Internal Structure of the Triangular Horst-Like Jonah High in the Levant Basin, Eastern Mediterranean*

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Abstract

A clear magnetic anomaly is evident across the central part of the Southern Levant Basin, coinciding with prominent structural features known as the Jonah High and Jonah Ridge. Jonah High is a triangular shaped, horst-like structure, bounded at each of its three rims by incoherent, steeply dipping seismic events and is capped in places by a high amplitude marker. Attempt to drill the structure by the Myra-1 exploration well in 2012 resulted in a loss of circulation at the level of the cap; the well was side-tracked to the east and penetrated a Lower Miocene and Upper Oligocene deep-water section including the Tamar Sands, the main reservoir found in all the other wells in the basin. Few models have been suggested since the 1980's to explain the combined magnetic and oddly-shaped structure; they include basement high, deep intrusive body and shallow volcanic edifice. All these remotely related models obtained a good fit between observed and calculated measurements of the magnetic data, an inherent problem in potential field methods. This study focuses on seismic imaging rather than using the magnetic data as a constraint. It takes advantage of a recently released 3D survey acquired over the Jonah High and few yet unpublished reports. The interior of the upper part of the high, from about 5 to 7 km, has been suggested by most previous works to be a carbonate buildup or a reef, yet contemporaneous with the surrounding strata. These models are now challenged by the definition of the Oligo-Miocene section in the well to be of outer neritic to upper bathyal paleo-environment. Alternatively, this study suggests that this part of the structure is composed, as its surroundings, of an Oligocene and Lower Miocene deep water section and probably contains the Tamar Sands. It is further suggested that it has been intruded during the Lower to Middle Miocene by allochthones bodies that formed its triangular shape. These are contemporaneous with the formation of all the gas-bearing structures in the basin. The intrusions formed local features, elevated by a few hundred meters, mainly along the eastern rim. The deep part of the high, below 7 km, may contain Mesozoic volcanic rocks that upwelled with the intrusive bodies and subsequently caused the magnetic anomaly to acquire the shape of the structure. The deep part is characterized by high amplitude events dipping away from its central axis but as yet these are not easily correlated to the surrounding strata. The Jonah High at all its levels requires further imaging efforts, even reshooting of a large aperture 3D survey, in order to solve this highly complex feature and maybe shed more light on the history of the Levant Basin as a whole.

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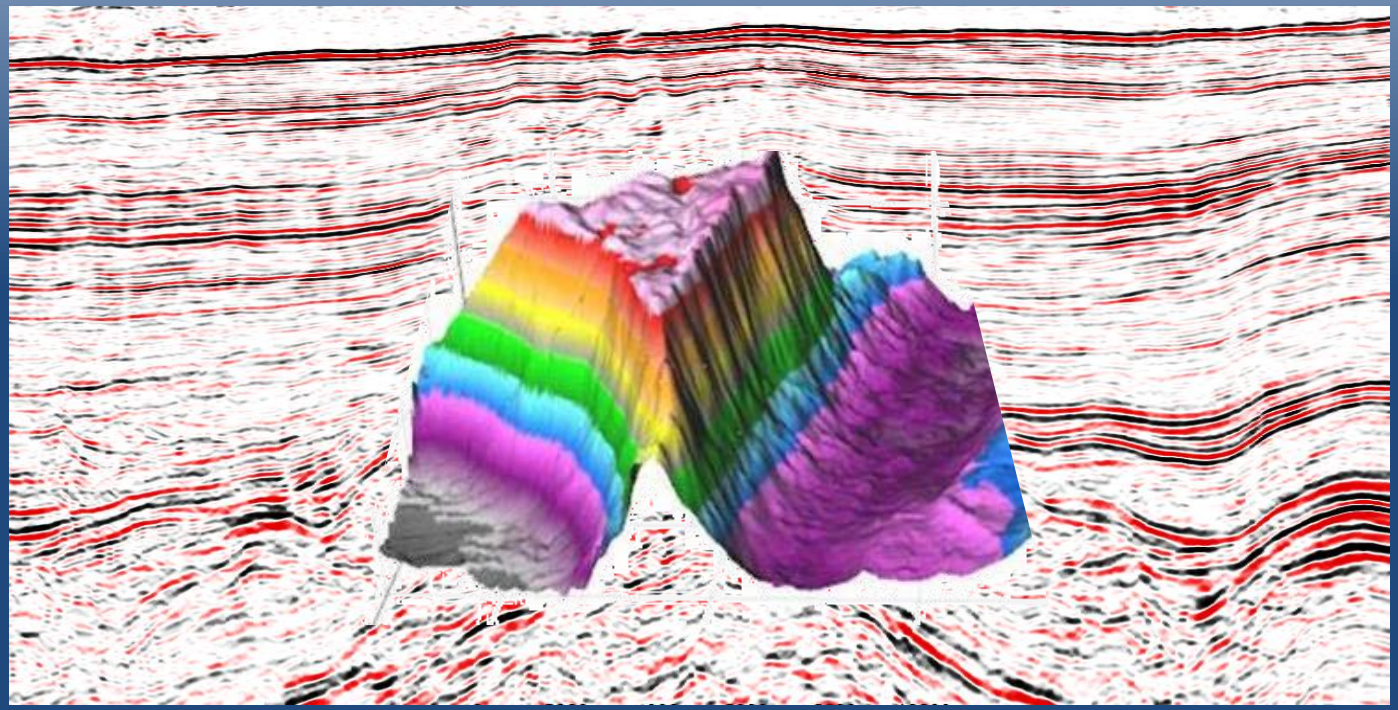
Pelagic Consortium



AAPG Geosciences Technology Workshops 2019

Exploration and Development of Siliciclastic and Carbonate Reservoirs in the Eastern Mediterranean

26-27 February 2019 · Tel Aviv, Israel

Talk Outline

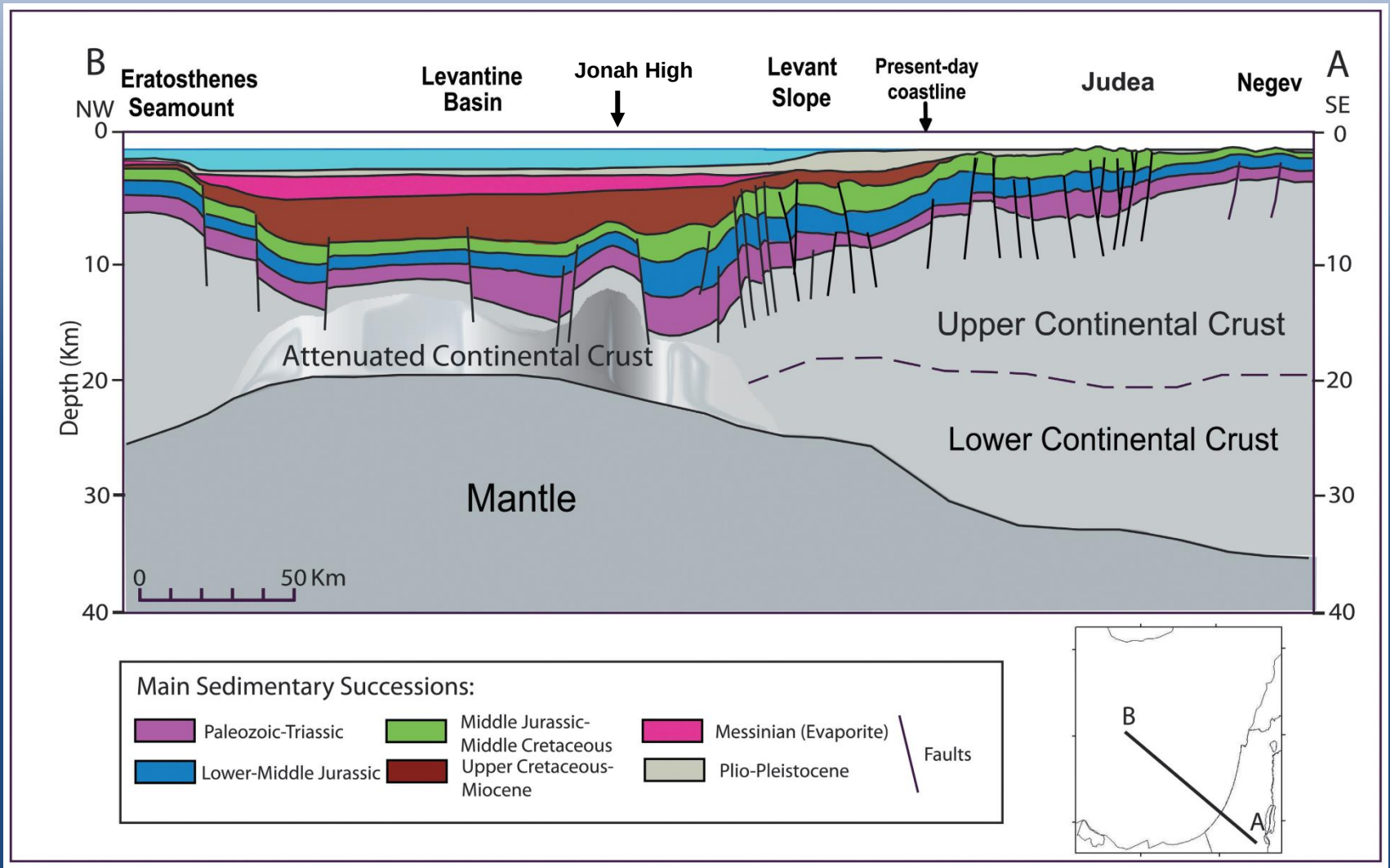
- General tectonic setting
- History of the Jonah High Models
- Revised Seismic Interpretation
- Concluding Remarks
- References

Physiographic Domains

Jonah High is located in the heart of the Levant Basin, which comprised the easternmost basin in the Mediterranean.

