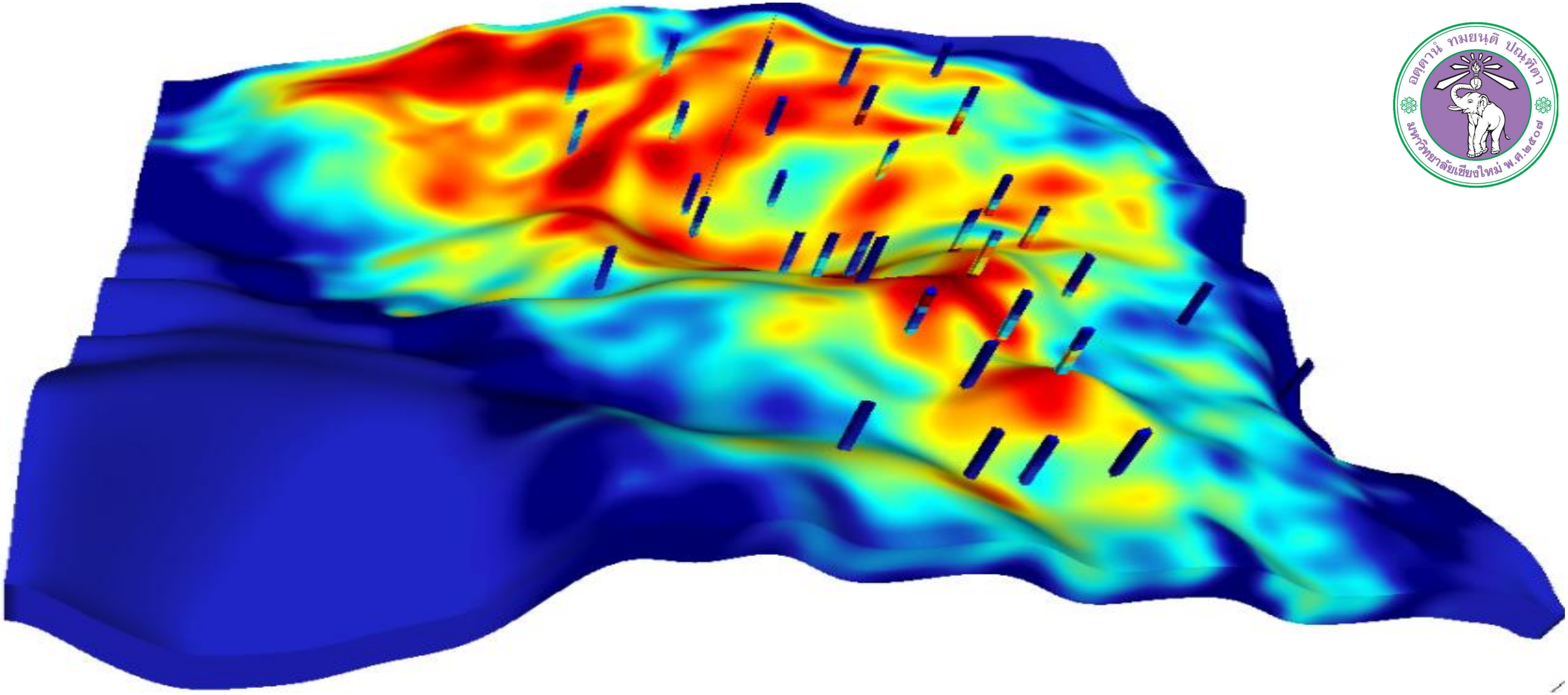


Seismic Attribute Analysis and Evaluation of Stratigraphic Features of Maui 4D, New Zealand

Shefa Ul Karim

Introduction

Seismic Attributes:

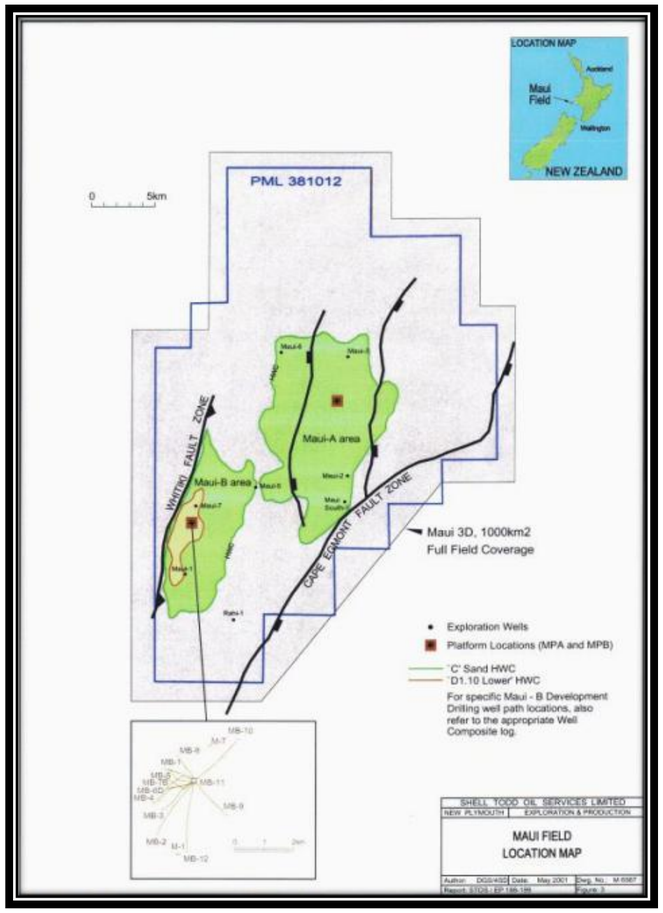
- A measurement derived from seismic
- Usually based on measurement of time, amplitude, frequency, shape of wavelet, and/or attenuation.
- The primary usefulness of attributes is that they sometimes help to see features and relationship of geological events.

Objectives:

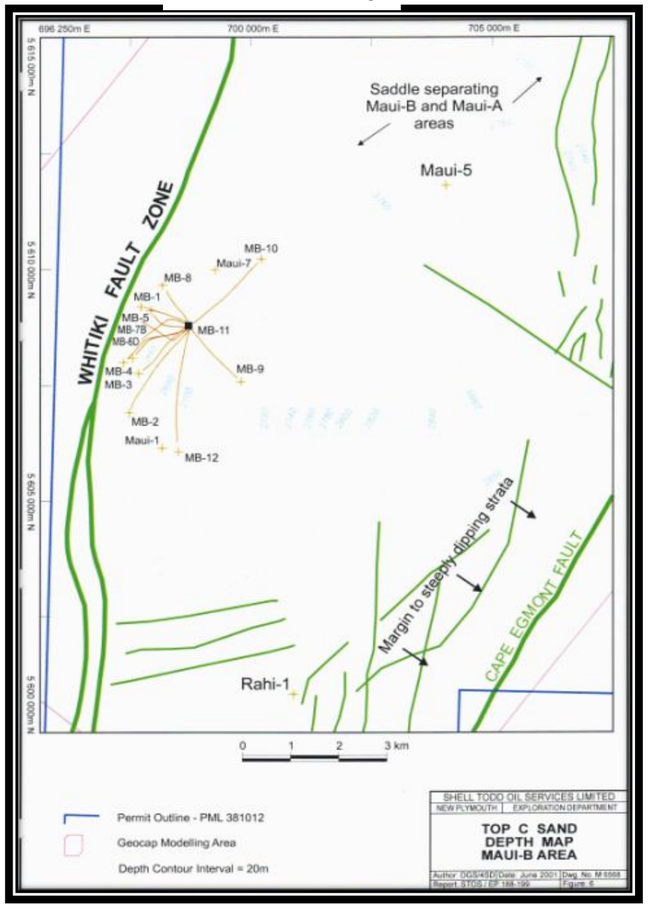
- To create crop volume
- Pick horizon within the cropped volumes
- Fatten the cropped volume with reference horizon.
- Run attributes and choose the best attributes and parameter set for each cube that show geological features
- Geological interpretation of imaged features with the help of well data.

Study Area

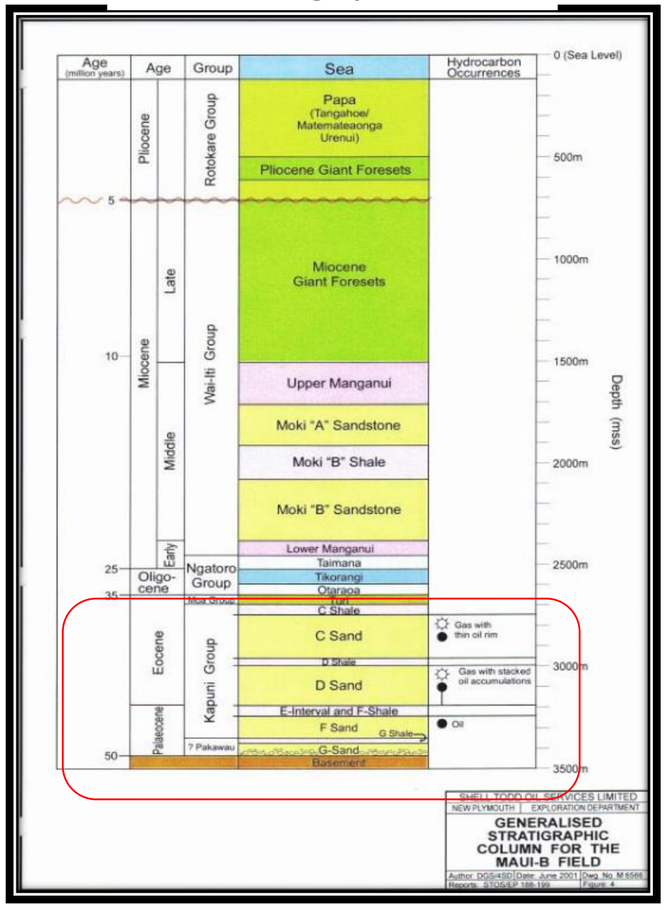
Location map



Structural Map



General stratigraphic column

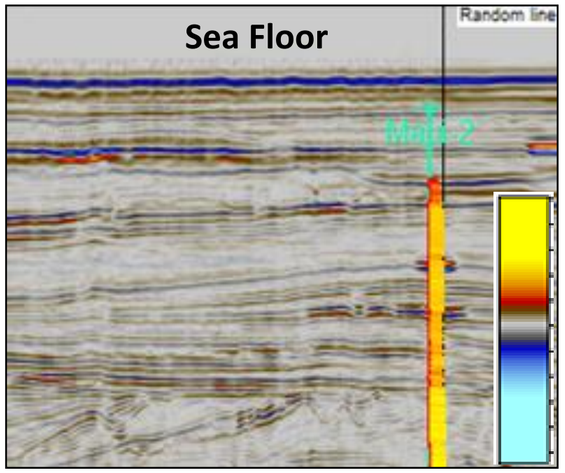


- Maui Field is situated in Southern part of the Taranaki Basin, New Zealand. The Maui gas condensate field was discovered offshore Taranaki in early 1969 by the exploration well Maui-1.
- It lies on the boundary of the Western Stable Platform and the Eastern Mobile Belt structural domains.
- The Maui Field has a north-south structural trend in the north, and a NNE- SSW structural trend in the south.
- Depositional/structural settings ranged from fault bounded half-grabens and basins, through to low relief fluvial/shallow marine dominated coastal plain environments .
- A number of hydrocarbon accumulation formed within sandstone reservoirs associated with the "C", "D" and "F" Sands of Kapuni Group.
- The Kapuni Group accumulated in a coastal plain environment of deposition with a range of sediments.

Seismic and Available Well Data

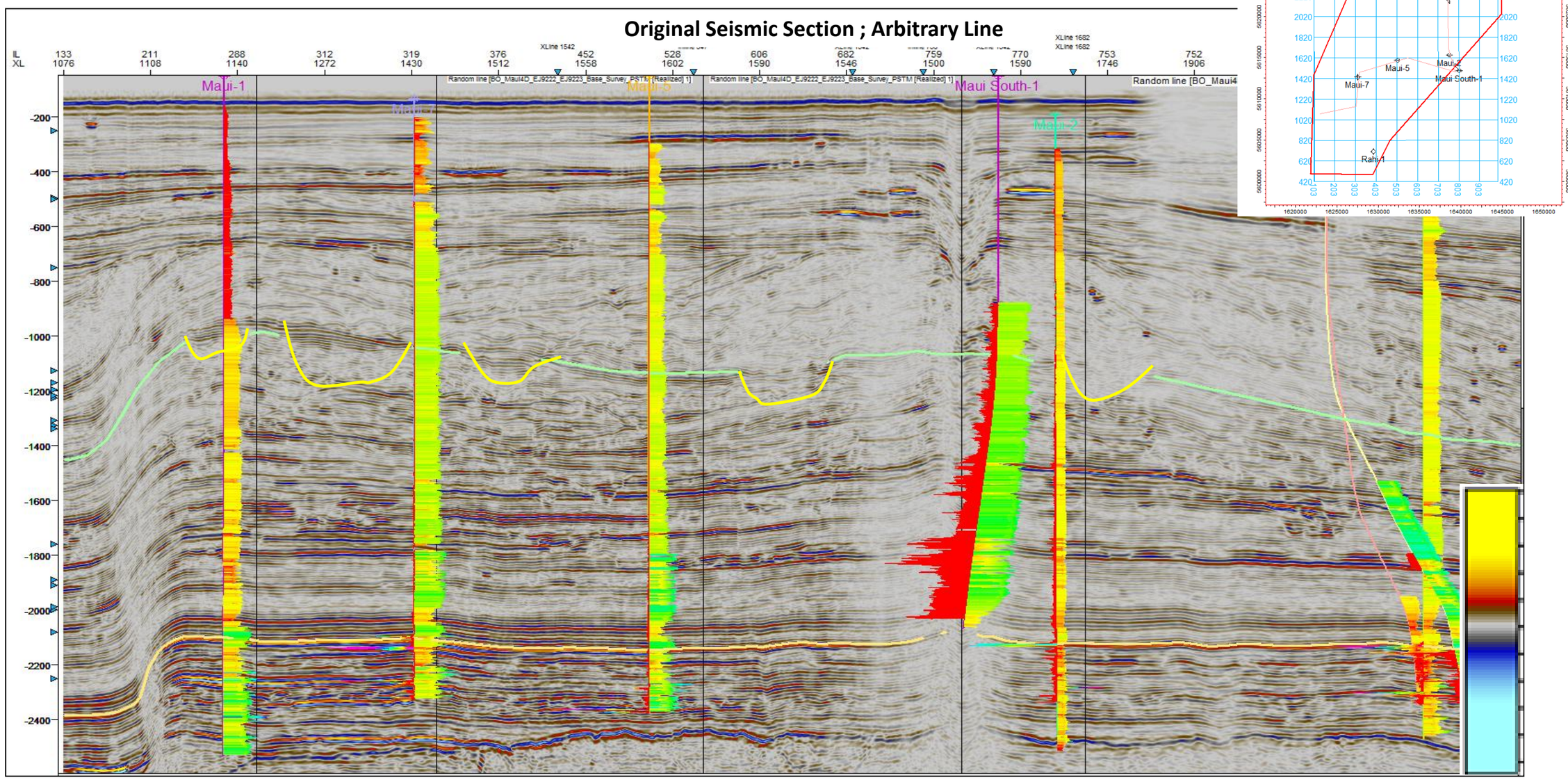
Available Well data:

