T/RL1
Bass Basin, Tasmania

Yolla 3D
2000 Reprocessing
&
Interpretation Report

Origin Energy Resources Ltd
Author: Randall Taylor
December 2001

Executive Summary

- The Yolla 3D grid was reprocessed in 2000 with aims of improving image quality and enabling better velocity estimation, thereby forming the basis for more accurate gross rock volume (GRV) estimation for the Yolla field.

- The reprocessing resulted in significant data quality improvement.

- Data interpretation using attribute volumes such as Variance Cube™ led to improved delineation of features such as dykes and faults.

- Detailed horizon velocity analysis (using seismic gathers loaded into Paradigm Geophysical's "Power 2D" software) produced dense velocity control across the field. The resultant average and interval velocity grids were calibrated to well check-shot data for use in depth conversion. The seismic velocities correlated very closely to the well control, thereby providing confidence in the final depth maps.

- The primary depth conversion technique (P50 case) was an interval velocity approach using map-migration. P10 and P90 depth maps were created by estimating the percentage error in the average velocity away from the well control. Two other depth conversion methods were also performed, (average velocity depth conversion and regular interval velocity depth conversion). These maps produced GRV estimates within the P10 to P90 range.

- A seismic facies classification map for the Top EVCM derived using the Stratimagic™ software showed good correlation with the most likely OWC for this zone, providing independent support for the accuracy of the depth mapping.

Table of Contents

Page No.

APPENDICIES

List of Figures

List of Enclosures

1 INTRODUCTION

The purpose of reprocessing the Yolla 3D seismic data volume was to facilitate decision making for the proposed development of the Yolla gas field in T/RL1 of the Bass Basin, (Figure 1.1). Specifically the aim was to better define the reserves estimate of the field, so that the engineering design of the facilities could commence. Hence, an improved 3D data volume was required to achieve greater certainty in time structure mapping and depth conversion of the main reservoir horizons.

Mapping of the original Yolla 3D data set was constrained by, a) relatively poor image quality of the reservoir horizons and b) uncertainty in the velocities required for depth conversion. Hence the aim of the reprocessing effort was two-fold:

1. Improve the image quality of the reservoir horizons.
2. Reduce the uncertainty in the velocities required for depth conversion.

These objectives were achieved by applying recent advances in seismic processing technology that were not available at the time the data was first recorded, and by preforming detailed horizon-based stacking and interval velocity analysis to provide continuous velocity data over the field.

The report is divided into 4 main sections. Section 2 outlines the reprocessing steps and the reasons for the image quality improvement. Section 3 describes the interpretation and time structure mapping and Section 4 describes the depth conversion methodology and final depth maps. Section 5 discusses amplitude and attribute mapping that was also performed as part of the interpretation.

The resultant depth maps were loaded into a 3D geological model-building package for detailed reserves estimation. This component of the project is discussed in the Yolla Subsurface Development Plan, 2001.

2 YOLLA 3D REPROCESSING

New developments in seismic processing algorithms since the original processing of the Yolla 3D survey in 1993, were thought to be capable of improving the image quality of the main target sands within the mid Paleocene section of the field. Preliminary tests in 1999 on a 2D line extracted from the 3D data supported this view, and hence a decision was made to undertake full reprocessing of the survey. The final reprocessed data set achieved greater attenuation of multiple energy and better imaging of the faults and dykes than the original data, (Fig. 2.1). Overall the new data are a significant improvement on the original.

The reprocessing was conducted by Veritas, (who also processed the original data) in their Perth processing centre. A full report on the reprocessing steps, algorithms used and testing conducted is included in Veritas's reprocessing report, (Appendix 1).

2.1 Processing Sequence

The final processing sequence was as follows:

1. Transcription from SEG-D format
2. Resample to 4msec with anti-alias filter applied
3. Despike and trace editing
4. Spherical divergence correction VVT using regional velocity function
5. FK filter on shots ± 1750 ms with NMO applied
6. WEMA
7. Tau-p deconvolution
8. Adjacent trace summation with partial NMO correction
9. Shot interpolation
10. FK filter on receivers ± 1750 ms with NMO applied
11. Velocity analyses at every 1 km x 1 km interval
12. Radon Demultiple
13. Remove Interpolated traces
14. Flood (3D trace interpolation for missing offsets)
15. 3D Kirchhoff pre-stack time migration on target lines
16. Velocity analyses at every 0.5 km x 0.5 km interval
17. NMO correction using final 0.5 km x 0.5 km vels (Picked and qc'd by Nigel Fisher)
18. Trace Mute applied
19. Stack
20. Shot and Cable corrections
21. Trace interpolation: in-line direction
22. Dechequer
23. TV Filter
24. Expanding AGC

2.2 Key Processing Steps

The main reasons for the improvement in data quality is believed to be the improved de-multiple processes, coupled with the Kirchhoff pre-stack time migration. In effect, it was a cascading of new technologies which allowed the primary events to be better imaged at successive stages of the processing.

There were four processes in particular which lead to improved multiple attenuation. These were:

1. Tau-P decon for better collapsing of short period multiples (not available when original data were processed, X-T decon applied on original data)
2. Wave equation Multiple Attenuation (WEMA) for attacking water bottom multiples (not available when original data were processed)
3. Radon de-multiple for attacking all multiples (superior to the F-K demult applied on original data)
4. careful velocity picking to maximise the multiple attenuation of the stack.

The first three steps allowed better discrimination of primary events during the velocity picking, which meant that the 3D migration was applied with a more accurate velocity field. The overall result was a significantly better imaged data volume. However, in some areas, residual multiple energy and poor penetration of primary energy continues to limit the resolution of the main reservoir events. Around the main volcano, where strong lateral velocity gradients occur, the image quality may be further improved in future by using pre-stack depth migration.

2.3 Additional Attribute Volumes

Three additional attribute volumes were generated to assist the interpretation. These were:

1. near offset volume
2. far offset volume
3. Variance cube™ volume (generated by Schlumberger's variance cube software)

The first 2 attribute volumes were produced to assit the time interpretation and to derive some basic 3D AVO attributes at the top EVCM horizon. The variance volume was used to delineate the dykes and faults, which it did with great clarity.

3 INTERPRETATION

3.1 Horizons Picked

The reprocessed Yolla 3D Seismic Survey was loaded into Schlumberger's Geoframe software and interpreted using the IESX and Geoviz modules. Eight horizons were interpreted as shown in Figure 3.1 and Table 3.1. The upper horizons were used for the interval velocity depth conversion.

Table 3.1

Horizon Interpreted	Seismic Character	Purpose
Water Bottom (WB)	Strong Peak	Interval velocity Depth Conversion
Lower Mid Miocene (LMM)	Strong Peak	Interval velocity Depth Conversion
Top Volcano (V)	Strong Peak	Interval velocity Depth Conversion
Base Volcano (BV)	Strong Peak	Interval velocity Depth Conversion
Near top EVCM	Strong Trough	Secondary Target
Middle M.Diversis (MDIV)	Strong Peak	Used to constrain picks on deeper horizons
Top 2718 Sand	Weak Peak	Uppermost Sand of the main reservoir section
Top 2809 Sand	Weak Peak	Most prominent event within Main Reservoir section

3.2 Well Ties

Synthetic seismograms were generated with the "Geoframe Synthetic" software and used to tie the well data into the 3D grid. The seismic ties are fair and are demonstrated in Figures 3.2 and 3.3. A composite traverse between the wells shows the tie of the Gamma ray logs to the seismic data (Fig 3.3).

3.3 Time Structure Mapping

Time structure maps were produced for all horizons shown in Table 3.1. Picks for the main target horizons were interpreted on every 5th inline, and cross-lines were interpreted as required. Manual picks on the upper, more continuous horizons were made at sufficient density to control the auto-picker. Auto-picking was used to fill in the remaining lines in the 3D grid. Time picks for the 2809 sand to the north of the field have a greater uncertainty due to a deterioration in data quality, however this region is outside the area of the gas accumulation. Time maps for most horizons are shown in Figures 3.5 to 3.10, and for the main three target horizons in Enclosures 1-4. Note that a second time map of the 2809 sand is included that extends to the south beyond the 3D grid. The purpose of including this map is to delineate the full extent of the Yolla South closure. It was produced after the main interpretation and depth conversion was performed, and includes time picks from several 2D lines that extend south of the 3D survey area.

3.4 Igneous Features

3.5 Main Volcano

This feature forms a prominent circular time high on most mapped horizons. It is about 3 km NE of the main Yolla fault block, and had been expected to influence the acoustic velocities in a radius at least as far as the main fault block. This is proven to be the case, and therefore it has a significant influence on the depth conversion, as will be demonstrated in section 4.

3.6 Dykes and Sills

The Yolla 3D region is intersected by a number of prominent dykes and several smaller ones that disrupt the stratigraphy. These features are prominent on the variance-cube time-slices, on which they can be seen to strike approximately N-S, (Figure 3.11). The dykes are interpreted to be the primary source of the mid-Tertiary volcanism and also to be the source of a number of sills that have intruded the Eastern View Coal Measure sequence, (eg. as shown on Figure 3.1). Several smaller dykes are interpreted to intersect the fault block containing the gas reservoirs. These may be partial barriers to the transmissibility of gas and have therefore been included in the interpretation and subsequent reservoir modelling. A horizon-time slice through the variance cube volume was used to help verify the extent of some of the smaller dykes interpreted in the main fault block, (Figure 3.12).

4 DEPTH MAPPING

4.1 Methodology

As shown in Figure 3.1, a prominent volcano lies immediately adjacent to the Yolla Gas field. This feature, together with a number of dykes and sills, has a major influence on seismic velocities over the structure. The time depth curves from the check-shot surveys of Yolla 1 and 2 show a strong divergence, indicating that the interval velocities are highly laterally-variant, (Figure 4.1). It is for this reason, together with the sparse well control, that a horizon-based velocity analysis approach was taken to the depth conversion.

CMP gathers from 33 2D lines were extracted from the 3D survey and used for horizon based stacking and interval velocity analysis. Twenty in-lines and 13 cross-lines were extracted. The gathers had all pre-processing steps applied, up to but excluding DMO. They were loaded into Paradigm Geophysical's "Power2D" software to perform the analyses.

4.2 Horizon Based Velocity Analyses

Both Horizon Stacking Velocity Analysis (HSVA) and Interval Velocity Analysis (IVA) were used to derive velocity information for depth conversion. The HSVA velocities were used for an average velocity depth conversion and the IVA velocities were used for an interval velocity depth conversion.

Horizon Stacking Velocity Analysis

HSVA is simply regular stacking velocity analysis applied along an interpreted time horizon. The analysis is done for every CMP at the time of the interpreted horizon so that a continuous velocity profile may be interpreted. HSVA analysis was done for the EVCM and 2718 horizons along the 33 2D lines extracted from the 3D survey. The horizon velocity picks were then gridded to create horizon stacking velocity maps. The maps were then scaled to tie the average velocities at Yolla 1 and 2. An average velocity map of the 2809 sand was also created in this way by scaling the 2718 map to tie the 2809 average velocities. This is a valid practice because the 2718 and 2809 events are only two cycles apart on the seismic and will therefore have almost identical stacking velocities. The subsequent average velocity maps are considered reliable, but are likely to be less accurate than the interval velocity method close to major faults, due to the inherent smoothing in this approach. Examples of the HSVA analysis along inline 541 are shown in Figure 4.2.

Interval Velocity Analysis

IVA is akin to HSVA but computes the semblance for a range of velocities in a target layer defined by two interpreted horizons. It is a layer stripping process that builds up a velocity model for successive layers from the top down. Ray-tracing is used to account for non-hyperbolic move-out. Its ability to derive the velocity field for a given layer relies on the accuracy of the velocity field derived in the overlying section. The method employed was the coherency inversion technique, as implemented in Paradigm Geophysical's "Power2D" module.

IVA was applied to the five layers bounded by the horizons shown in Figure 3.1. This was done for each of the 33 2D lines extracted from the 3D survey. For each successive layer, the interval velocity semblances on all lines were interpreted simultaneously, to produce a consistent grid of raw velocity picks, before proceeding to analyse the next layer. This was an important step as it minimised any systematic line to line errors. Examples of the IVA analysis along inline 541 are shown in Figure 4.3.

After this step, the raw interval velocity for each layer was scaled to tie the interval velocity at each well (including Bass 1 for the shallower layers) as defined by the check-shot surveys in the wells. This calibration step showed that the accuracy of the horizon based approach to velocity analysis was very good, thereby providing confidence in the final depth conversion results. This aspect is discussed more full in a paper presented at the ASEG 2001 Conference, (Taylor, 2001)

4.3 Depth Conversion

The main method of depth conversion was an interval velocity approach using map-migration to convert successive layers to depth, (Figures 4.4 to 4.10 & Enclosures 5 to 7). The maps produced using this technique were the P50 case for volumetric estimates. A vertical-stretch type interval velocity depth conversion was also produced, (ie interval velocities without map-migration). These maps were very similar to the P50 maps. A third depth conversion using average velocities based on the HSVA velocity picks was also produced but is regarded as the least accurate because of a tendency to overly smooth velocities across the faults.

All velocity maps were calibrated to check-shot velocities in the wells. For the upper horizons the well Bass 1 was included together with Yolla 1 and 2. For each layer, the seismically derived velocities were scaled by a constant factor to approximately tie the check-shot velocities, then map-migrated to depth. A hand contoured mistie map was then used to flex the grids to exactly tie the wells.

The 2809 Sand depth map that includes the Yolla South feature, (encl 8), was generated by extending the average velocity contours (back-calculated from the map-migration depth conversion), in accordance with the time map outside the 3D survey limits. An approximate 2755 sand depth map has also been generated by phantoming up from this map using a smooth isopach derived from the well data, (encl.9).

The overall effect of the volcano on the velocity field can be seen by examining the final average velocity map produced by dividing the final depth conversion of the 2809 sand by the two-way-time map, (Figure 4.11). It shows that the volcano has a large bearing on the velocities with the average velocity decreasing in a concentric manner away from the centre of the volcano. This is a reasonably plausible given the expected effect of volcanic activity and is therefore taken as support for the veracity of the depth conversion.

4.4 Depth Uncertainty

For each horizon, all methods of depth conversion produced fairly similar maps. The average velocity derived depth maps had a slightly larger closure at the top EVCM (Figure 4.12) and a slightly smaller closure at the 2718 and 2809 sands, (Figure 4.13).

To generate upside and low-side cases for the volumetrics, a depth percentage error estimate was determined from the range of velocity picks reasonably interpreted from the HSVA and IVA semblance profiles. This figure was determined to be ± 0.3 % average velocity uncertainty at around 2-3 km from the wells, with zero percent error at the well locations. A percent error map was generated by hand contouring around the wells, (Figure 4.14). A slightly larger gradient in error was contoured in the direction of the volcano.

Upside (P10) and low-side (P90) depth maps for the 2809 sand were produced by applying the uncertainty map to the final 2809 sand depth map. These are shown as Figures 4.15 and 4.16. Note that all three methods of depth conversion produced maps within the P10 to P90 range.

5 AMPLITUDE & ATTRIBUTE MAPPING

Several amplitude maps were extracted from the top EVCM TEV4 horizon to help define the areal extent of hydrocarbons in this unit. The maps produced were instantaneous amplitudes extracted from the full offset volume, the far offset volume, and the near offset volume, (Figures 5.1 to 5.3). The difference between the near and far offset amplitudes was computed to approximate the AVO gradient, (Figure 5.4).

Stratimagic™ was also used to generate a seismic facies classification map about the EVCM horizon, (Figure 5.5). This software uses neural network technology to "classify" traces in a given window on the basis of wave shape. In this case the window used was 60 ms, centred on the horizon.

These maps all display a degree of correlation to the depth structure contours. However, the seismic facies map clearly has the strongest correlation and in particular correlates well to the most likely OWC contour at 1831.4 m, (Figure 5.5). The consistency between the seismic facies and depth contours is considered to be evidence in support of the accuracy of the depth map. Note that the time structure contours do not correlate so well with the seismic facies map.

Overall it is interpreted that the seismic facies approximately correspond to the areal extent of the hydrocarbon reservoir, and support the depth map. More work is required to ascertain whether extra detail such as distinguishing the different extent of the oil and gas pools can be determined from the data. This would be a task to consider once the first development well provides more data on the TEV4 reservoir.

6 REFERENCES

1. Origin Energy Resources Ltd, 2001 Yolla Subsurface Development Plan, 2001, internal company report.
2. Taylor, R. J. 2001, Horizon velocity analysis for depth conversion – A case study, ASEG 2001 Conference Proceedings

Figures

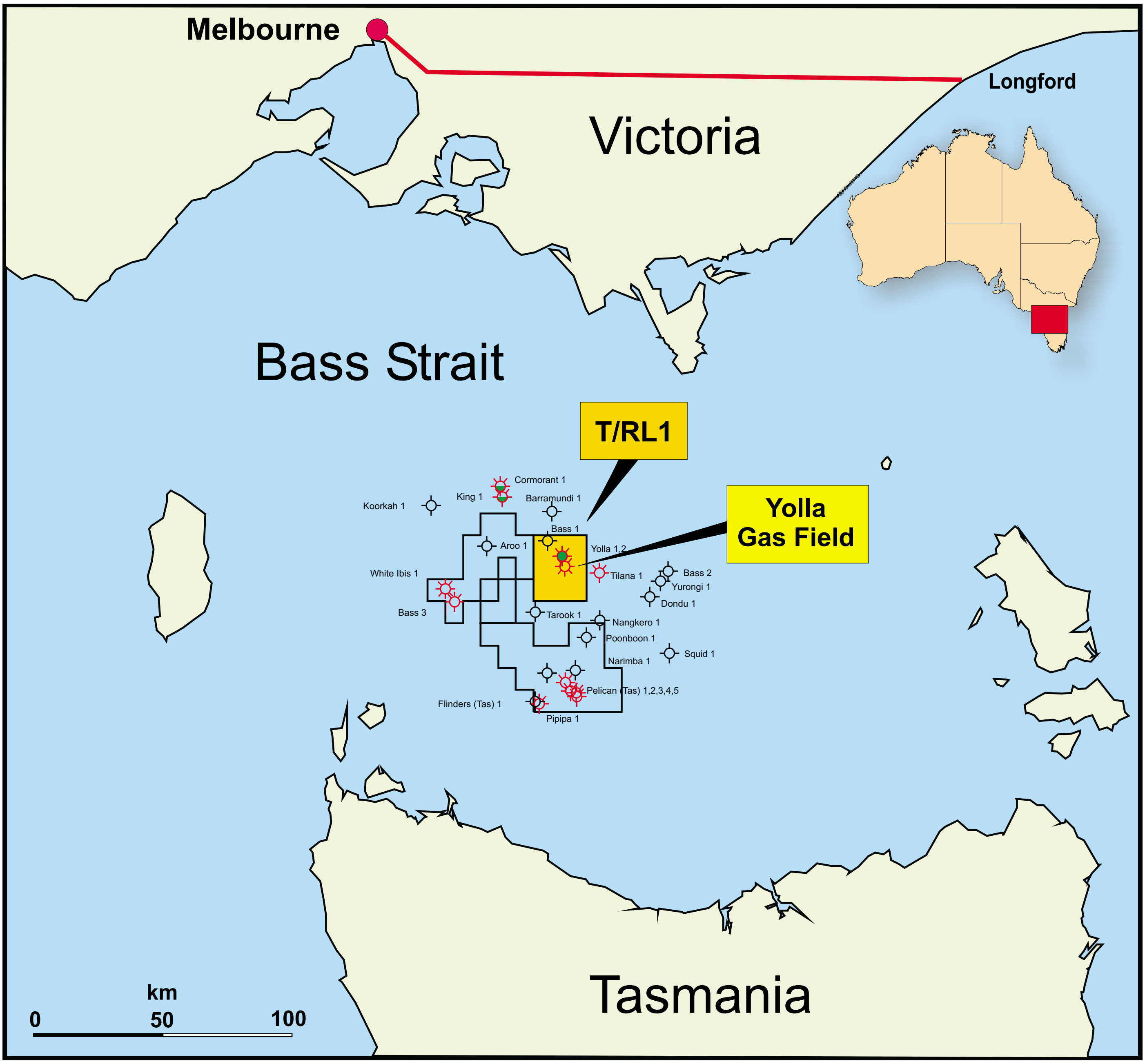

Melbourne
Longford
Victoria
Bass Strait
T/RL1
Yolla
Gas Field
Cormorant 1
King 1
Barramundi 1
Koorkah 1
Bass 1
Aroo 1
Yolla 1,2
White Ibis 1
Tilana 1
Bass 2
Yurongi 1
Dondu 1
Bass 3
Tarook 1
Nangkero 1
Poonboon 1
Squid 1
Narimba 1
Pelican (Tas) 1,2,3,4,5
Flinders (Tas) 1
Pipipa 1
Tasmania
km
0
50
100

Figure 1.1

Comparison of reprocessed (top) and original data (bottom) on Inline 550

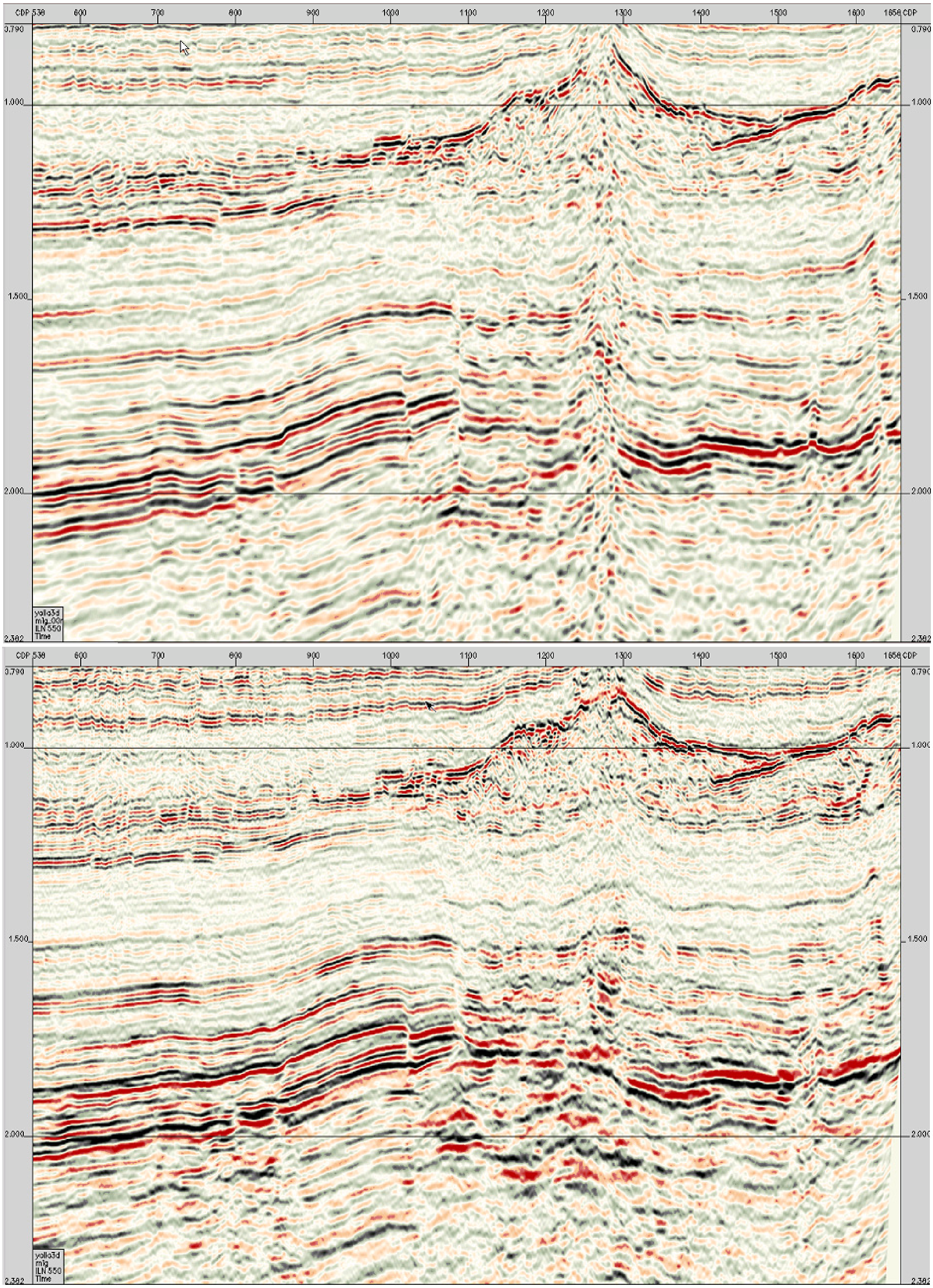


Figure 2.1

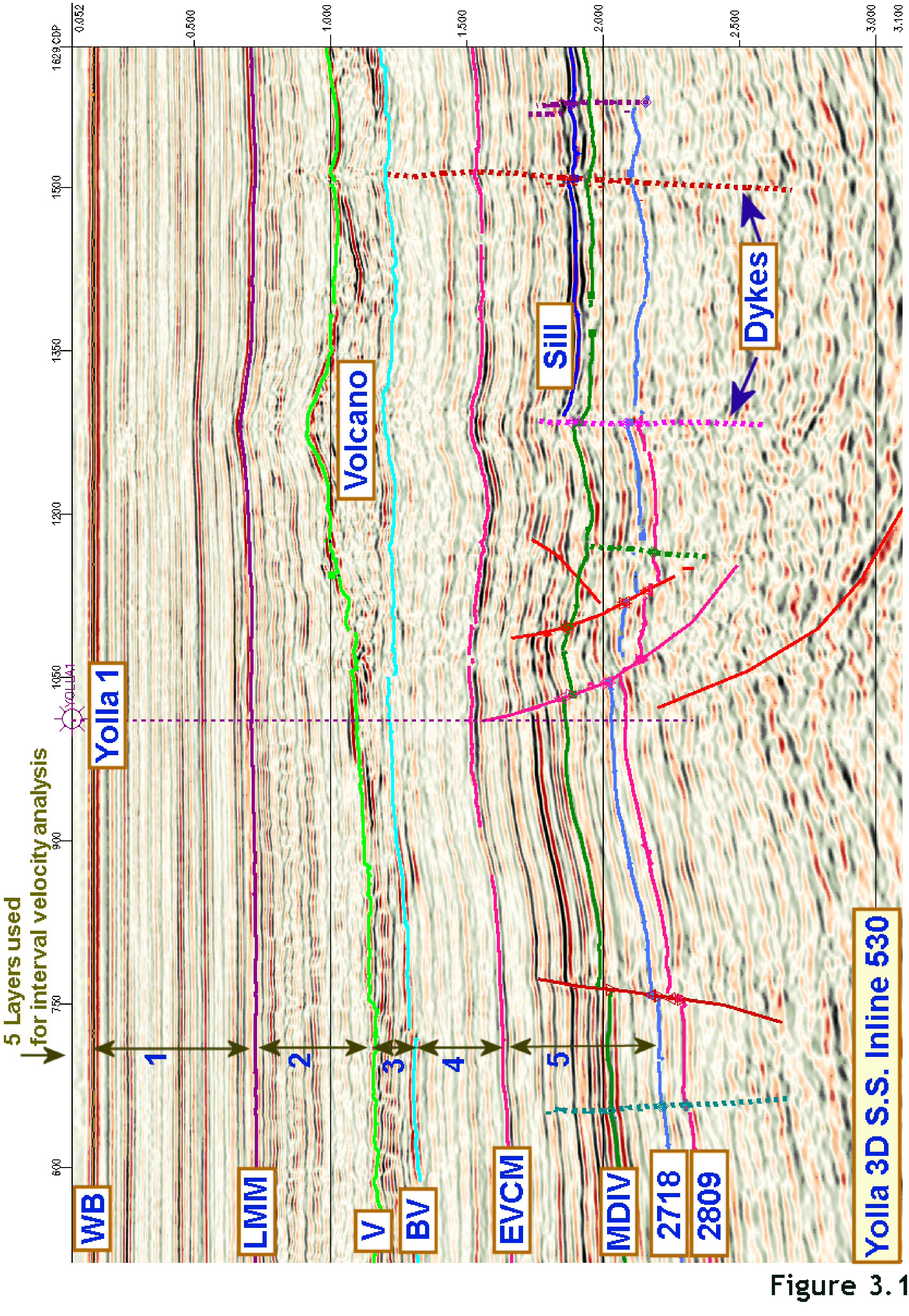
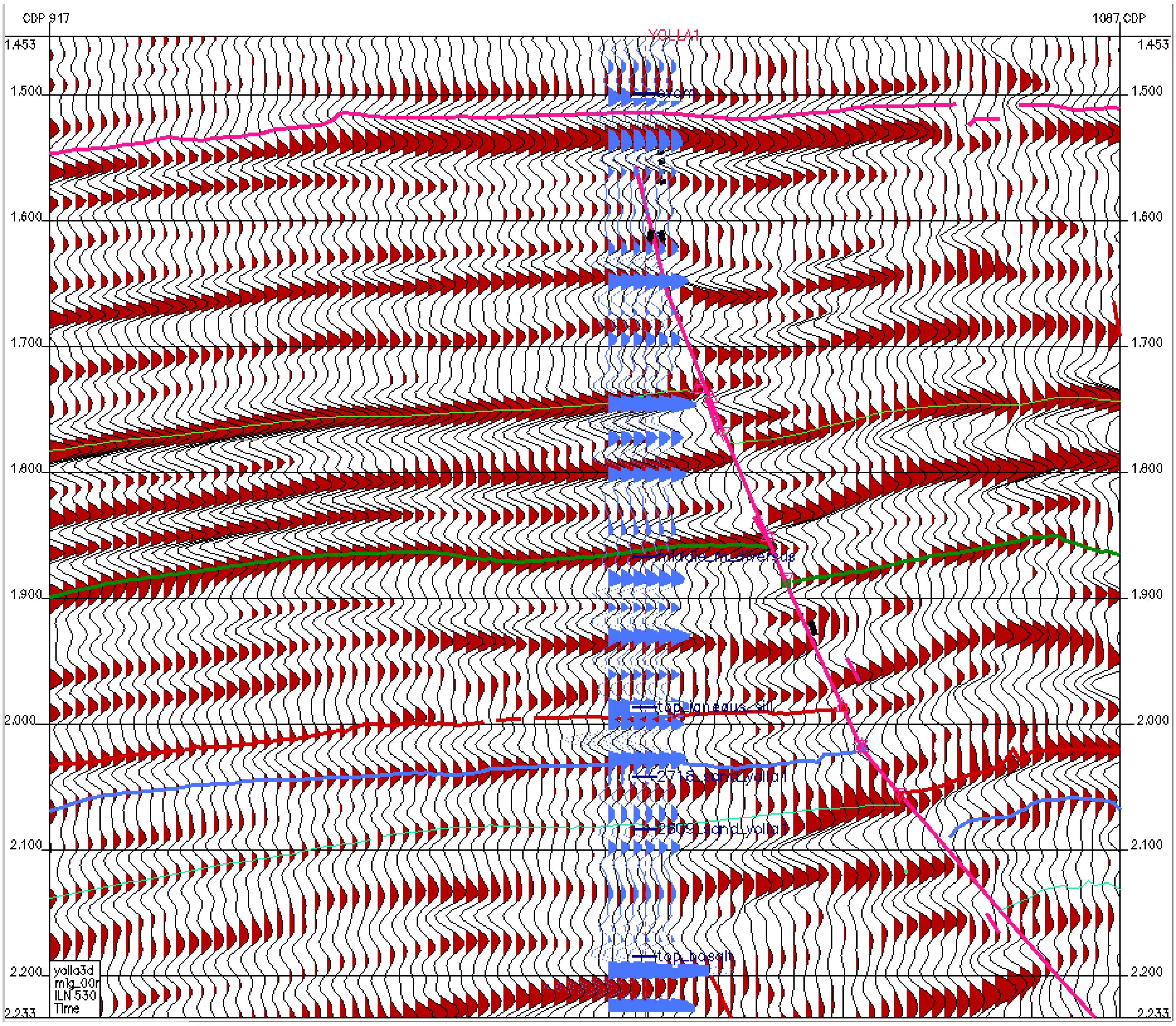

5 Layers used for interval velocity analysis
Yolla 1
Volcano
Sill
Dykes
WB
LMM
V
BV
EVCM
MDIV
2718
2809
1
2
3
4
5
Yolla 3D S.S. Inline 530