The Crust:

Oceanic, hyperextended continental or hybrid?



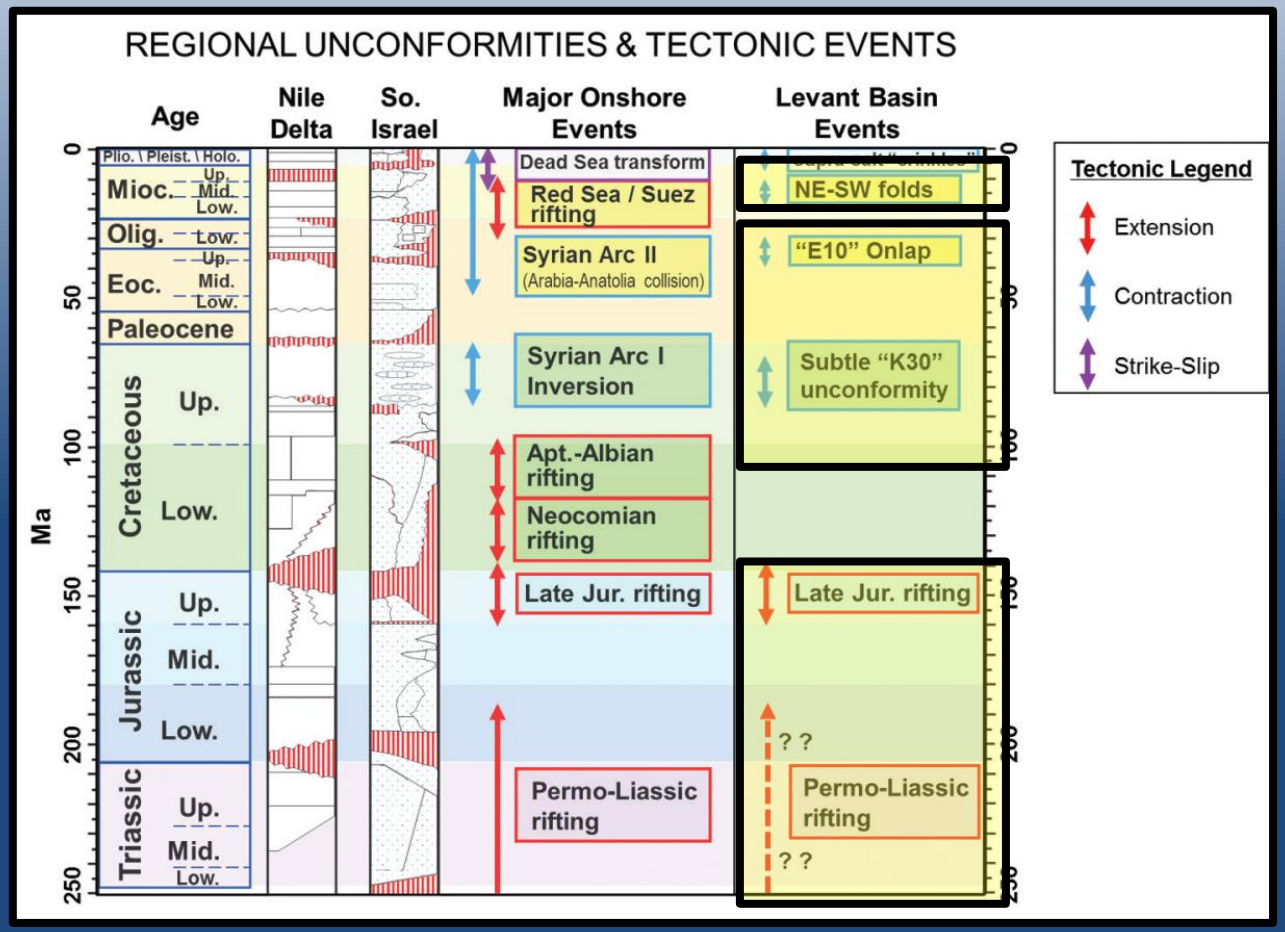
Gardosh and Tannenbaum, 2014

Tectonic Events

Contraction:
Miocene Folds

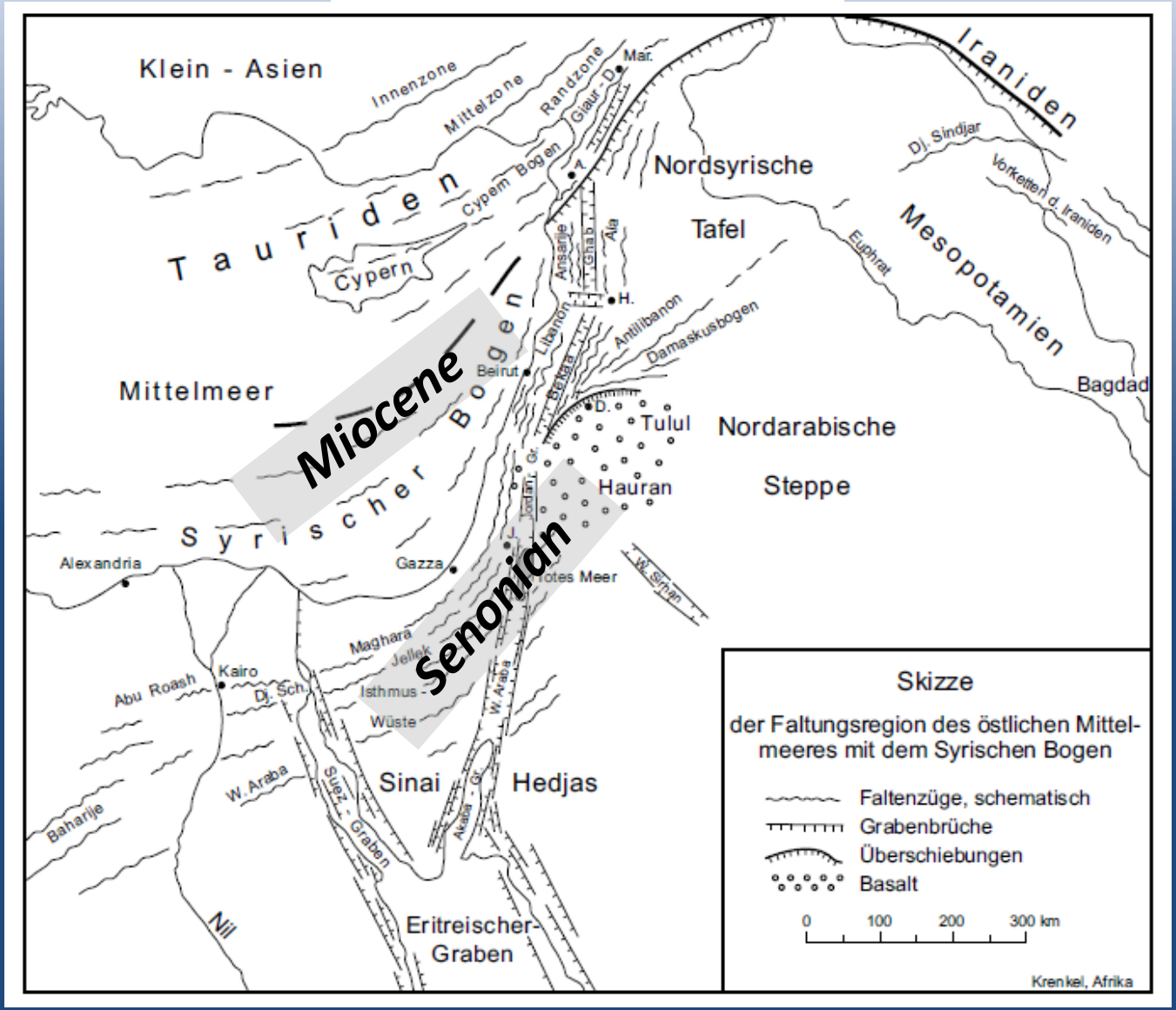
Contraction:
Subtle expression of the Syrian Arc Phases

