Seismic Interpretation, Seismic to Well Tie and Potential Drill Locations

(Maui 4D, Taranaki Basin, New Zealand)

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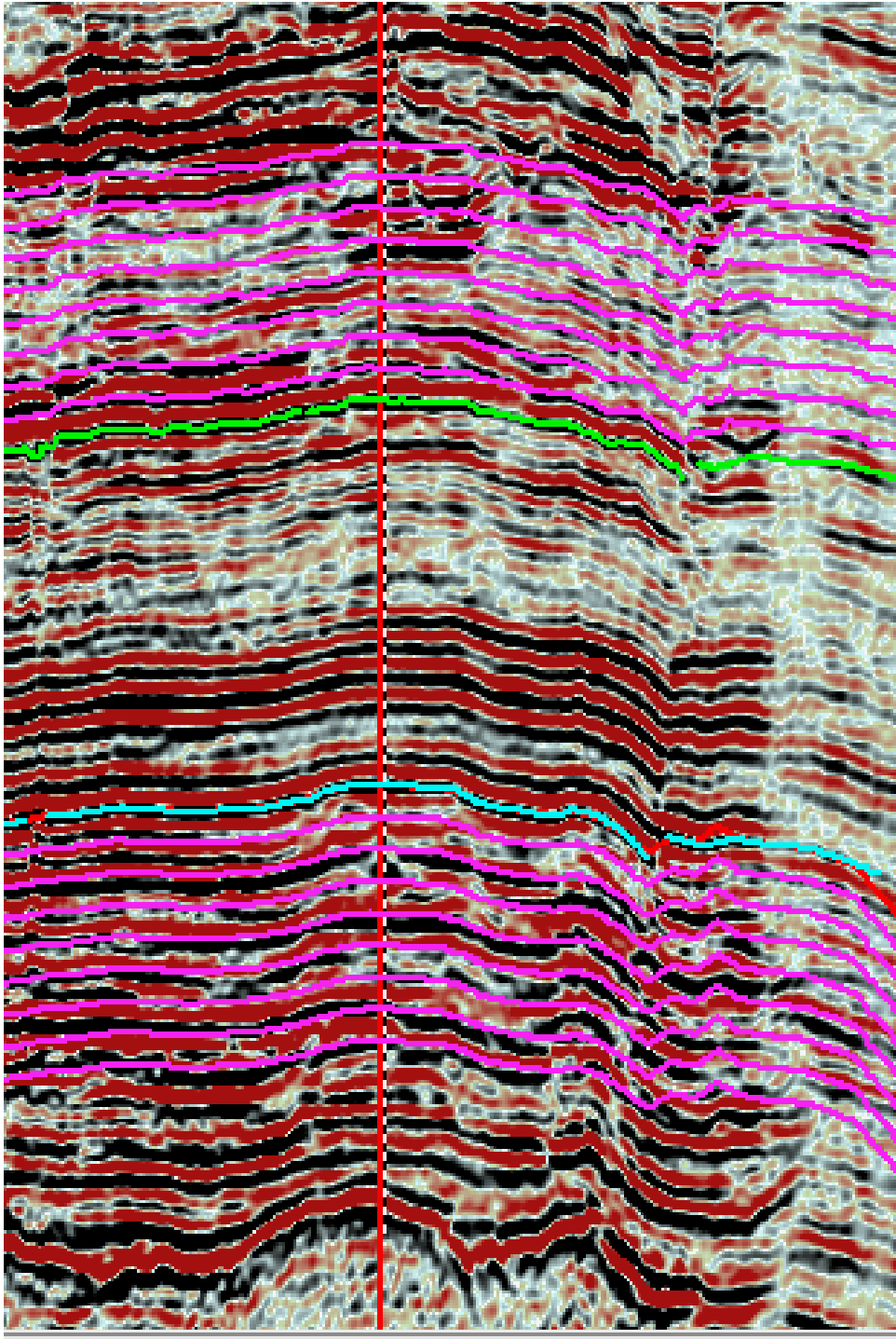
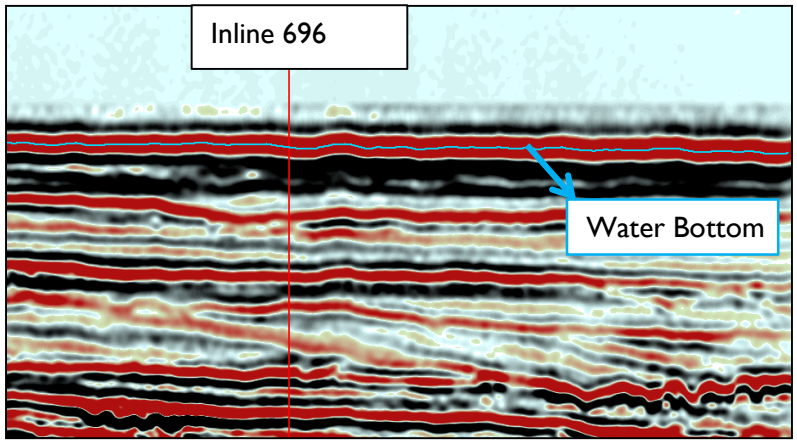
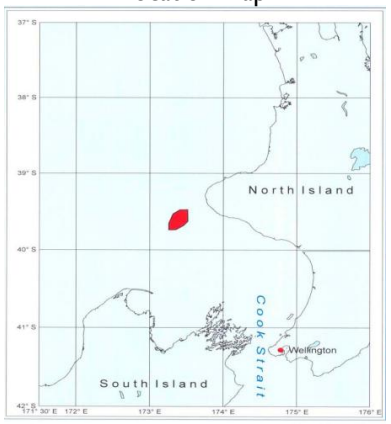


Survey Details

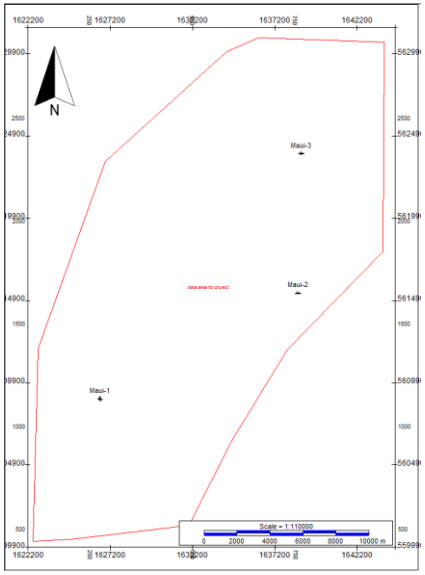


Location Map



Survey area Shown in red

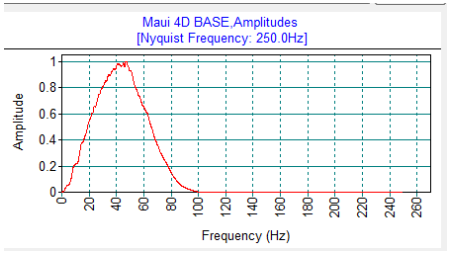
Base Map



Study area enclosed by red polygon

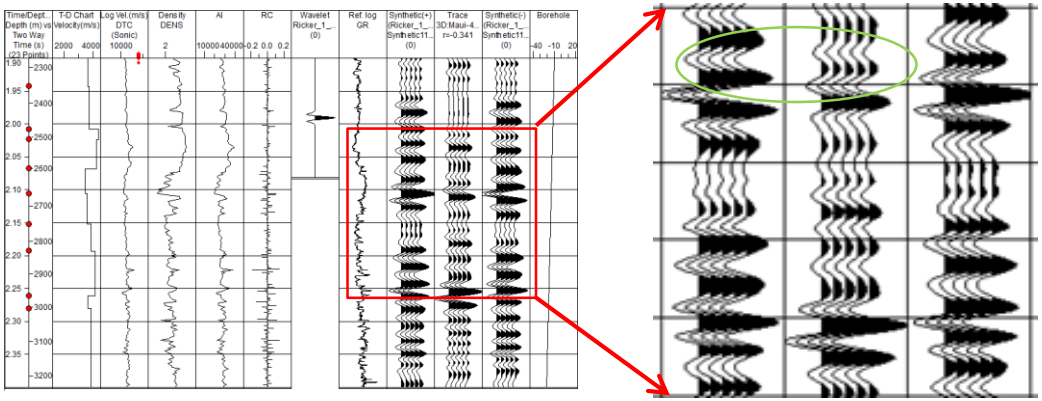
- Data Polarity: Negative or Trough (based on the sea floor reflection)
- Phase: Zero Phase
- Total Inline = 889 (103-991)
- Total Crossline = 2518 (420-2936)
- Bin Spacing: ΔIL = 25m and ΔXL = 12.5m
- Record length= 5.5s
- Dominant frequency= 45 Hz
- Reservoir zones= 2ms-2.4ms (2650-3100m)

Frequency Spectrum of the Survey

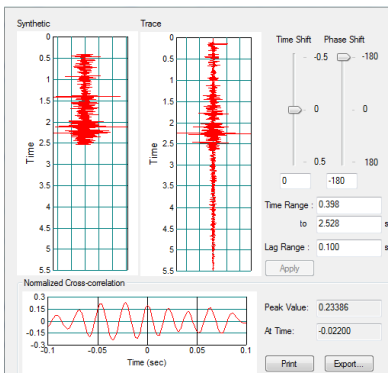


Synthetic Trace Using Ricker Wavelet Well Maui #1

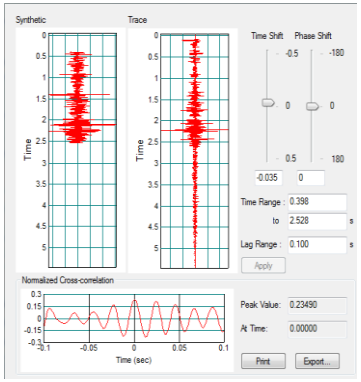
Correlation Window (Ricker Zero)



Suggested Phase Shift

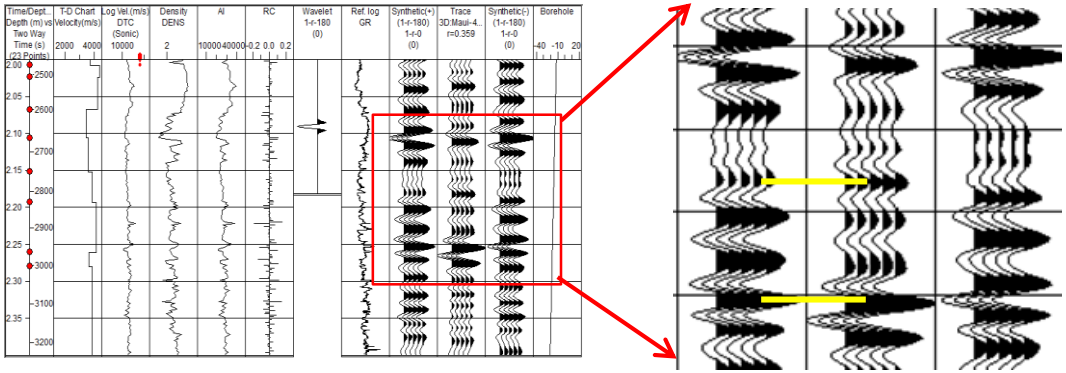


Suggested Time Shift

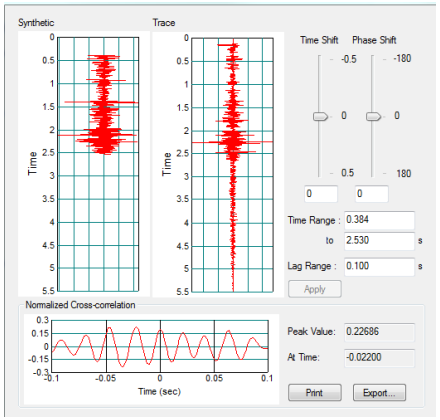


Applied time range for synthetic is (1.9s-2.4s). Synthetic Correlation shows actual trace and artificial trace are in almost reverse position (Green Circle). Trace compare window suggest (180) phase shift for maximum peak and time shift is 35ms.

Correlation Window (Ricker -180)



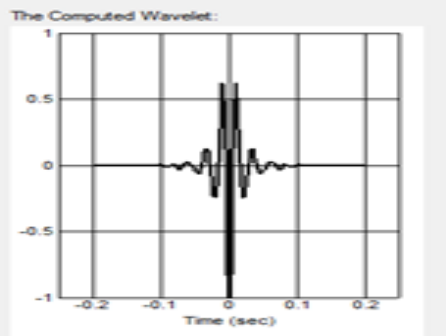
Suggested Time Shift



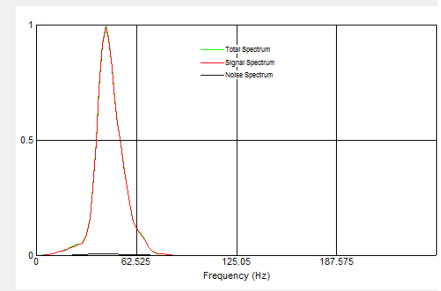
Correlation window using -180 Ricker Wavelet. It shows moderate correlation coefficient (0.35). For best fit suggested time shift 38ms.