Figure 3.1

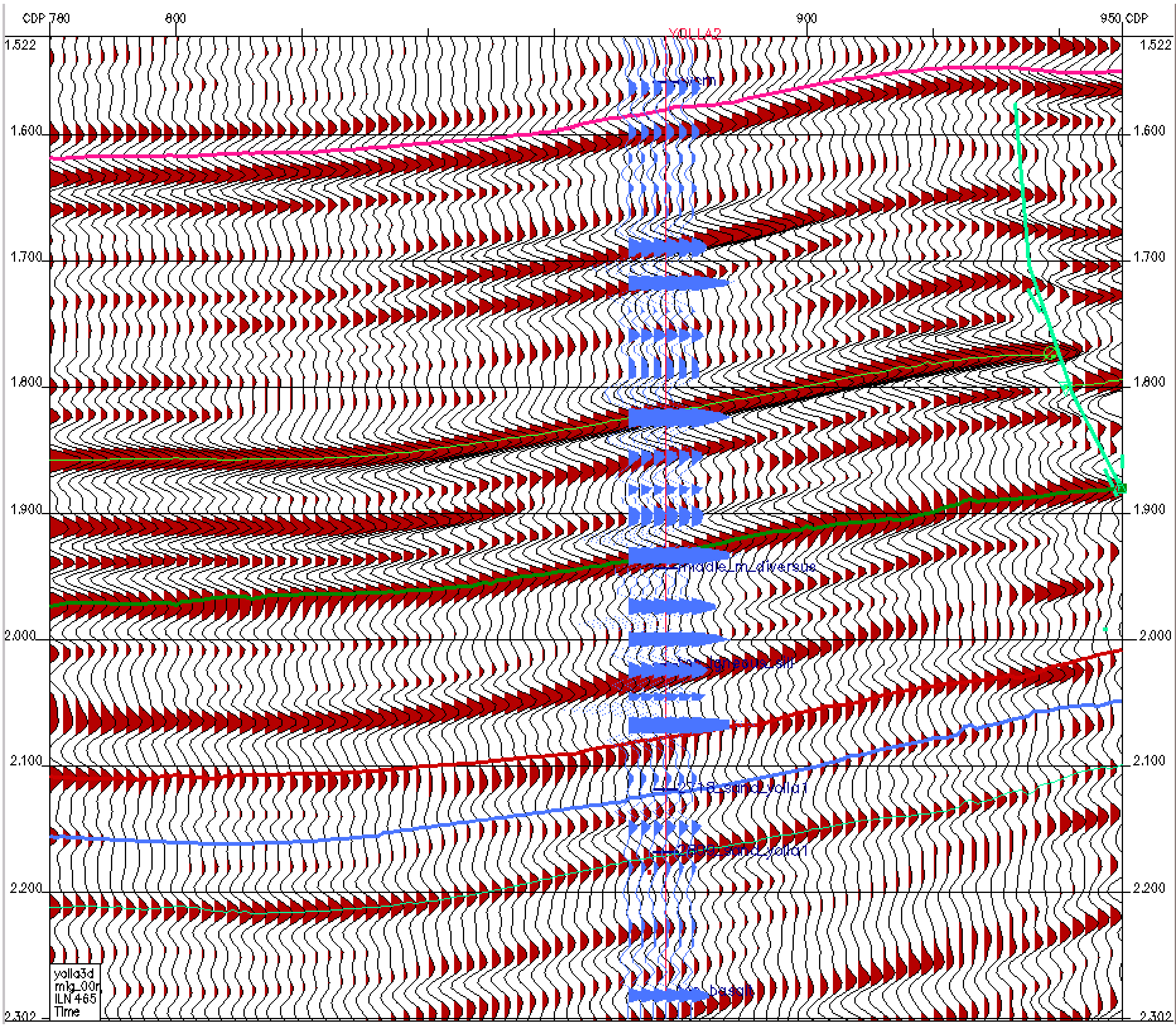
Yolla 1 Synthetic Seismogram



Yolla 3D Seismic Survey Inline 530

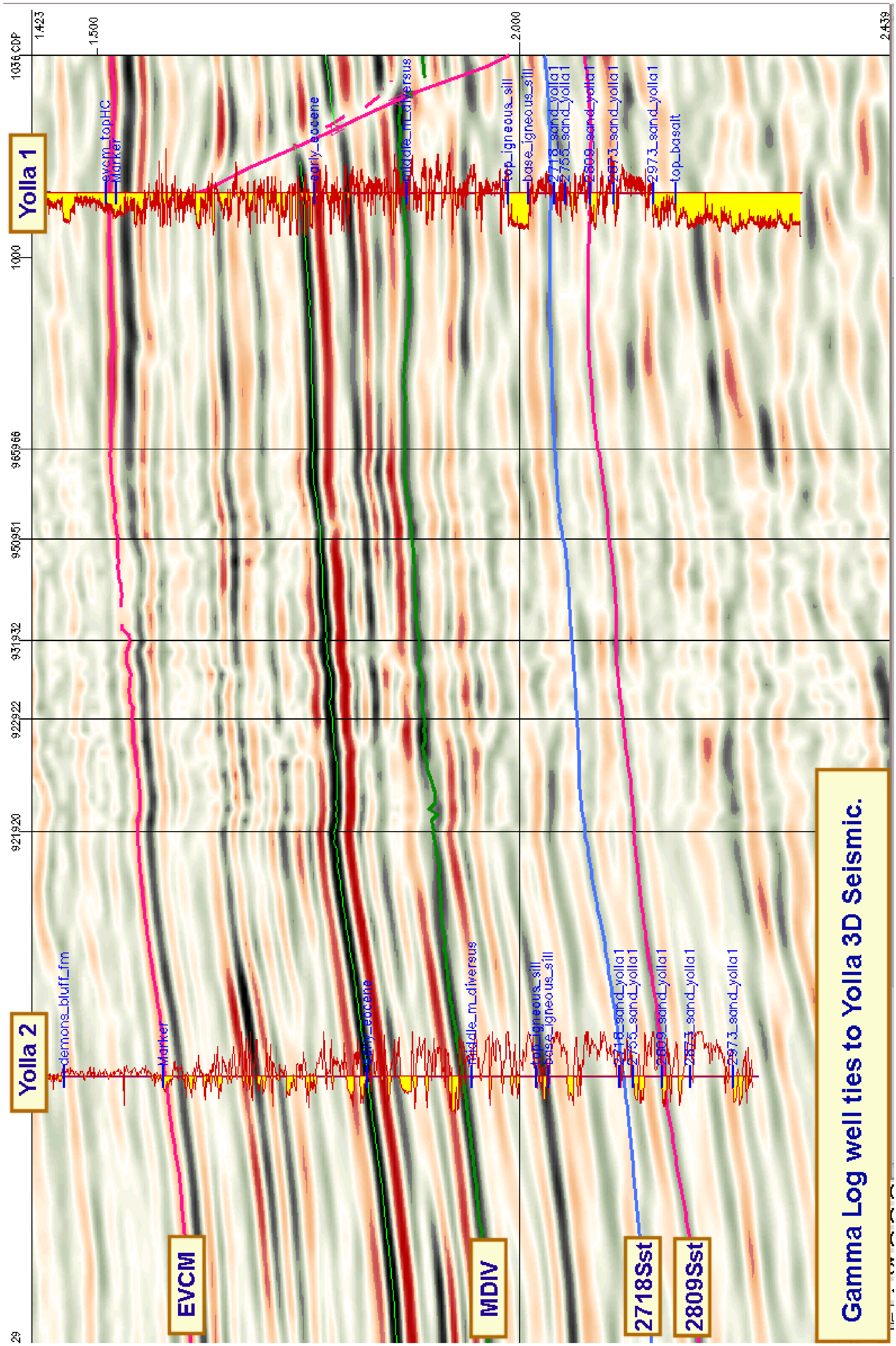
Figure 3.2

Yolla 2 Synthetic Seismogram



Yolla 3D Seismic Survey Inline 465

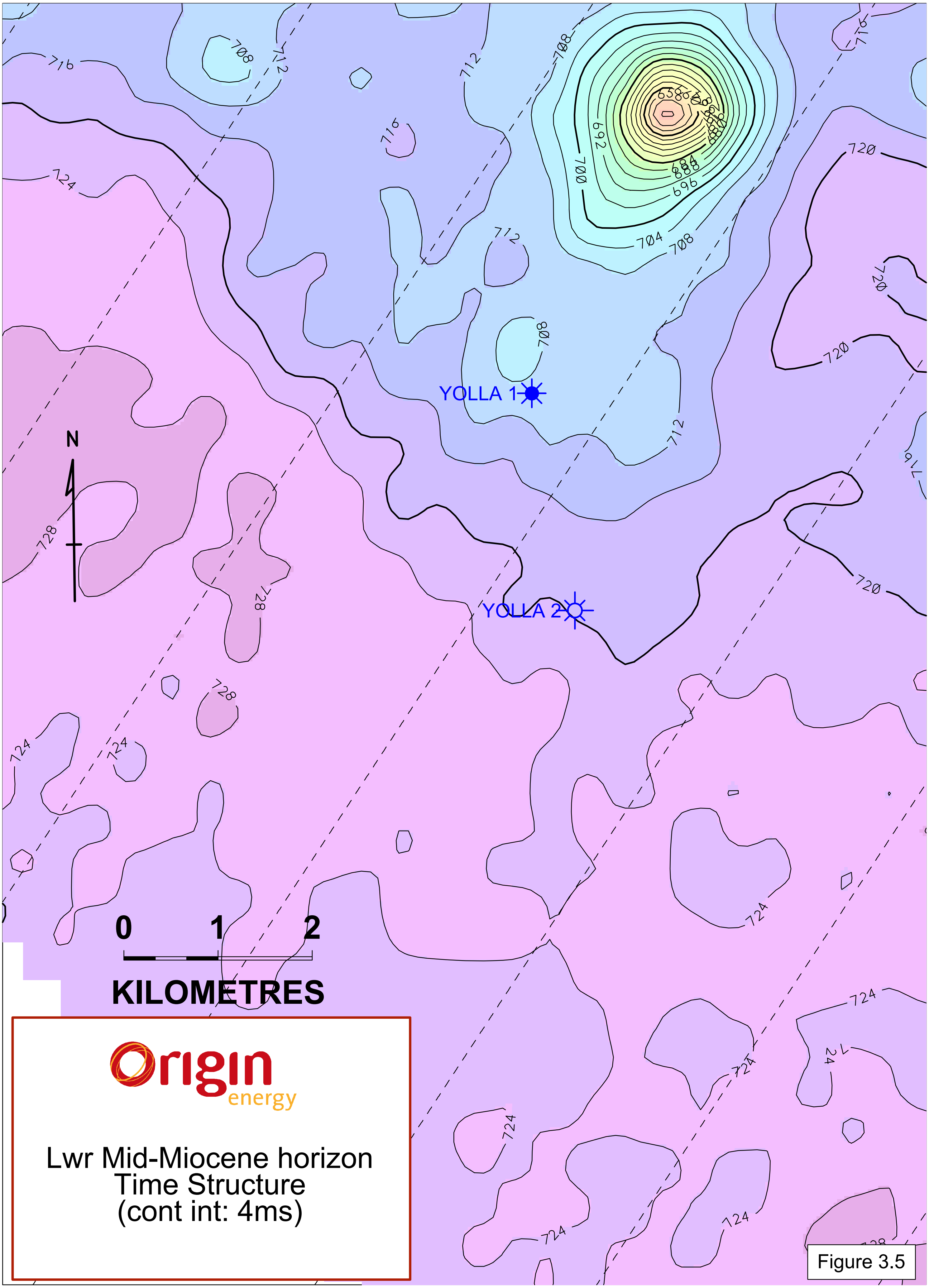
Figure 3.3



Yolla 1
Yolla 2
EVCM
MDIV
2718Sst
2809Sst
Gamma Log well ties to Yolla 3D Seismic.

Figure 3.4

Yolla Gas Field T/RL1



Lwr Mid-Miocene horizon
Time Structure
(cont int: 4ms)

Figure 3.5

Yolla Gas Field T/RL1

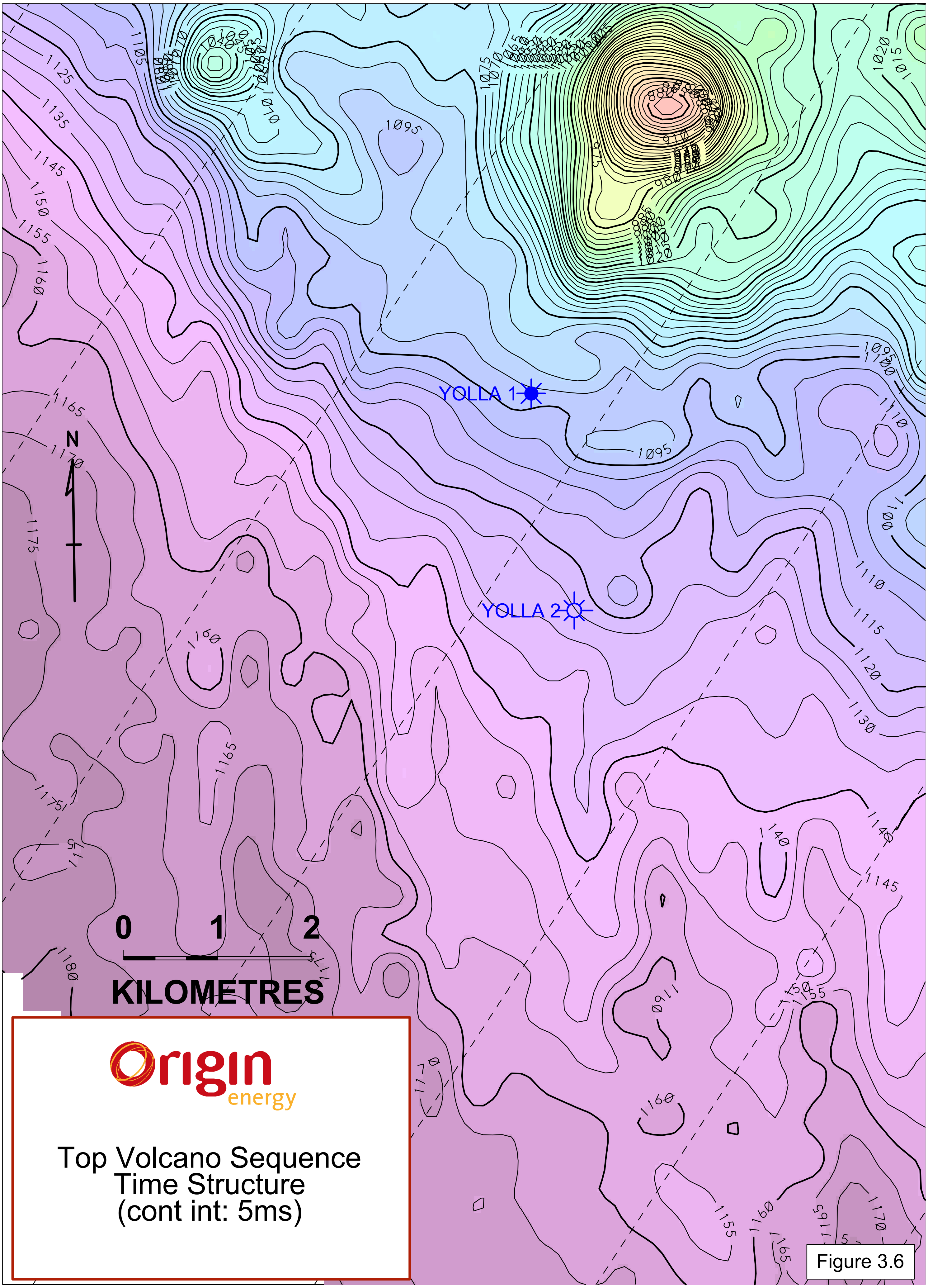


Figure 3.6

Yolla Gas Field T/RL1

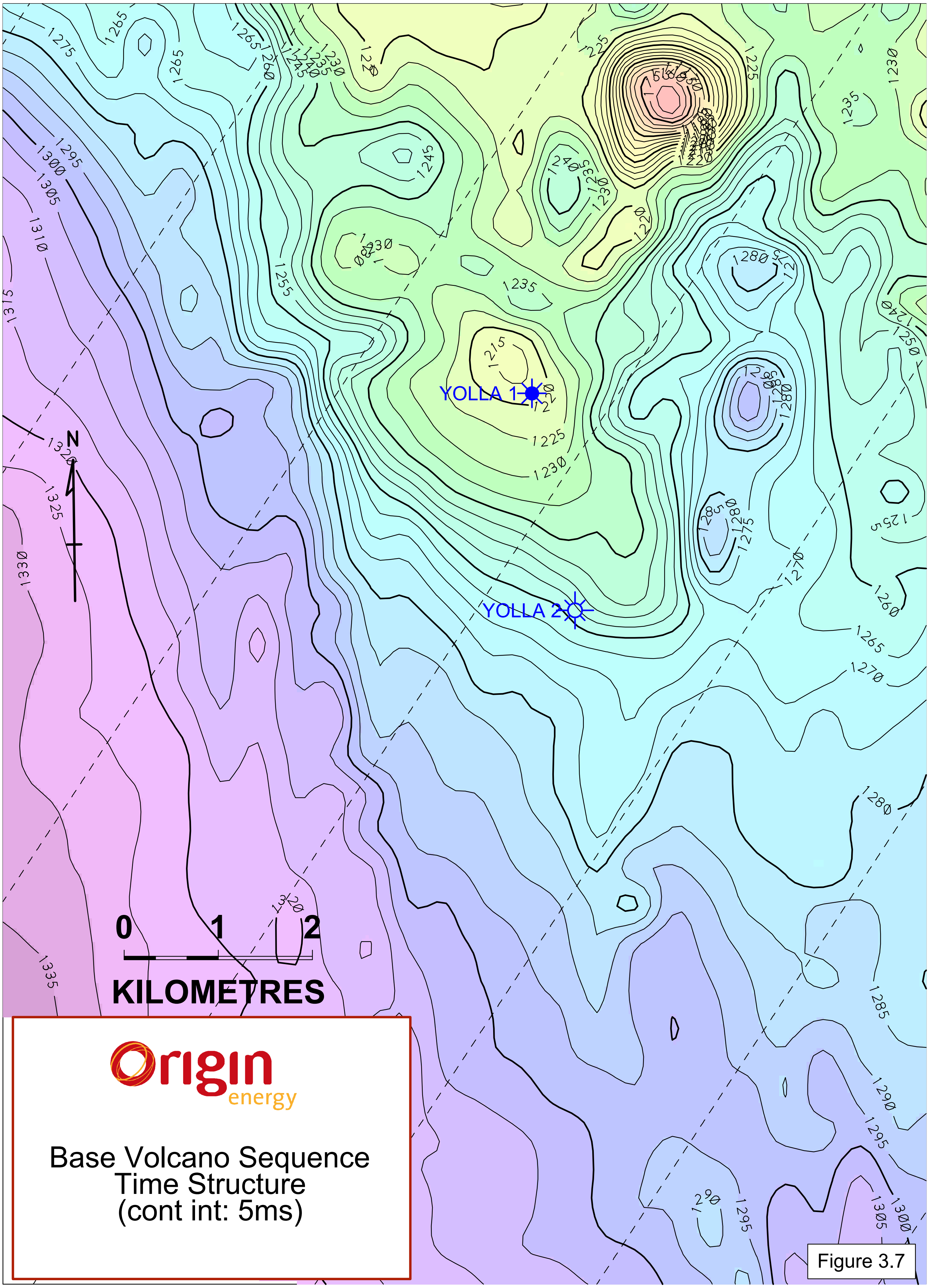


Figure 3.7

Yolla Gas Field T/RL1

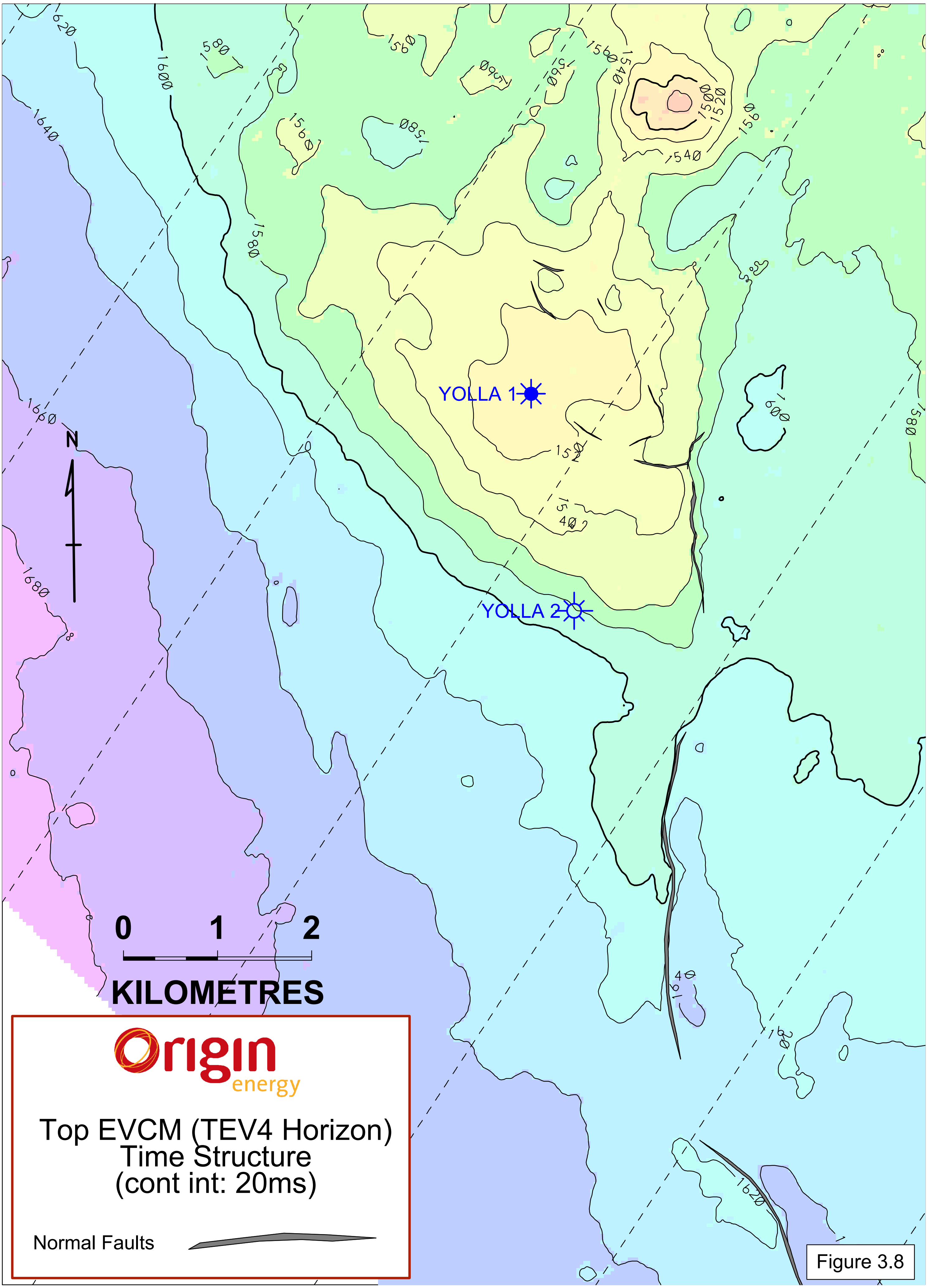


Figure 3.8

Yolla Gas Field T/RL1

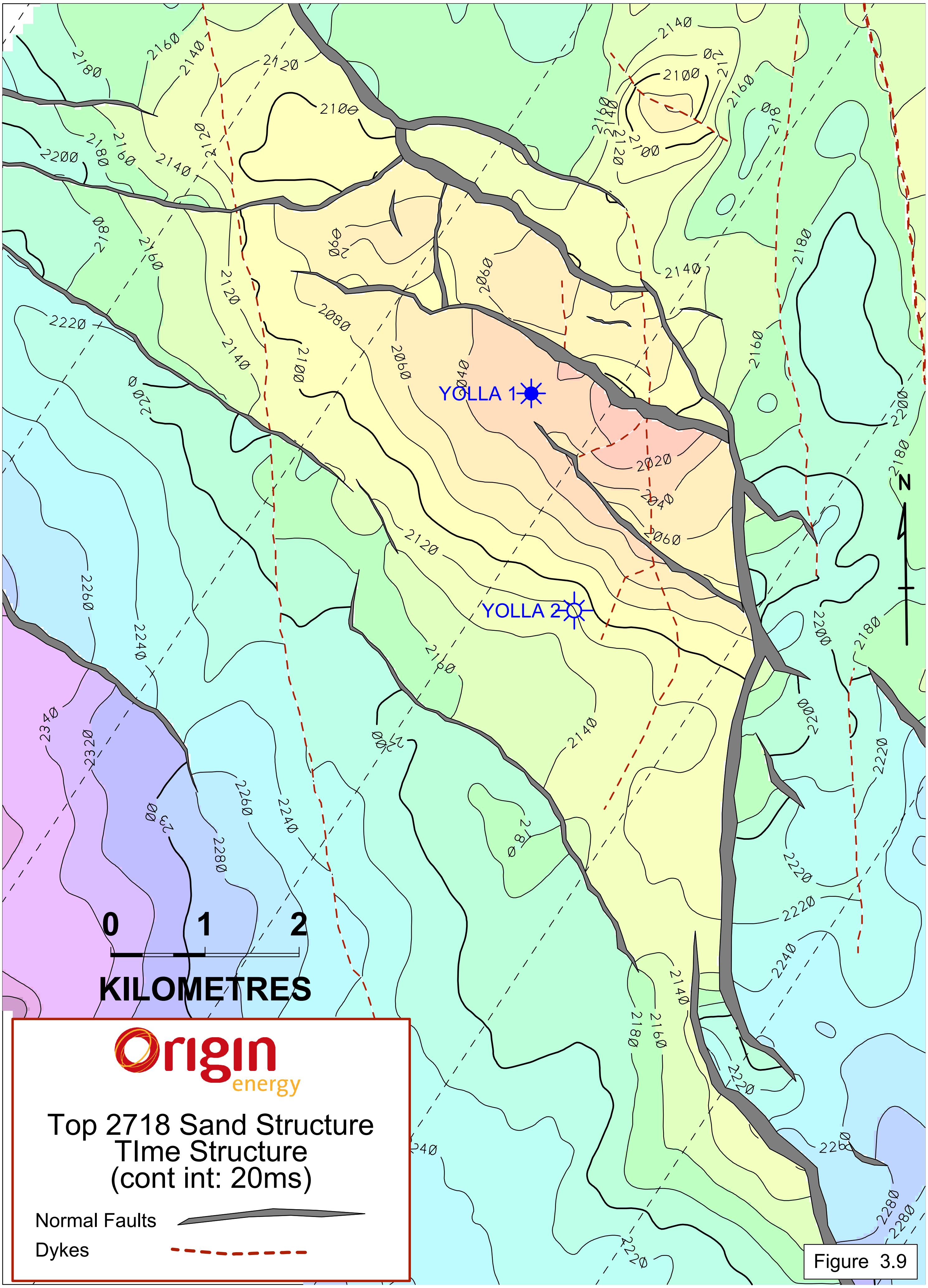


Figure 3.9

Yolla Gas Field T/RL1

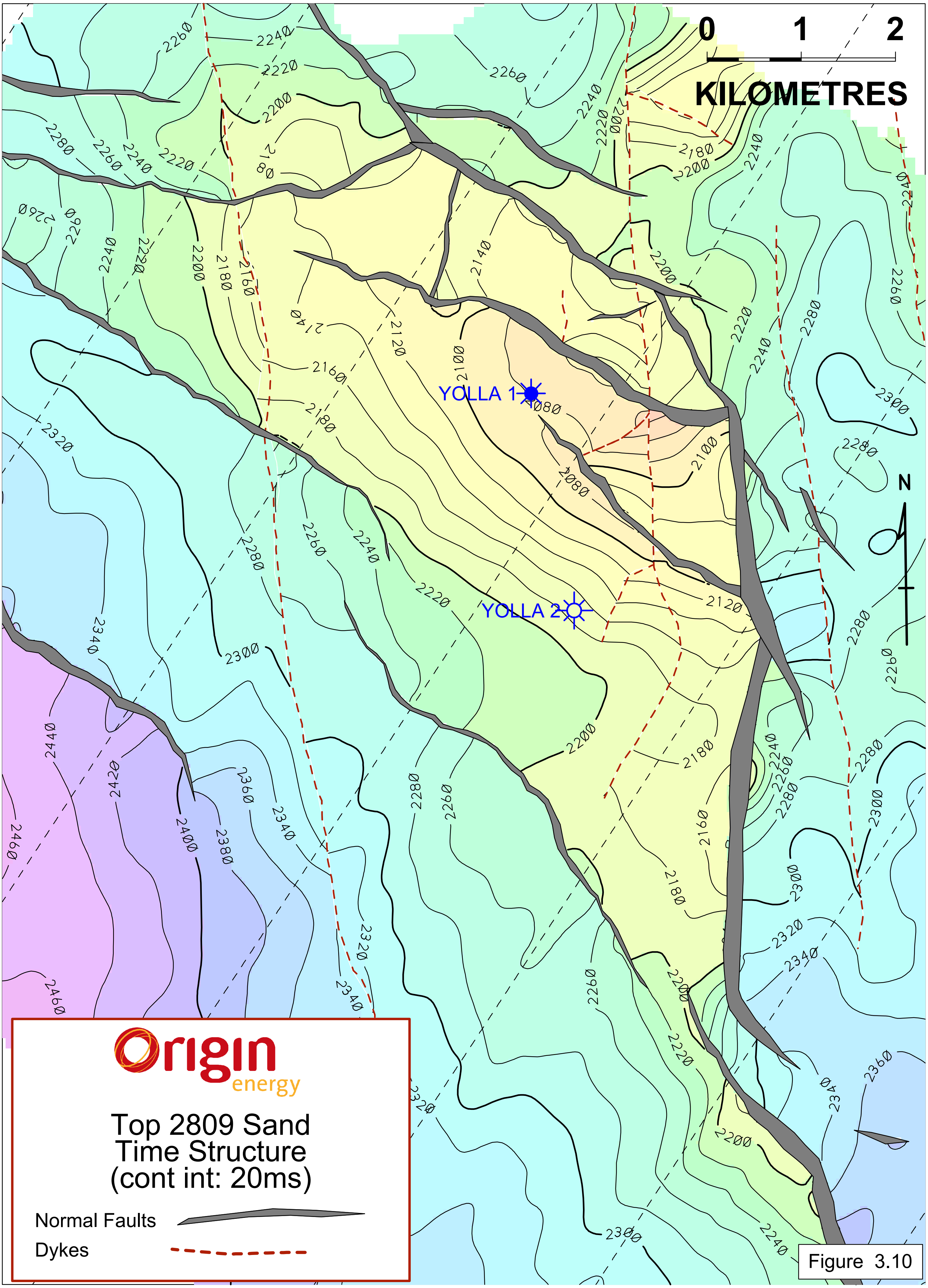


Figure 3.10

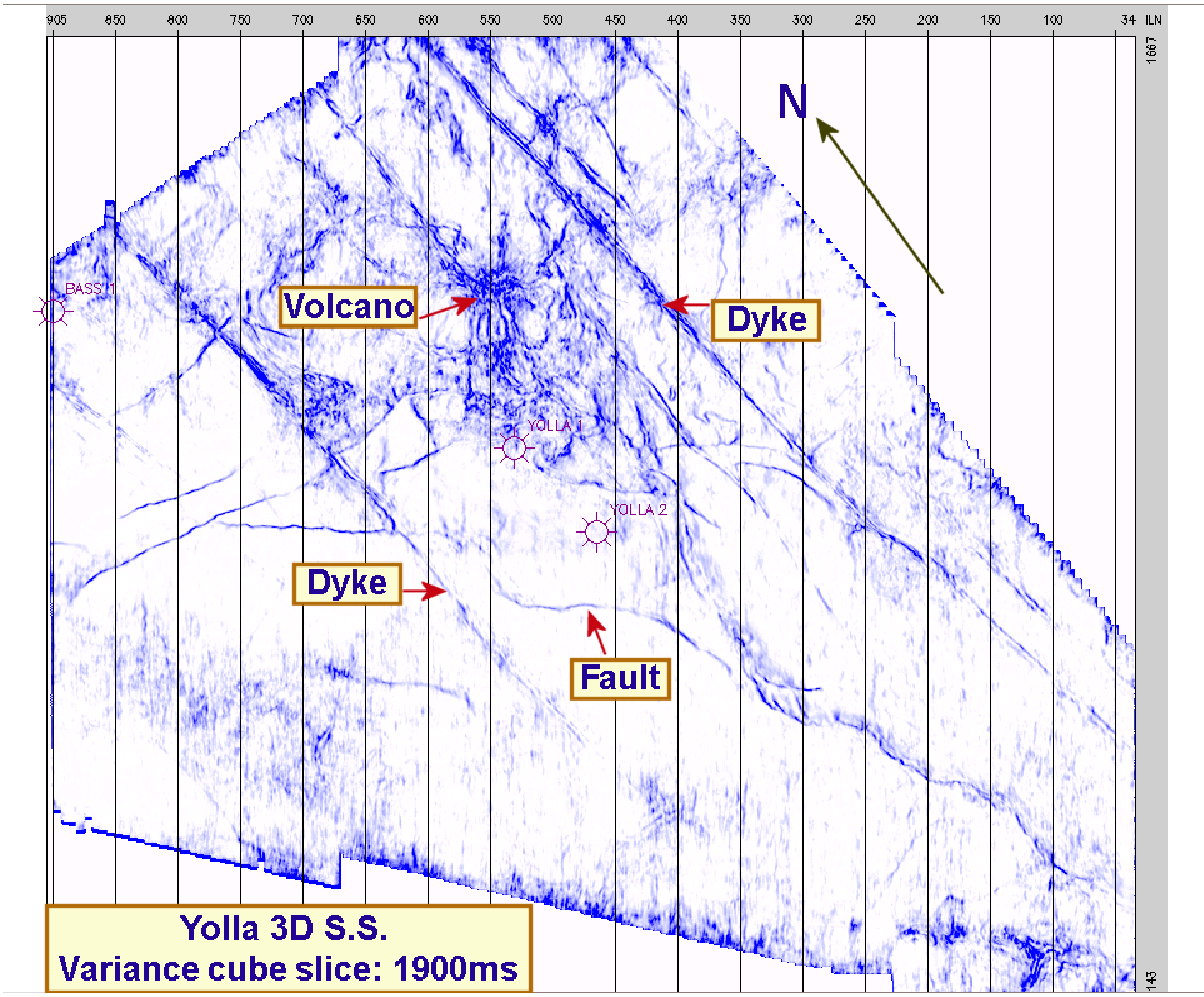

905
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
34
ILN
1667
143
N
BASS 1
Volcano
Dyke
YOLLA 1
YOLLA 2
Dyke
Fault
Yolla 3D S.S.
Variance cube slice: 1900ms