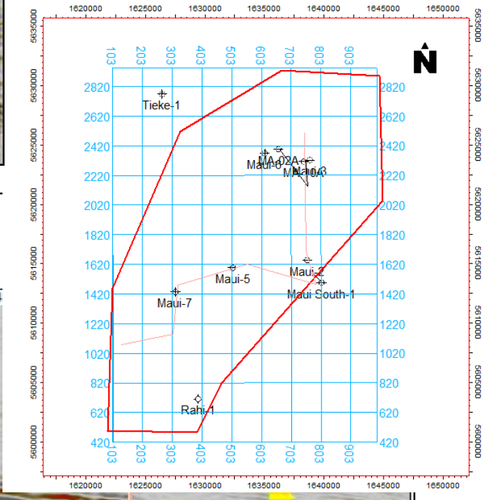
Maui 1
Maui 2
Maui 2A
Maui 5
Maui 6
Maui 7
Maui south



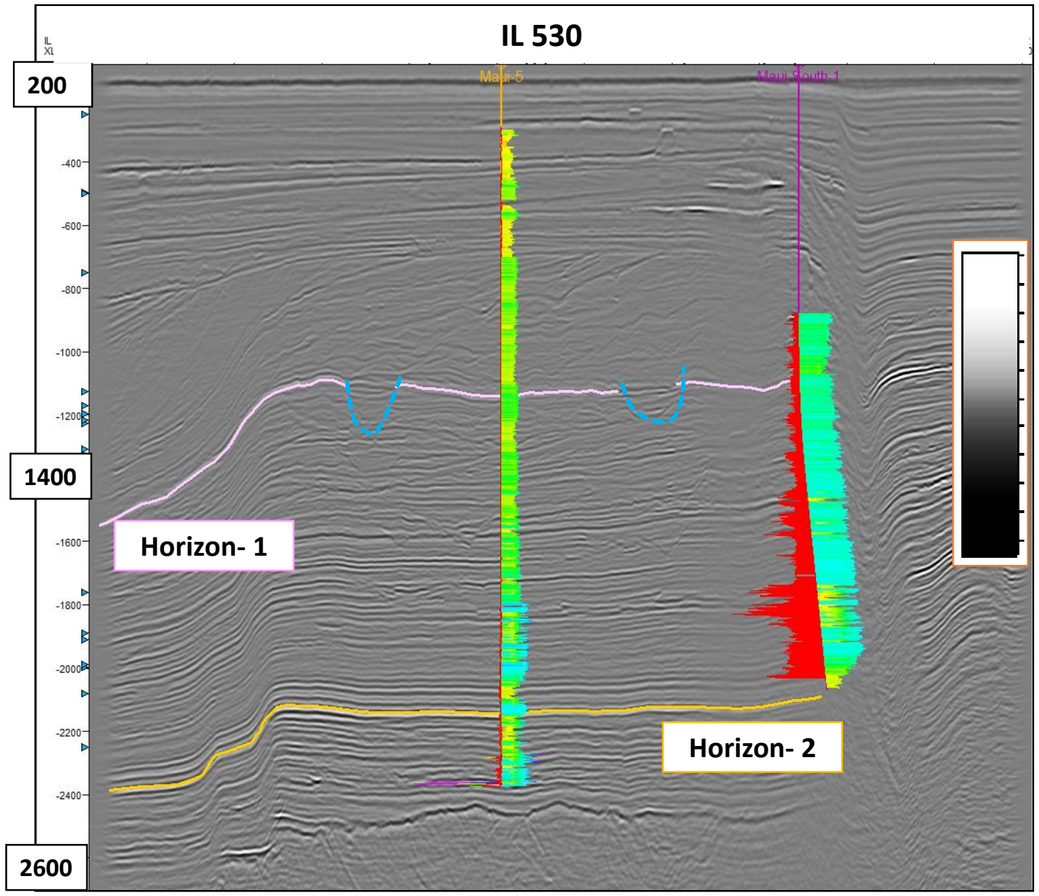
Data Polarity: Negative (based on the sea floor reflection)

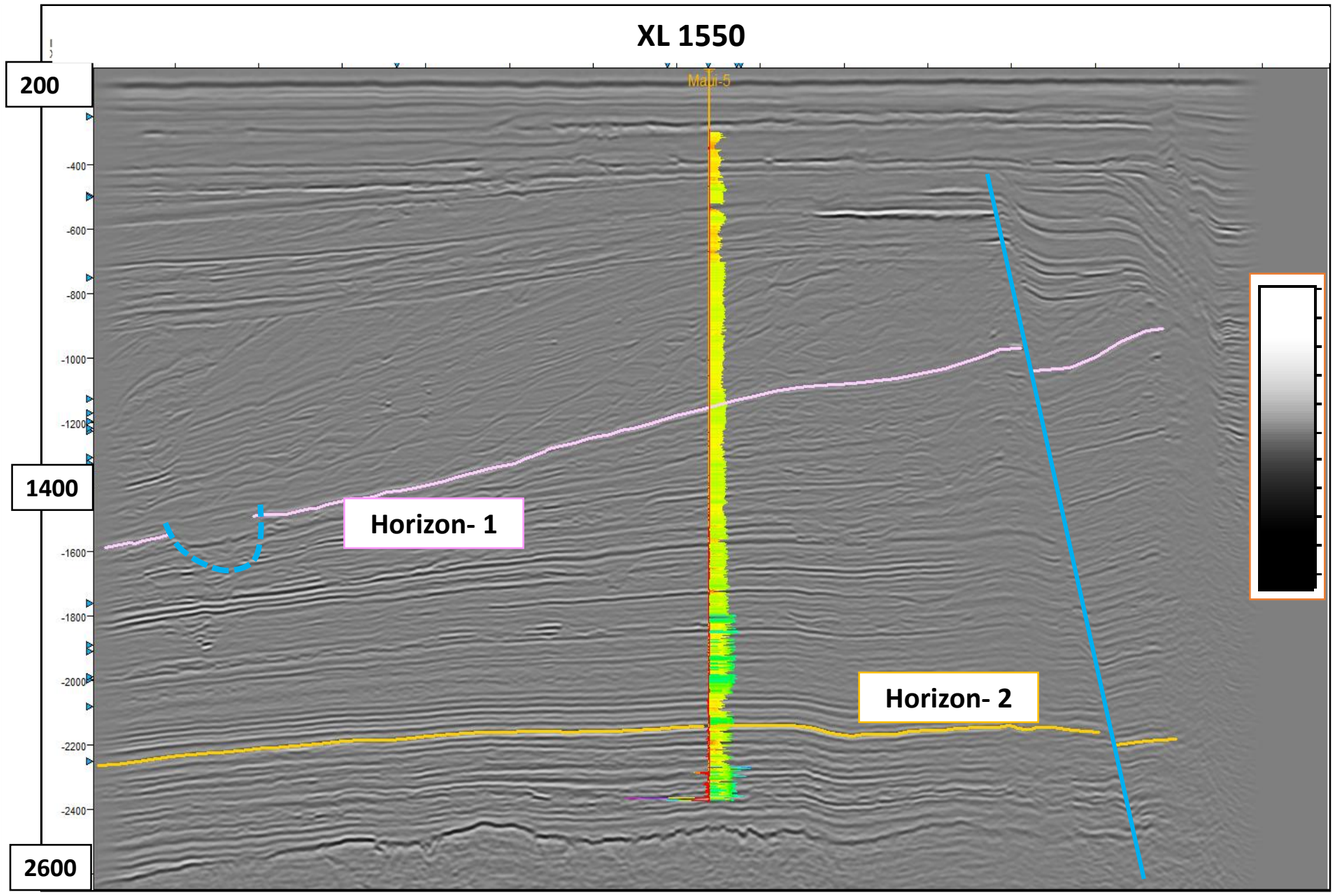
Original Seismic Section ; Arbitrary Line

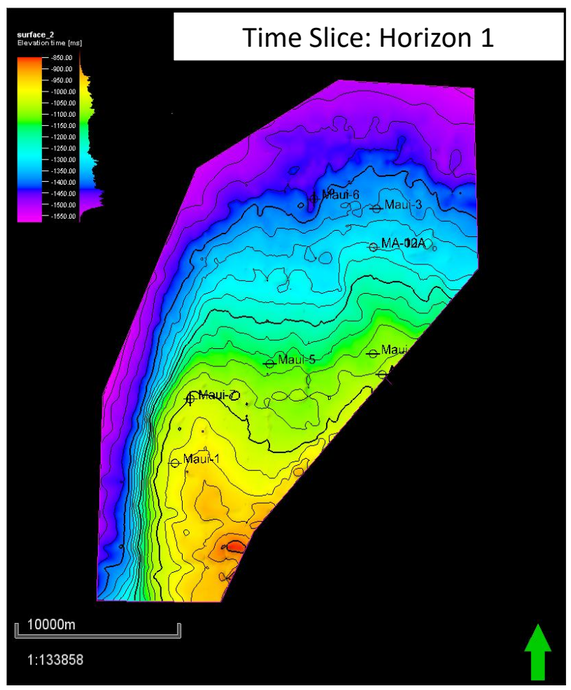


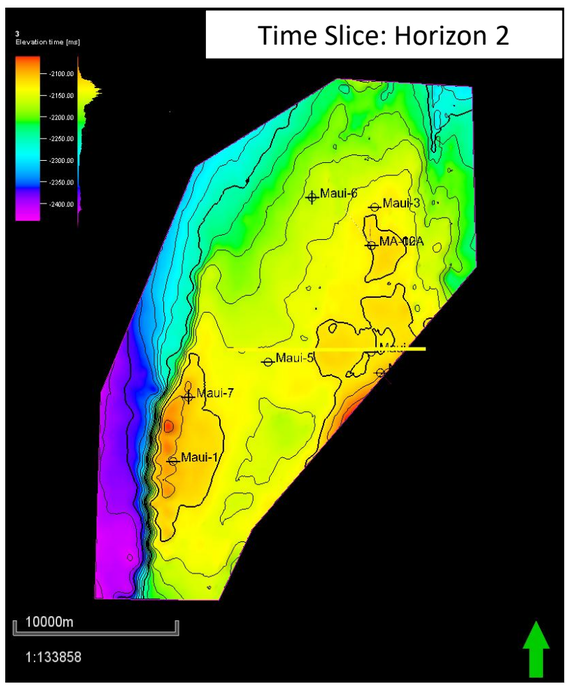


Horizon and Time Slice Map



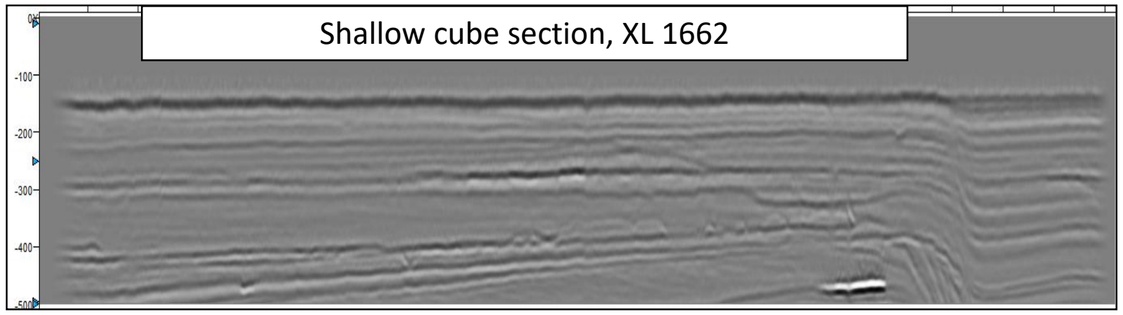


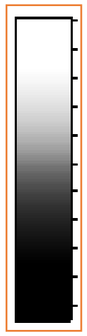




- Upper part of the data shows some high amplitude reflection and reflection package are relatively continuous.
- In middle part, highly discontinuous, low amplitude and mound shape reflection package.
- Lower reflections package show the relatively continuous and.

Cropped Volume

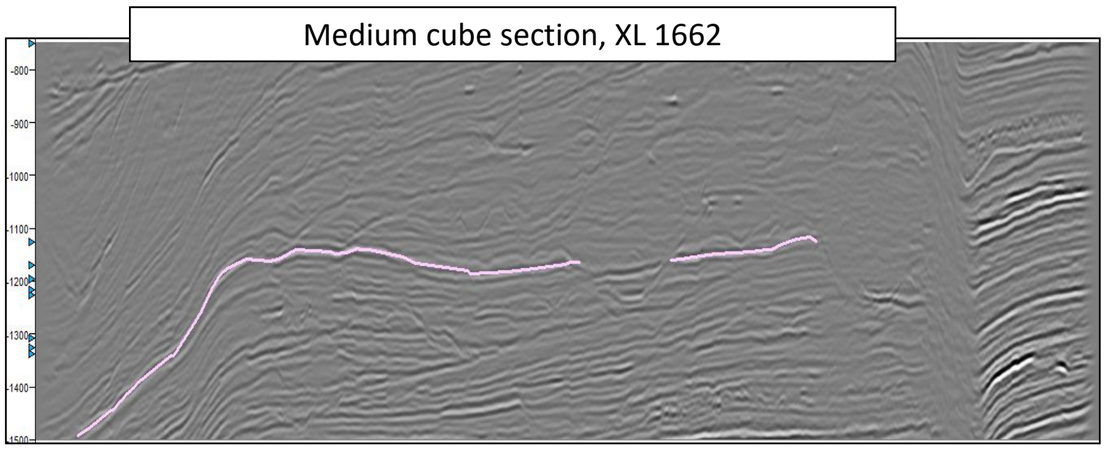


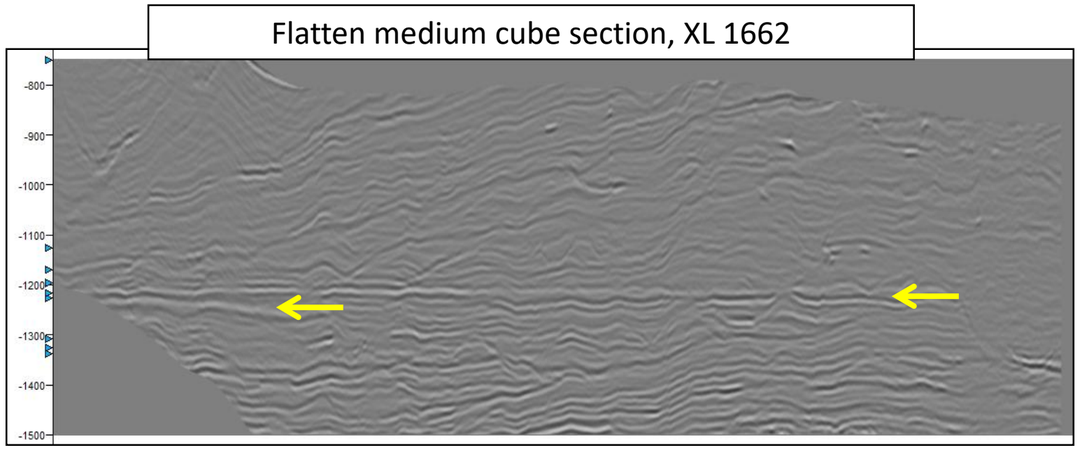


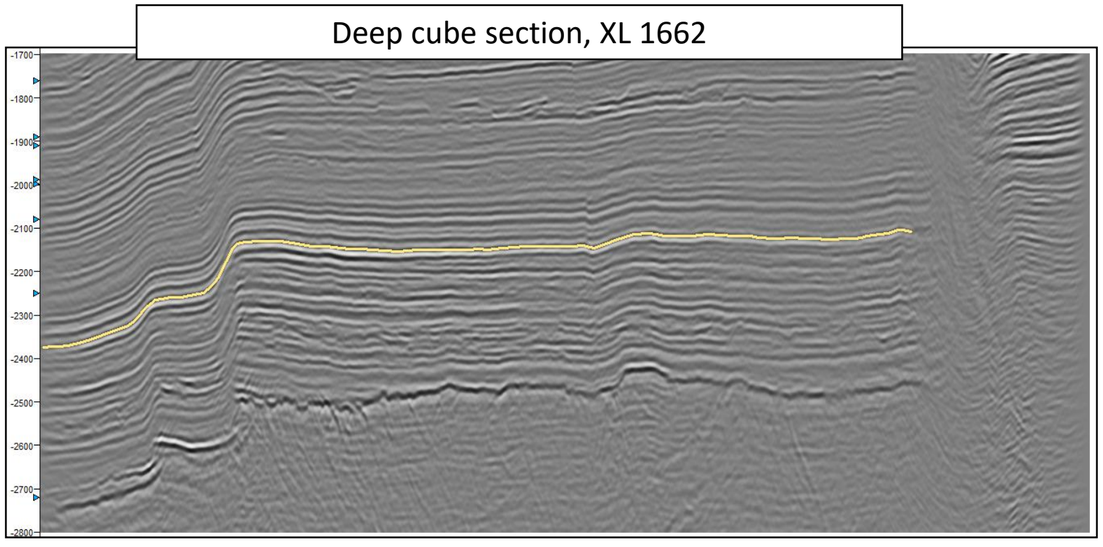
3 Cropped cube:

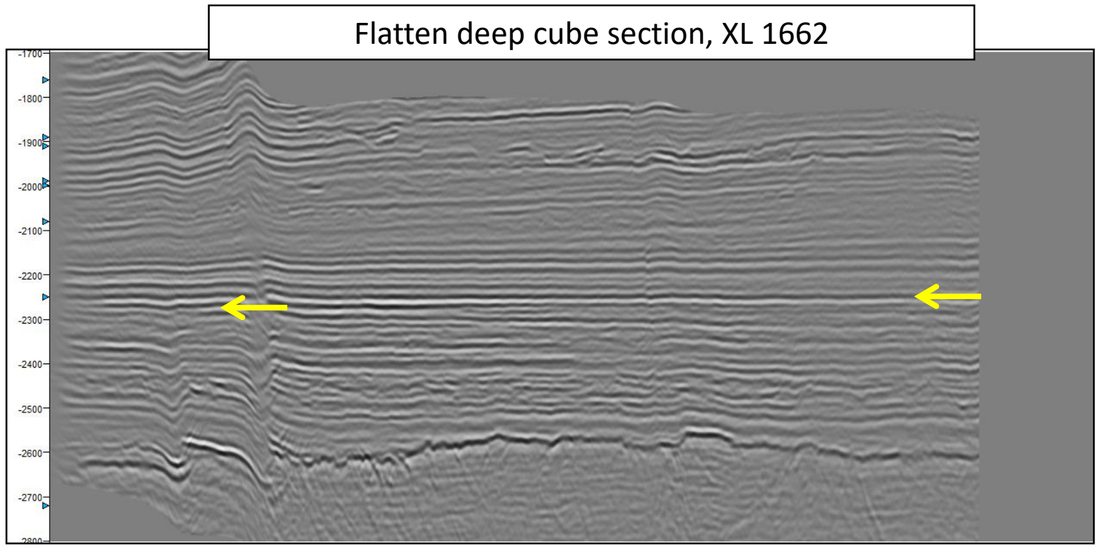
- Shallow: 0-500 ms
- Medium: 750-1500 ms
- Deep: 1700-2800 ms

Horizon 1 surface use as reference surface for flattening the medium cube and Horizon 2 for Fattening the deep cube.









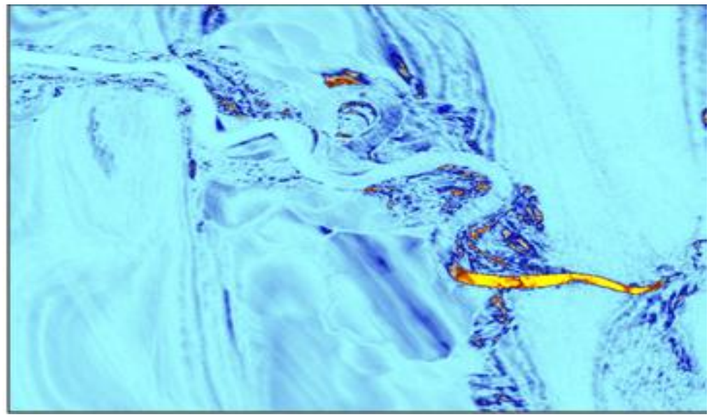
Different Attributes

(a) Sweetness:

Sweetness is the implementation of two combined attributes (Envelope and Instantaneous Frequency) and is used for the identification of features where the overall energy signatures change in the seismic data.

Sweetness is a seismic can be very effective for channel detection. It also useful for detect isolated sand body.

(a)

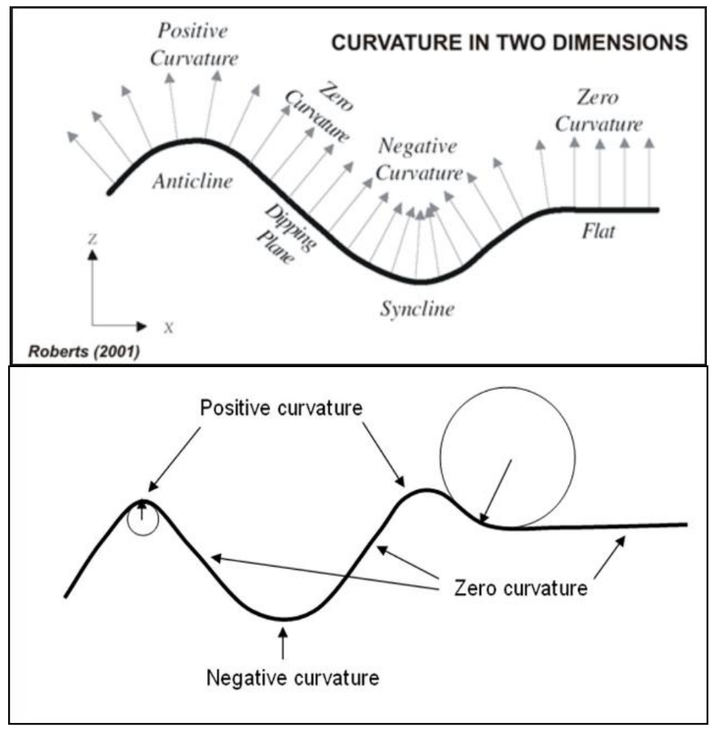


(b) Curvature:

Curvature is a two-dimensional property of a curve and describes how bent a curve is at a particular point on the curve.

3D curvature can be used to bring out stratigraphic features in sedimentary environments, karst features or structural discontinuities.

(b)

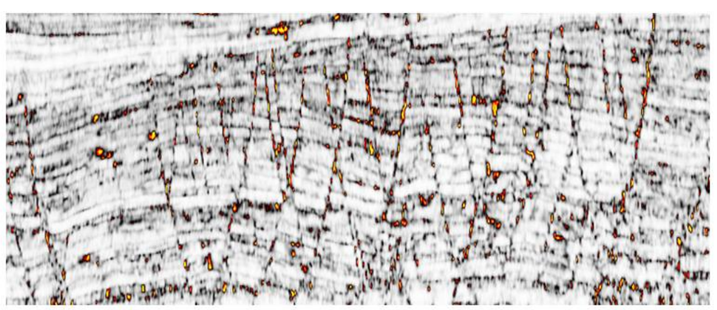


(C) Variance (Edge Method):

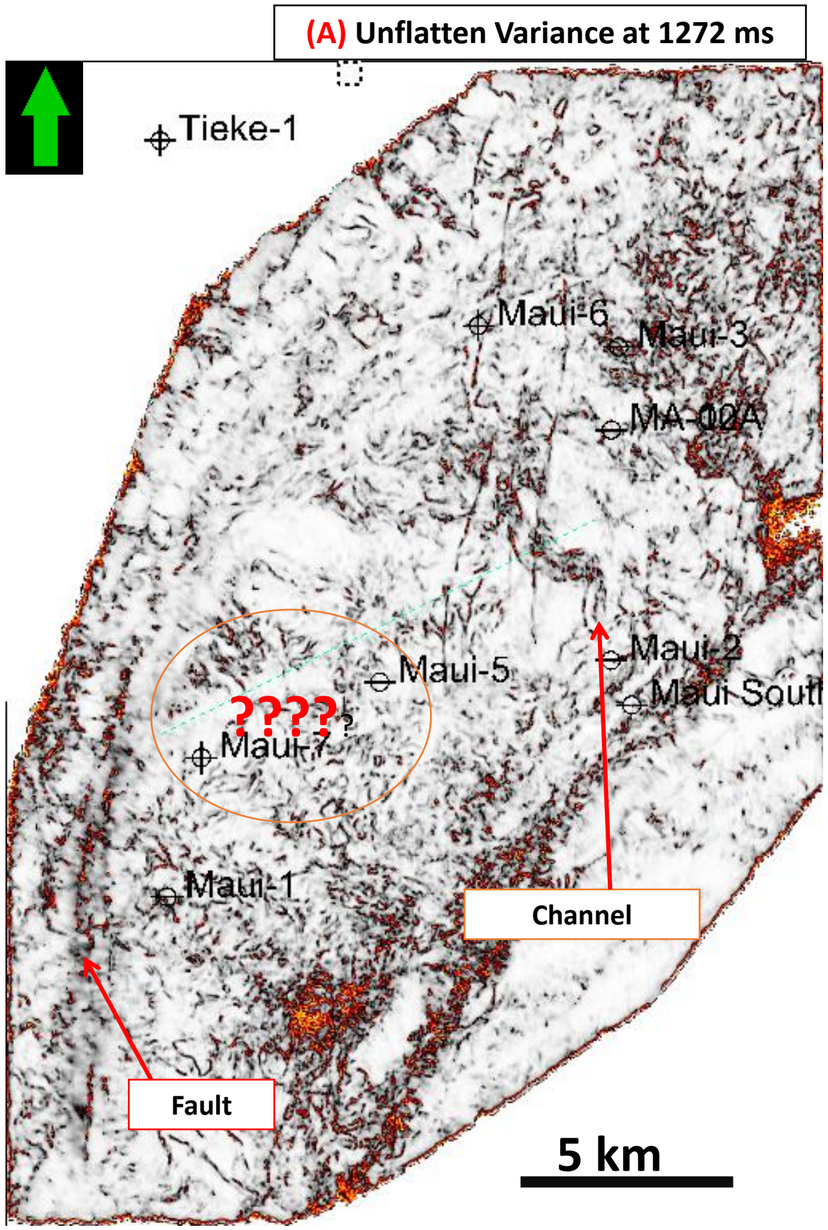
The estimation of local variance in the signal. By edge, this means discontinuities in the horizontal continuity of amplitude.

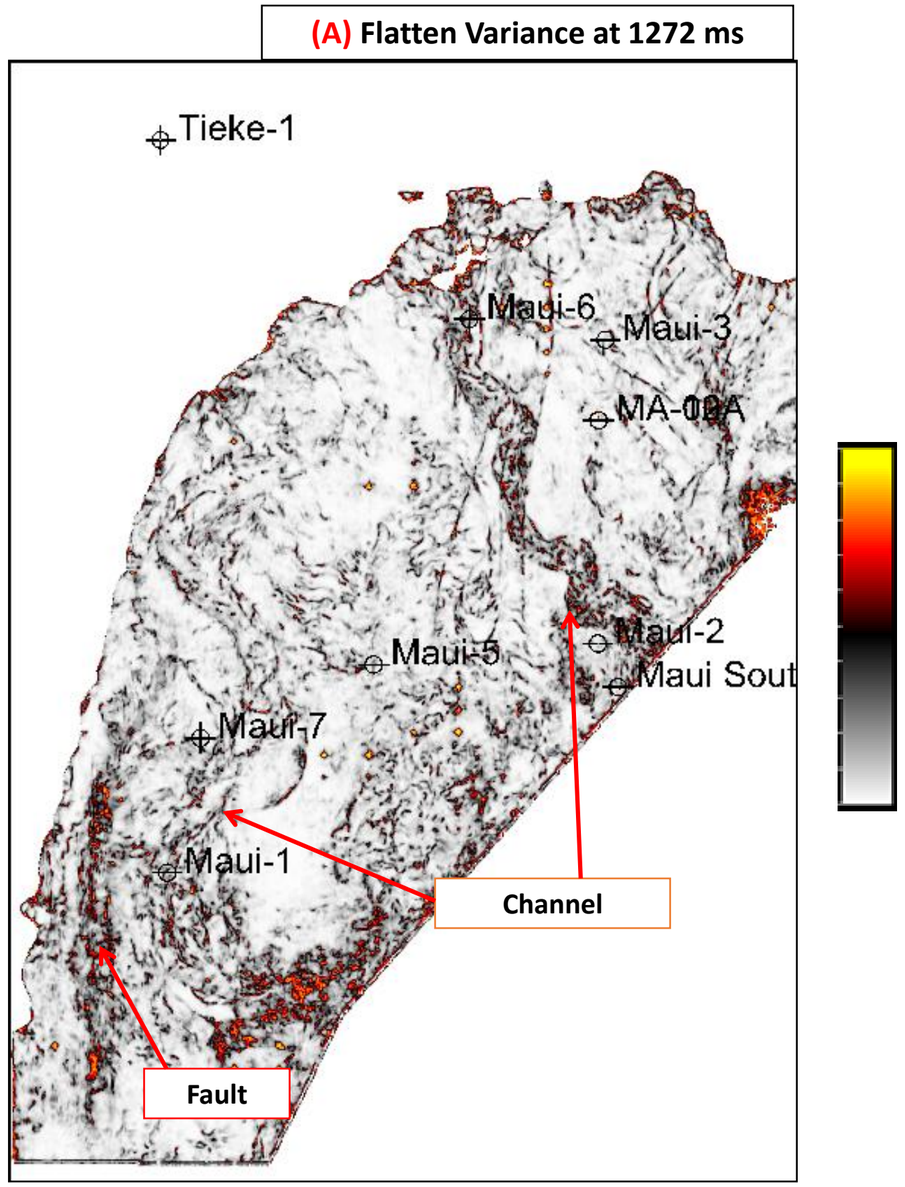
Variance is applicable as a stratigraphic attribute. Short window and dip guidance is better choice for stratigraphic features.