Rifting:
Paleozoic, Triassic, Jurassic And / Or Cretaceous



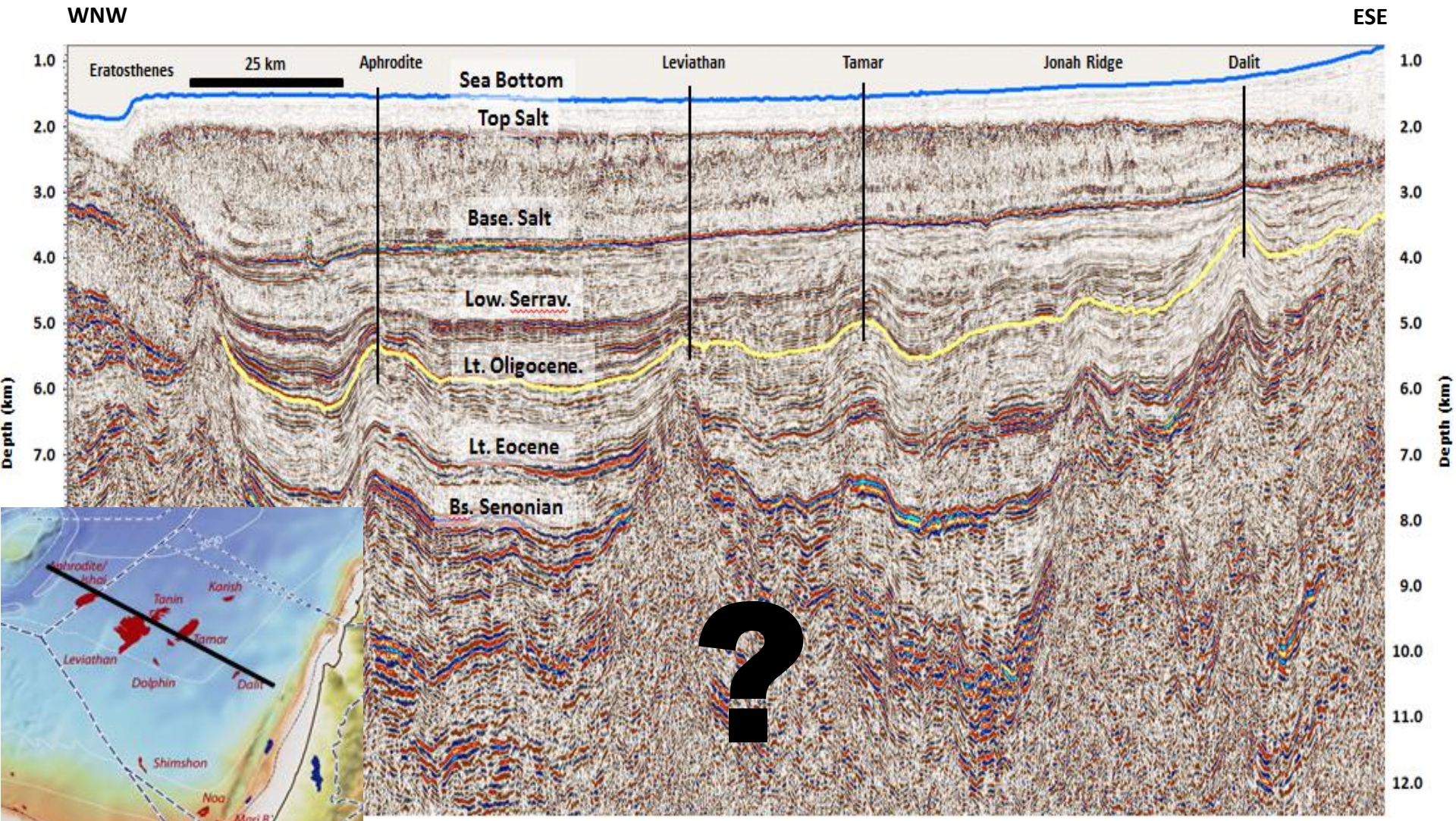
Needham et al. (2018)

Krenkel, 1924



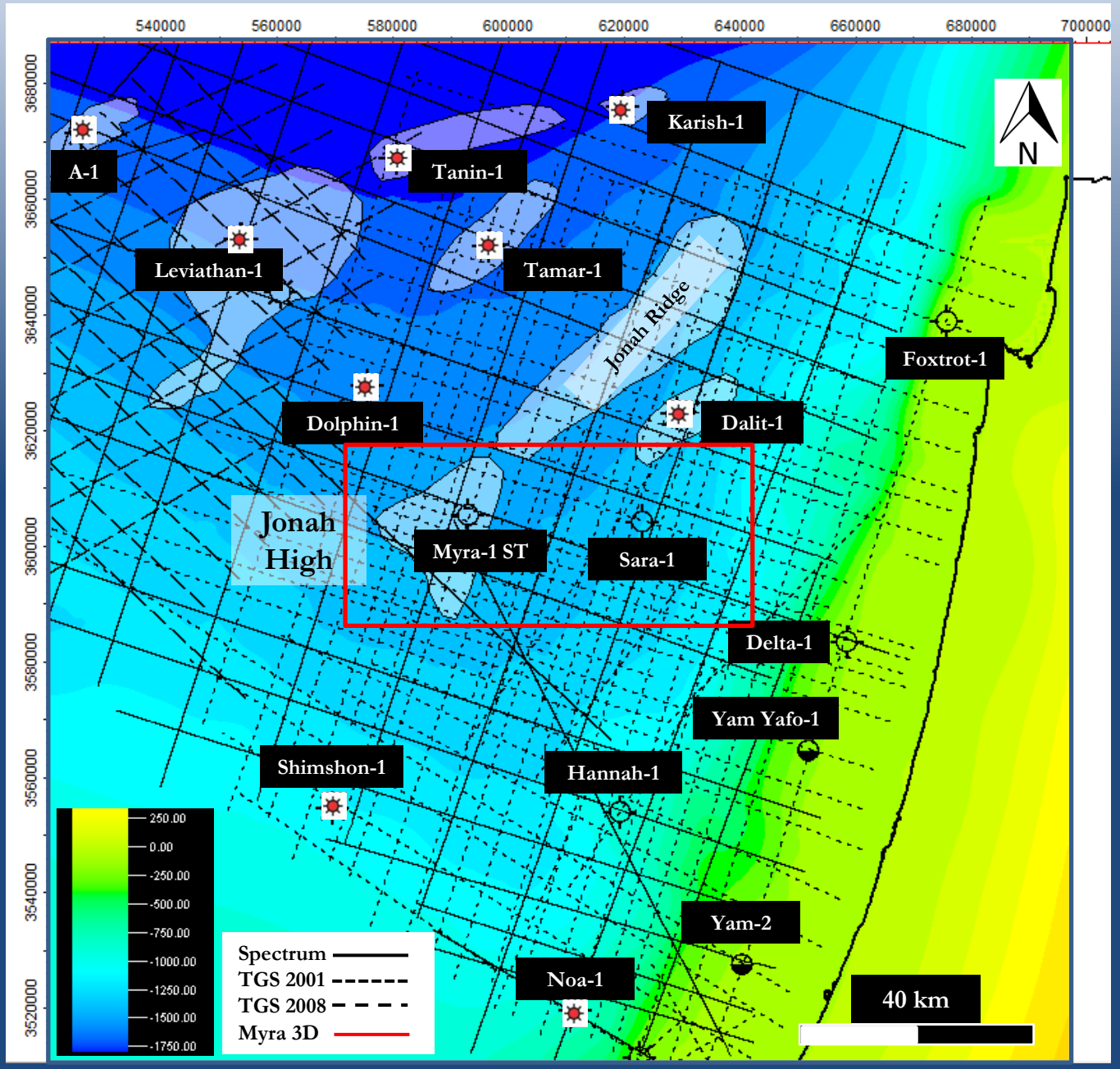
The Syrian Arc Structures were predicted by Krenkel to extend to the basin, but they were found to be distinctively different in age from the marginal folds.