Figure 3.11

Yolla Gas Field T/RL1

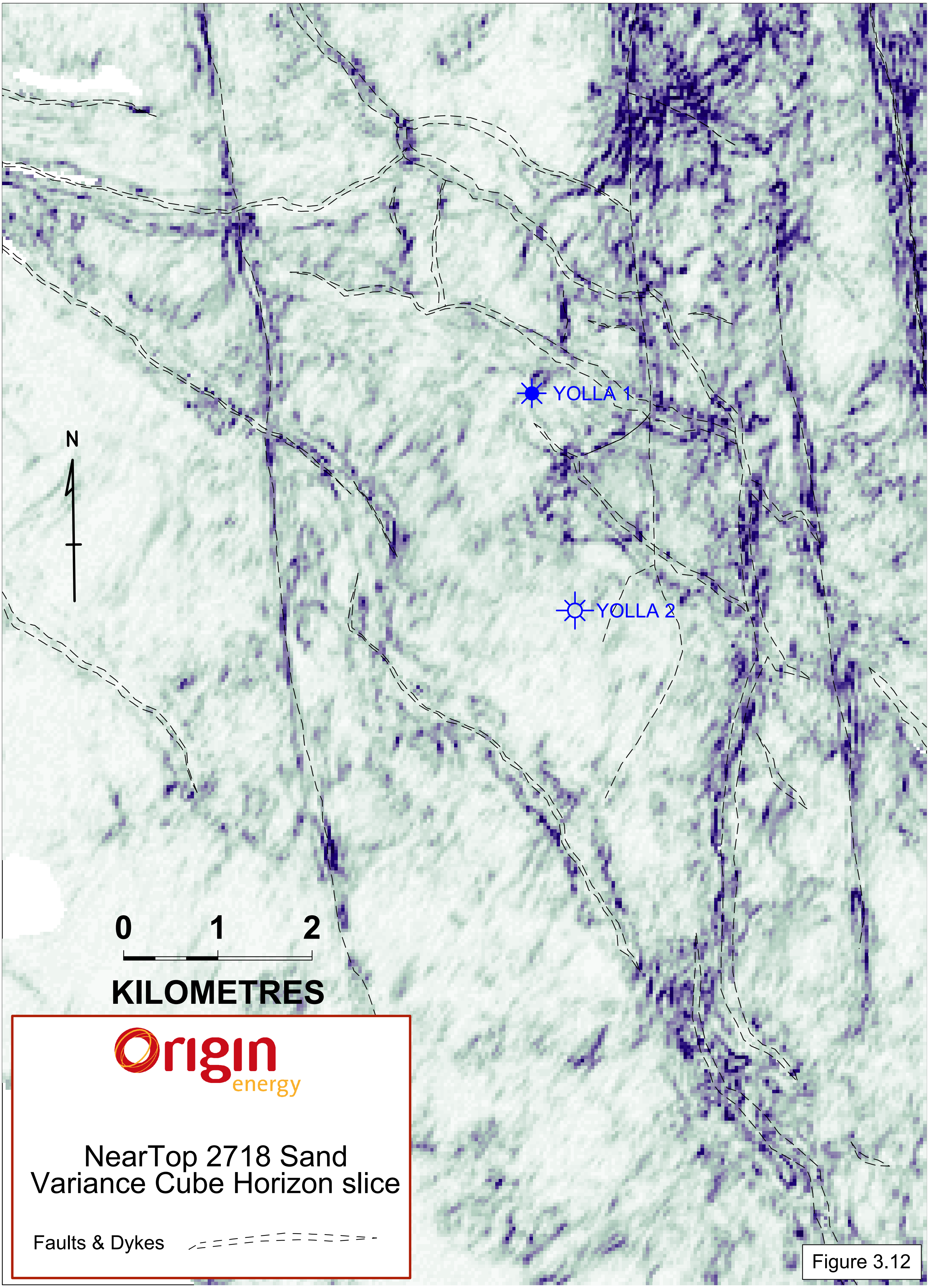


Figure 3.12

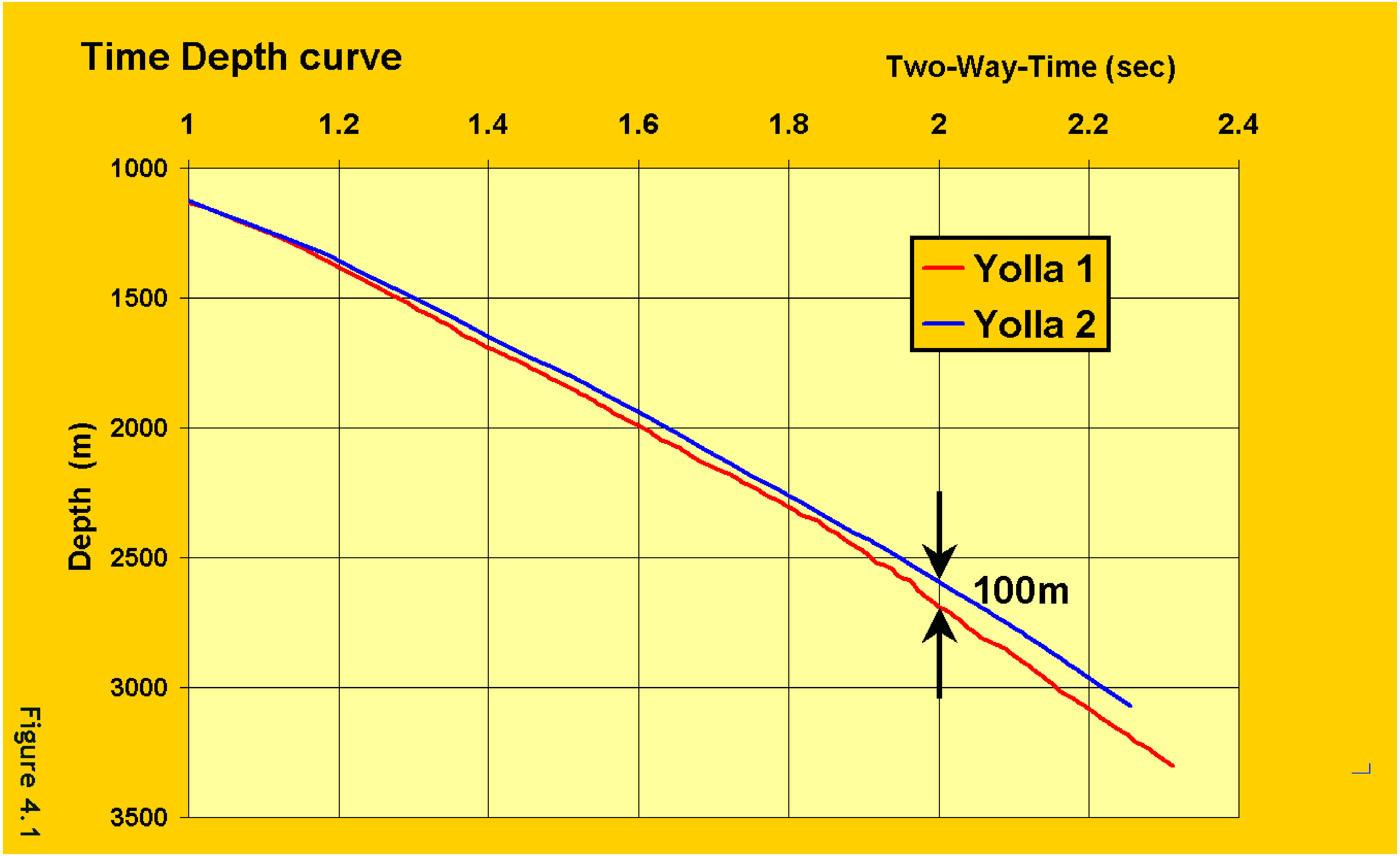

Time Depth curve
Two-Way-Time (sec)
1
1.2
1.4
1.6
1.8
2
2.2
2.4
Depth (m)
1000
1500
2000
2500
3000
3500
Yolla 1
Yolla 2
100m

Figure 4.1

Horizon Stacking Velocity Semblance Profiles for Inline 541

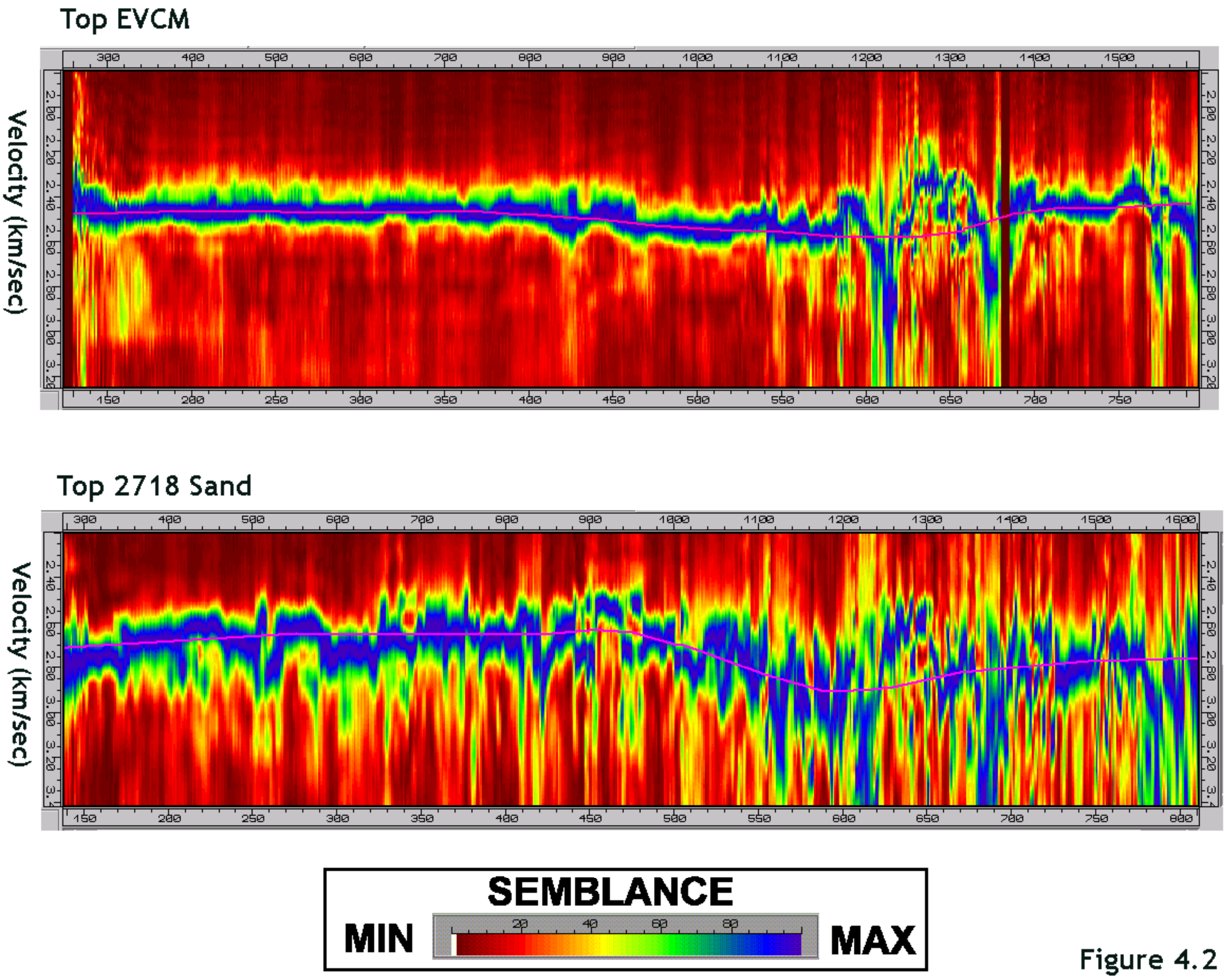
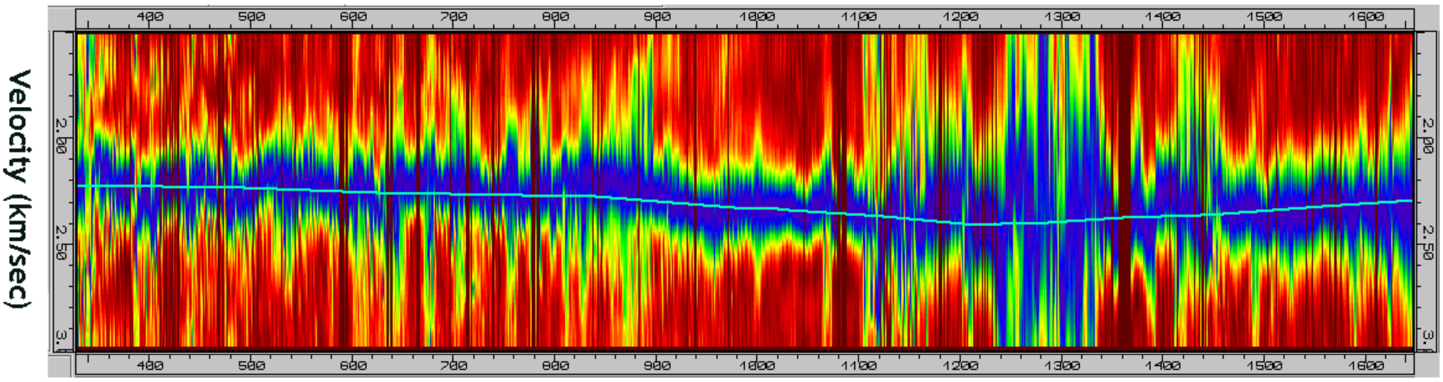


