HGP2002A Final Interpretation Report

January 2005

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HGP2002A Seimic Interpretation Report Contents

- Introduction
  - Equity and Work Program
- Acquisition
  - Parameters
  - Operational Statistics
- Processing
  - Processing Flow
  - Data quality overview
- Interpretation
  - Well ties
  - Time interpretation
- Depth Conversion
- Prospects and Leads

HGP2002A Seimic Interpretation Report
Introduction

The HGP2002A 3D seismic survey was shot over VIC/P45 in the Gippsland Basin and completed on 27 September 2002.

The 996 KM^2 of 3D seismic survey is centered approximately 100km from the Gippsland Coast, southwest of the Giant Kingfish Field.

The HGP2002A 3D survey was designed to provide a comprehensive 3D coverage of the Permit, to constrain ambiguous structural interpretation on 2D and provide high quality velocity control, through High Density Velocity Analysis (HDVA).

Onboard processing was carried out to provide a fast-track Post Stack Time Migrated dataset for initial interpretation. Interpretation of this fast-track PoSTM dataset commenced in December 2002.

The final PreStack Time Migrated (PreSTM) dataset was completed in January 2003.

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Equity and Work Program

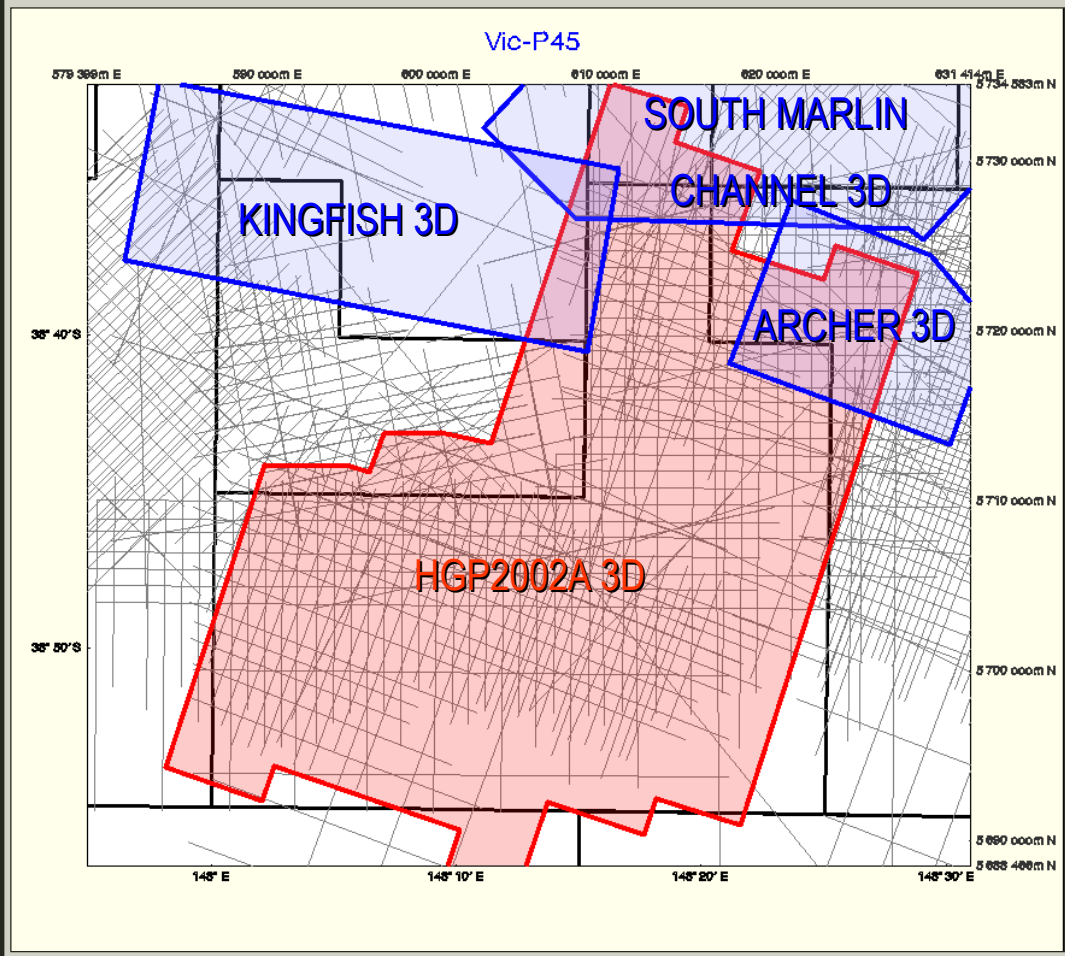
The Permit was granted to Liberty Petroleum Corporation on 16 May 2000. BHPB acquired Liberty Petroleum Corporation's equity in January 2001, with the title of permit transferred to BHPP effective 21st February 2001.

Inpex Alpha, Ltd farmed into Vic/P45 on 12th October 2001 to earn a 40% equity interest in the permit. The farmin was registered effective 20th February 2002.

The 996 km^2 HGP2002A-3D Seismic Survey was recorded in VIC/P45 during Permit Year 1 and completed on 27 September 2002.

HGP2002A Seimic Interpretation Report
Seismic Acquisition Parameters

Survey:	HGP2002A
Permit:	VIC/P45
Size:	996km2
Vessel:	M.V. Geco Beta
Average Line Length:	30km (full fold)
Heading:	198 / 018
Duration:	8-8-02 to 27-9-02
Streamers:	8 (100m separation)
Shotpoint Interval	18.75
Sources and (Separation)	2 guns (50m)
Array Volume:	3542cu in
Air Pressure:	2000psi
Source Depth:	7m
Streamer length	4600m
Group Interval:	12.5m
Sample rate	2ms
Record Length:	6144ms



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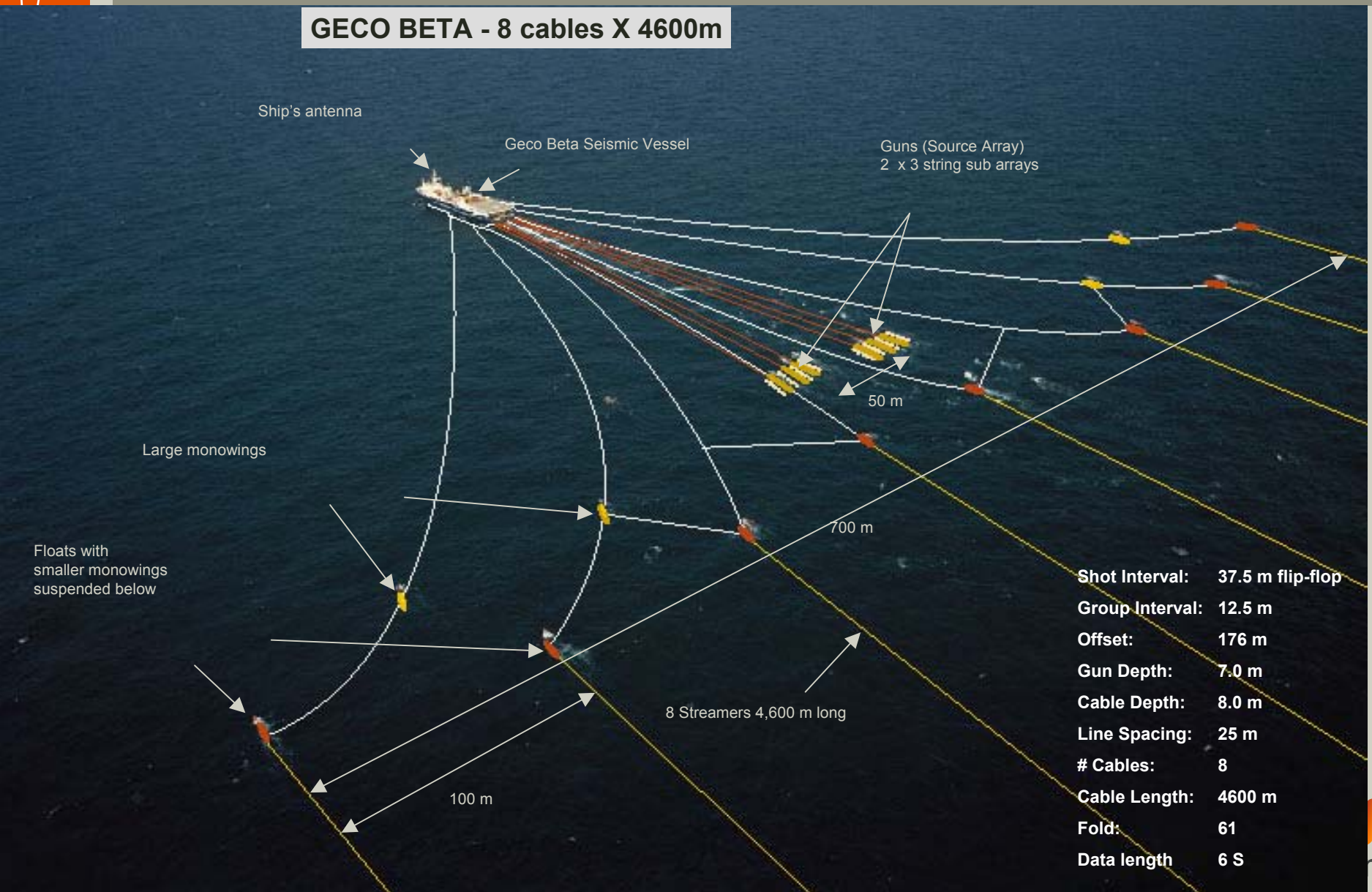
Acquisition Configuration



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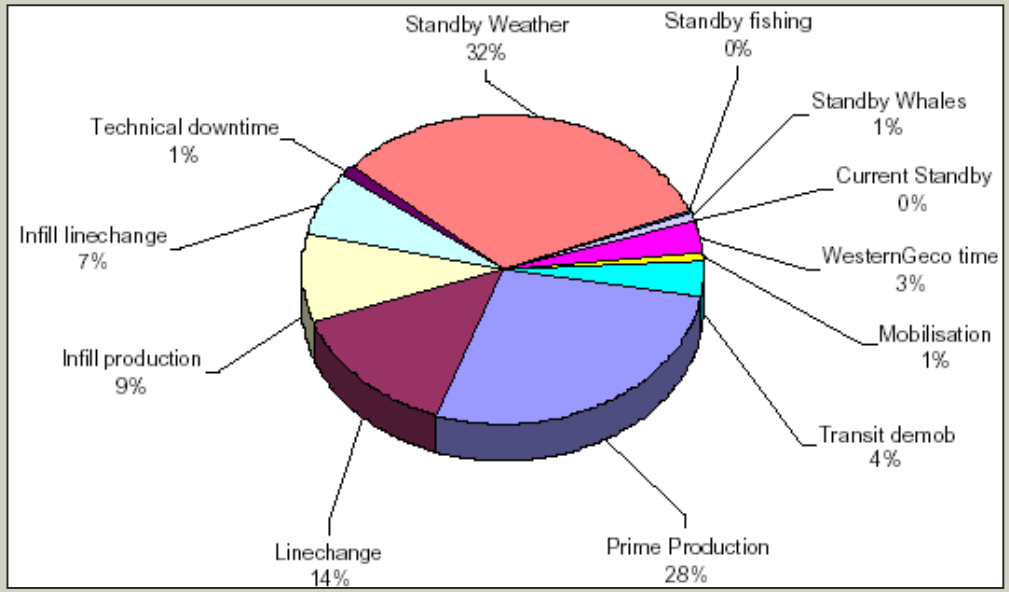
Acquisition Statistics

Time Distribution (Hours)		
Prime Production	331.801 Hours	27.6%
Linechange	169.849 Hours	14.1%
Infill production	108.584 Hours	9.0%
Infill linechange	81.451 Hours	6.8%
Technical downtime	14.916 Hours	1.2%
Standby Weather	387.599 Hours	32.3%
Standby fishing	1.917 Hours	0.2%
Standby Whales	9.900 Hours	0.8%
Current Standby	1.467 Hours	0.1%
WesternGeco time	41.250 Hours	3.4%
Mobilisation	7.417 Hours	0.6%
Transit demob	44.500 Hours	3.7%
Total Survey Time	1200.650 Hours	100.0%



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Seismic Processing

Data was recorded by the WesternGeco vessel M/V Geco Beta from August 2002 to September 2002. The data processing was conducted between August 2002 and February 2003. Data processing was carried out both onboard the Geco Beta and at the Melbourne Processing Centre. Full details of the seismic processing sequence is provided in the 'Processing Report for the HGP2002A Marine Seismic Survey Gippsland Basin'.

The geophysical requirements for this project were as follows:

1. Definition and focus of deeper section.
2. Imaging with Pre Stack Time Migration (PSTM)
3. The processing of data through a fast-track processing flow for fast turnaround to satisfy constraints imposed by drilling schedules.
4. Lateral continuity within shallow high velocity channels.
5. High density velocity field generation to be used for depth conversion
6. AVO consistent processing.

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HGP2002 Fast Track Processing (OBP)

Sequence:

1. Noise reduction (swell & coherent noise)
2. First Pass Velocities (1000 m grid)
3. Deconvolution (XT)
4. Demultiple (FK)
5. 3D Binning (Flex)
6. DMO Velocity Analysis (1000 m grid)
7. DMO
8. Stack
9. Post Stack Migration
10. Archive

Input to PreSTM

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HGP2002 Final Processing

Sequence:

1. Noise reduction (swell & coherent noise)
2. First Pass Velocities
3. Deconvolution (Tau-P)
4. Demultiple (Radon)
5. 3D Binning (FXY Interpolation)
6. Target PreSTM Velocity Analysis (1000 m grid)
7. PreSTM
8. Residual Velocity Analysis (500 m grid)
9. Stack
10. Post Stack Processing
11. Archive

From OBP

Performed onboard due to greater hardware availability

Performed at Melbourne Processing center

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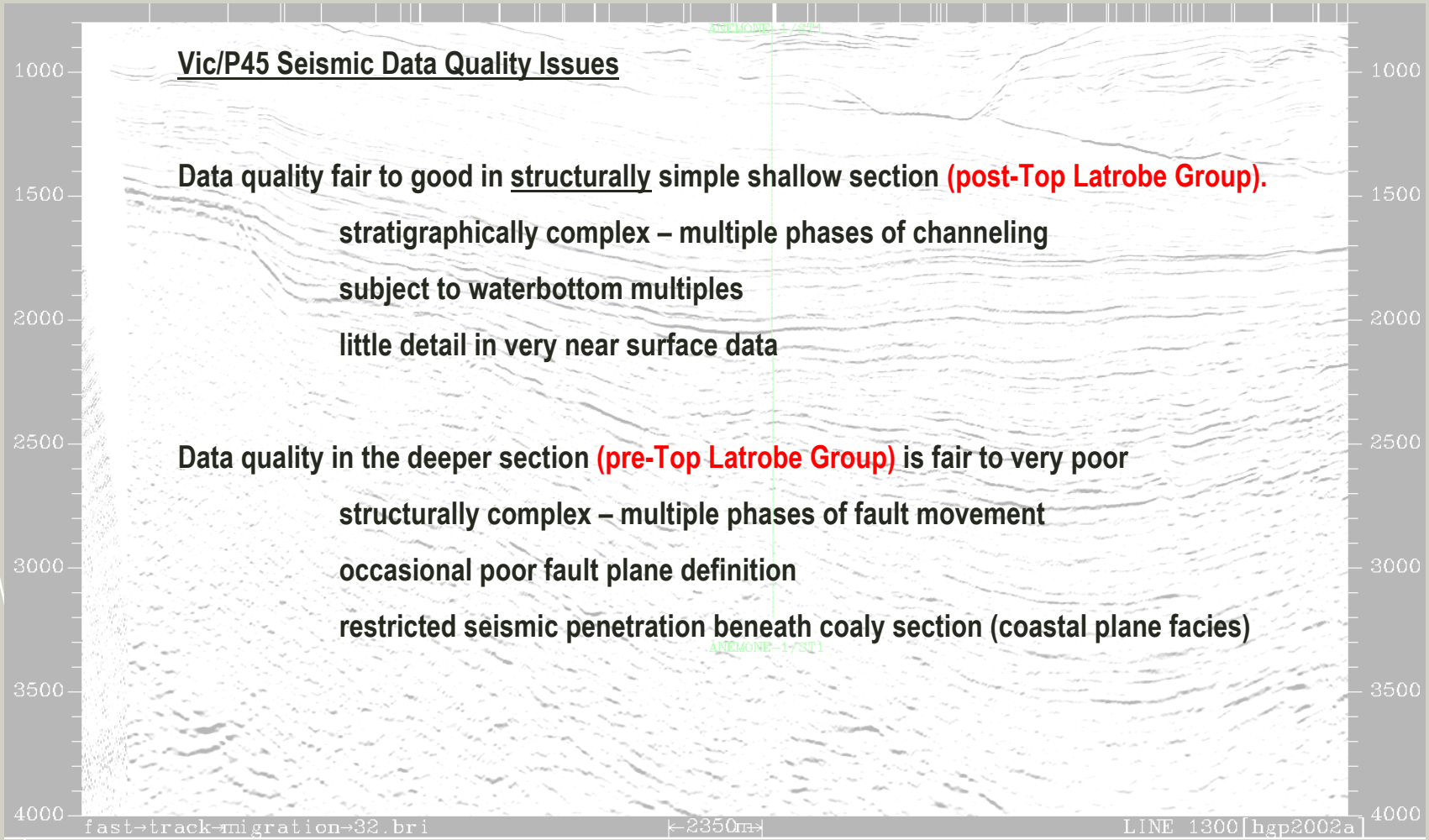
HGP2002A-3D Seismic Data Quality



Vic/P45 Seismic Data Quality Issues

Data quality fair to good in structurally simple shallow section (post-Top Latrobe Group).

- stratigraphically complex – multiple phases of channeling
- subject to waterbottom multiples
- little detail in very near surface data

Data quality in the deeper section (pre-Top Latrobe Group) is fair to very poor

- structurally complex – multiple phases of fault movement
- occasional poor fault plane definition
- restricted seismic penetration beneath coaly section (coastal plane facies)

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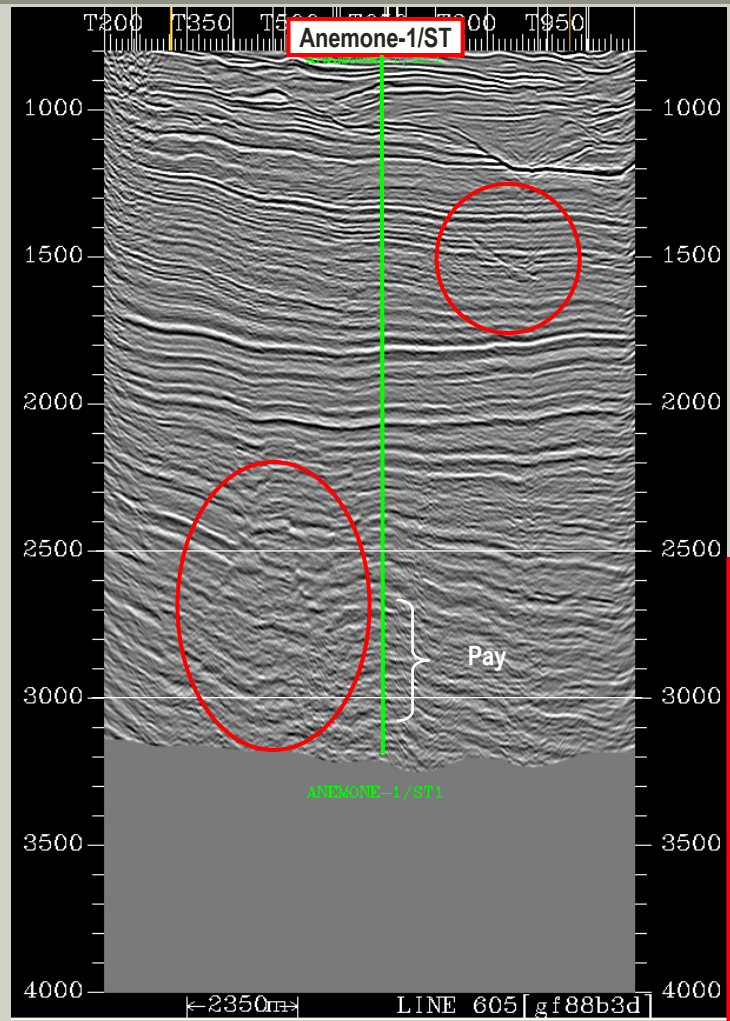
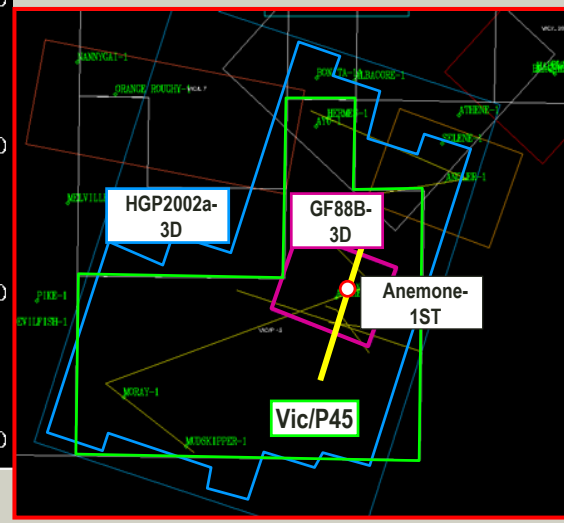
GF88B PSDM converted back to time – Iline 605

Archer-3D recorded by Petrofina in 1988, focusing on Archer-1 and Anemone-1ST discoveries.

Reprocessed several times; data quality fair to good in structurally simple shallow section (post-Top Latrobe Group) . Deeper section (pre-Top Latrobe Group) structurally complex – multiple phases of fault movement





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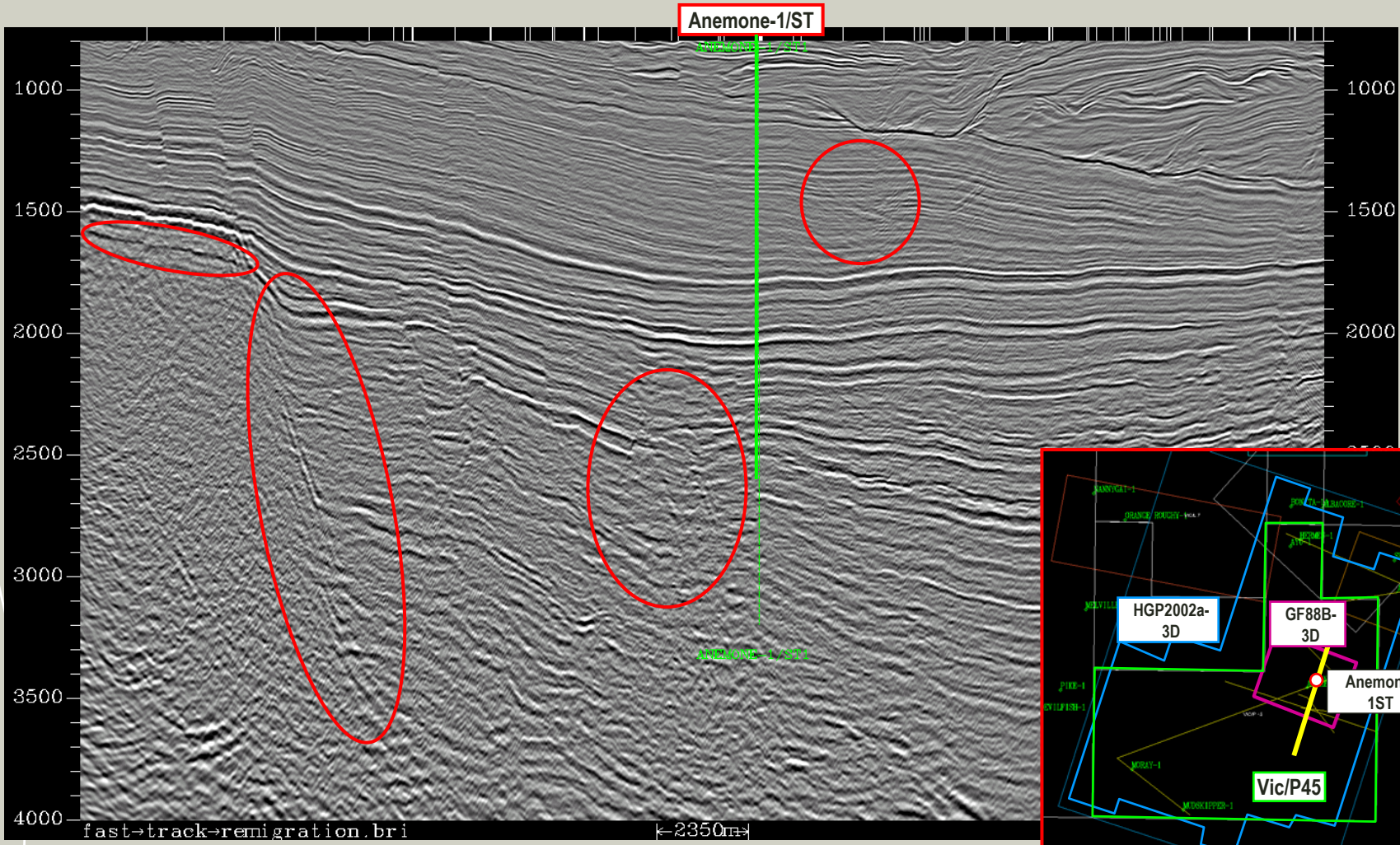
PoSTM Fast-Track Cube Remigration – Iline 1300



Improved fault plane definition with application of steeper dip Migration Operator

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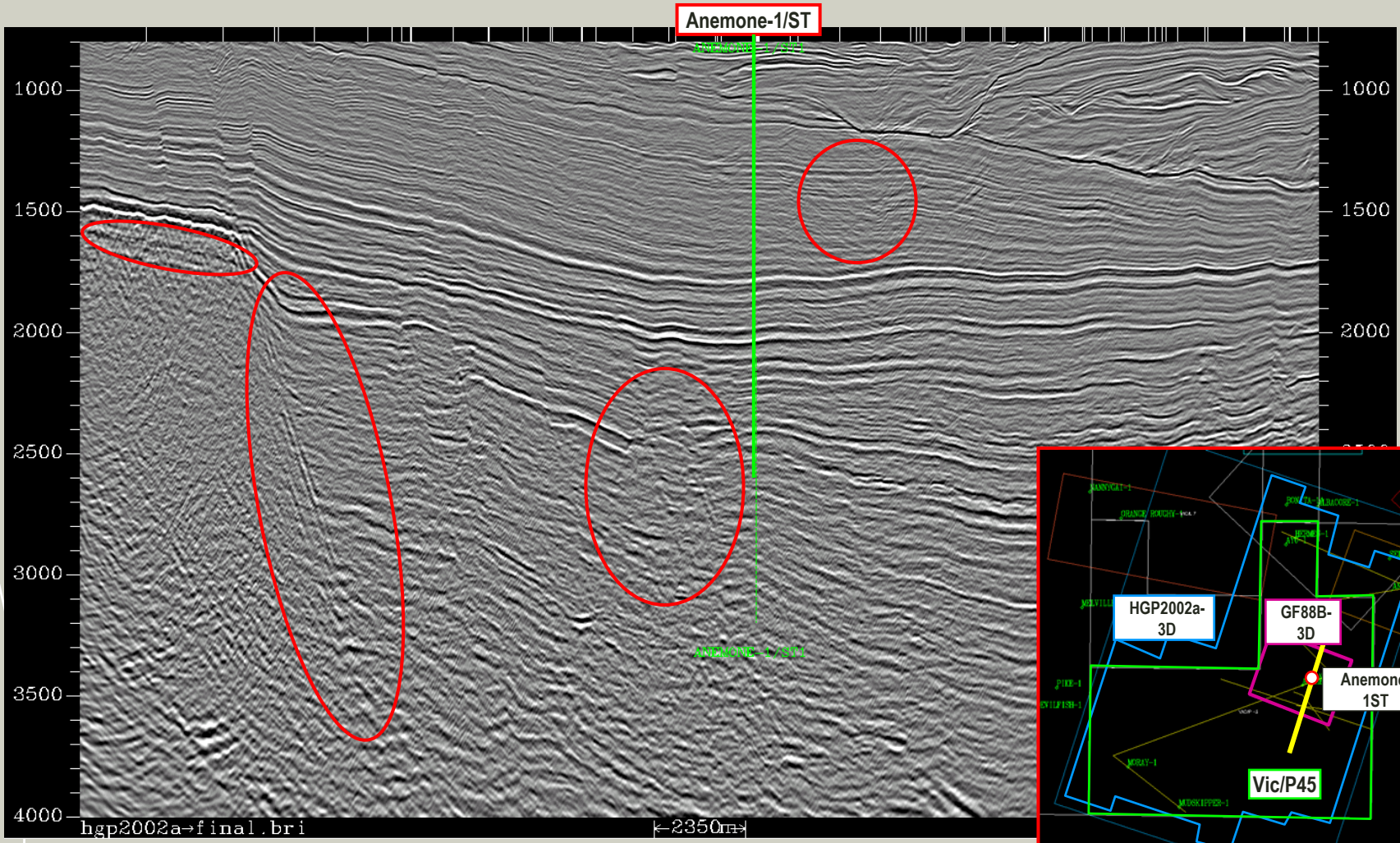
PreSTM "Final" Cube – Iline 1300



Reduction in Waterbottom multiple on LHS at 1600msec.