(c)



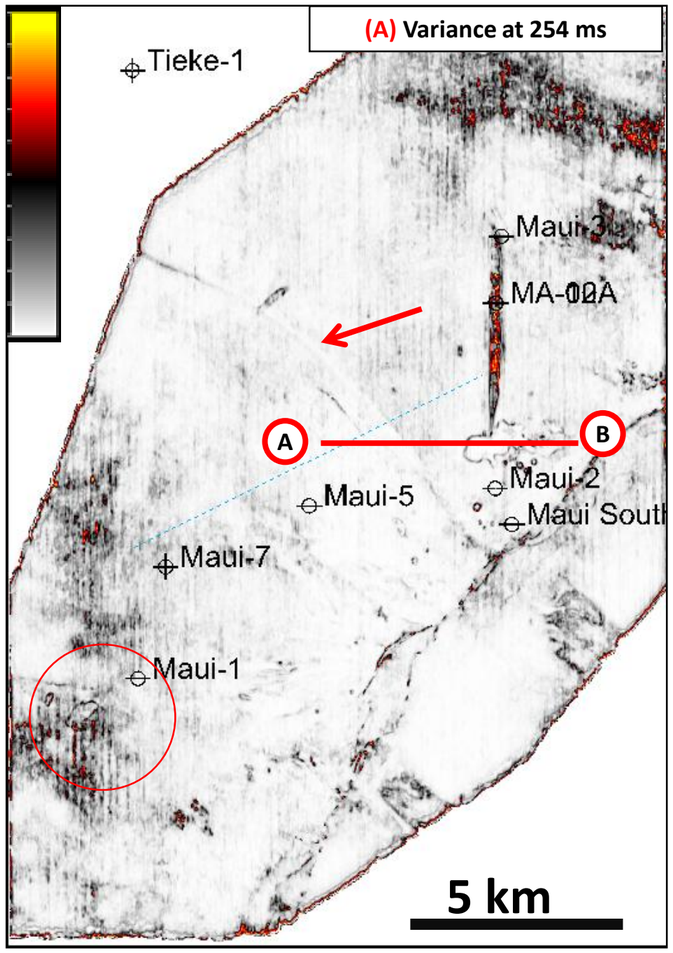
Why Flatten…???

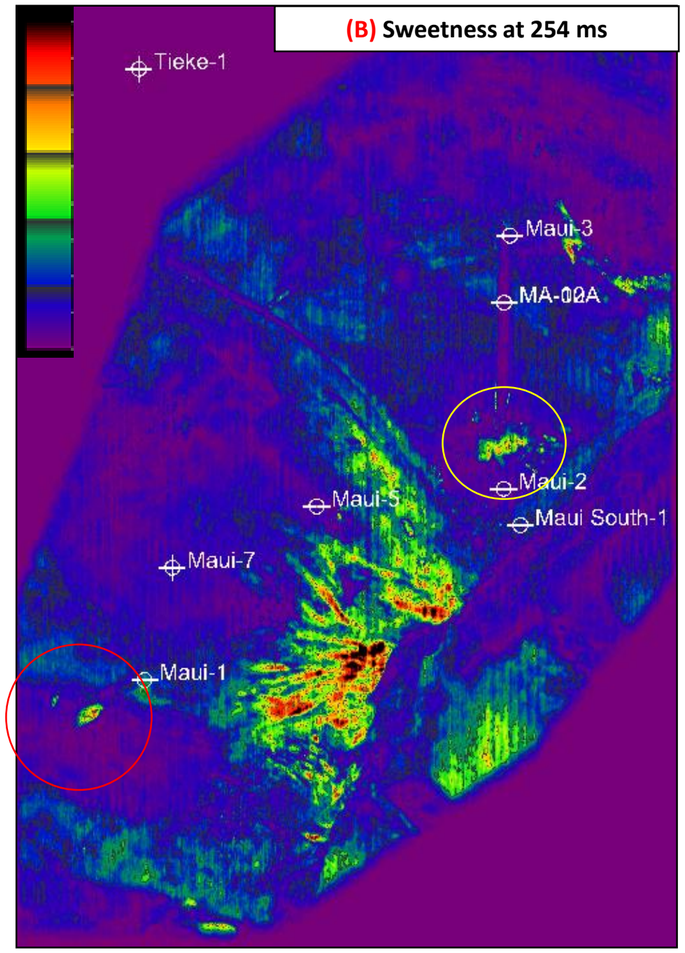


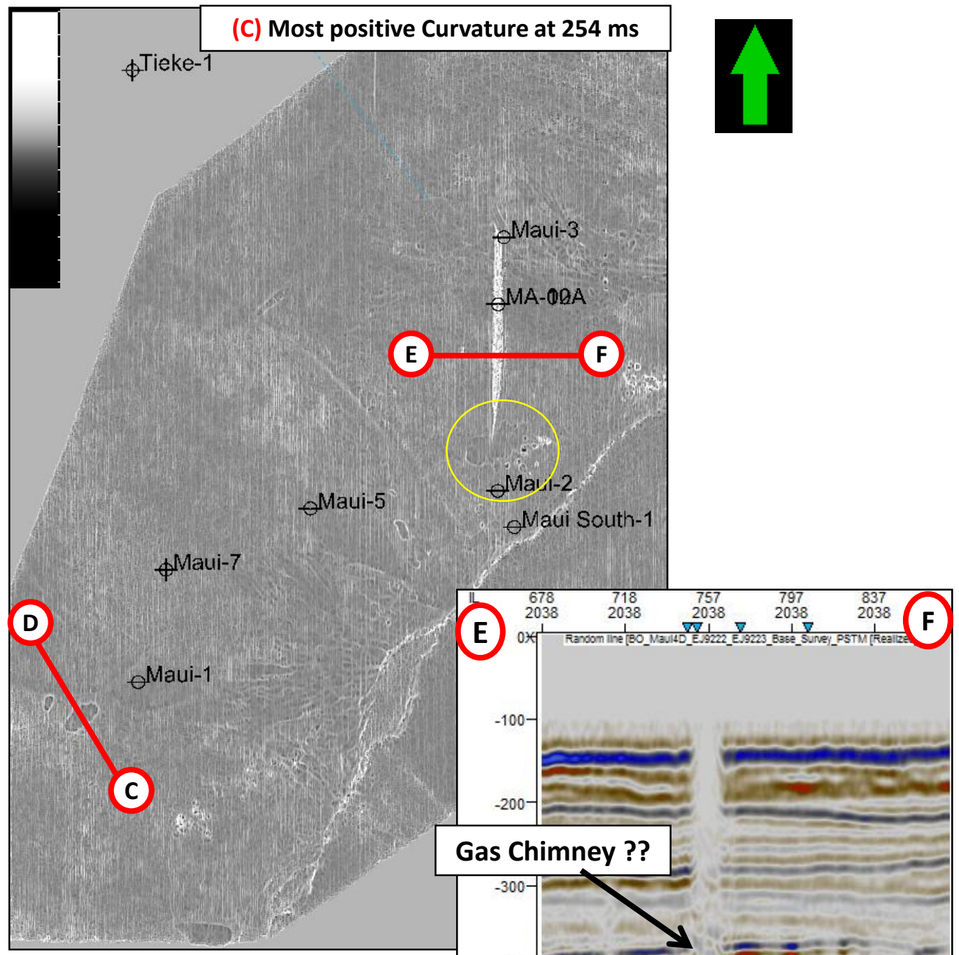


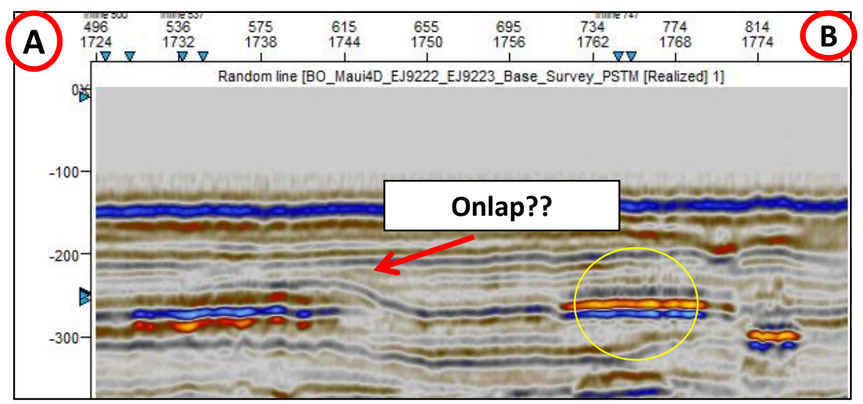
Variance on flatten cube, it is clearly observe the channel features and fault plane is well defined. Conversely, in unflatten volume has shown blur fault plane and a segment of one channel.

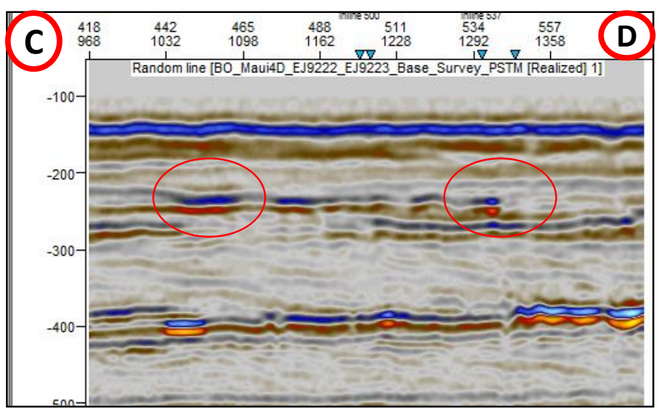
Attributes Shallow Cube (254 ms)

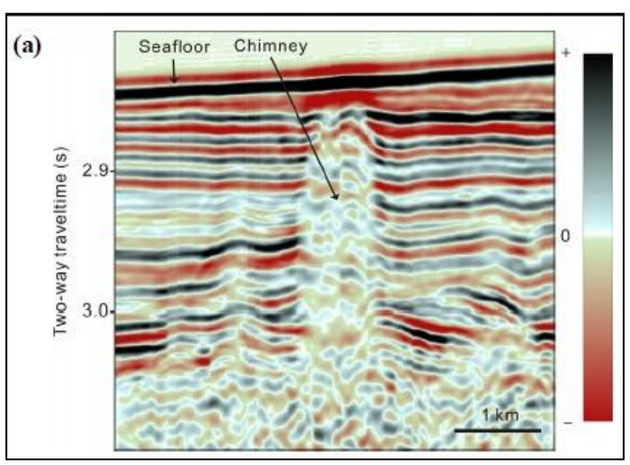








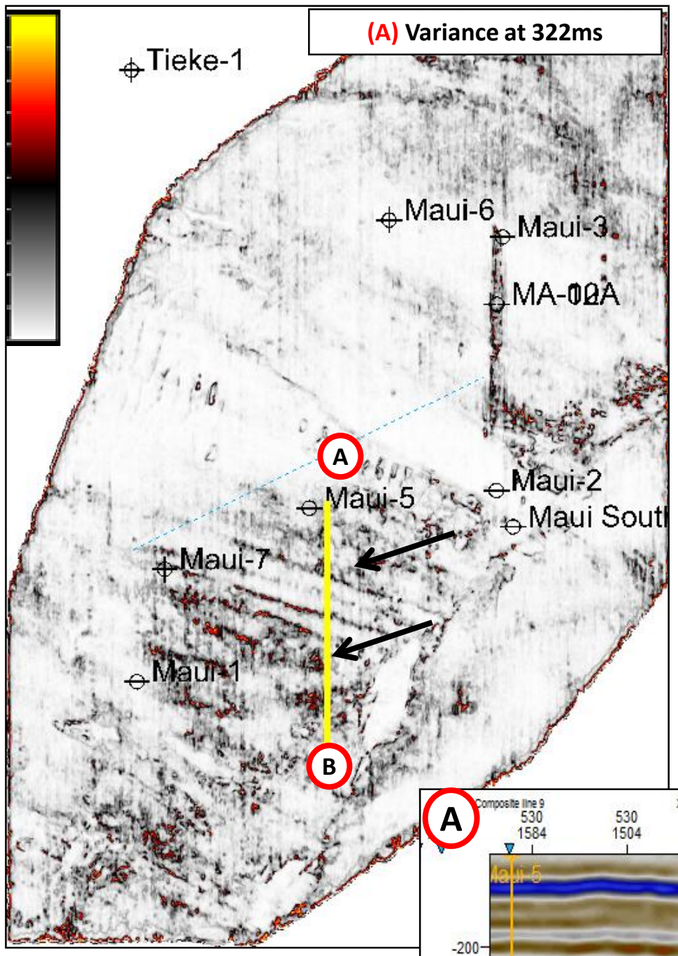


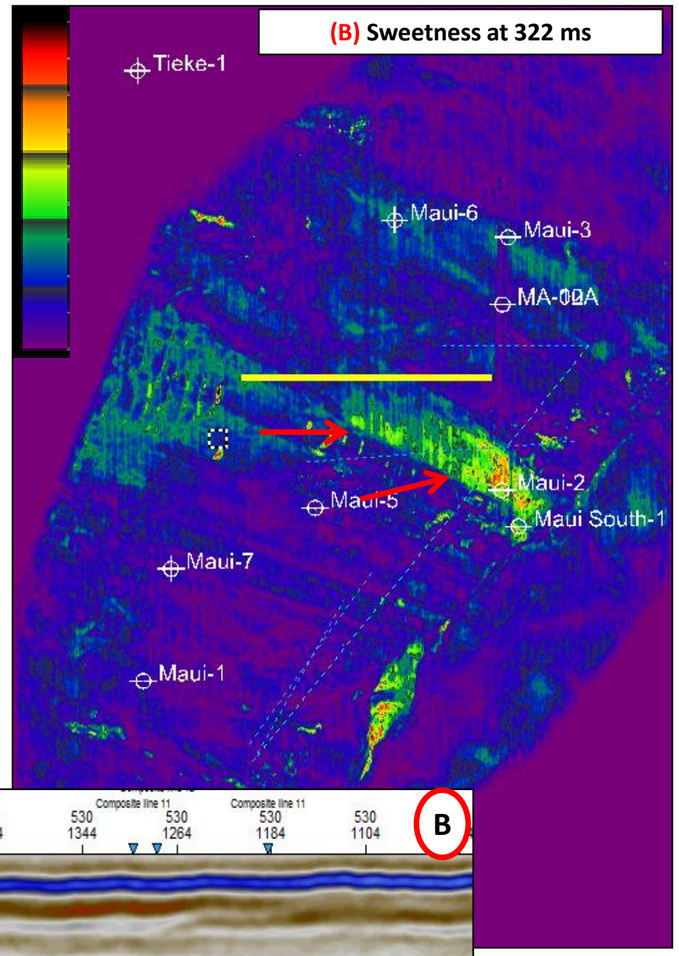


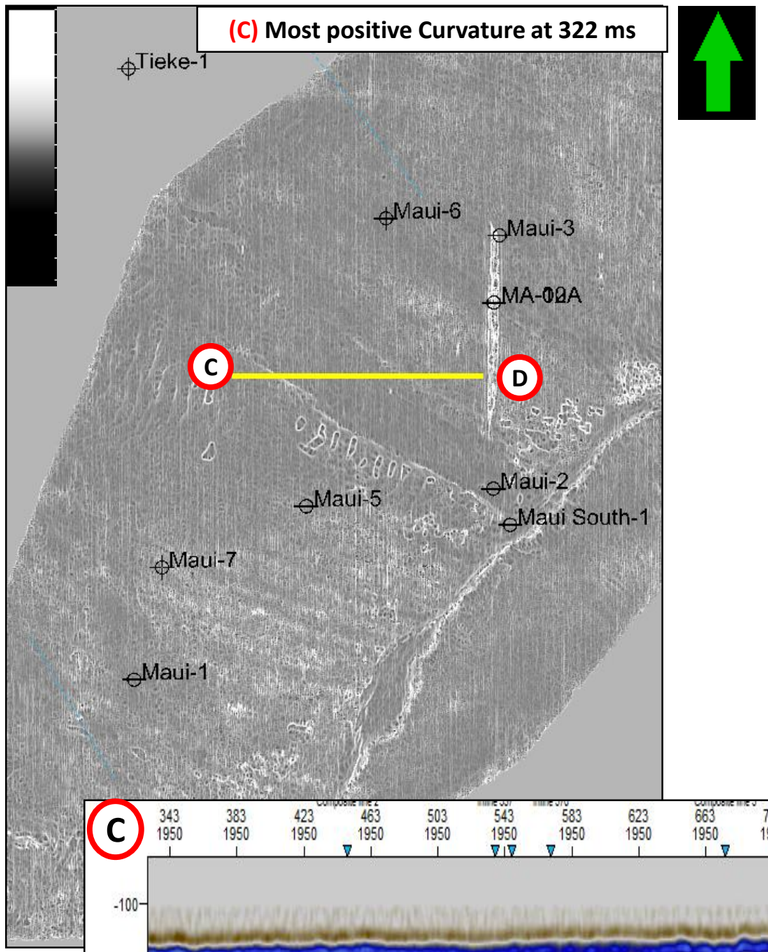
- The straight N-S may be response to pull up effect of shallow gas (gas chimney).
- High sweetness round features in time slice may be presence of shallow gas.
- Straight channel like feature can be related to onlap (truncation)??