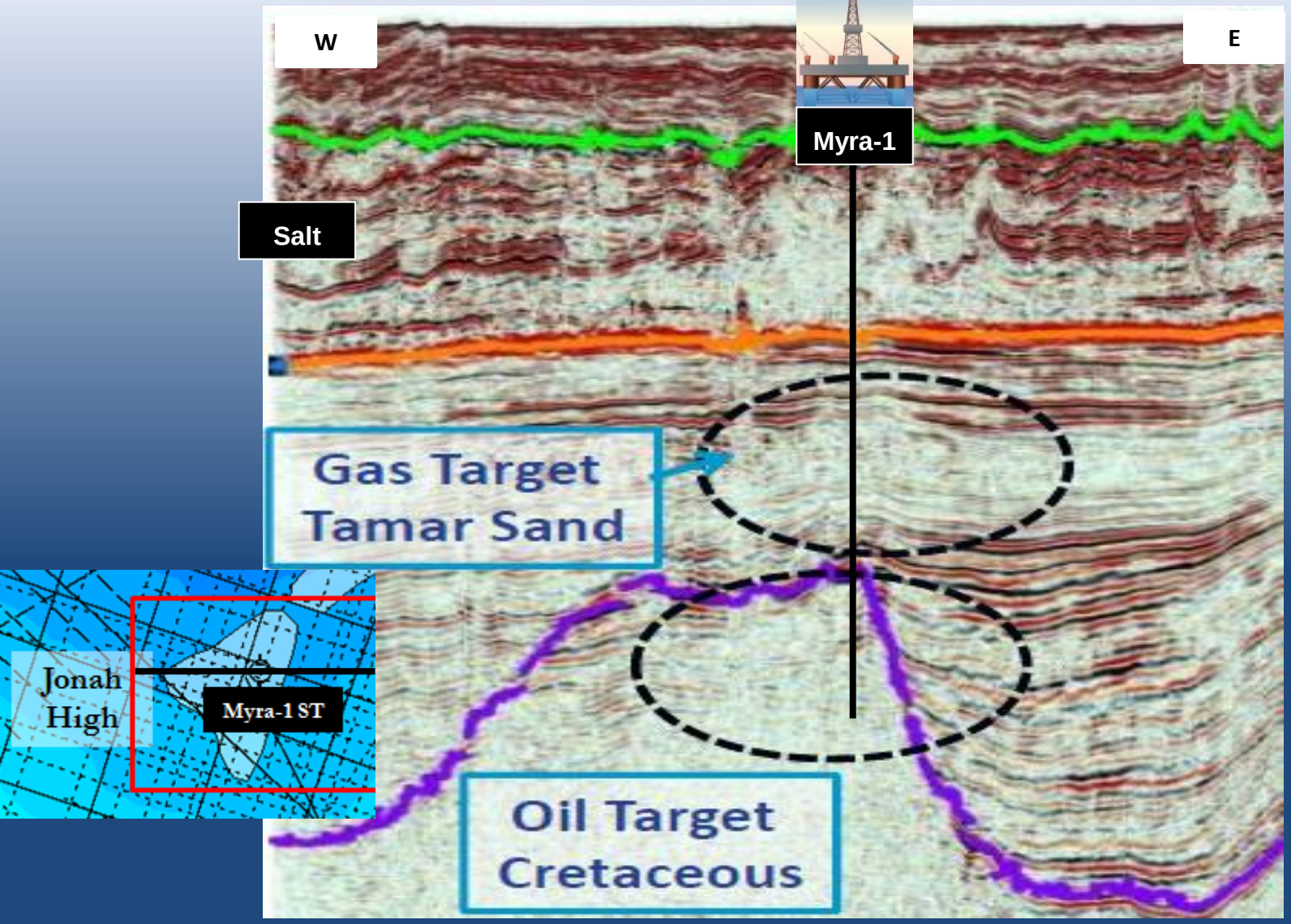
Seismic Line through the Gas Discoveries



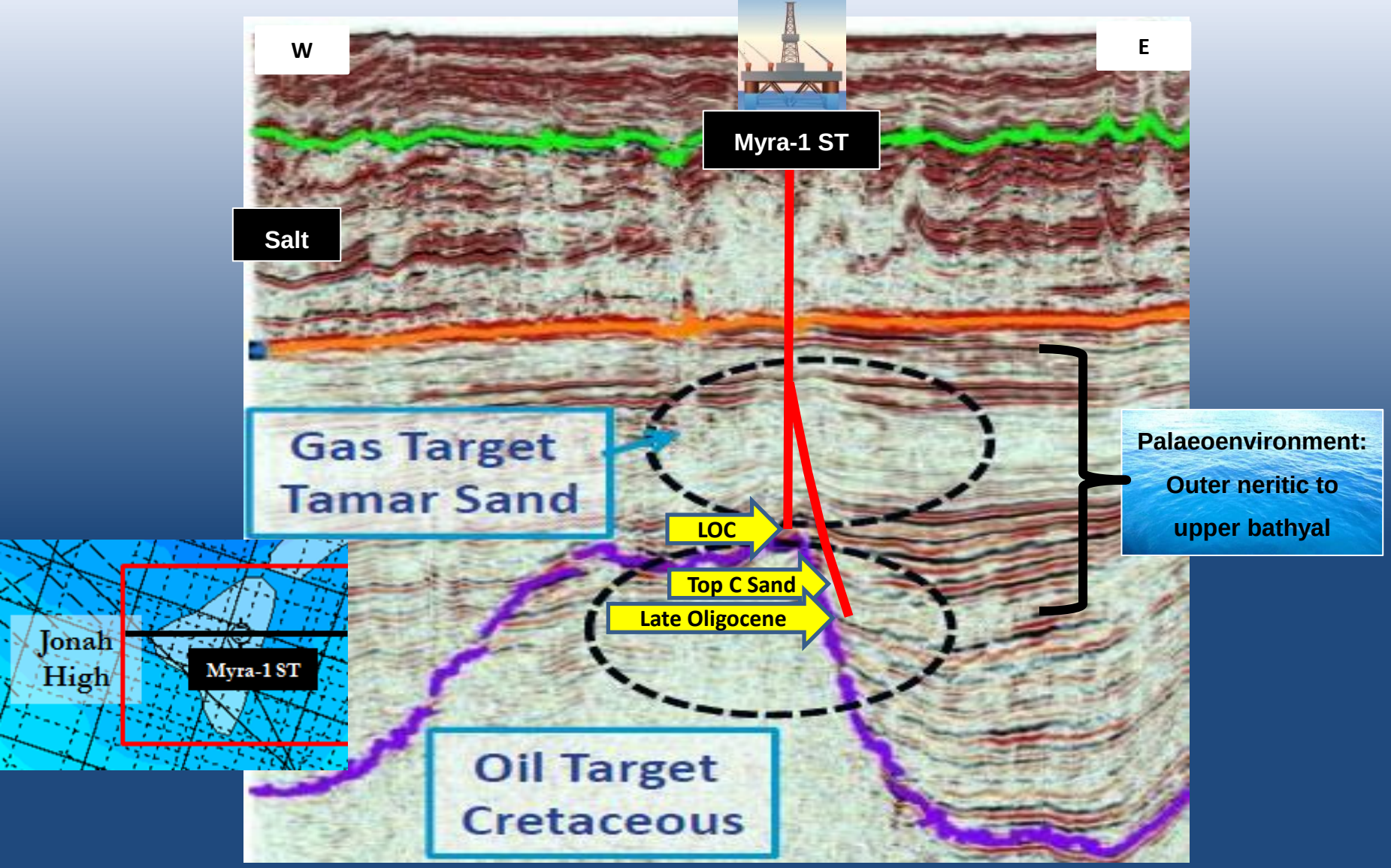
While we know a lot about the section down to the Late Oligocene, nothing much is known about the deep part.

Dataset in the Israel Offshore Area



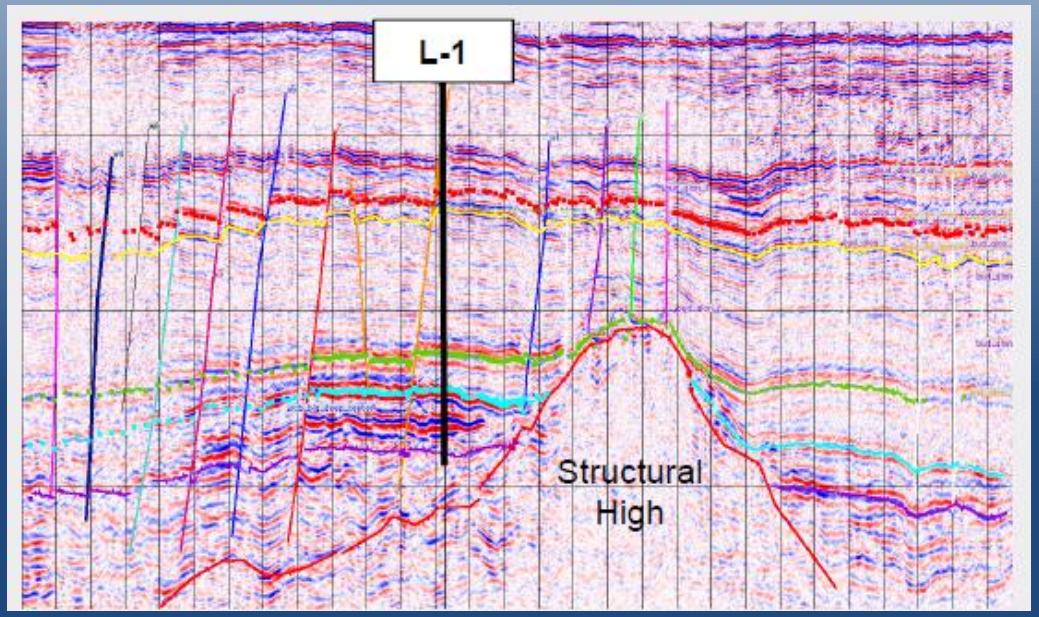


In 2012, the Jonah High was about to be drilled with this model, over a 3D line across the well, presented by the partners. It was suggested to be a Mesozoic seamount, elevated by about 2.5 km above the background.