Synthetic Trace Using Extracted Wavelet Well Maui #1

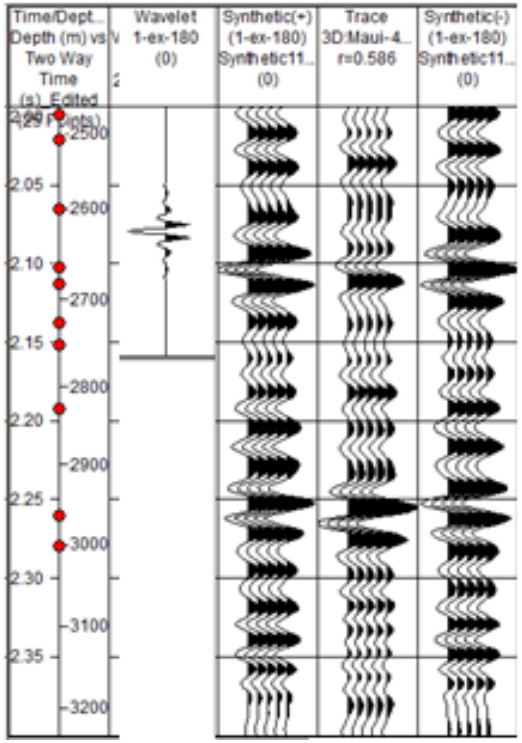
Extracted Wavelet



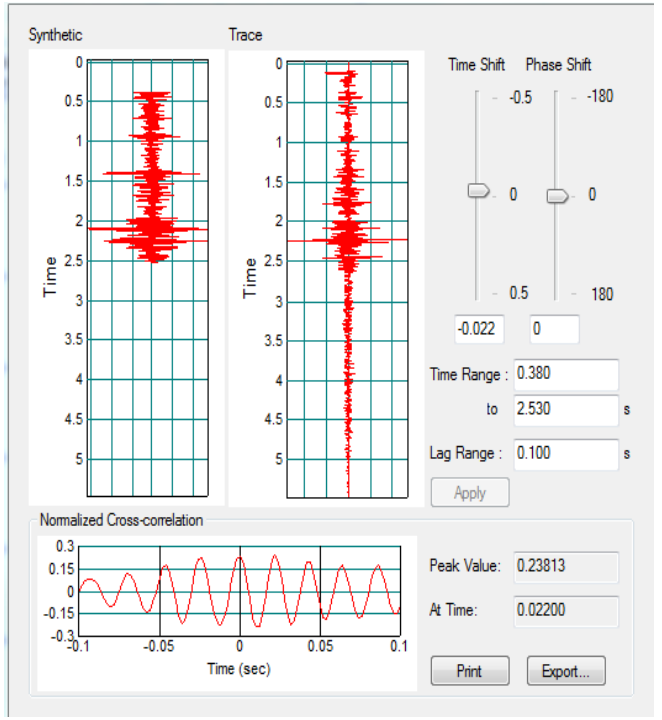
Frequency Spectrum



Correlation Window



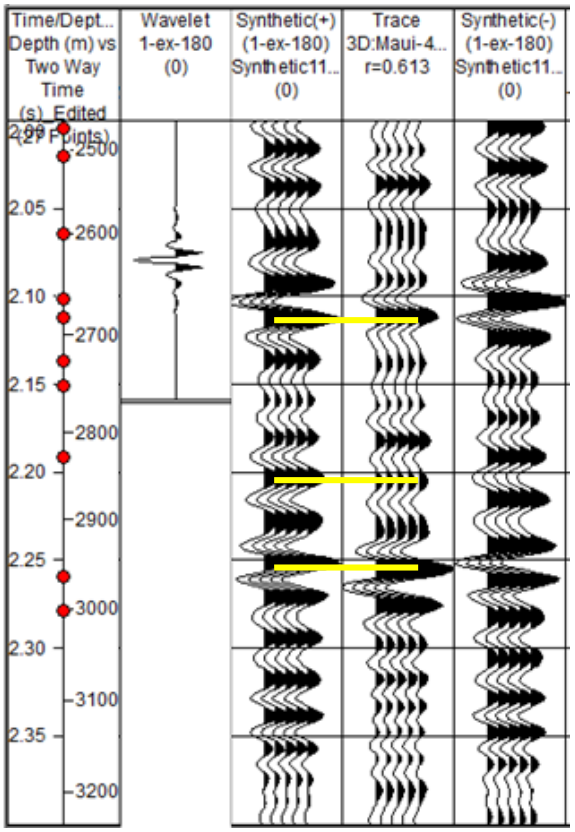
Trace Compare Window



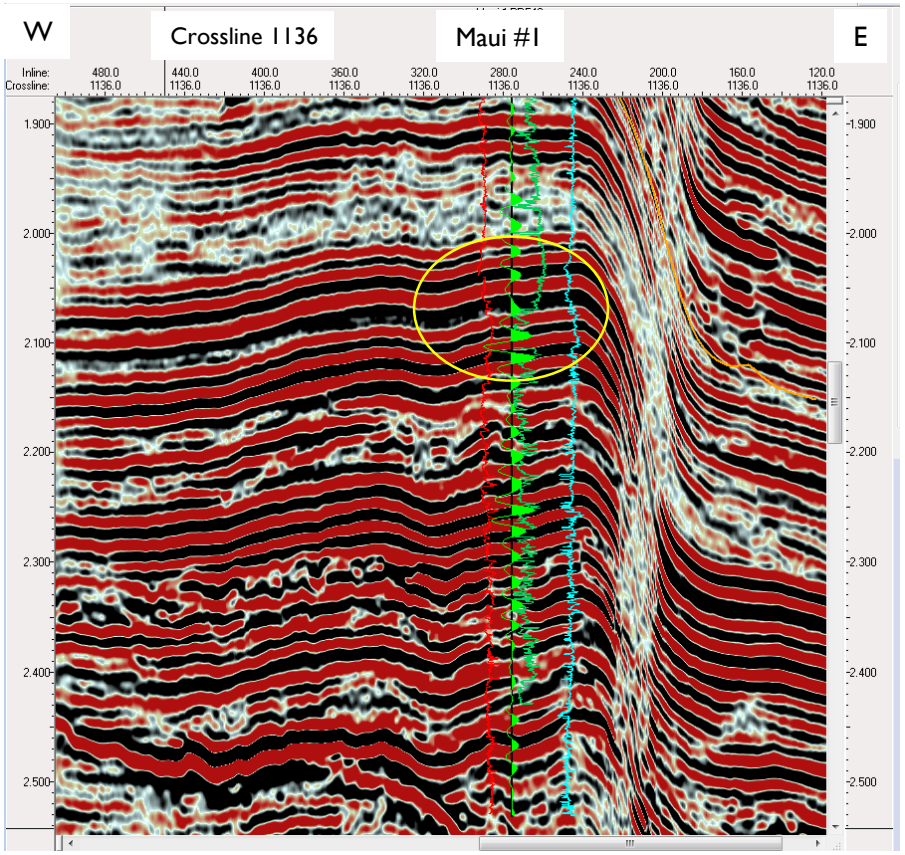
- Wavelet extracted near borehole location with 100 m radius and dominant frequency is about 40 Hz . Phase shifted to -180.
- Applied time range 1.9s-2.4s(reservoir zones exist within the location).
- Correlation window using Extracted Wavelet shows good correlation coefficient (58%).
- For best fit suggested time shift 22ms.

Synthetic Trace After Time Shifting at Well Maui #1

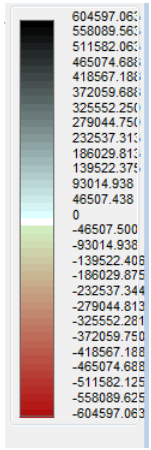
Correlation Window



Synthetic Trace over Seismic Section



High Amplitude

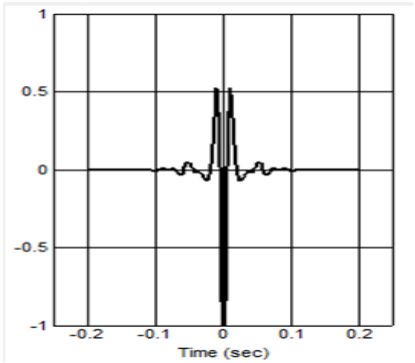


Low Amplitude

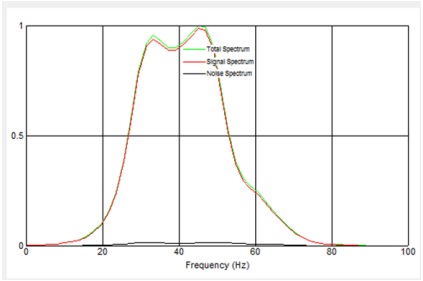
- After time shift correlation increased slightly to 61%.
- Extracted wavelet is the best wavelet for this data set.
- Extracted wavelet has provided high correlation and lowest suggested time shift for best fit.

Synthetic Trace Using Extracted Wavelet at Well Maui # 2

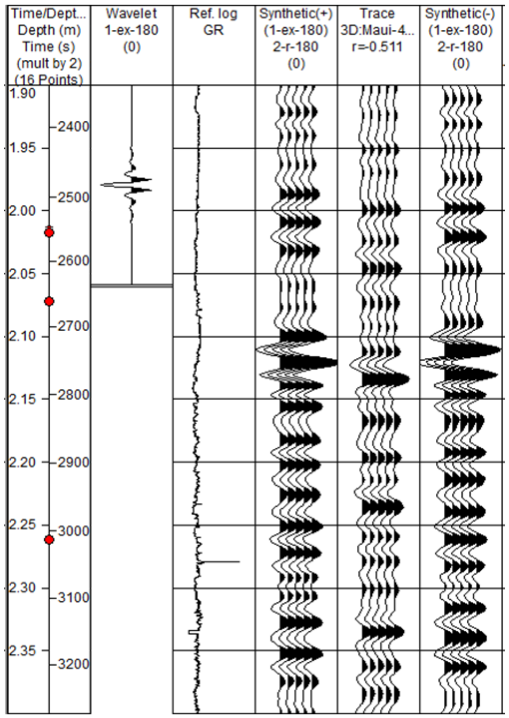
Extracted Wavelet



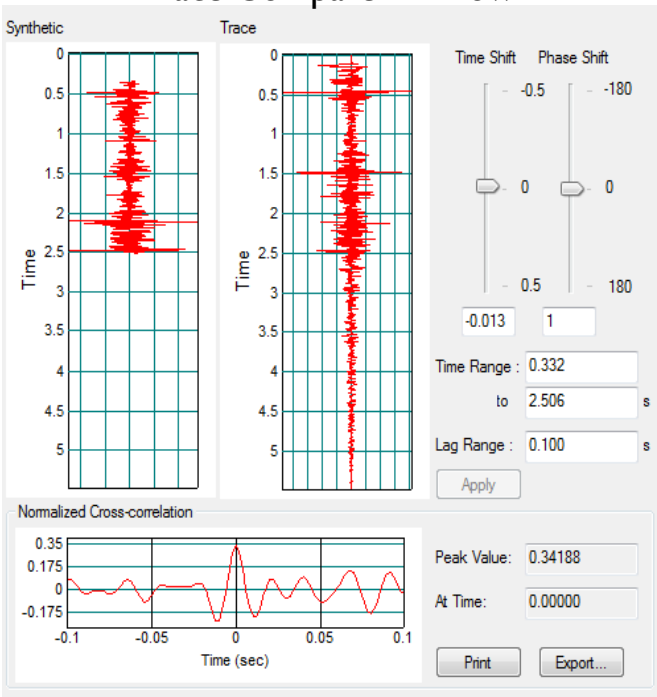
Frequency Spectrum



Correlation Window



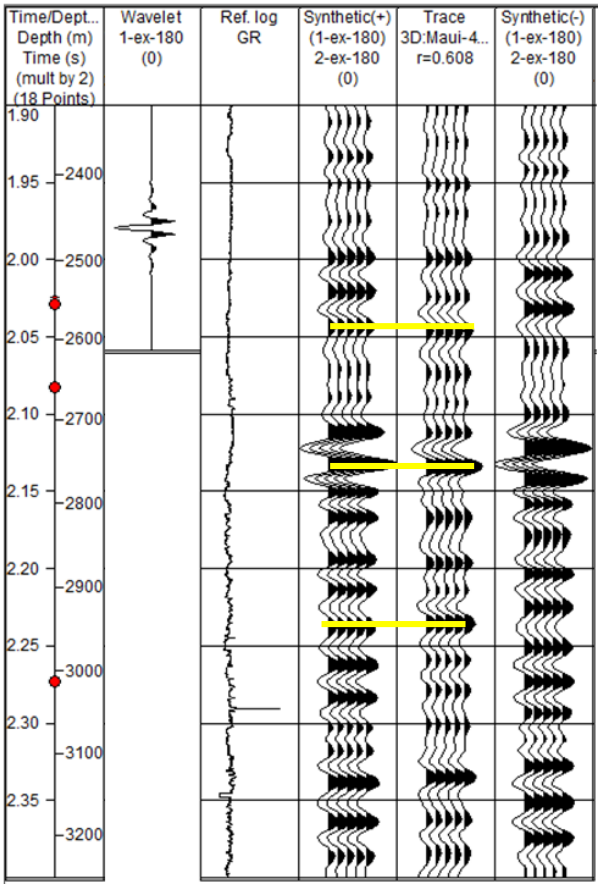
Trace Compare Window



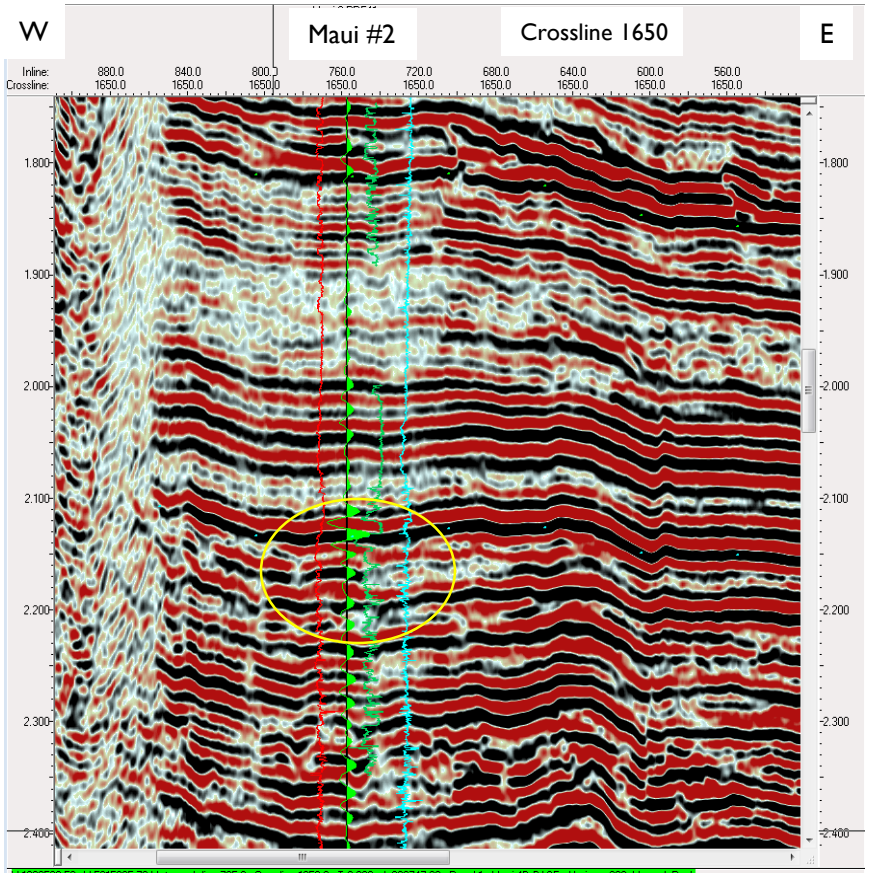
- Wavelet extracted near borehole location with 100 m radius and dominant frequency is about 45 Hz . Phase shifted to -180.
- Applied time range 1.9s-2.35s(reservoir zones exist within the location).
- Correlation window using Extracted Wavelet shows good correlation coefficient (51%).
- For best fit suggested time shift 13ms.

Synthetic Trace After Time Shifting at Well Maui #2

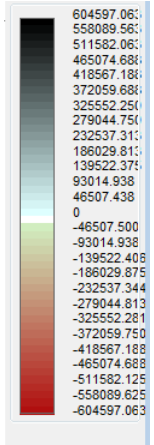
Correlation Window



Synthetic Trace over Seismic Section



High Amplitude

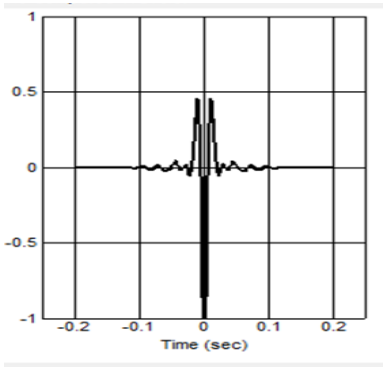


Low Amplitude

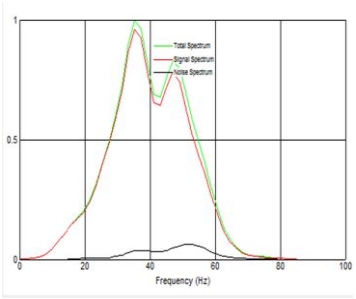
- After time shift correlation increased from 51% to 60%.
- On seismic section shows synthetic trace is almost same as seismic trace except (1900-200ms). At that time range synthetic shows anomaly and very dimming amplitude.

