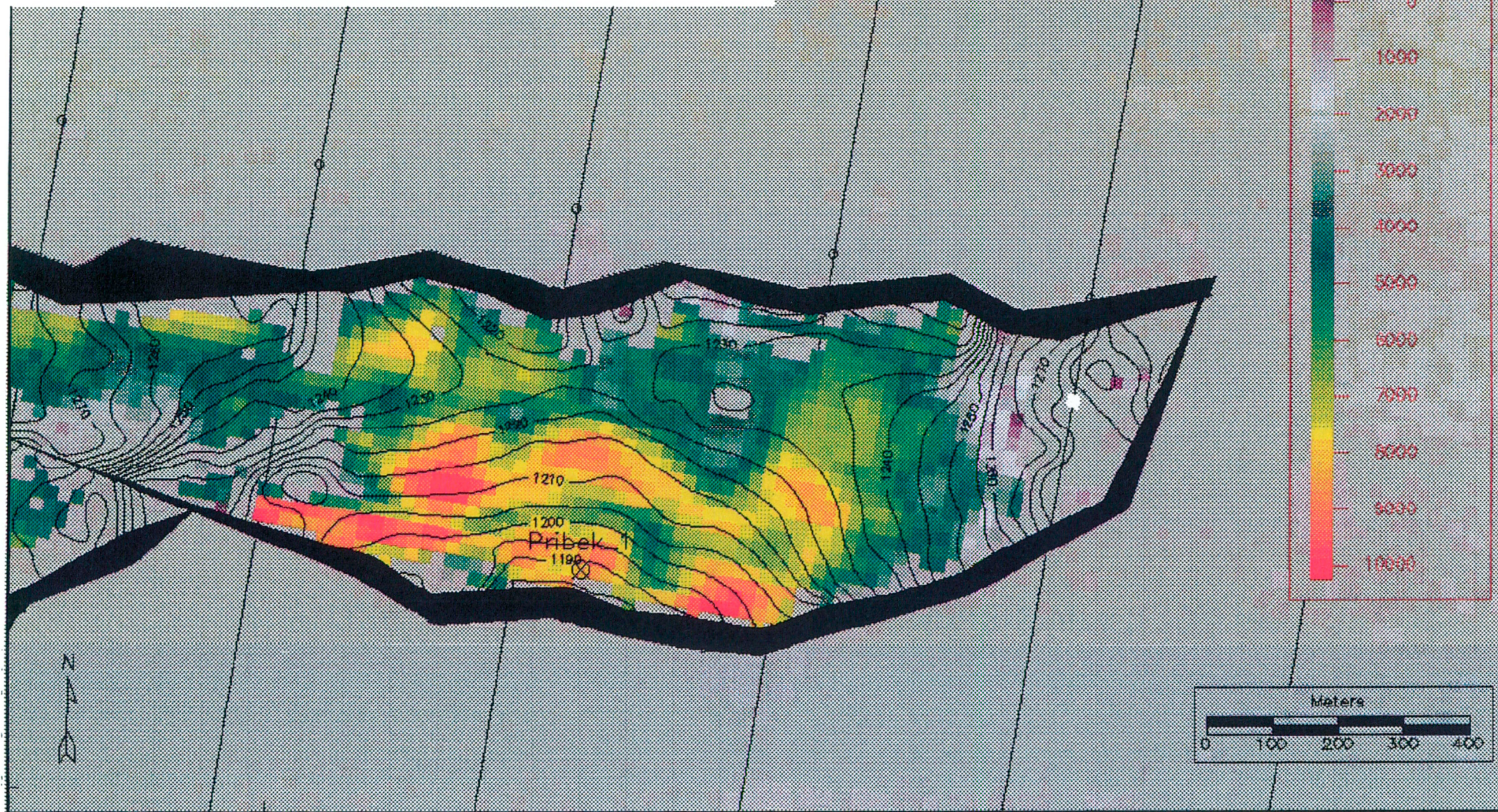


Figure 3

909014 015 PE909014_color 003

*Penryn 2 Structure Top Waarre Sand
Near Offset Amplitude on