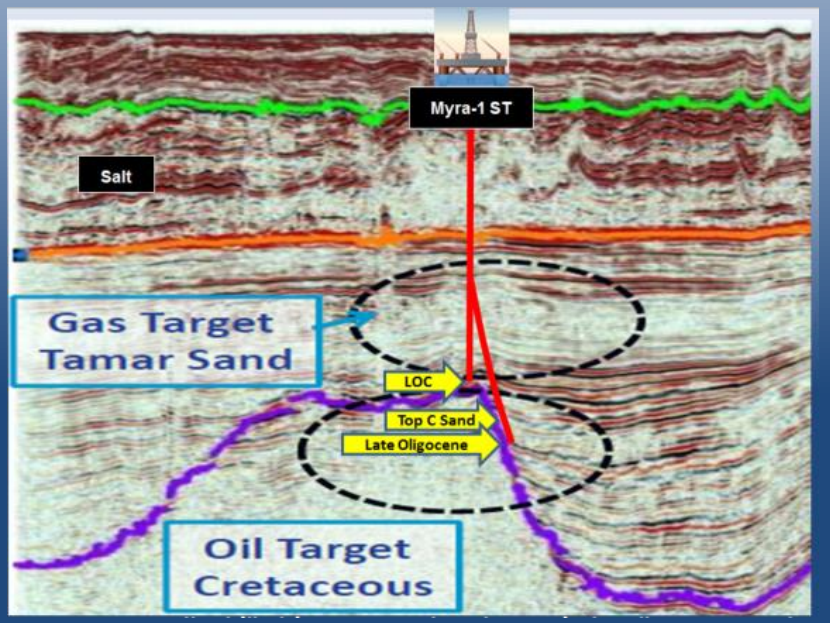


Myra-1 was eventually drilled in Q3 2012, but the vertical well encountered Loss of Circulation just above the seamount core. The well was side-tracked to the flank, and found the normal section of the Lower Miocene Tamar sand, unfortunately water-wet. The palaeoenvironment for the entire Miocene was defined as deep water based mainly on microfauna.

Leviathan-1 Deep

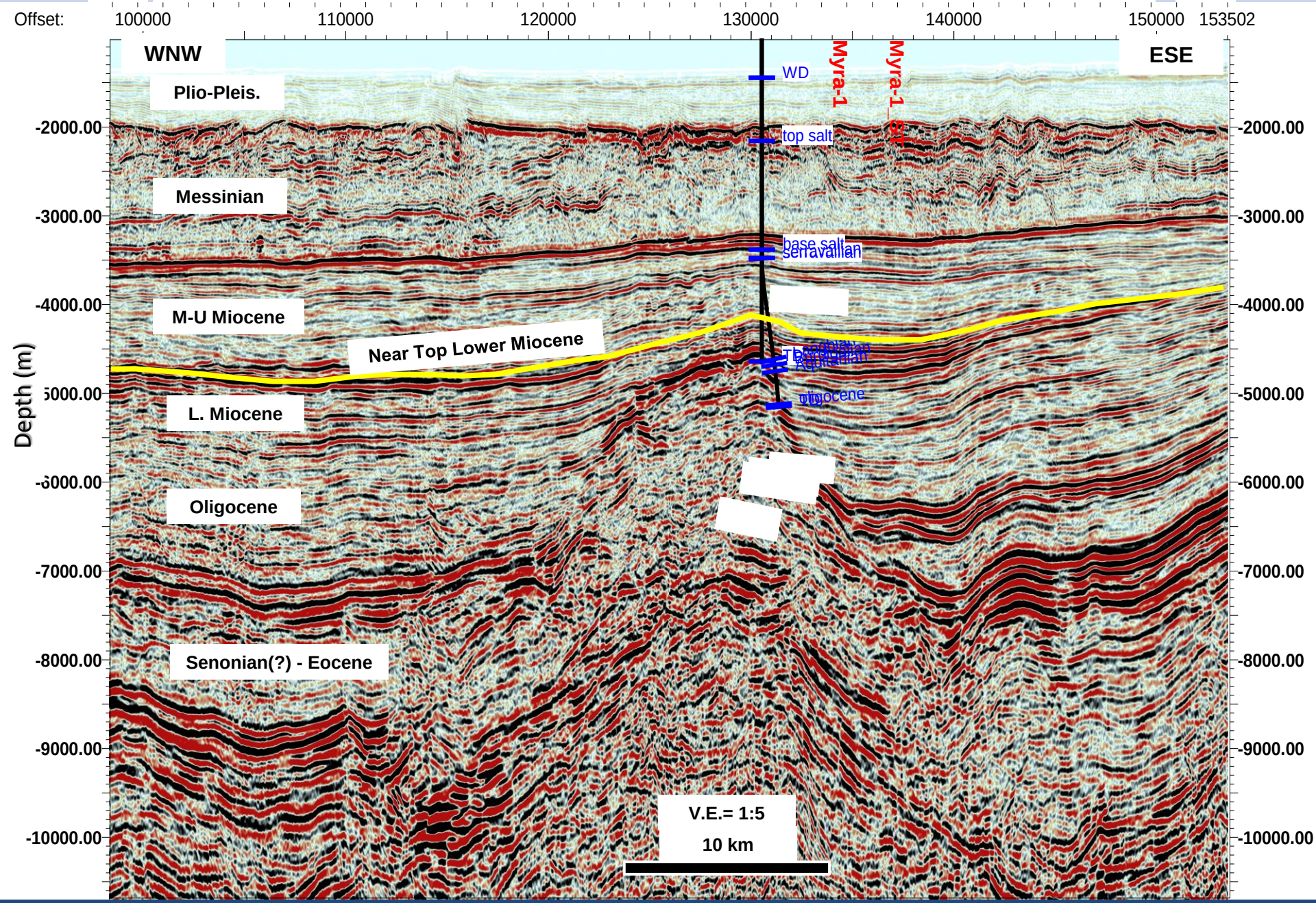


Myra-1 ST

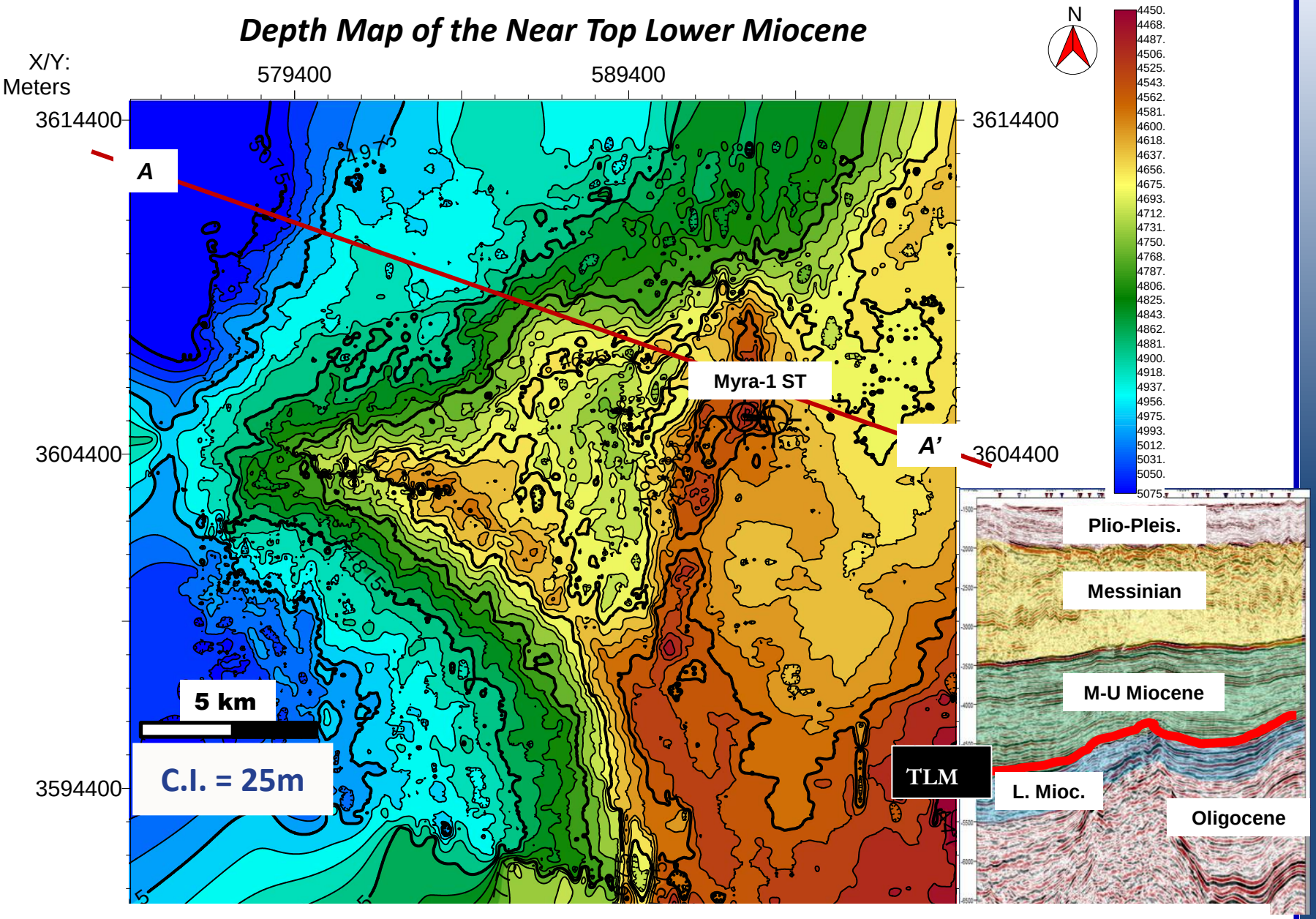


Both Myra-1 and Leviathan-1 Deep were drilled adjacent to a feature defined as structural high. So far, none of these highs in the basin have been penetrated by drilling.