Synthetic Trace Using Extracted Wavelet Well Maui #3

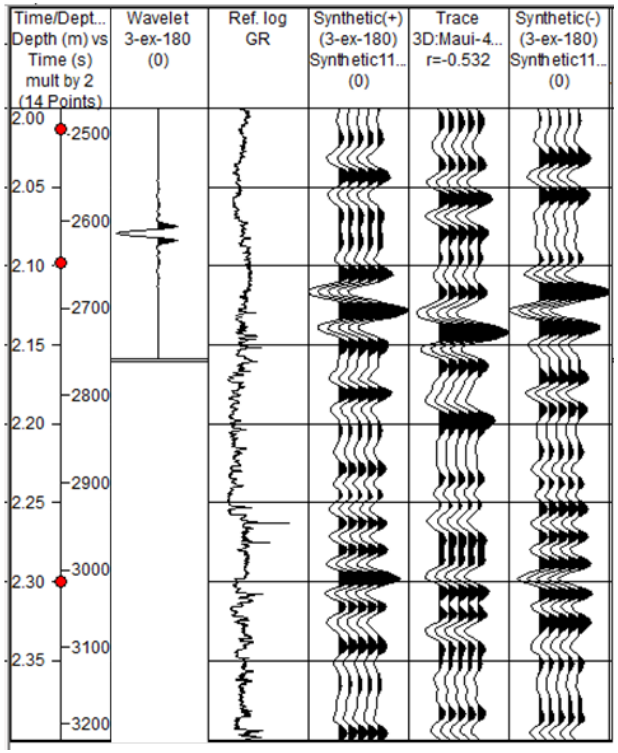
Extracted Wavelet



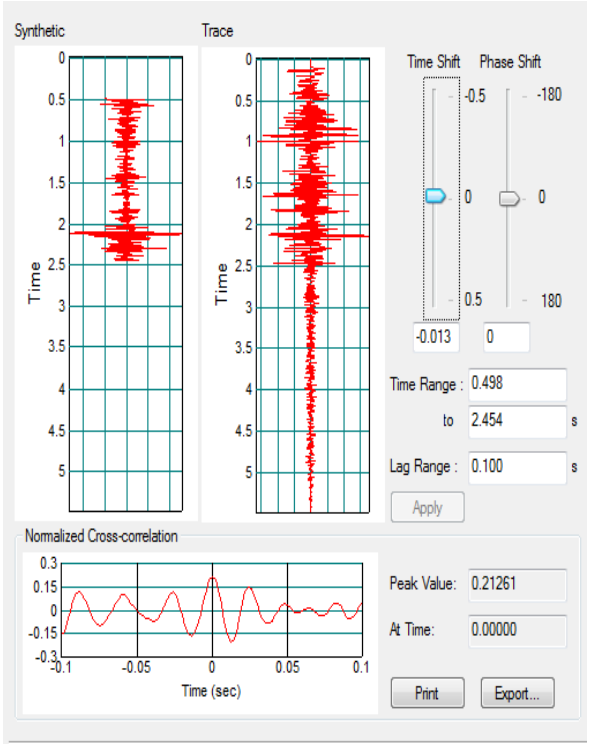
Frequency Spectrum



Correlation Window



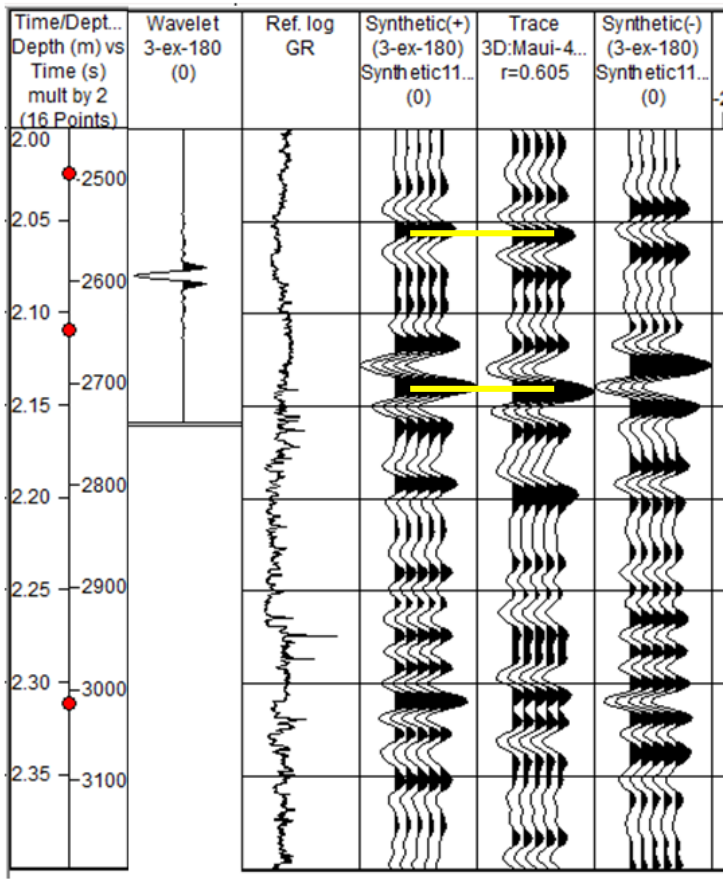
Trace Compare Window



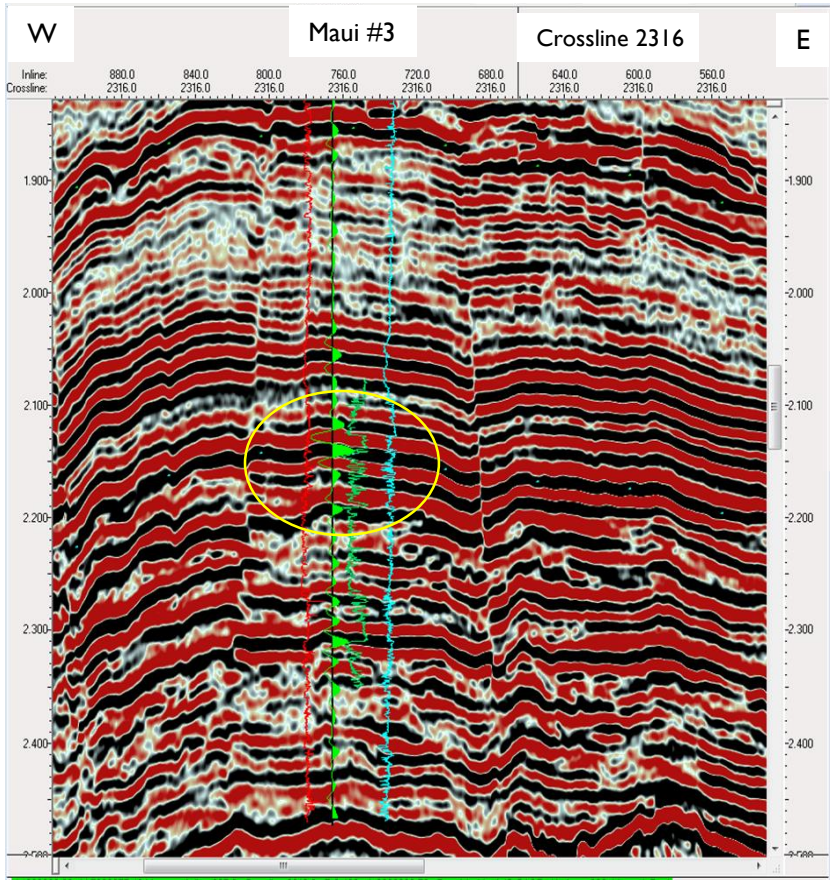
- Wavelet extracted near borehole location with 100 m radius and dominant frequency is about 35 Hz . Phase shifted to -180.
- Applied time range 2s-2.4s(reservoir zones exist within the location).
- Correlation window using Extracted Wavelet shows good correlation coefficient (53%).
- For best fit suggested time shift 13ms.

Synthetic Trace After Time Shifting at Well Maui #3

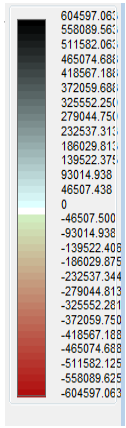
Correlation Window



Synthetic Trace over Seismic Section



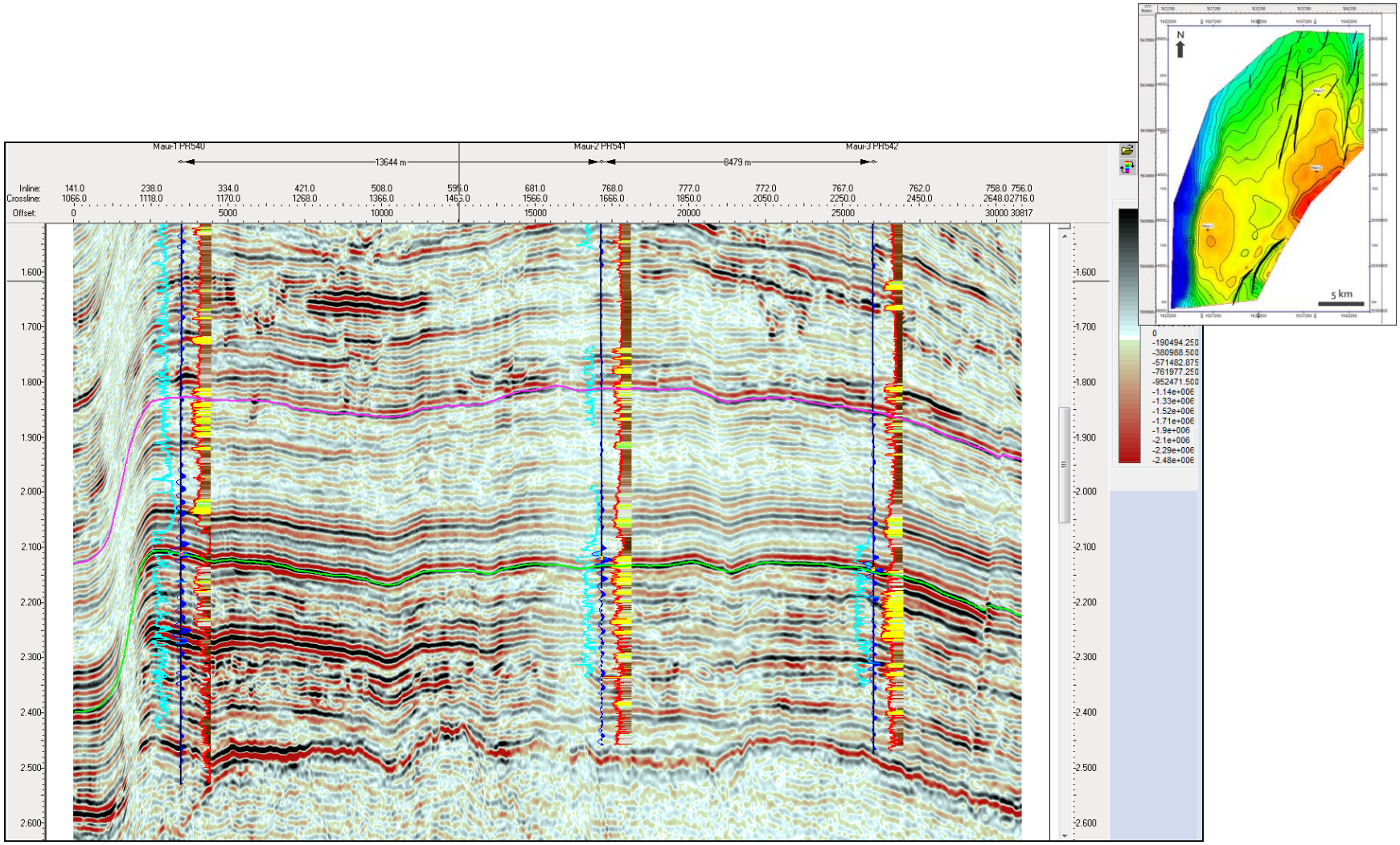
High Amplitude



Low Amplitude

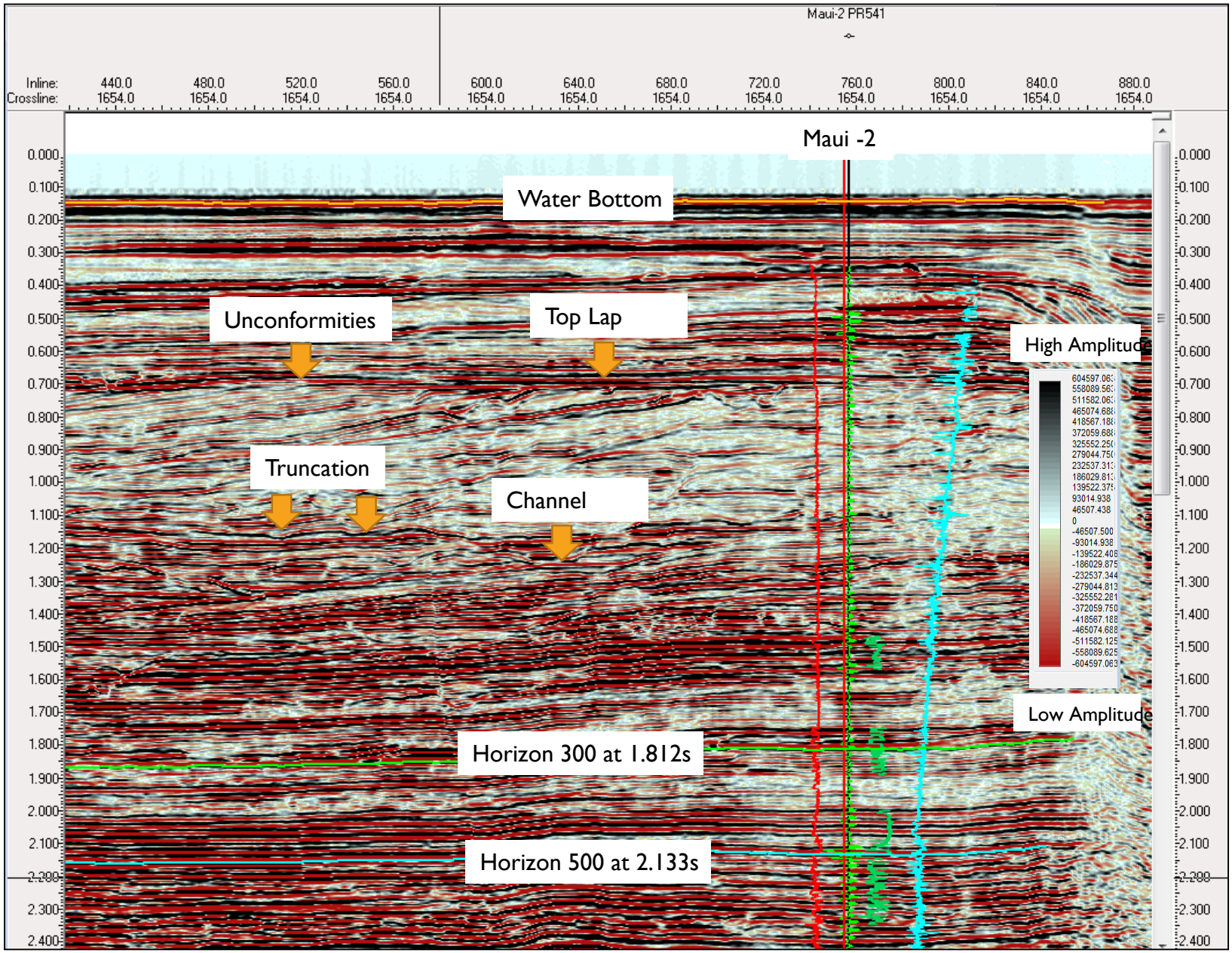
- After time shift correlation increased from 53% to 60%.
- On seismic section shows synthetic trace is almost same as seismic trace except near 1950ms and 2400ms.At that time range synthetic shows anomaly and very dimming amplitude.

Arbitrary Line Along Wells



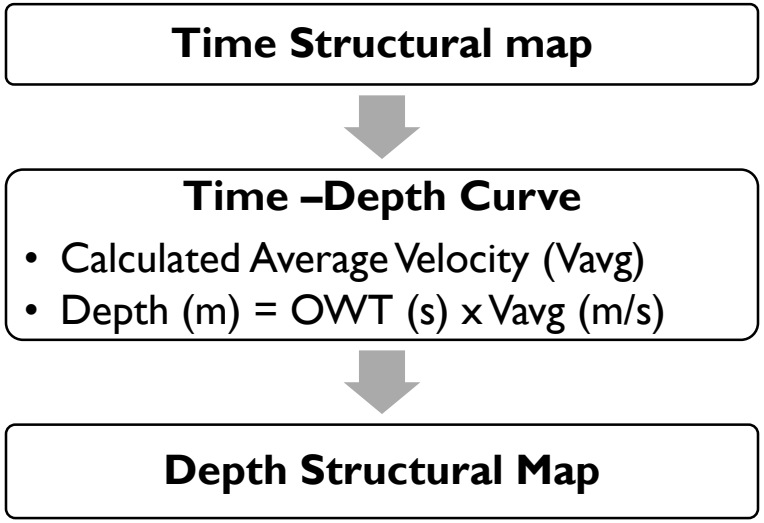
- Horizon 300 and 500 were picked on the peak reflector which is the contrast of shale over sand.
- These peak reflectors (shale over sand) can be observed for all wells and can correlated each other.
- Horizon 500 reflector is more continue and stronger amplitude when compare to horizon 300.