Minor improvement in fault plane definition with PreSTM.

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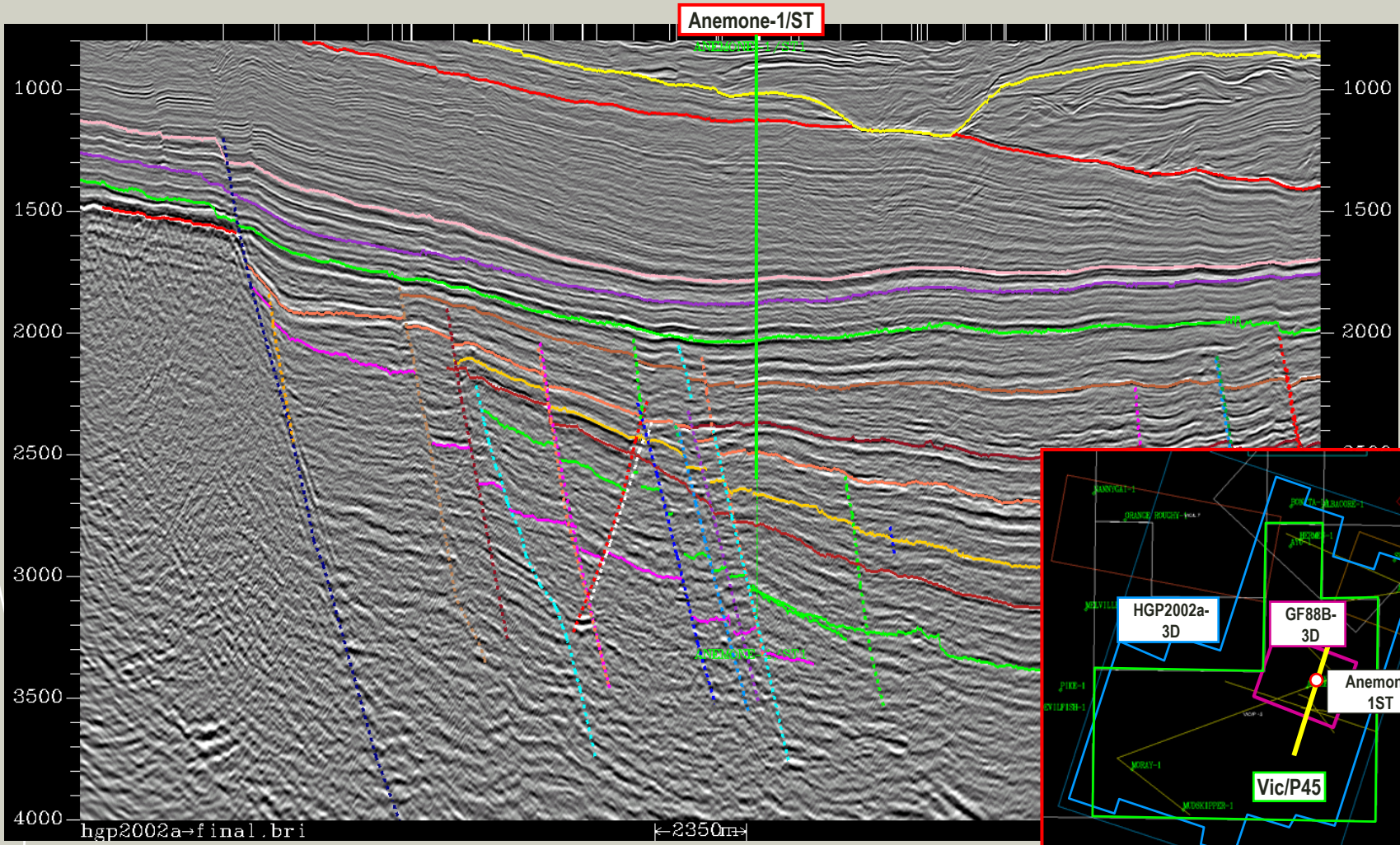
"Final" PSTM Cube – Iline 1300 Interpreted



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HGP2002A Seimic Interpretation Report
HGP2002a-3D Data quality: Summary

Shallow Section (post Top Latrobe):

Data quality fair to good, in places very good

Problematic interpretation caused by stratigraphic complexity

Clear reduction in waterbottom multiple content

Much improved detail in near surface section.

Deep Section (pre-Latrobe Group)

3 geographic data quality zones:

Southern Margin – fair to good in places.

Archer Trend - very poor to fair (worst in the heavily faulted area south of Archer).

Northern half of permit – fair to good in places. Discontinuous events within coastal plane section of the Latrobe Group challenges the interpretation.

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HGP2002A Interpretation Report VIC/P45

Interpretation:

- Well ties
- Key seismic events

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Seismic Well Tie

Interpretation focused on tying to well locations that were covered by the survey. Synthetics were used to tie well formation depths and determine well velocities below the Top Latrobe.

The key wells used were: Anemone-1ST, Angler-1, Albacore-1, Archer-1, Ayu-1, Roundhead-1, Bonita-1, Helios-1, Hermes-1, Melville-1, Moray-1, Mudskipper-1.

Polarity for the HGP2002A survey is SEG normal, i.e., a positive acoustic impedance boundary is displayed as a peak or positive amplitude value.

HGP2002A Seimic Interpretation Report
HGP2002A-3D Seismic Datasets

- **Fast-track Post Stack Time Re-Migration**
- Final Pre-Stack Time Migration (Raw)
- **Final Pre-Stack Time Migration (Spectral Balance)**
  (Primary Interpretation Dataset)
- Angle Stacks - Near 4-16deg
  - Mid 28–40 deg
  - Far 28-40deg
- Post Stack depth Migration

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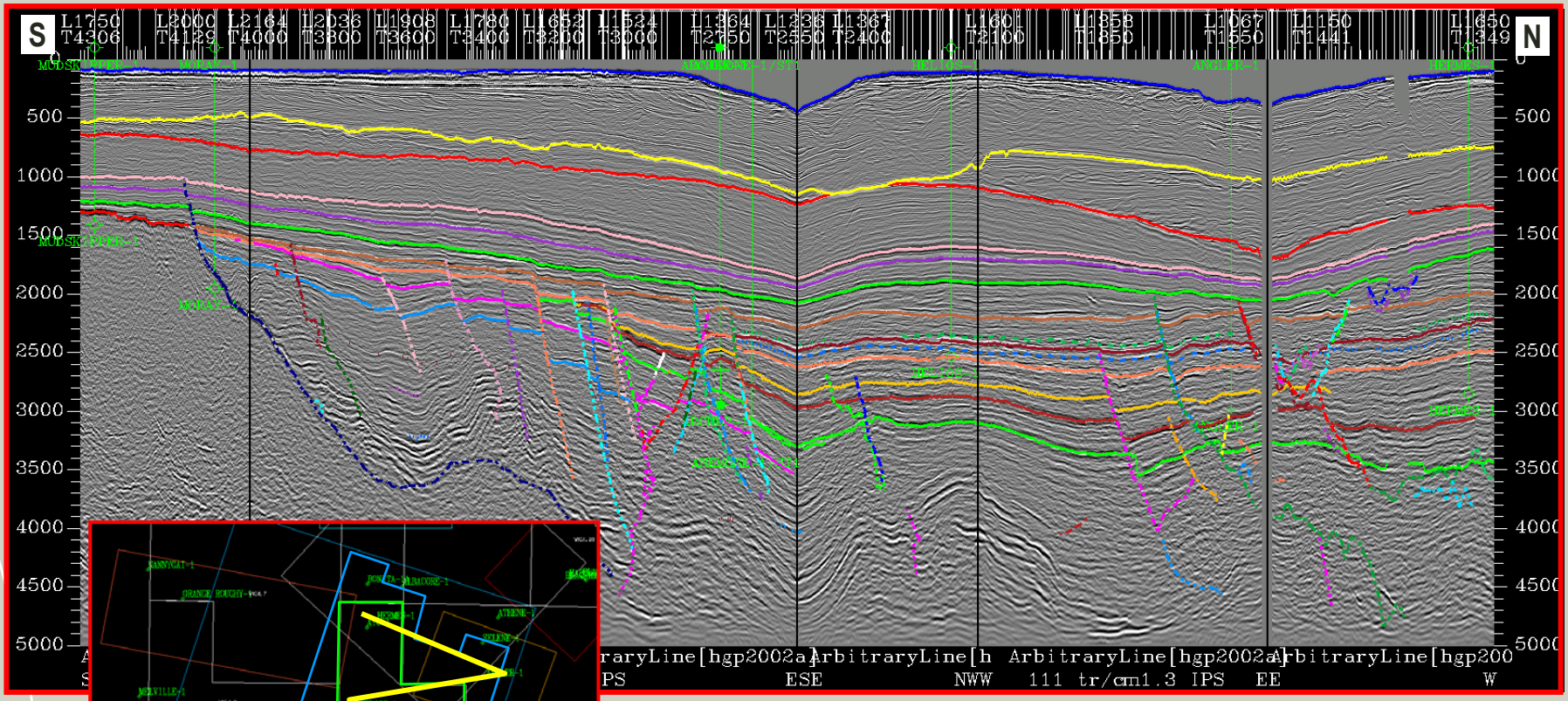
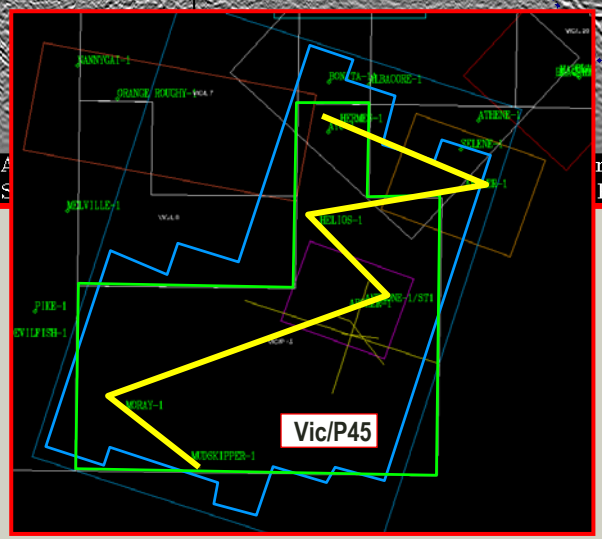
Summary of Key Interpreted Events





Seafloor (000)	Lower Latrobe Group (710)
Base Shallow Channeling (150)	Lower Latrobe group (735)
Base High Velocity Layer (199)	Lower Latrobe Group (750)
Mid Miocene Marker (400)	Top Golden Beach Group (800)
Early Miocene Marker (450)	Intra Golden Beach Group (810)
Near Top Latrobe Group (500)	Lower Golden Beach Group (850)
Lower Latrobe Group (690)	Top Emperor Group (840)
Lower Latrobe Group (705)	Intra Emperor Group
	Basement (900)

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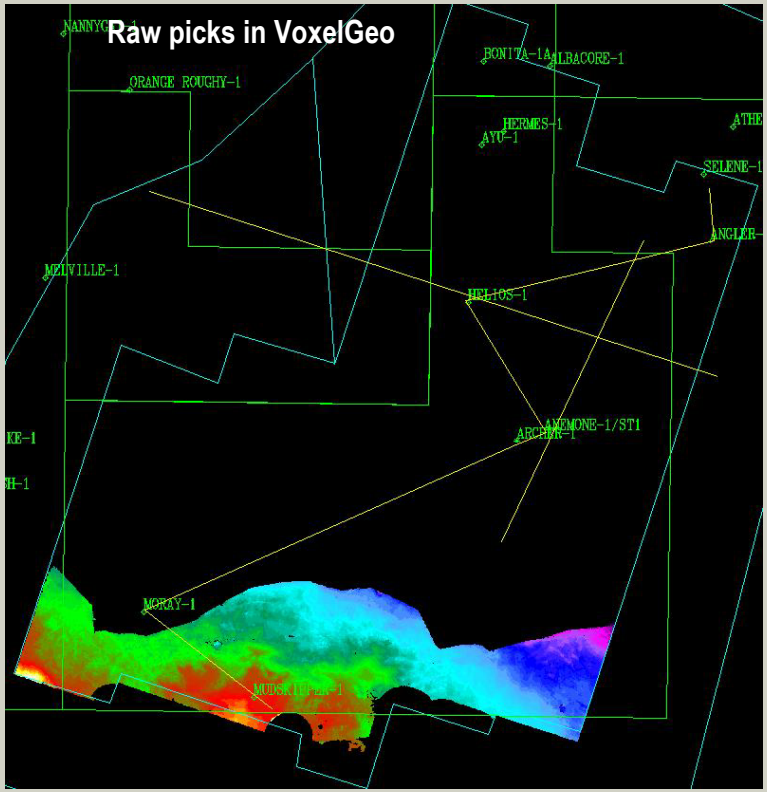
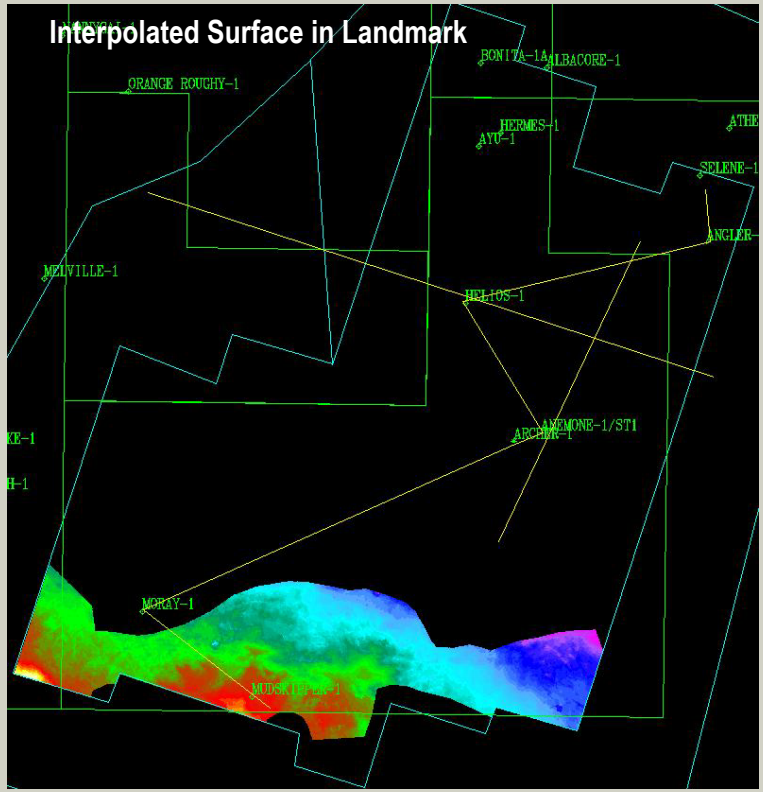
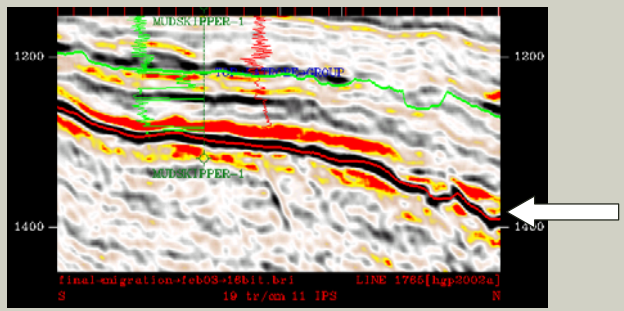
999 Basement TWT Structure





Granitic basement marking base of the Cretaceous Basin in the southern part of the Vic/P45; Picked as a very strong black peak.



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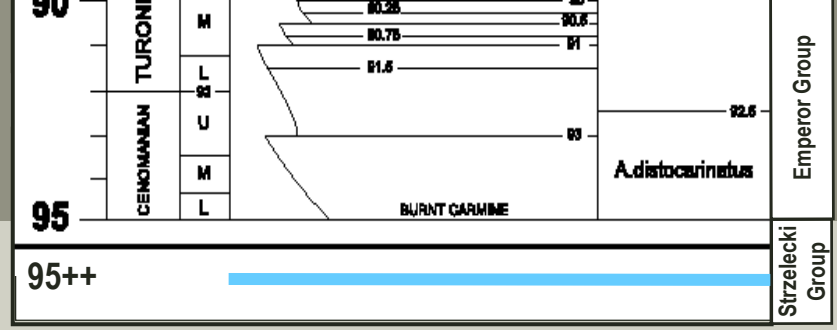
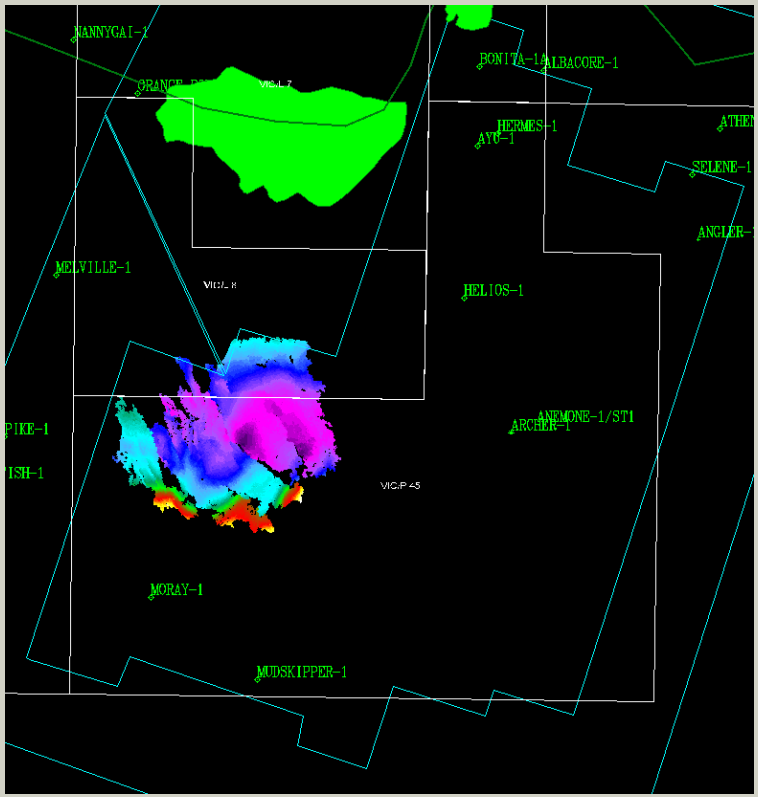
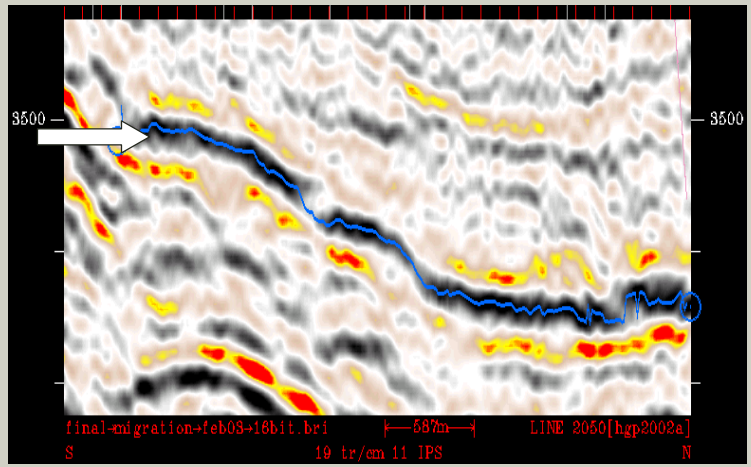
896 TWT Structure





Raw picks in Voxelgeo



Deep intra-Strzelecki Fm Marker used to assess internal Strzelecki geometry and guide the Top Strzelecki Interpretation;

Picked as a locally strong black peak

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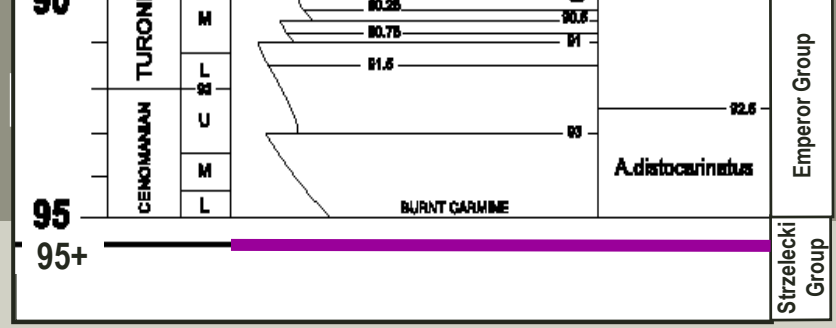
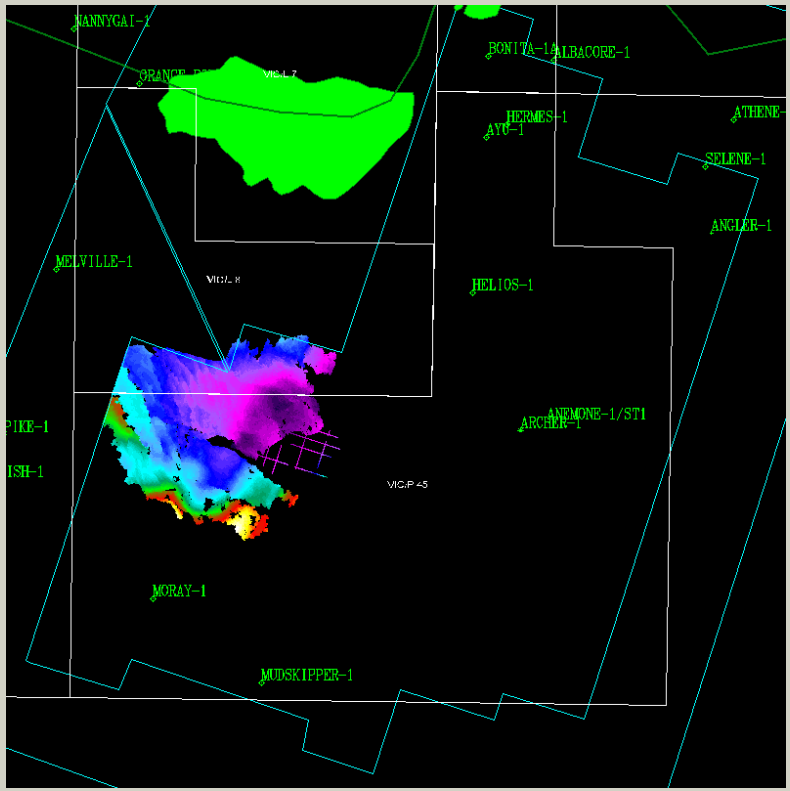
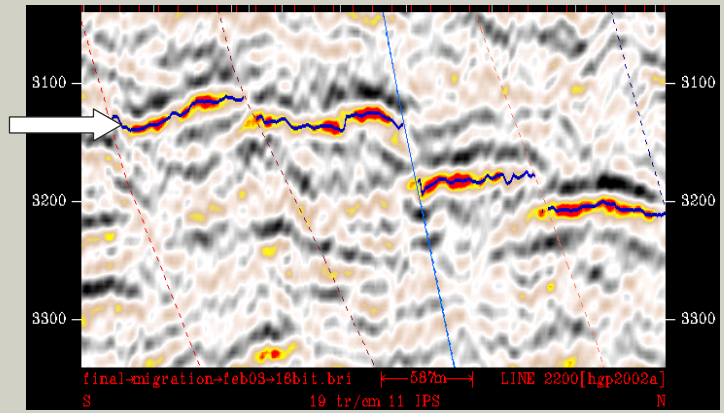
895 TWT Structure





Raw picks in Voxelgeo



Intra-Strzelecki Fm Marker used to assess internal Strzelecki geometry and guide the Top Strzelecki Interpretation;

Picked as a moderately strong red trough.