TWT Contour Map*

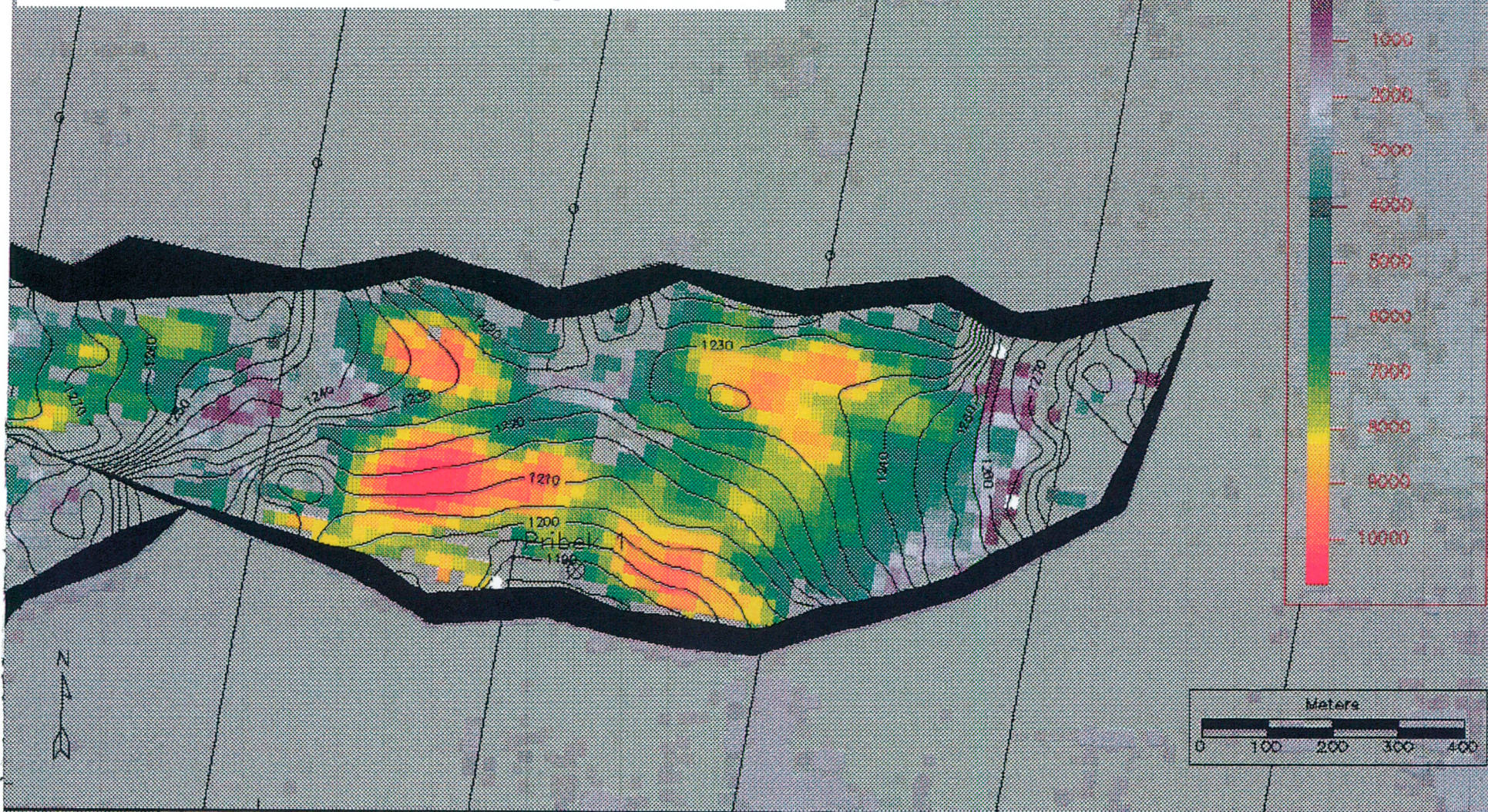


Send lines or paths	Map: penryn_2	CDP: 10371	SP: 10371	Ln: 3242
	Svy: heytesbury_ft	H:	HZ:	F:

Figure 4

903014 016 PE909014-color004

*Penryn 2 Structure Top Waarre Sand
Far Offset Amplitude on
TWT Contour Map*



909014 017

PE909014-color005

Figure 5

Send lines or paths

Map: penryn_2	CDP: 10372	SP: 10372	Ln: 3247
Svy: heytesbury_ft	H:	HZ:	F:

PENRYN 1



KB : 116.89 METRES
TD : 1822.5 METRES

LICENCE : PPL 5

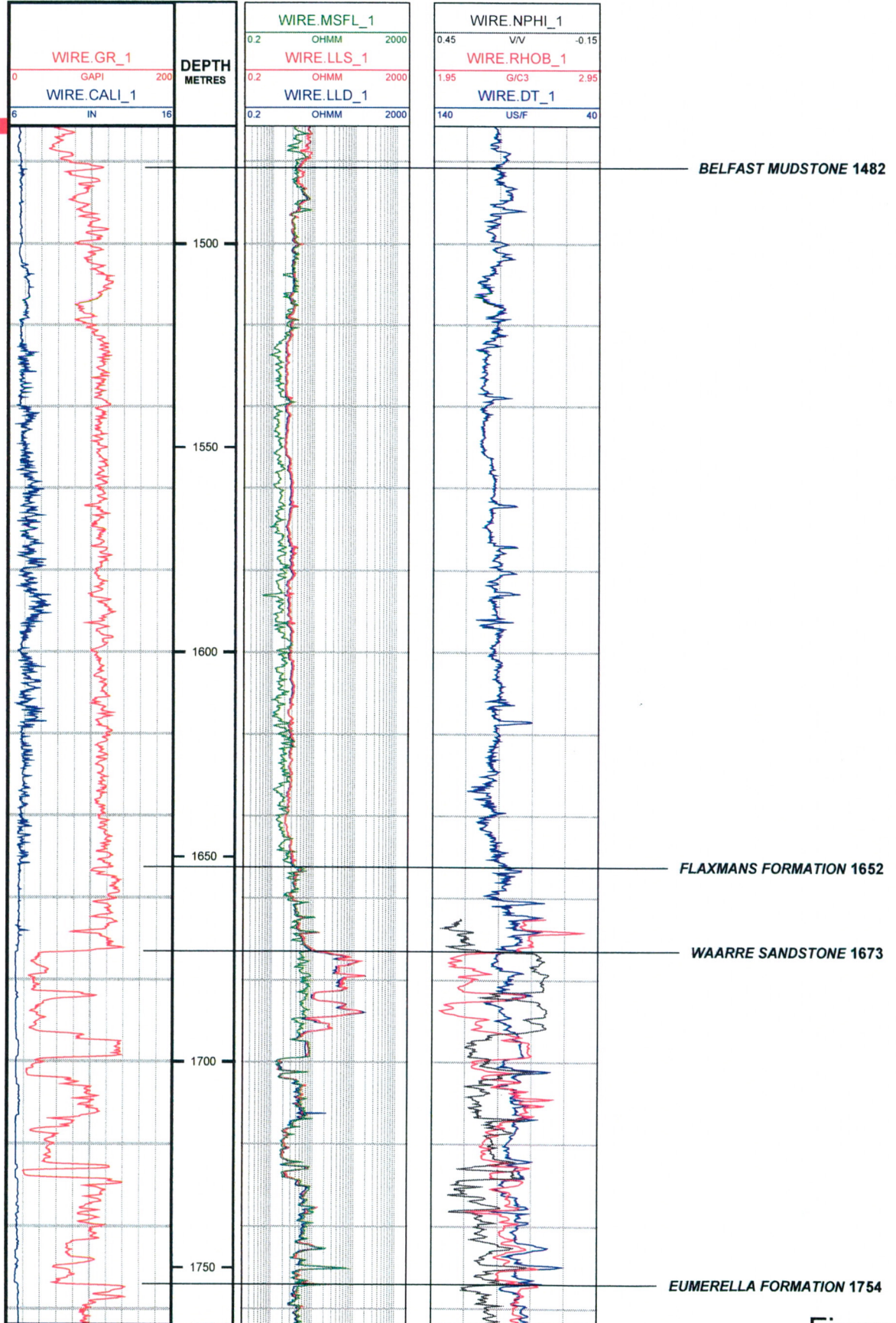


Figure 6

MYLOR 1



KB : 103.2 METRES

LICENCE : PPL 4

TD : 1922.4 METRES

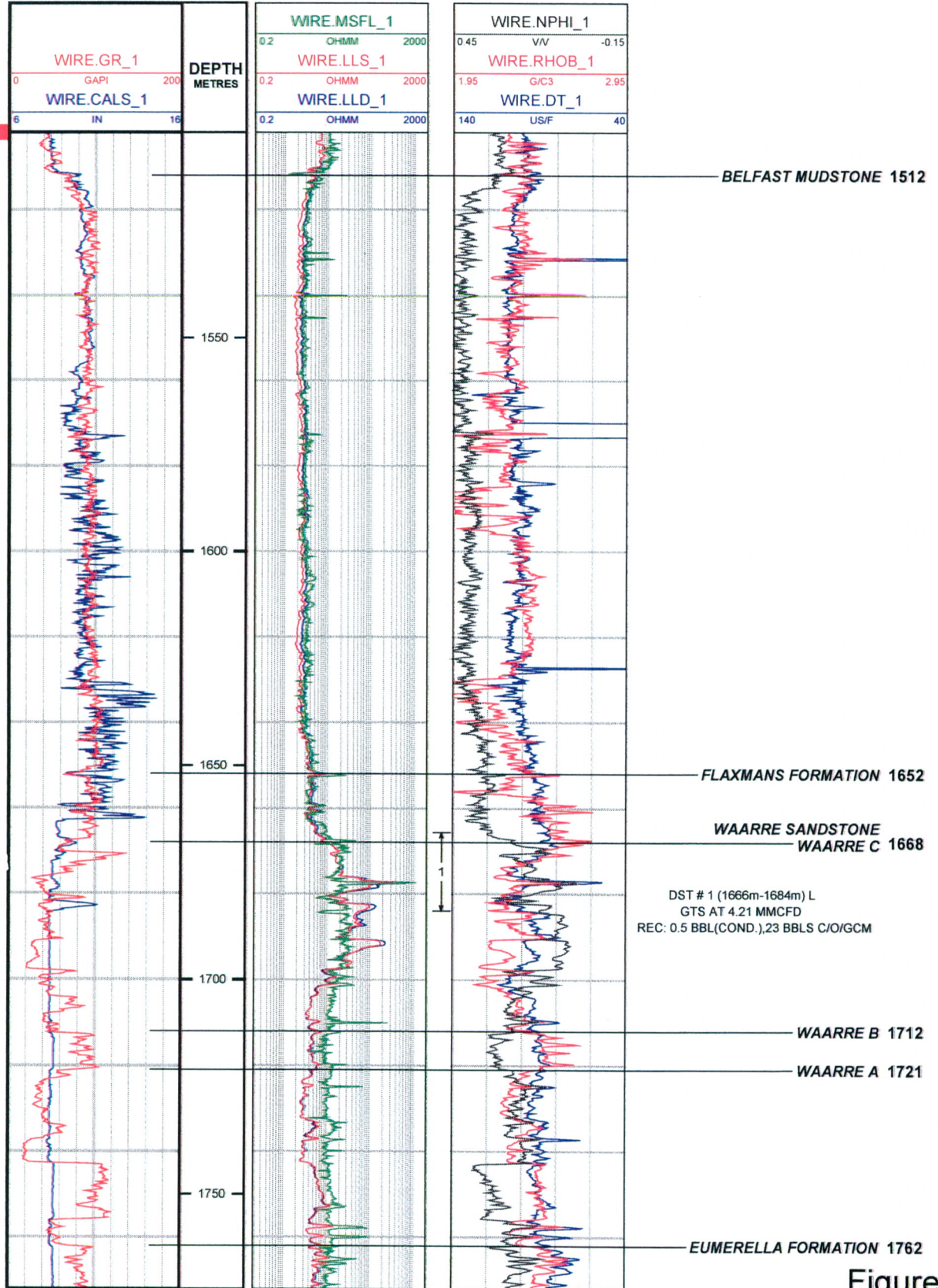


Figure 7

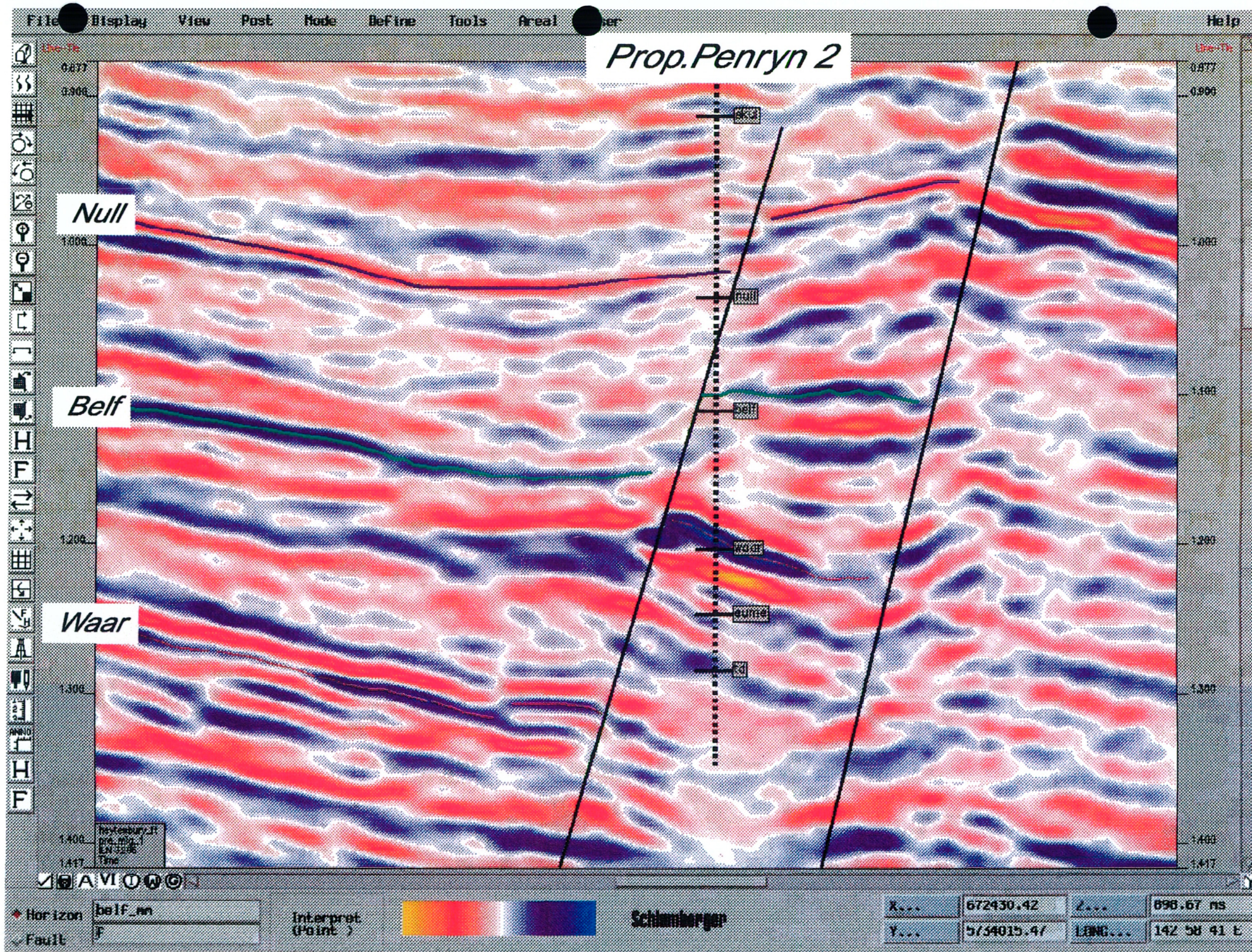


Figure 8

909014 020 PE909014-color008

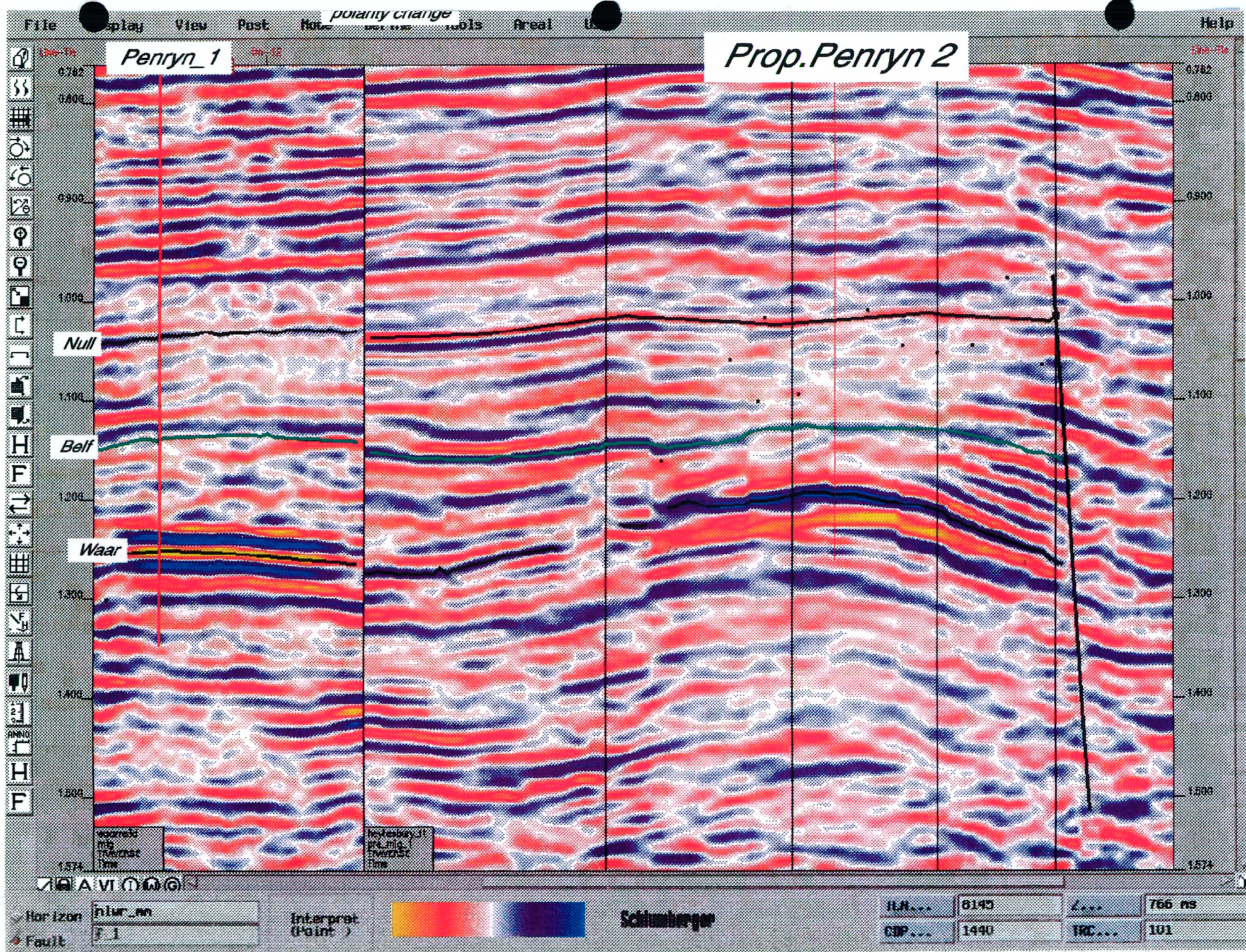


Figure 9

909014 021 PE999914_color009

PE909015