2D PSDM Seismic Line and outline of the Near Top Lower Miocene (TLM)

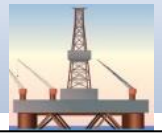


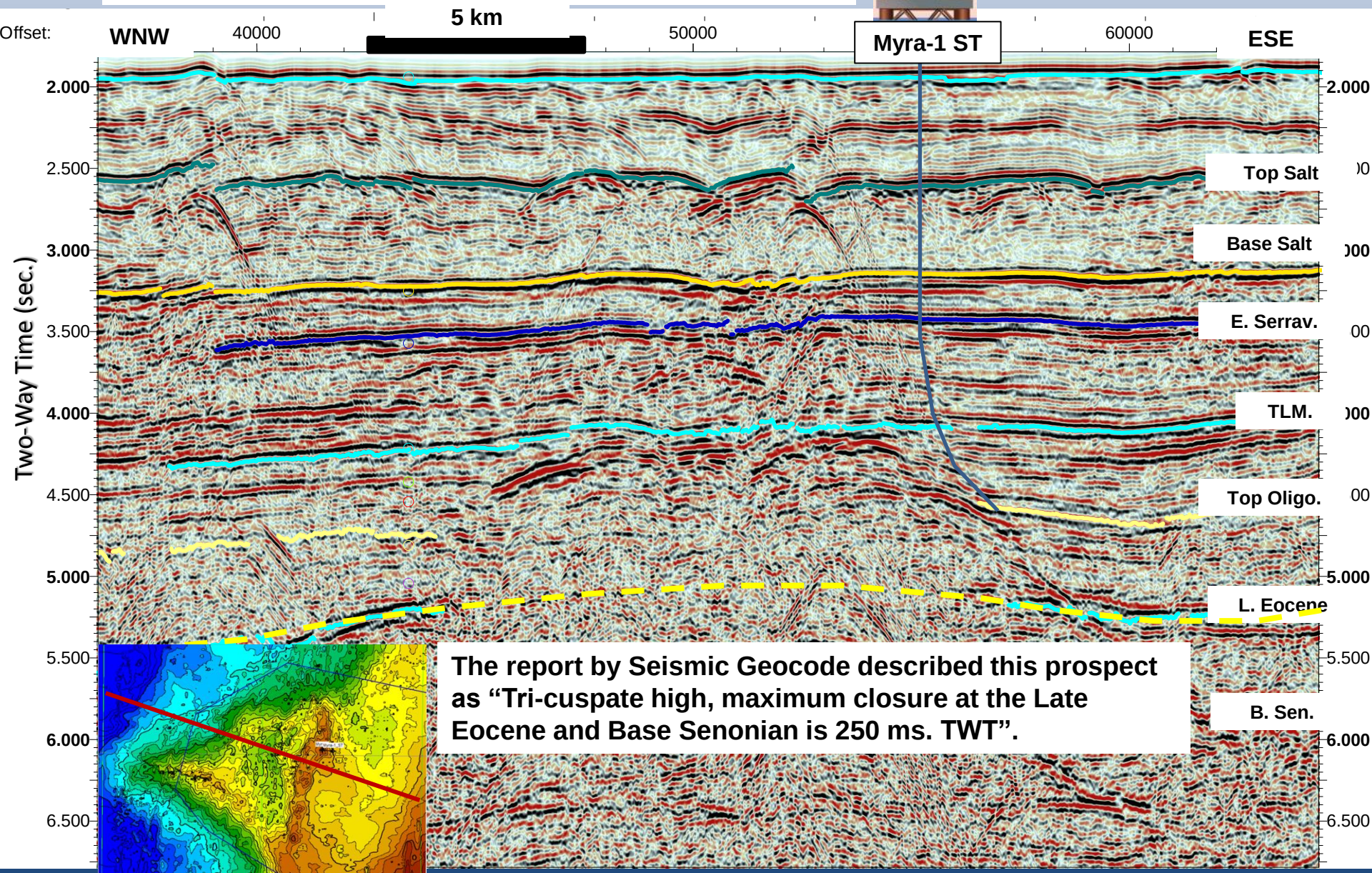
Depth Map of the Near Top Lower Miocene



The structural map of the Near Top Lower Miocene, which is a prominent reflector in the Levant Basin, is used throughout this presentation as a reference map. The highs are suggested to be the expression of a Miocene intrusion.

First seismic line across the Jonah High: Seismic Geocode 1984, EM-83-32





The report by Seismic Geocode described this prospect as "Tri-cuspate high, maximum closure at the Late Eocene and Base Senonian is 250 ms. TWT".

Seismic Geocode Interpretation of line EM-83-32 (in Hirsch et al., 1995): No "Structural High" is recognized