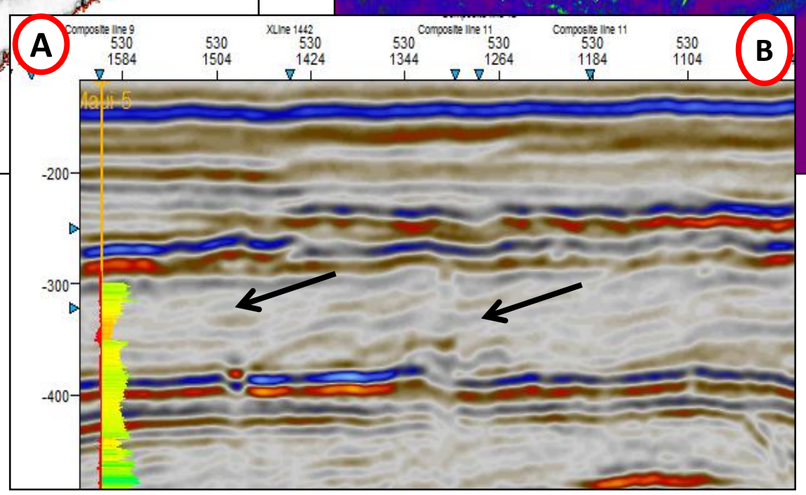
Hyo, K.D., 2013

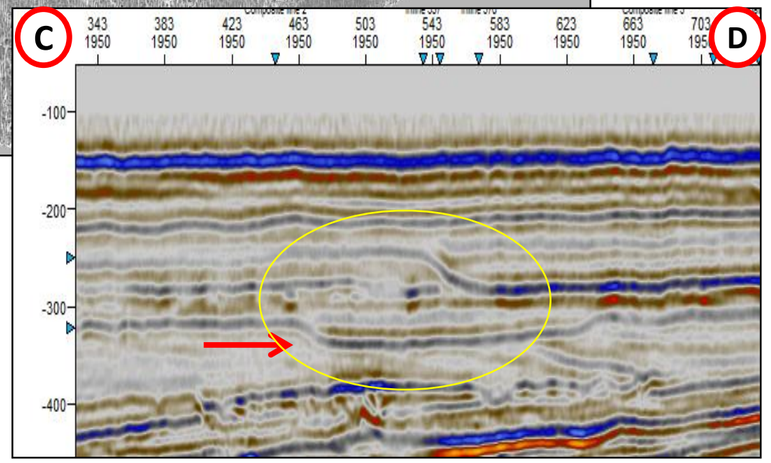
Attributes; Shallow Cube (322 ms)







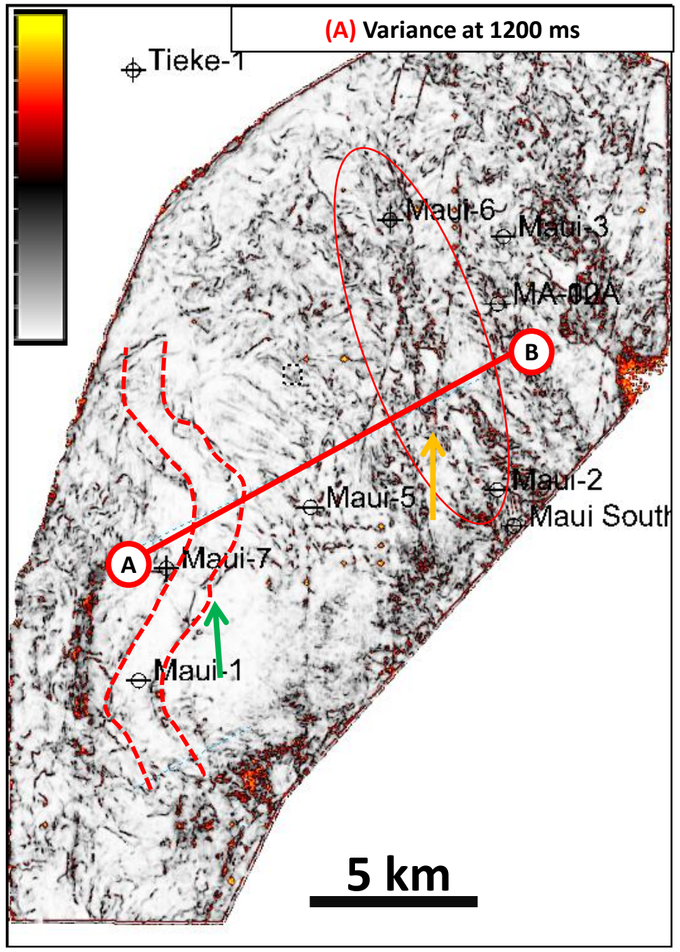


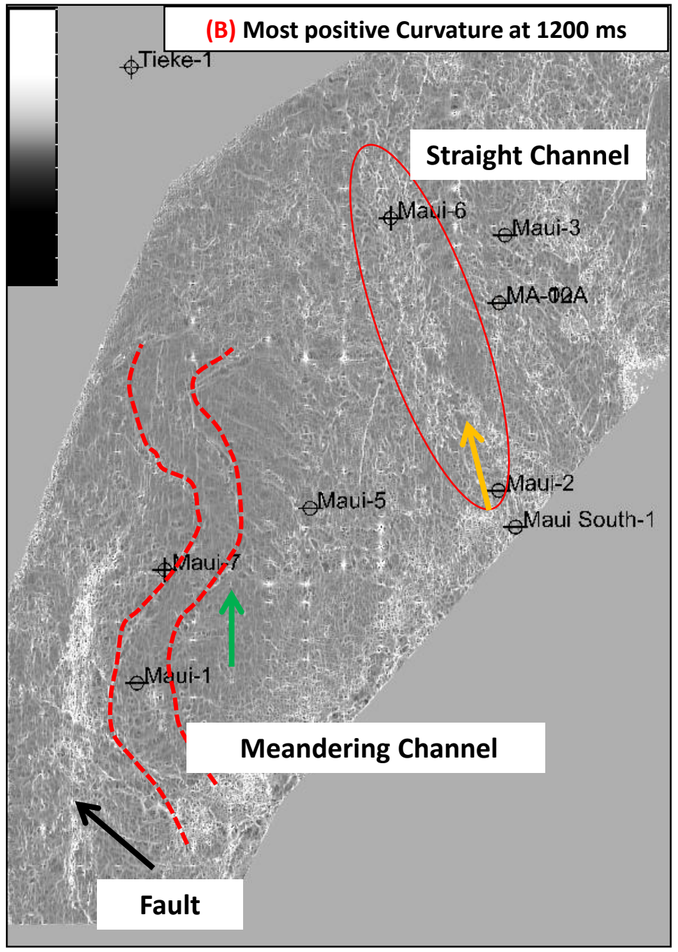


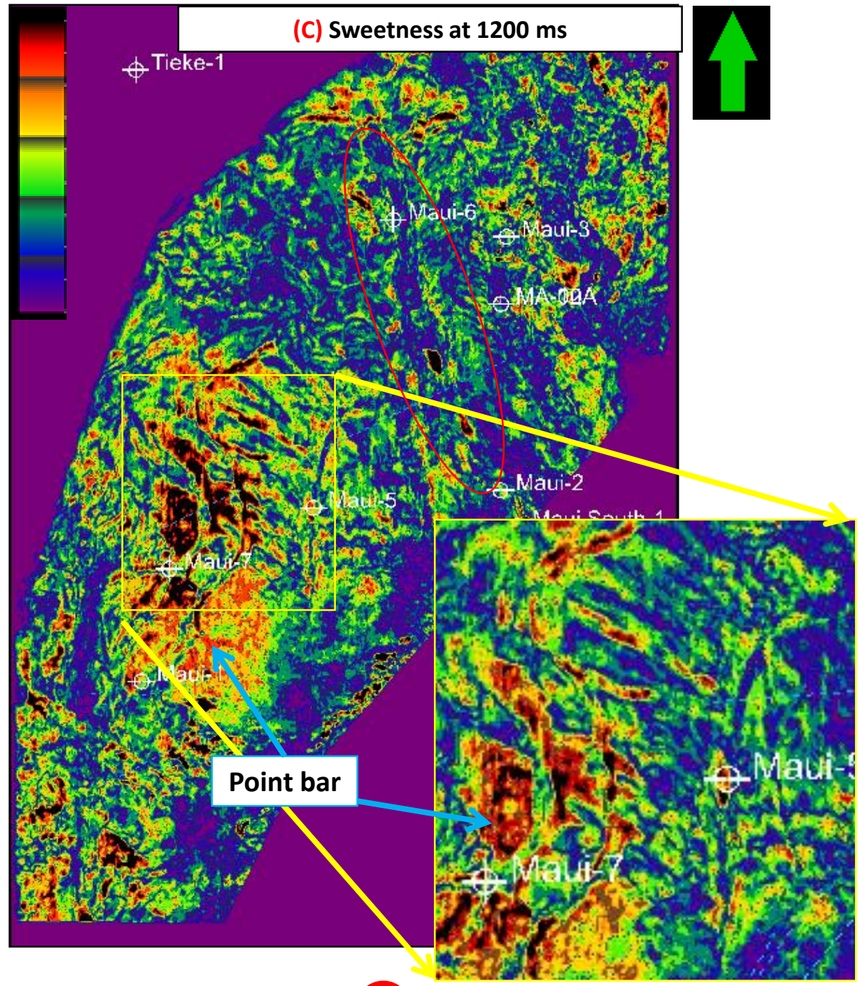
5 km

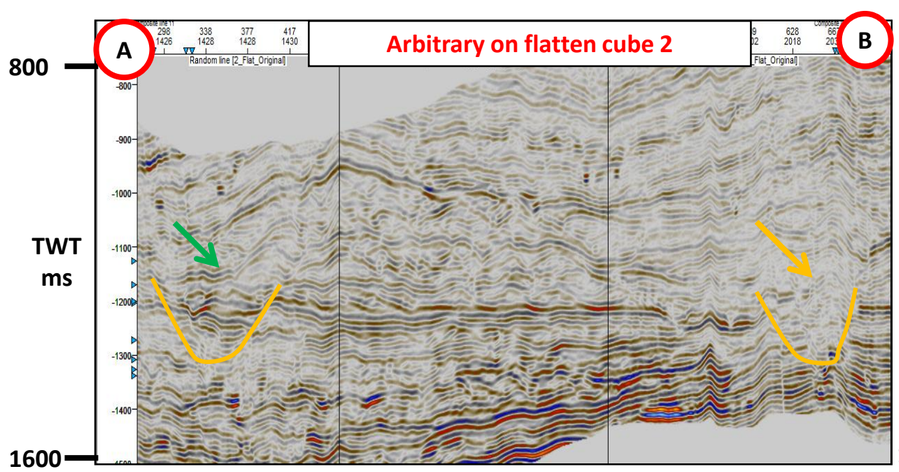
- In variance map marked section looks like stack of channel, it may be related to high discontinuous mounted reflection features.
- As mentioned previous slide, straight channel like feature may be related to onlap (truncation).

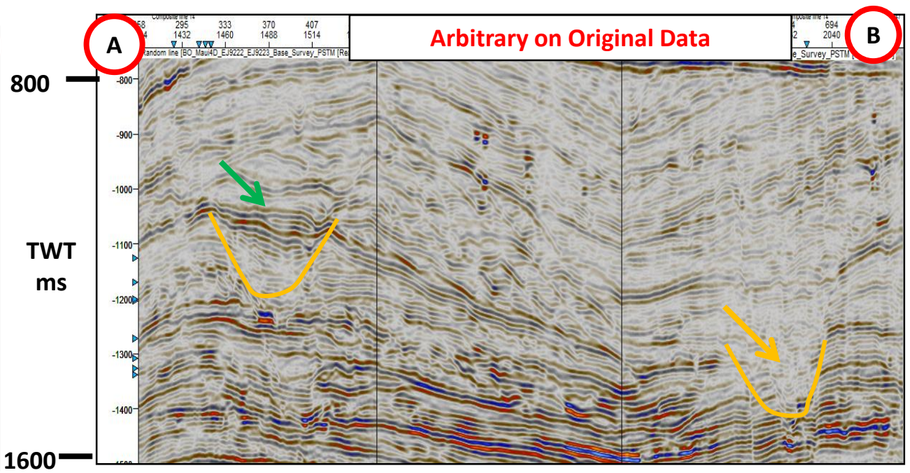
Attributes; Medium Cube (1200 ms)