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CONTAINER_BARCODE = PE909014
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BASIN = OTWAY
ONSHORE? = Y
DATA_TYPE = SEISMIC
DATA_SUB_TYPE = ISOCHRON_MAP
DESCRIPTION = Encl.1 Top Waarre Sand Time Map, Scale
1:10000, Datum: GRS 1980, C.I: 5m,
Universal Transverse Mercator
Projection, W1325, PEP/153. Enclosure
1. is contained within "Penryn-2 Well
Proposal Report" (PE909014).
REMARKS =
DATE_WRITTEN = 26-JUN-2001
DATE_PROCESSED =
DATE_RECEIVED =
RECEIVED_FROM = Santos (BOL) Pty Ltd
WELL_NAME = Penryn-2
CONTRACTOR =
AUTHOR =
ORIGINATOR =
TOP_DEPTH =
BOTTOM_DEPTH =
ROW_CREATED_BY = CD000_SW

(Inserted by DNRE - Vic Govt Mines Dept)

PE909016

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BASIN = OTWAY
ONSHORE? = Y
DATA_TYPE = SEISMIC
DATA_SUB_TYPE = ATTRIBUTE_MAP
DESCRIPTION = Encl.2 Amplitude Map at Top of Waarre
Sand over Penryn field, Scale 1:10000,
Datum: GRS 1980, Universal Transverse
Mercator Projection, W1325, PEP/153.
Enclosure 2. is contained within
"Penryn-2 Well Proposal Report"
(PE909014).
REMARKS =
DATE_WRITTEN = 26-JUN-2001
DATE_PROCESSED =
DATE_RECEIVED =
RECEIVED_FROM = Santos (BOL) Pty Ltd
WELL_NAME = Penryn-2
CONTRACTOR =
AUTHOR =
ORIGINATOR =
TOP_DEPTH =
BOTTOM_DEPTH =
ROW_CREATED_BY = CD000_SW

(Inserted by DNRE - Vic Govt Mines Dept)

~~909014 024~~
909014 024