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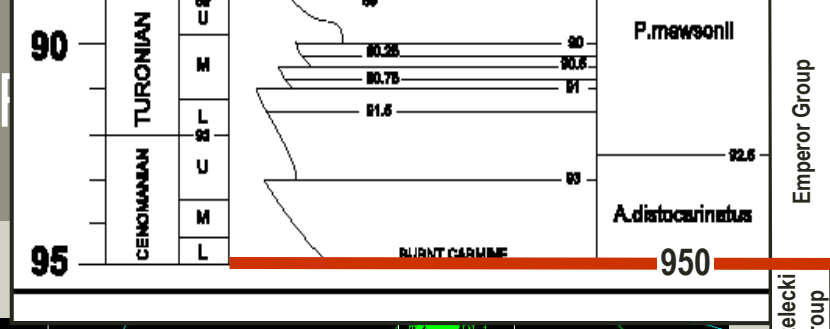
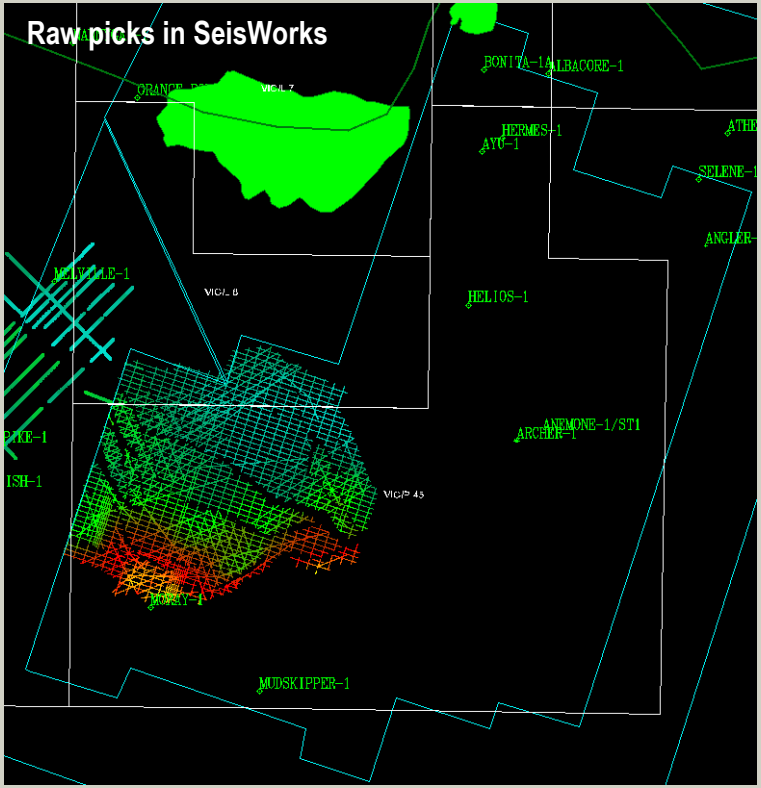
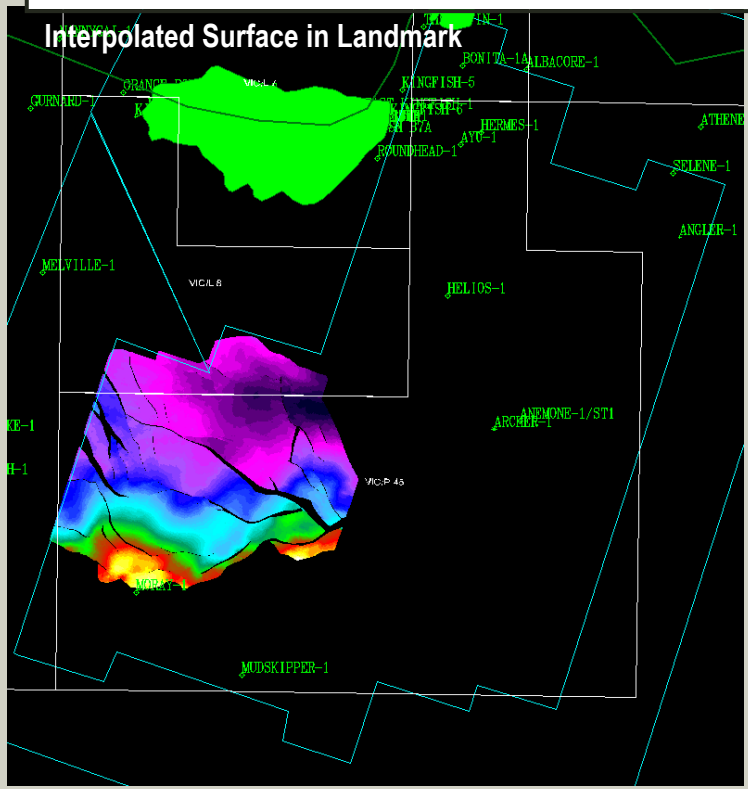
950 Top Strzelecki Fm TWT Structure

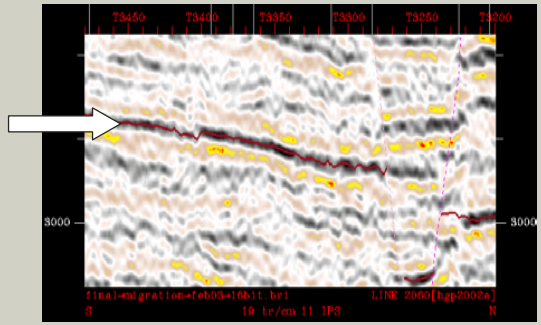






Top Strzelecki Fm/Base Emperor Group. Onlap surface that represent the onset of a rifting episode. Often thought of as economic basement due to depth of burial.

Picked as a variable black peak and onlap surface.



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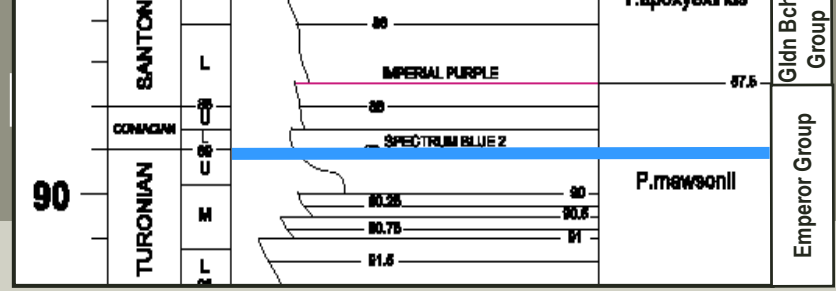
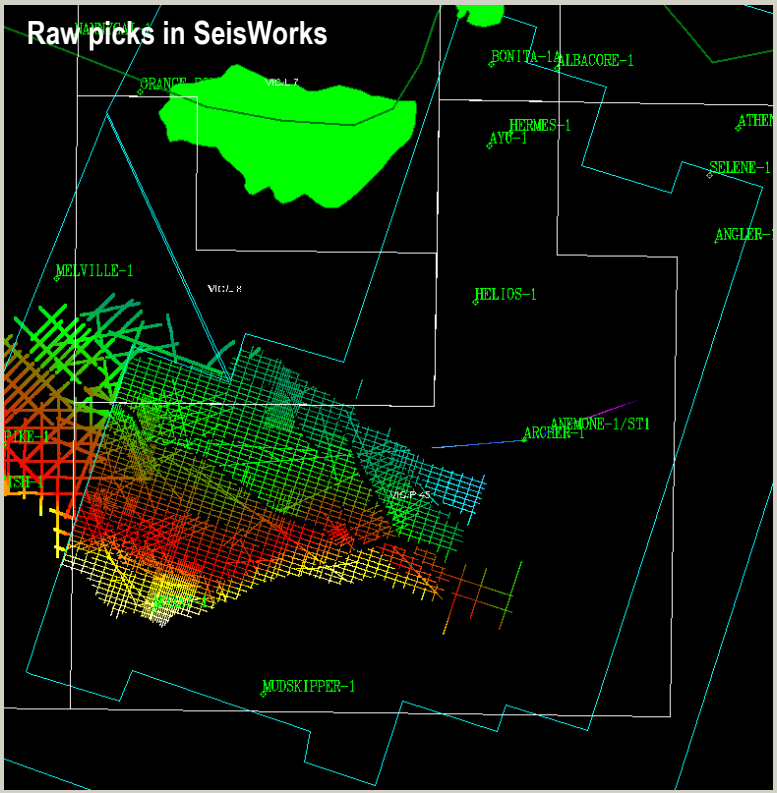
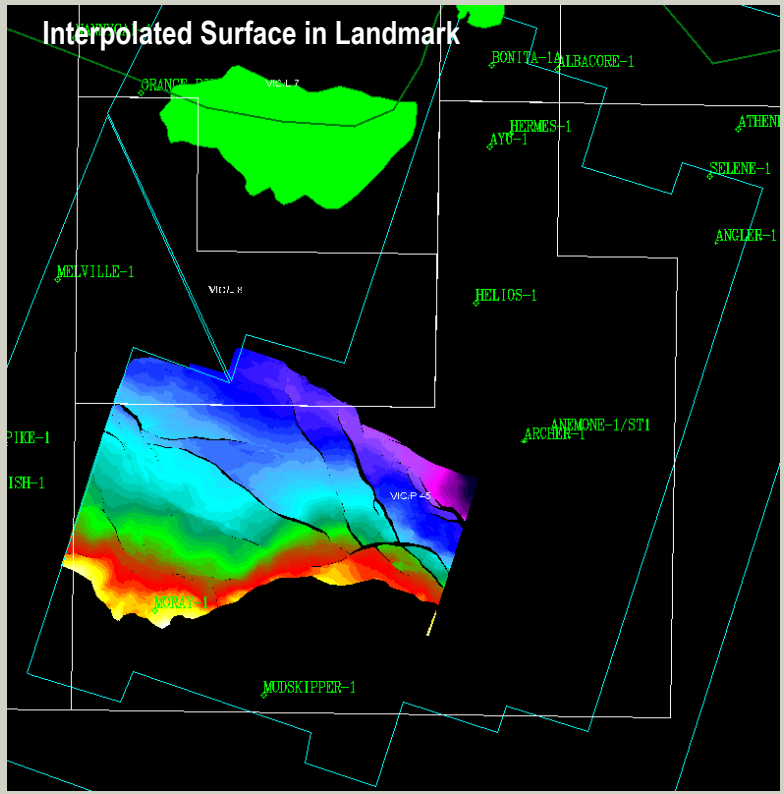
890 TWT Structure

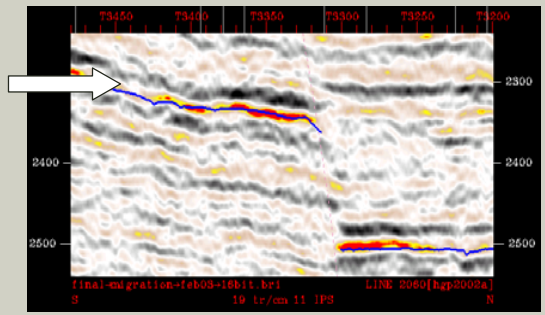






Reasonably consistent event within the Emperor Group that represents the end of a rifting episode and possibly base of (P.mawsonii) Kipper Shale equivalent.

Picked as a reasonably consistent red trough.



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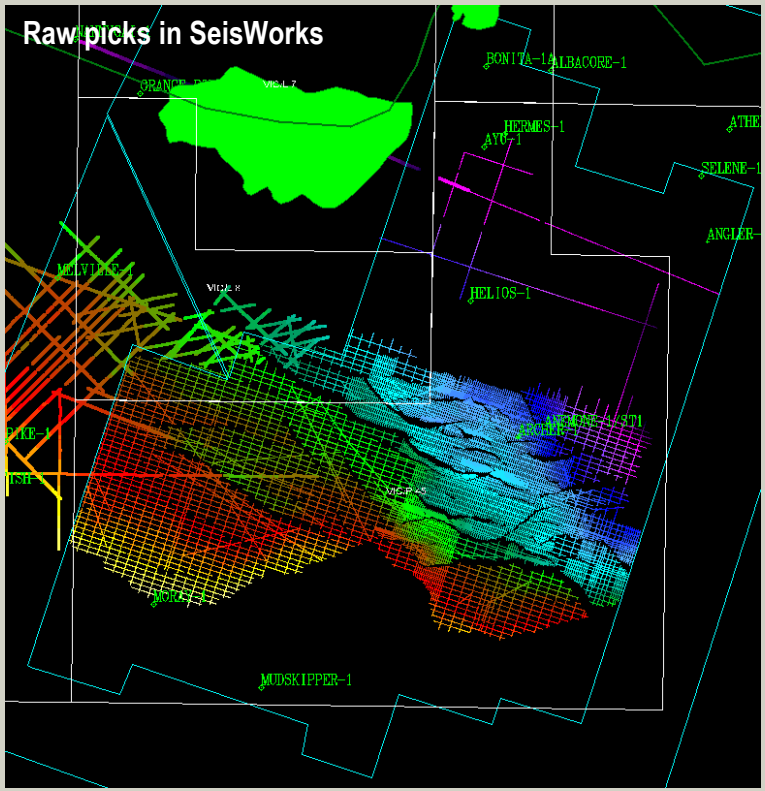
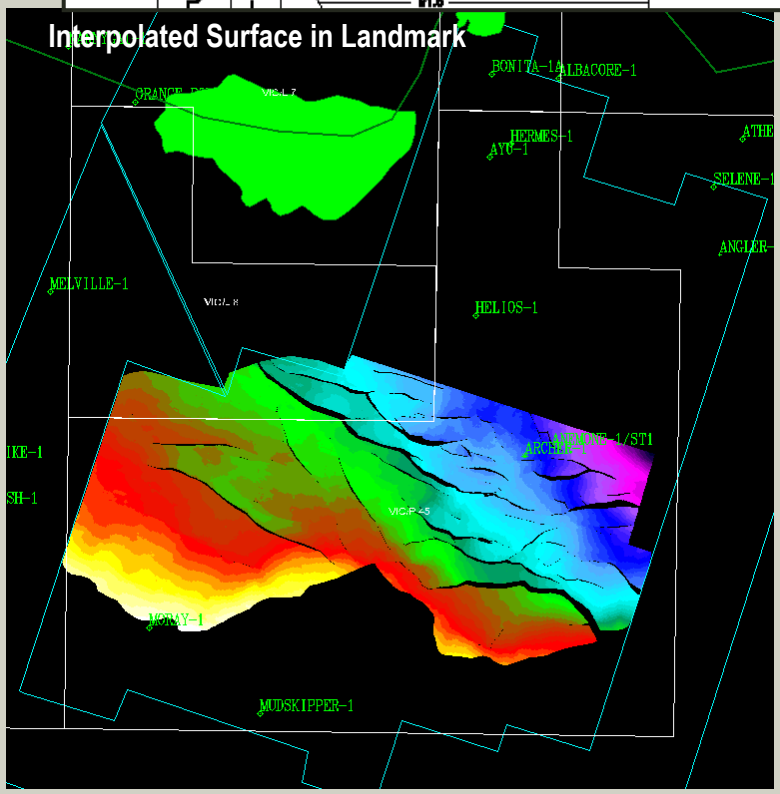
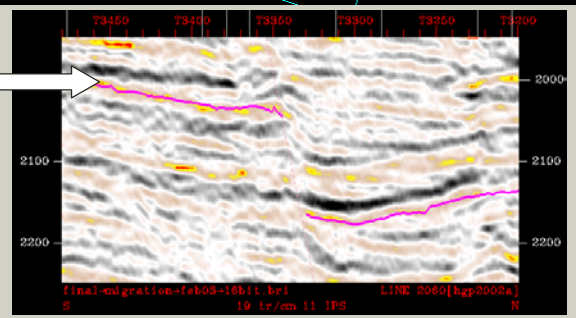
875 TWT Structure





Represents the top of the Emperor Group and near top (P.mawsonii) Kipper Shale equivalent.

Picked as a reasonably consistent red trough.



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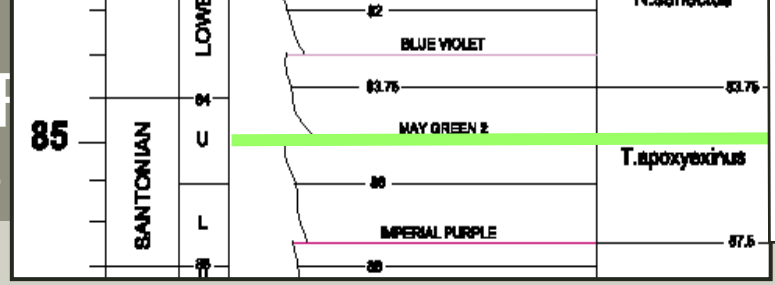
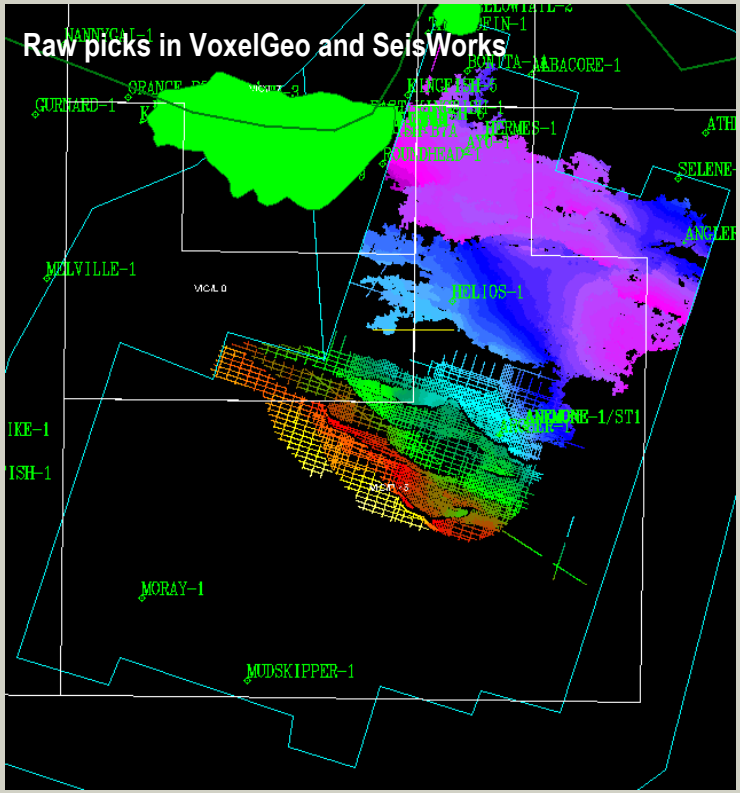
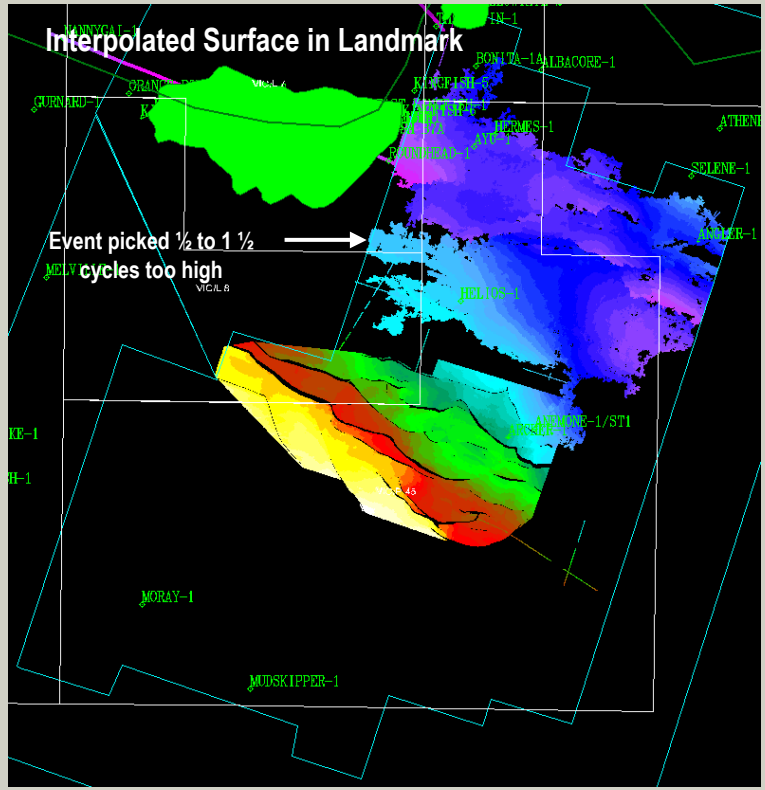
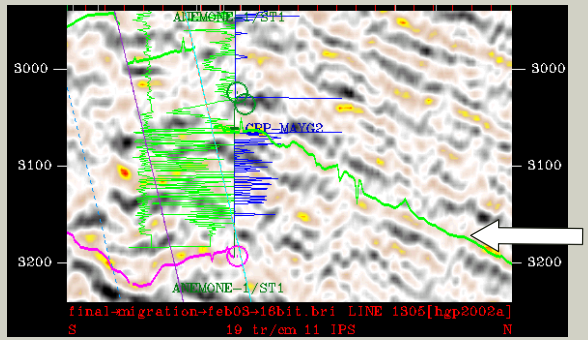
HGP2002A Seimic Interpretation F
850 Intra Golden Beach TWT Structure









Onlap surface representing the onset of second rifting episode, equivalent to top hydrocarbon pay at Anemone-1 (T.apoxyexinus sand) beneath the “Anemone Shale”.

Picked as a variable red trough. Diverging event in basin setting to the north picked ½ to 1 ½ cycles too high – requires updating.

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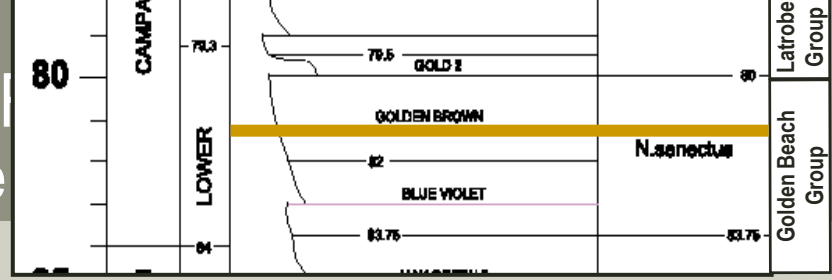
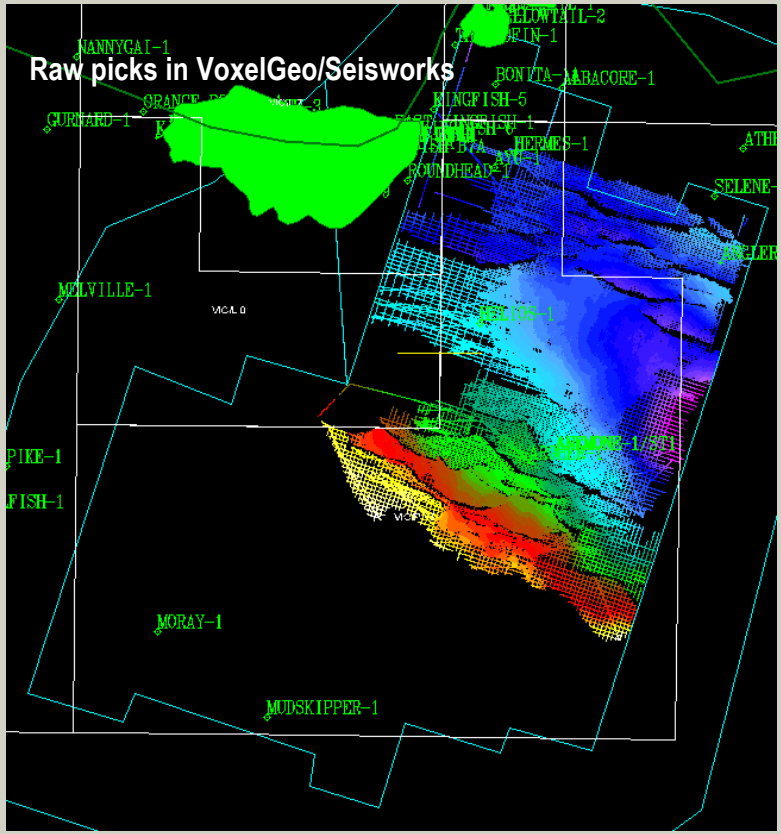
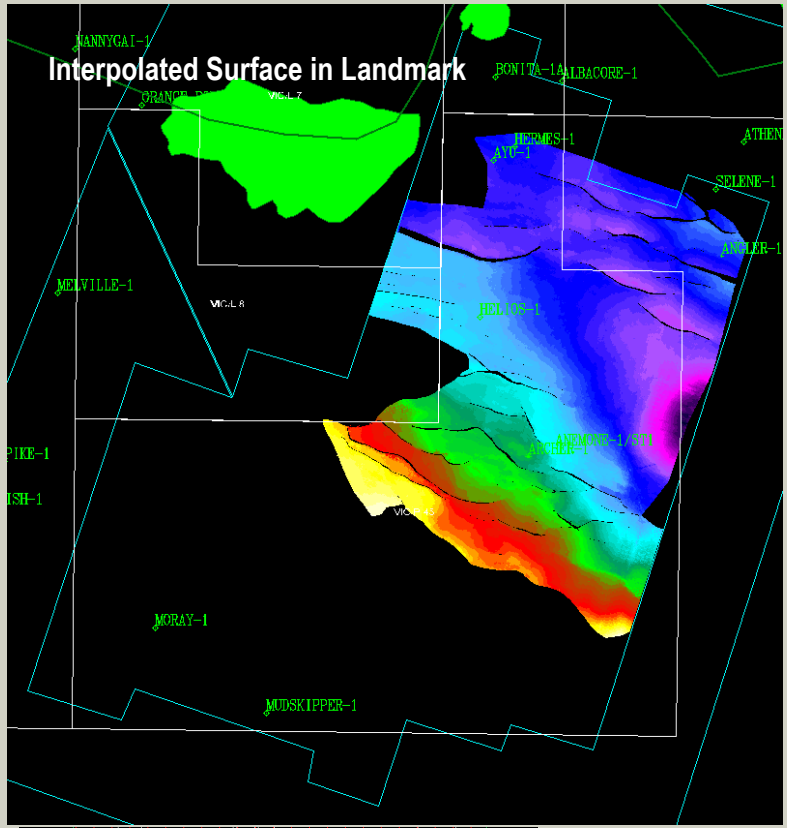
810 Intra Golden Beach TWT Structure

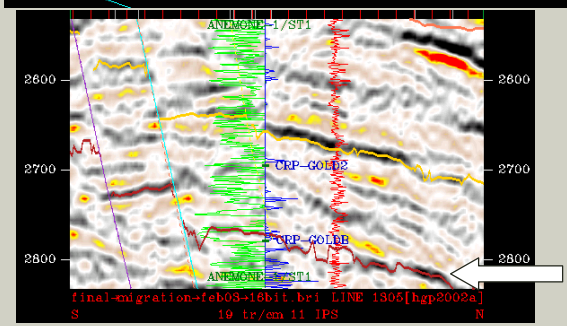






Prominent onlap event along the southern margin; lies within the pay interval at Archer-1 and Anemone-1; represents a period of accelerated subsidence.

Picked as a black peak of variable quality.