Picked Horizons on Seismic Section



Time-to-depth Conversion

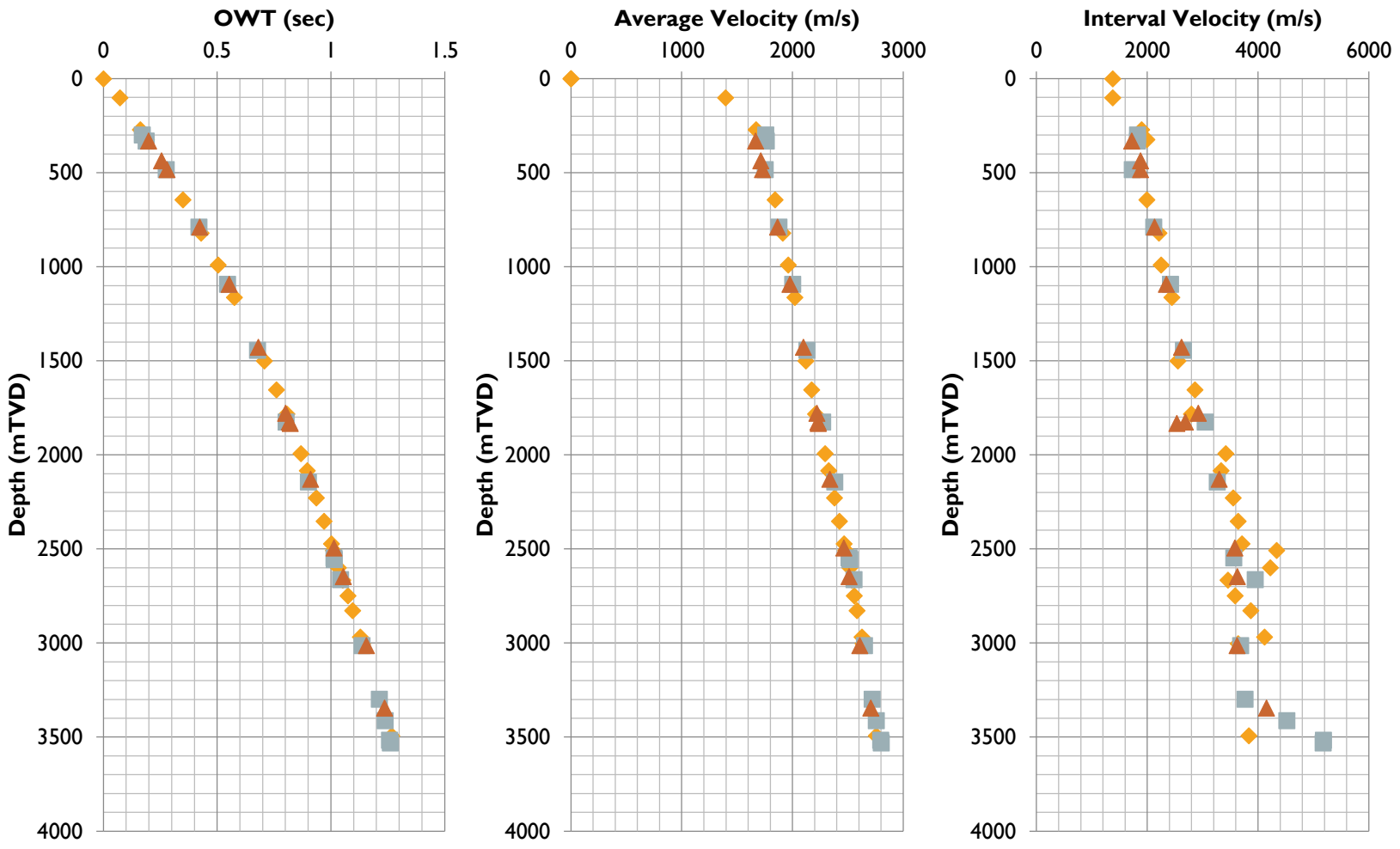
Workflow



- Time-Depth curve and average velocity for all wells are in a similar trend. Therefore, time-depth curve of Maui-2 was used as a representative well for time-depth conversion.

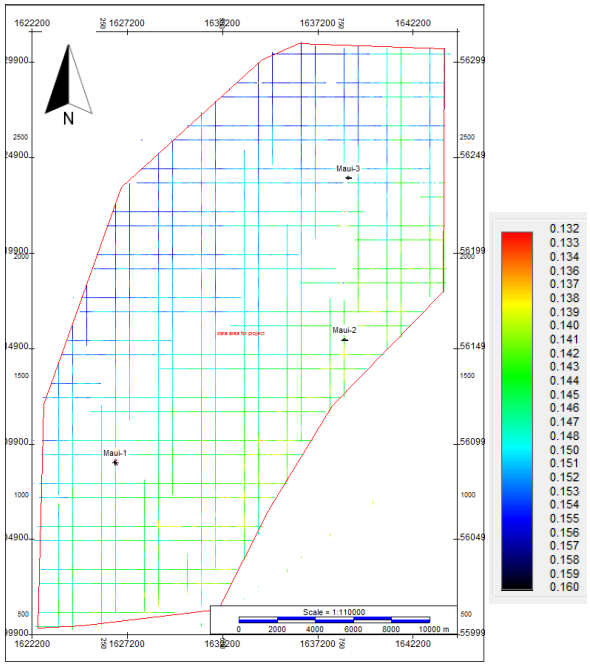
- For interval velocity, all well show quite similar trend in the shallow part but there are more scatter in the deeper part (below 2500 m)

Time-to-depth Conversion

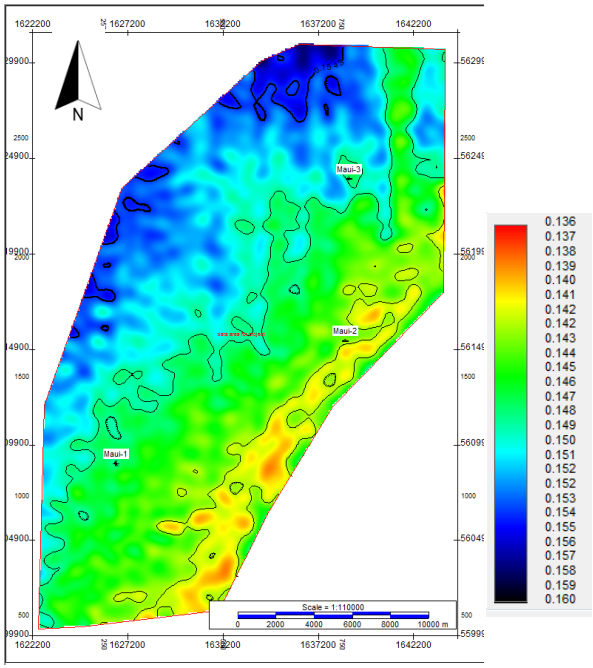


000 Water Bottom

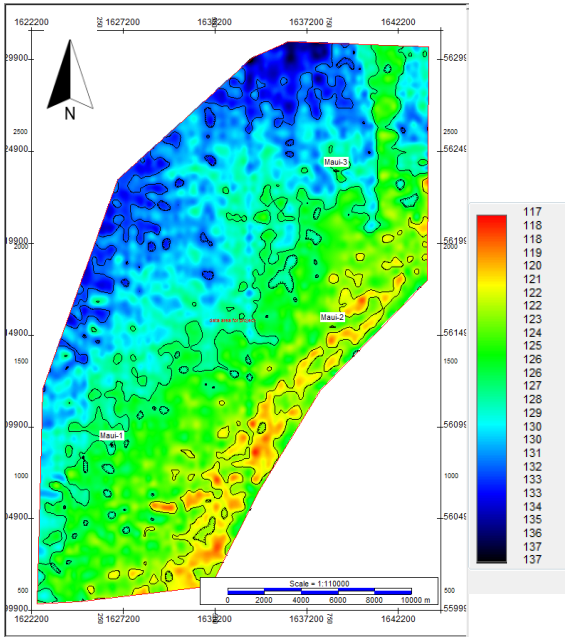
Horizon map



Time Structure Map



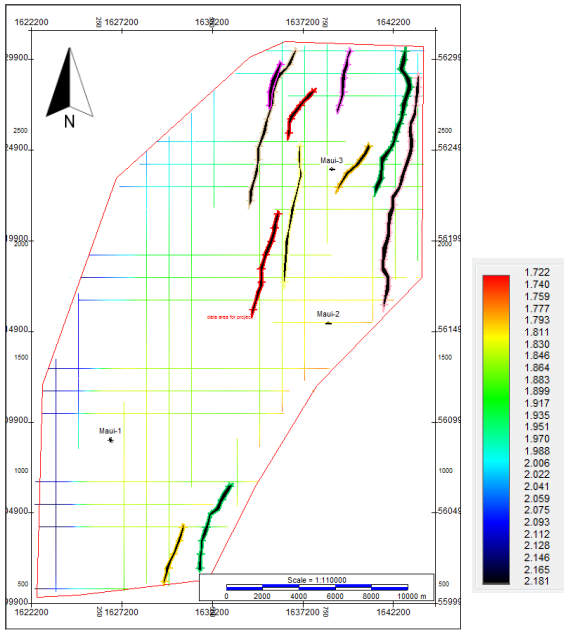
Depth Structure Map



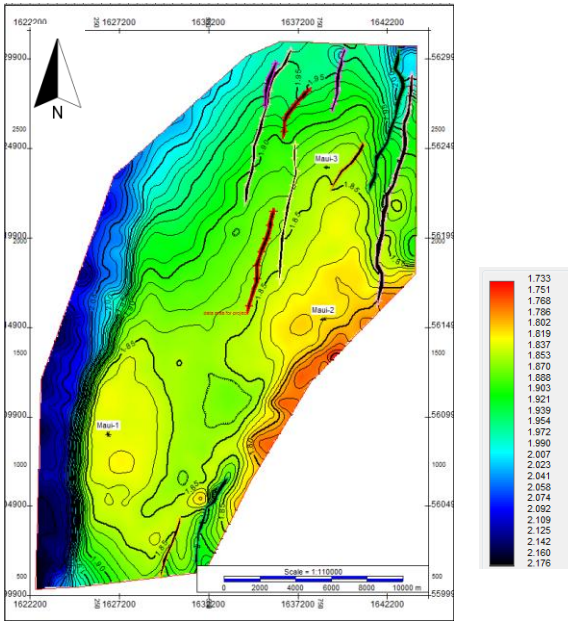
Horizon for water bottom picked 40 by 40. this horizon continuous and most of the part has high amplitude. We picked water bottom at trough. High scatter shows on the time structure and depth structure because of non-uniform sediment. Water bottom become more deeper from southeast to northwest.

Horizon 300 _1.812s _Peak at Maui #2

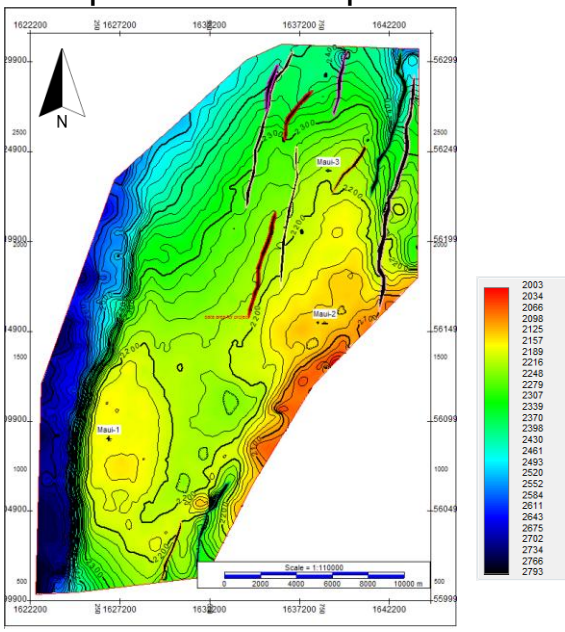
Horizon Map and Fault Polygon



Time Structure Map



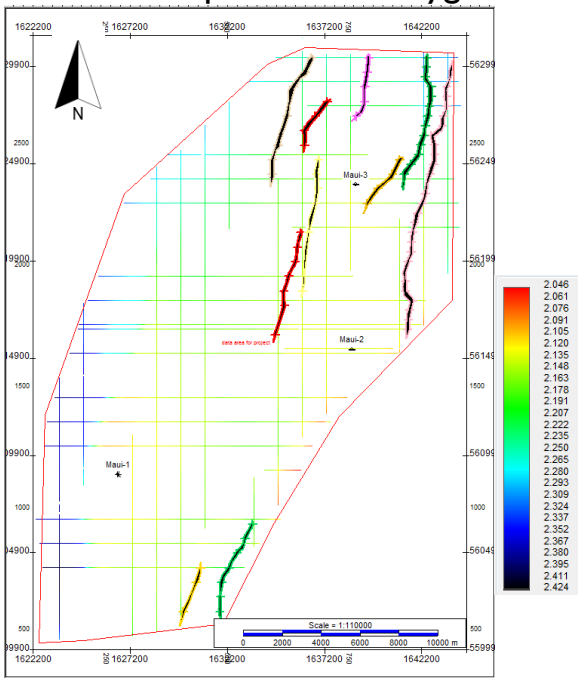
Depth Structure Map



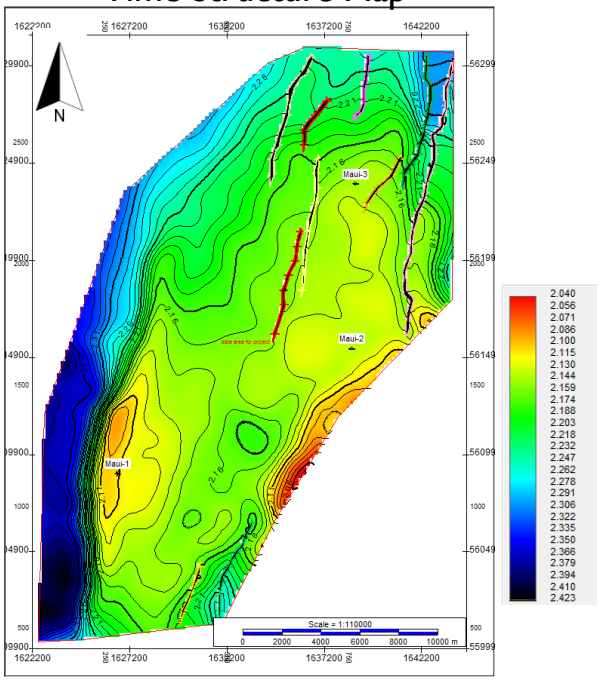
Horizon 300 has picked using 50 by 50 grid. In horizon map shows some of the locations are empty because of lower scale for large data set. Two major faults are at eastern part. Most of the faults located at north-eastern part. This structure is relatively complex, due to imperfection of horizon picking grid map give more scattered contour view. To make relatively uniform applied smoothing operation. Depth structure map shows structure is downward from SW to NW direction. All of the wells location are high structure.