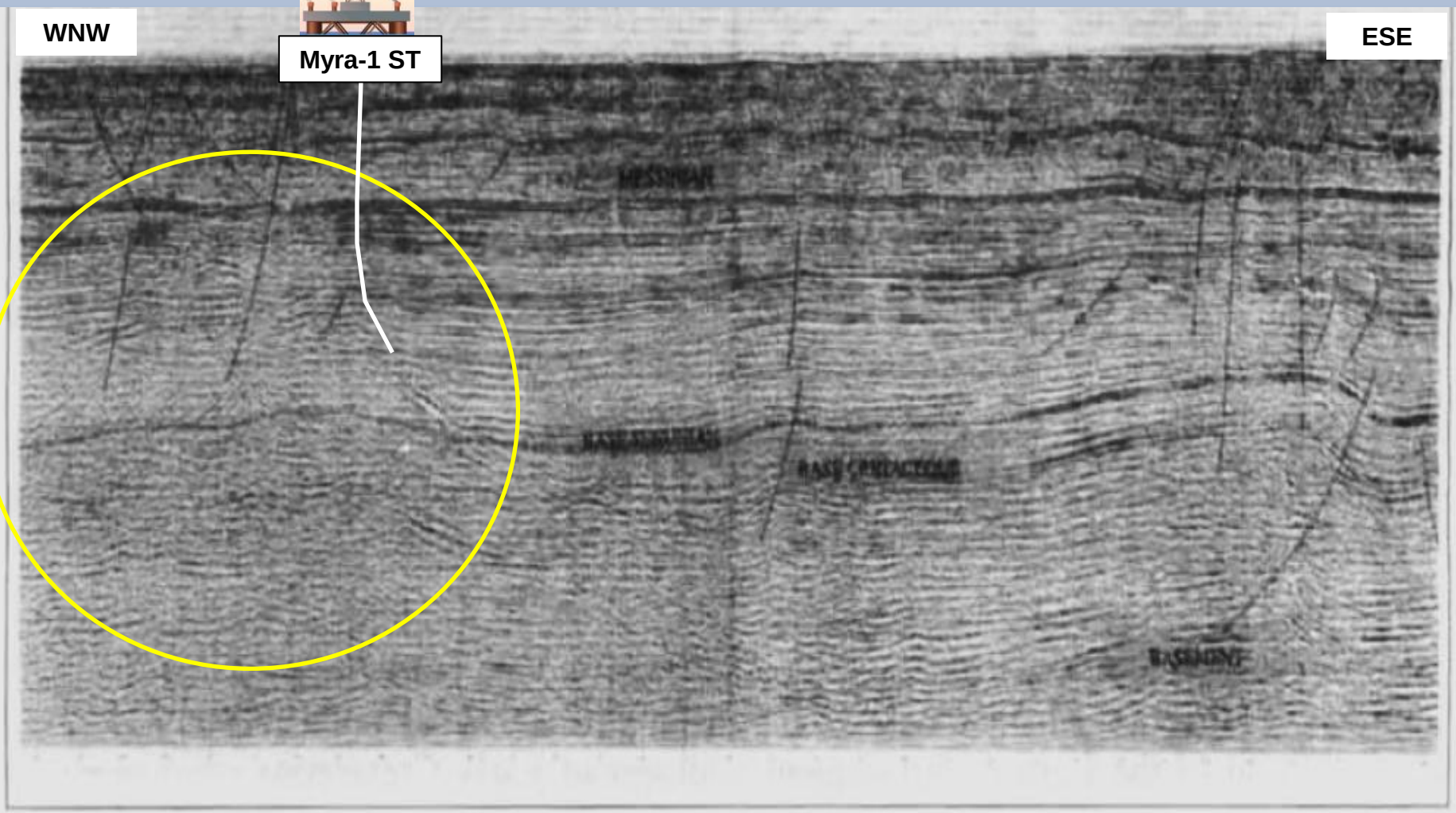
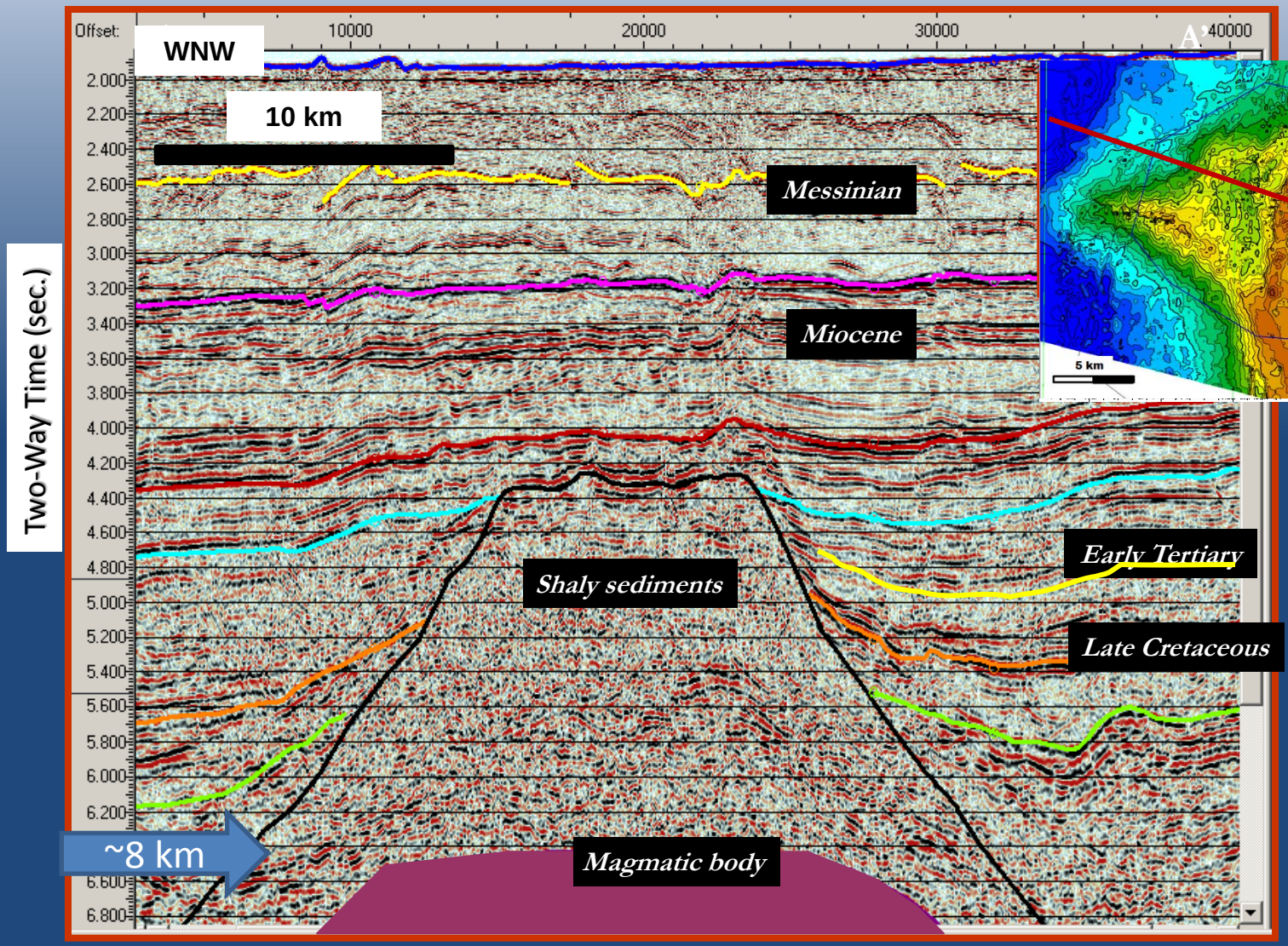


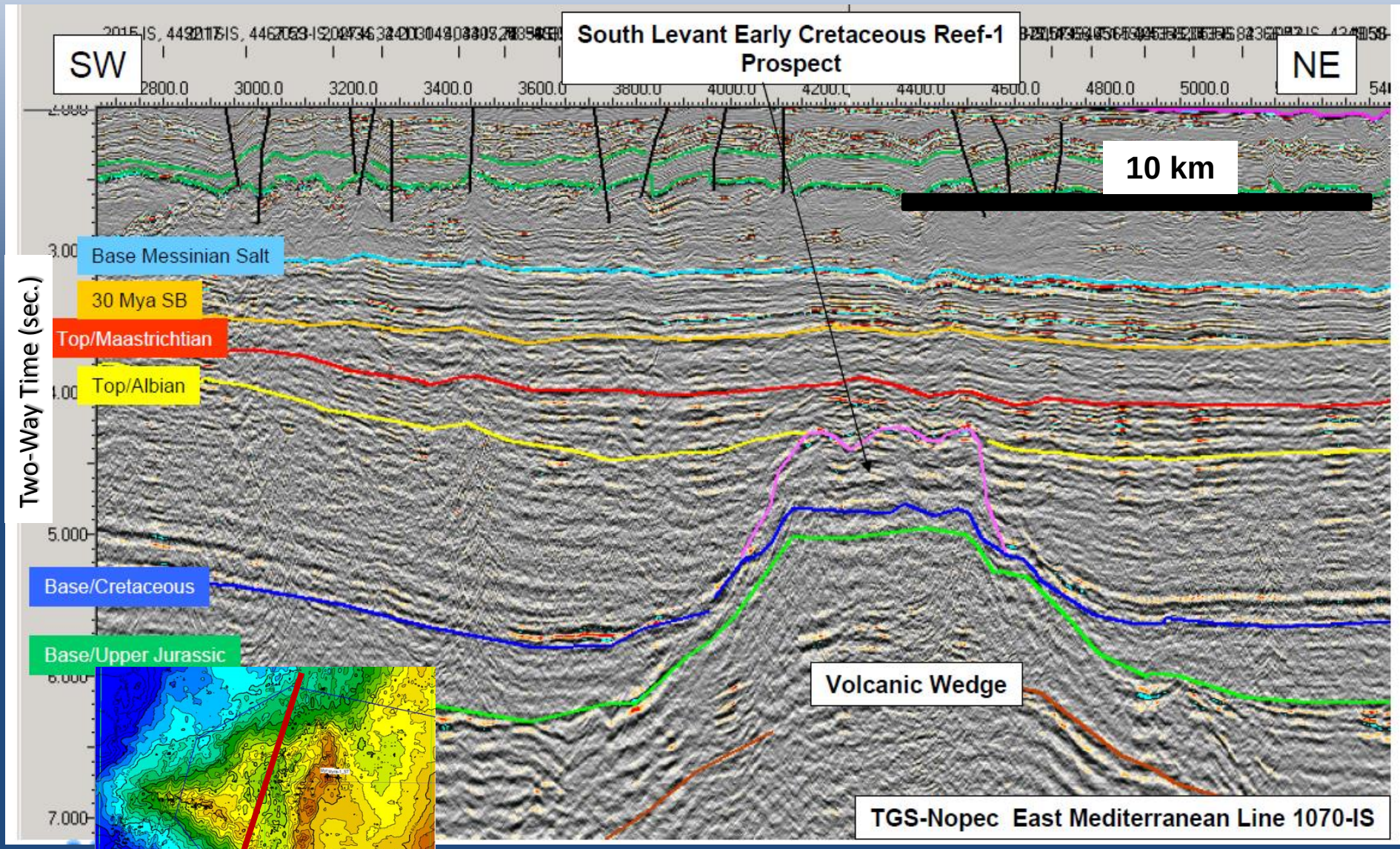
Fig. 8b (cont.). Panel II: Centre of the Pleshet Basin.

The "Jonah" buried seamount (Folkman and Ben-Gai, 2004)
Uplift and intrusion of sediments



The name "Jonah" was first coined by Folkman and Ben-Gai (2004) to describe a buried seamount.

Peck, TGS Report (2005)



Jim Peck was the first to suggest a reef at the top of the high. His age definitions for the background were later proved to be wrong.