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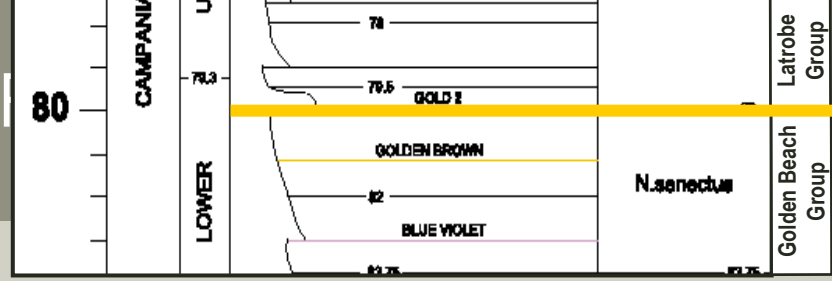
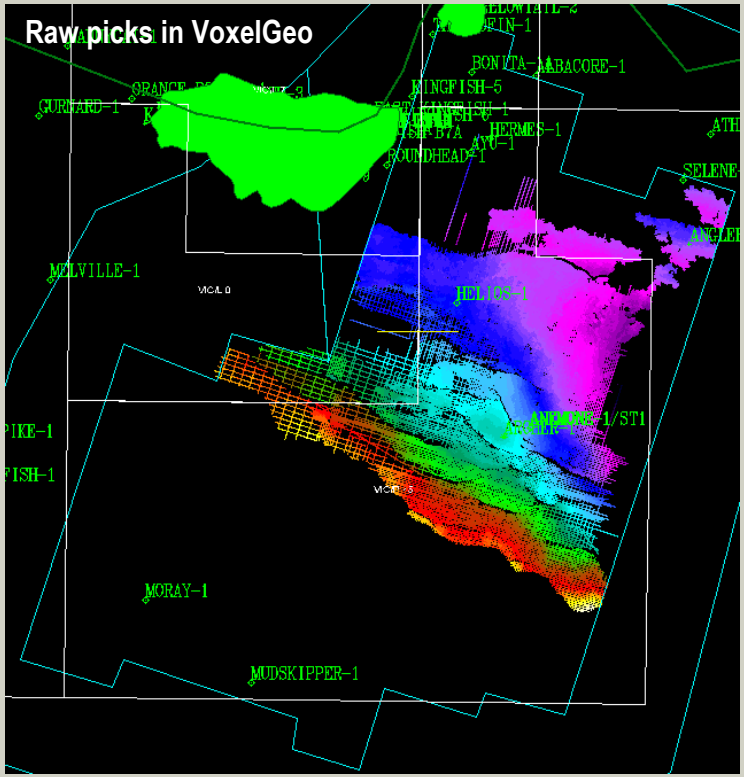
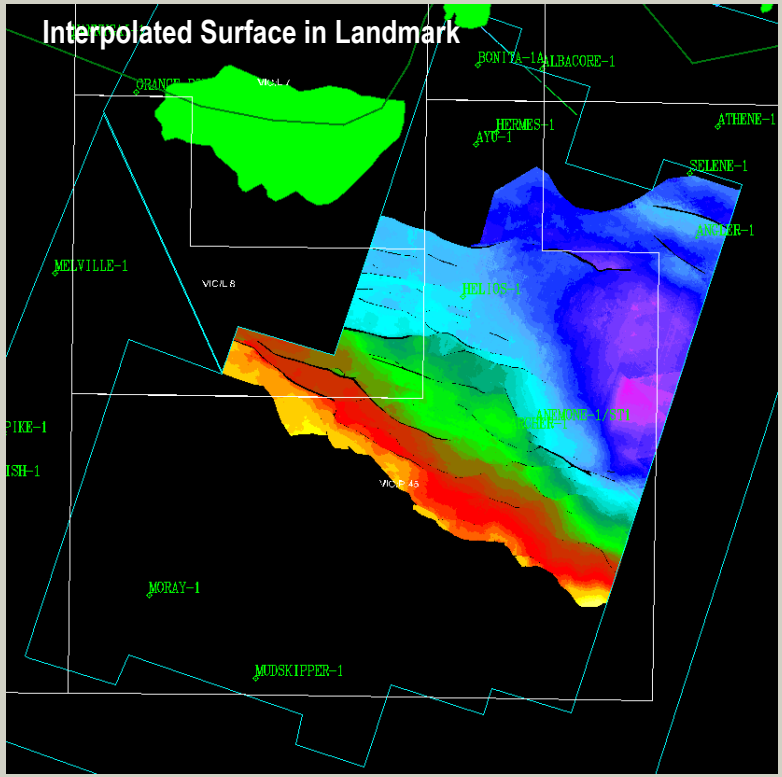
HGP2002A Seimic Interpretation I
800 Top Golden Beach TWT Structure



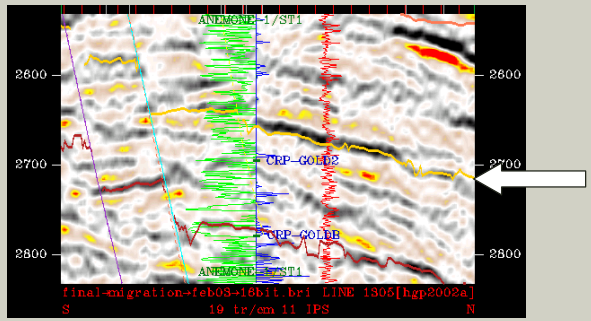
Middle Campanian - Gold2





Top of pay (N.Senectus sands) at Angler-1 beneath the Angler Shale and within pay zone at Archer-1. Event onlaps the 810event.

Picked as a black peak of variable quality.



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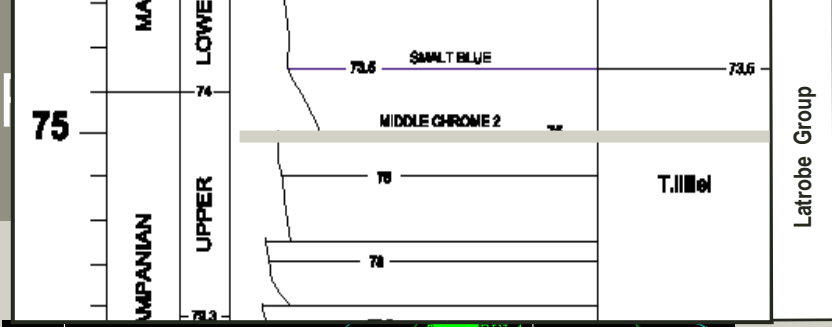
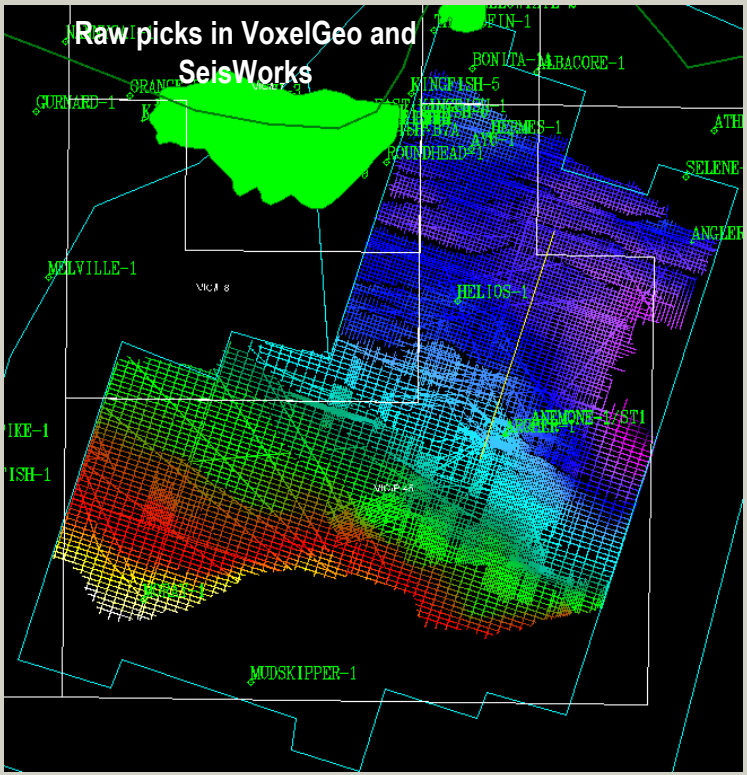
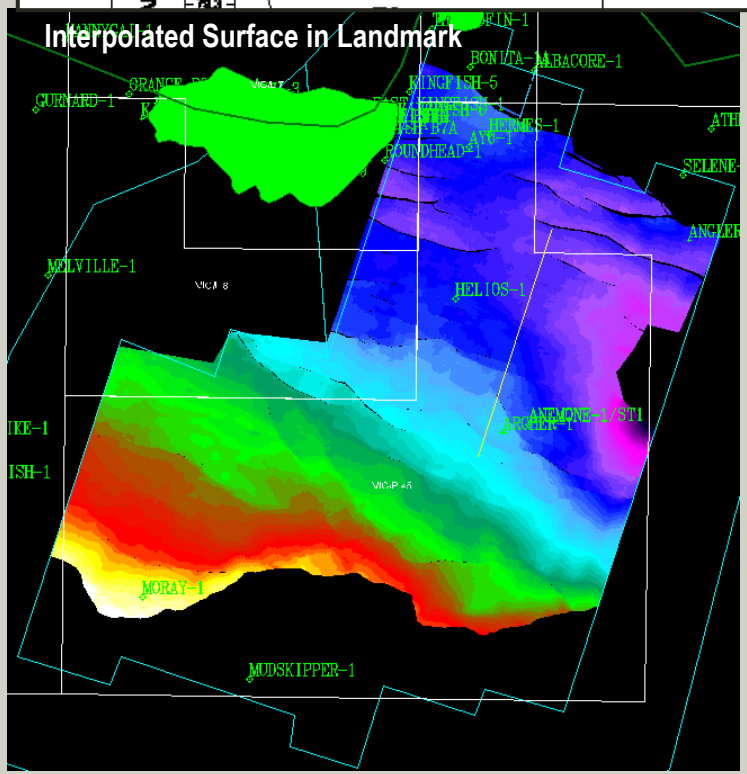
HGP2002A Seimic Interpretation I
750 Intra Latrobe TWT Structure



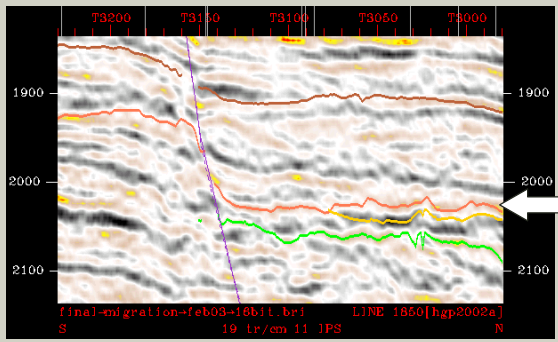
Mid-Chrome2 – Upper Campanian





Composite unconformity surface representing cessation of rifting; stratigraphically the top of the Angler shale.

Picked as a locally strong but regionally variable red trough.



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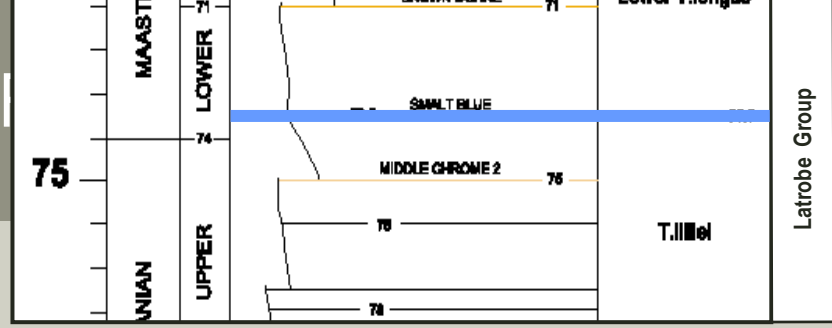
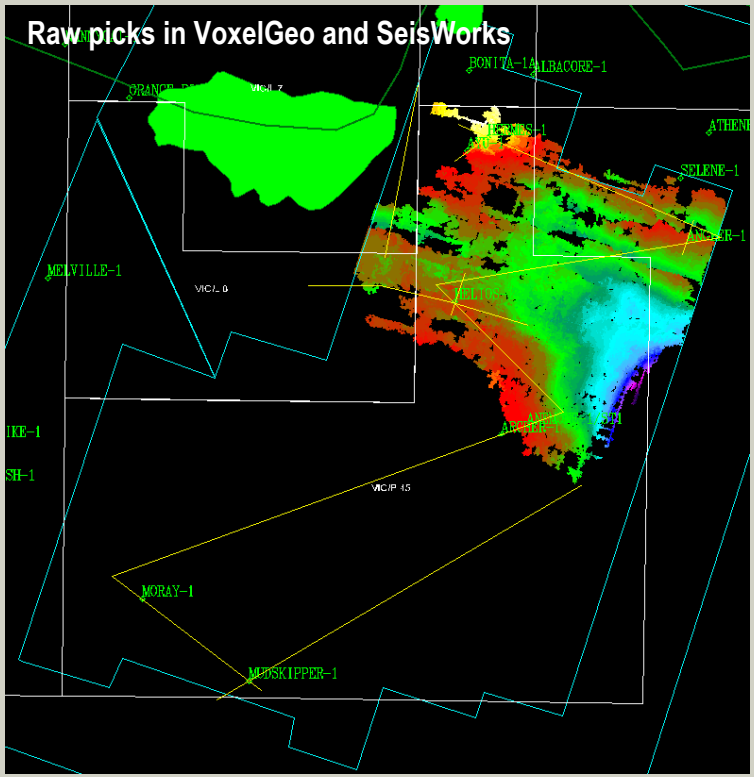
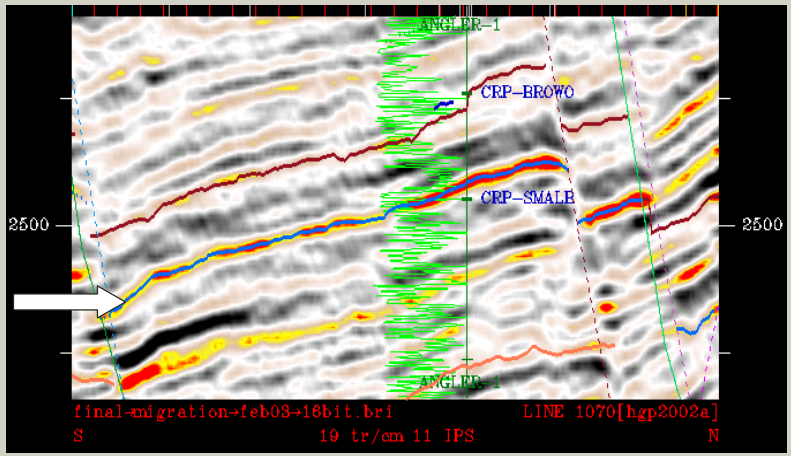
HGP2002A Seimic Interpretation I

735 Intra Latrobe Group TWT Structure

Early Maastrichtian - Smalt Blue







Marker event in the northern part of the permit that represents the top of a shale dominated section at Angler-1. Terminates against faults along the Archer Trend.

Picked as a locally strong but regionally variable red trough.

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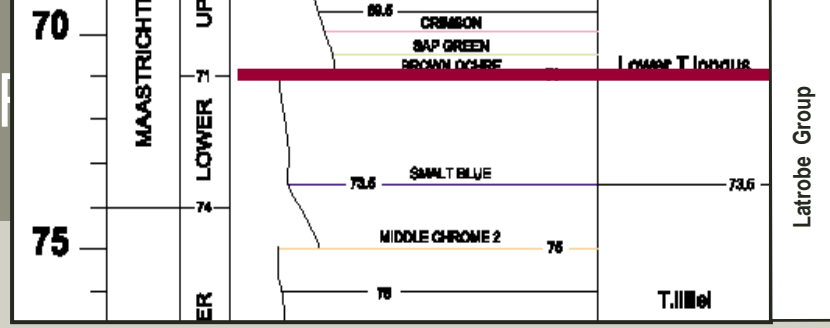
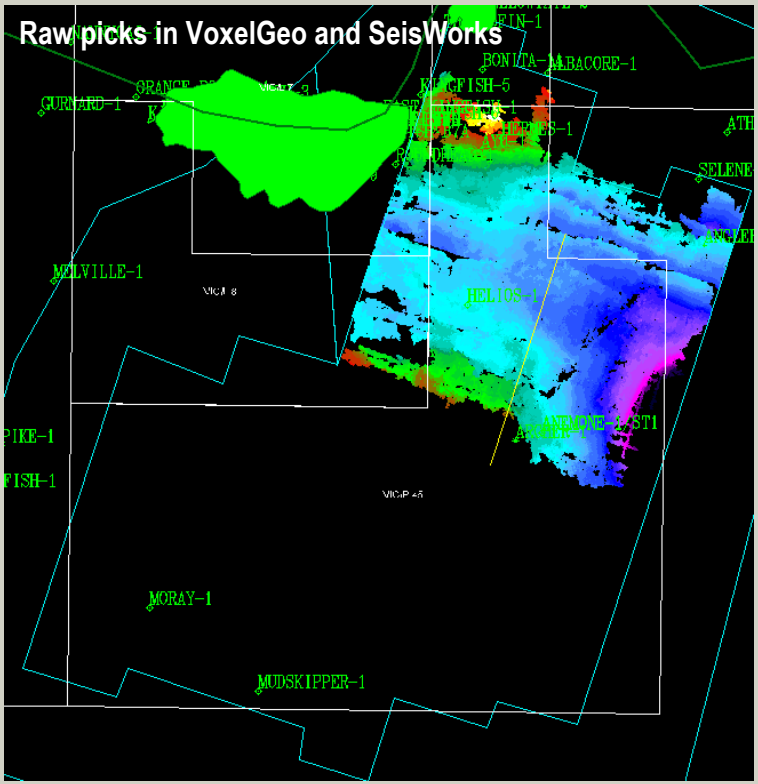
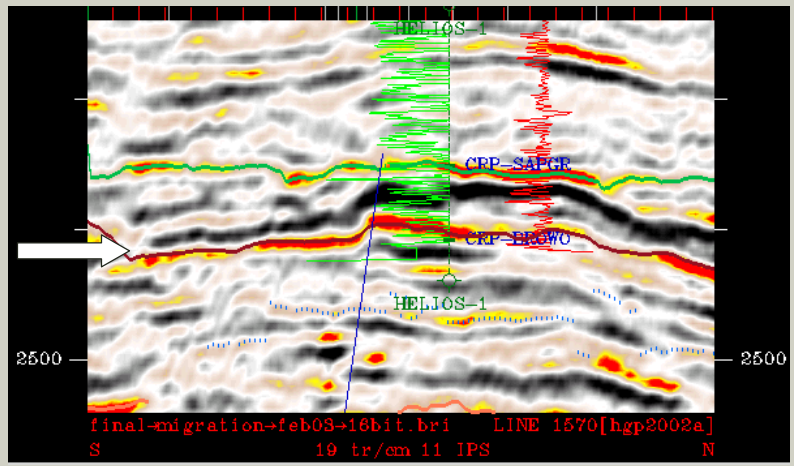
HGP2002A Seimic Interpretation
710 Intra Latrobe Group TWT Structure

Middle Maastrichtian – Brown Ochre







Marker event in the northern part of the permit within the coastal plane dominated part of the Latrobe Group. Terminates against faults along the Archer Trend.

Picked as a red trough of variable consistency.

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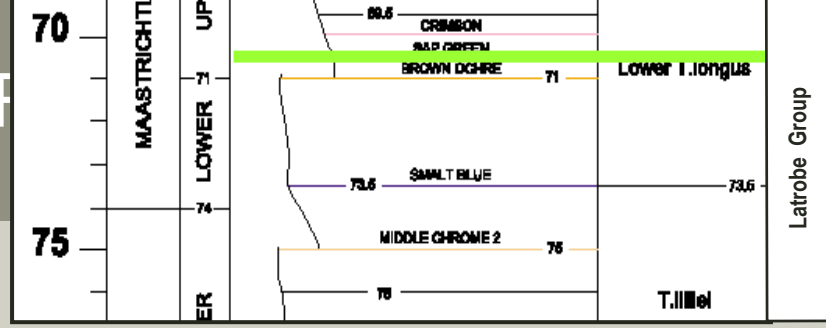
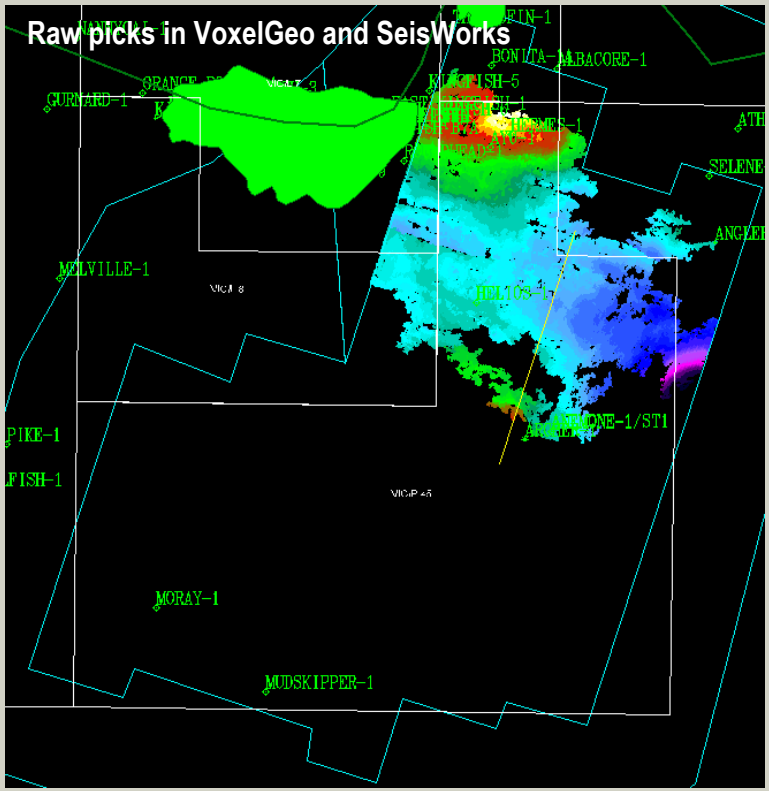
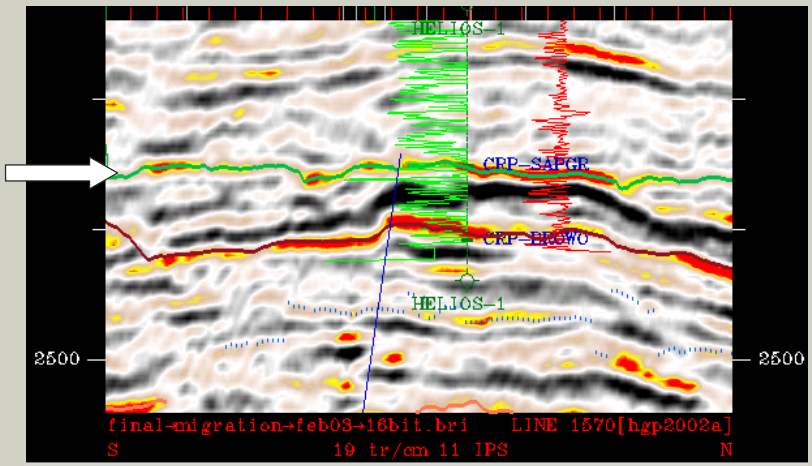
705 Intra Latrobe Group TWT Structure

Late Maastrichtian – Sap Green







Marker event in the northern part of the permit within the coastal plane dominated part of the Latrobe Group. Terminates against faults along the Archer Trend.

Picked as a red trough of variable consistency.

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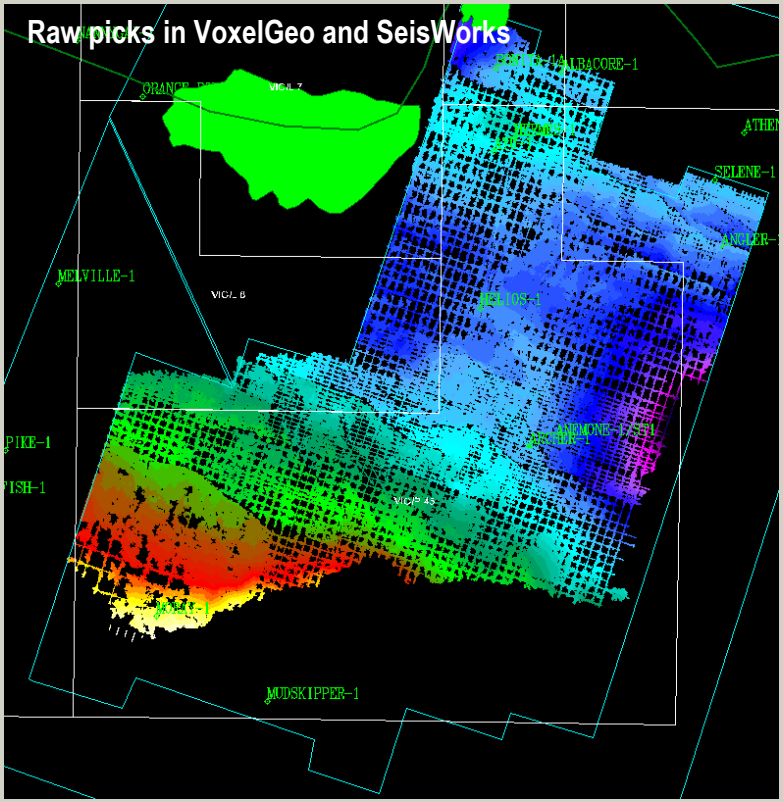
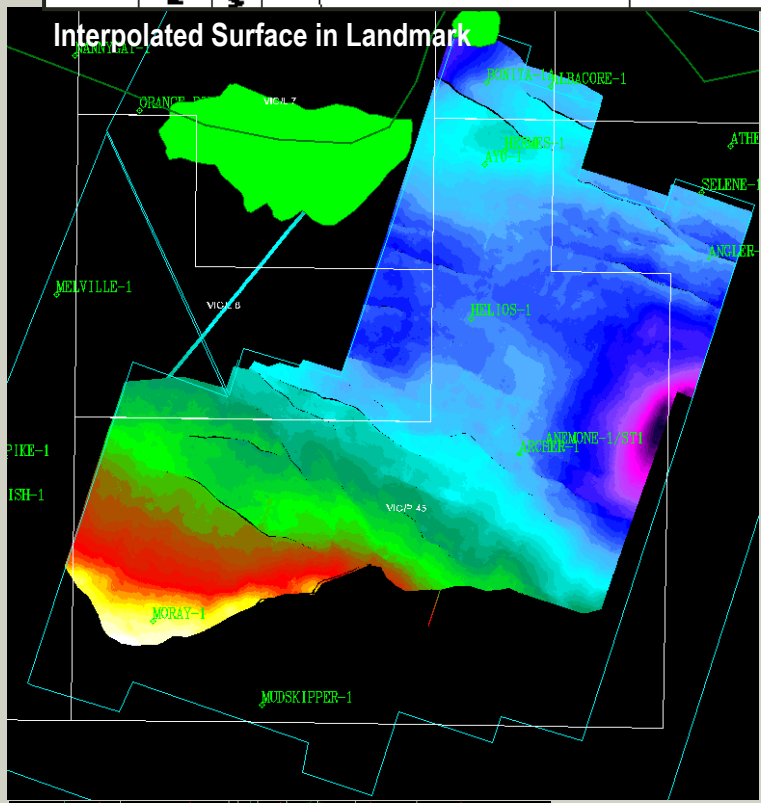
HGP2002A Seimic Interpretation

690 Intra Latrobe Group TWT Structure

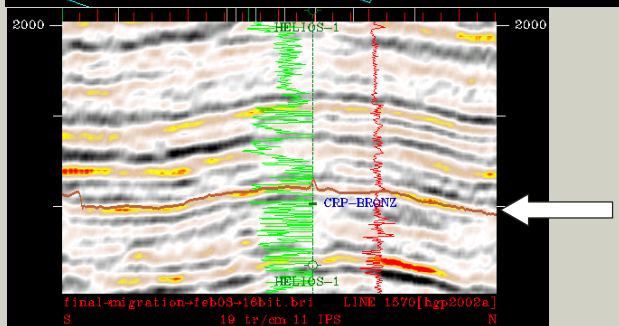
Late Maastrichtian - Bronze





Reasonably consistent marker within the Latrobe Group that represents the onset of a third rifting episode.