Horizon 500 _2.133s _Peak at Maui #2

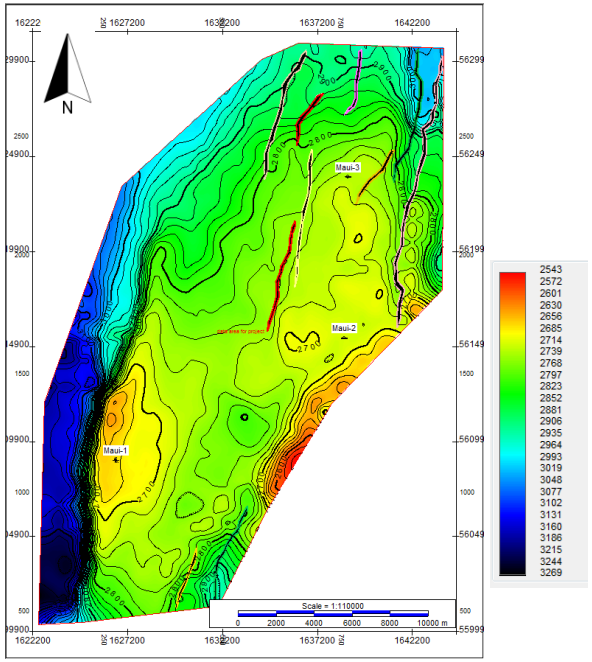
Horizon Map and Fault Polygon



Time Structure Map



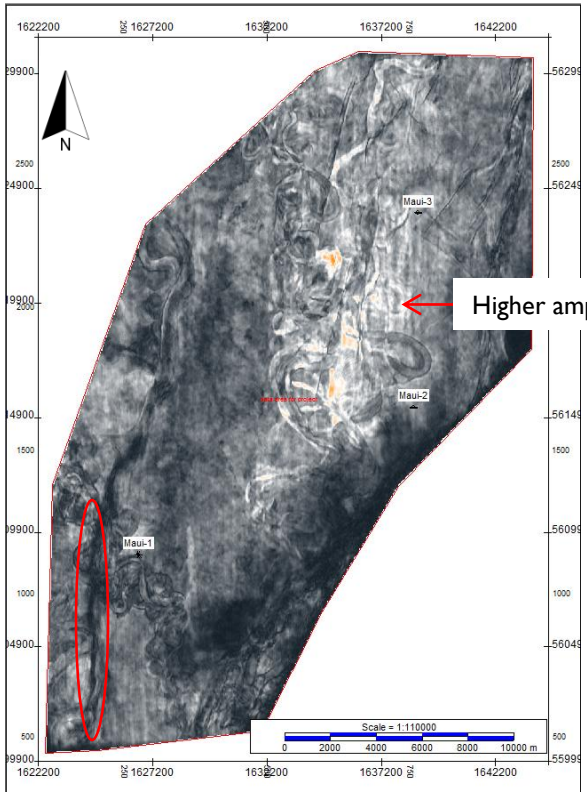
Depth Structure Map



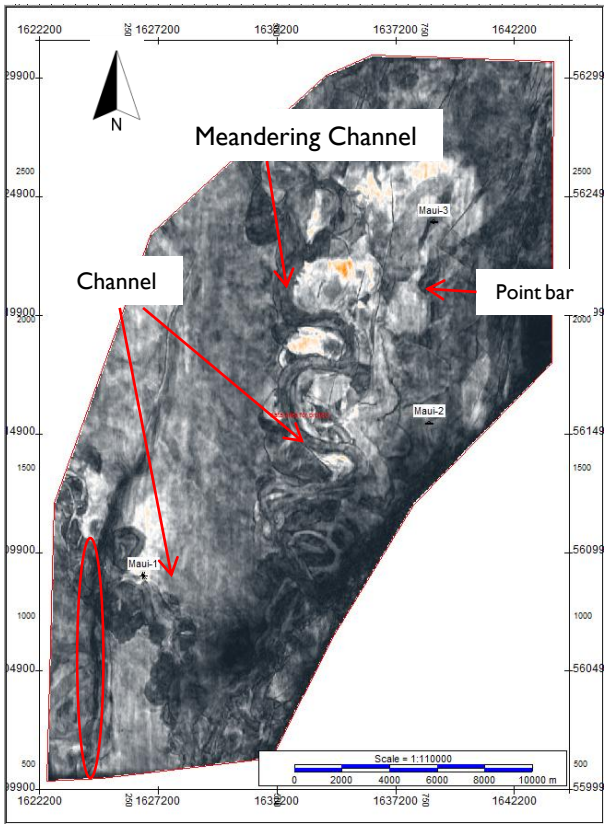
To peak horizon 500 used 50 by 50 grid. Most of the faults located at north eastern part. Two minor faults exist at southern part. Time structure map wells location are relatively low two way travel time. Western part has high travel time means lower zone. Depth structure map shows that well 2 to well 3 zone is higher structure. Southwestern part with overlapped contour map is high downward slope structure.

RMS Amplitude Upper Section of Horizon 300

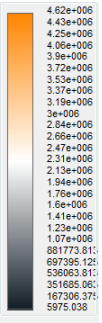
(25-50ms) Upper than Horizon_300



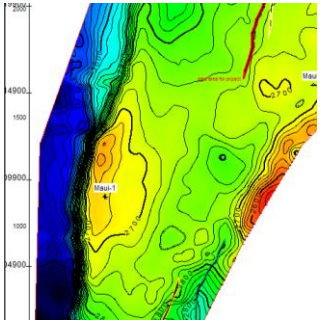
(50-75ms) Upper than Horizon_300

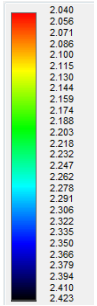


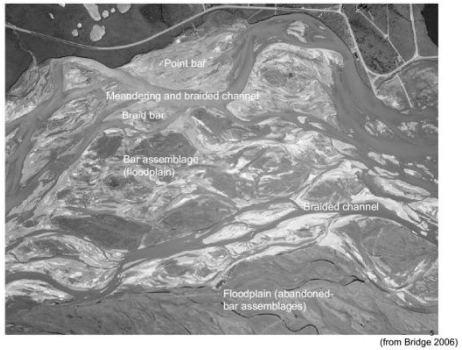
High



Low



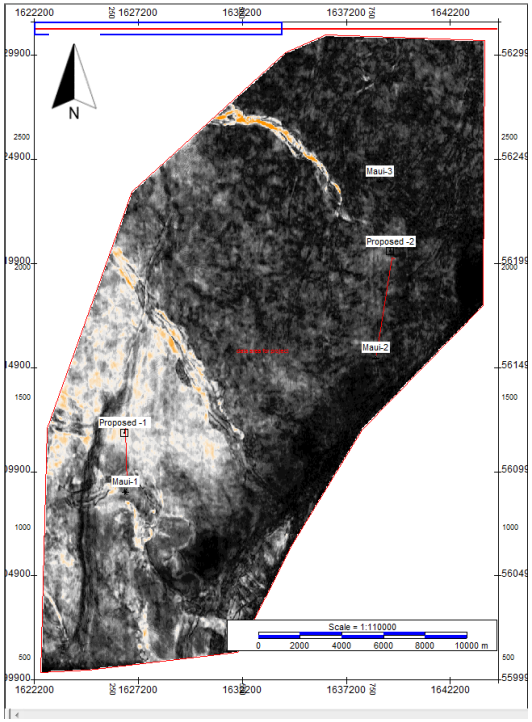




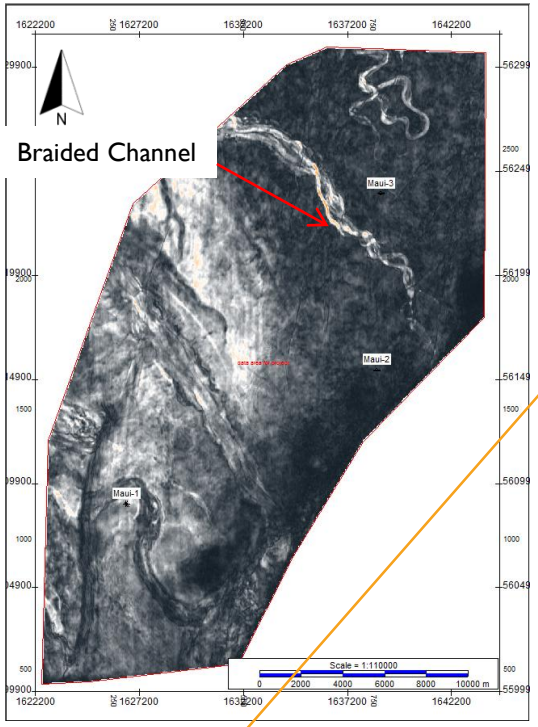
(from Bridge 2006)

- Red marked zone look like channel. But this zone is (Time structure showed)down deep structure.
- Bright spot represent higher amplitude zones.

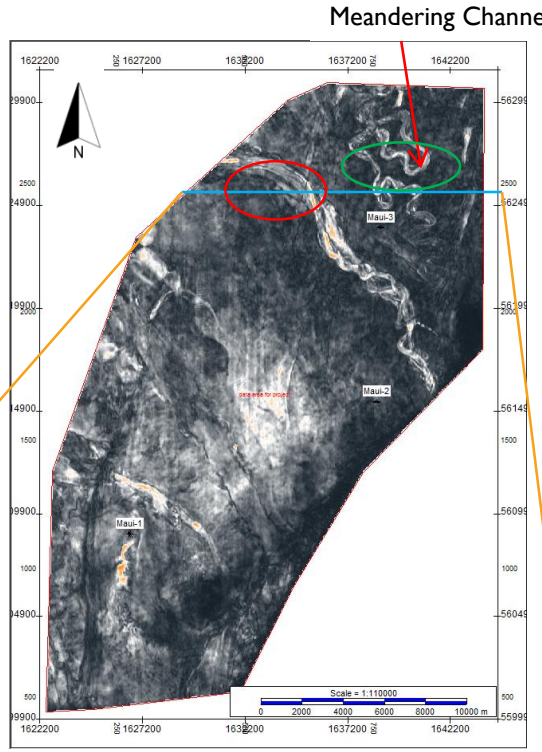
RMS Amplitude and Interpretaiton



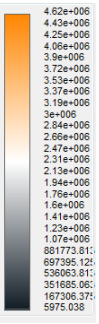
(75-100ms) Upper than Horizon_300

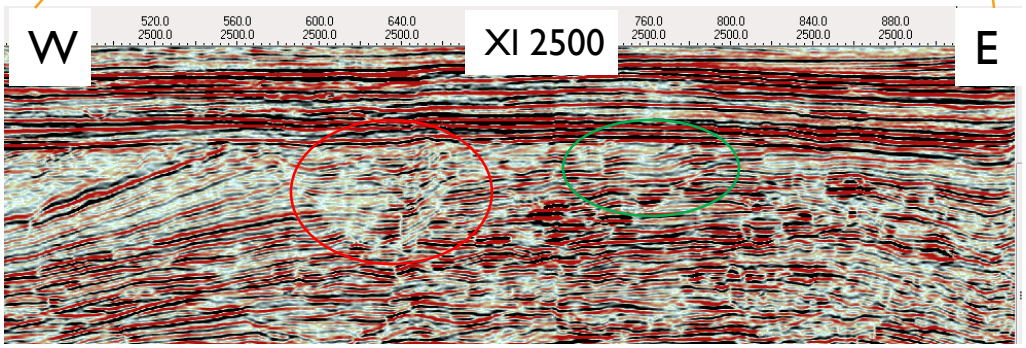


(100-125ms) Upper than Horizon_300



(125-150ms) Upper than Horizon_300

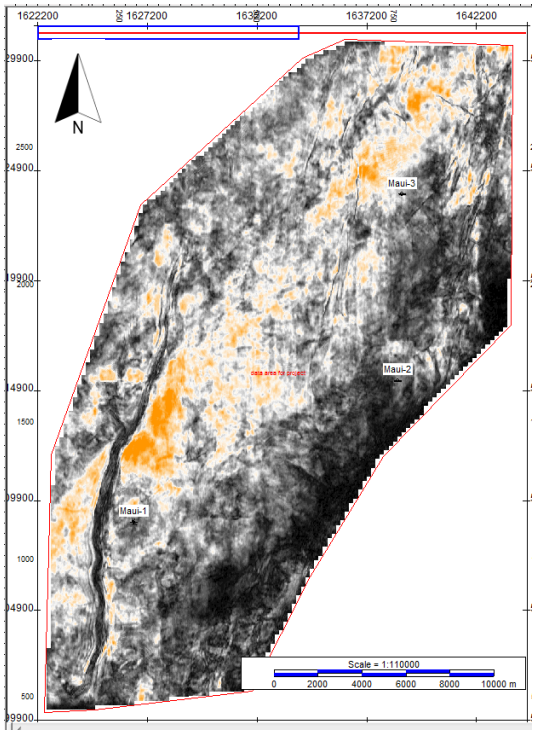




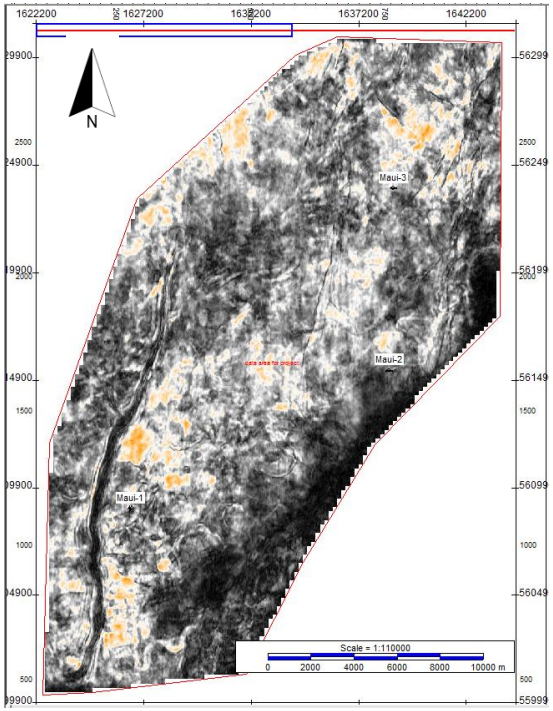
Braided channel move downward from NW to SE at more younger formation. Red circle represent the braided channel and Green one shows Meandering channel on cross-line. Middle part to SW part shows higher amplitude zone.

RMS Amplitude at Lower Section of Horizon 500

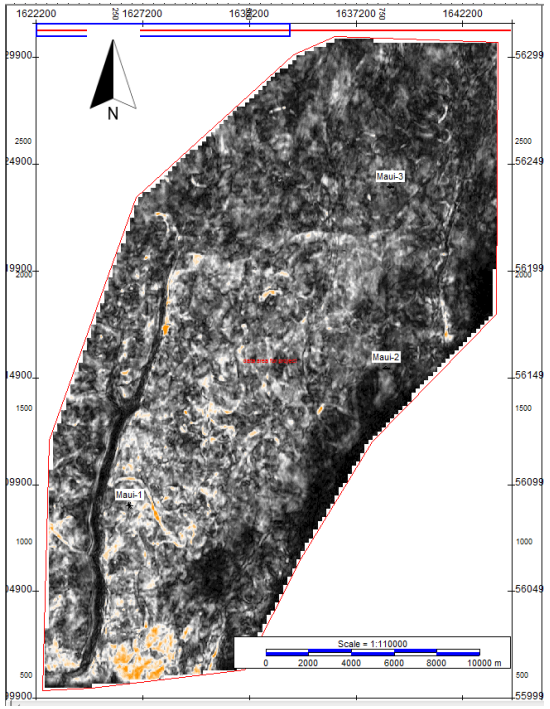
A. (25-50ms) Lower than Horizon_500

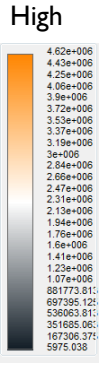


B. (50--75ms) Lower than Horizon_500



C. (175-200ms) Lower than Horizon_500

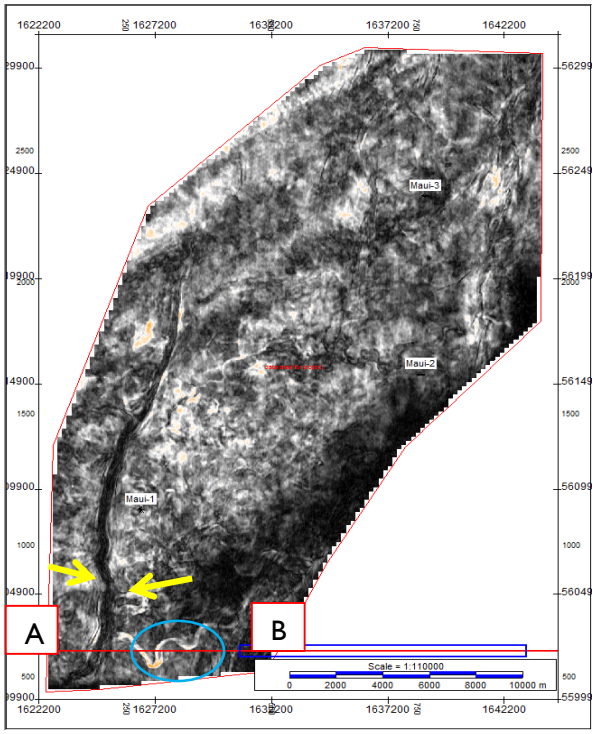




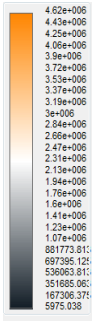
- A and B are at shallow depth and C at deeper depth.
- A and B show more scattered amplitude almost allover the area. but there doesn't give clear structure.
- In figure C shows some structures look like channel but not clear.