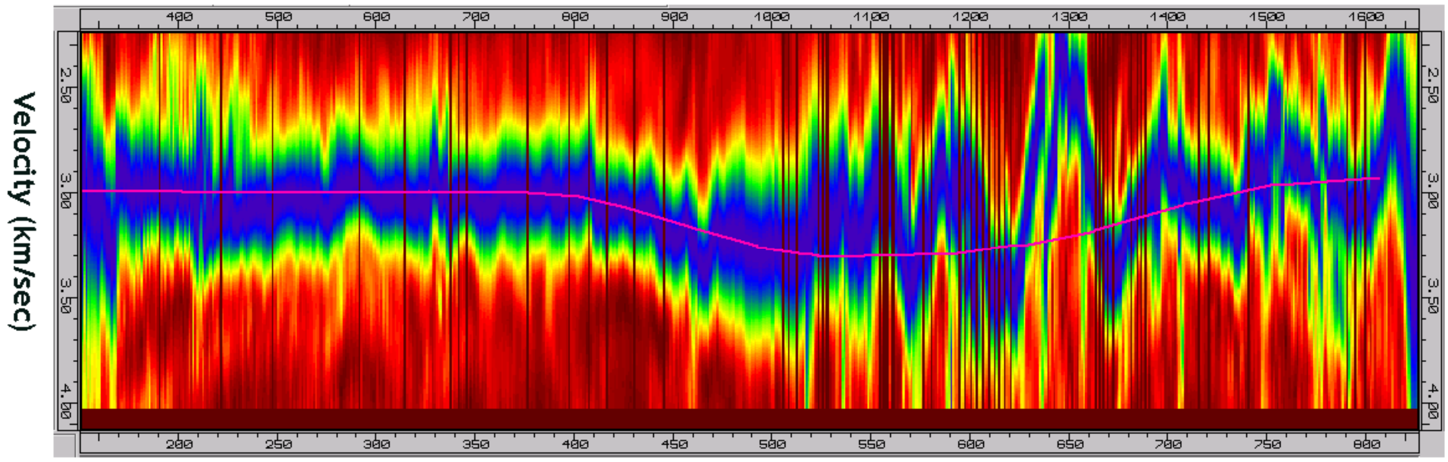
Figure 4.2

Interval Velocity Semblance Profiles for Inline 541

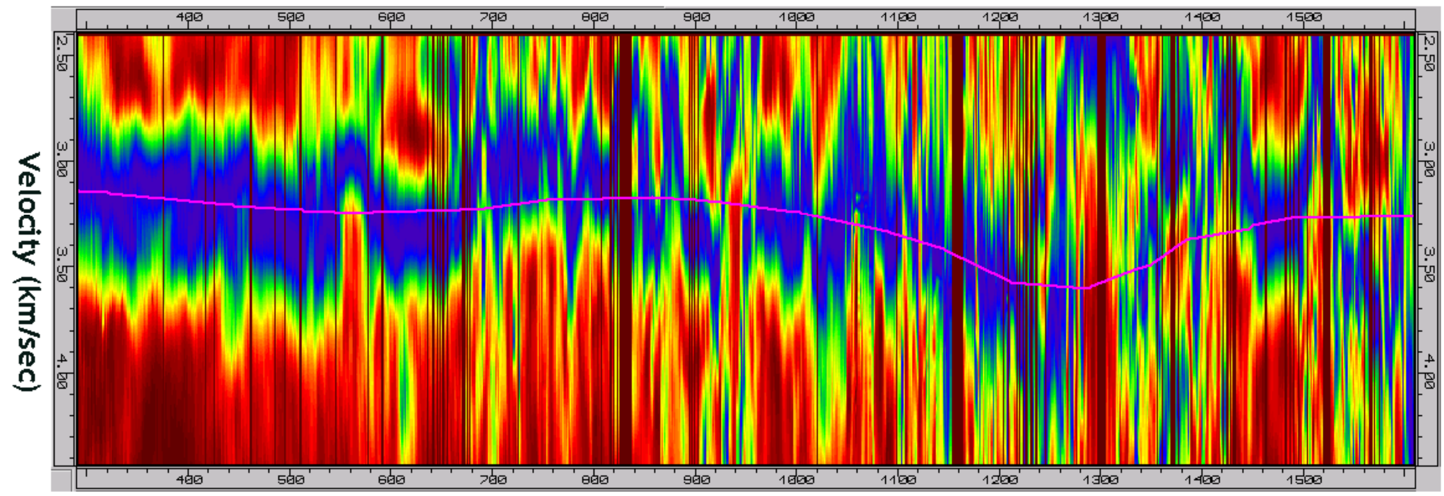
Lwr Mid Miocene to Top Volcano interval



Base Volcano to Top EVCM interval



Top Evcm to Top 2718 interval



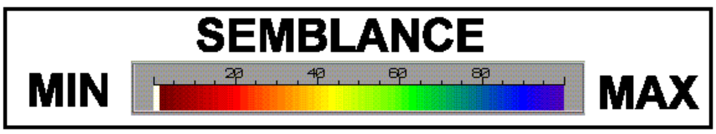


Figure 4.3

Yolla Gas Field T/RL1

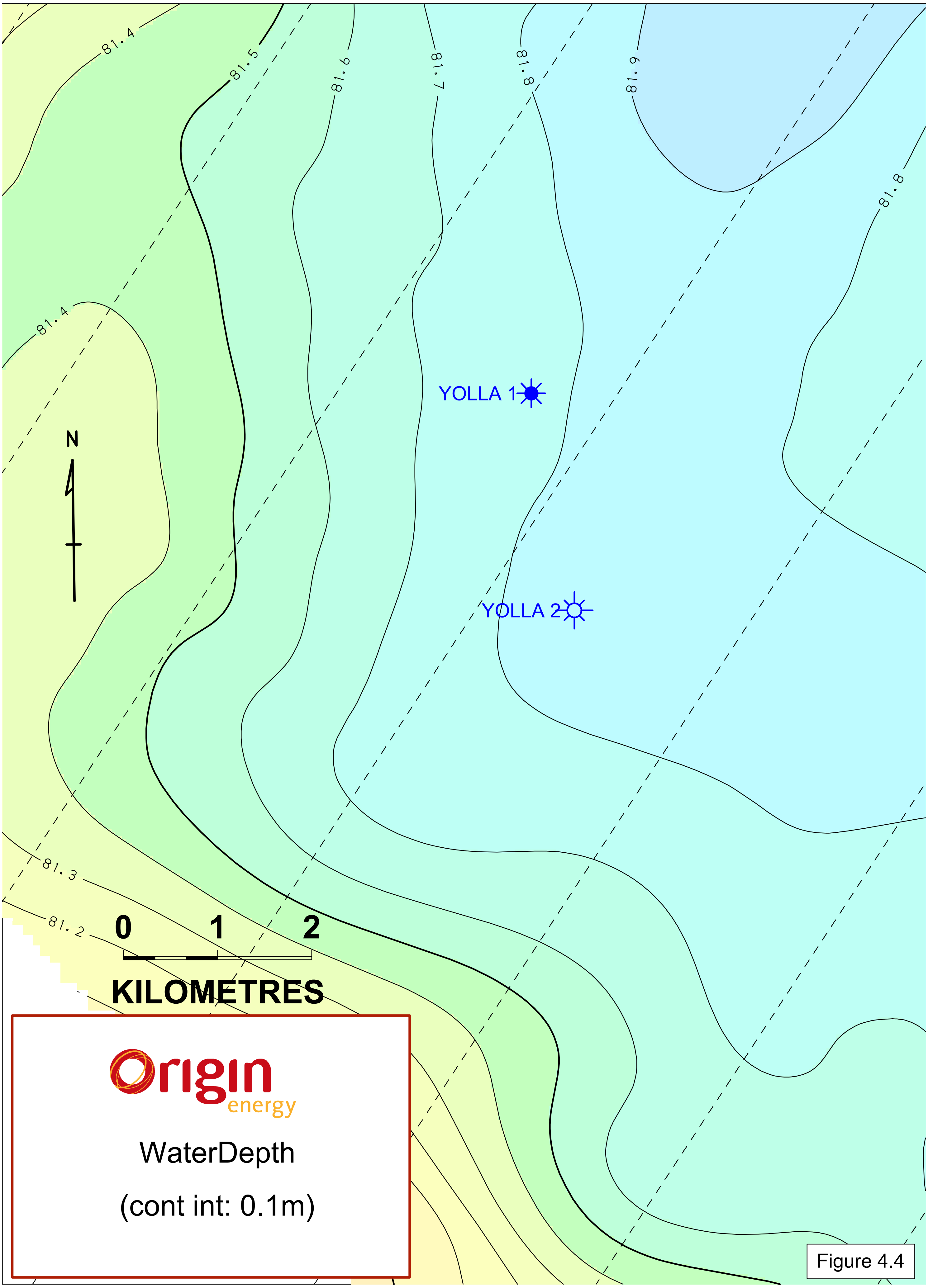


Figure 4.4

Yolla Gas Field T/RL1

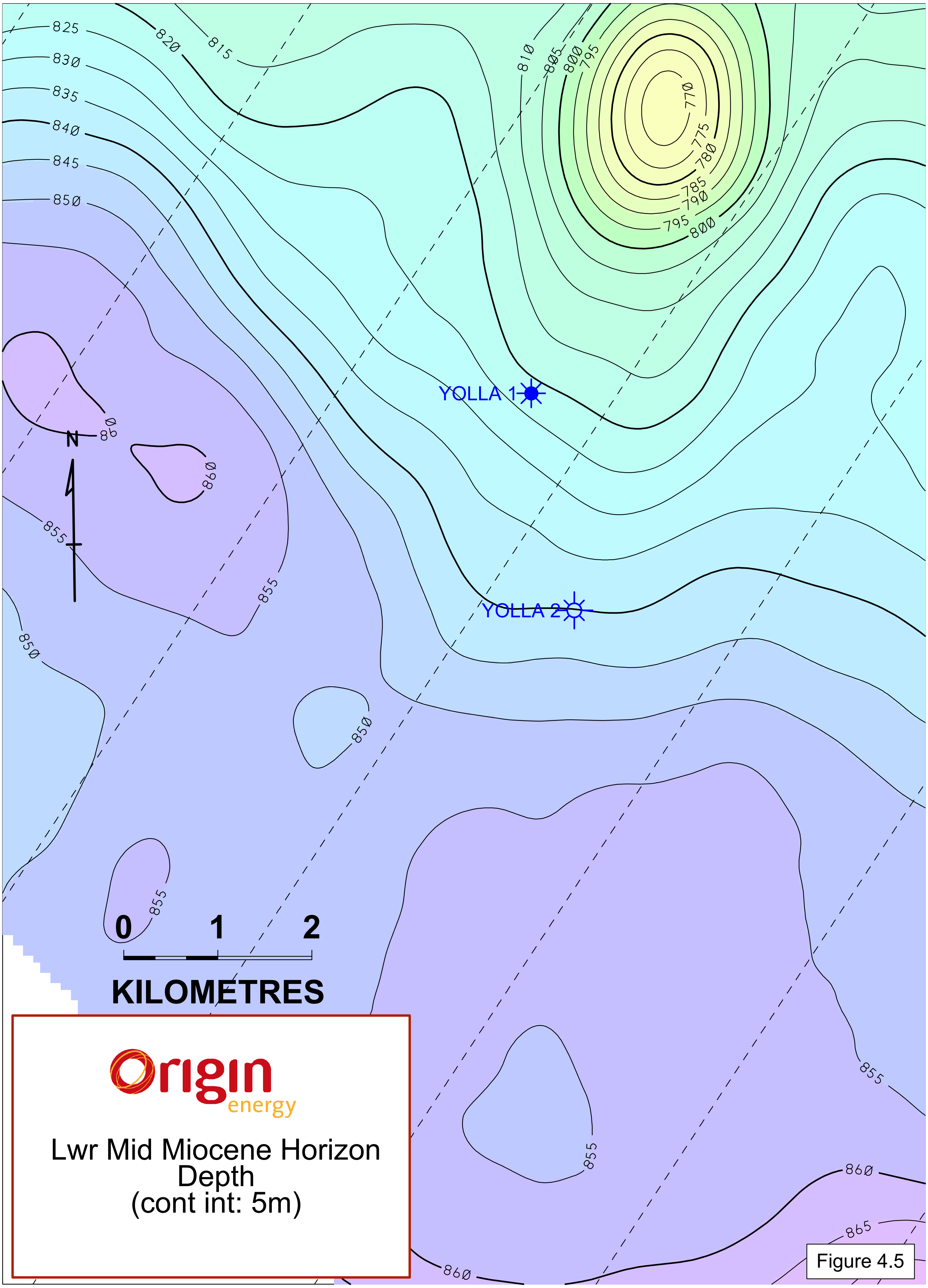


Figure 4.5

Yolla Gas Field T/RL1

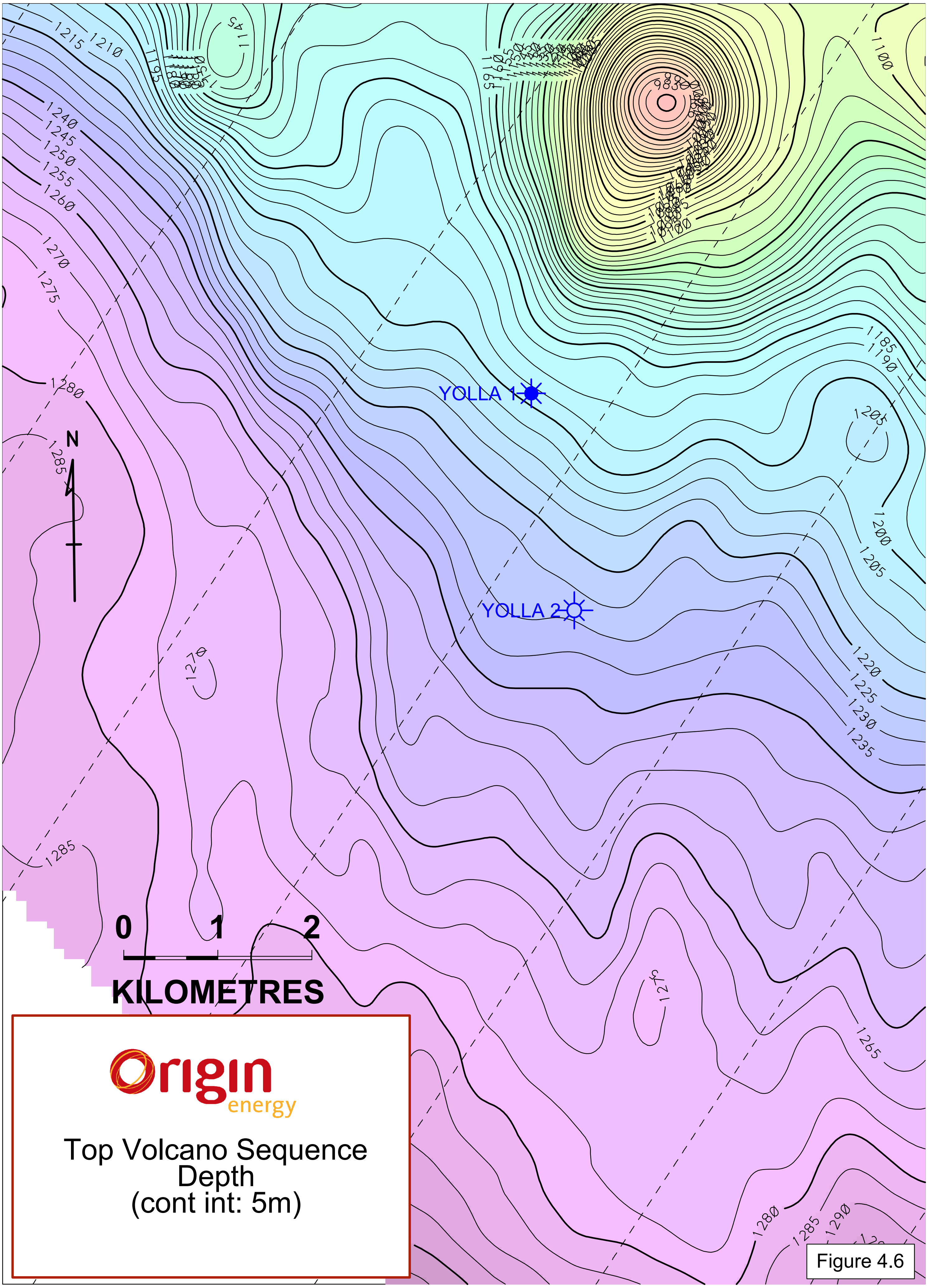


Figure 4.6

Yolla Gas Field   T/RL1

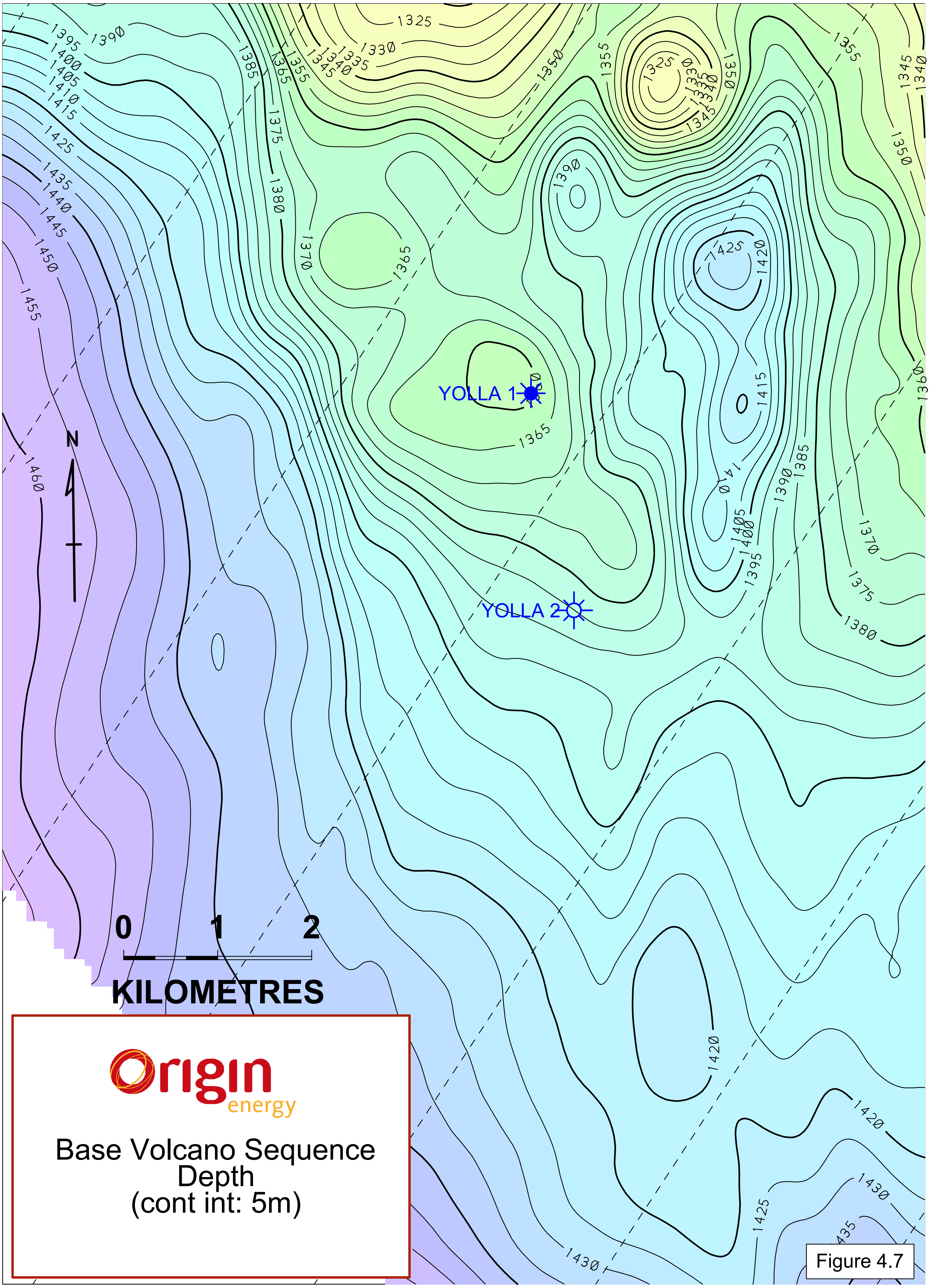


Figure 4.7

Yolla Gas Field T/RL1

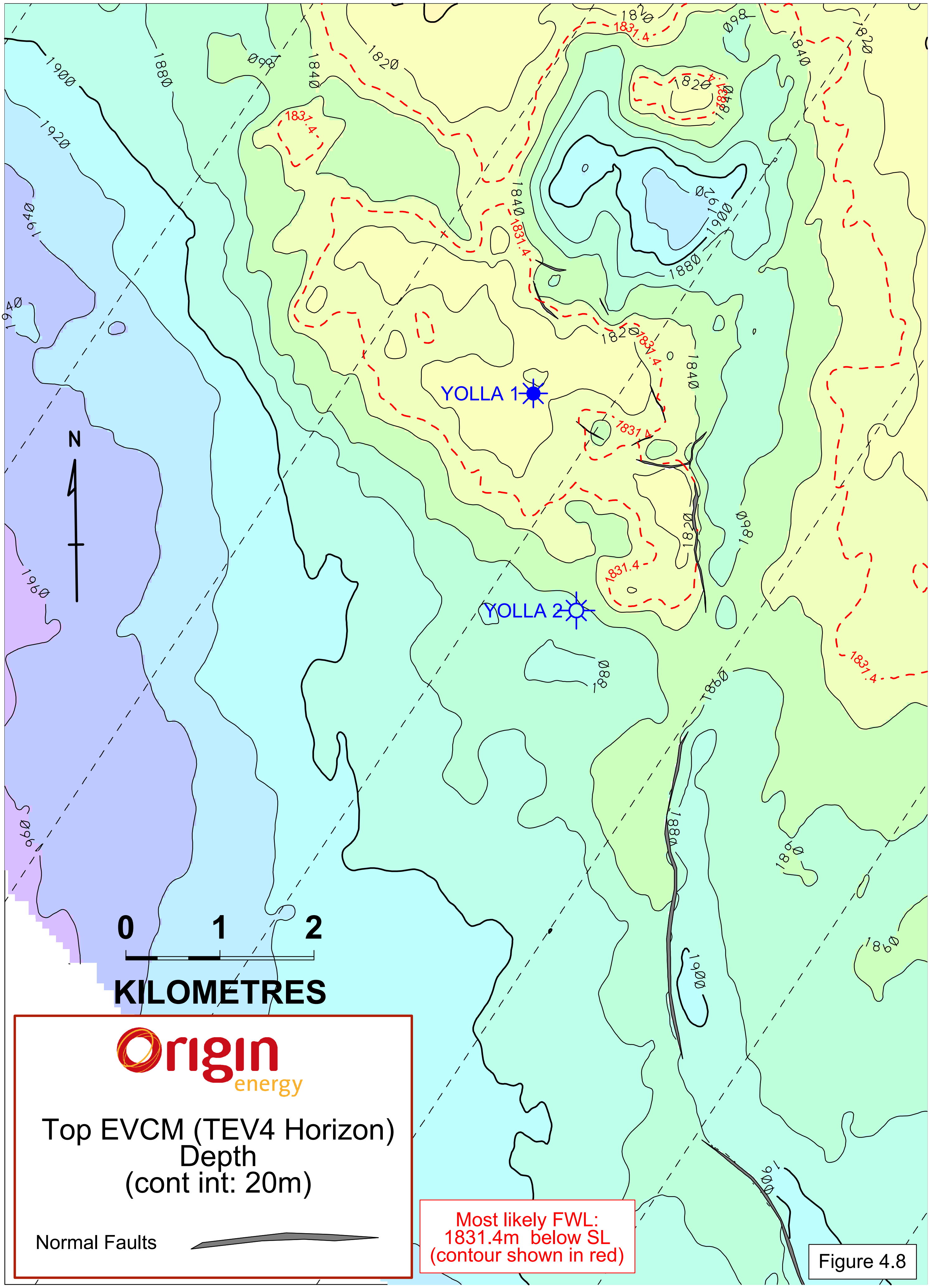


Figure 4.8

Yolla Gas Field T/RL1

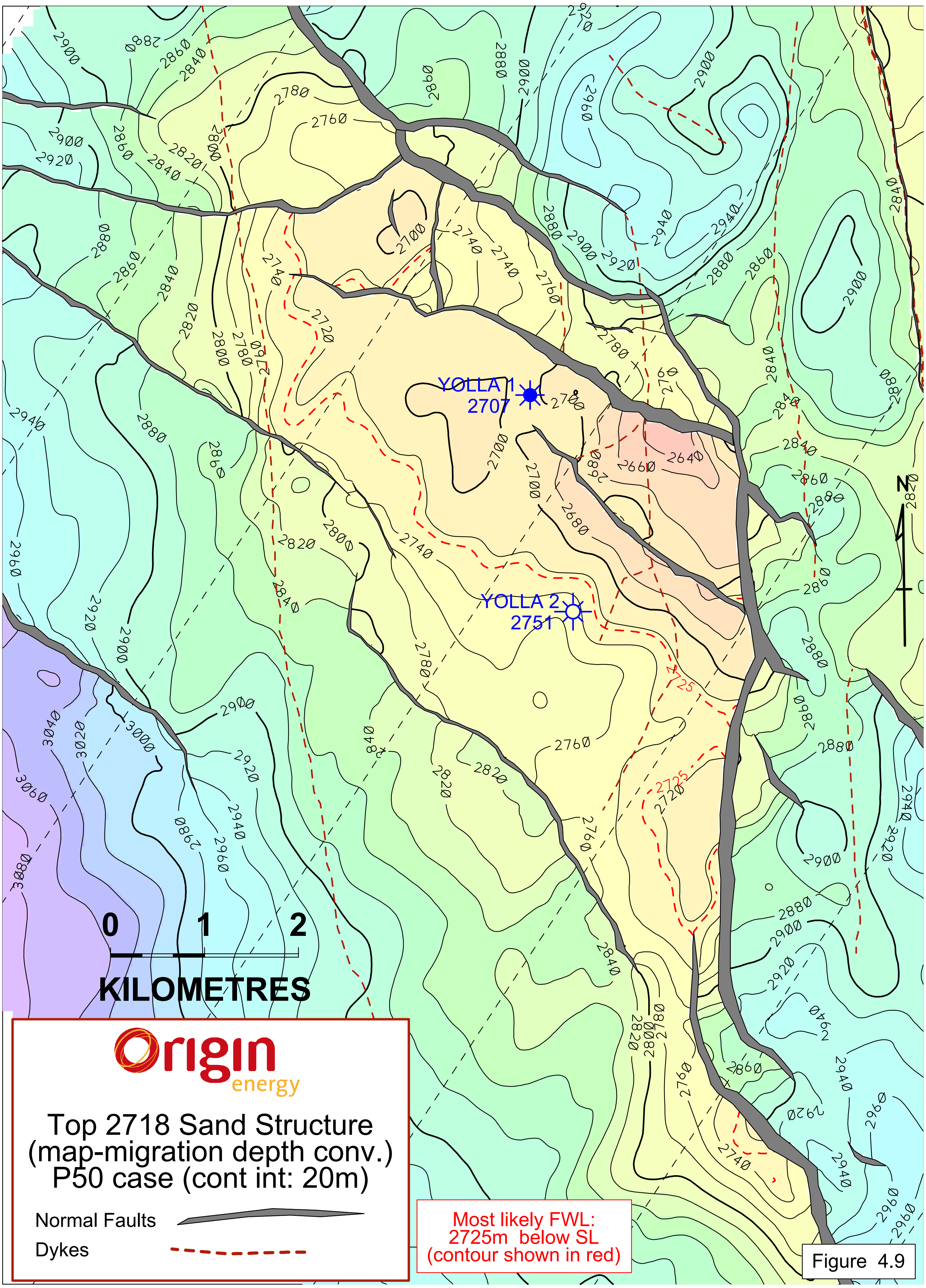


Figure 4.9

Yolla Gas Field T/RL1

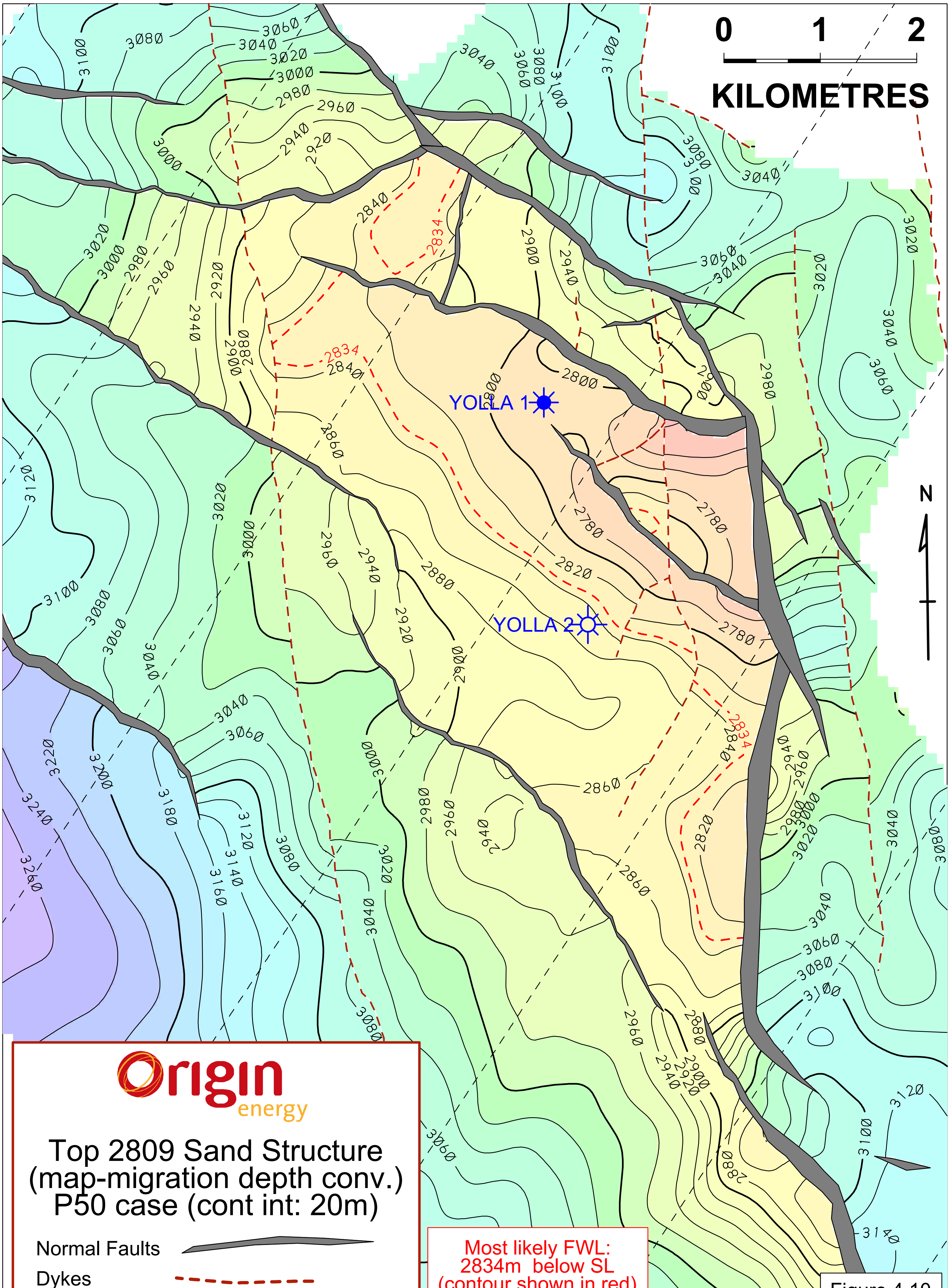


Figure 4.10

Yolla Gas Field T/RL1

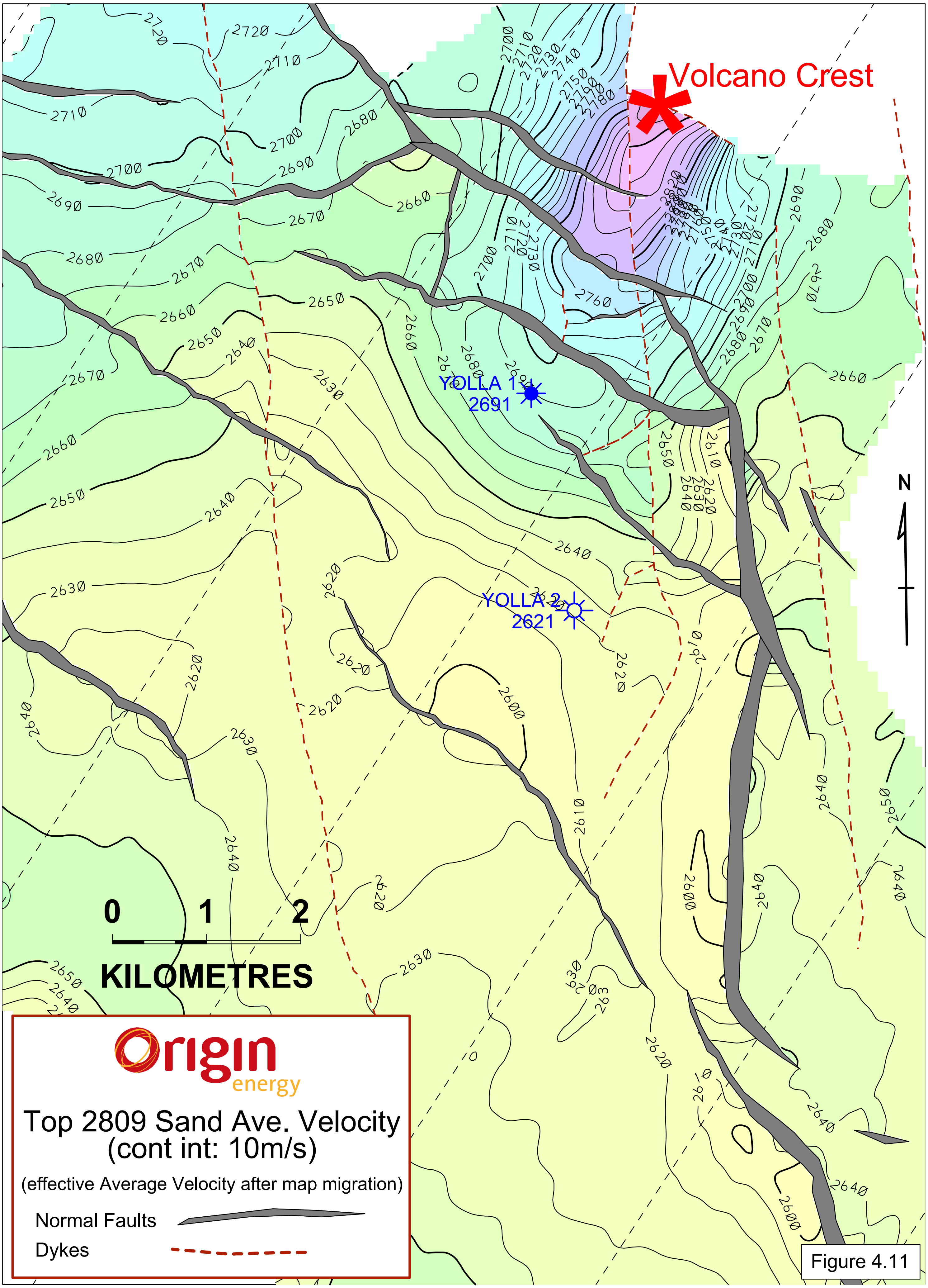


Figure 4.11

Yolla Gas Field T/RL1

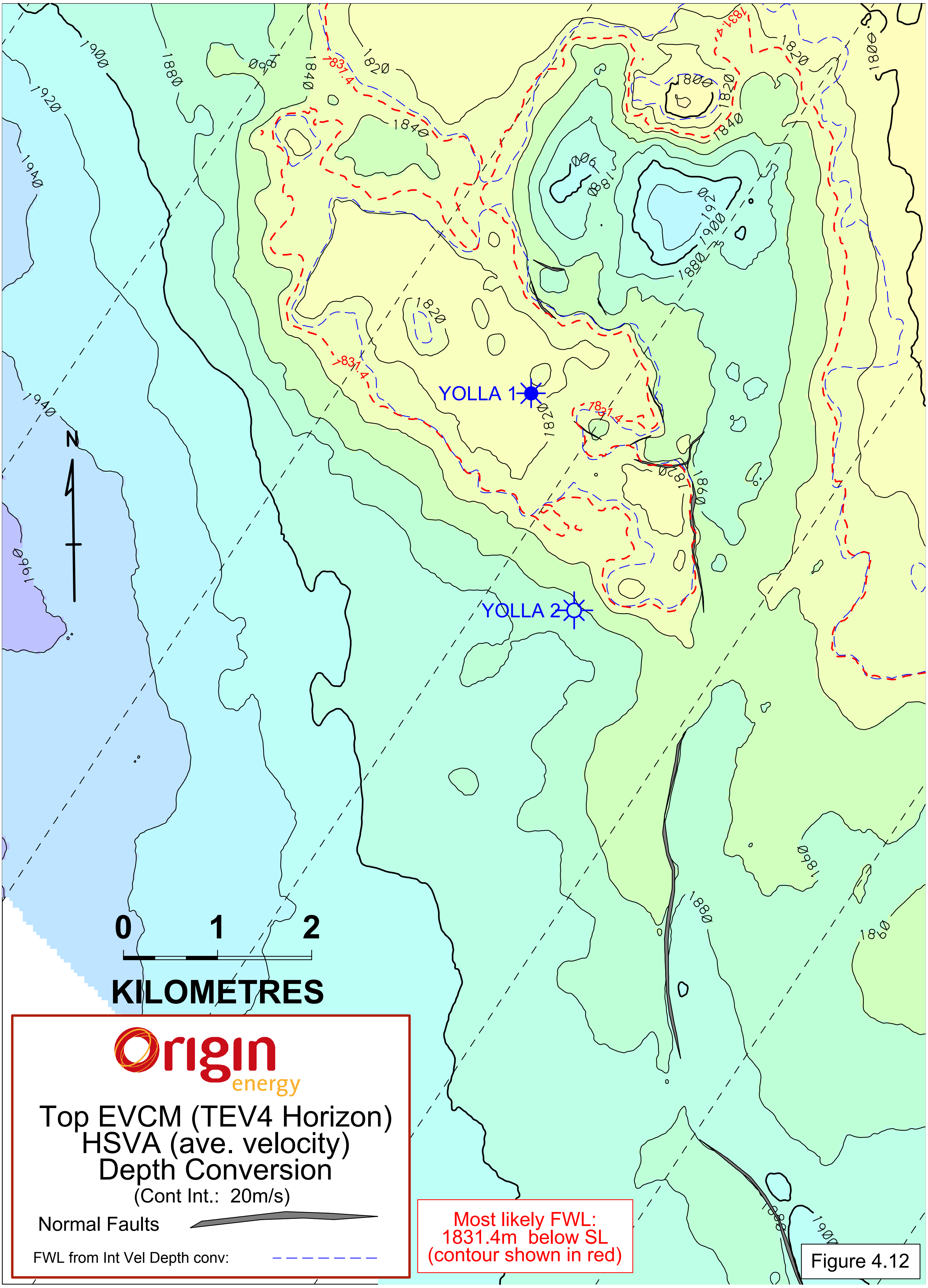
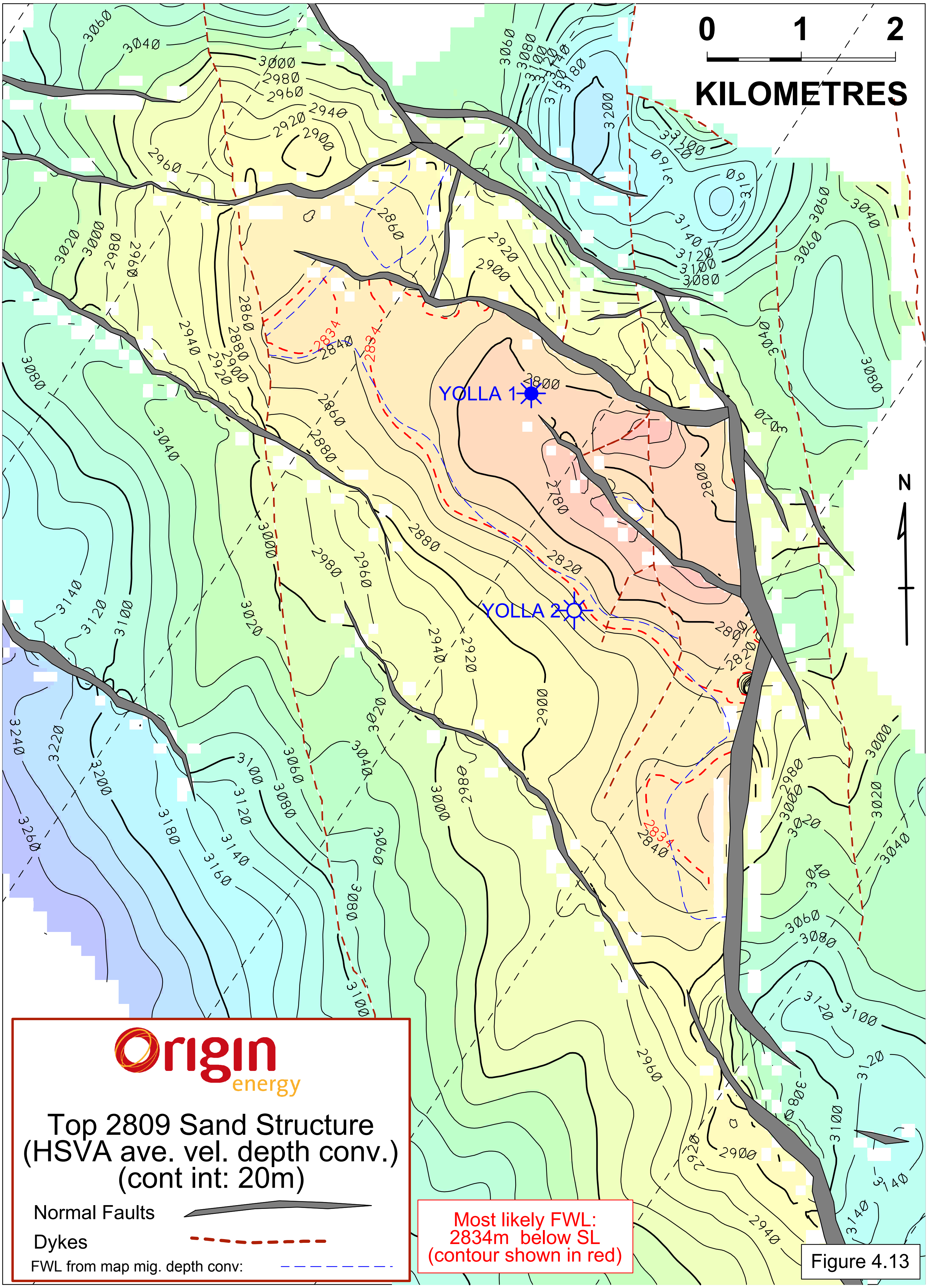