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document.

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ONSHORE? = Y
DATA_TYPE = SEISMIC
DATA_SUB_TYPE = HRZN_CONTR_MAP
DESCRIPTION = Encl.2 Top Waarre Sand Depth Map, Scale
1:10000, Datum: GRS 1980, C.I: 5m,
Universal Transverse Mercator
Projection, W1325, PEP/153. Enclosure
3. is contained within "Penryn-2 Well
Proposal Report" (PE909014).

REMARKS =
DATE_WRITTEN = 26-JUN-2001
DATE_PROCESSED =
DATE_RECEIVED =
RECEIVED_FROM = Santos (BOL) Pty Ltd
WELL_NAME = Penryn-2
CONTRACTOR =
AUTHOR =
ORIGINATOR =
TOP_DEPTH =
BOTTOM_DEPTH =
ROW_CREATED_BY = CD000_SW

(Inserted by DNRE - Vic Govt Mines Dept)

PE909018

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document.

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CONTAINER_BARCODE = PE909014
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BASIN = OTWAY
ONSHORE? = Y
DATA_TYPE = WELL
DATA_SUB_TYPE = WELL_CORRELATION
DESCRIPTION = Encl.4 Stratigraphic Cross Section,
Fenton Creek-1, Mylor-1, Penryn-1,
Namgib-1, W1325, PEP/153. Enclosure 4.
is contained within "Penryn-2 Well
Proposal Report" (PE909014).
REMARKS =
DATE_WRITTEN = 14-JUN-2001
DATE_PROCESSED =
DATE_RECEIVED =
RECEIVED_FROM = Santos (BOL) Pty Ltd
WELL_NAME = Penryn-2
CONTRACTOR =
AUTHOR =
ORIGINATOR =
TOP_DEPTH =
BOTTOM_DEPTH =
ROW_CREATED_BY = CD000_SW

(Inserted by DNRE - Vic Govt Mines Dept)