RMS Amplitude Interpretation

(75-100ms) Lower than Horizon_500

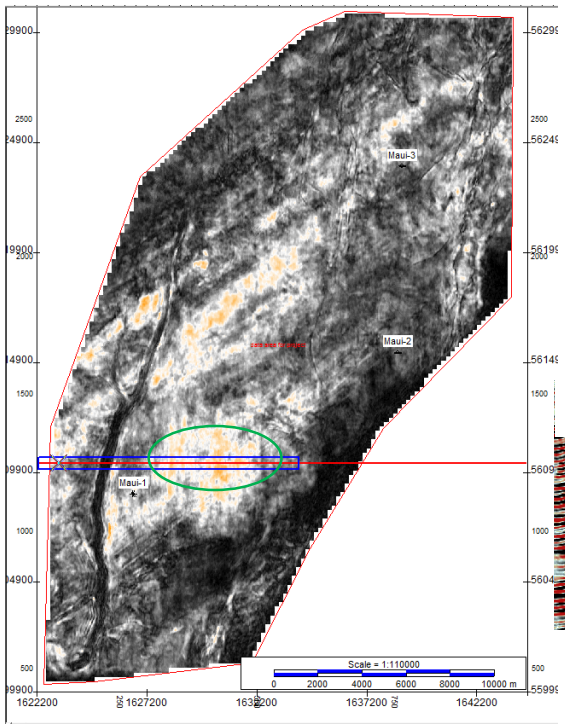


High



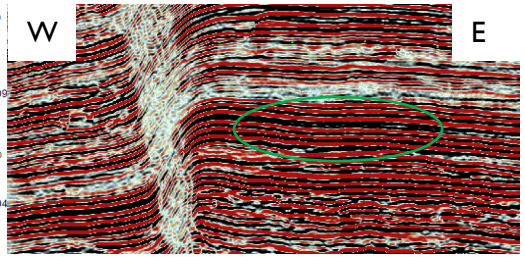
Low

(100-125ms) Lower than Horizon_500



Green Circle zone represent high amplitude for respective location on seismic section (Enclosed by green circle) .

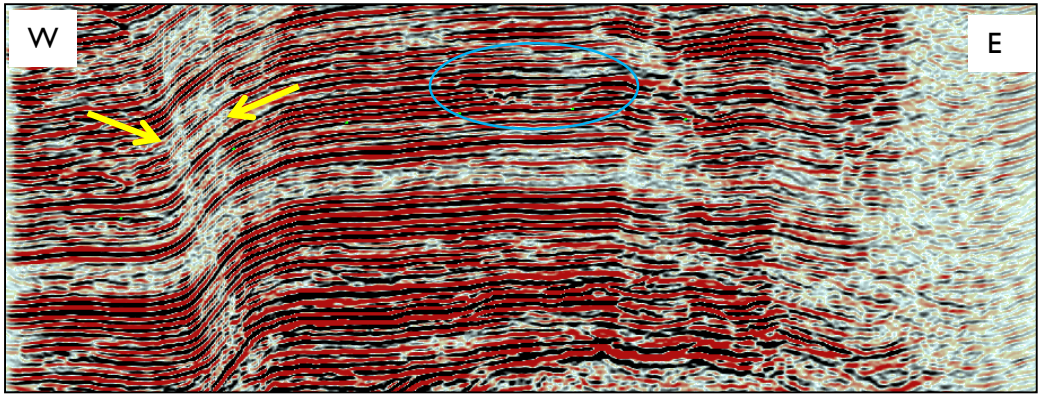
XL 1268



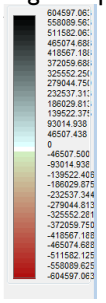
A

XL 600

B



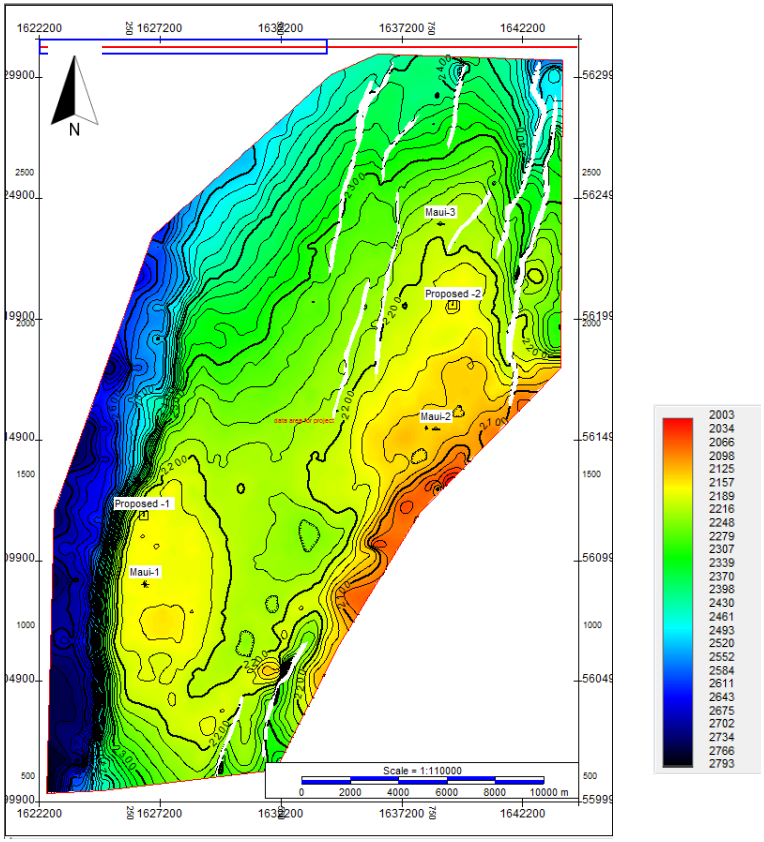
High Amplitude

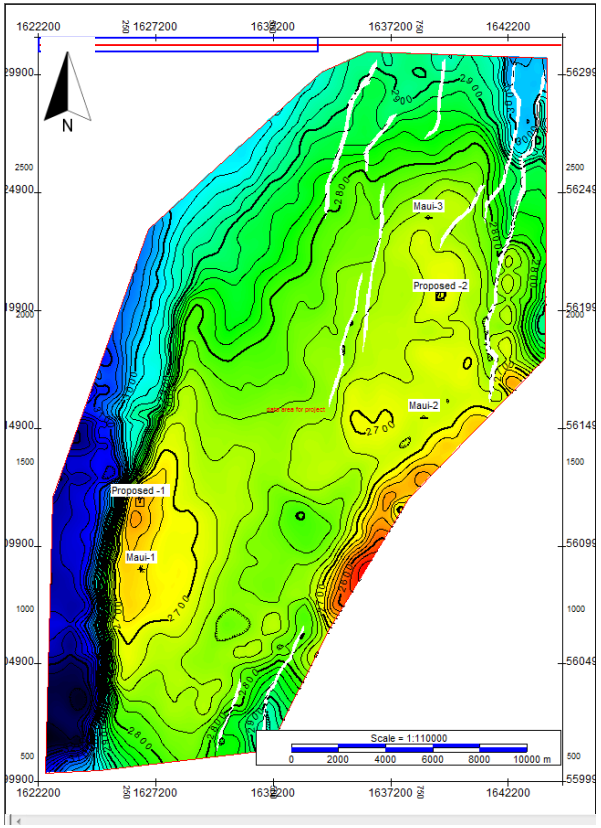


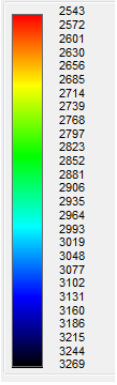
Low Amplitude

Blue Circle Shows the meandering Channel and yellow arrows indicate downward slope section.

Proposed Wells Location Based on Depth Structure Map





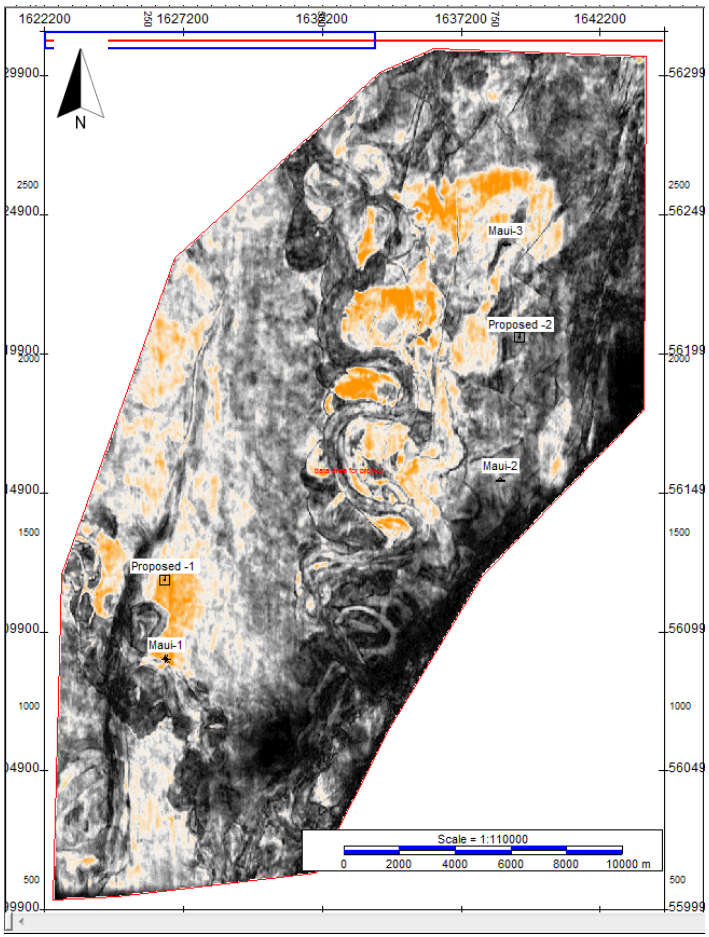


Here I have proposed two wells locations based on depth structure map. I looked for higher (folded) structure and have selected locations which are shown on map (Proposed-1 &2).

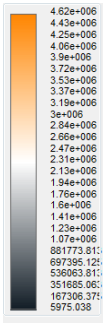
- Proposed-1 (Surface location):
  X=1626534m & Y=5611755m
- Proposed-2 (Surface location):
  X=1639324m & Y=5620483m

RMS Amplitude and Proposed Well Locations (Horizon 300)

A. (25-50ms) upper than Horizon_300

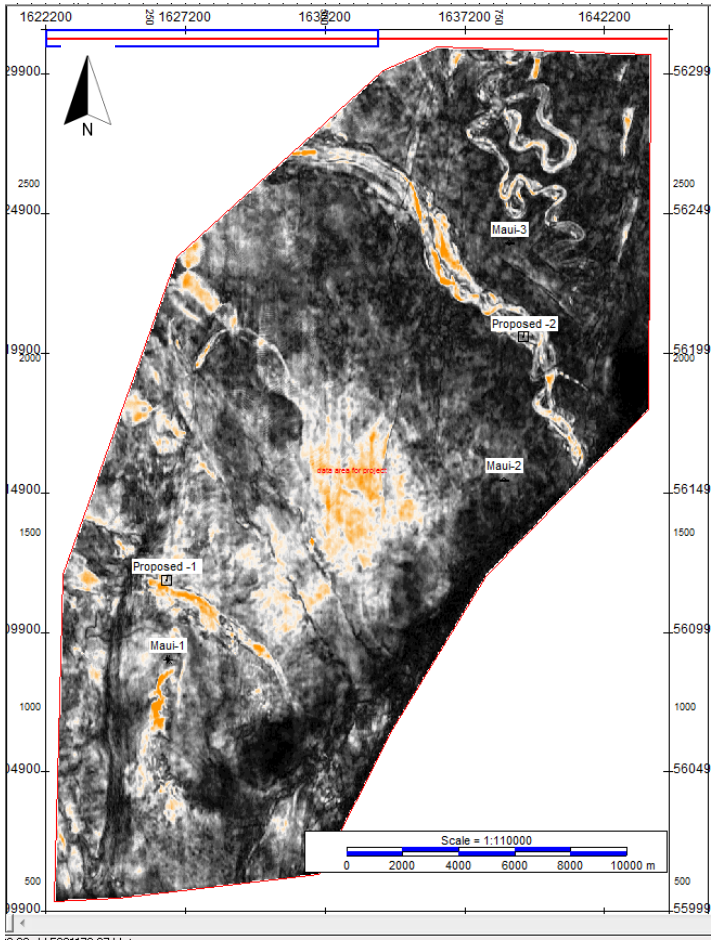


High



Low

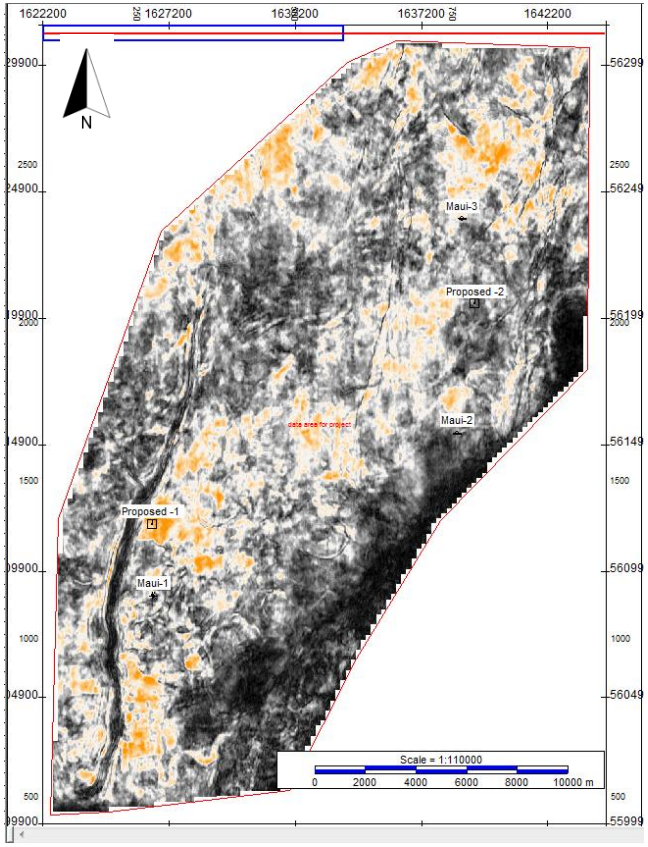
(125-150ms) upper than Horizon_300



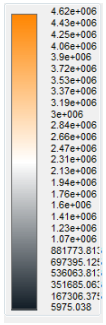
Both of the RMS map shows zone near proposed well-1 are high amplitude. But, at near Horizon-300 (A), Proposed-2 exist a bit far from high amplitude zone.