Figure 4.12

Yolla Gas Field T/RL1



Yolla Gas Field T/RL1

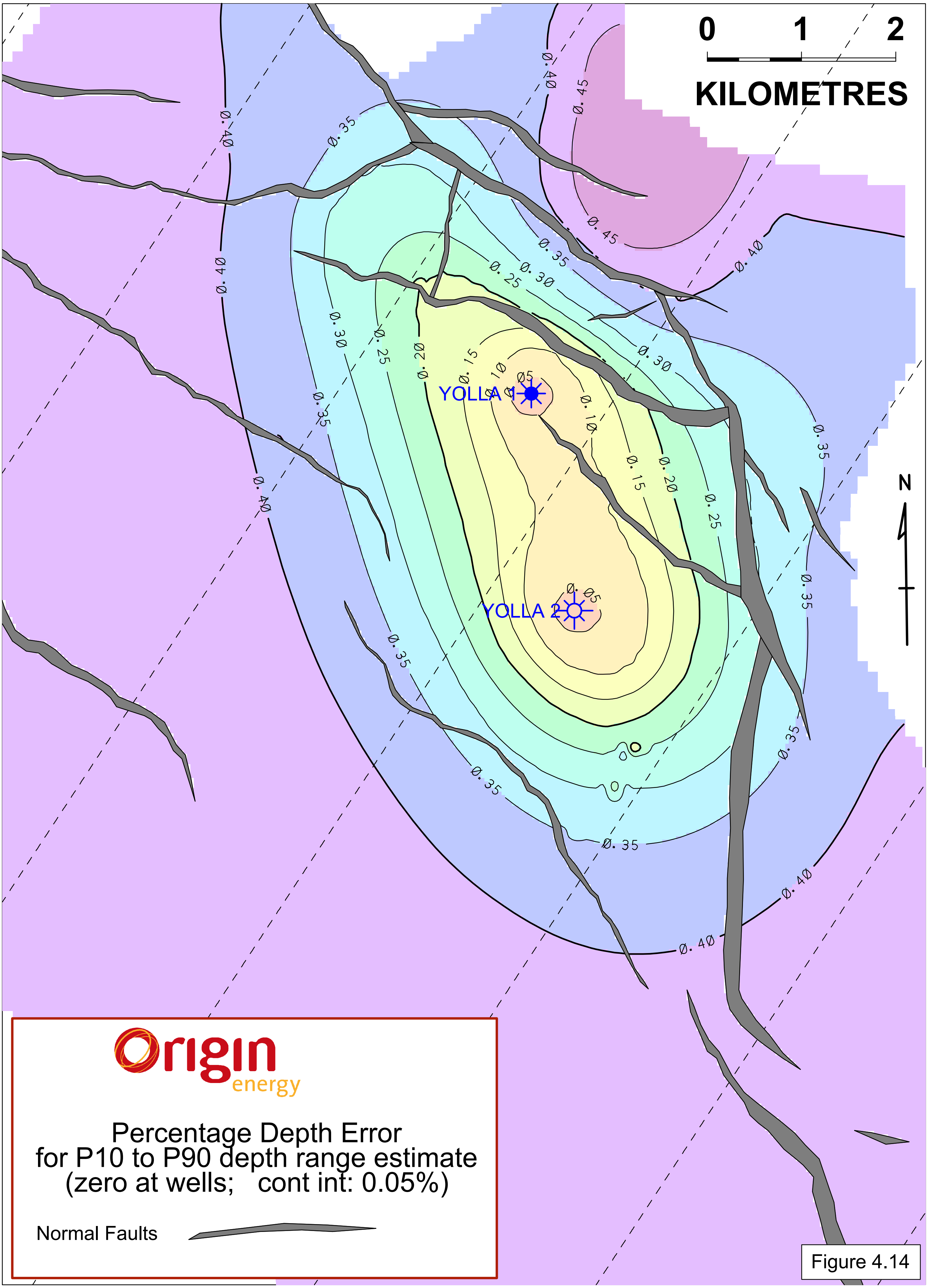


Figure 4.14

Yolla Gas Field T/RL1

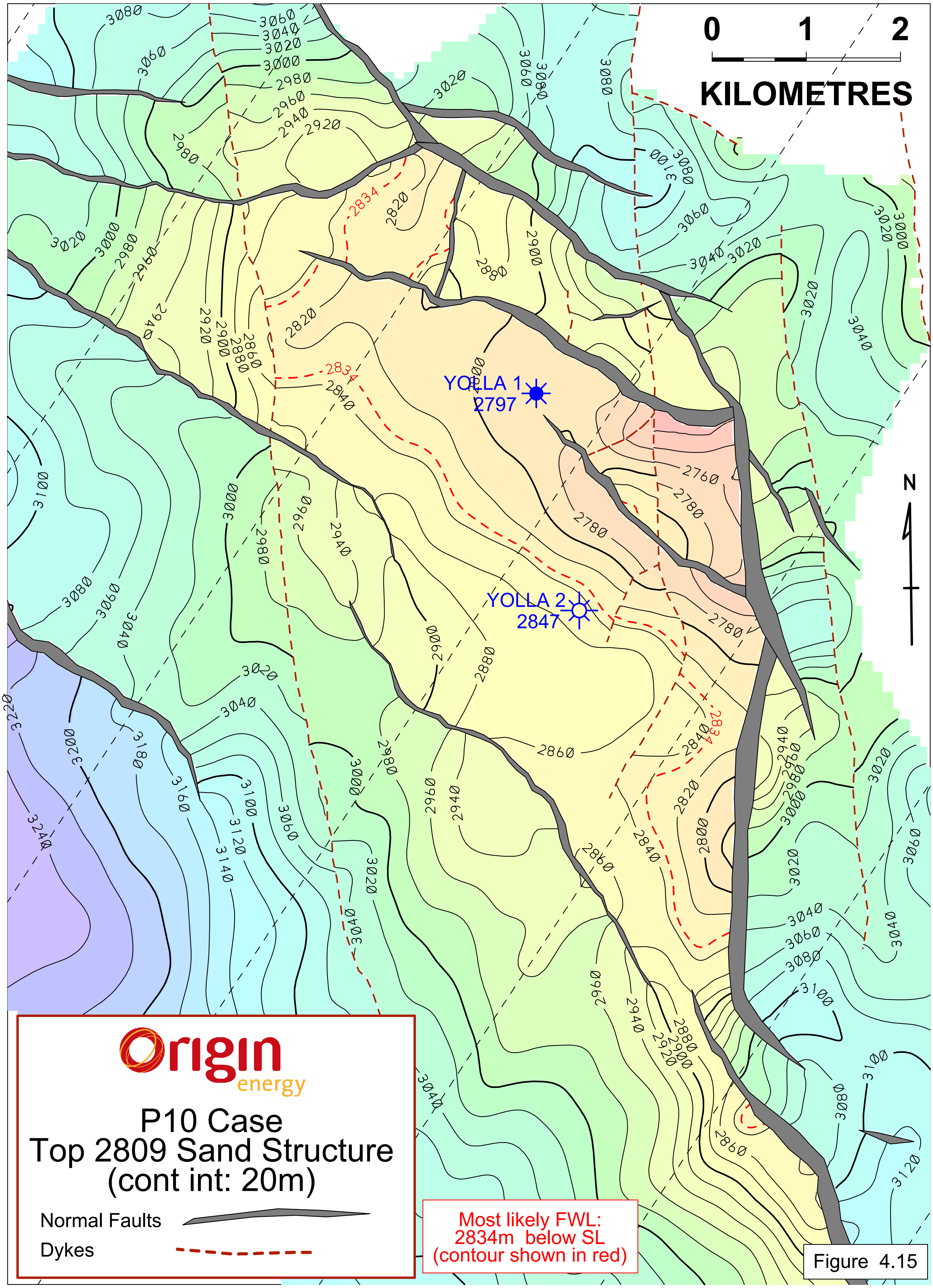


Figure 4.15

Yolla Gas Field T/RL1

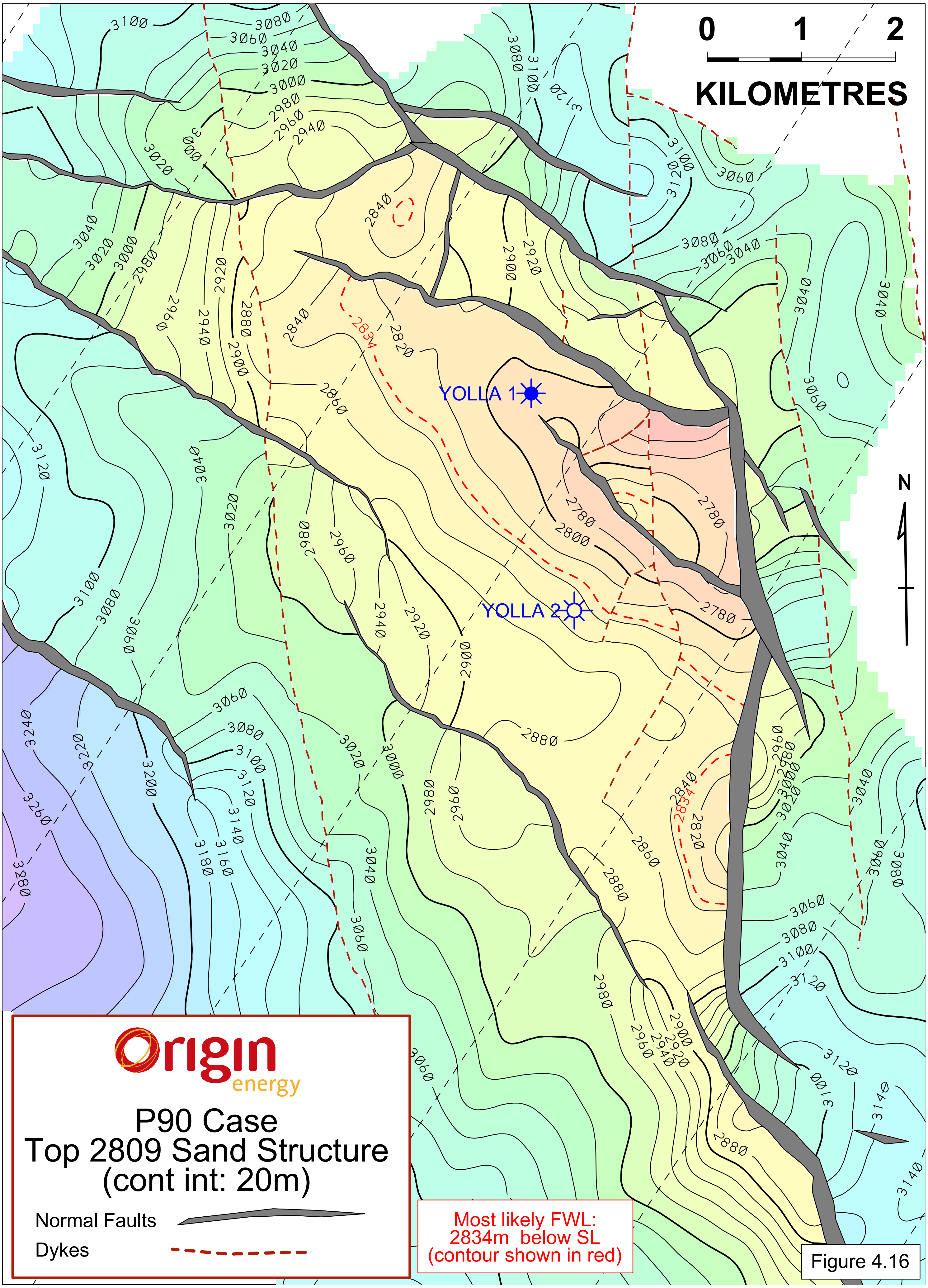


Figure 4.16

Yolla Gas Field T/RL1

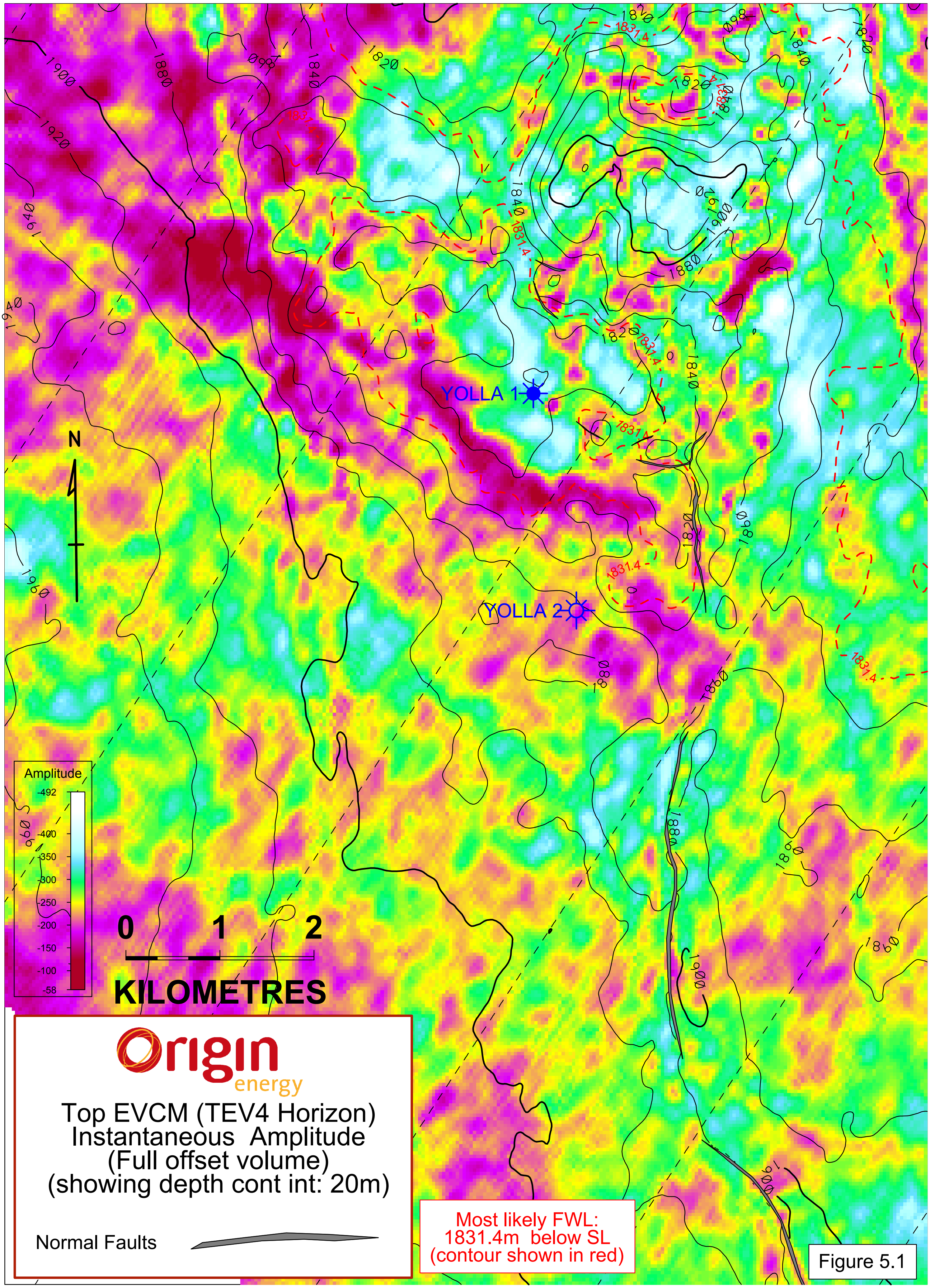
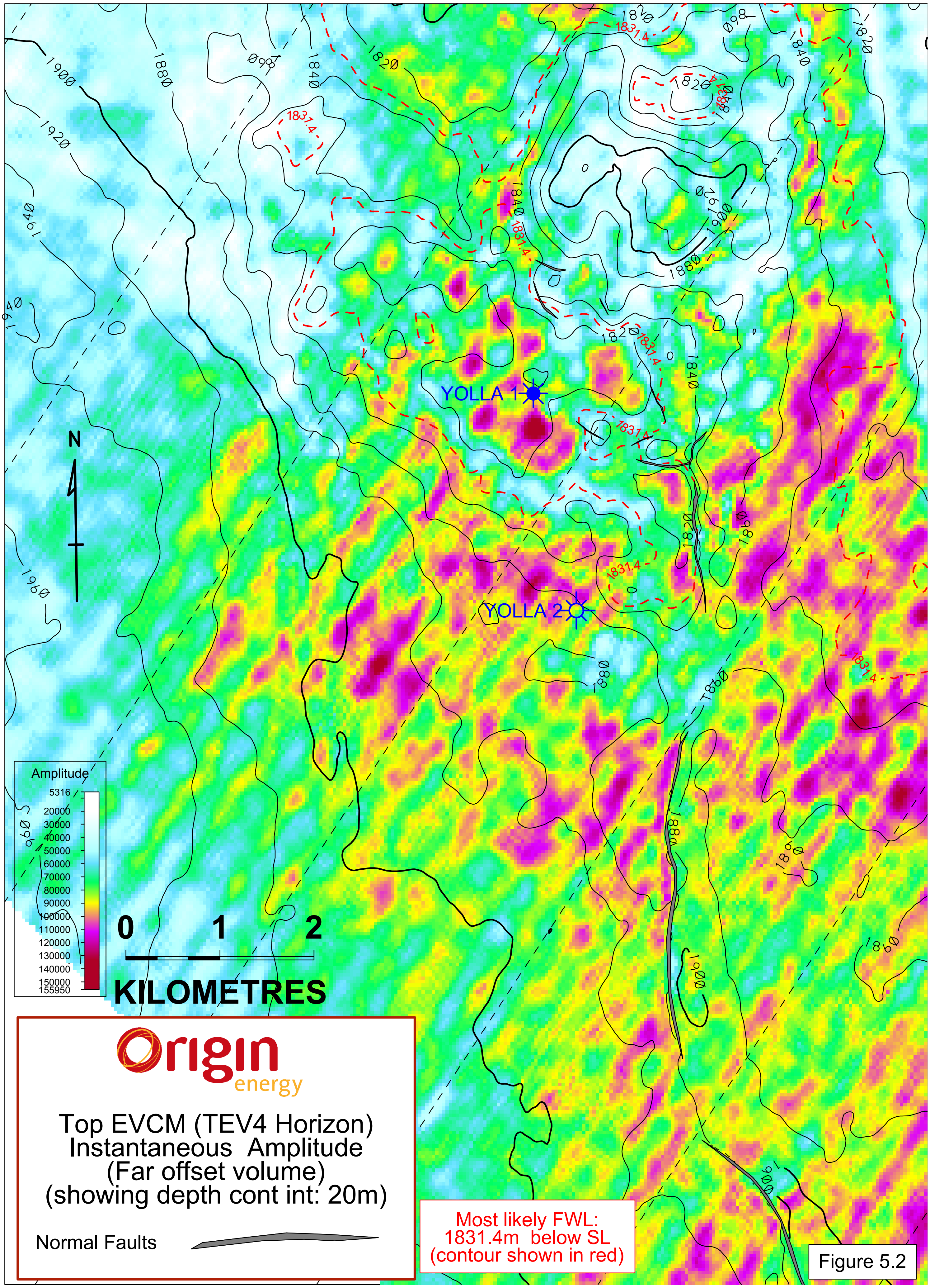


Figure 5.1

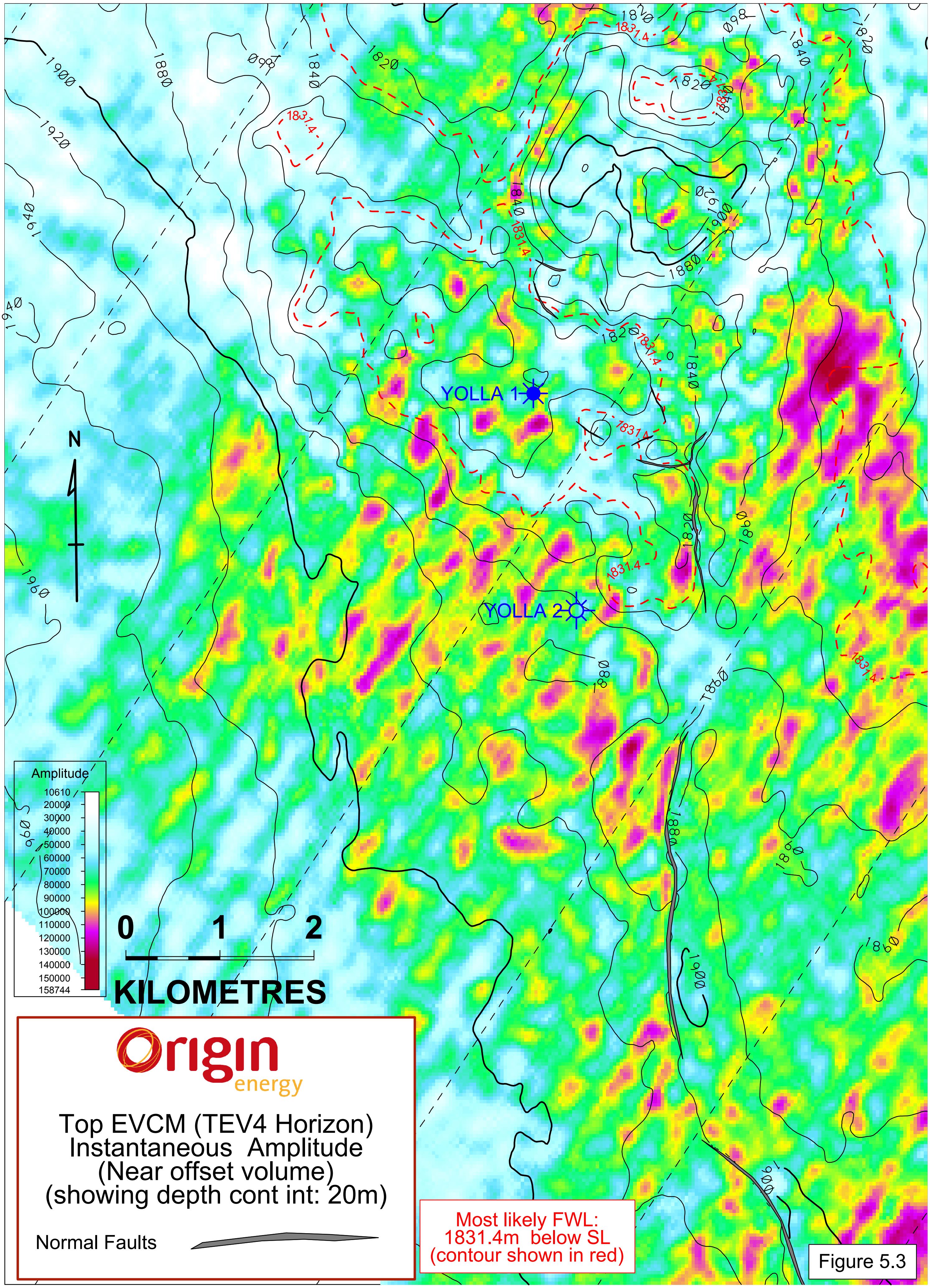
Yolla Gas Field T/RL1



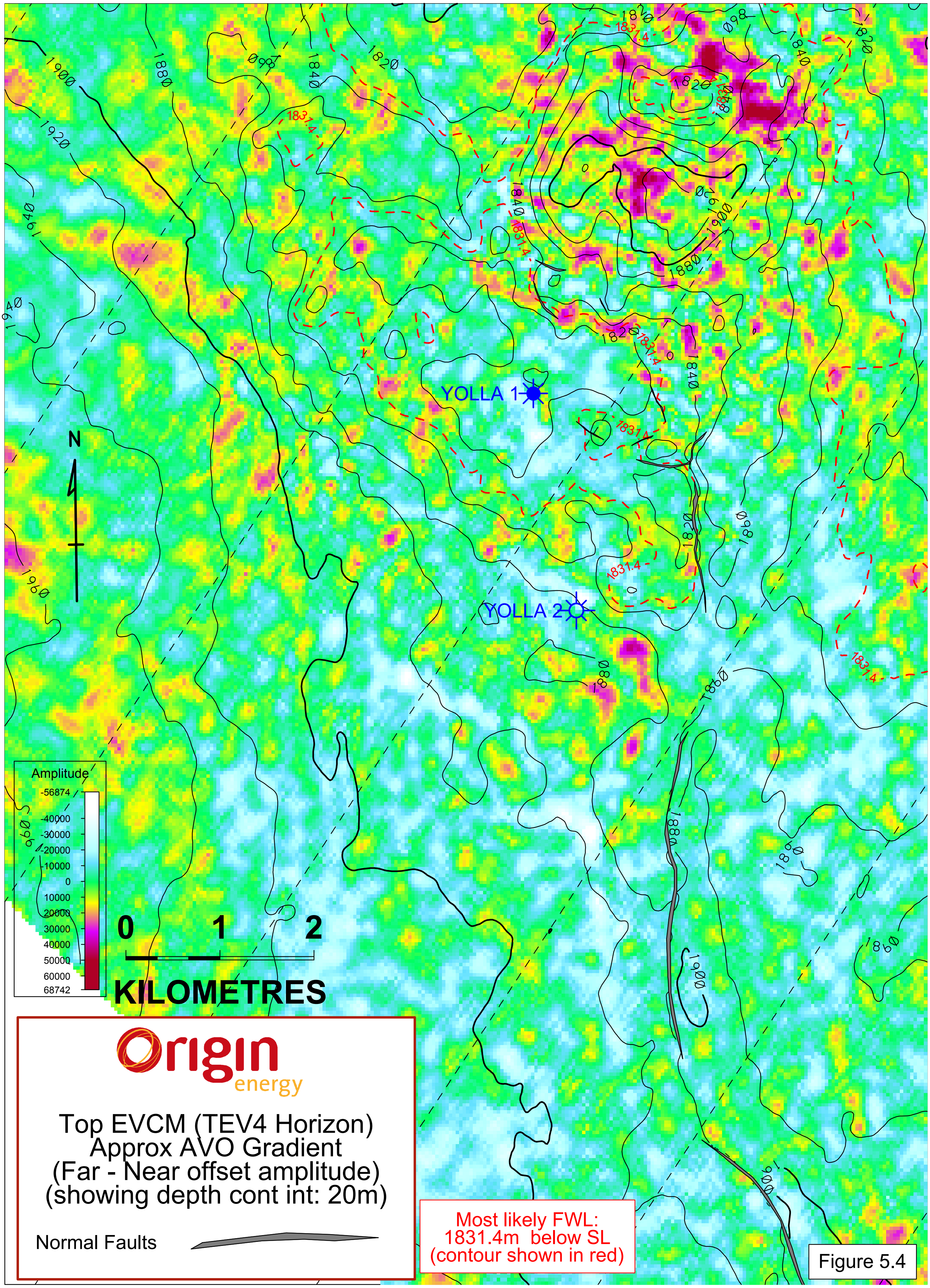
Top EVCM (TEV4 Horizon)
Instantaneous Amplitude
(Far offset volume)
(showing depth cont int: 20m)

Figure 5.2

Yolla Gas Field T/RL1



Yolla Gas Field T/RL1



Yolla Gas Field   T/RL1

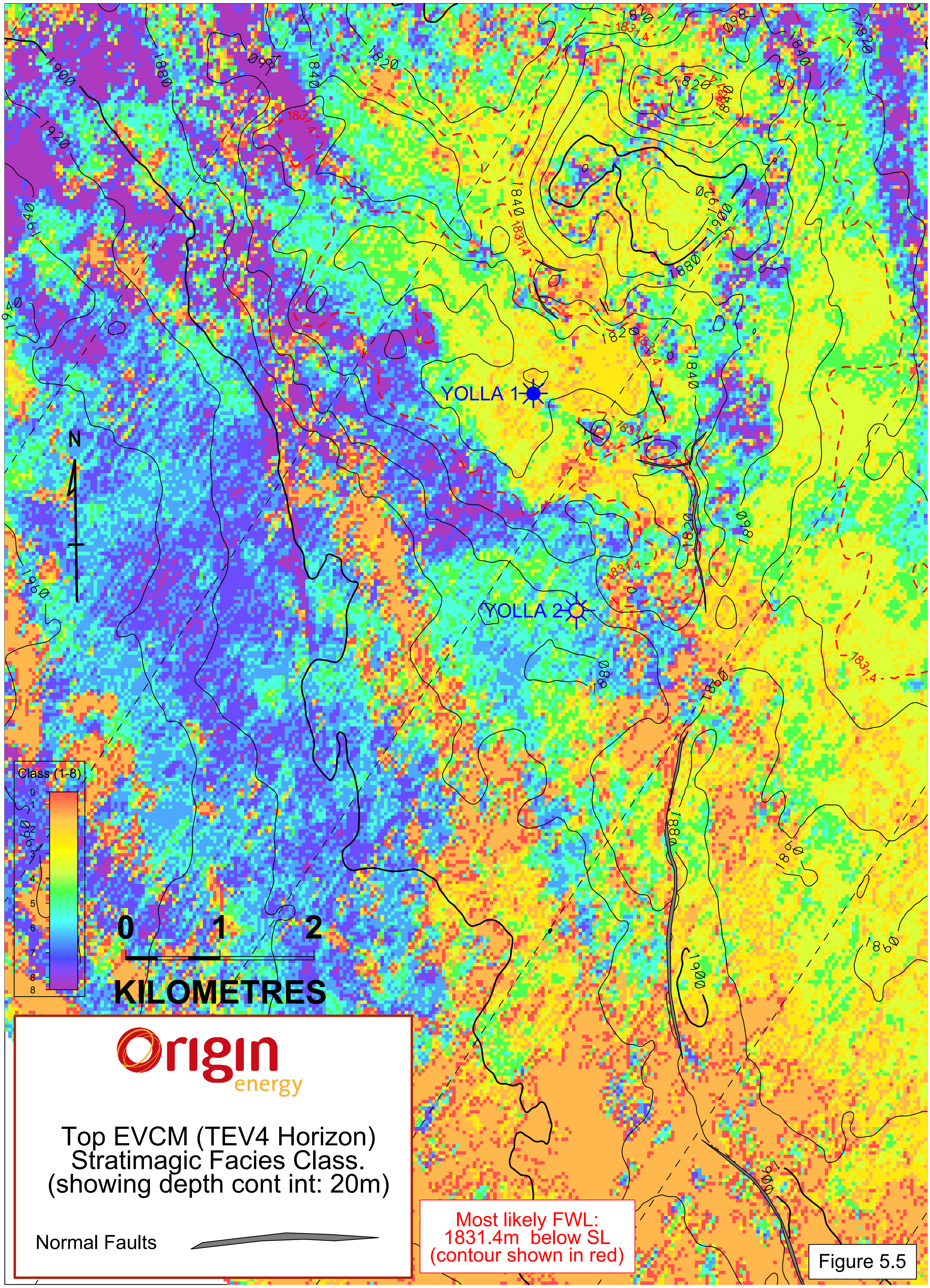


Figure 5.5

APPENDIX 1

YOLLA 3D REPROCESSING REPORT BY VERITAS

YOLLA 3D SEISMIC SURVEY

BASS BASIN BLOCK:T/RL 1

SEISMIC DATA PROCESSING REPORT

FOR

Origin energy

SUBMITTED BY

VERITAS DGC AUSTRALIA PTY. LTD.
38 ORD STREET
WEST PERTH W.A. 6005
AUSTRALIA

VERITAS
Geophysical Integrity

MARCH 2001

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

1.1 SURVEY LOCATION

The YOLLA 3D reprocessing was obtained within the Block T/RL 1 in the Bass Basin for Origin Energy Ltd. (Figure 1.1 & 1.12)

1.2 SURVEY SIZE

The survey consisted of approximately 13, 618 line kms (11, 734 cdp kms) data.
(See Appendix A for detailed line information)

1.3 ACQUISITION

The data was recorded during February and March 1994 by Western Geophysical using the seismic vessel M/V WESTERN ATLAS.

1.4 PROCESSING CONTRACTOR

All of the data was processed by Veritas DGC Australia in their Perth and Singapore processing centres for ORIGIN ENERGY LTD. Processing began on the 10th April 2000 and was completed on the 16th September 2000.

1.5 PROCESSING LOCATION

Processing was initialised at Veritas DGC Australia's Perth office on local hardware. The data was then sent to the Singapore office for the PSTM stages.

1.6 KEY PERSONNEL

Contractor Personnel (Perth):

Amy Cheang	-	Processing Manager, responsible for accuracy and throughput.
Gary Koo	-	Team Leader, responsible for project organisation and Q C.
Paul Webster	-	Geophysicist
Heidi Best	-	Technical Assistant

Origin Energy Personnel:

Randall Taylor	-	Adviser, Geophysics and Data Manager
Nigel Fisher	-	Consultant

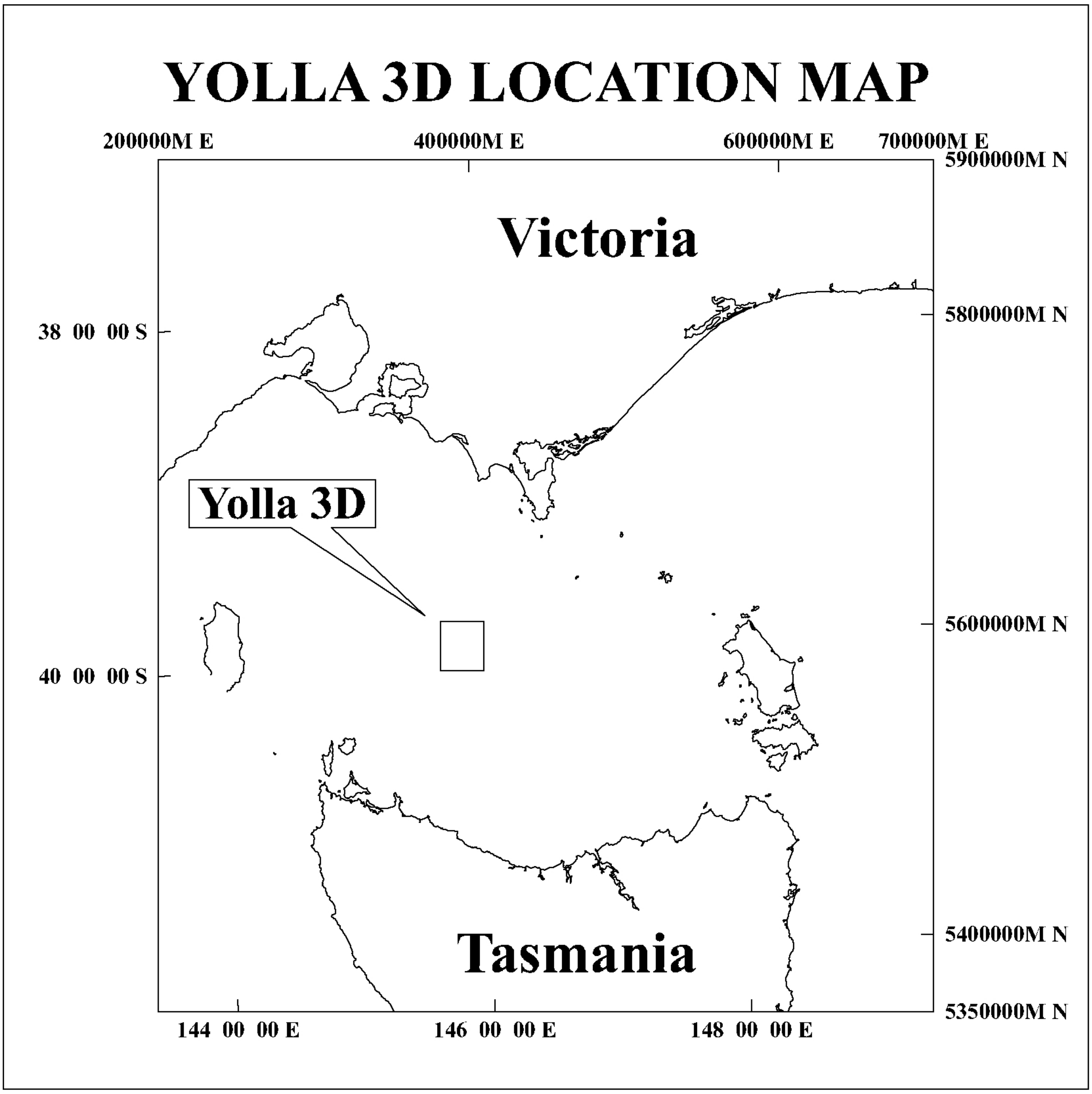


Figure 1.1: Yolla 3D Location Map

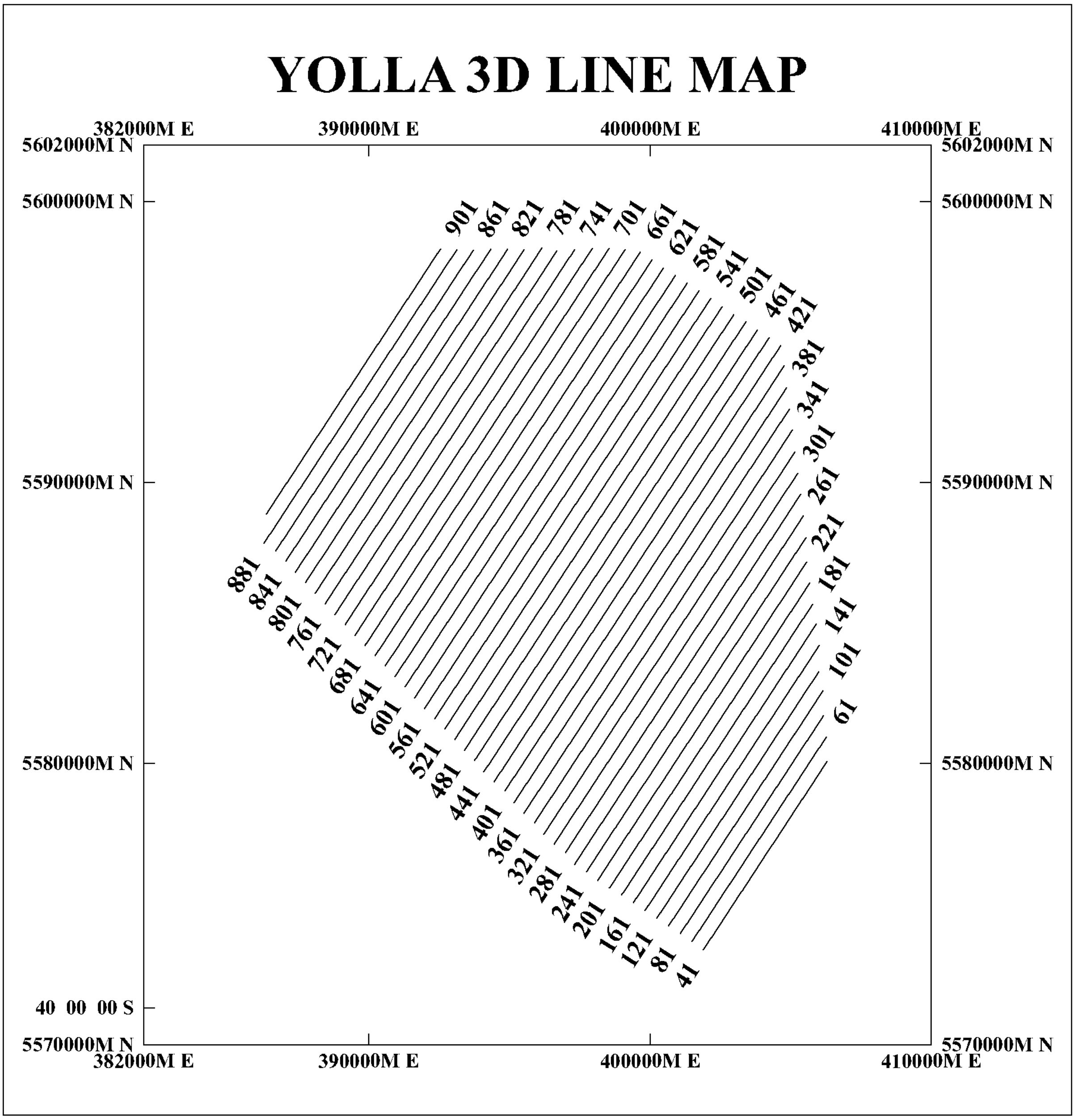


Figure 1.12: Yolla 3D Line Map

1.7 PROCESSING FLOW - Brief Summary

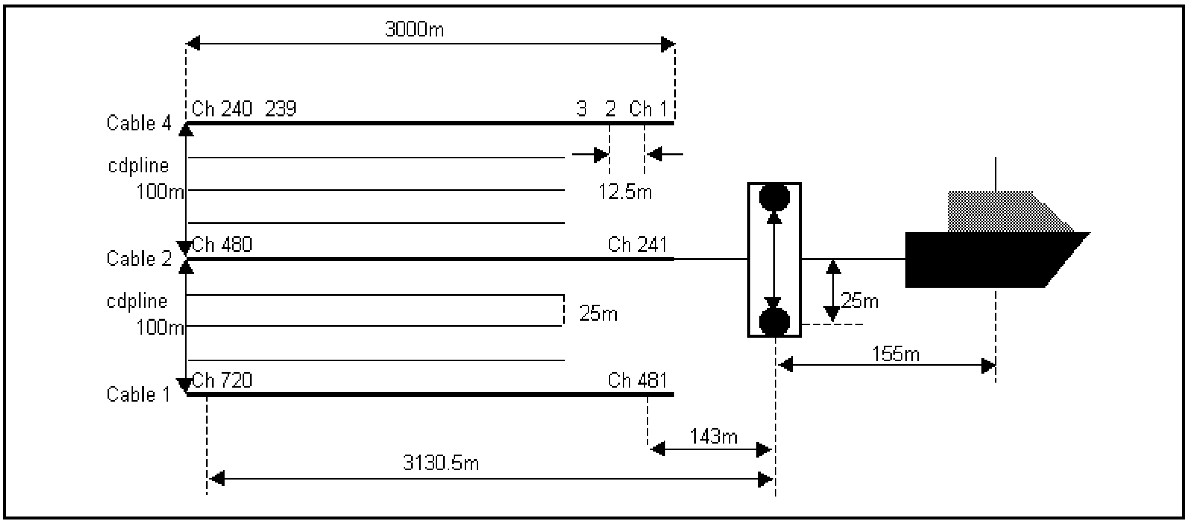
Processing Parameters:

- Transcription from SEG-D format
- Resample to 4msec with anti-alias filter applied
- Despike and trace editing
- Spherical divergence correction VVT using regional velocity function
- FK filter on shots +/- 1750 ms with NMO applied
- WEMA
- Tau-p deconvolution
- Adjacent trace summation with partial NMO correction
- Shot interpolation
- FK filter on receivers +/- 1750 ms with NMO applied
- Velocity analyses at every 1km x 1km interval
- Radon Demultiple
- Remove Interpolated traces
- Flood
- 3D Kirchhoff pre-stack time migration on target lines
- Velocity analyses at every 0.5km x 0.5km interval
- NMO correction using final 0.5km x 0.5km vels (Picked and qc'd by Nigel Fisher)
- Trace Mute applied
- Stack
- Shot and Cable corrections
- Trace interpolation: in-line direction
- Dechequer
- TV Filter
- Expanding AGC

2. ACQUISITION SUMMARY

The following is the list of seismic data acquisition parameters for the YOLLA 3D Seismic Data Processing 2000 contract

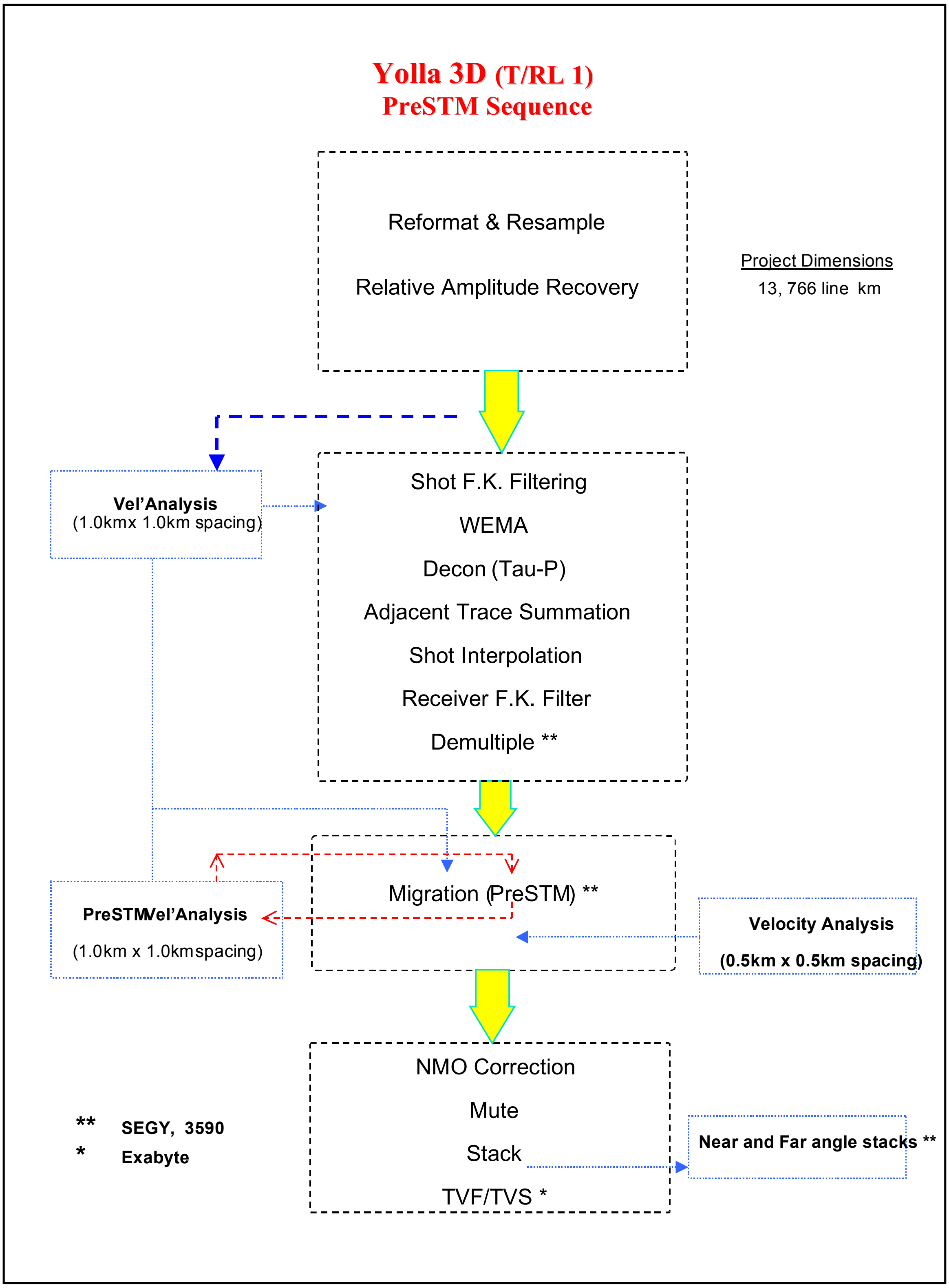
Contractor	:	WESTERN GEOPHYSICAL
Vessel	:	M/V WESTERN ATLAS
Date	:	February 1994
Energy Source:		
Source	:	Dual source
Gun depth	:	6.0 (+/- 1.5) meters
Source Interval	:	25.0 meters flip flop (50m per array)
Source to Antenna	:	155.0 meters
Receiving Arrangement:		
Near trace offset	:	143 m
Number of groups	:	720
Group interval	:	12.5 m
Streamer depth	:	10.0 (+/- 1.5) meters
Streamer length	:	3000 m
Fold of coverage	:	30
Instrumentation:		
Recording system	:	WG-24 (S/N # 14)
Recording format	:	SEG-D 4 byte 3480 cartridge
Record length	:	6 s
Sample interval	:	2 ms
Recording filter	:	low cut 6 Hz / 18 dB/Oct
	:	high cut 196 Hz / 214 dB/Oct



Source-Receiver Pattern
NB: Diagram not to scale

3. PROCESSING SUMMARY

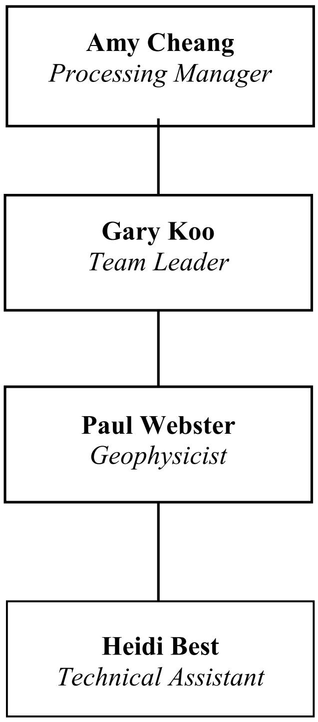
3.1 PROCESSING FLOW CHART



4. PERSONNEL AND EQUIPMENT

4.1 GEOPHYSICAL STAFFING AND ORGANISATION

Amy Cheang was the overall supervisor for this project. As Processing Manager she was responsible for technical accuracy and throughput. Gary Koo was the team leader of the processing group whilst the Geophysicist primarily involved was Paul Webster. Heidi Best was also involved during various stages of the project.



4.2 COMPUTER HARDWARE DESCRIPTION

HARDWARE INVENTORY FOR PERTH PROCESSING CENTRE

<u>HEWLETT PACKARD N CLASS</u>

PROCESSORS	:	8 PA-RISC 8500 cpu's
REAL MEMORY	:	16 Gigabytes
DISKS	:	2.4 Tbytes of Raid-5 disk arrays
TAPES	:	8 IBM Magstar 3590 cartridge drives (shared)

<u>HEWLETT PACKARD KITTYHAWK K460</u>

PROCESSORS	:	4 PA-RISC 8000 cpu's
REAL MEMORY	:	4 Gigabytes
DISKS	:	790 Gigabytes of Fast/Wide SCSI Disk RAID 5
TAPES	:	4 IBM Magstar 3590 cartridge drives (2 shared)
		1 x 3480 / 3490/E cartridge drives

<u>HEWLETT PACKARD KITTYHAWK K460</u>

PROCESSORS	:	4 PA-RISC 8000 cpu's
REAL MEMORY	:	2 Gigabytes
DISKS	:	420 Gigabytes of Fast/Wide SCSI Disk RAID 5
TAPES	:	4 IBM Magstar 3590 cartridge drives (2 shared)
		1 X 3480 / 3490/E cartridge drives

<u>HEWLETT PACKARD KITTYHAWK K160</u>

PROCESSORS	:	1 PA-RISC 8000 cpu
REAL MEMORY	:	512 Megabytes
DISKS	:	160 Gigabytes of Fast/Wide SCSI Disk RAID 5
TAPES	:	Dual ported to Magstar 3590 drives
		1 x Exabyte 8200/8500

PERIPHERALS

PLOTTERS	:	Xerox 8830 36" Laser plotter
	:	OYO GS-636-2 36" thermal plotter
	:	OYO GS-6X42 thermal film plotter
	:	HP750C Design Jet Plotter with SDI-HP Jet server plot software
	:	2 X Combination PC-SDI "R90" plotting engine
PRINTERS	:	HP 4M+ and HP 5si laser printers
	:	TEKTRONIC Phaser 350
	:	Various printers for labels and job sheets
TAPES	:	6 Exabytes CTS 8510 2.3/5 Gigabytes of data storage

WORKSTATIONS

- ❖ 5 x Hewlett Packard 9000 series 712/60 graphic workstations with 64 Megabytes of memory, 2 Gigabytes local disk
- ❖ 1 Hewlett Packard 9000 series 712/60 dual head graphics workstations with 128 Megabytes of memory, 5 Gigabytes local disk

- 4 x Hewlett Packard 9000 series 735 workstation with 400 Megabytes of memory and 4 Gbyte of disk storage
- 1 x HP B-160 dual headed workstation with 256 Mb memory and 4 Gbyte of external disk storage
- 3 HP C-180 dual-headed workstations with 1 Gigabyte of memory and 46 Gigabytes of external disk space
- 1 x HP C-360 dual headed workstation with 2 Gb of memory and 180 Gb of external Raid-5 disk storage arrays
- 3 x Gateway GL-266 computers with 64 Mb of memory 4 Gigabytes disk space
- 2 x Hewlett Packard C3235A X-Terminals
- 1 x Dell Poweredge server with 128Mb of memory and 8Gb of raid-5 arrays
- 2 x Dell 400 Workstation PI 300 with 64 Mb of memory and 6 Gb of disk space
- 2 x Dell dimension XPS T450 workstations with 128Mb of memory and 6 Gb of disk space
- 3 x Dell workstations with 128 Megabytes of memory and 6 Gigabytes disk space
- 7 x Dell Pentium/Pentium Pro P.C.'s with X emulation
- 4 x HP Kayak XA6/400 with 128 Megabytes of memory and 4 Gigabytes of disk space
- 2 x HP Kayak XA6/400 dual headed with 128 Mb of memory and 4 Gb of disk space
- 3 x HP Vectra VL8PII/400 with 128Mb of memory and 6 Gb of disk space
- 4 x Dell Inspiron laptops with 80 Megabytes of memory and 6 Gigabytes of disk space

POWER SYSTEMS

U.P.S.	:	HP main cabinets contain individual UPS units with 1.8 and 3 KVA capacities
		Liebert 7200 60 KVA computer room system with 20 minutes battery autonomy of full load

HARDWARE INVENTORY FOR SINGAPORE PROCESSING CENTRE.

NEC SX4 8/16A SUPER COMPUTER

PROCESSORS	:	8 CPU'S
REAL MEMORY	:	16 Gbyte
DISKS	:	3.6 Tbyte
TAPE SYSTEMS	:	4 x 3590 tape drives.

5. PROJECT MANAGEMENT

5.1 REPORTING PROCEDURES

Both formal and informal project meetings were held frequently with the Processing Group and Project Supervisors. Spreadsheets of individual job status were updated weekly and provided an accurate, simple check of current throughput. Excel spreadsheets were used internally to monitor the progress of the project and to flag upcoming tasks. These Microsoft files were updated once a week and sent to Nigel Fisher and Origin Energy Ltd.

5.2 PROJECT STATISTICS

The project commenced on 10th April 2000 and was completed on the 16th September 2000.

6. TESTING

6.1 PROCESSES TESTED

6.1.1 PRE STACK TESTING

1. Deconvolution Before Stack Tests

Line: YOL00427 entire line

Input data: Production shot FK & WEMA applied shot record

- Tau-P decon. 32 msec gap, 400 msec Operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Tau-P decon. 32 msec gap, 400 msec Operator, 2-gates 0.3-3.0 secs and 2.0-5.0 secs (near and far offsets). First operator applied to 2.5 secs and second operator from 3.0 seconds so operator is tapered over 500 msec
- Predictive decon. 32 msec gap, 400 msec operator, 1-gate 0.3-3.0 secs near, 2.2-4.0 secs far
- Predictive decon. 32 msec gap, 400 msec operator, 2-gates 0.3-3.0 secs near, 2.2-4.0 secs far, and 2.0-5.0 secs near and 3.0 to 5.5 secs far
- Tau-P decon. 32 msec gap, 300 msec operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Tau-P decon. 32 msec gap, 200 msec operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Predictive decon. 32 msec gap, 300 msec operator, 1-gate 0.3-3.0 secs near, 2.2-4.0 secs far
- Predictive decon. 32 msec gap, 200 msec operator, 1-gate 0.3-3.0 secs near, 2.2-4.0 secs far
- Tau-P decon. 24 msec gap, 300 msec operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Tau-P decon. 48 msec gap, 300 msec operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Designature – Tau-P decon. 32 msec gap, 400 msec operator, 1-gate 0.3-3.0 secs (near and far offsets)
- Predictive decon. 32 msec gap, 400 msec operator, 1-gate 0.3-3.0 secs near and far, with NMO and mute applied before decon.
- Predictive decon. 32 msec gap, 200 msec operator, 1-gate 0.3-3.0 secs near and far, with NMO and mute applied before decon.

2. WEMA test
Wave equation multiple attenuation.

Line: YOL00427 entire line

Input Data: Production shot FK filter applied

- WEMA with no Decon
- WEMA + Tau-P Decon (32ms + 400 Operator)
- WEMA + 32ms Gap 400ms Operator

3. Slam (Tau-P domain)
Water layer multiple attenuation using a second order predictive deconvolution in the Tau-P domain.

Line: YOL00427 entire line

Input Data: Production shot FK filter applied

- SLAM with no Decon
- SLAM + Tau-P Decon (32ms + 400 Operator)

4. Radon Multiple Attenuation Test (PMULT)

Line: YOL00427 entire line

Input data: Production FK 1750 ms gathers
- Pmult applied using 100% of Nigel Fisher's QC'd 1km velocities.

No of P traces = 500
Start Time: 300ms Full on 1000ms
Reference offset: 3000m
1) No radon
2) Transform window:-200 to 2500 ms; Subtract Window: 80 to 2500 ms, 60 fold, 500p
3) Transform window:-200 to 2500 ms; Subtract Window: 100 to 2500 ms, 60 fold, 500p
4) Transform window:-200 to 2500 ms; Subtract Window: 120 to 2500 ms, 60 fold, 500p
5) Transform window:-200 to 2500 ms; Subtract Window: 140 to 2500 ms, 60 fold, 500p
6) Transform window:-200 to 2500 ms; Subtract Window: 80 to 2500 ms, 120 fold, 500p

5. PSTM testing
Pre-stack time migration.

Line: Subline 481 entire line

Input Data: Production PMULT gathers

- 2D PreSTM stack
- 2D MOVES stack
- OMEGAX migration (90%, 95%, 97.5%, 100%, 105%) - test run on Subline 441 & 681
- PreSTM stack

6. Outer trace mute

Line: Subline 521 entire line

Input Data: Production 3D PreSTM gathers

- No mute
- Outer trace mute X = 100 T=2000, X = 700 T=2200, X = 1000 T=2500, X=1300 T=4000

Angle Mutes
- 0º - 15º
- 15º - 30º

7. Inner trace mute

Line: Testlines 201 & 361 entire line

Input Data: Production PreSTM gathers

- Inner Trace Mute X=100 T=2000, X=700 T=3000, X=1300 T=4000
- Inner Trace Mute X=100 T=2000, X=1300 T=3000, X=1900 T=4000

6.1.2 POST STACK TESTING

1. Filter Tests

Line: Subline 521 entire line

Input Data: Production Final PSTM Stack with trace interpolation in Inline direction and Dechequer applied

The following filters were tested: -

- out-7
- 5-10
- 10-20
- 15-30
- 20-40
- 25-50
- 30-60
- 40-80
- 50-100
- 60-120
- 70-120
- 80-120
- 90-120

2. Scaling Tests

Line: Subline 521 entire line

Input Data: Production Final PSTM Stack with trace interpolation in Inline direction and Dechequer and Final filter applied

- No Scaling
- AGC 500 ms
- AGC 1000 ms
- AGC 2000 ms
- with expanding AGC
- with 1-gate balance
- with 2-gate balance

7. PRODUCTION PROCESSING

7.1 COMPREHENSIVE PROCESS AND PARAMETER DESCRIPTION

1) Transcription and Resample
The field data were converted to Veritas DGC Australia's internal trace sequential format. A minimum phase anti-aliasing filter of 100Hz/72dB (see Appendix B) was applied prior to the data being resampled to 4 ms. The input data was in SEG-D format and was 6 seconds in length with a sample rate of 2 ms.

2) True Amplitude Recovery
Spherical Divergence correction (V^2T) using regional velocity function as set out below:

T (ms)	V (m/s)		T (ms)	V (m/s)
0	1500		1870	2525
110	1500		2310	2740
540	1955		2430	2820
730	2200		2590	3010
1140	2240		2710	3070
1290	2280		4800	3985
1590	2425		6000	4400

3) Navigation/Geometry

In receipt of the processed navigation data it was possible to define the limits of the 3D grid on which the data would be binned. In order to have a regular geometry the data was rotated from its real world orientation to an east-west orientation. The average direction of the sail lines was found to be 33.3 degrees from north and so the survey was rotated 56.7 degrees.
The origin of the rotated survey was selected as:
X = 4877500.0, Y = 2723000.0
This co-ordinate represents the centre of the lower left-hand bin in the survey. Subsequent bins were defined at
- 12.5 metres intervals along the x-axis (west-east)
- 12.5 metres intervals along the y-axis (south-north)

A grid of 920 sublines x 1840 crosslines was defined:
- sublines numbered 1 to 920 incremented by 1
- crosslines numbered 1 to 1840 incremented by 1

The seismic traces may now be sorted into the above 3D bins based on a primary key of common-mid-point and a secondary key of increasing offset distance within each bin group. The maximum fold is 30.

4) Shot Domain Velocity Filtering
Prior to velocity filtering, reversible NMO (using velocities provided by Origin Energy from previous processing) and a reversible 400ms AGC were applied.

Pass range:	-1750 m/s	+1750 m/s
Dips	-7.143ms/trace	+7.143 ms/trace

75% cosine tapering was used in the application of the velocity filtering.

5) WEMA
Wave Equation Multiple Attenuation was applied using a water velocity of 1500 m/s.

6) Tau–P Deconvolution
Tau-P Deconvolution was performed using the following parameters:

Gate 1 = 24 ms Gap, 200 ms Operator, design 0-2000 ms
Gate 2 = 32 ms Gap, 200 ms Operator, design 900-2800 ms
Gate 3 = 48 ms Gap, 400 ms Operator, design 2000-5000 ms

7) Adjacent Trace Summation

A differential NMO was applied prior to trace summation.

No. groups before summation	Group interval before summation	No. groups after summation	Group interval after summation
240	12.5 m	120	25 m

8) Shot interpolation

Shot interpolation was done in the receiver domain to increase the nominal fold to 60.

9) Receiver Domain Velocity Filtering

Prior to velocity filtering, reversible NMO (using velocities provided by Origin Energy) and a reversible 400ms AGC were applied.

Pass range:	-1750 m/s	+1750 m/s
Dips:	-14.28 ms/trace	+14.28 ms/trace

75% cosine tapering was used in the application of the velocity filtering.

10) Velocity Analysis (1st Pass)

The 1st pass velocity analysis was produced at a 1.0 km x 1.0 km interval using 15 cdp's in the 'mini-stacks' and 21 velocity functions for the fan. Origin Energy Ltd provided final velocities (used in previous processing) that were used as the guide velocity. These velocities were picked and QC'd by Nigel Fisher.

11) Radon Multiple Attenuation

Veritas DGC Australia's PMULT is a Multiple Attenuation program which uses a parabolic transform to decompose Normal Moveout overcorrected data into negative and positive curvature using Radon transform. The positive curvature represents multiples and the negative curvature primaries.

For the program to attenuate multiples, an appropriate normal Moveout (NMO) correction must be applied prior to the application of PMULT. The NMO overcorrection applied to these data was of the primary velocity field. The following velocities were used: -

100% Nigel Fisher QC'd 1.0km x 1.0 km velocities

Transform Window: -200 to 2500 ms
Subtract Window: 80 to 2500 ms
120 fold
500 p values were used
Start time: 300 ms and Full on at 1000 ms

The effect of the Radon transform multiple attenuation is to remove the faster velocity multiples from the data.

12) Remove Interpolated traces

Remove interpolated traces for subsequent processing sequence. Output 30 fold with 100 m offset.

13) Flood

Fold Levelling for Optimised Offset Distribution is a pre-stack interpolation algorithm that resamples the data from its original irregular positions to a regular grid of traces whose mid points lie at bin centres.

14) Velocity Analysis (2nd Pass)

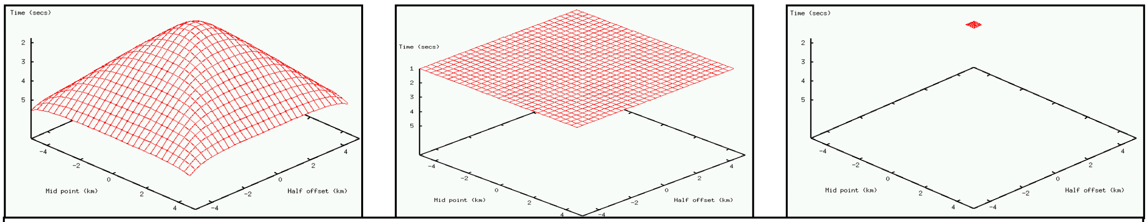
The 2nd pass velocity analysis was produced at a 1.0 km x 1.0 km interval using 15 cdp's in the 'mini-stacks' and 21 velocity functions for the fan PreSTM applied. 1st pass 1.0 km x 1.0 km velocities were used as the guide velocity. These velocities were picked and QC'd by Nigel Fisher.

PSTM for target velocity lines were produced with the following vels:
100% vels at 0.0 – 1.8 sec
95% vels at 2.2 – 6.0 sec

15) Pre-Stack Time migration

INTRODUCTION

Migration may be viewed as the process of flattening and stacking diffraction surfaces, see figure below. The better the migration algorithm is at computing the corrections necessary to flatten these shapes the sharper and more detailed the final image will be. In conventional processing many assumptions are made and the corrections are not optimal.



Migration may be viewed as diffraction flattening and summation.

Kirchhoff pre-stack time migration may be implemented so as not to make any assumptions on the shape of the diffraction surfaces. Veritas' implementation of pre-stack time migration (prestm3d) falls into this category. Provided lateral velocity variations are small Kirchhoff pre-stack time migration will often give as good an answer as pre-stack depth migration.

Kirchhoff migration may be implemented in a variety of ways. Prestm3d is based on the following implementation details:

1. For any input trace the migration "corrections" are based on the time varying velocity at the mid-point of the input trace. A trace at a different mid-point will be migrated using a potentially different velocity function.

2. The corrections are based on the actual source and receiver locations. Travel-times from the shot and receiver to the imaging point (output target) are computed and added together to form the corrections.

3. Each input trace is "sprayed" after corrections and summed into all output target locations.

4. The amplitude weights are based on Schneider's (1978) paper.

5. A derivative filter is also applied before summing into the output volume.

6. Anti-aliasing is applied to minimize aliasing noise on the output image. The anti-aliasing is based on the paper by Lumley et. al. (1994) but modified to handle finite offsets better.

KIRCHHOFF PRE-STACK TIME MIGRATION PROCESSING FLOW

After pre-processing velocities are picked to form a smooth velocity field to be used for the first pass of prestm3d. Gathers are output from the migration on a user-specified grid, every 1 km. Inverse NMO is then performed on the migrated gathers before picking new velocities. These velocities are picked from data that is close to its correct spatial location and should thus be more accurate than velocities picked from conventional processing.

The data are then migrated with the spatially varying velocity field either outputting to a sparse grid for another iteration of velocity estimation or to the full output volume. After the last iteration a final fine-tuning of velocities is performed before stacking the data.

16) Velocity Analysis (Final)

The final velocity analysis was produced at a 0.5 km 0.5 km interval fan using gathers from final PSTM production. 1.0 km x 1.0 km 2nd Pass velocities were used as the guide velocity. These velocities were picked and QC'd by Nigel Fisher.

17) NMO Correction

Using final velocities approved by Nigel Fisher.

18) Mute

Offset of Inner Mute	Time of Inner mute	Offset of Outer mute	Time of Outer mute
100	2000	300	20
700	2200	425	450
1000	2500	1650	1300
1300	4000	3150	2700
1301	6000		

19) Common Midpoint Stack
Nominal fold: 30

20) Gun and Cable Depth Corrections
Source correction = 4.00 ms   Streamer correction = 6.66 ms

21) Trace interpolation
Trace interpolation was done in the In-line direction. The Cross-line interval after trace interpolation was at a 12.5m interval.

22) Dechequer
K-domain anti-alias filter to remove the chequerboard noise amongst the shallow data.
For this survey dechequer was applied at 50ms to 600ms.

23) Time Variant Filter

5/24 - 90/72	0 ms
5/18 - 80/70	1000 ms
8/12 - 70/60	2000 ms
5/8 - 50/40	3000 ms
5/8 - 40/30	6000 ms

24) Scaling
Expanding AGC

Gate time (ms)	Gate length (ms)
0	250
3000	1000
4500	2000

8. VELOCITY ANALYSIS

8.1 TYPE OF VELOCITY ANALYSIS AND PARAMETERS

All of the velocity analyses were picked using Veritas DGC Australia's interactive DIVAN software (part of the Tango processing system) using HP735 and HP712 workstations. The screen display consisted of the central gather, a stack panel for each of the velocity functions in the fan, and a velocity window showing coloured semblance contours and stack amplitude picks. Iso-velocity contour displays were also displayed. Fifteen cdp's were used in the mini-stacks and twenty-one velocity functions were used in the fan.

The 1st Pass Velocities were picked and QC'd by Nigel Fisher - with brute stacks created with these velocities.

The 2nd Pass and Final Velocities were picked and QC'd by Nigel Fisher. PSTM stacks and iso-velocity plots (using the 2nd pass velocities) were produced to aid in the QC of the Final Velocities. PSTM stacks created with these velocities were produced and sent to Origin Energy Ltd. for final QC.

9. QUALITY CONTROL

9.1 PROCEDURES / METHODS

Quality control procedures were conducted at every phase of this processing project. The following is a summary of the QC steps taken on a regular basis for each of the major processing phases.

- Display of raw near trace gathers produced at the completion of field tape processing.
- Raw shot displays every 100th shot produced at the completion of field tape processing.
- Timeslices of the regional velocity field produced by Origin Energy displayed on a pseudo 3D-velocity grid.
- Brute stack display for Pre-processed data using the velocities supplied by Origin Energy.
- Timeslices of the 1st pass velocities displayed on a pseudo 3D-velocity grid.
- Brute stack display for the pre-processed data using the 1st pass velocities that were picked and QC'd by Nigel Fisher.
- PSTM Stack - Stacked with 1st pass velocities.
- Time slice displays of the 1st pass velocities.
- Timeslices of the 2nd pass velocities displayed on a 3D-velocity grid.
- Preliminary PSTM Stack (V2) - Stacked with 2nd pass velocities.
- QC PSTM Stack
- Final Migrated Stack Seg-Y QC

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 COMMENTS ON PERFORMANCE OF PROJECT

The project began well with the initial Reformatting / Resampling and Pre-processing jobs running without any major problems. This was followed by a period of relatively constant production, which directly represented the 1st pass velocities. Unfortunately a lull in production associated with shortage of NEC or machine time for Pre Stack Time Migration pulled the project percentage complete down below plan. Once the final velocities were completed and the post stack parameters confirmed the project was completed rapidly.

10.2 CONCLUSIONS

From a processing point of view the overall data quality of the project was good with a definite increase in frequency content, especially in the shallow part of the section. The fault planes and volcanic intrusions were well defined by using Kirchhoff Prestack Time Migration.

It must be noted that Veritas DGC Australia greatly appreciated the client / contractor liaison which figured prominently throughout the duration of the project. From the very beginning we had very good communications with Origin Energy and Nigel Fisher as the consultant.