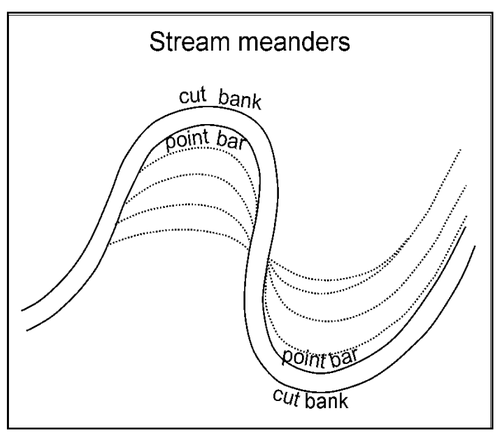






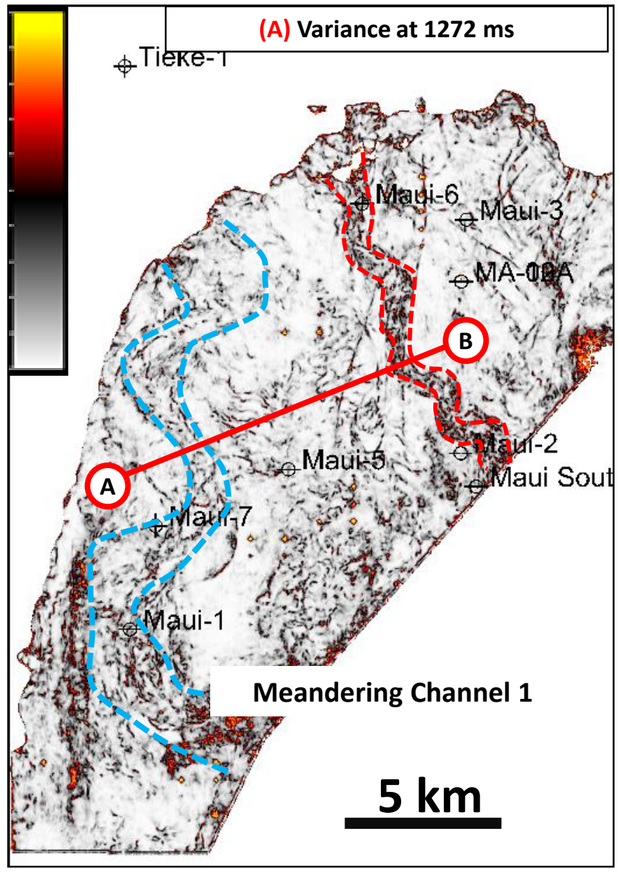


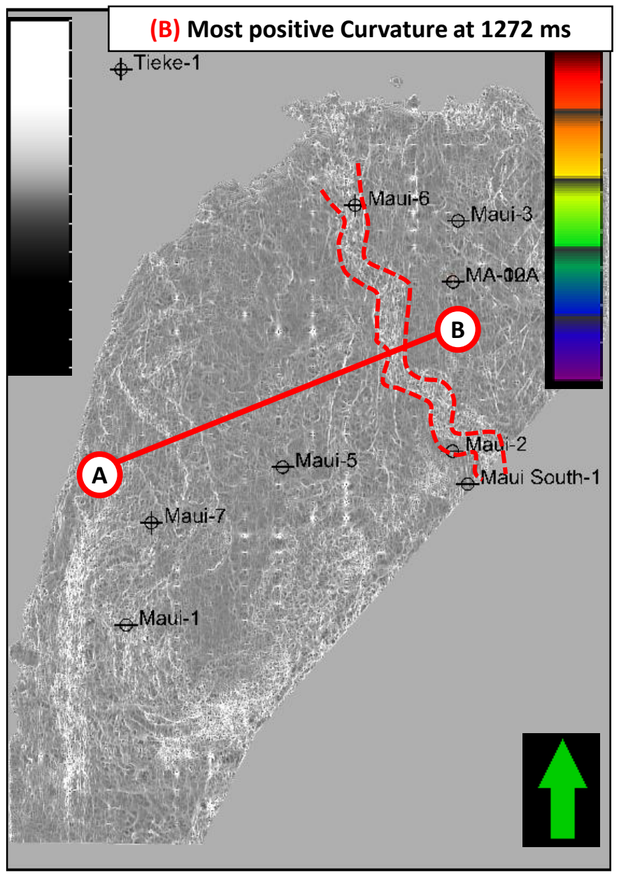


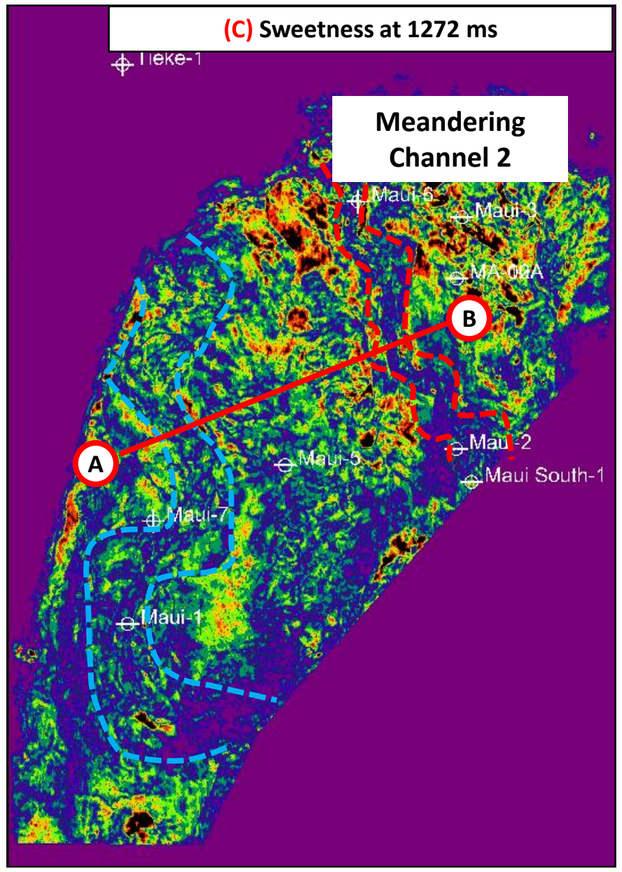


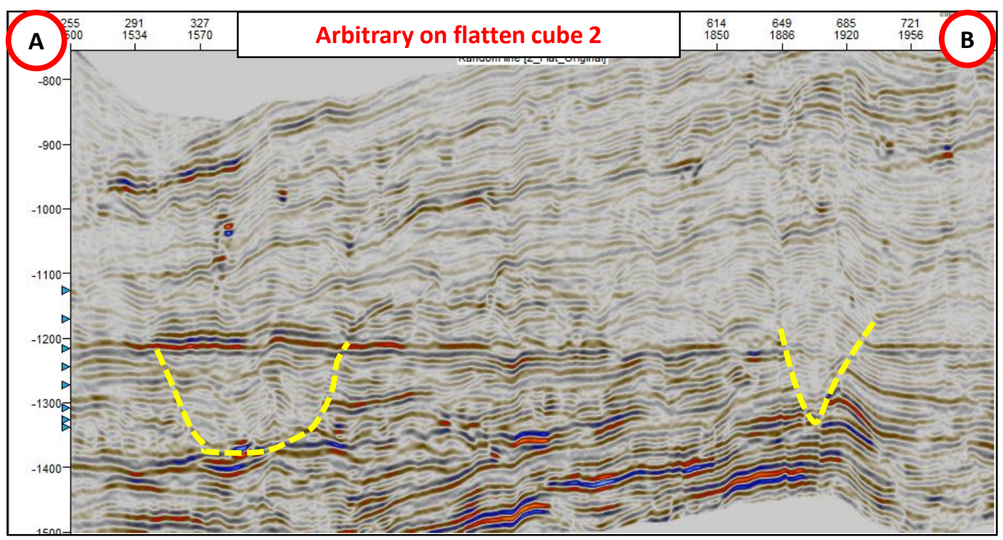
- Straight channel and fault are more clearly shown in shown in the curvature map.
- In sweetness map, straight channel has low sweetness. Conversely, meandering channel shows high sweetness that may be related to sand fill.

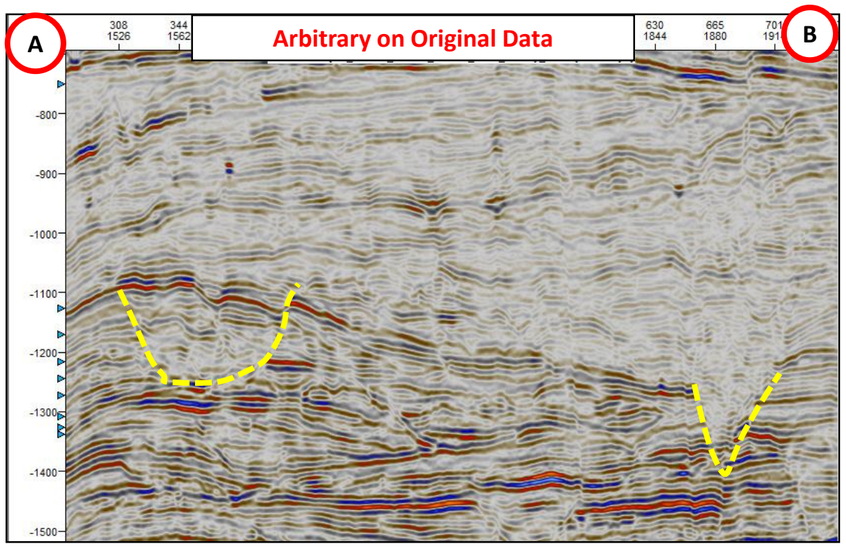
Attributes; Medium Cube (1272 ms)





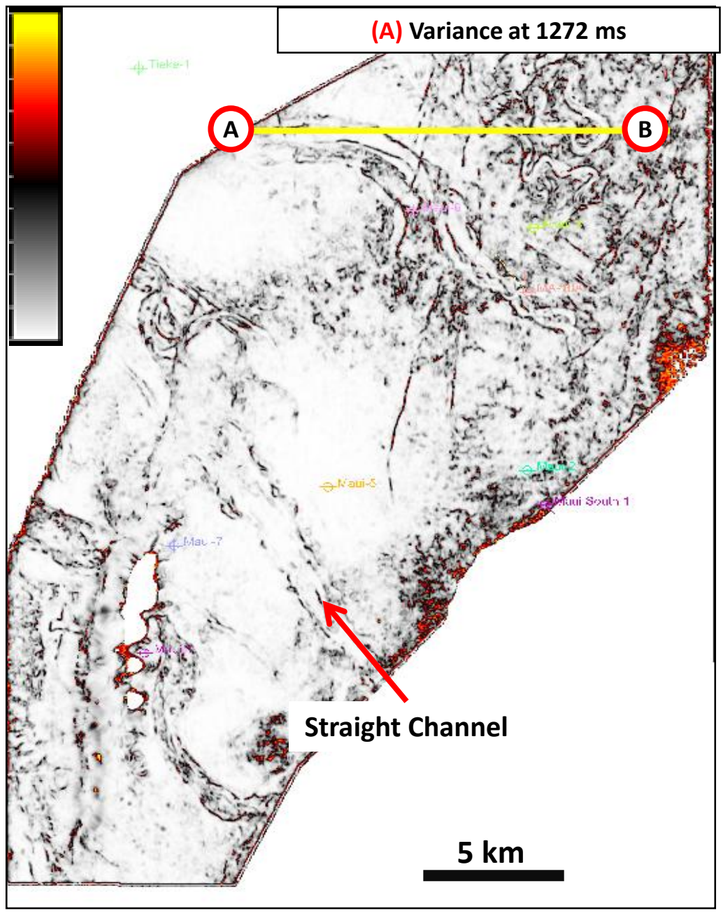


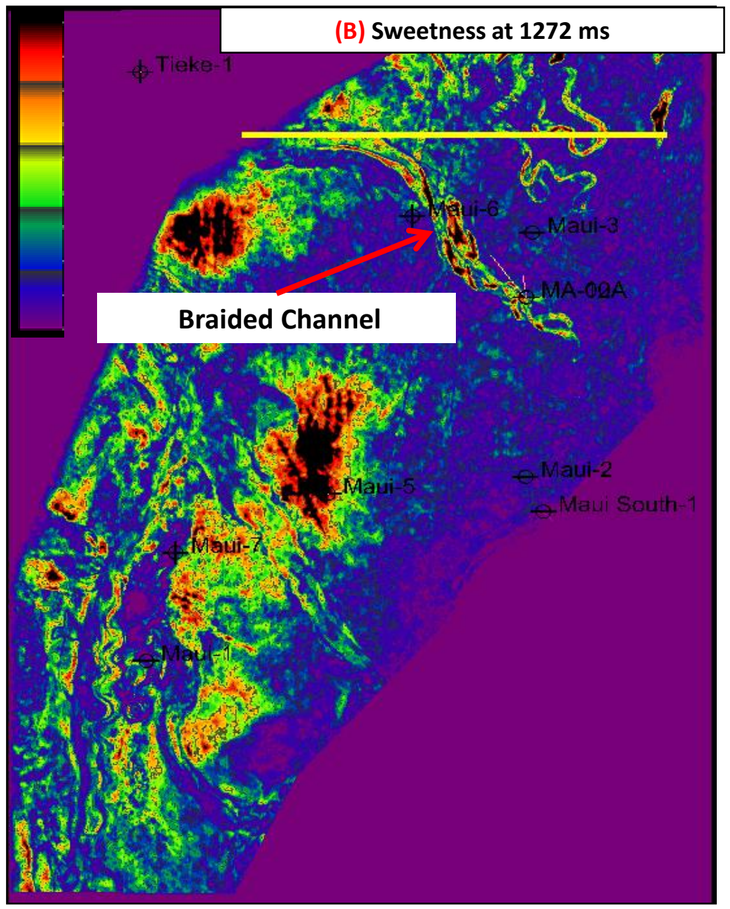


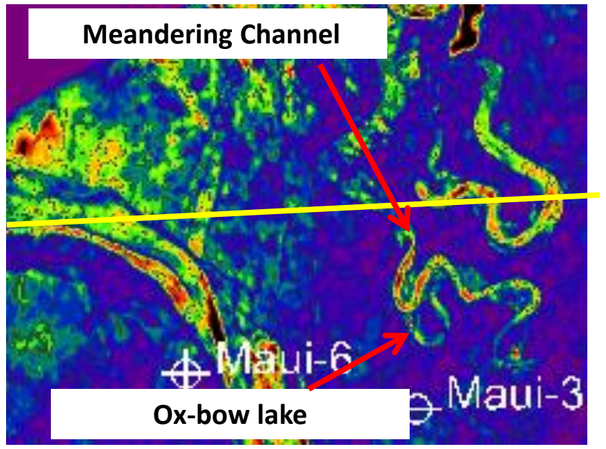


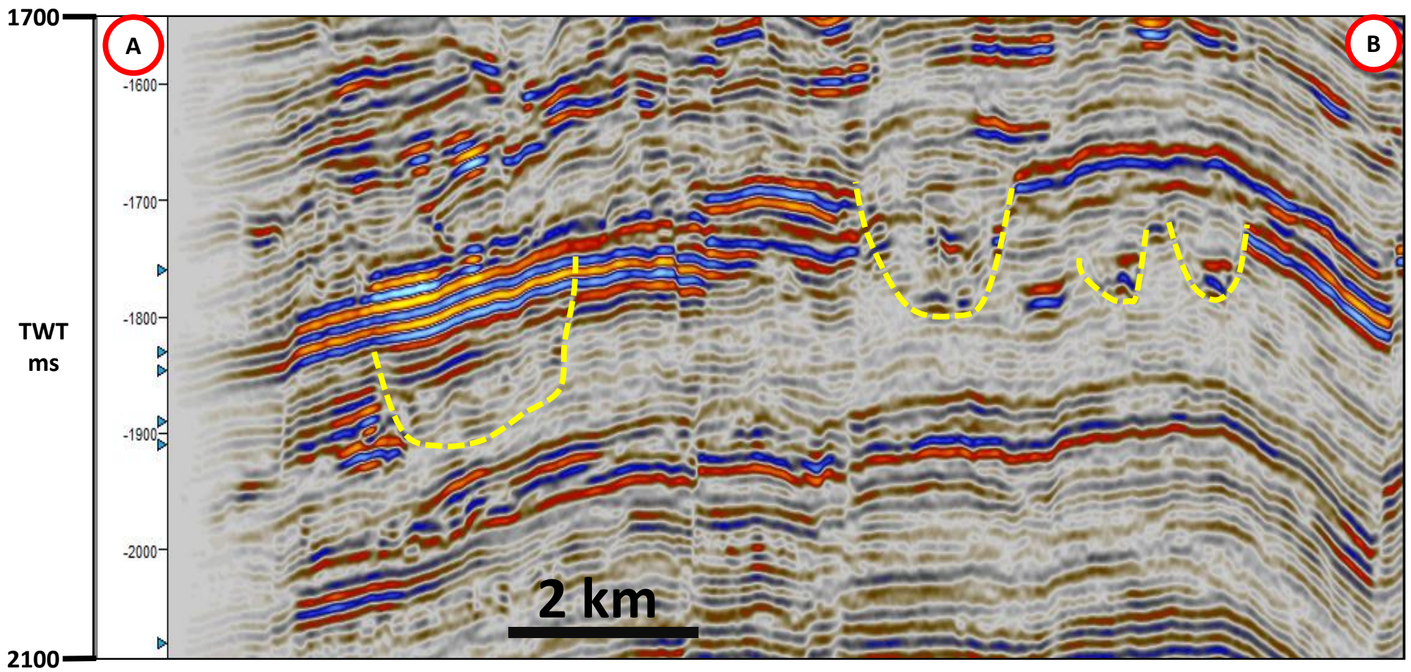
- Meandering channel 1 is not clearly defined on curvature map.
- On the other hand, meandering channel 2 boundaries are well defined in both variance and curvature attributes.
- Sweetness attribute has provided wider boundary than others.
- Straight channel with low sweetness may represents shale filled channel