Picked as a red trough and downlap surface.



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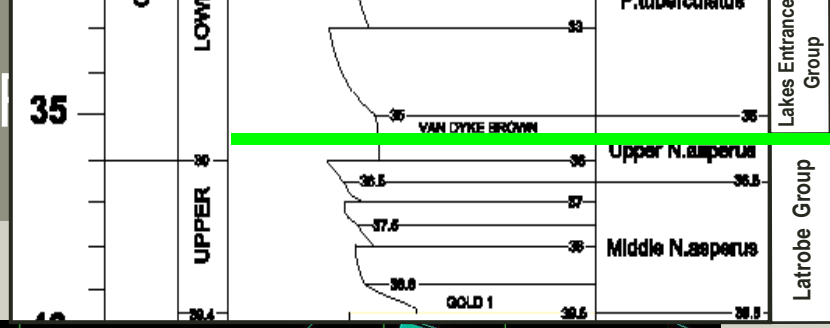
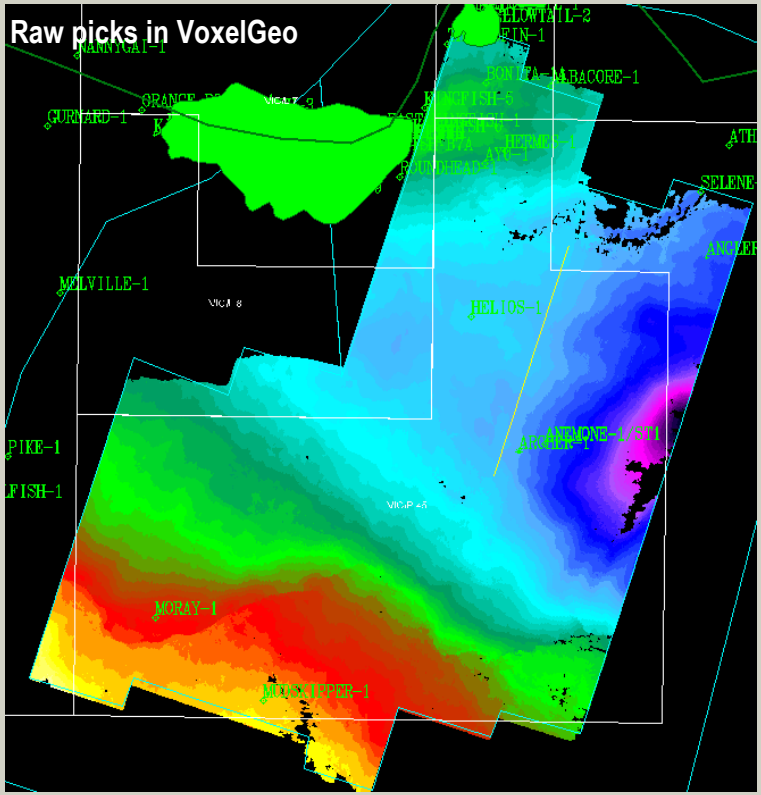
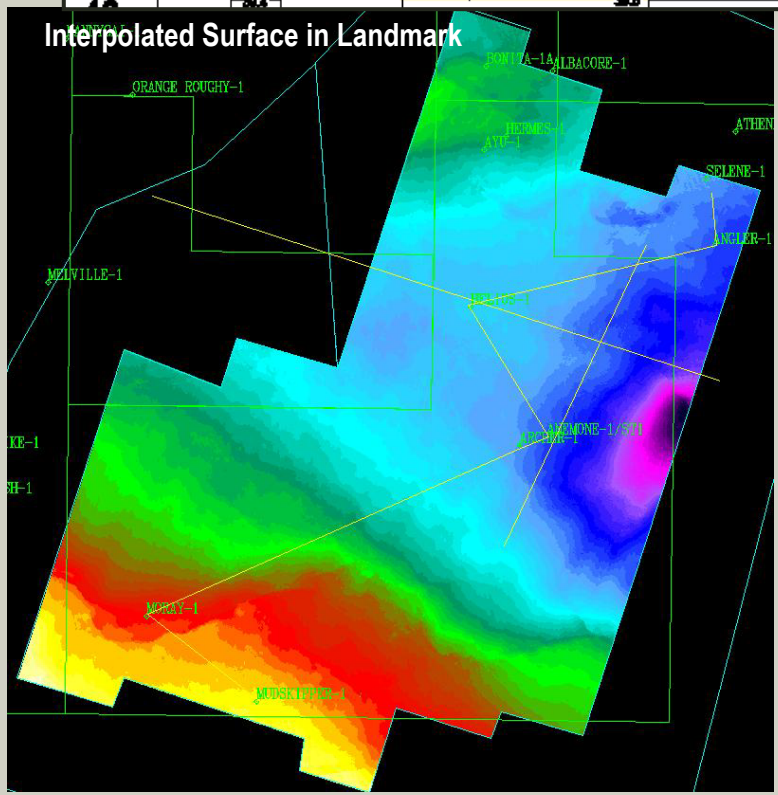
HGP2002A Seimic Interpretation I
350 Top Latrobe Group TWT Structure

Lower Oligocene – Van Dyke Brown

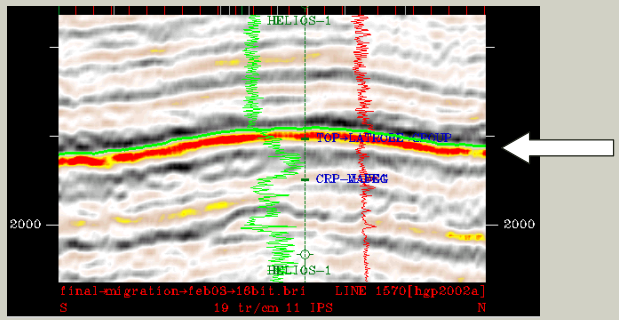






Consistently strong horizon representing near top reservoir at the top of the Latrobe Group.

Picked as a zero crossing between a moderate black peak and a strong red trough.



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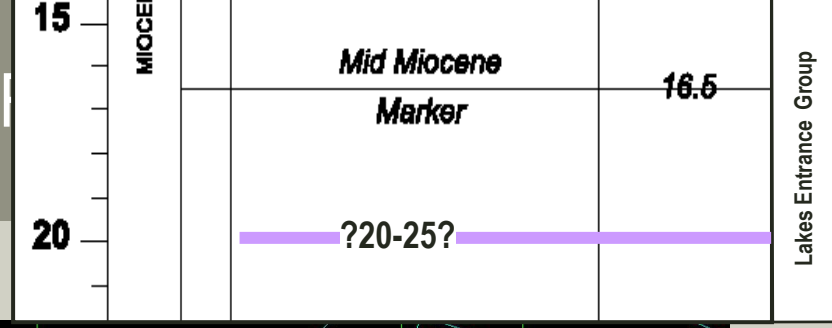
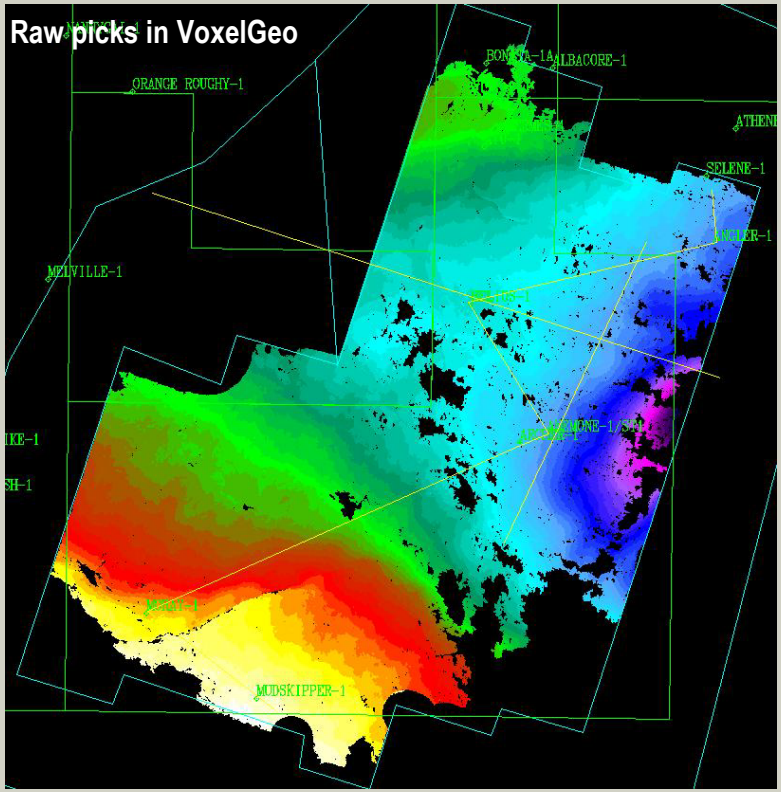
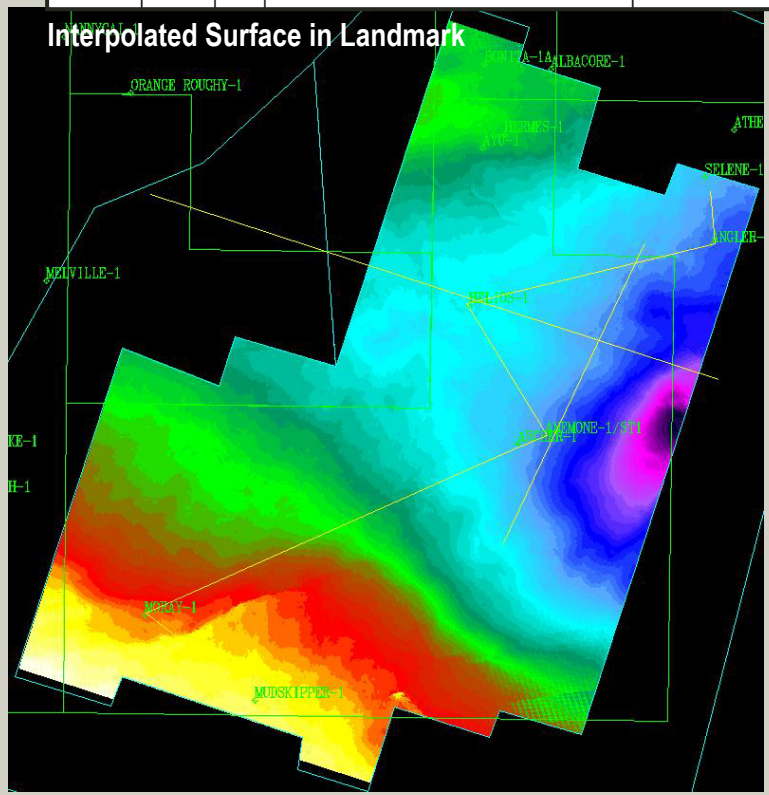
HGP2002A Seimic Interpretation I

250 Intra-Lakes Entrance TWT Structure



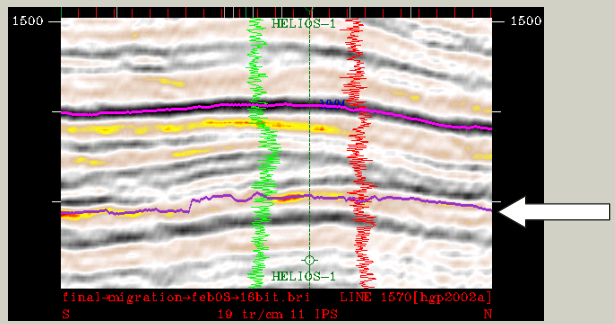
Early Miocene – colour unallocated





Consistent marker horizon within the Lakes Entrance Group and good datuming surface.

Moderately strong but consistent red trough across most of the permit; complex faulting in the south west.



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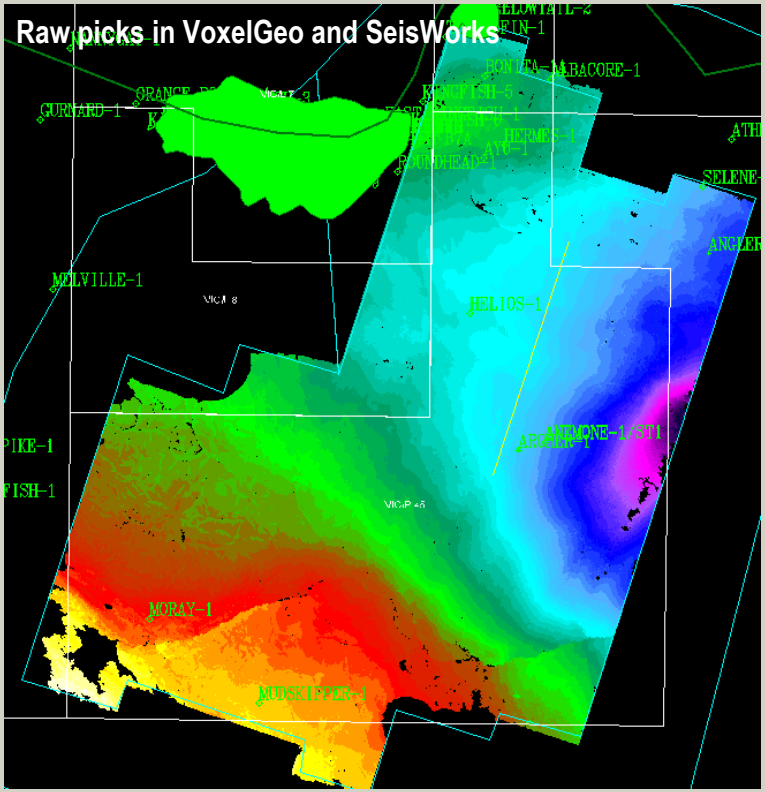
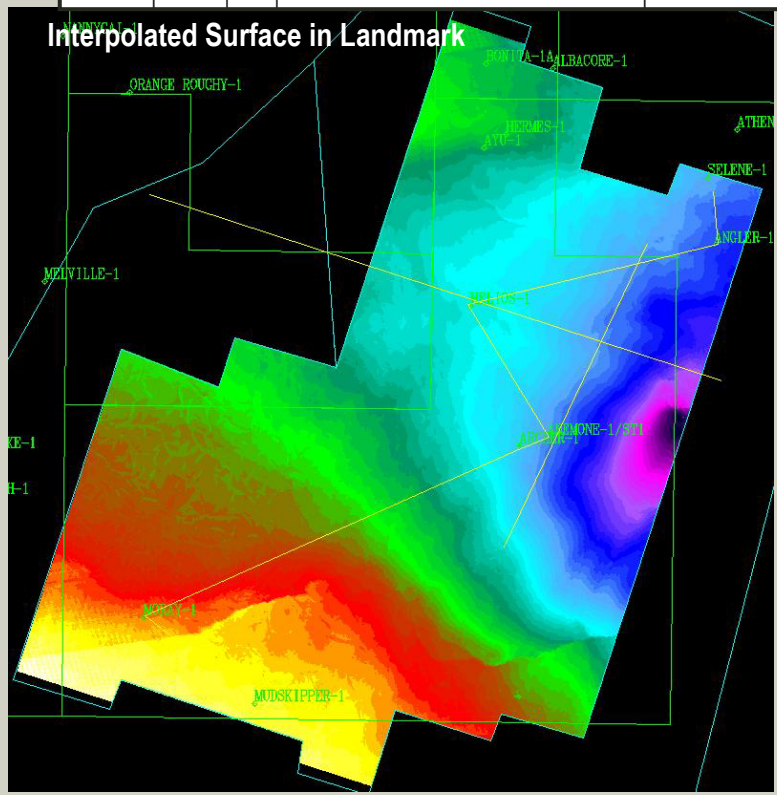
HGP2002A Seimic Interpretation I

165 Intra Lakes Entrance TWT Structure

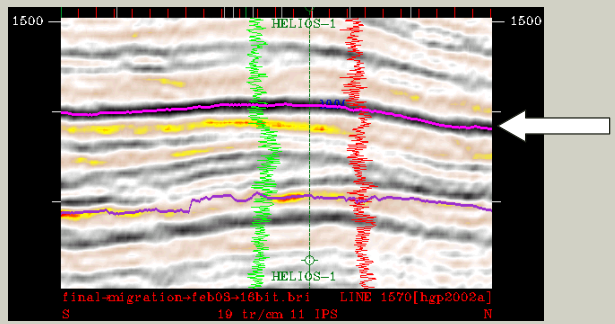
"Mid Miocene Marker" – colour unallocated





Prominent marker within Lakes Entrance Group and good datuming surface.

Consistently strong black peak across most of the permit; heavily and complexly faulted in the south west.



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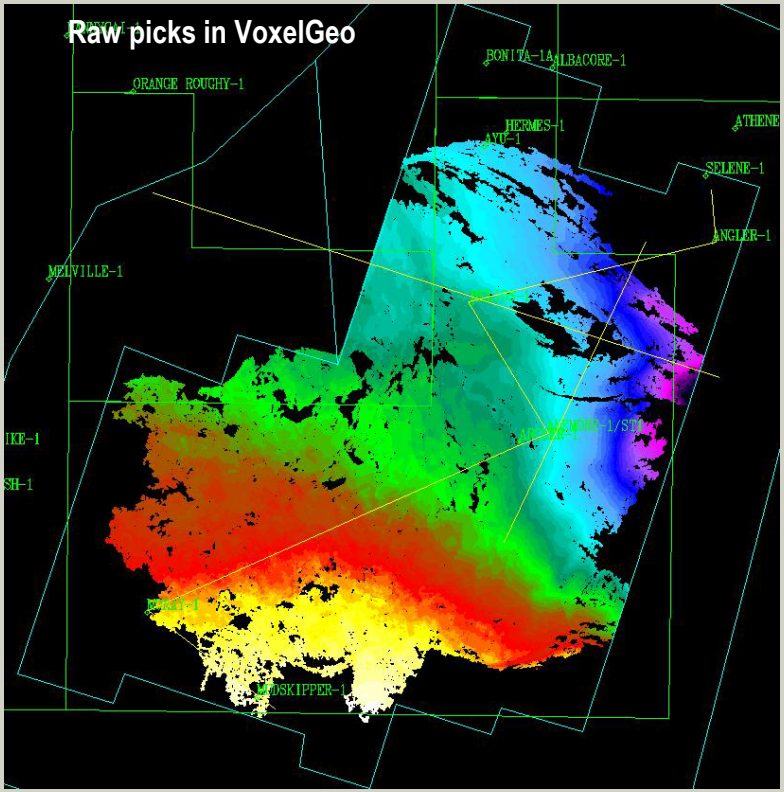
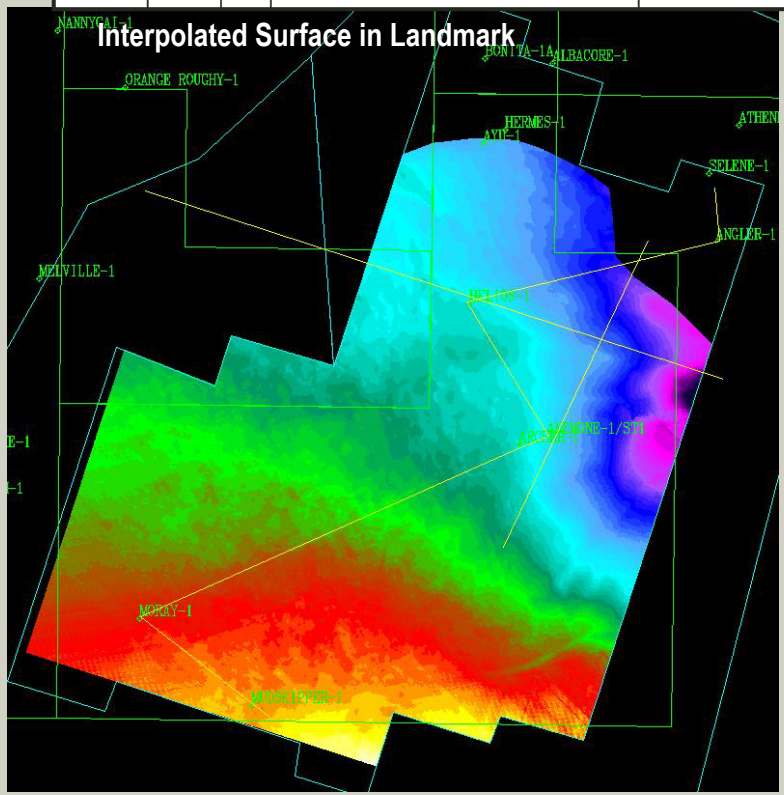
HGP2002A Seimic Interpretation I

135 Base Gippsland Lst TWT Structure (1)

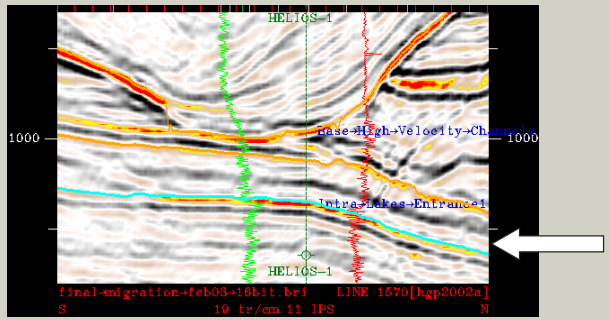
?Pliocene Marker – colour unallocated





Base of the high velocity Carbonate section in the south of the permit and important depth conversion surface.

Strong red trough, down-lapped by shallower carbonate marker in the north-east; intersected by Pliocene channel across central (Helios-1) region of the permit. Event weakens in the southwest.



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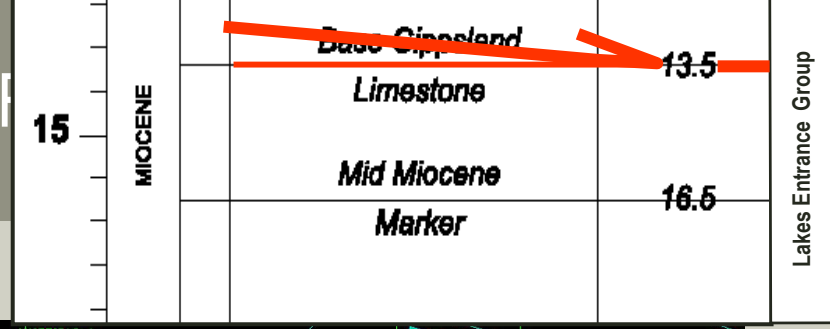
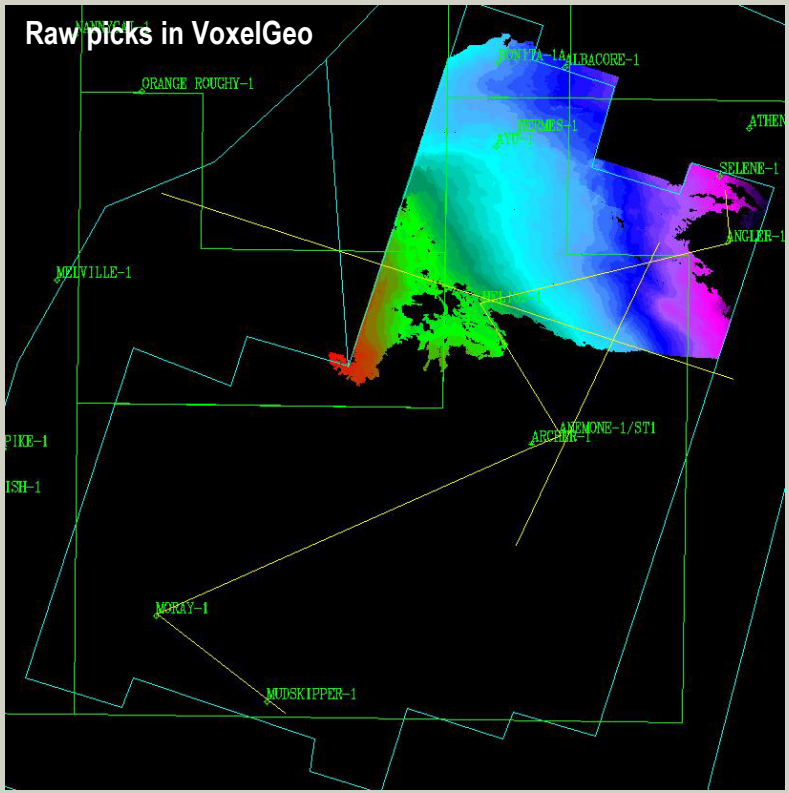
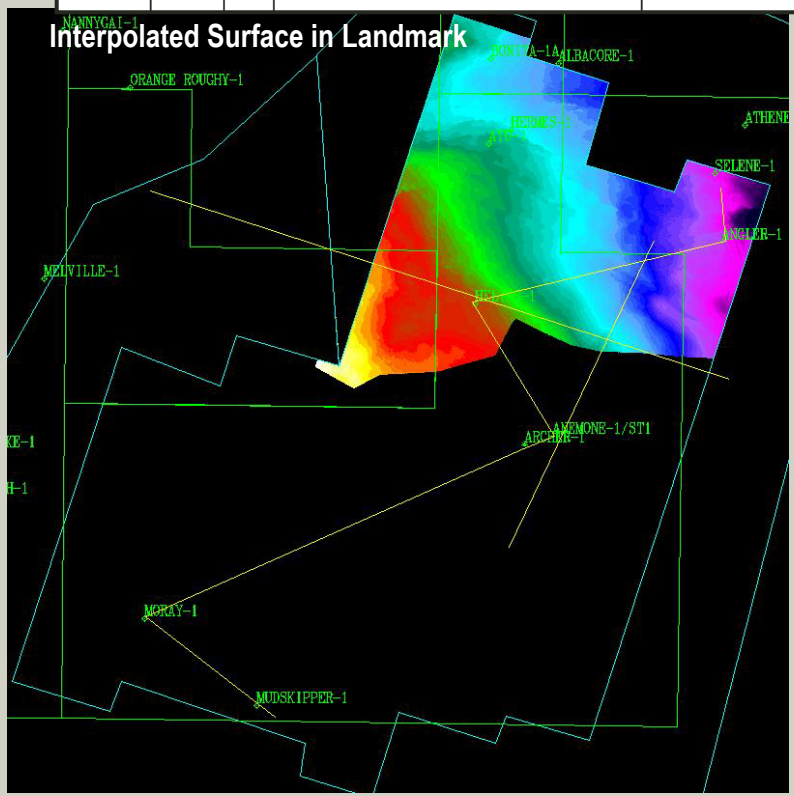
HGP2002A Seimic Interpretation
130 Base Gippsland Lst TWT Structure (2)

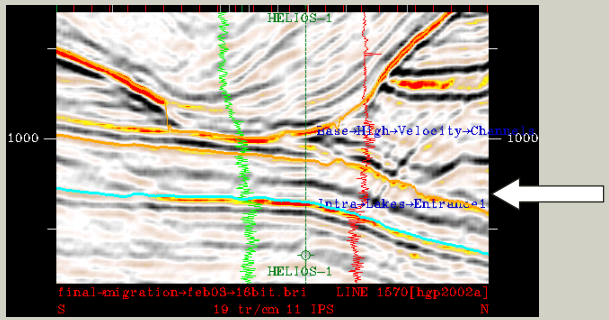






Base of the high velocity Carbonate section in the north-east; downlaps the underlying 135 event. An important depth conversion surface.