10.3 RECOMMENDATIONS

Reduce delay of decisions on processing parameters for critical processes. This must begin with improved planning, prompt creation, delivery, and examination of these tests by both Veritas DGC Australia and Origin Energy (Nigel Fisher). This was not a problem with respect to the overall project.

APPENDIX A – DETAILED LINE INFORMATION

I. SEISMIC LINE DATA LIST

(Shot gather SEGY at 2ms sample rate)

Line	Reel	First Navshot	Last Navshot	Sail Line KM's	CDP KM's
YOL00001	1shotsegy	292	32	6.500	39.000
YOL00007	7shotsegy	299	32	6.675	40.050
YOL00013	13shotsegy	307	32	6.875	41.250
YOL00019	19shotsegy	314	32	7.050	42.300
YOL00025	25shotsegy	321	32	7.225	43.350
YOL00031	31shotsegy	329	32	7.425	44.550
YOL00037	37shotsegy	336	32	7.600	45.600
YOL00043	43shotsegy	344	32	7.800	46.800
YOL00049	49shotsegy	351	32	7.975	47.850
YOL00055	55shotsegy	358	32	8.150	48.900
YOL00061	61shotsegy	366	32	8.350	50.100
YOL00067	67shotsegy	373	32	8.525	51.150
YOL00073	73shotsegy	380	32	8.700	52.200
YOL00079	79shotsegy	388	32	8.900	53.400
YOL00085	85shotsegy	395	32	9.075	54.450
YOL00091	91shotsegy	403	170	5.825	34.950
YOL00097	97shotsegy	410	32	9.450	56.700
YOL00103	103shotsegy	417	32	9.625	57.750
YOL00109	109shotsegy	425	32	9.825	58.950
YOL00115	115shotsegy	412	52	9.000	54.000
YOL00121	121shotsegy	439	32	10.175	61.050
YOL00127	127shotsegy	447	32	10.375	62.250
YOL00133	133shotsegy	454	32	10.550	63.300
YOL00139	139shotsegy	461	32	10.725	64.350
YOL00145	145shotsegy	469	32	10.925	65.550
YOL00151	151shotsegy	476	32	11.100	66.600
YOL00157	157shotsegy	484	32	11.300	67.800
YOL00163	163shotsegy	491	32	11.475	68.850
YOL00169	169shotsegy	498	32	11.650	69.900
YOL00175	175shotsegy	506	32	11.850	71.100
YOL00181	181shotsegy	513	32	12.025	72.150
YOL00187	187shotsegy	520	32	12.200	73.200
YOL00193	193shotsegy	110	606	12.400	74.400
YOL00199	199shotsegy	110	613	12.575	75.450
YOL00205	205shotsegy	110	621	12.775	76.650
YOL00211	211shotsegy	110	628	12.950	77.700
YOL00217	217shotsegy	110	635	13.125	78.750
YOL00223	223shotsegy	110	643	13.325	79.950
YOL00229	229shotsegy	110	650	13.500	81.000
YOL00235	235shotsegy	110	657	13.675	82.050

YOL00241	241shotsegy	126	584	11.450	68.700
YOL00247	247shotsegy	113	672	13.975	83.850
YOL00253	253shotsegy	110	675	14.125	84.750
YOL00259	259shotsegy	116	687	14.275	85.650
YOL00265	265shotsegy	117	694	14.425	86.550
YOL00271	271shotsegy	119	702	14.575	87.450
YOL00277	277shotsegy	120	709	14.725	88.350
YOL00283	283shotsegy	122	717	14.875	89.250
YOL00289	289shotsegy	123	724	15.025	90.150
YOL00295	295shotsegy	124	731	15.175	91.050
YOL00301	301shotsegy	126	739	15.325	91.950
YOL00307	307shotsegy	127	486	8.975	53.850
YOL00313	313shotsegy	143	753	15.250	91.500
YOL00319	319shotsegy	130	761	15.775	94.650
YOL00325	325shotsegy	131	768	15.925	95.550
YOL00331	331shotsegy	133	593	11.500	69.000
YOL00337	337shotsegy	134	783	16.225	97.350
YOL00343	343shotsegy	135	609	11.850	71.100
YOL00349	349shotsegy	137	798	16.525	99.150
YOL00355	355shotsegy	138	805	16.675	100.050
YOL00361	361shotsegy	140	813	16.825	100.950
YOL00367	367shotsegy	141	820	16.975	101.850
YOL00373	373shotsegy	142	827	17.125	102.750
YOL00379	379shotsegy	144	829	17.125	102.750
YOL00385	385shotsegy	145	829	17.100	102.600
YOL00391	391shotsegy	147	829	17.050	102.300
YOL00397	397shotsegy	148	829	17.025	102.150
YOL00403	403shotsegy	149	749	15.000	90.000
YOL00409	409shotsegy	151	829	16.950	101.700
YOL00415	415shotsegy	152	829	16.925	101.550
YOL00421	421shotsegy	154	829	16.875	101.250
YOL00427	427shotsegy	155	829	16.850	101.100
YOL00433	433shotsegy	157	829	16.800	100.800
YOL00439	439shotsegy	158	829	16.775	100.650
YOL00445	445shotsegy	160	356	4.900	29.400
YOL00451	451shotsegy	161	829	16.700	100.200
YOL00457	457shotsegy	162	829	16.675	100.050
YOL00463	463shotsegy	164	829	16.625	99.750
YOL00469	469shotsegy	165	829	16.600	99.600
YOL00475	475shotsegy	167	829	16.550	99.300
YOL00481	481shotsegy	168	829	16.525	99.150
YOL00487	487shotsegy	170	829	16.475	98.850
YOL00493	493shotsegy	171	829	16.450	98.700
YOL00499	499shotsegy	173	829	16.400	98.400
YOL00505	505shotsegy	174	829	16.375	98.250
YOL00511	511shotsegy	175	829	16.350	98.100
YOL00517	517shotsegy	177	829	16.300	97.800
YOL00523	523shotsegy	178	829	16.275	97.650
YOL00529	529shotsegy	180	815	15.875	95.250
YOL00535	535shotsegy	181	829	16.200	97.200

YOL00541	541shotsegy	183	829	16.150	96.900
YOL00547	547shotsegy	184	829	16.125	96.750
YOL00553	553shotsegy	186	829	16.075	96.450
YOL00559	559shotsegy	187	829	16.050	96.300
YOL00565	565shotsegy	188	829	16.025	96.150
YOL00571	571shotsegy	190	829	15.975	95.850
YOL00577	577shotsegy	191	829	15.950	95.700
YOL00583	583shotsegy	208	467	6.475	38.850
YOL00589	589shotsegy	194	829	15.875	95.250
YOL00595	595shotsegy	196	829	15.825	94.950
YOL00601	601shotsegy	197	829	15.800	94.800
YOL00607	607shotsegy	198	829	15.775	94.650
YOL00613	613shotsegy	200	829	15.725	94.350
YOL00619	619shotsegy	201	829	15.700	94.200
YOL00625	625shotsegy	203	829	15.650	93.900
YOL00631	631shotsegy	212	829	15.425	92.550
YOL00637	637shotsegy	748	128	15.500	93.000
YOL00643	643shotsegy	744	129	15.375	92.250
YOL00649	649shotsegy	740	131	15.225	91.350
YOL00655	655shotsegy	735	132	15.075	90.450
YOL00661	661shotsegy	732	133	14.975	89.850
YOL00667	667shotsegy	728	135	14.825	88.950
YOL00673	673shotsegy	724	136	14.700	88.200
YOL00679	679shotsegy	720	138	14.550	87.300
YOL00685	685shotsegy	716	139	14.425	86.550
YOL00691	691shotsegy	712	141	14.275	85.650
YOL00697	697shotsegy	709	147	14.050	84.300
YOL00703	703shotsegy	705	143	14.050	84.300
YOL00709	709shotsegy	701	145	13.900	83.400
YOL00715	715shotsegy	697	145	13.800	82.800
YOL00721	721shotsegy	693	148	13.625	81.750
YOL00727	727shotsegy	689	149	13.500	81.000
YOL00733	733shotsegy	685	150	13.375	80.250
YOL00739	739shotsegy	681	152	13.225	79.350
YOL00745	745shotsegy	677	153	13.100	78.600
YOL00751	751shotsegy	671	154	12.925	77.550
YOL00757	757shotsegy	669	156	12.825	76.950
YOL00763	763shotsegy	665	158	12.675	76.050
YOL00769	769shotsegy	661	159	12.550	75.300
YOL00775	775shotsegy	657	160	12.425	74.550
YOL00781	781shotsegy	653	162	12.275	73.650
YOL00787	787shotsegy	649	163	12.150	72.900
YOL00793	793shotsegy	645	165	12.000	72.000
YOL00799	799shotsegy	641	166	11.875	71.250
YOL00805	805shotsegy	637	168	11.725	70.350
YOL00811	811shotsegy	615	169	11.150	66.900
YOL00817	817shotsegy	629	170	11.475	68.850
YOL00823	823shotsegy	625	172	11.325	67.950
YOL00829	829shotsegy	621	173	11.200	67.200
YOL00835	835shotsegy	617	183	10.850	65.100

YOL00841	841shotsegy	613	172	11.025	66.150
YOL00847	847shotsegy	609	177	10.800	64.800
YOL00853	853shotsegy	605	179	10.650	63.900
YOL00859	859shotsegy	601	188	10.325	61.950
YOL01055	1055shotsegy	358	40	7.950	47.700
YOL01067	1067shotsegy	340	40	7.500	45.000
YOL01085	1085shotsegy	184	40	3.600	21.600
YOL01115	1115shotsegy	420	80	8.500	51.000
YOL01133	1133shotsegy	410	40	9.250	55.500
YOL01145	1145shotsegy	345	38	7.675	46.050
YOL01187	1187shotsegy	510	40	11.750	70.500
YOL01343	1343shotsegy	140	780	16.000	96.000
YOL01349	1349shotsegy	140	370	5.750	34.500
YOL01367	1367shotsegy	150	810	16.500	99.000
YOL01421	1421shotsegy	300	825	13.125	78.750
YOL01439	1439shotsegy	170	545	9.375	56.250
YOL01451	1451shotsegy	170	820	16.250	97.500
YOL01469	1469shotsegy	175	820	16.125	96.750
YOL01487	1487shotsegy	170	820	16.250	97.500
YOL01499	1499shotsegy	173	820	16.175	97.050
YOL01517	1517shotsegy	177	820	16.075	96.450
YOL01595	1595shotsegy	335	820	12.125	72.750
YOL01637	1637shotsegy	206	820	15.350	92.100
YOL01649	1649shotsegy	735	365	9.250	55.500
YOL01661	1661shotsegy	605	140	11.625	69.750
YOL01667	1667shotsegy	720	175	13.625	81.750
YOL01679	1679shotsegy	450	140	7.750	46.500
YOL01685	1685shotsegy	680	145	13.375	80.250
YOL01709	1709shotsegy	701	155	13.650	81.900
YOL01739	1739shotsegy	681	160	13.025	78.150
YOL01751	1751shotsegy	541	160	9.525	57.150
YOL01817	1817shotsegy	385	695	7.750	46.500
YOL01835	1835shotsegy	260	620	9.000	54.000
YOL10091	10091shotsegy	184	32	3.800	22.800
YOL10109	10109shotsegy	406	374	0.800	4.800
YOL10307	10307shotsegy	486	745	6.475	38.850
YOL10319	10319shotsegy	301	380	1.975	11.850
YOL10331	10331shotsegy	500	776	6.900	41.400
YOL10343	10343shotsegy	594	790	4.900	29.400
				2269.675	**13618.050**

APPENDIX B - DELIVERABLE ITEMS

I. CDP GATHER SEG-Y ARCHIVE TAPES

PMULT/PSTM gathers			
		PMULTGATH	**PSTMGATH**
Tape Number	Subline Range	Tape Name	Tape Name
1	34-50	PMULTGATH_1	PSTMGATH_1
2	51-100	PMULTGATH_2	PSTMGATH_2
3	101-150	PMULTGATH_3	PSTMGATH_3
4	151-200	PMULTGATH_4	PSTMGATH_4
5	201-250	PMULTGATH_5	PSTMGATH_5
6	251-300	PMULTGATH_6	PSTMGATH_6
7	301-350	PMULTGATH_7	PSTMGATH_7
8	351-400	PMULTGATH_8	PSTMGATH_8
9	401-450	PMULTGATH_9	PSTMGATH_9
10	451-500	PMULTGATH_10	PSTMGATH_10
11	501-550	PMULTGATH_11	PSTMGATH_11
12	551-600	PMULTGATH_12	PSTMGATH_12
13	601-650	PMULTGATH_13	PSTMGATH_13
14	651-700	PMULTGATH_14	PSTMGATH_14
15	701-750	PMULTGATH_15	PSTMGATH_15
16	751-800	PMULTGATH_16	PSTMGATH_16
17	801-850	PMULTGATH_17	PSTMGATH_17
18	851-905	PMULTGATH_18	PSTMGATH_18

II. STACK DATA SEG-Y ARCHIVE TAPES

Stack Archive (3590)		
Tape	***Description***	***Format***
FINAL3DPSTM1 (34-450)	Final filtered Migration (Full/Far/ Near)	Seg-Y
FINAL3DPSTM2 (451-905)	Final filtered Migration (Full/Far/Near)	Seg-Y

NB: Two times five sets of Full Migration data and two times one set of Near and Far Migration data were delivered to the client.

III. MISCELLANEOUS DELIVERABLES

Velocities		
Copy	***Description***	***Format***
Digital - sent through Email	Stacking Velocities	Western
Archive CD-ROM	Report/Velocities + Navigation data	

APPENDIX C - DETAILS OF CRITICAL PROCESSES

I. ANTI-ALIAS FILTER (Used in resampling)

Sample No. Coefficients

0	-	4	0.089900	0.401200	0.837100	1.000000	0.621300
5	-	9	-0.030200	-0.391600	-0.238500	0.108300	0.223300
10	-	14	0.053800	-0.124400	-0.106500	0.029000	0.091200
15	-	19	0.029000	-0.049300	-0.047500	0.009600	0.039200
20	-	24	0.014400	-0.020400	-0.021400	0.003100	0.017000
25	-	29	0.007000	-0.008500	-0.009600	0.000900	0.007300
30	-	34	0.003300	-0.003300	-0.004100	-0.000100	0.002500
35	-	39	0.001500	-0.000700	-0.001200	-0.000200	0.000600
40	-	44	0.000400	-0.000200	-0.000300	-0.000100	0.000100
45	-	49	0.000100	-0.000100	0.000100	0.000000	0.000000
50	-	54	0.000000	0.000000	0.000000	0.000000	0.000000
55	-	59	0.000000	0.000000	0.000000	0.000000	0.000000
60	-	63	0.000000	0.000000	0.000000	0.000000	

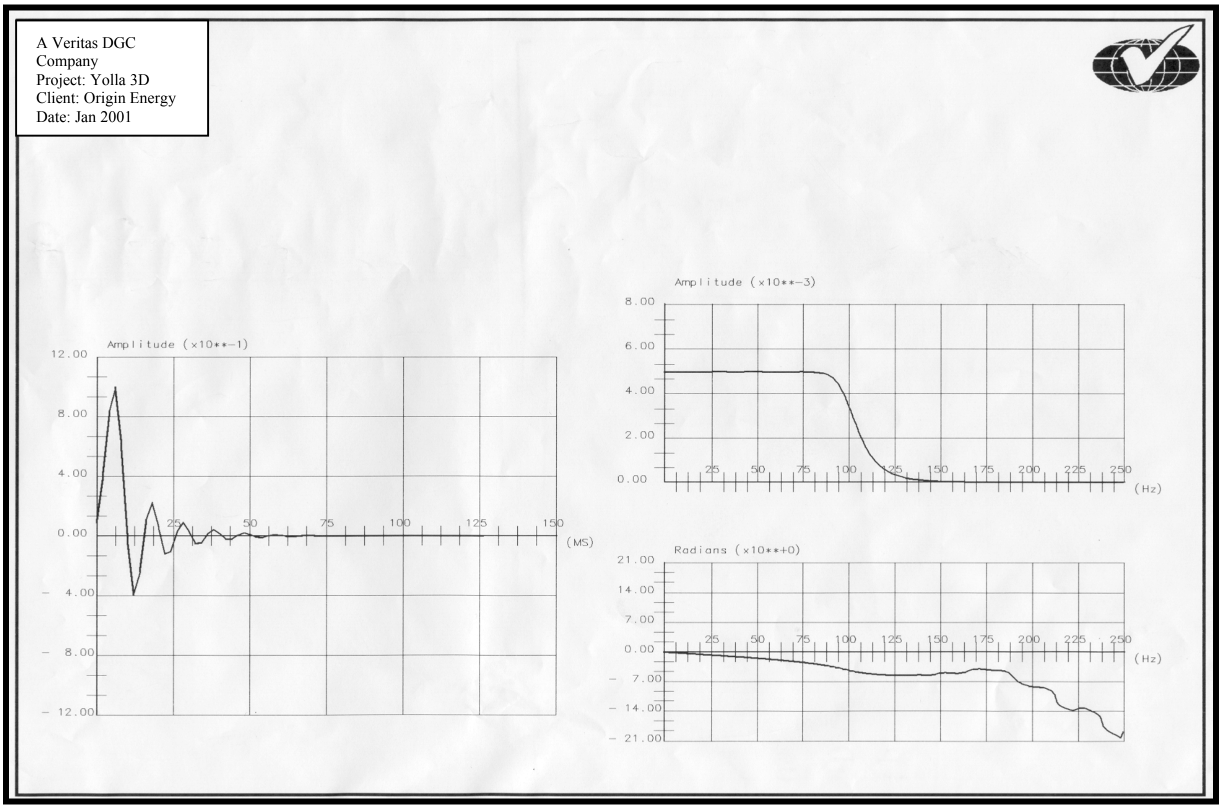


Figure C.1: Frequency spectrum plot of anti-alias filter used in resampling process.

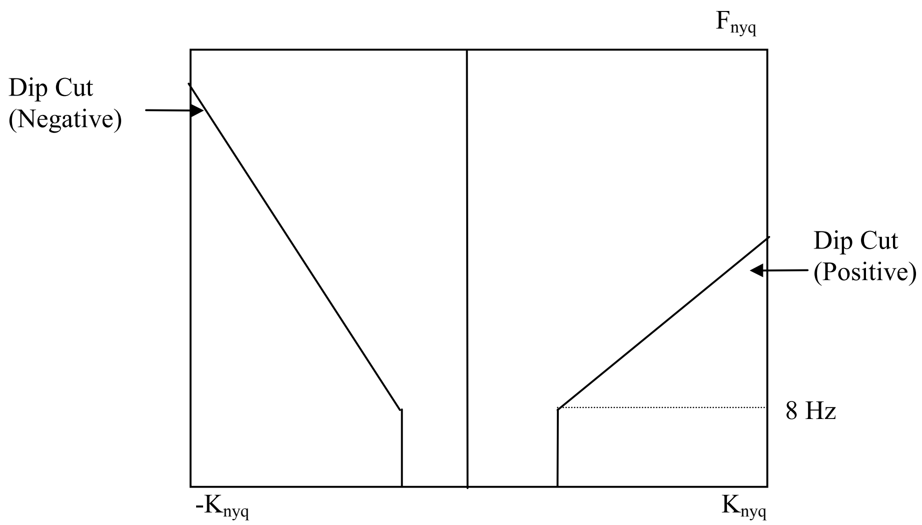
APPENDIX D - TECHNOLOGY DESCRIPTIONS

TRANSCRIPTION AND RESAMPLE
The process of converting and/or demultiplexing the field data into Veritas DGC Australia's internal trace sequential format. A minimum phase anti-alias filter is used to avoid temporal aliasing when resampling. This filter has a simple high cut form.

TRUE AMPLITUDE RECOVERY
This is a correction for amplitude losses that are due to the spherical spreading of the wavefront. Thus, as the amplitude of the recorded trace varies inversely with the radius of the advancing wavefront, each trace is multiplied by a function Velocity (V) and Time (T) (eg: V^2T, VT, VT^2), where V is the seismic wave velocity and T is the two-way time. An additional exponential or linear gain correction may also be applied.

SHOT AND STREAMER DEPTH STATIC CORRECTIONS
Simple static corrections are made to compensate for the depths of the sources and receivers and shift the seismic data to a sea level datum. These statics are usually so small that the point of application is not significant.

SHOT DOMAIN FK VELOCITY FILTER
FK velocity filtering can be applied as a two-dimensional T-X convolution in the FK domain. The default attenuation at the specified dip value is 40 dB (for Cosine tapering). Low frequencies are protected by the use of "chimney" (see diagram) starting at a default value of 8 Hz.



There are two options for the construction of the filters:

(a) Cosine Tapering

A cosine shaped taper begins at a given percentage of the distance between K=0 and the Dip cut. 100% cosine tapers begin to taper at K=0 and, for example, 25% cosine tapers begin to taper at 75% of the distance from K=0 to the dip cut. The default value for attenuation at the dip cut is -40 dB.

(b) Cut / Slope Parameterisation (The "Power" option)

Here the Dip Cut value is specified and a dB/octave roll-off for the attenuation past that point.

SPIKING AND PREDICTIVE DECONVOLUTION

Veritas DGC Australia's implementation of spiking and predictive deconvolutions follow the conventional Weiner - Levinson theory. Optimum minimum phase squared error filters are computed over a given design window for a given filter length. Multiple filters can be computed and applied in a time variant manner.
There are options for standard single trace Deconvolution or filter computations using running averaged autocorrelations (averaging distance specified in metres), or also based on a whole shot averaged autocorrelation (ie. One Deconvolution filter per shot).
The aim of the spiking Deconvolution is to whiten the wavelet spectrum and increase resolution. Predictive Deconvolution uses autocorrelations to predict and subtract features like multiple reflections.

Q COMPENSATION / ABSORPTION CORRECTIONS

Inelastic attenuation causes a frequency dependent energy loss during propagation. These effects are removed using inverse Q filtering. Veritas DGC Australia's QMOD module performs inverse Q filtering using Pareto-Levy stretch, as described in Brickel, S., 1993, Geophysics, Vol. 58, pages 1629 - 1633.
Options exist for amplitude and / or phase correction as well as for interval Q, effective Q or constant Q / T specification. The Q modules can be tied to water bottom times.

MULTIPLE ATTENUATION BASED ON MOVEOUT DIFFERENCES

For multiple attenuation based on Moveout difference between primary and multiple reflections, the critical step is to determine the primary and multiple velocities. Usually the multiple velocity is specified as a time variant percentage of the primary velocities.

(a) ZMULT

The CDP gather is Moveout corrected using the multiple velocity. This forces primary energy to be over corrected and multiples to be either flattened or undercorrected. The Moveout corrected gather is transformed to the FK domain where primaries will be in the negative K quadrant and multiples in the positive K quadrant. The positive quadrant is then simply zeroed and the data is inverse transformed back to the T-X domain. The original Moveout correction is then removed and CDP gathers with attenuated multiples is the result.

(b) PMULT

PMULT decomposes the Moveout corrected CDP gather into parabolic Radon domain (i.e. parabolic curvature versus zero offset time). Parabolic curvature is specified in terms of differential Moveout (far offset time - near offset time).
A curvature range is specified for the transform and then a subset of this range is specified for either preservation or subtraction. Usually, the multiple range is specified for subtraction. In this mode the multiple range is inverse transformed to the T-X domain and subtracted from the original gather.
Other important parameters used in PMULT are the number of curvature samples (p traces) used in the transform and / or the maximum frequency used to automatically compute the number of p traces.

PRE STACK TIME MIGRATION

Veritas DGC 's pre-stack time migration utilises a Kirchhoff algorithm, and incorporates anti-aliasing filters to reduce migration noise. The application of 3D pre-stack migration can be thought of as a transform. The data is transformed to the migrated gather domain where velocity analysis, noise attenuation and multiple suppression can be easier, and is then inverse transformed after stack using inverse migration. The result is a superior stack and migration field. However it should be remembered that the pre-stack migration is a time migration. If rapid lateral velocity variations exist the process will not be applicable, as the time migration will not be able to migrate the events to the correct location.

The benefits of 3D pre-stack time migration include improved stacking attenuation of dipping noise, a more accurate velocity field and a better quality final migration.

NMO CORRECTION

The NMO is performed assuming that the energy travels in a straight ray path and utilizes the following equation:

$$TT = \sqrt{(T0^2 + X^2 / V_{rms}^2)}$$

where TT = Total recorded travel time in seconds; X = Offset
T0 = Time of reflector at zero offset in seconds; Vrms = RMS velocity

Velocity-time knee points are honoured on adjacent control points prior to interpolation of the temporal velocity field. The space variant velocity function is then derived by linear interpolation between control points.

COMMON DEPTH POINT STACK

Stack is the summation of traces within each CDP producing a single stacked trace for each input gather record. The stack is normalised and mute zone compensated to account for the smaller number of live traces in the mute zone and for uneven fold of coverage. This recovery scaling is usually 1/n or 1/√n, where n is the number of live traces at that two - way time value.

ZERO OFFSET TIME MIGRATION

Veritas DGC Australia has the following range of time migration algorithms:
STOLT or FK Migration
Very efficient but inaccurate in the presence of velocity variations.
PSPS (Phase Shift plus STOLT)
An extension of STOLT where the migration is performed in a series of constant velocity time strips, A phase-shift is used to move to the bottom of each strip. Stolt migration is used within each strip. PSPS migration accurately copes with vertical variations but has no response to lateral velocity variations.

Kirchhoff Migration

The conventional non-recursive Kirchhoff summation algorithm. The migration is based on local RMS velocities and has a somewhat weak response for both temporal and spatial velocity variations.

FD Migration

Finite Difference migration is performed in the T-X domain using an approximate form of the wave equation. This is a recursive migration that steps down through the data in small time steps. It copes well with vertical velocity variations and lateral velocity variations (not too rapid) but is dip limited to 45^o. The dip limitation is due to the approximation of the wave equation. The finite difference solution creates some noise through frequency dispersion.

Omega-X Migration

This is essentially the application of the FD migration in the frequency domain. In this domain the solution is achieved more accurately. There is less noise through frequency dispersion and a steeper dip response.
Phase-shift migration is a recursive FK domain migration that accurately migrates in the presence of vertical velocity variations. It has no response to lateral velocity variations. It is sometimes called Gazdag migration after its originator (see Gazdag, 1978). Phase shift migration is often considered to be the best possible migration when no lateral velocity variations exist.

PSPI

Phase shift plus interpolation (PSPI) is Gazdag’s modification to Phase-shift migration so that it can cope with lateral velocity variations. Each recursive time step is migrated (using the phase-shift algorithm) for a range of constant velocities and a variable velocity response is obtained by interpolation of these results.
When lateral velocity variations exist, PSPI migration is probably the best available time migration.

Explicit Migration

Explicit migration is a new algorithm (effectively an upgrade to omega-x migration) capable of migrating dips up to 70 degrees. In testing, the steep dip response of this algorithm has been better that PSPI migration. The essence of the explicit technique is the filters used to perform the downward continuation. These filters are computed using the Parks - McClellan algorithm (also as the Remez algorithm).

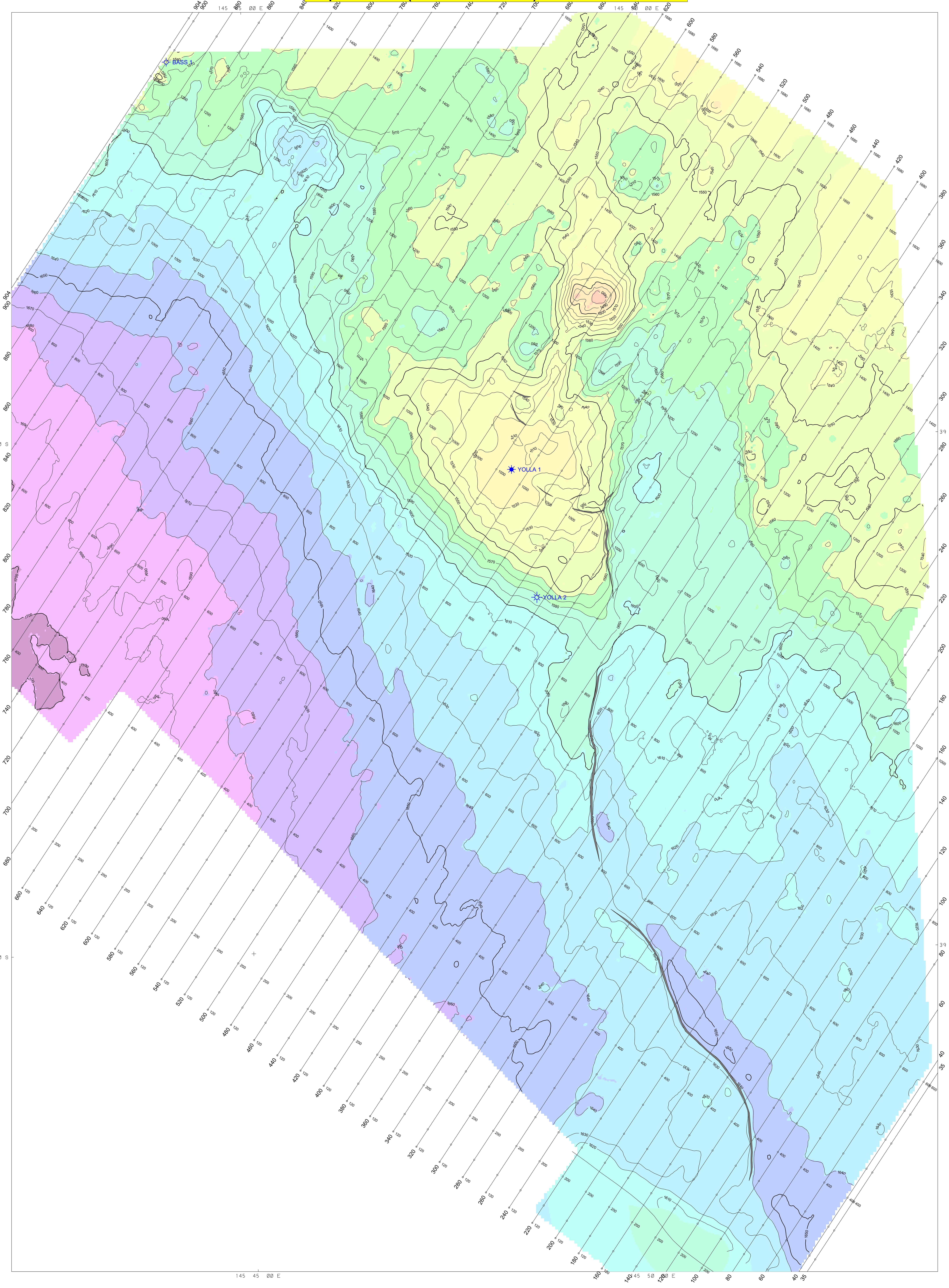
TAU-P Filter
This technique is based on a rolling Tau-p transform. A number of traces around a centre trace are transformed to the Tau-p domain where coherent events are easily recognised. A coherent event trace is created for each centre trace and these are weighted by adding back a percentage of the original trace.
The important parameters are the range of dips to be transformed, the dips increment within the transform (no p traces), the number of traces to use around each centre trace and the percentage addback of the original traces (can be time variant).

TIME VARIANT BAND PASS FILTER
These filters are usually defined by a low high frequency and a low and high rolloff slope in dB / Octave.

TRACE EQUALISATION
Options include:
scaling functions - exponential linear
whole trace balancing
windowed balance - allows for window overlap. Arbitrary window sizes
AGC - Automatic Gain Control - can be referenced to top, centre or bottom of window
Time - variant AGC - window size can vary within time
Running true-amplitude balancing, (RUNTRAMP) - traces are balanced to a spatially smooth amplitude trend.