Attributes; Deep Cube (1844 ms)

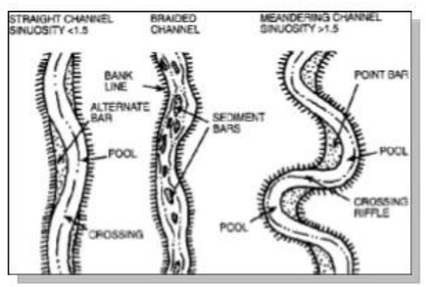




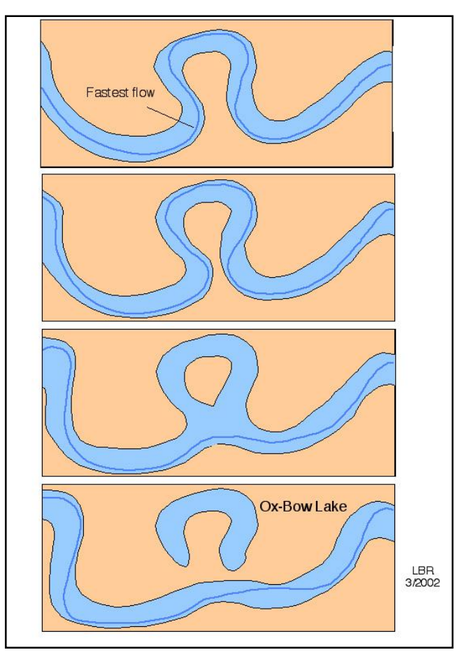




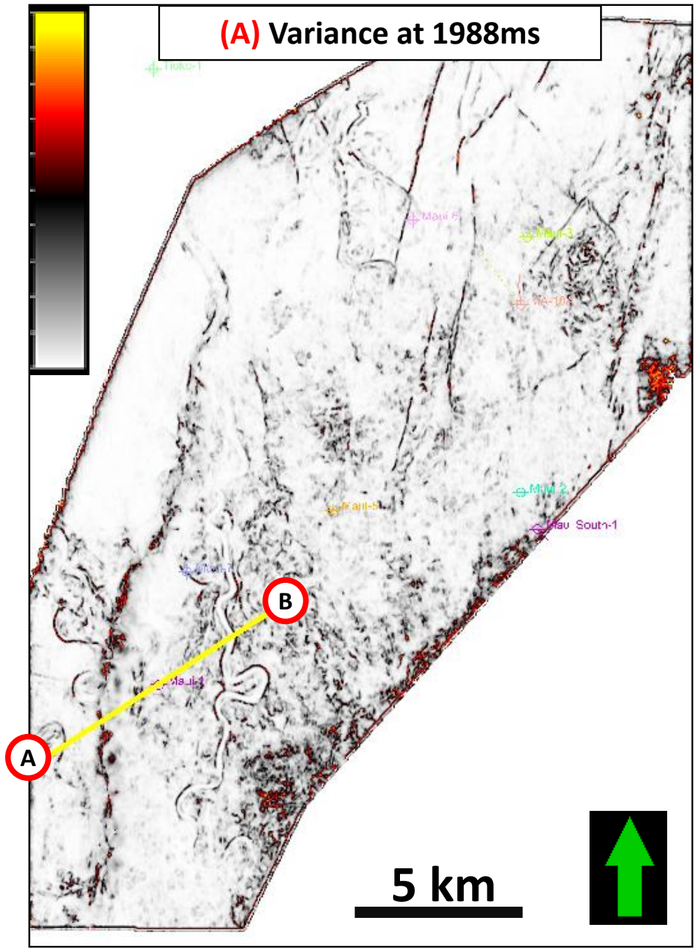
Channel types

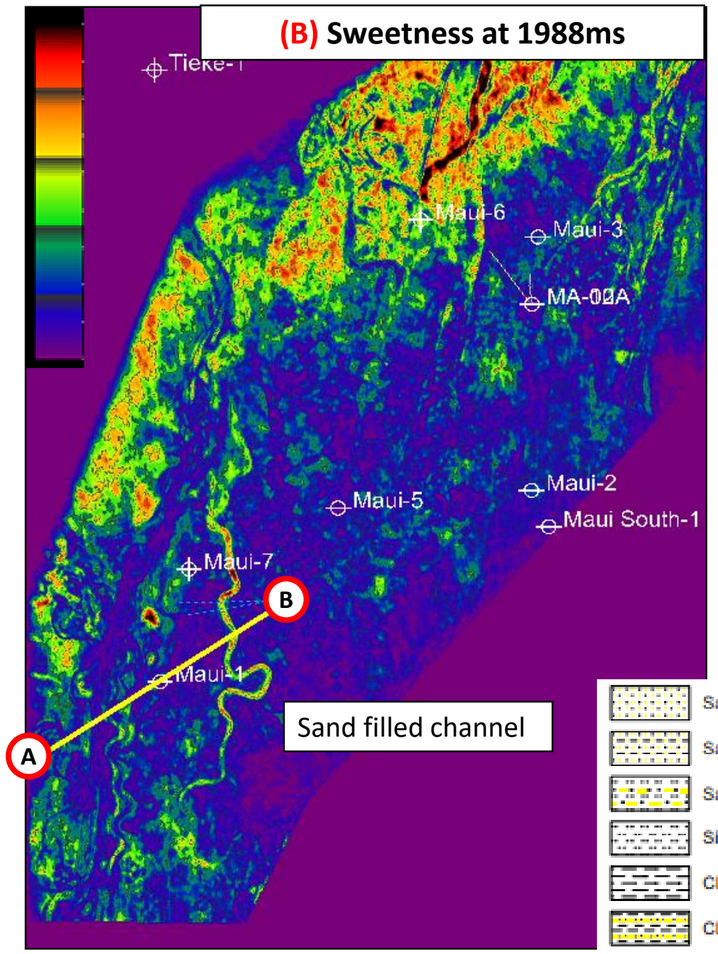


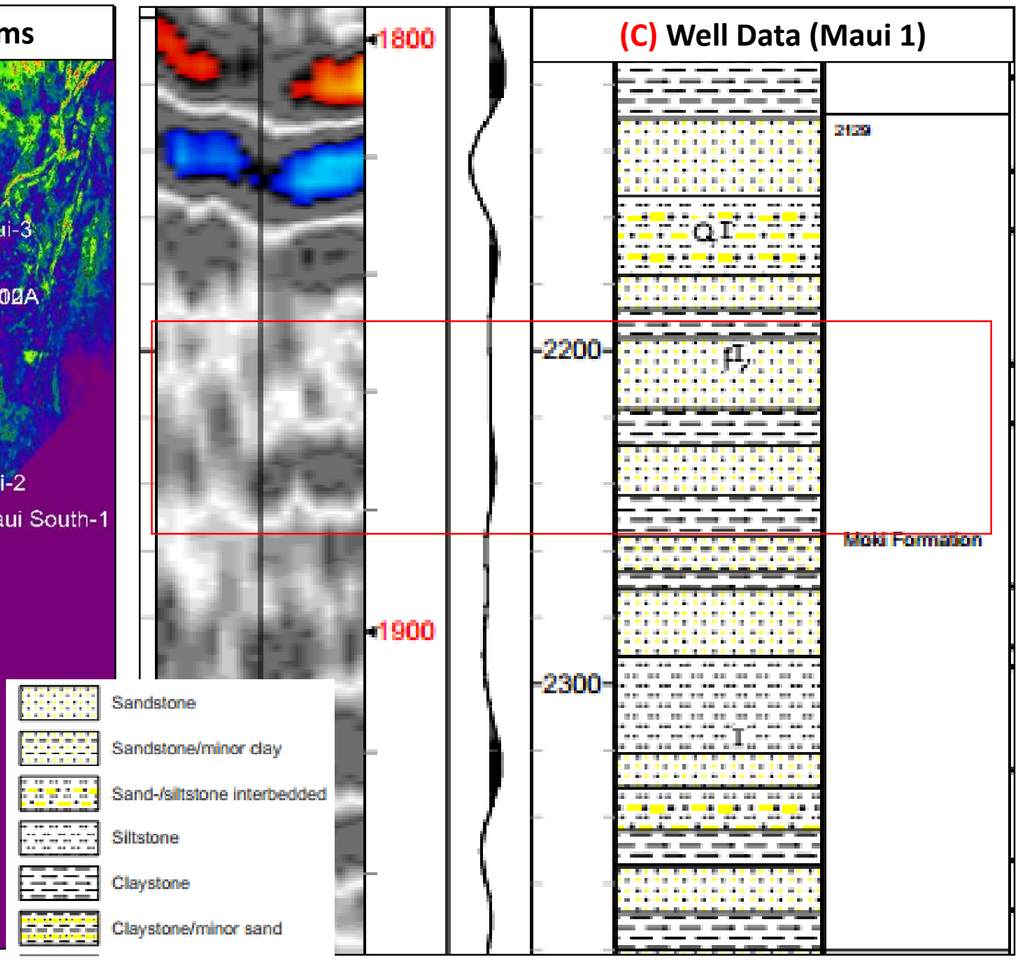
(a) Straight channel
(b) Braided channel
(c) Meander channel



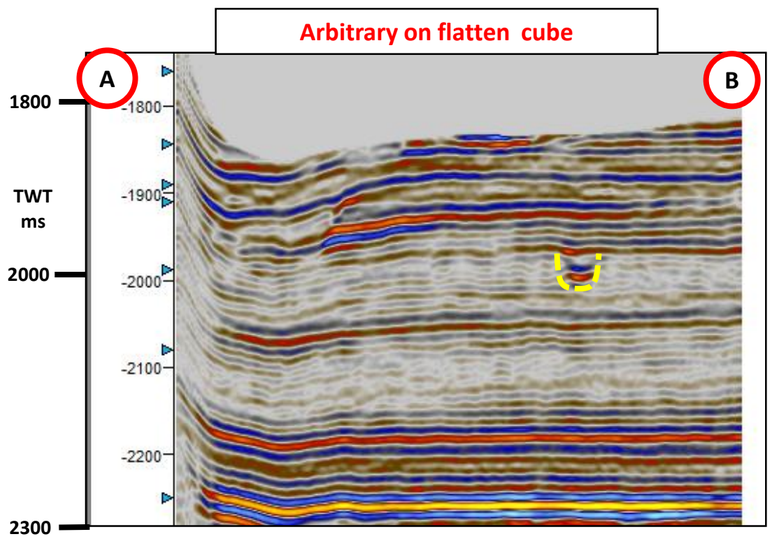
Attributes; Deep Cube (1988 ms)

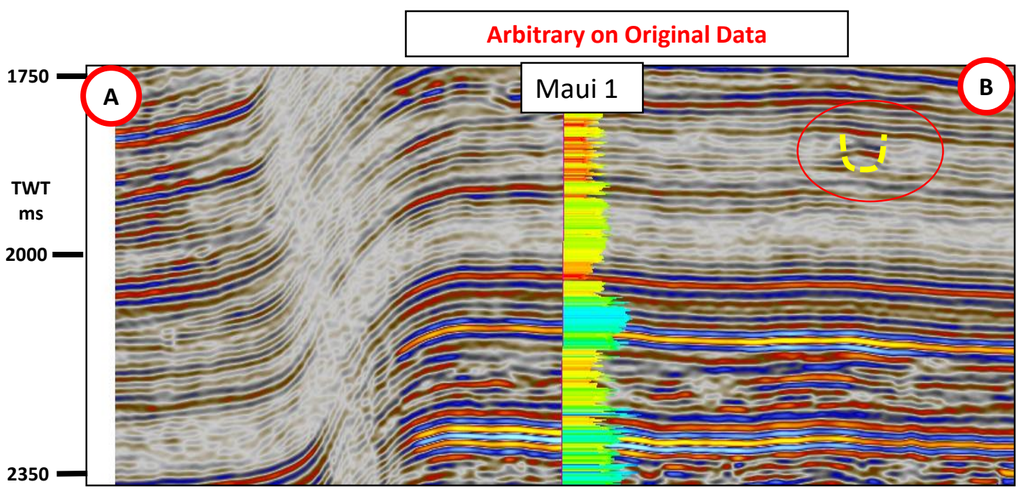






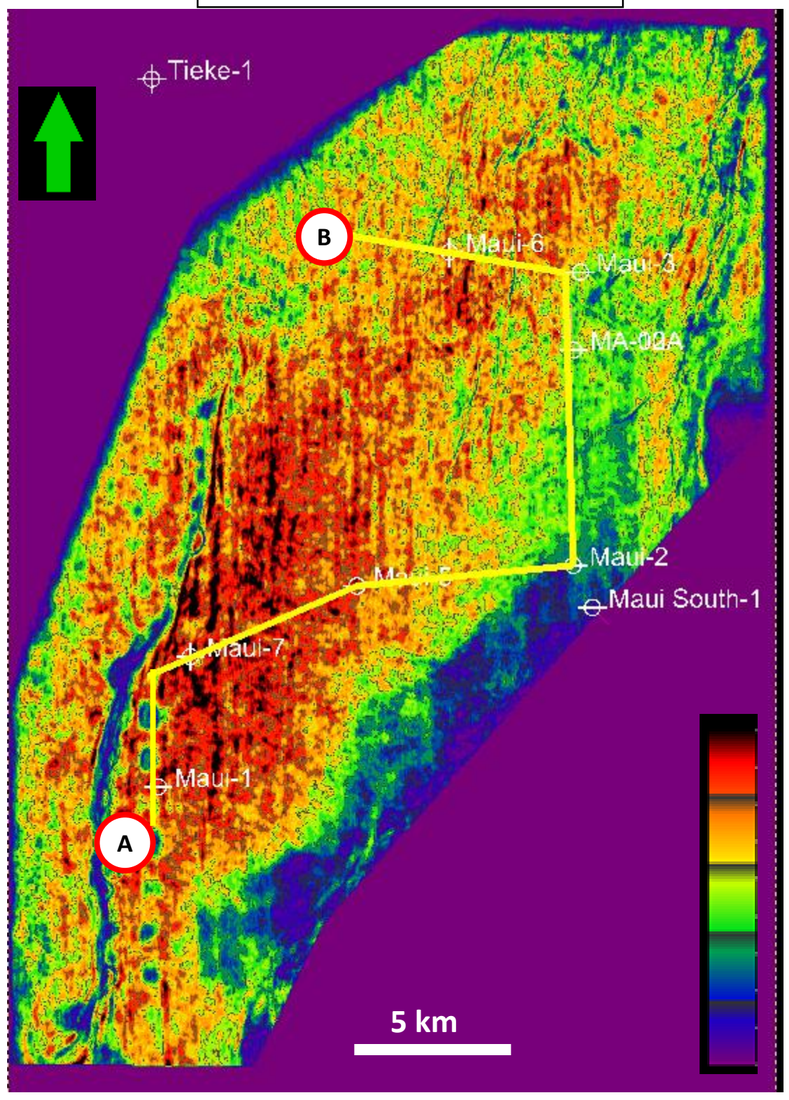
- Channel Shows the low sweetness which is response to the higher amplitude (marked by Red circle).
- at around 18000ms to 19000ms along the Maui 1 is Muki Formation (sand-shale altewration).
- So, channel cut with high amplitude at that level may represent filled by sand.