Moderately strong red trough eroded by channeling event in Helios-1 area.



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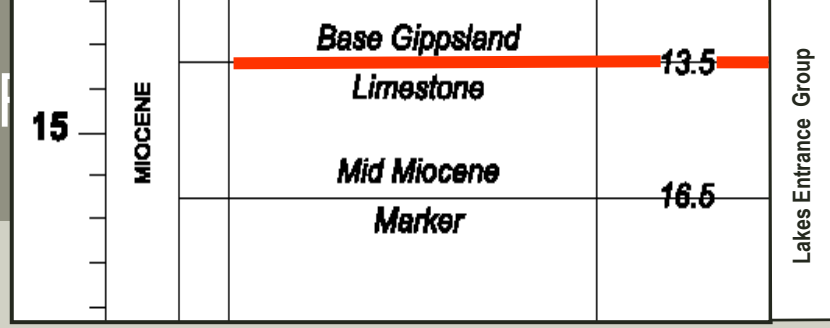
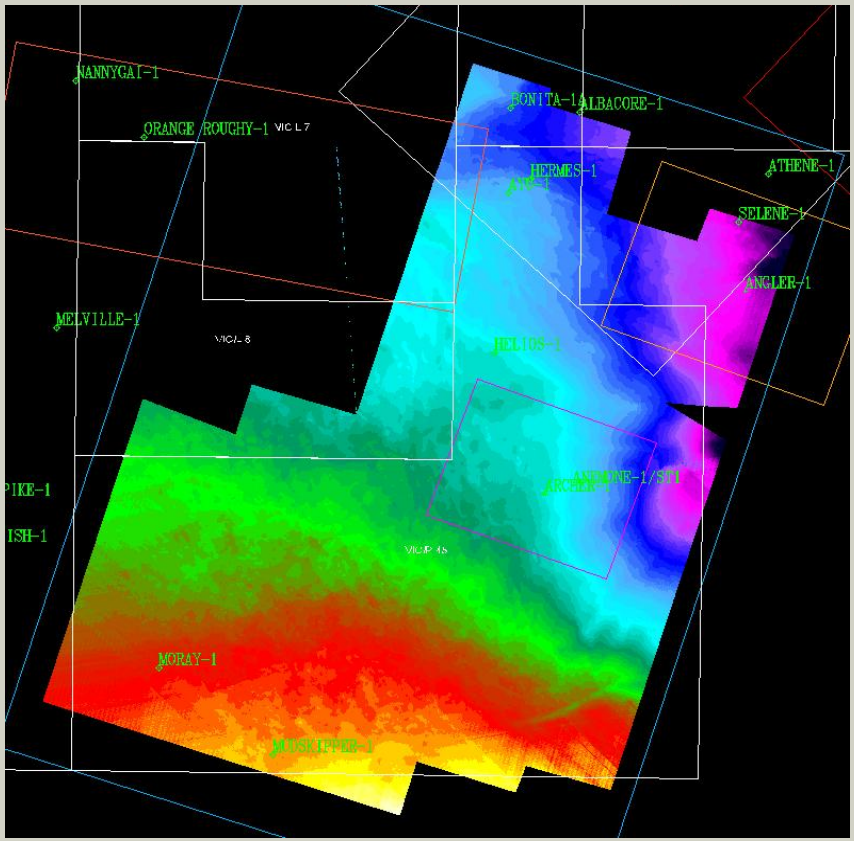
HGP2002A Seimic Interpretation I

136 (merge 130+135)

Base Gippsland Lst TWT Structure





Base High Velocity Zone TWT Structure

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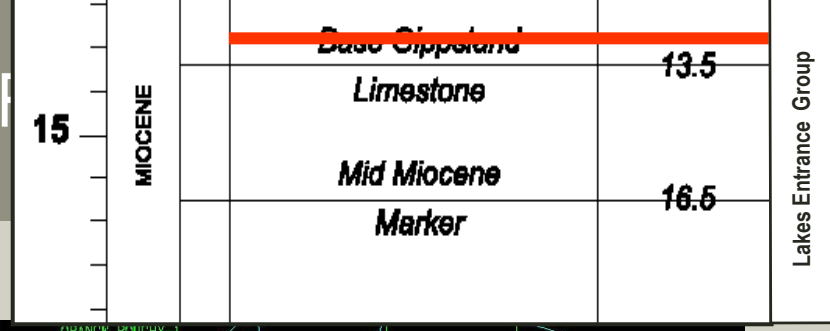
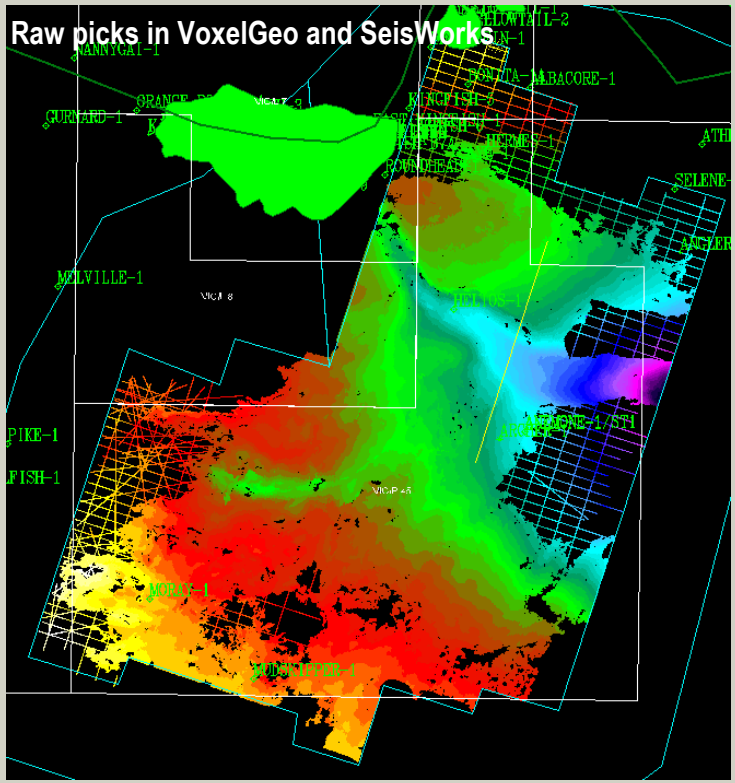
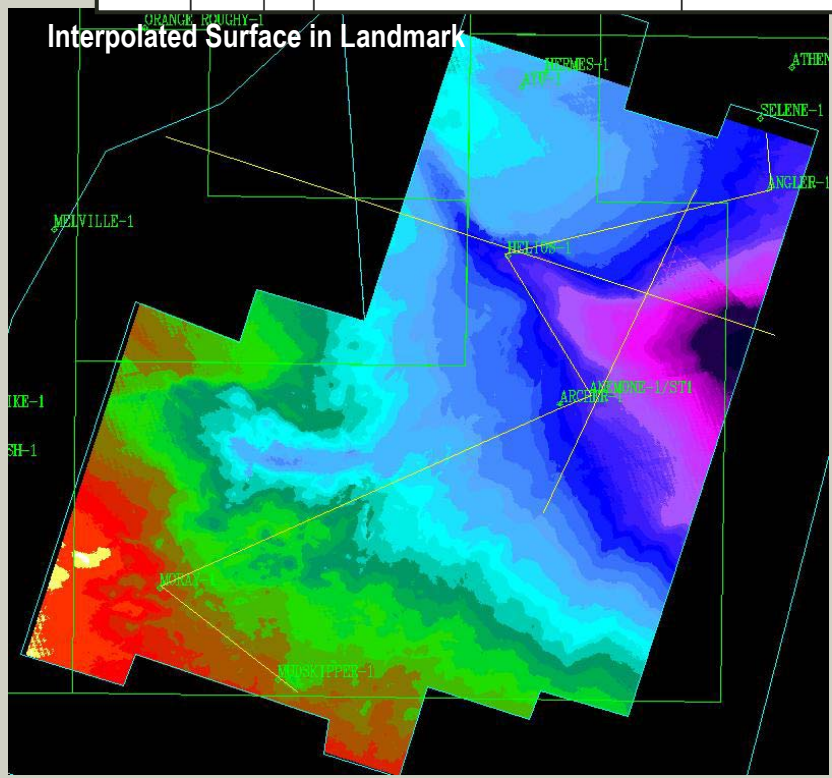
HGP2002A Seimic Interpretation
120 Base Channel TWT Structure



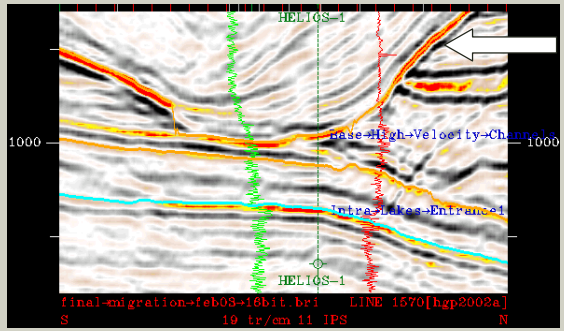
?Miocene/Pliocene – colour unallocated





Base of the ?Pliocene Carbonate channel that projects SW to E through the central (Helios-1) area of the Vic/P45; subordinate E-W channel in the central west. Base of Channel erodes down to Base Gippsland Limestone. Important Depth conversion surface.

Variable red trough most easily picked at event terminations; mapping becomes problematic outside main channel area.



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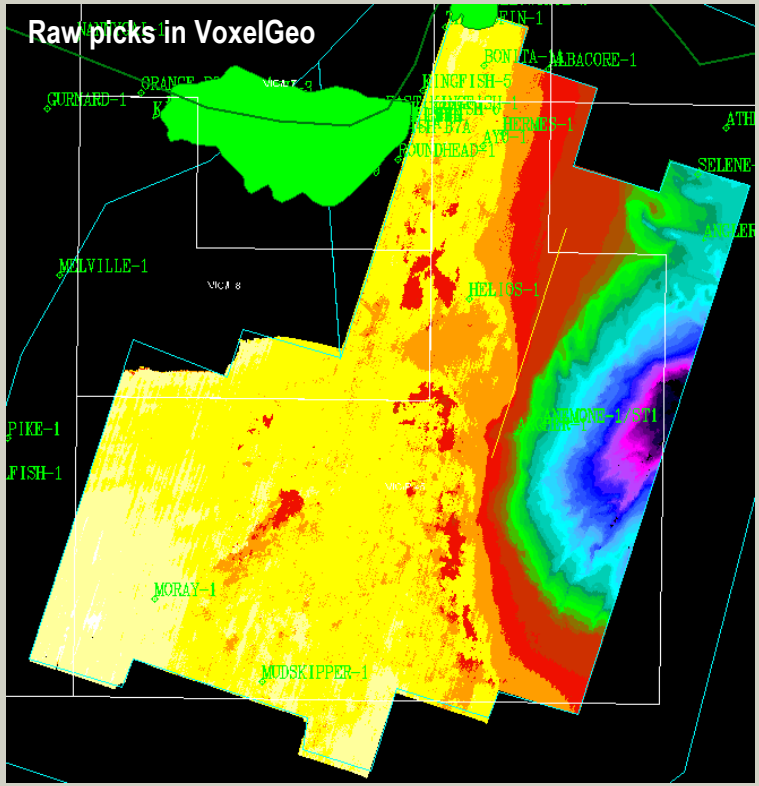
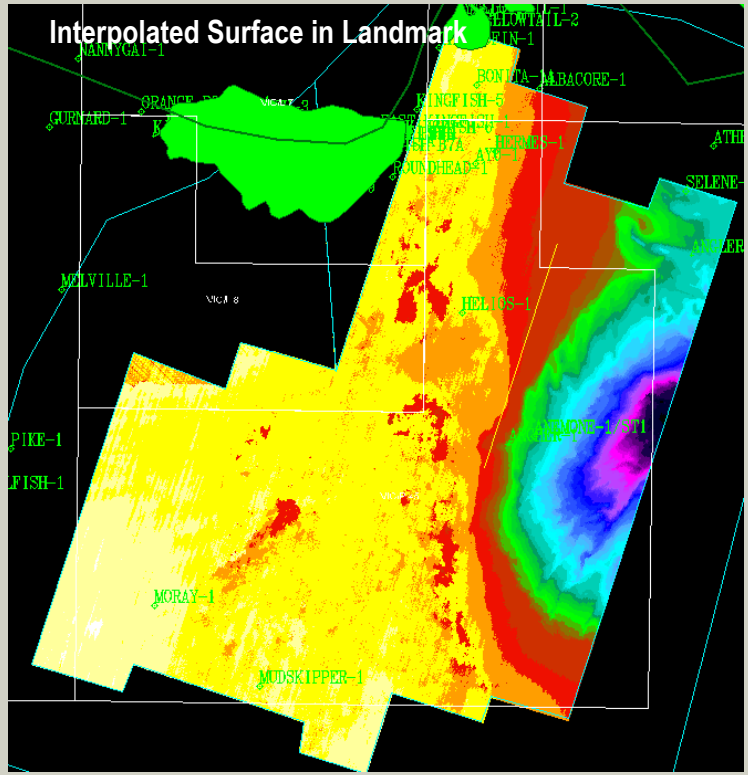
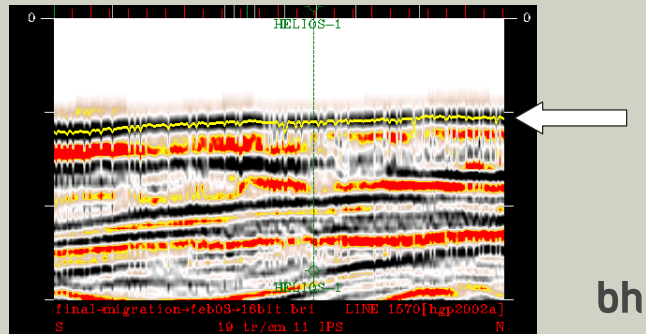
HGP2002A Seimic Interpretation Report
000 Seafloor TWT Structure







Waterbottom event picked as a strong black peak. Shallow water depth combined with processing mute makes event weak and discontinuous in western two thirds of permit.

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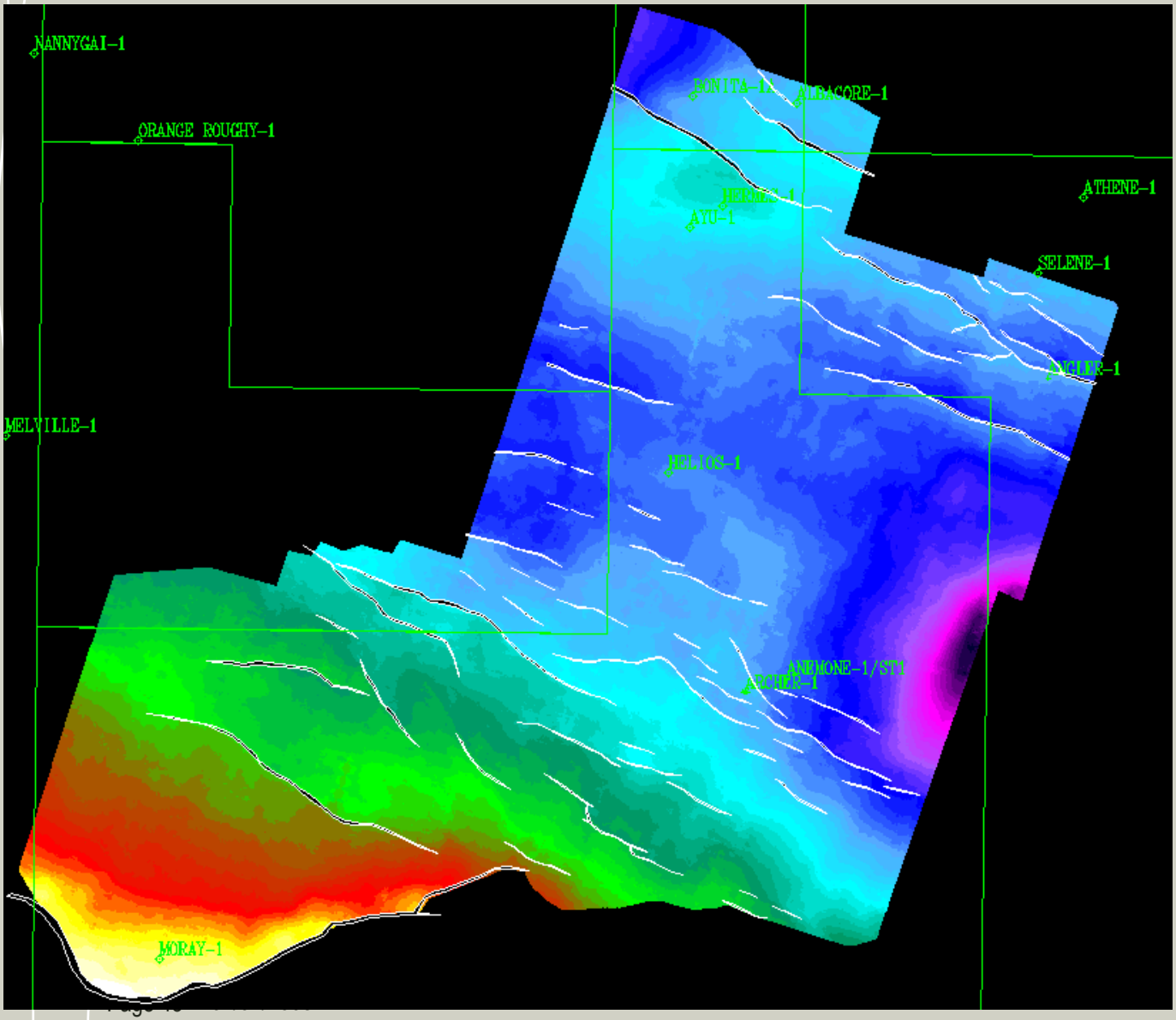
HGP2002A Seimic Interpretation Report
69Ma (Bronze) Sequence Boundary



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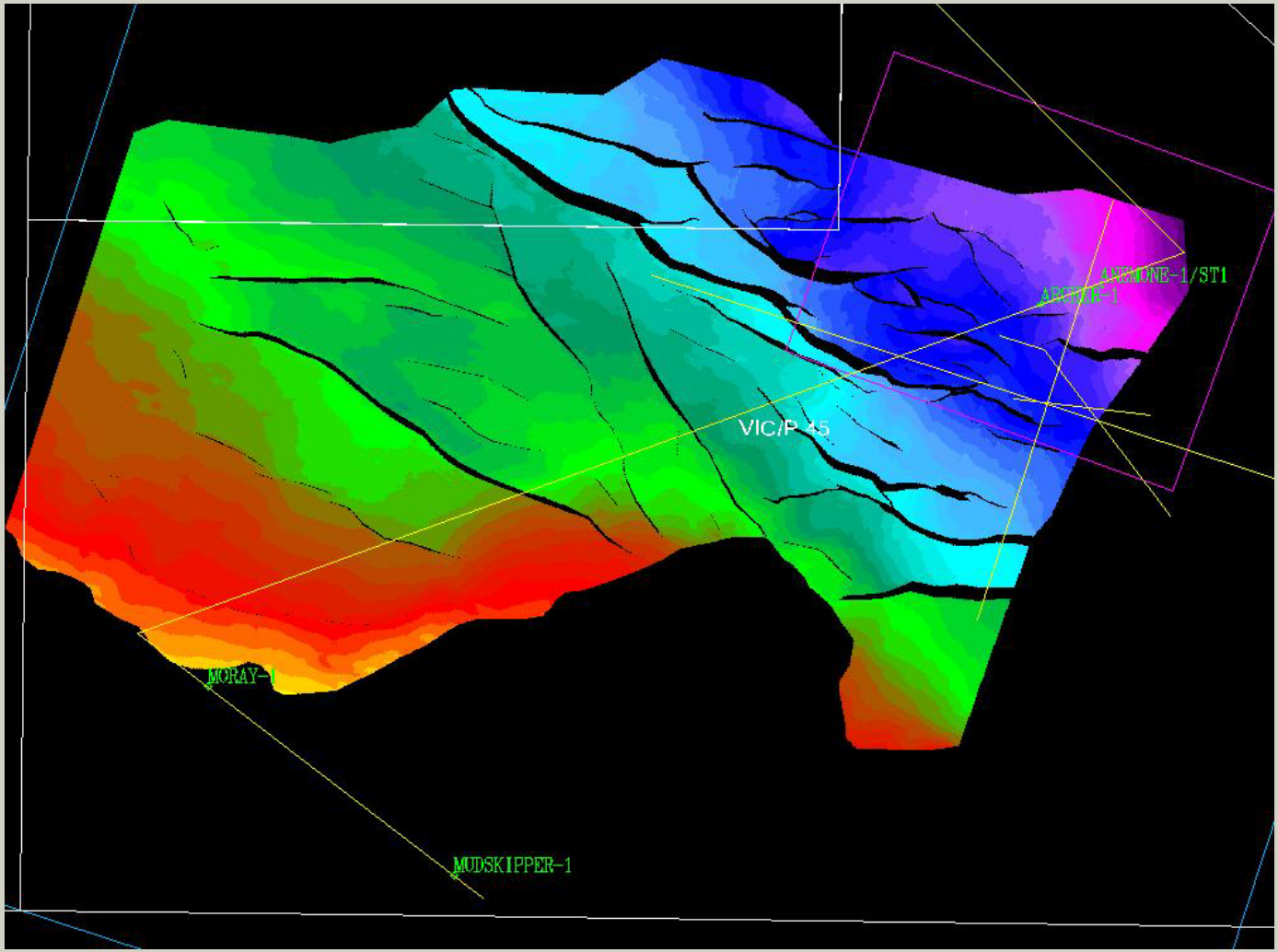
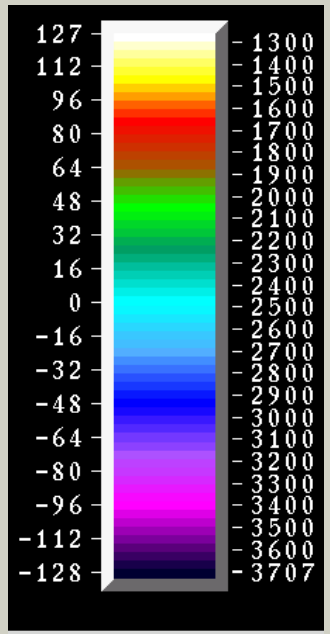
HGP2002A Seimic Interpretation Report
Top Emperor Sub-Group (87.5Ma) Sequence Boundary





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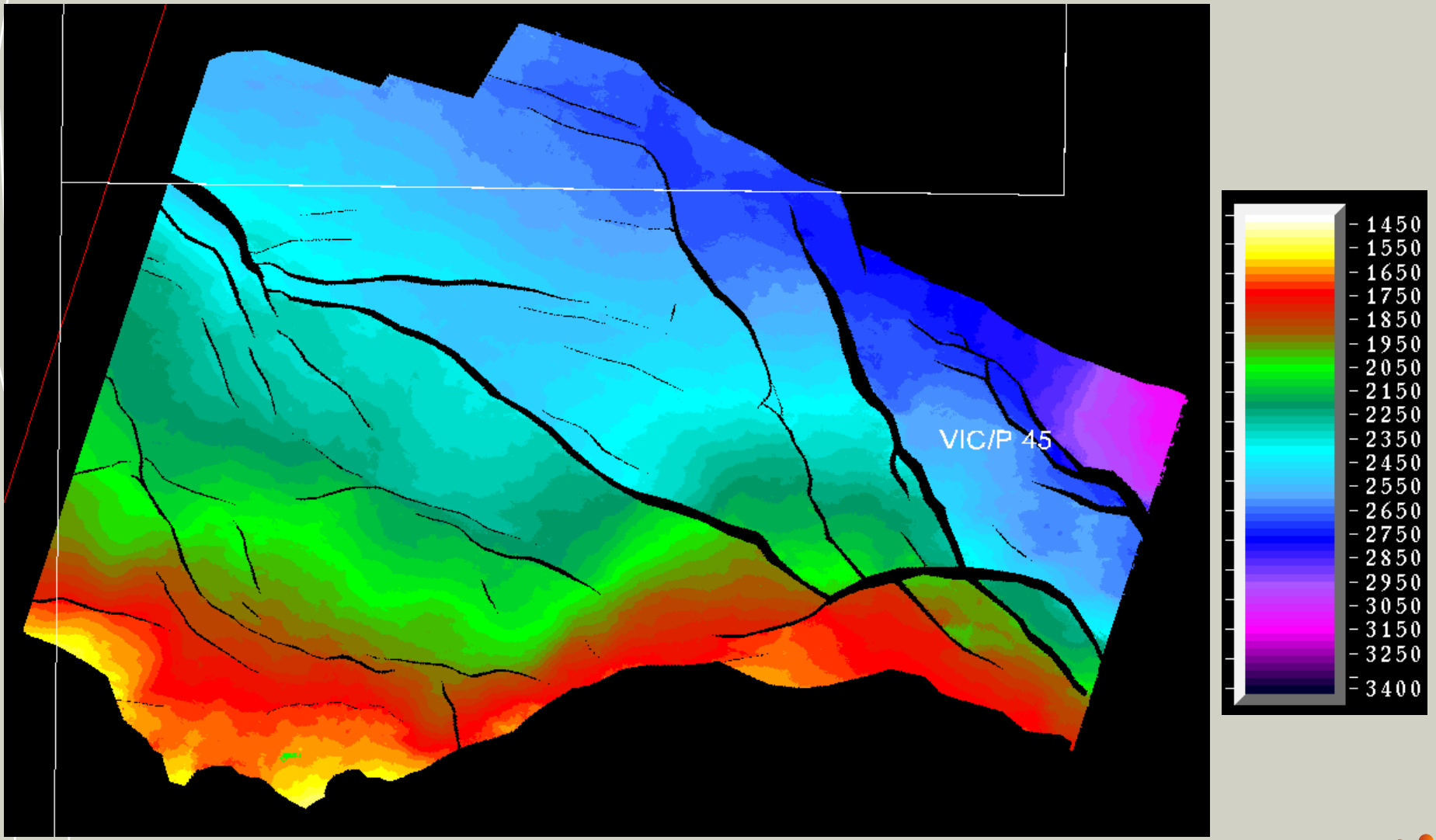
HGP2002A Seimic Interpretation Report
Intra-Emperor Sub-Group (89Ma)