Enclosures

Top EVCM (TEV4 Horizon)   Time Structure



Normal Faults

1: 25000

0 1 2

KILOMETRES

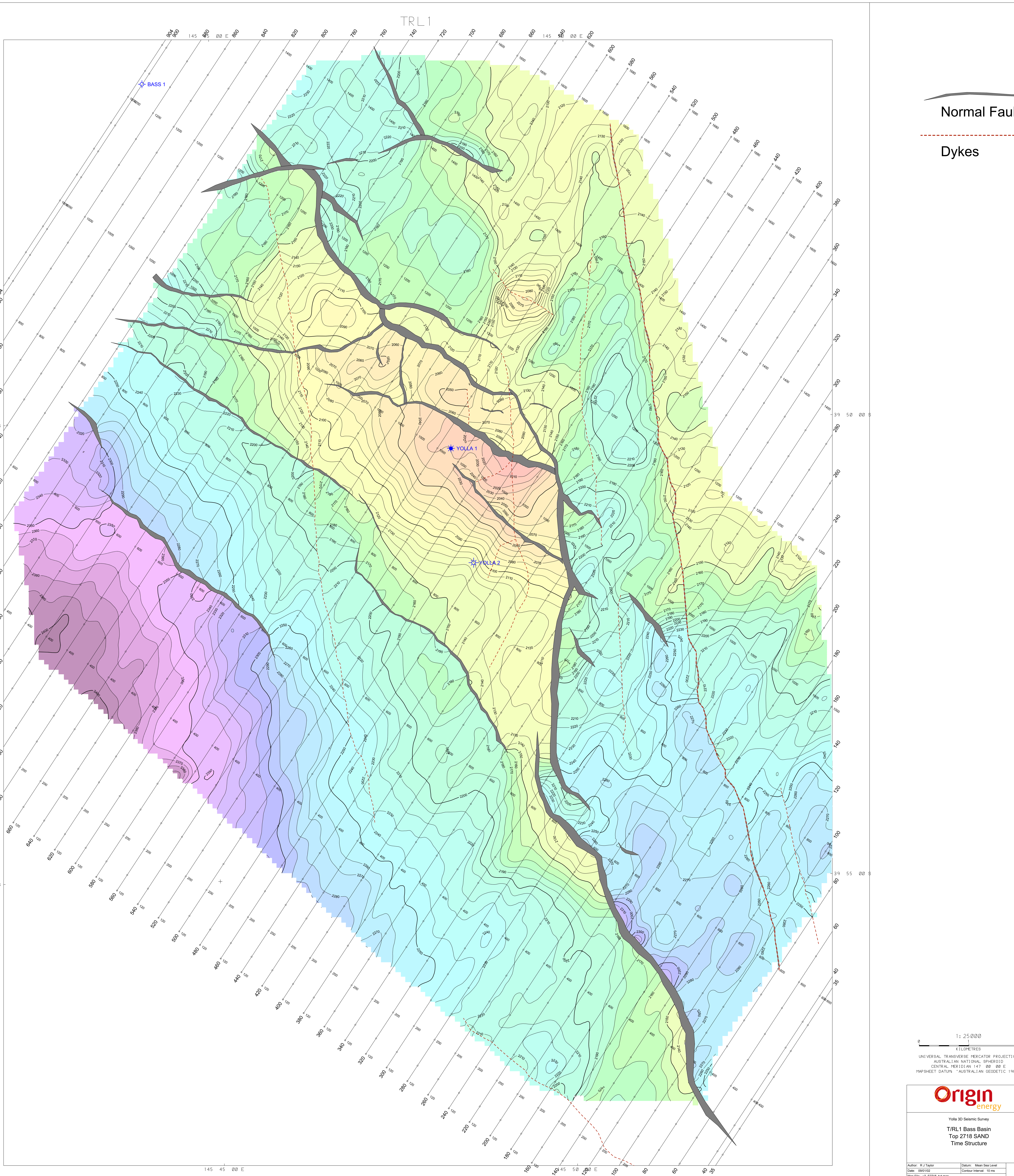
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top EVCM (TEV4 horizon)
Time Structure

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 1
Date: 09/01/02	Contour Interval: 10 ms	
Map File: y2_EVCM-twt.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

1:25000

0 1 2

KILOMETRES

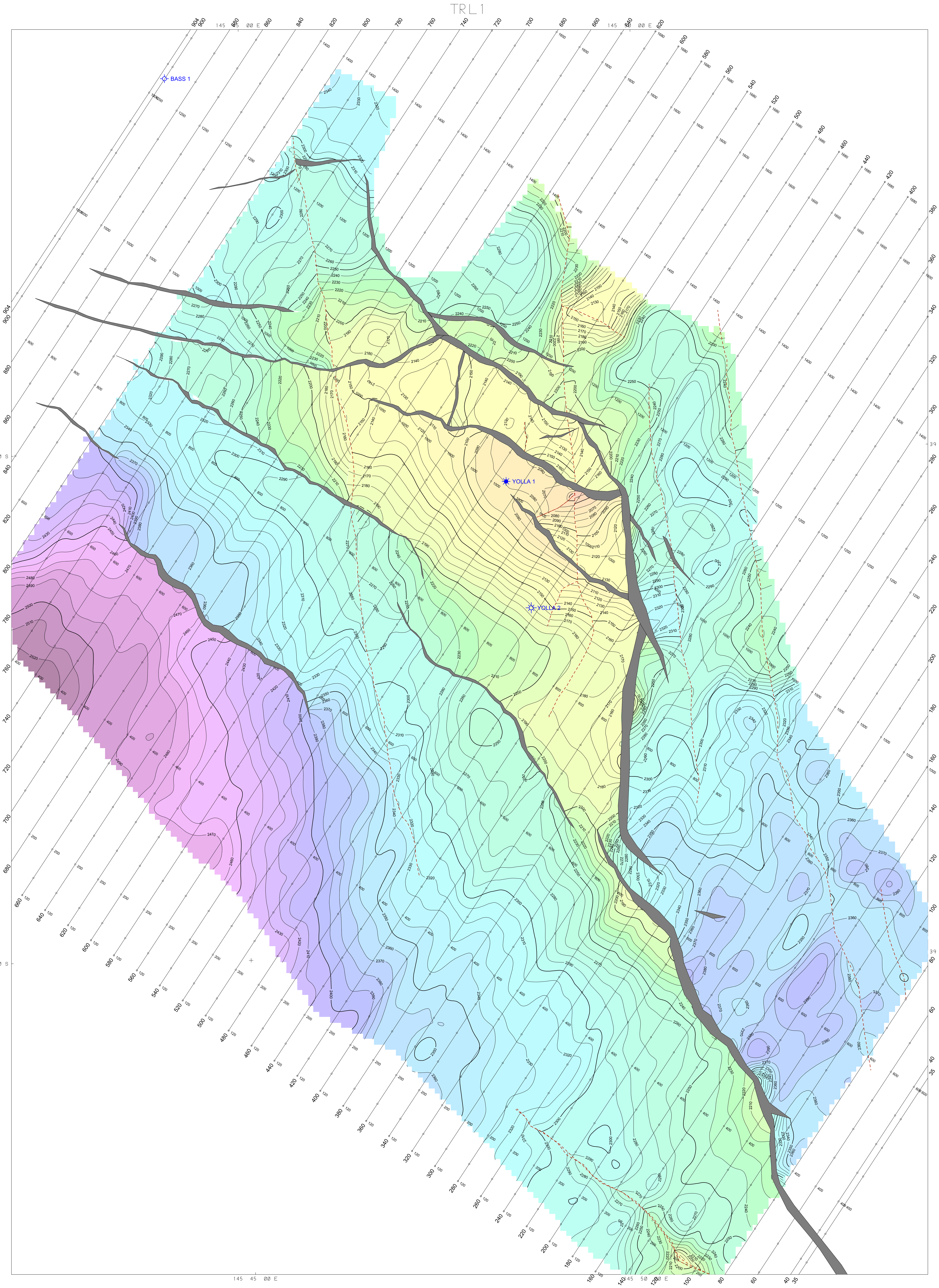
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2718 SAND
Time Structure

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 2
Date: 09/01/02	Contour Interval: 10 ms	
Map File: y2_S2718_twt.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

1: 25000

0 1 2

KILOMETRES

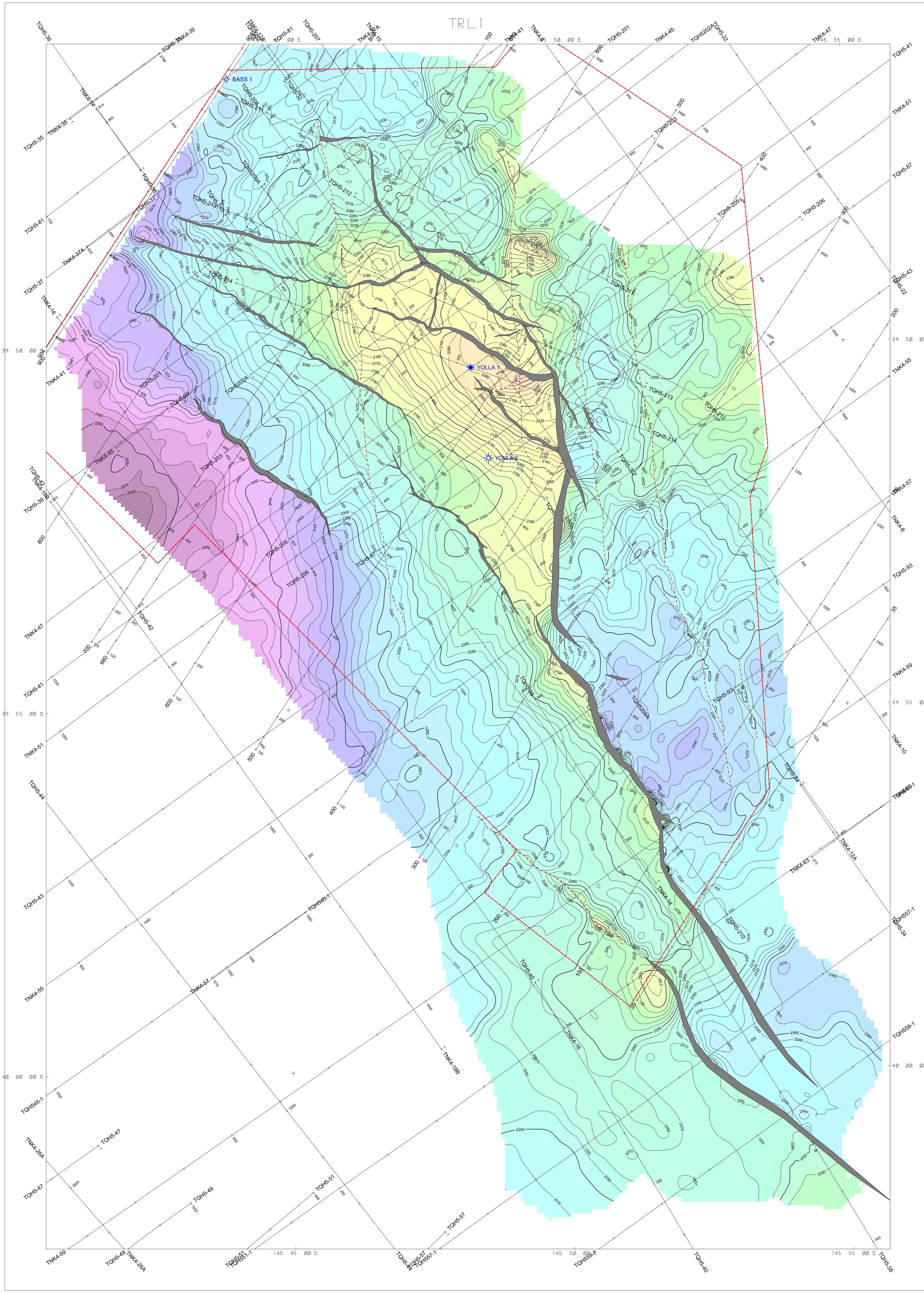
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2809 SAND
Time Structure

Author: R J Taylor	Datum: Mean Sea Level	Encl No:
Date: 09/01/02	Contour Interval: 10 ms	3
Map File: y2_S2809_twt.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

Yolla 3D Survey

1: 35000

0 1 2 3 4

KILOMETRES

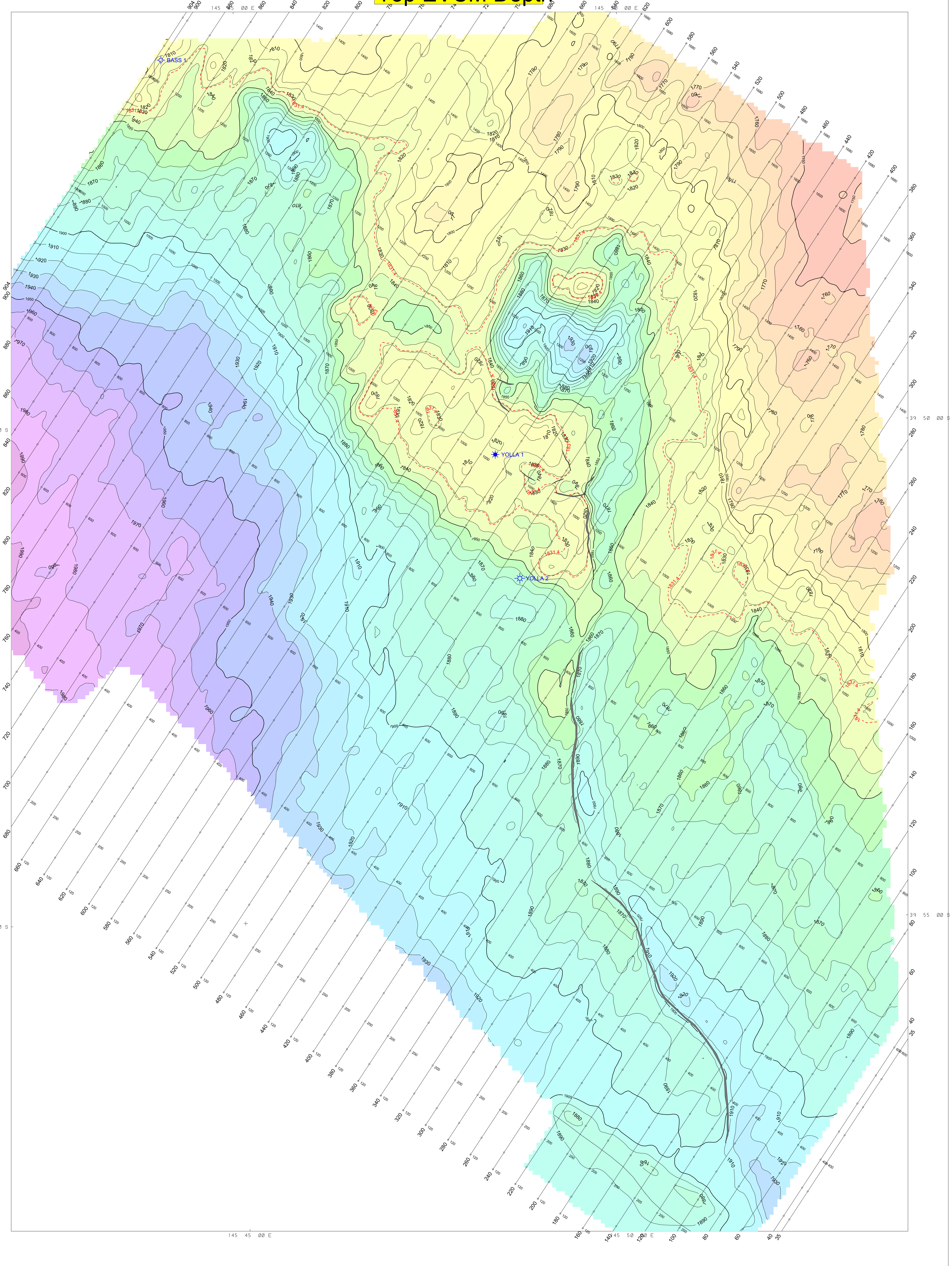
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2809 SAND
Time Structure

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 4
Date: 09/01/02	Contour Interval: 10 ms	
Map File: y2_S2809_twt_extended.map		
Map Sheet: YOLLA_35K		

Top EVCM Depth



Most likely Top ECVM
FWL: 1831.4m below SL
(contour shown in red)

1: 25000

0 1 2

KILOMETRES

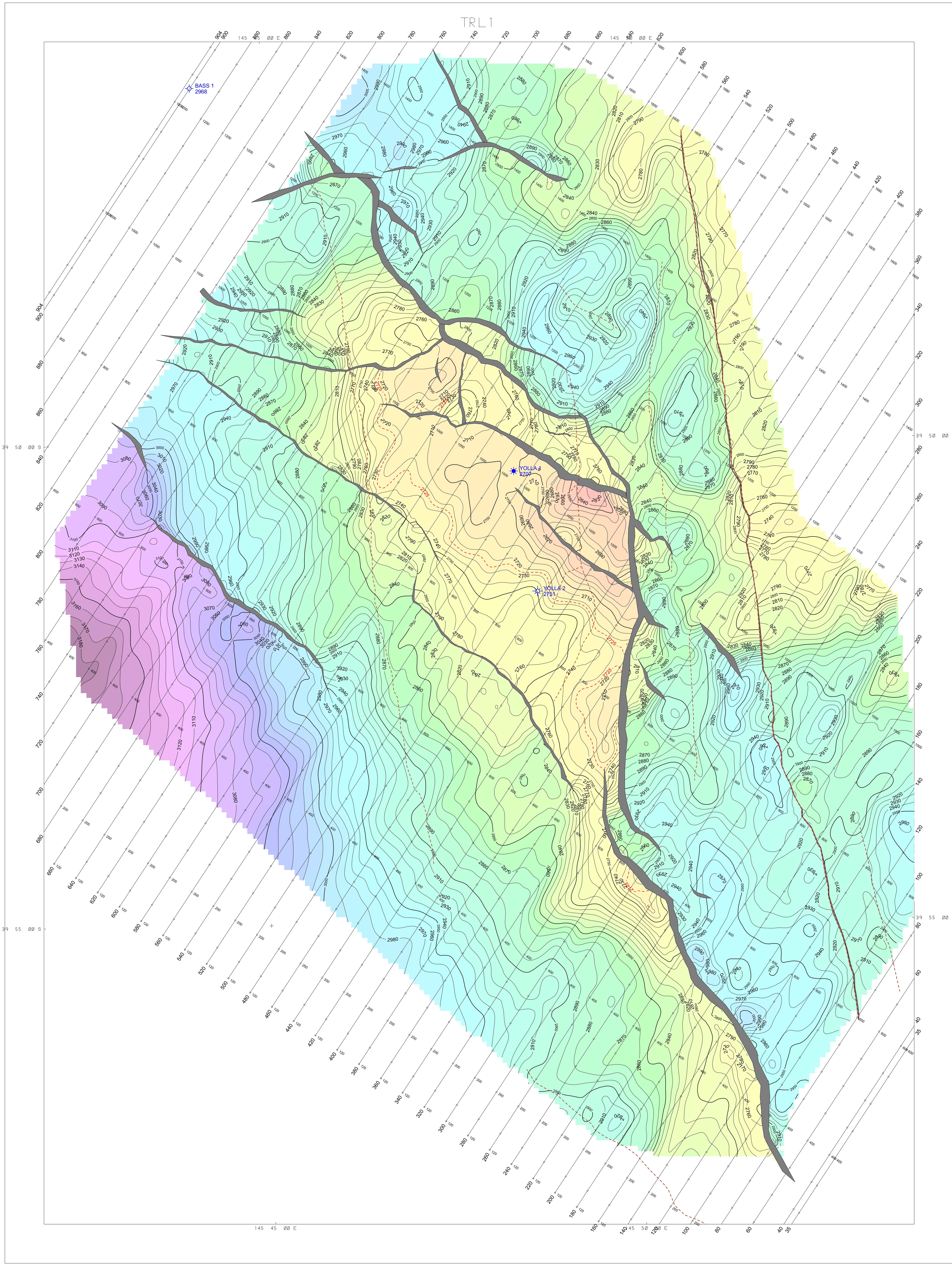
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

T/RL1 Bass Basin

Yolla 3D Seismic Survey
Top EVCM (TEV4 Horizon)
Depth
(map migration depth conversion)

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 5
Date: 09/01/02	Contour Interval: 10 m	
Map File: y2_evcm_dep.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

Most likely FWL:
2725m below SL
(contour shown in red)

1:25000

0 1 2

KILOMETRES

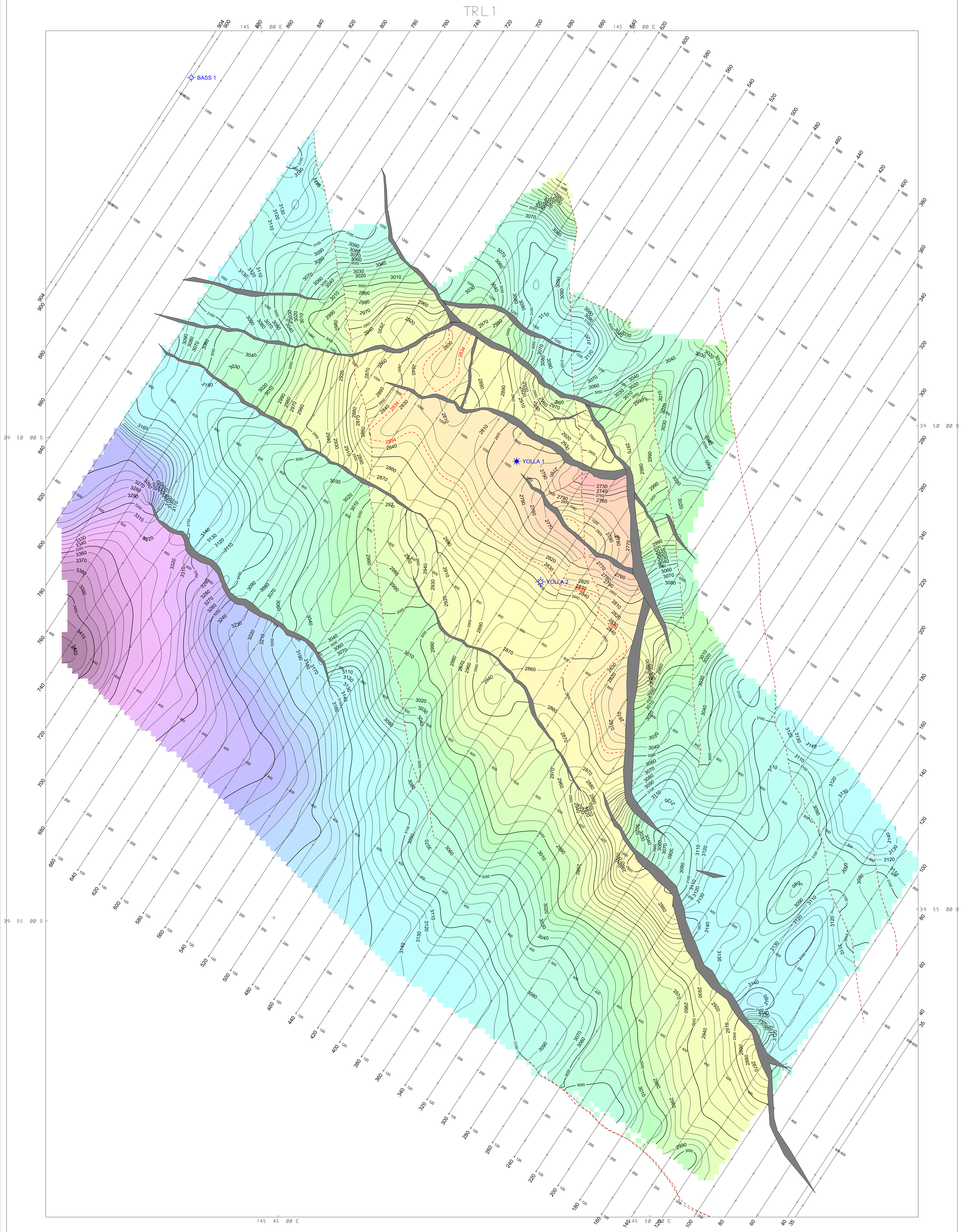
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2718 SAND Depth
Depth Conversion using
interval velocities and map migration

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 6
Date: 09/01/02	Contour Interval: 10 m	
Map File: y2-S2718_dep.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

Most likely FWL:
2834m below SL
(contour shown in red)

1:25000

0 1 2

KILOMETRES

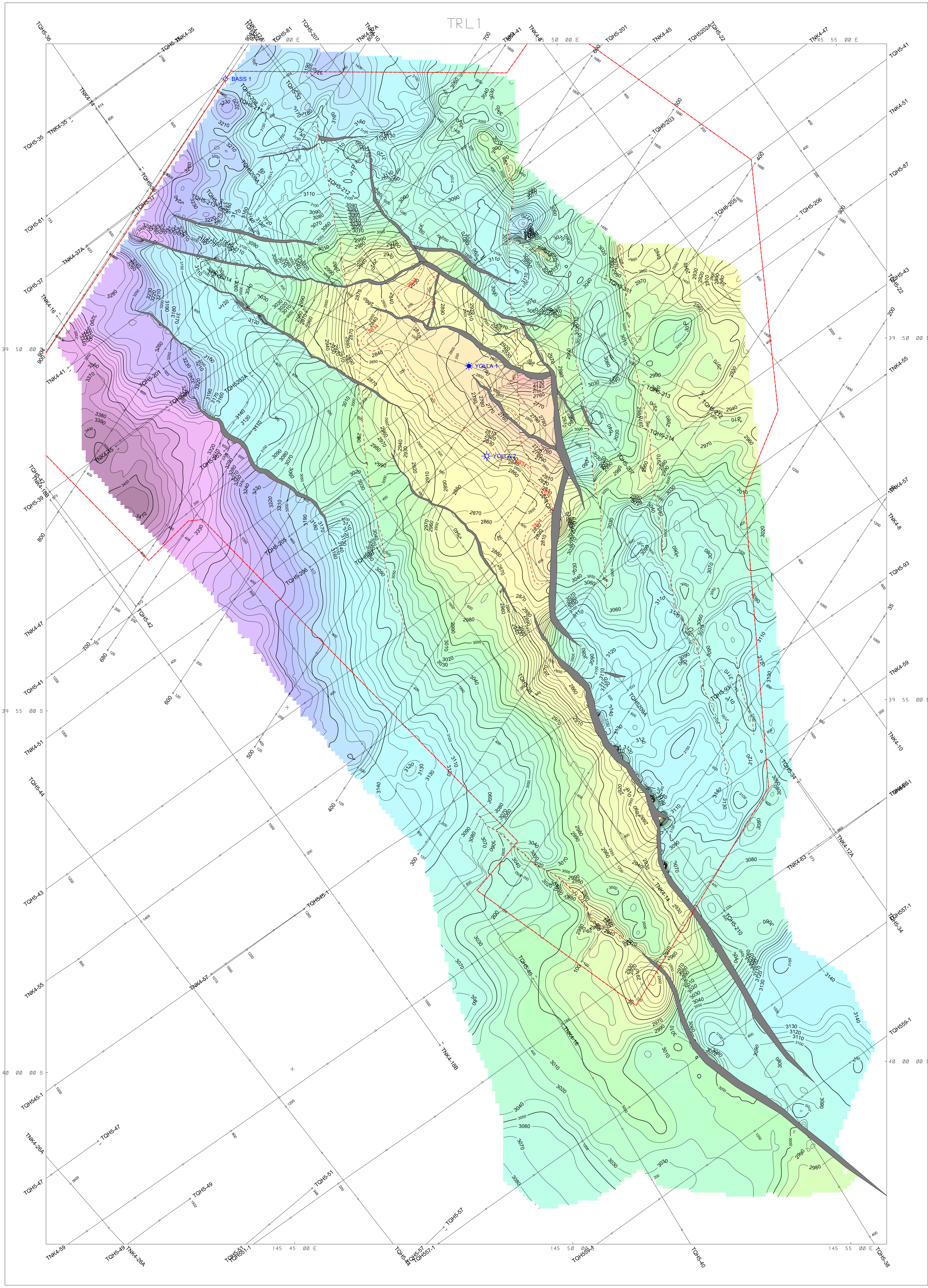
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2809 SAND Depth
Depth conversion using
interval velocities & map migration

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 7
Date: 09/01/02	Contour Interval: 10 m	
Map File: y2_S2809_dep.map		
Map Sheet: YOLLA_25K		



Normal Faults

Dykes

Most likely FWL:
2834m below SL
(contour shown in red)

To extend the depth map beyond the 3D grid to the south, the effective average velocity contours were extrapolated based on the time structure.

1:35000

0 1 2 3 4

KILOMETRES

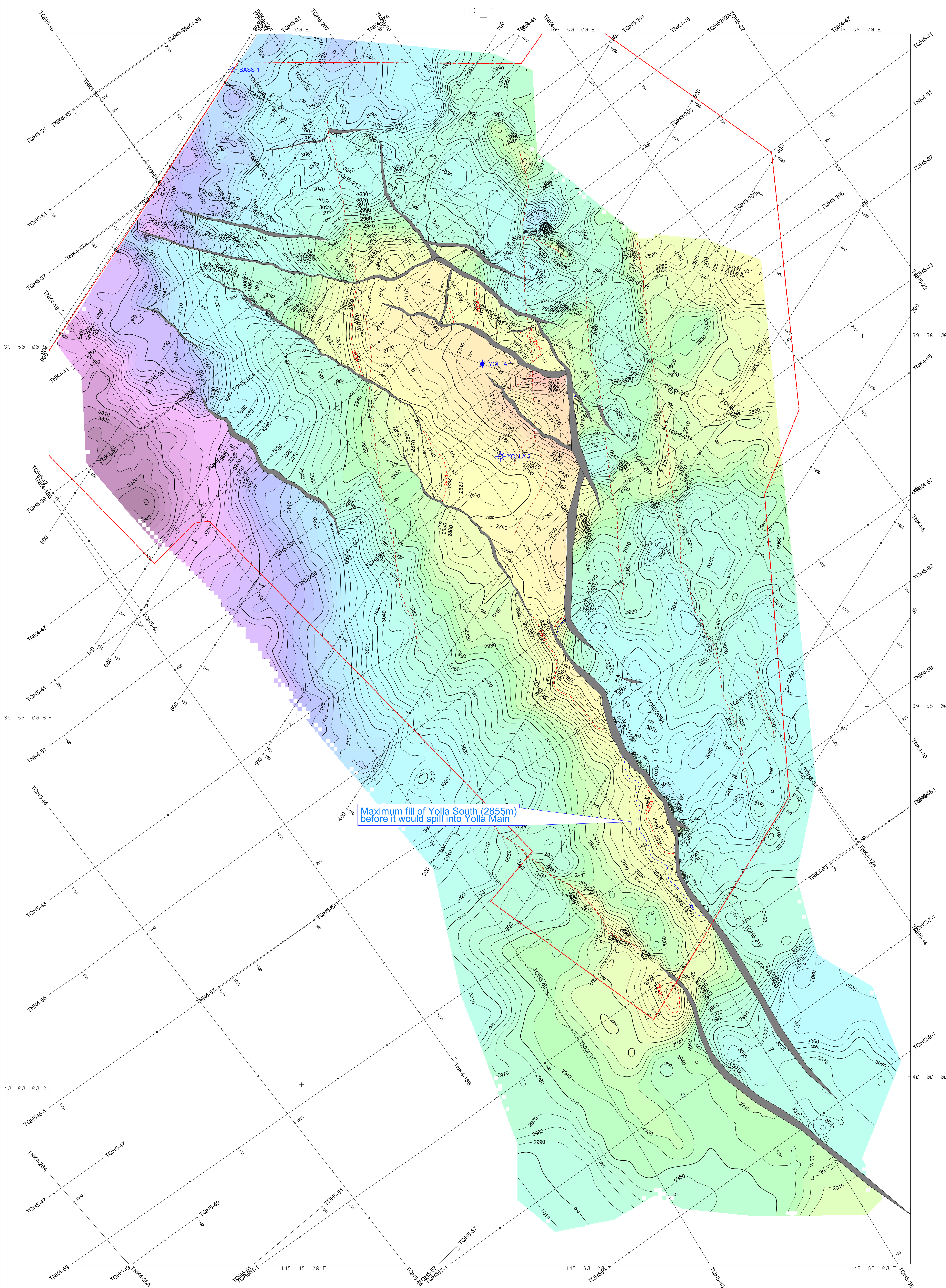
UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2809 SAND Depth
Interval Velocity Depth conversion

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 8
Date: 09/01/02	Contour Interval: 10 m	
Map File: y2_S2809_dep_extend.map		
Map Sheet: YOLLA_35K		



Normal Faults

Dykes

Yolla 3D Survey

Most likely FWL:
2834m below SL
(contour shown in red)

1:35000

0 1 2 3 4

KILOMETRES

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
AUSTRALIAN NATIONAL SPHEROID
CENTRAL MERIDIAN 147 00 00 E
MAPSHEET DATUM: "AUSTRALIAN GEODETIC 1984"

Origin energy

Yolla 3D Seismic Survey

T/RL1 Bass Basin
Top 2755 SAND Depth
(derived from the 2809 Sand depth map
by subtracting a near constant isopach)

Author: R J Taylor	Datum: Mean Sea Level	Encl No: 9
Date: 09/01/02	Contour Interval: 10 m	
Map File: y2_S2755_dep_extend.map		
Map Sheet: YOLLA_35K		