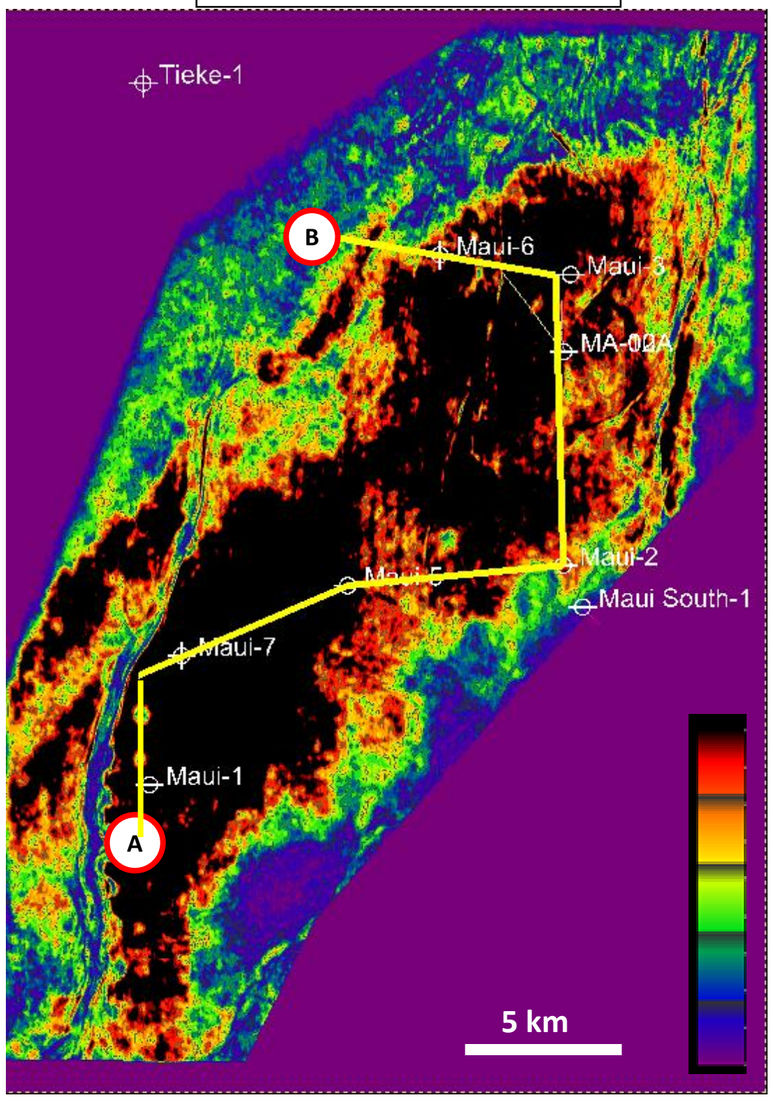


Gas Effect; Deep Cube

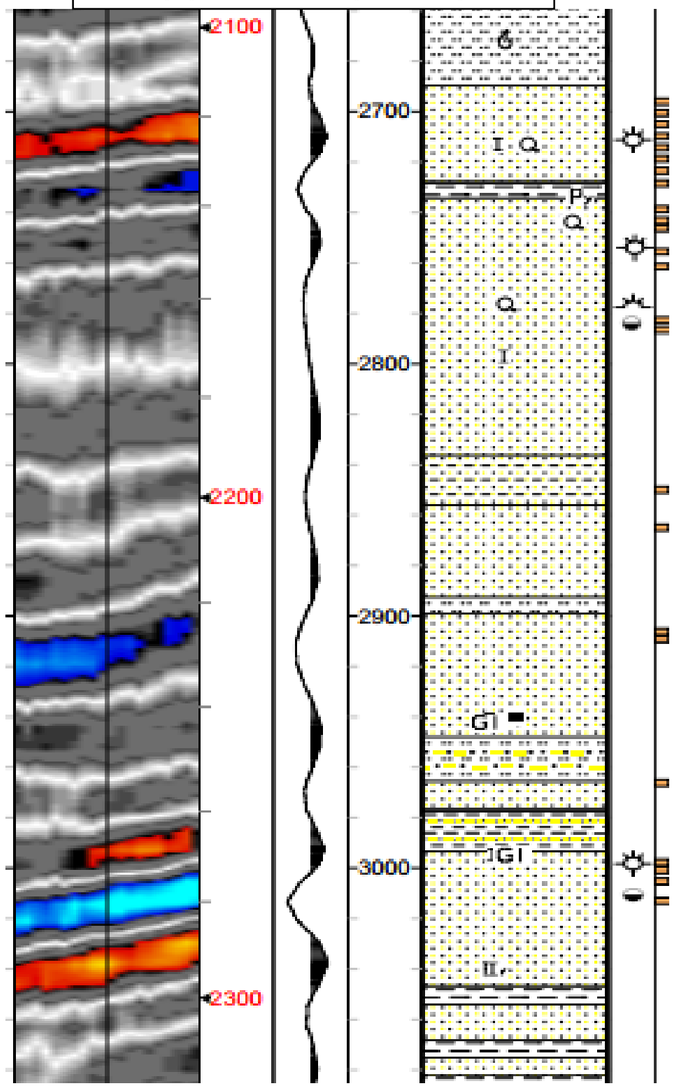
(A) Sweetness at 2182 ms



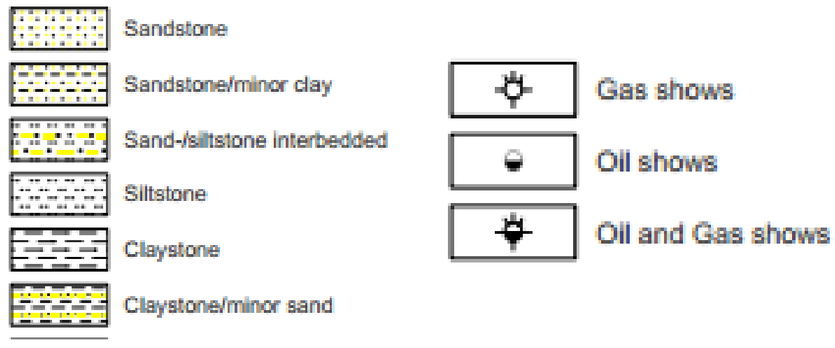
(B) Sweetness at 2266 ms



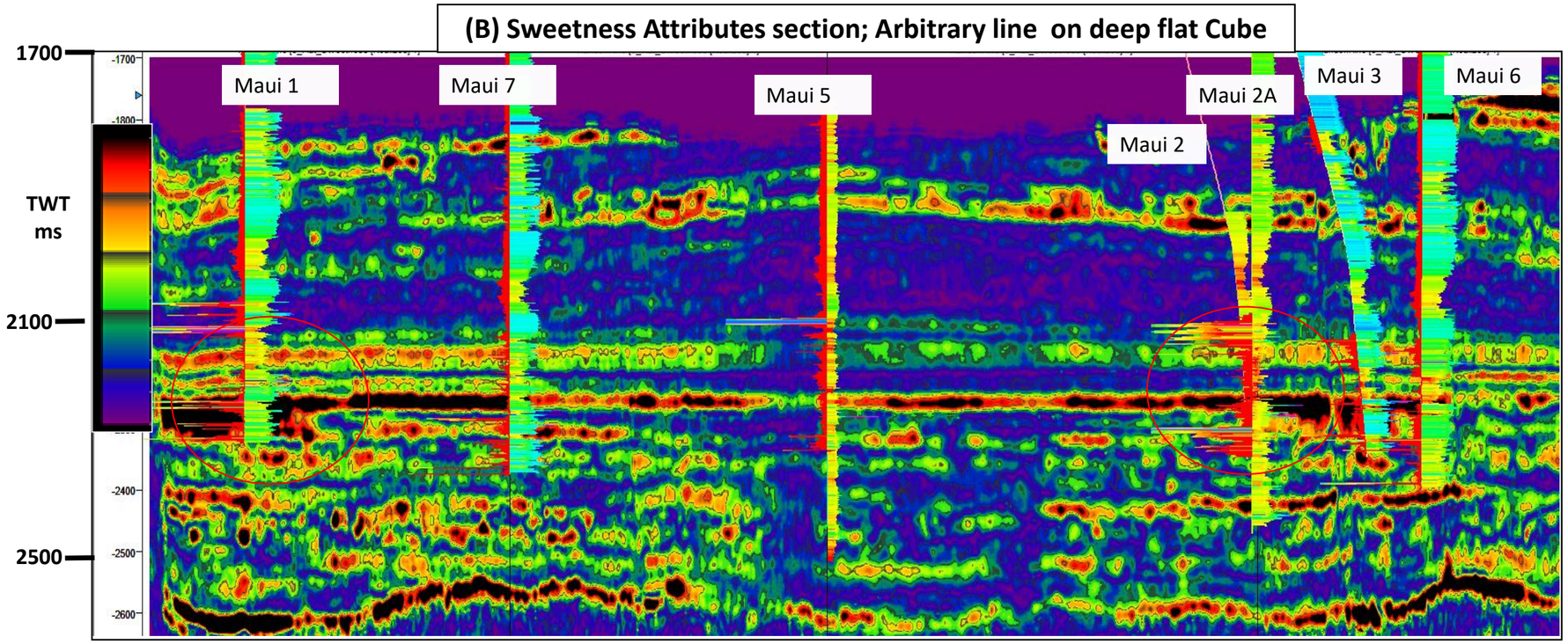
(C) Well Data (Maui 1)



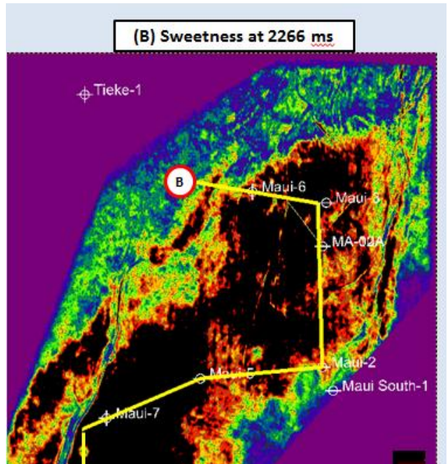
- 2100ms to 2300ms cover the Mangahewa Formation (C shale and C sand) and Lower Turi formation (D shale).
- This interval exist Oil and gas zones (well data C)

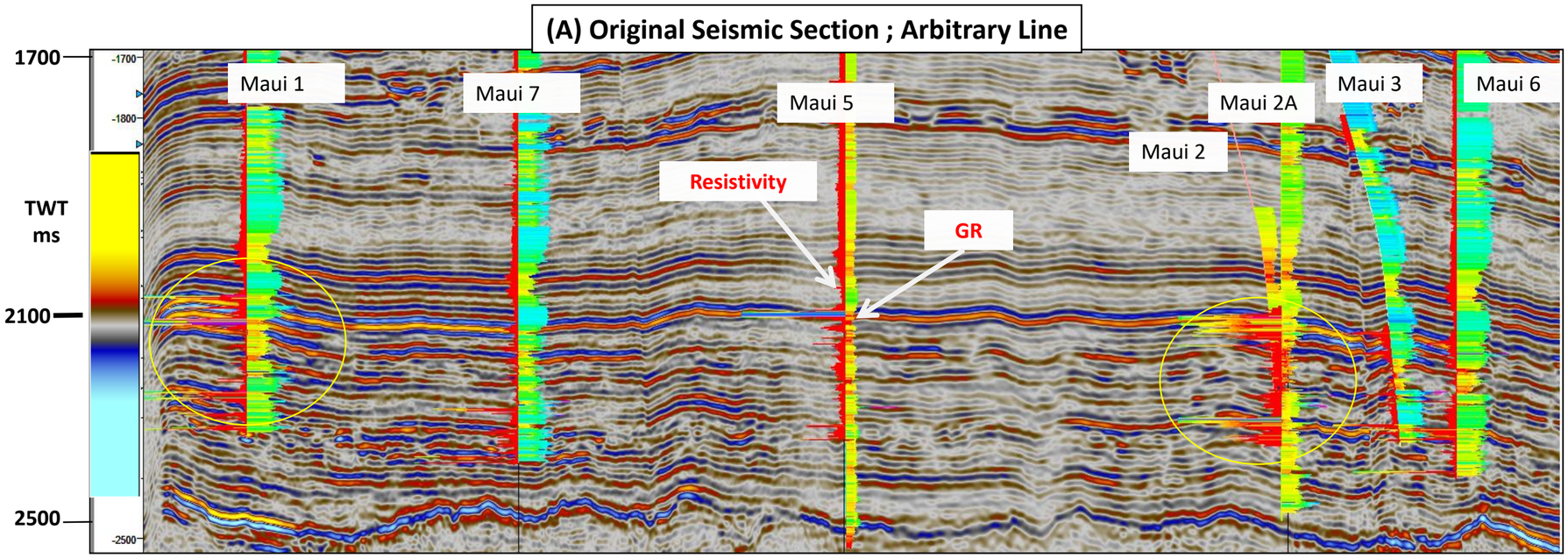


Gas Effect; Deep Cube



Ress.





GR

Very high resistivity and low gamma ray is the response to hydrocarbon present at Turi formation which show the very high sweetness.

Summary

- The provided seismic section are cropped into 3 separate volume with a specific time interval. Within three cropped volume deep and medium cube are applied flattening operation with reference horizon.

- Shallow cube didn’t apply flattening because reflection packages are comparatively uniform with time.

- The variance attributes has run for both flatten and unflatten volume with same parameter. Compare to these results flatten attributes gave more consistence and reliable feature. On the other hand, unflatten volume showed wrong and incomplete features.

- In this exercise three types of attributes are run to estimate geological features. It’s hard to say which one provided better features because consistency are varied one slice to another.

- However, Sweetness can be very effective for channel detection and differentiate the sand bodies. Some of the channels with high sweetness may indicate sand bodies.

- To sum up, applying different types of attributes in seismic volume is to get better and reliable idea about depositional environment and structural and stratigraphic features and should always be cross -checked with other data sources.

Thank You