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HGP2002A Interpretation Report VIC/P45

Depth Conversion

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HGP2002A Seimic Interpretation Report
Depth Conversion Methodology

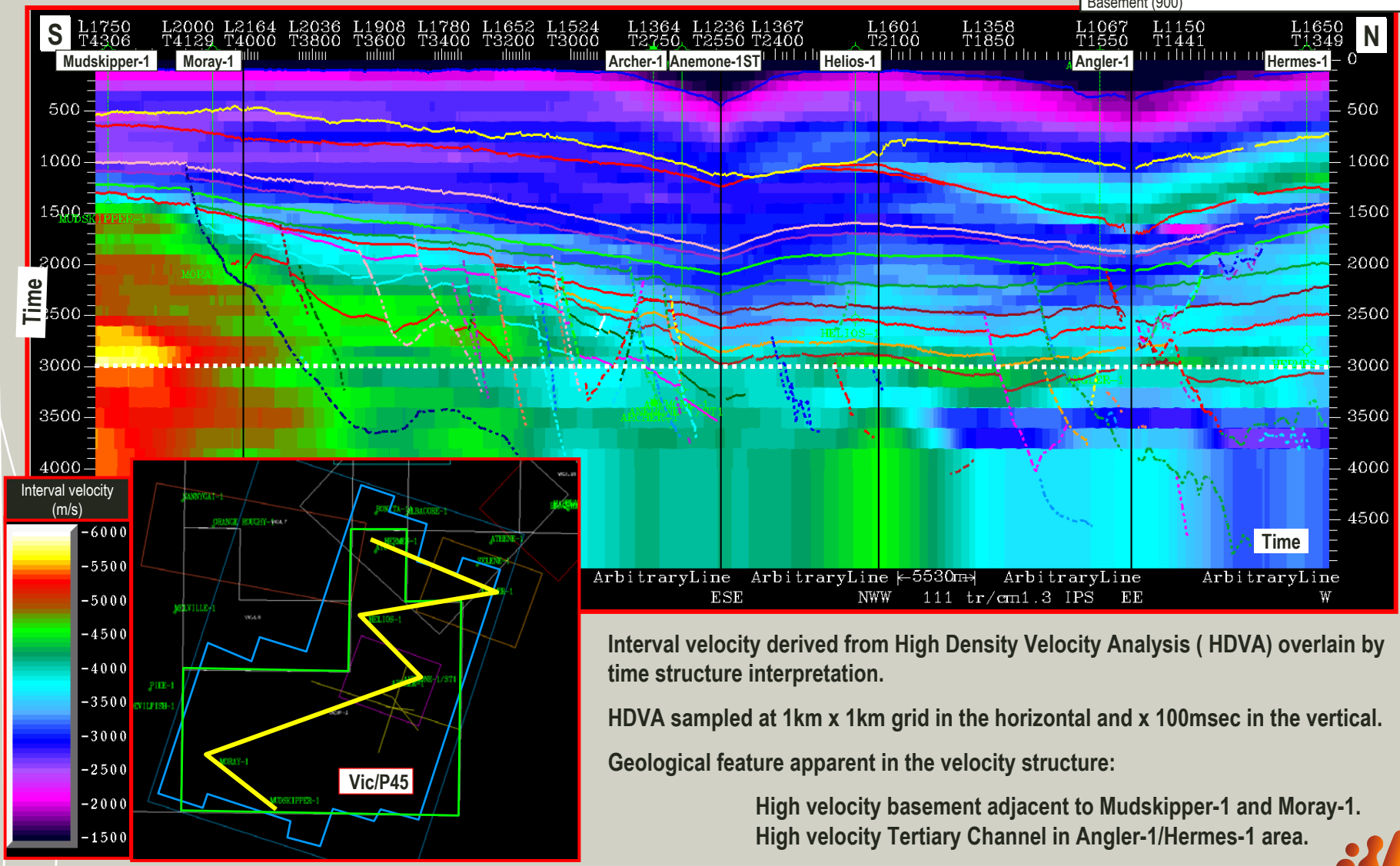
- At the time of processing the HGP2002A 3D survey, WesternGeco were contracted to carry out high-density velocity analysis (HDVA) to provide a dense 50x50m grid of automatically picked PrSTM migration velocities for depth conversion purposes.
- A velocity cube was then creating by generating smoothed velocities at 100ms timeslices, with the smoothing carried out using a complexity constraining method.
- The Depth model was then Loaded into Landmark TDQ to depth convert time horizons.

The method for detailed depth conversion of prospects was:

1. Convert to Top Latrobe by using velocity model in TDQ
2. Convert intervals below TOL using surrounding well interval velocities

HGP2002A Seimic Interpretati

HDVA Seismic Velocity Well Tie (Time)



Interval velocity derived from High Density Velocity Analysis (HDVA) overlain by time structure interpretation.

HDVA sampled at 1km x 1km grid in the horizontal and x 100msec in the vertical.

Geological feature apparent in the velocity structure:

High velocity basement adjacent to Mudskipper-1 and Moray-1.
High velocity Tertiary Channel in Angler-1/Hermes-1 area.

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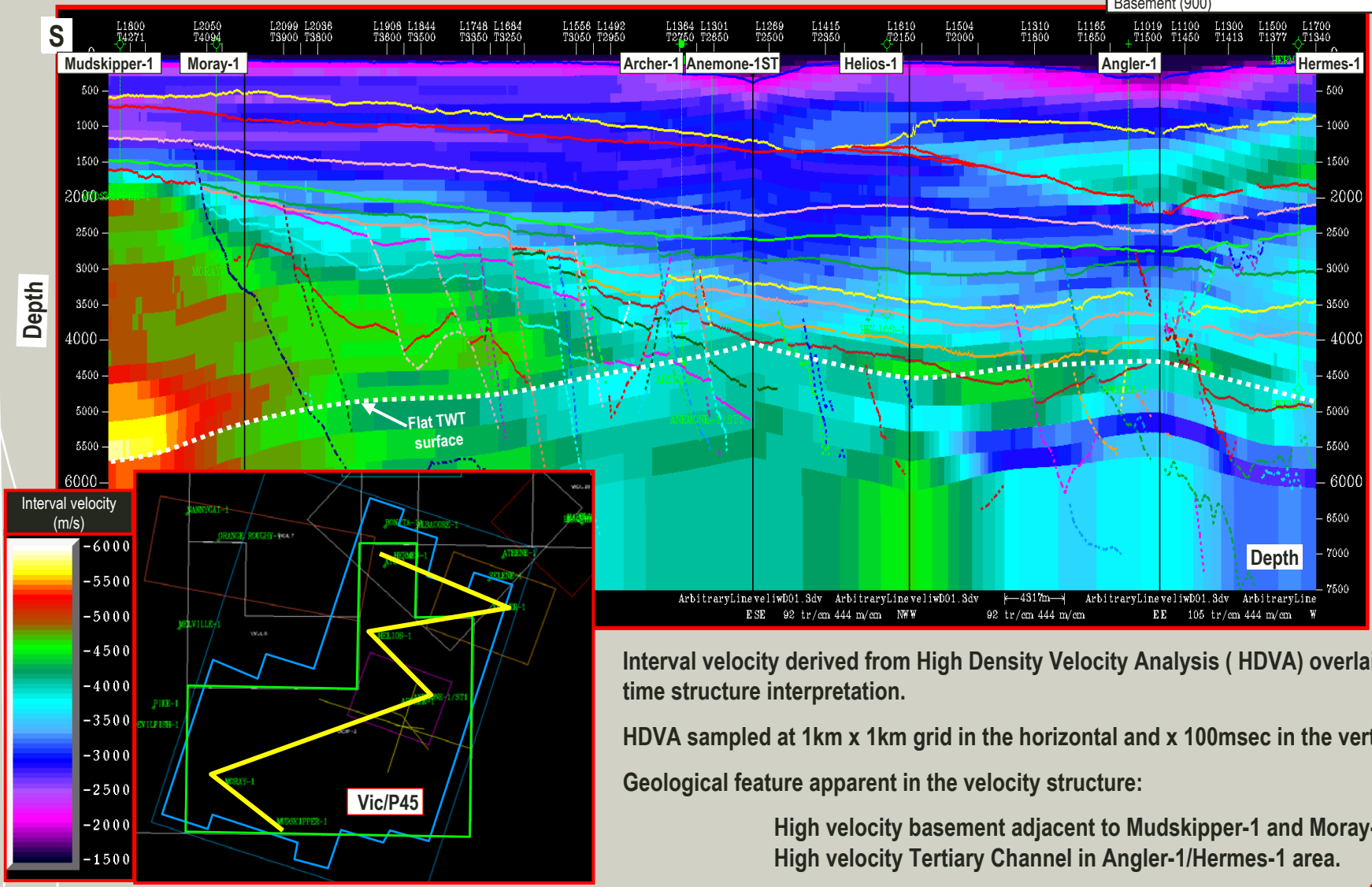
HDVA Seismic Velocity Well Tie (Depth)



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High velocity basement adjacent to Mudskipper-1 and Moray-1.
High velocity Tertiary Channel in Angler-1/Hermes-1 area.

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Prospects and Leads

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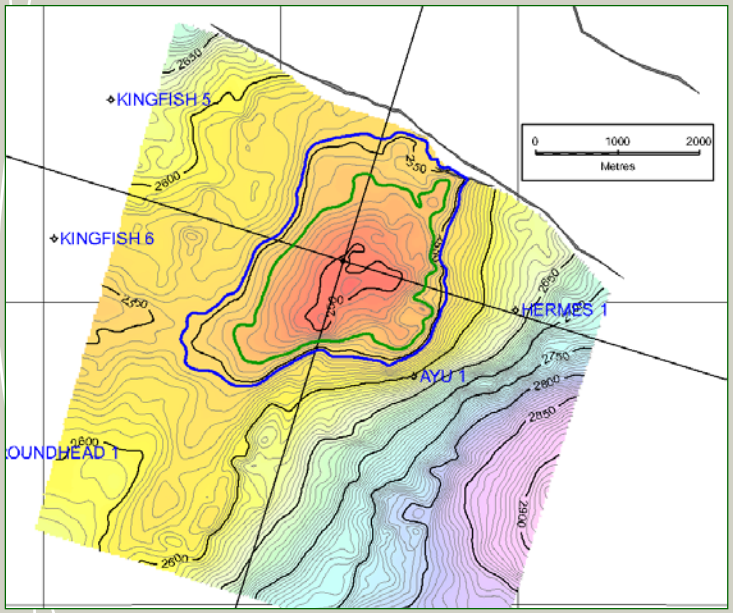
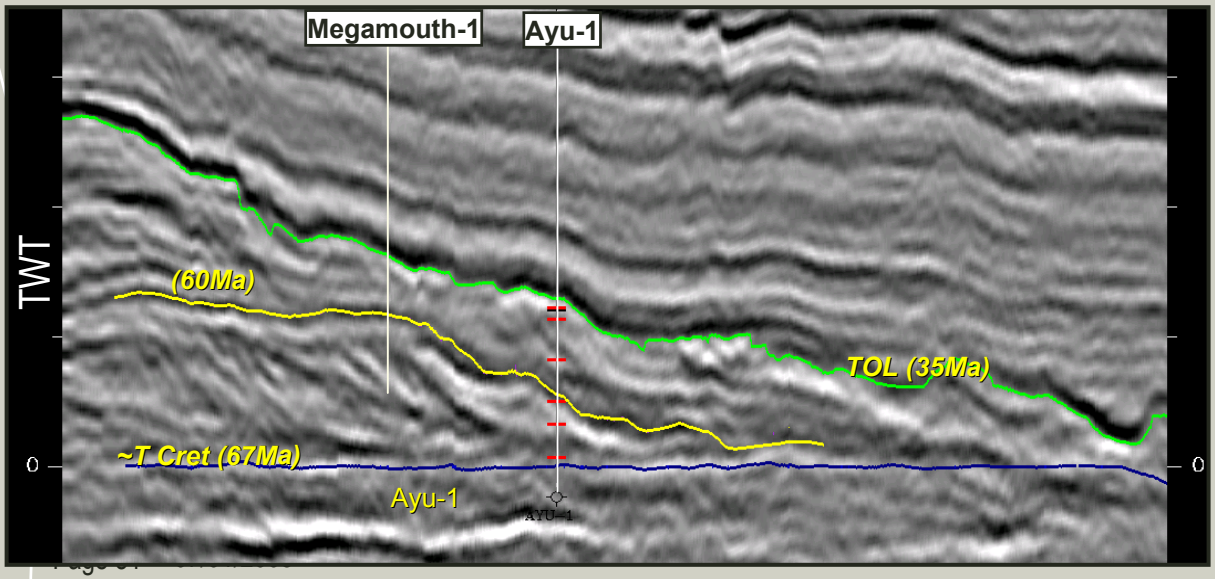
Megamouth-1/ST-1: Pre-drill Overview



Play Concept: Paleocene (Latrobe) sands in a 3 or 4-way dip closure sealed by thin transgressive shales demonstrated in Roundhead-1 & Bonita-1. Highly productive reservoirs within 5km of Kingfish Field result in attractive success case economics.

Key Risks: Top-seal thins distally toward Hermes-1 and Ayu-1, while in many volumetric scenarios closure relies on the sealing integrity of a small splay fault. Complex shallow velocity field indicates some remaining risk of structural invalidity



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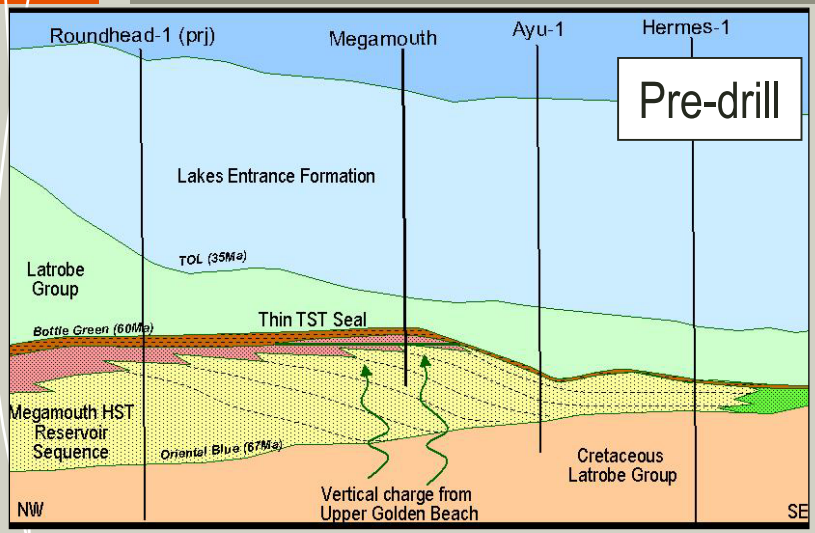
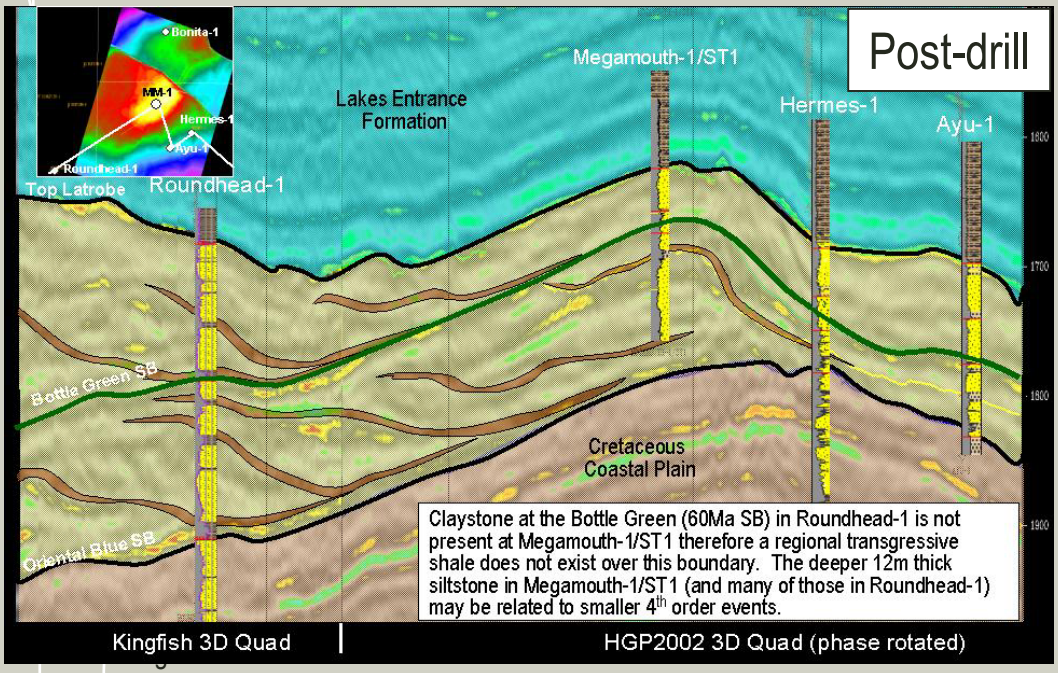
Megamouth-1/ST1: Post Well Conclusions





Megamouth-1ST was plugged and abandoned as a dry hole on 5th December 2003. **Failure is attributed to the principal pre-drill risk: a lack of seal coincident with structural closure**

The target horizon (60Ma sequence boundary) within the Intra-Latrobe Group was intersected 19m deep to prognosis and found to lack the postulated transgressive seal unit. Post-well mapping at this level indicates 20m of 4-way dip closure.

Two thin siltstone intervals (4m and 12m thick) are interpreted to lack significant lateral continuity and have poor indications of seal potential from FEWD logs

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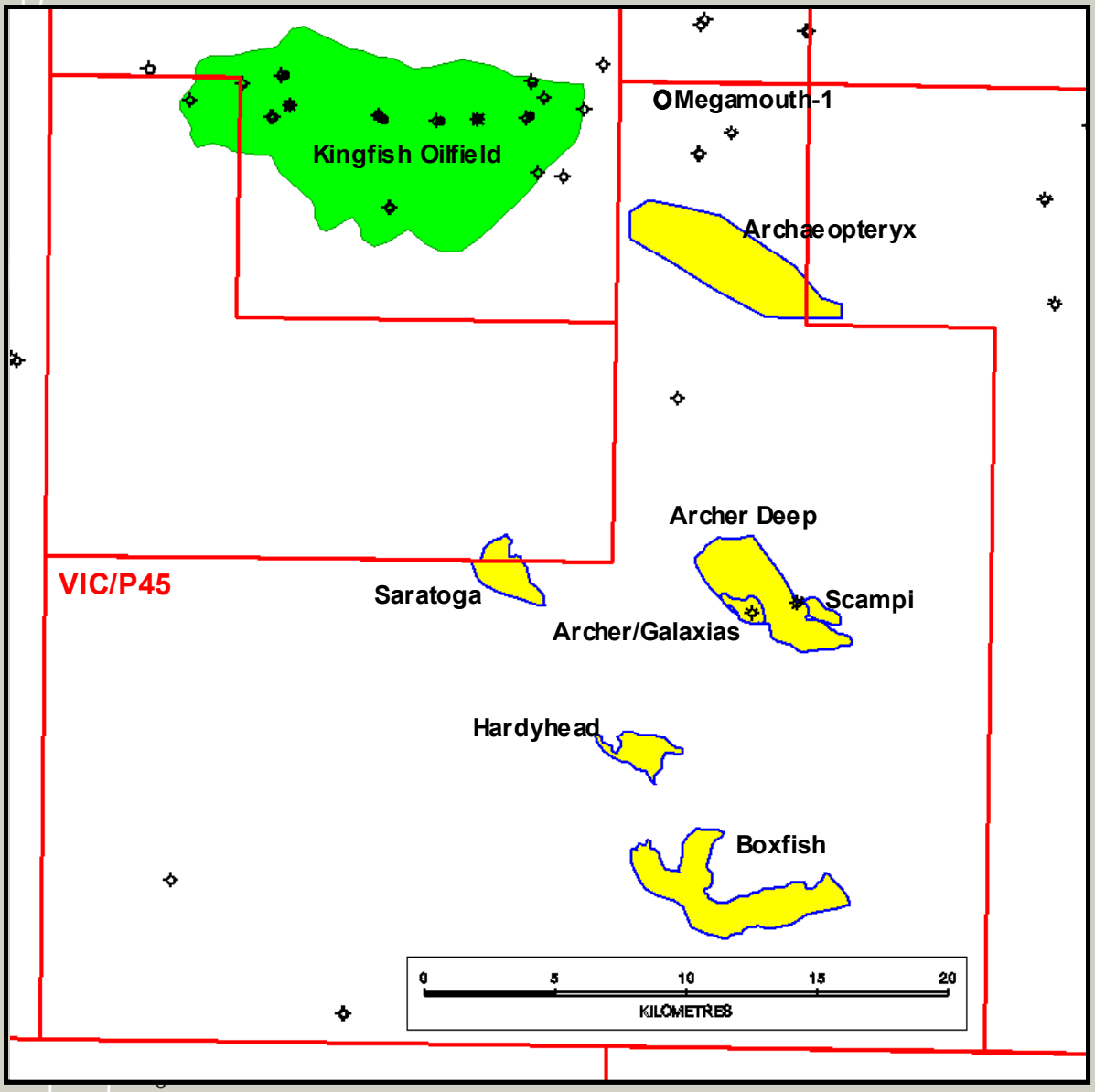
Location of Remaining Drilling Opportunities



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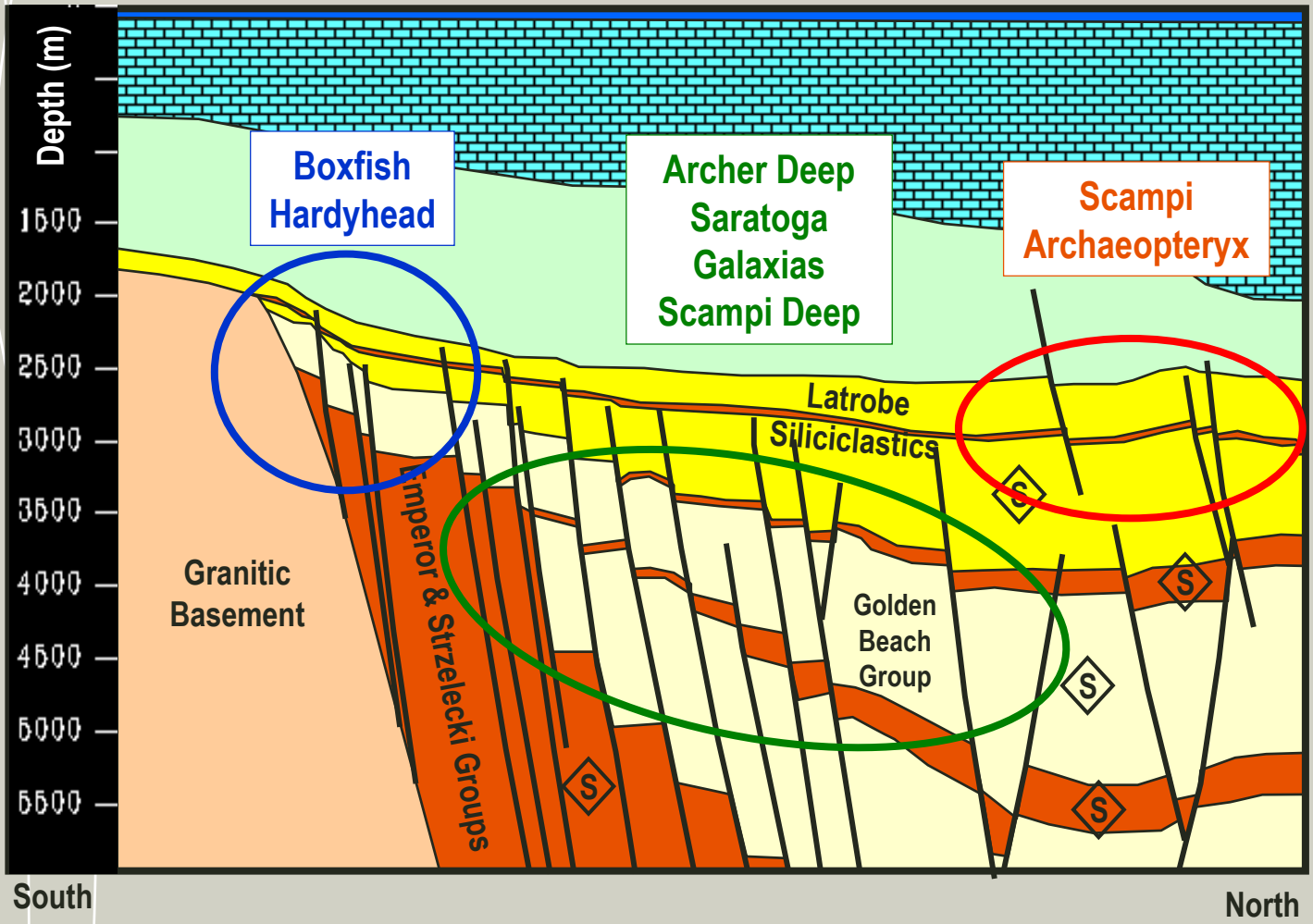
Primary Play Fairways



Upper Latrobe siliciclastic 4-way or 3-way dip closures

Amplitude driven low-side fault closures in the lower Latrobe & upper Golden Beach siliciclastics against the basin margin

Lowside 3-way or 4-way dip closures in the Golden Beach Group

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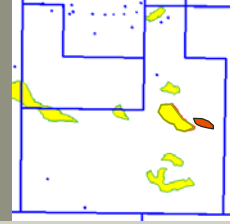
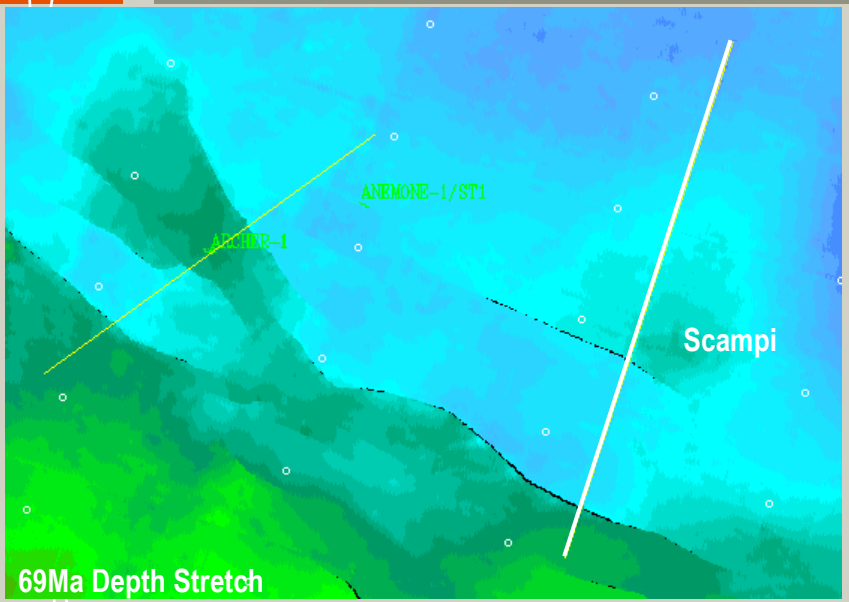
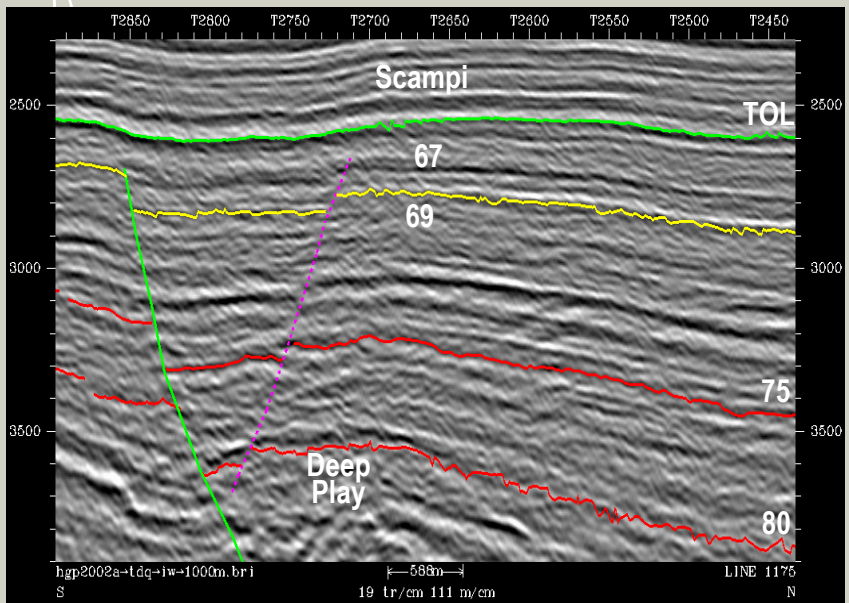
Scampi Lead







Play Concept: Late Cretaceous sands in a high-side largely 3-way dip closure. Deep stacked pay potential also mapped in a low-side four-way dip closure at Top Golden Beach level.