RMS Amplitude and Proposed Well Locations (Horizon-500)

(50-75ms) Lower than Horizon_500

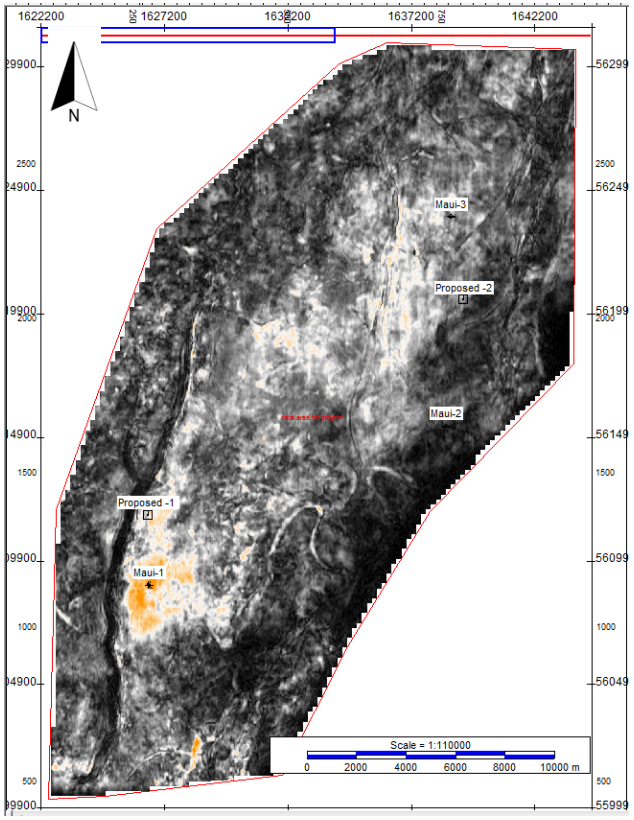


High



Low

(150-175ms) Lower than Horizon_500



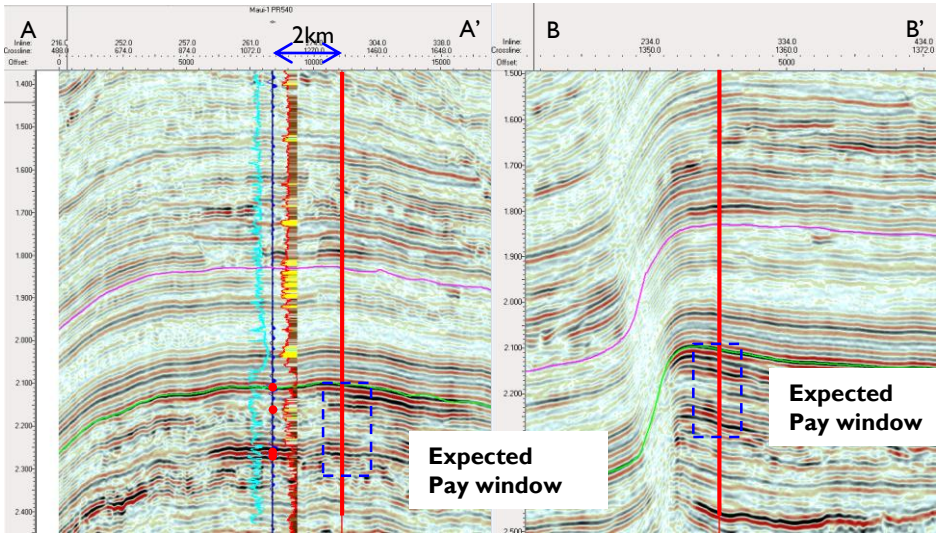
For zone below Horizon-500, Poposed-1 shows on high amplitude zone. But Proposed-2 on both of these figure has shown a bit distance from high amplitude zone. Based on the amplitude and structure map Proposed-1 is more potential location. For proposed-2, I should shift the location a bit towards the west direction.

Propose Well Location: Well 1

Hydrocarbon Shows

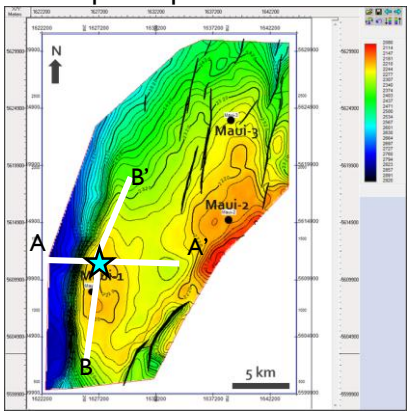
Proposed well

Propos well 1

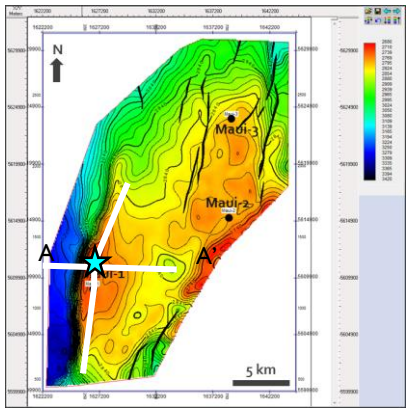


Propos well 1

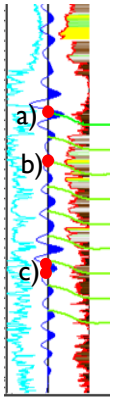
Depth Map : Horizon 300



Depth Map : Horizon 500

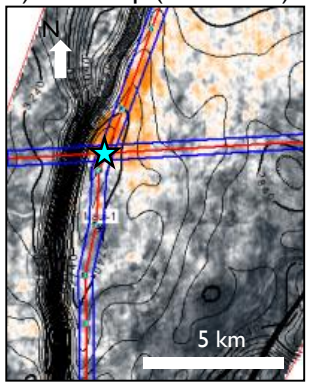


Maui-1

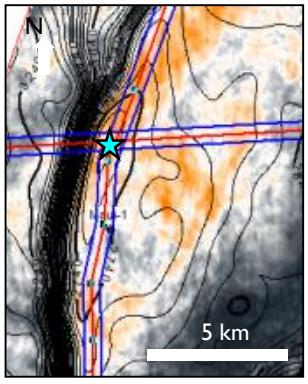


- The proposed well plan to drilled on the crest of 4-way dip closure which is very low risk. All petroleum system elements at this prospect were proved by Maui-1 such as reservoir, migration, trap and seal.
- Main target of this well is sand in Mangahewa formation (below horizon 500)
- RMS amplitude attribute at proposed well location show very bright amplitude which indicate AI contrast between shale and good reservoir rock. Good reservoir with high porosity and gas sand make rock softer and provide high AI contrast and strong amplitude.

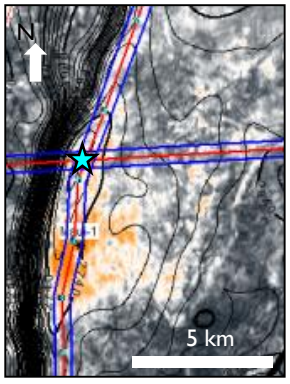
a) RMS map (500+25ms)



b) RMS map (500+50ms)



c) RMS map (500+175ms)

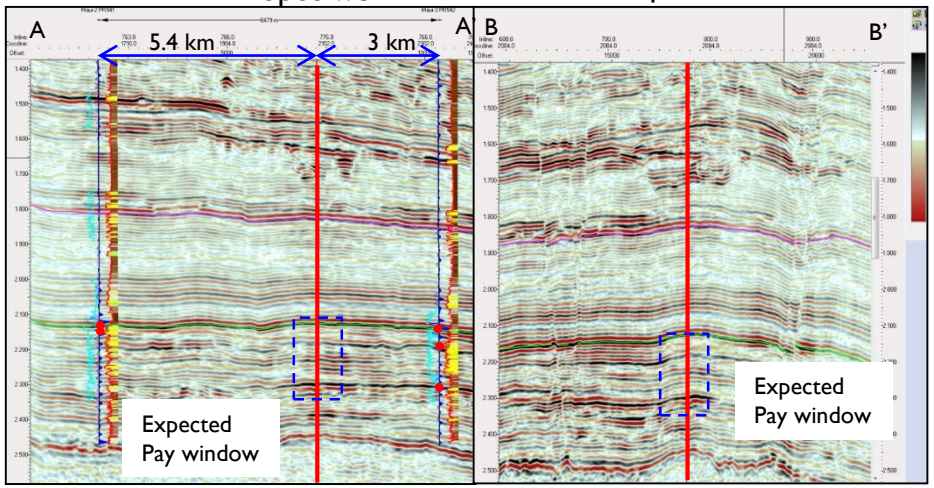


Propose Well Location: Well 2

Hydrocarbon Shows

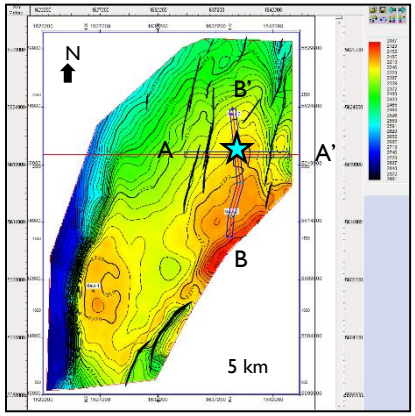
Proposed well

Propos well 2

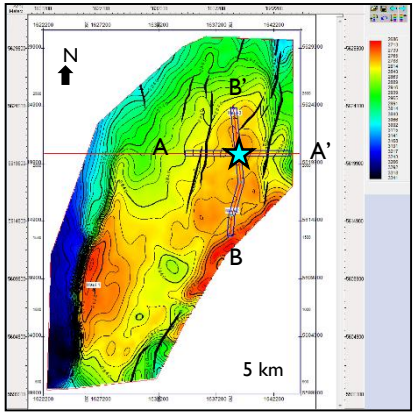


Propos well 2

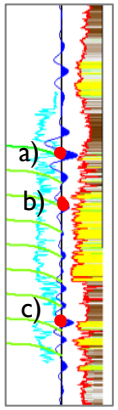
Depth Map : Horizon 300



Depth Map : Horizon 500

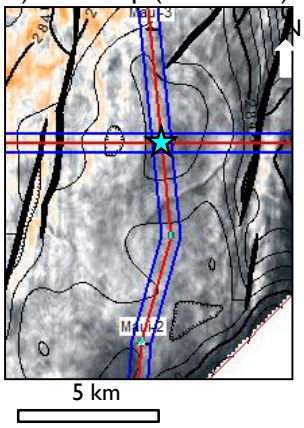


Maui-3

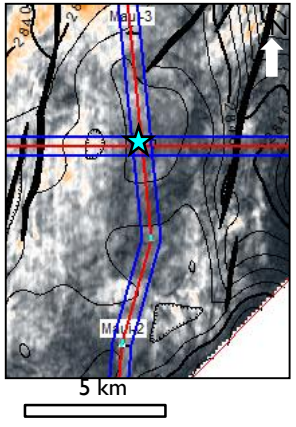


- The proposed well plan to drilled on the closure between Maui-2 and Maui-3 which show very good reservoir and contain some hydrocarbon. Therefore, this proposed well has low risk in term of reservoir and migration.
- Main target of this well is sand in Mangahewa formation (below horizon 500)
- RMS amplitude attribute at proposed well location show quite low amplitude on RMS attribute which is similar characteristic ofMaui-2 and Maui-3. This might be the thick sand area which is low AI contrast.

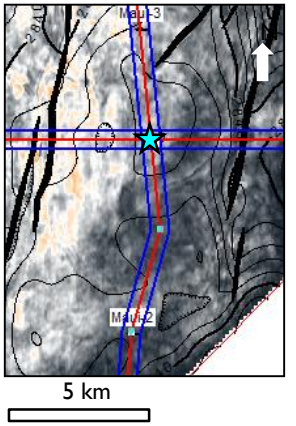
a) RMS map (500+25ms)



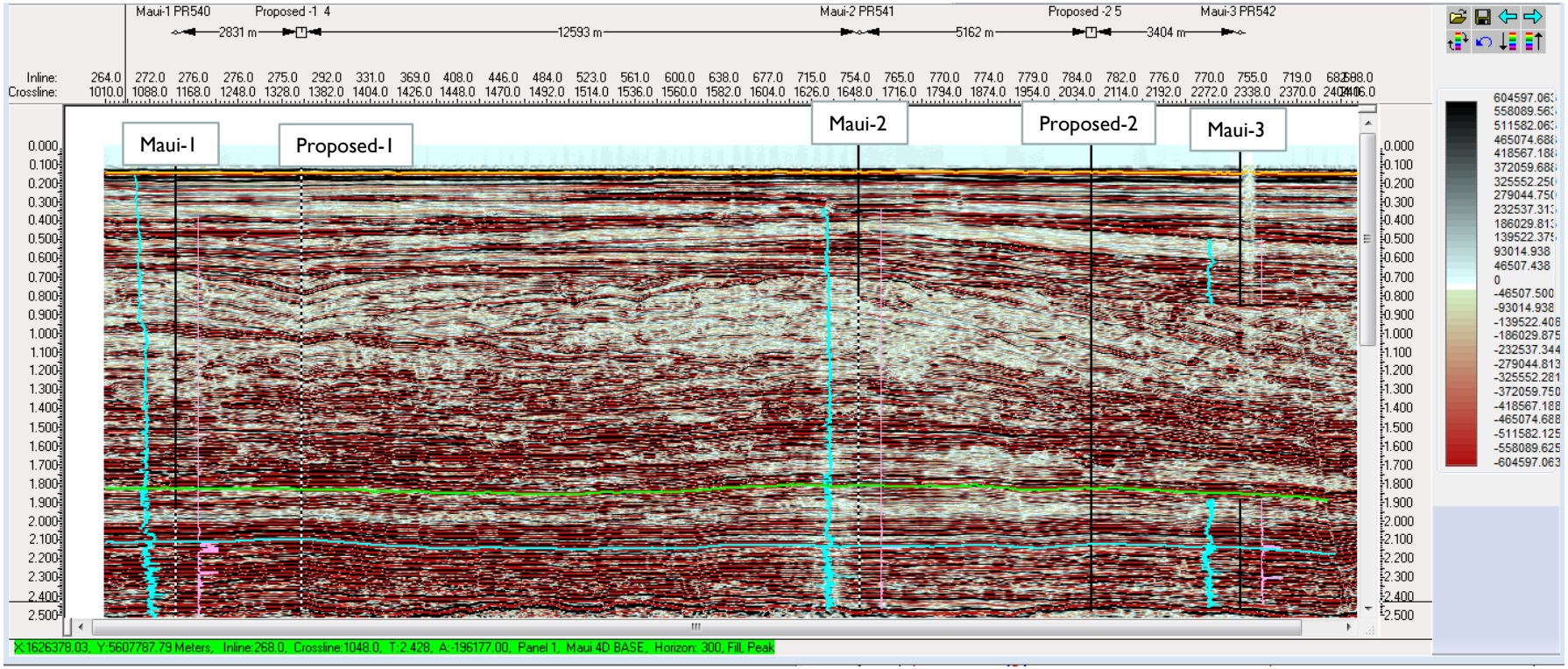
b) RMS map (500+50ms)



c) RMS map (500+175ms)



Arbitrary Line on Seismic Section Following the Well Locations



- Arbitrary line shows the all of wells over the seismic section.
- Proposed-1 location is almost 2 Km away from Maui-1.
- For Proposed-2, about 5 and 3.5 Km far from Maui-2 and Maui-3 respectively.
- Yellow, Green and Blue are Horizons line for 000-Waterbottom, 300-Horizon and 500-Horizon respectively.

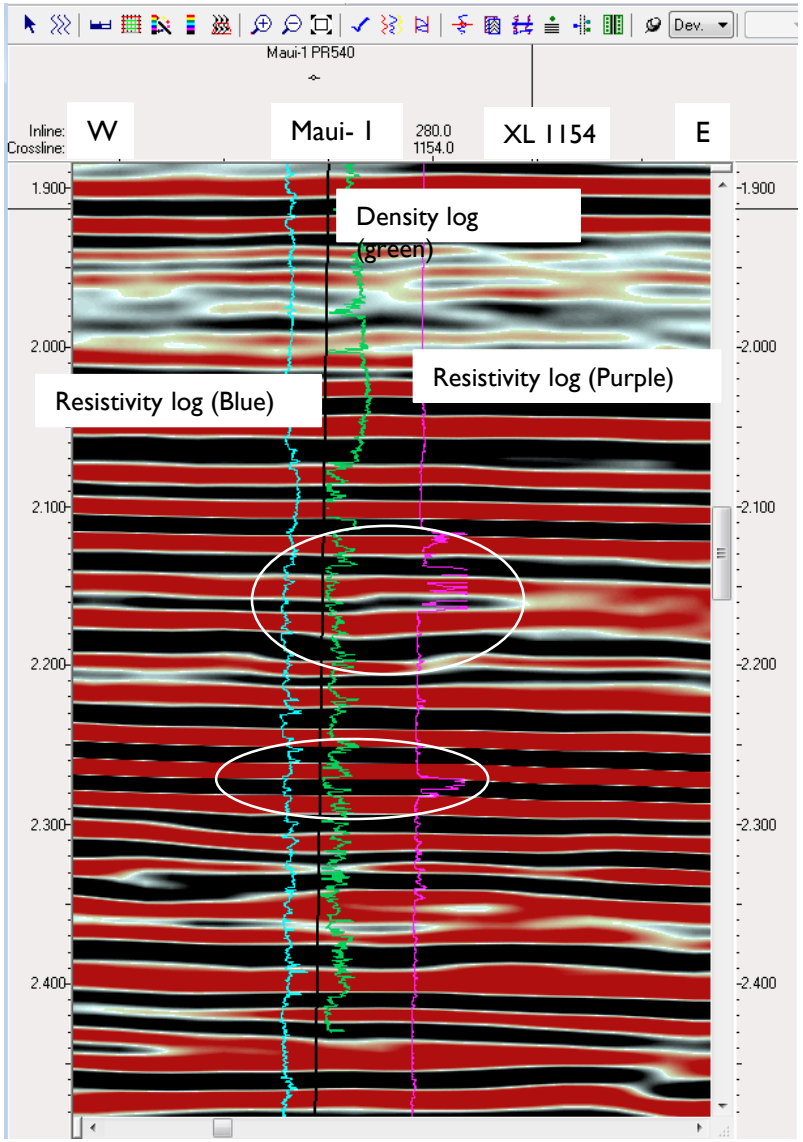
Conclusion

- Dominant frequency for whole survey is 45Hz, But at well locations about 35 Hz.
- Extracted wavelet gives higher correlation coefficient about 0.60 at reservoir zones.
- Reservoir zones for all of wells between about 1.9 ms to 2.4ms (Based on well completion report).
- Based on Depth structure map has proposed two well locations.
- RMS amplitude maps at different depths shows Proposed well Proposed_1 are desirable.
- For Proposed_2, location should shift a little bit towards the west direction.

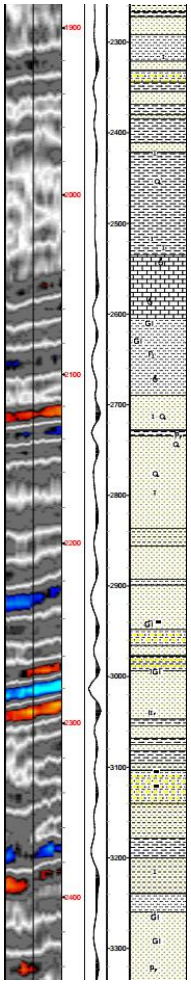
Thank You

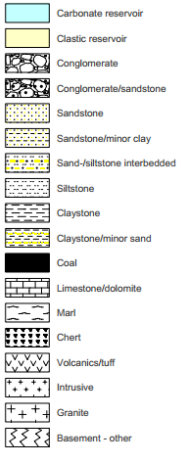
BACK UP

COMPARISON OF SEISMIC REFLECTION WITH WELL LITHOLOGY



Stratigraphy at well location





Circular marked zone are reservoir zones Time between 2100ms-2150ms and 2260 -2270ms with low resistivity and low gamma ray. Low amplitude portion below 1900ms is claystone with high density. Below 2000 ms with high zone is limestone.

WELL INFORMATION

WELL: MAUI-1

- Location:
  Longitude: 173° 18' 35.6" E
  Latitude: 39° 40' 15" S
- Water bottom: 112m
- Total drilling depth: 3512m

  Reservoir zone:
  2690m-2790m
  2990m-3016m

- GR log: 119-3492m
- Density log: 1462-3300
- Sonic Velocity log: 289-3500m

WELL: MAUI-2

- Location:
  Longitude: 173° 18' 35.6" E
  Latitude: 39° 40' 15" S
- Water bottom: 113m
- Total drilling depth: 3566 m

  Reservoir zone:
  2787m-2807m
  2807m-2807m

- GR log: 330-3570m
- Density log: 2530-3180
- Sonic Velocity log: 530-3180m

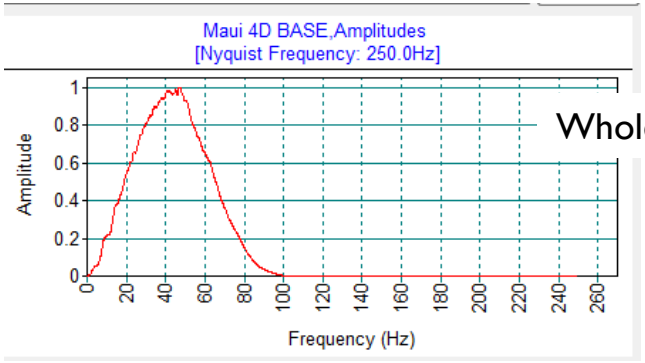
WELL: MAUI-3

- Location:
  Longitude: 173° 27' 04.99" E
  Latitude: 39° 32' 10.99" S
- Water bottom: 109m
- Total drilling depth: 3401 m

  Reservoir zone:
  2735-2809 m
  2828-2831 m
  3045-3086 m

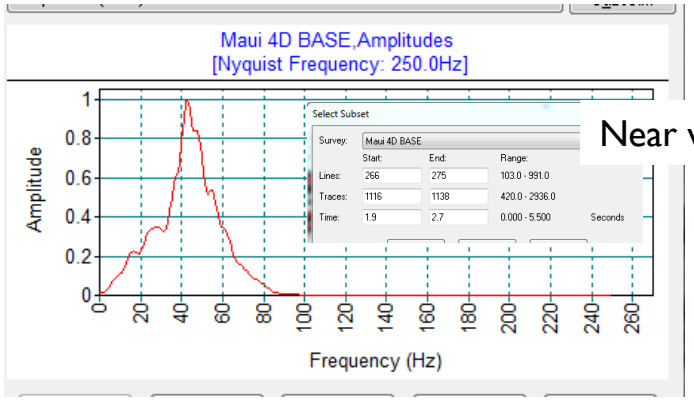
- Density log: 2623-3131
- Sonic Velocity log: : 457-3338m

FREQUENCY SPECTRUM OF THE SURVEY



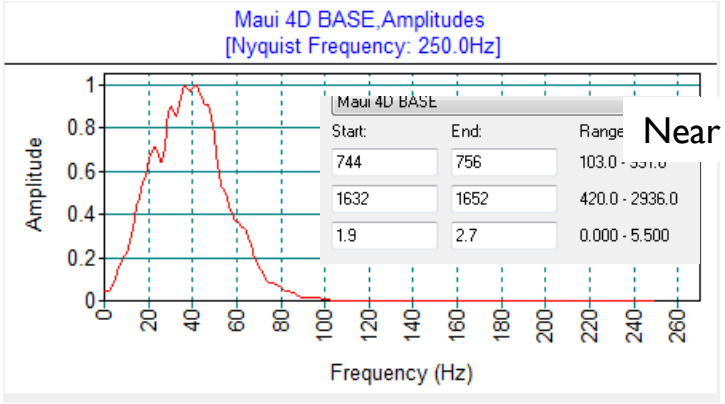
Whole survey

Our data frequency ranges from 0 to 125Hz but we can only observe 5-80Hz. The Nyquist frequency of the data is 250Hz. The mean frequency is around 45Hz. Frequency more than 80 may be noise signal (red circle).



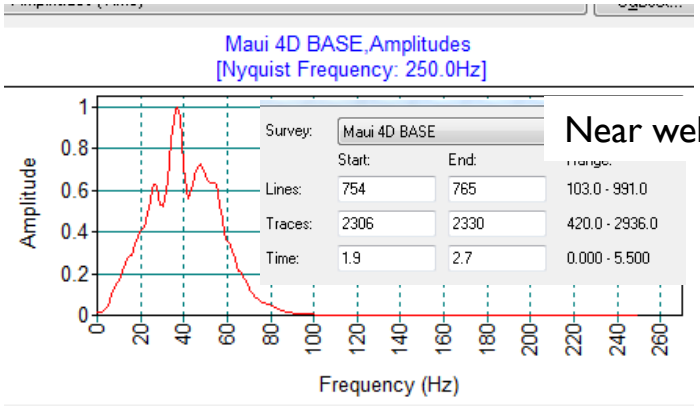
Near well Maui 1

Frequency spectrum at near well 1 applying time range 1.9 to 2.7. Dominant frequency is about 45 Hz.



Near well Maui 2

Dominant frequency is about 40 Hz. Frequency more than 80 Hz may be noise signal



Near well Maui 3

At well 3, Dominant frequency is about 35 Hz.

WELL: MAUI-2

Country: New Zealand

Basin: Offshore Taranaki

Latitude: 39° 36' 46.00" S **Longitude:** 173° 26' 57.98" E

NZ Transverse Mercator: 1 638 597.9 m E; 5 615 317.6 m N

Spud Date: 5 October 1969

Directional Data: Near vertical well

Operator: Shell BP & Todd Oil Services Limited

Petroleum Report: 541

Scale: 1:2500

Total Depth: 3566 m bdf

Ground Level Elevation: 113 m bmsl

Rotary Table Elevation: 32.5 m amsl

Status: Suspended

Hydrocarbon Shows: Gas & condensate

Edited by: GNS Science
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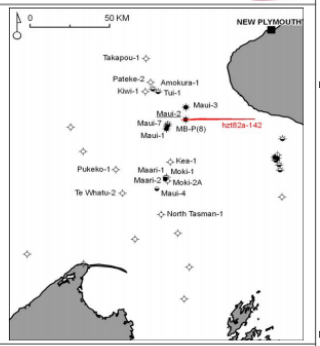
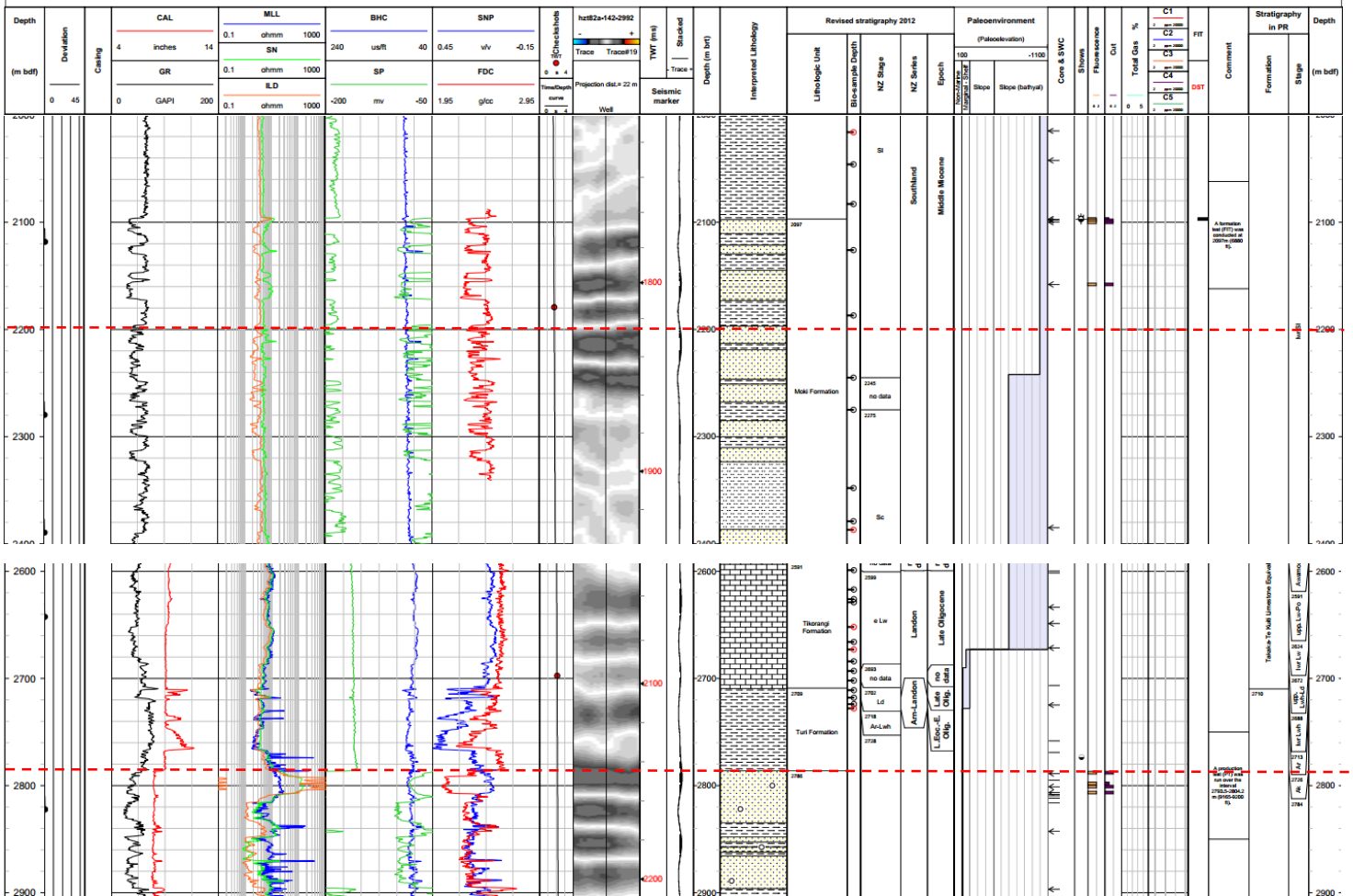
Technical summary

Maui-2 was spudded on the 5th of October 1969. The objective of Maui-2 was the Lower Tertiary sands below 2712.7 m bdf which are hydrocarbon-bearing in Maui-1. The Kapuni Formation equivalent was encountered between 2709.6-3450.3 m bdf. Hydrocarbon-bearing intervals are as follows: 2780.4-2807.8 m, 21 m net gas-condensate; and 2808.8-2809.0 m, 1.2 m net oil (?). The well was production tested between 2793.4-2804.1 m. Maui-2 reached TD at 3566 m. Maui-2 is currently suspended.

Drilling Data	Units	Logging Suite 1	2	3	4
Top Depth	m	325.83	1077.47	2531.3	3154.68
Base Depth	m	1093.93	2581.35	3185.16	3567.68
Casing driller	m	326.74	1077.16	2533.49	2533.5
Casing logger	m	325.83	1077.47	2531.3	2531.36
Bit size	in	15	10.625	8.5-13.5[1]	8.5-13.5[1]
Mud Type		Fresh water-Spersene XP20	Fresh water-Spersene XP20	Freshwater gel-Spersene XP20	Freshwater gel-Spersene XP20
Rm	ohm m	2.51	2.11	1.99	1.69
Temp Rm	°C	15.5	22	24	21
Rmf	ohm m	n/a	1.84	1.58	1.24
Temp Rmf	°C	n/a	18	20	21
Rmc	ohm m	n/a	4.5	3.15	2.83
Temp Rmc	°C	n/a	18	20	21
Mud Weight	lbm/gal	n/a	n/a	n/a	n/a
Max recorded temp	°C	45.6	68	92	103
Fluid Loss	cc/30 min	8.6	3.9	3.9	3.8

[1] Runs 3 & 4. Bit sizes varied during the run - 13.5" to 2542.0 m, 10.625" to 2579.22 m, and 8.5" to 3183.02 m.





GENERAL

Well Location

Co-ordinates

Elevation

Drilling Rig

Timing

Total Depth

Objective

Result

Result (Cont'd)

PHANTOM HORIZON