Key Risks:

Seal – top & cross fault seal reliant on condensed glauconitic siltstone facies with poorly constrained potential

Depth Conversion – Currently based on regional depth stretch using HDVA velocities. More robust (PSDM) methodology required

Primary target Depth: 2725m

Water Depth: 460m

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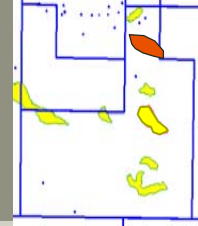
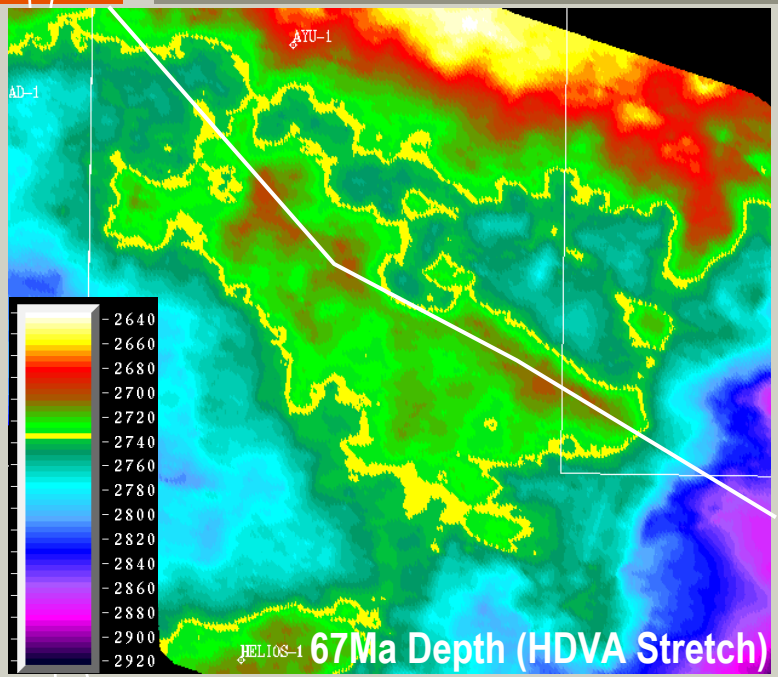
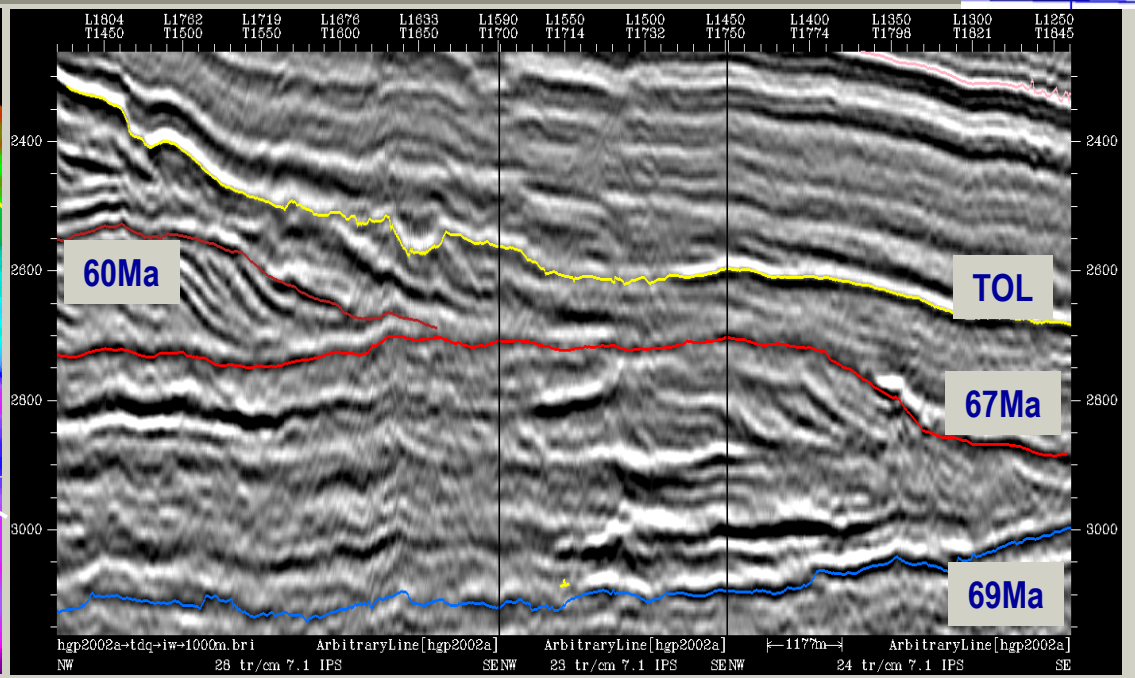
Archaeopteryx Lead







Play Concept: Near top Cretaceous sands in a low-relief depth-conversion dependent four-way dip closure set up by the palaeo-shelf-break (Kingfish analogue).

Key Risks: Topseal & Presence of structure. The subtle nature of the closure and the complex velocity field indicate that the current depth conversion methodology is not sufficient to reliably determine the presence (or otherwise) of closure. In addition, top-seal is an extremely high (and essentially irreducible) risk, as it relies on thin glauconitic sandstones with highly variable expression in well penetrations to date.

Primary target Depth: ~2700m

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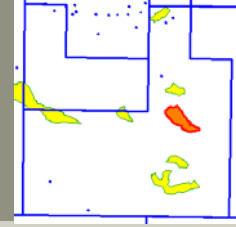
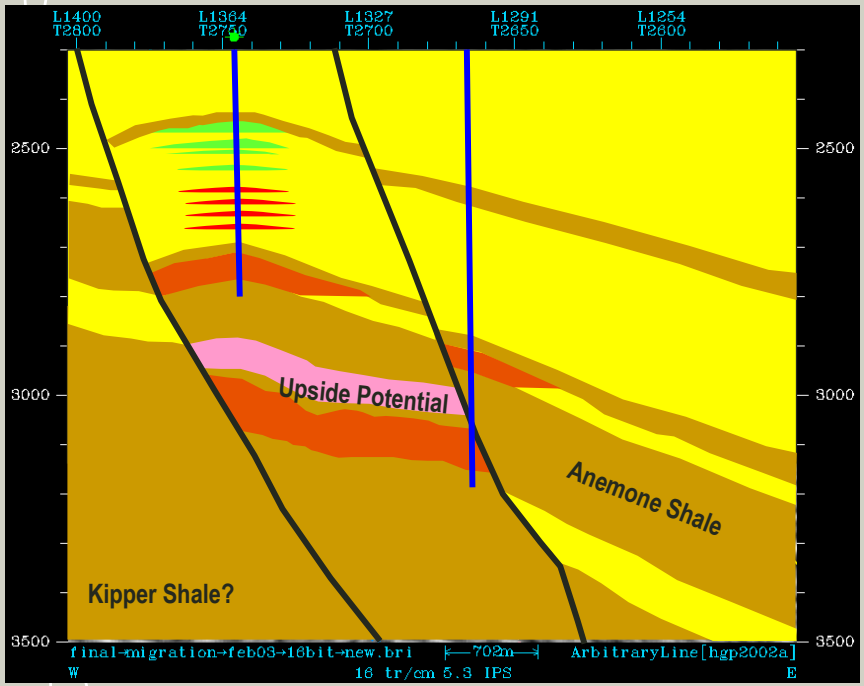
Archer Deep Lead



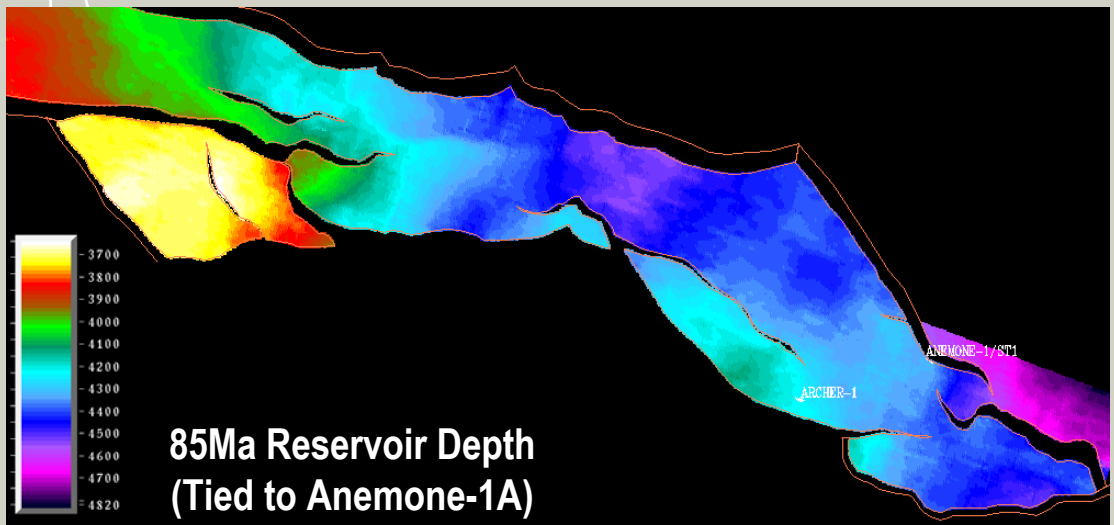


Play Concept: Santonian sands in a lowside, fault dependent closure.

Key Risks: Reservoir Quality. Anemone-1A is now interpreted to have tested the Archer Deep play, encountering over-pressured gas in sub-commercial reservoirs. Play relies on reservoir quality improving updip and away from the fault penetration

Primary target Depth: ~4350m

Trap size: 350m & at least 8km^2



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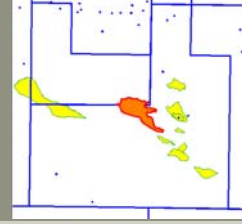
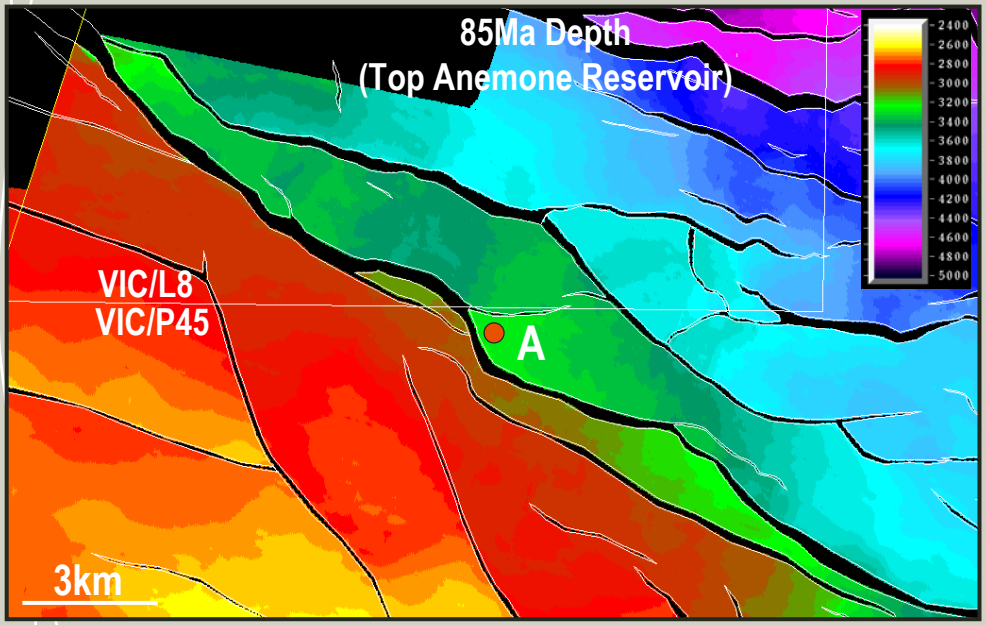
Saratoga Lead



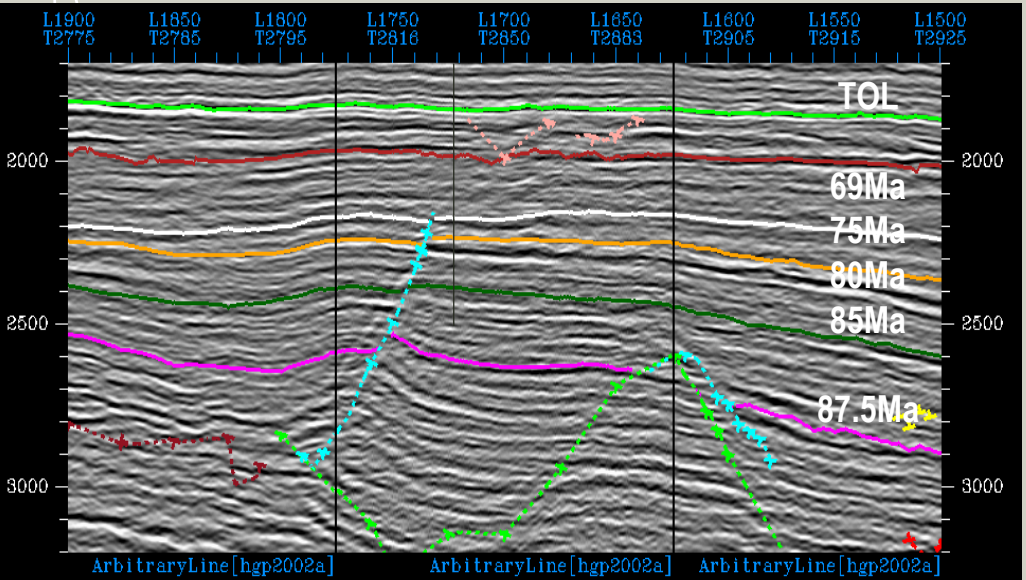


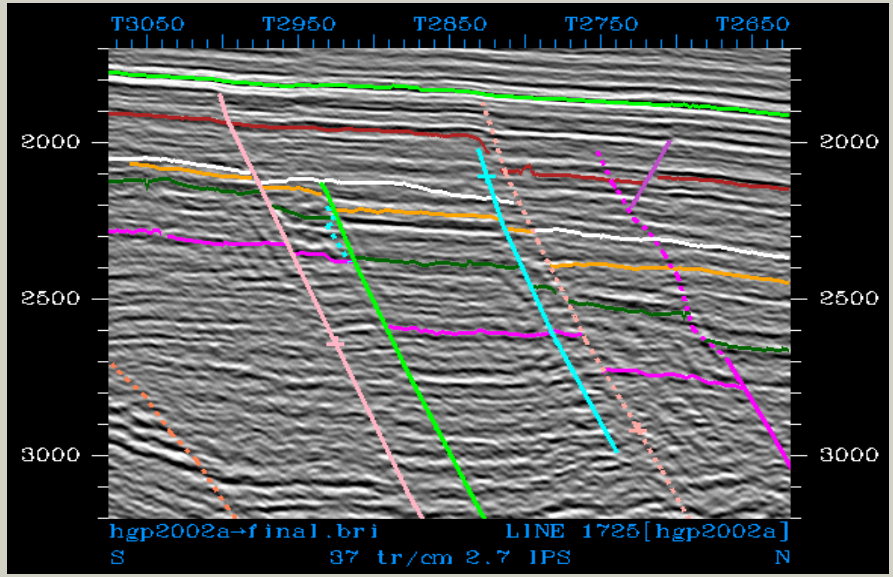
Play Concept: Apoxyexinus sands in a lowside, fault dependent closure. High risk upside provided by possible sealing geometry to west as well as shallower sands mapped within closure

Key Risks: X-fault seal. Favourable facies juxtaposition is difficult to demonstrate given distance from well control

Primary target Depth: ~3300m

Trap size: 170m & 6km^2





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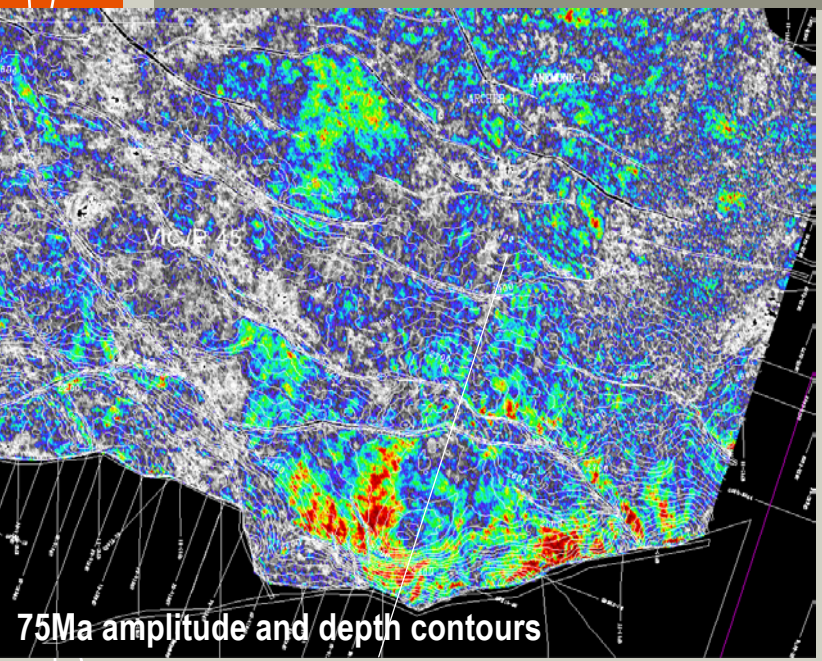
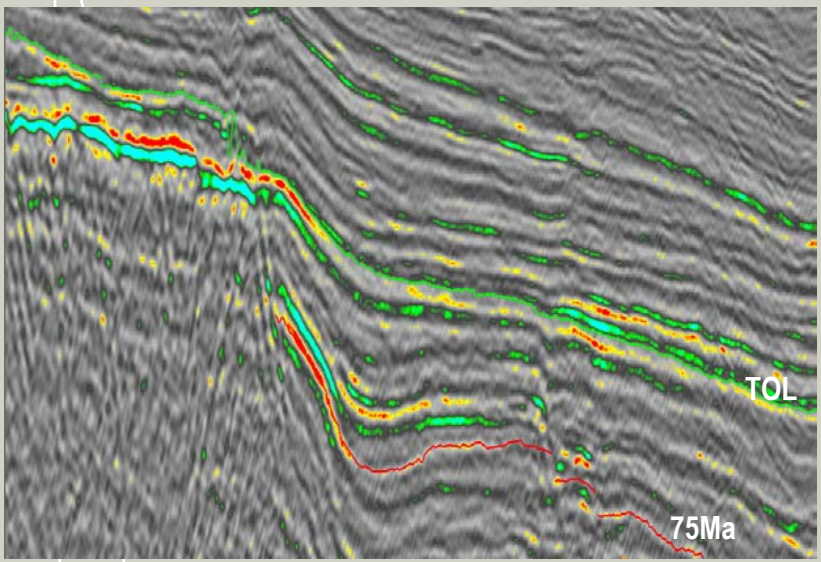
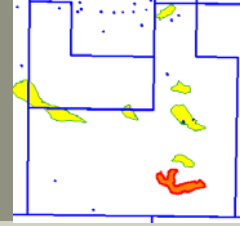
Boxfish Lead







Play Concept: Intra-Latrobe sands beneath floodplain or marine shales in a complex lowside trapping geometry. Very high risk but with substantial follow-up potential. High amplitudes may indicate HC's but more likely to be representative of stratigraphy.

Key Risks: Seal – lateral extent of floodplain shales; cross-fault juxtapositions and onlap against sand prone Golden Beach Group; efficiency of faulted contact against granitic basement.

Primary target Depth: ~2250m

Trap size: 250m and up to 30km^2

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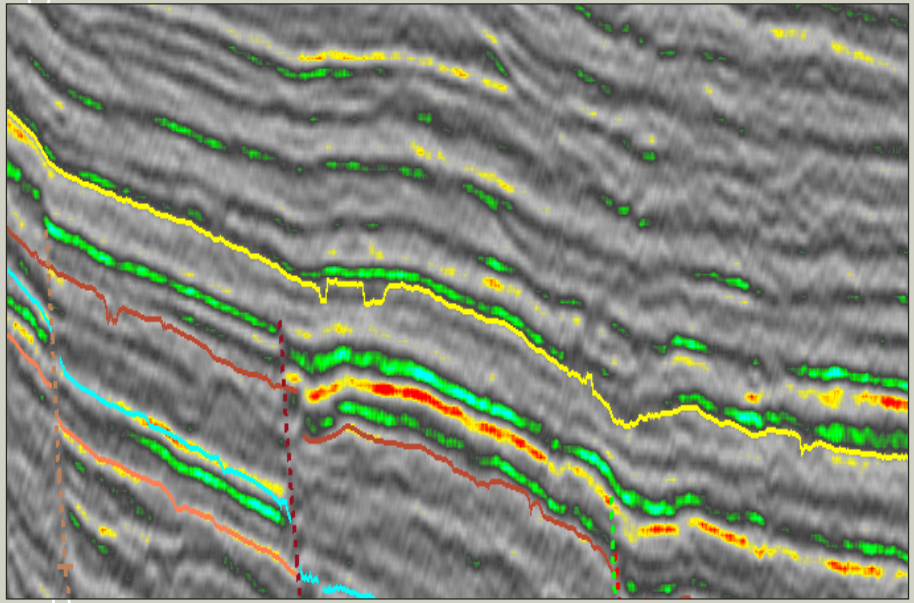
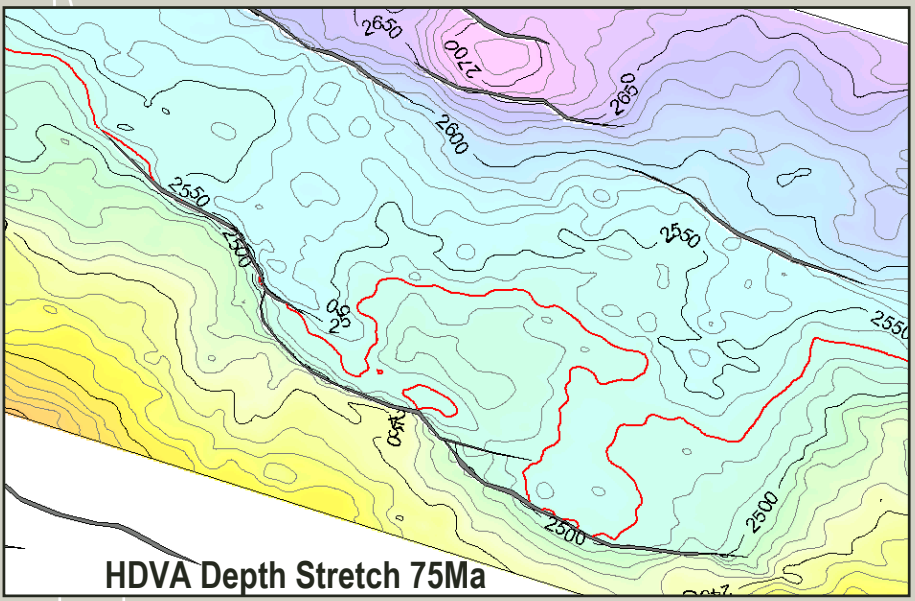
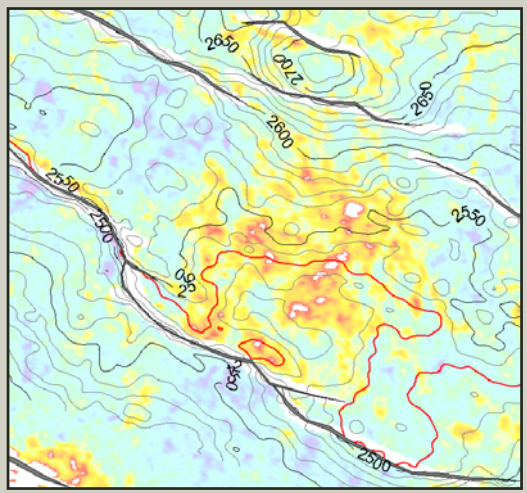
Hardyhead Lead







Play Concept

Upper Latrobe lowside 3-way with small fault intendant closure sealed by Top Cretaceous marine shale as seen in Archer-1. Identified on the basis of amplitude response which is now attributed to stratigraphy

Water Depth: 90m

Target Depth: ~2450m

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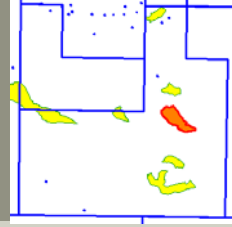
Archer/Galaxias Lead



- Now mapped as a four-way dip closure
- Base case recoverable resource estimated at 1.5MMstb – Clearly sub-commercial
- TWT picking is robust within Archer fault block; primary area of uncertainty is in depth conversion.
- Previously identified shallow oil targets (Top Latrobe & Top Cretaceous) have also been invalidated by mapping revisions. Accordingly, Archer/Galaxias is no longer considered a viable drilling candidate.