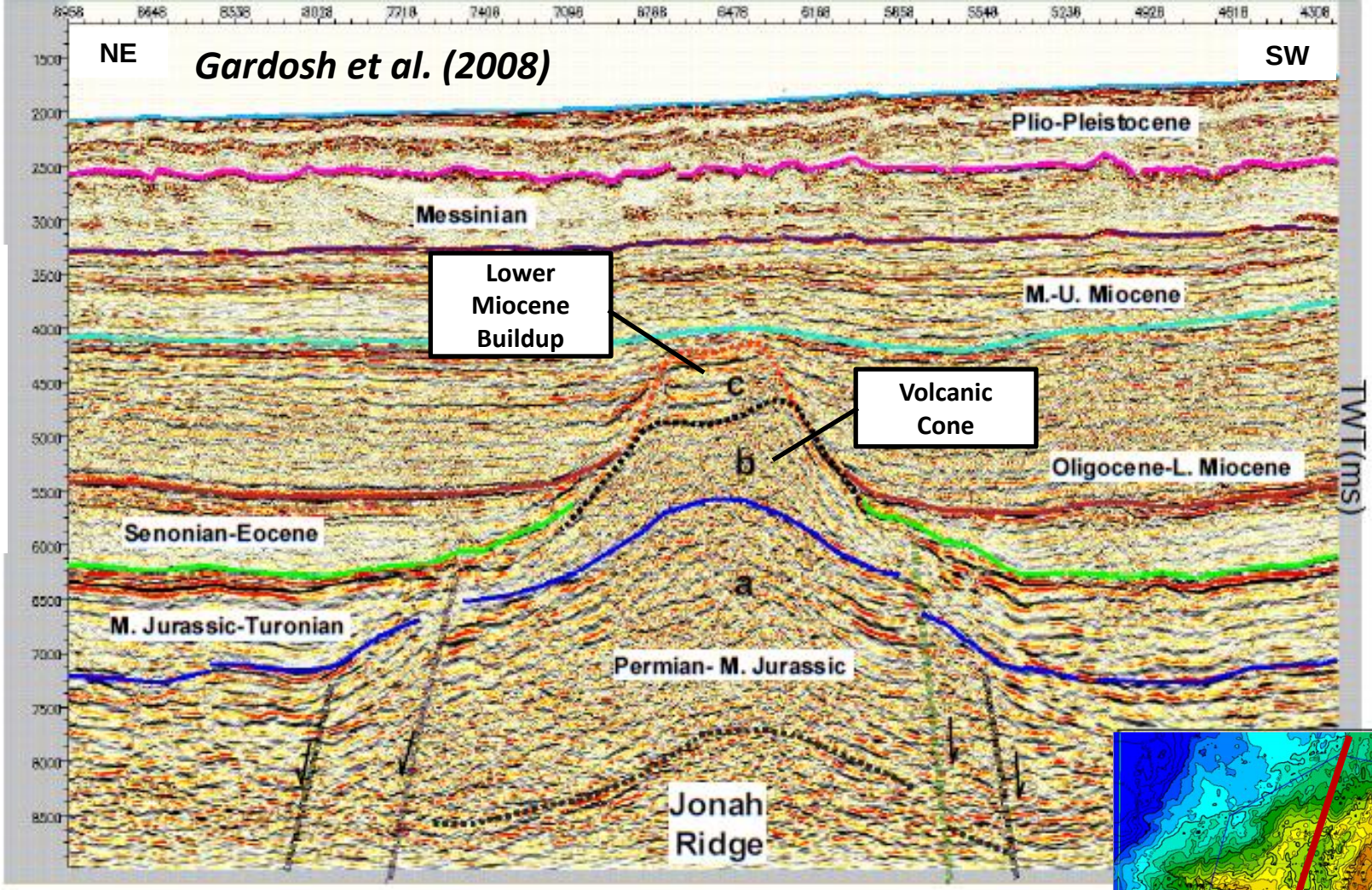
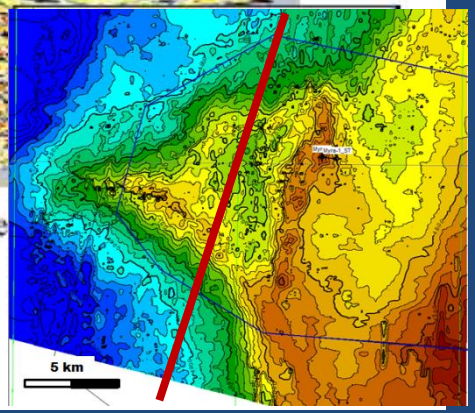


Fig 5.11- Interpreted SW-NE seismic profile showing the southern part of the Jonah Ridge. The ridge is composed of three units: (a) an Early Jurassic horst block, (b) a chaotic seismic package interpreted as a volcanic cone with highly dipping slopes, of Late Cretaceous to Early Tertiary age and, (c) a series of parallel, high-amplitude reflections interpreted as a carbonate buildup of Lower Miocene age.



Few years later, Gardosh and others suggested a model with a shallower causative body of volcanic origin and a development of an atoll-type carbonate build-up on top, this time of a Miocene age.

Peace (2010)

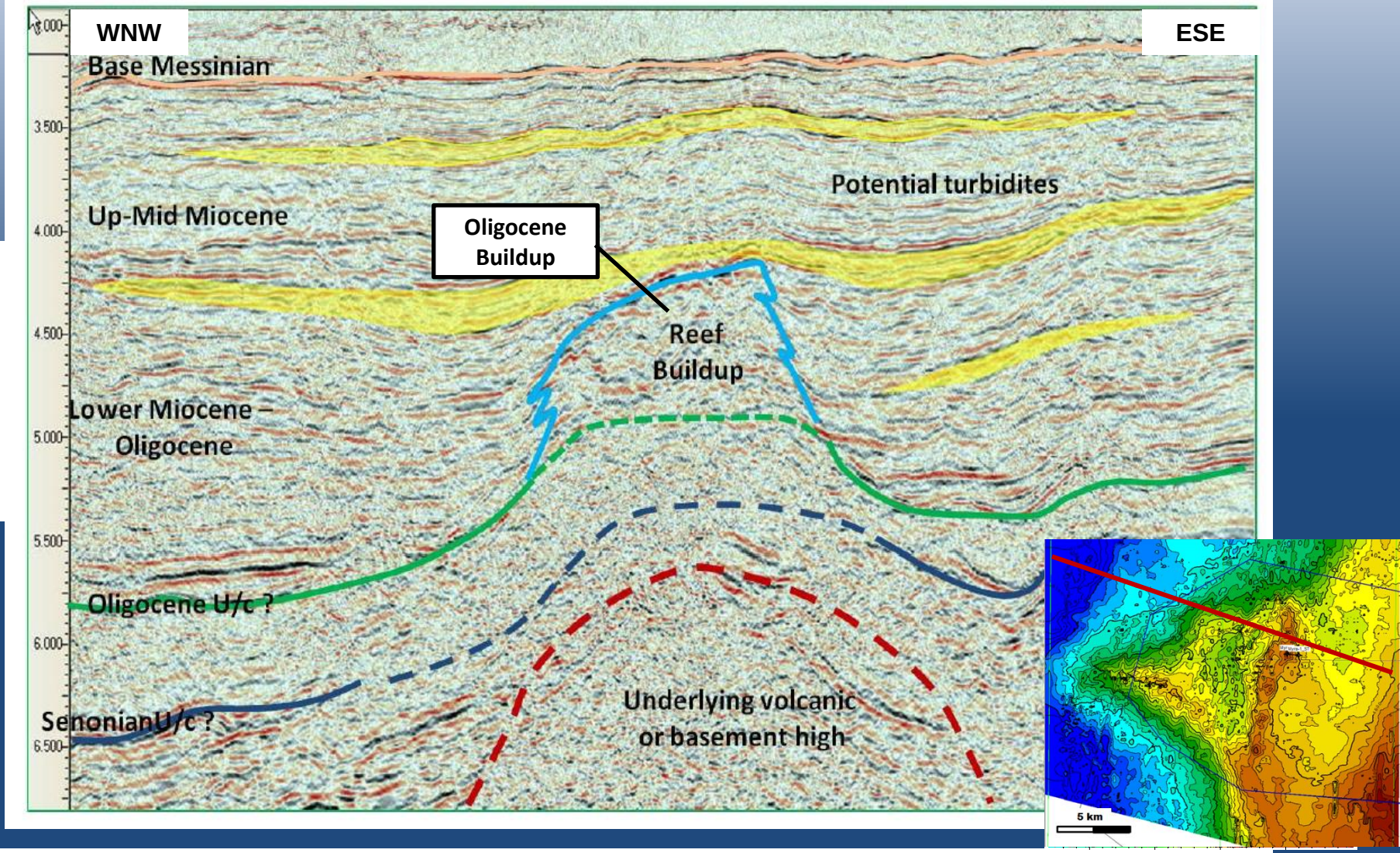
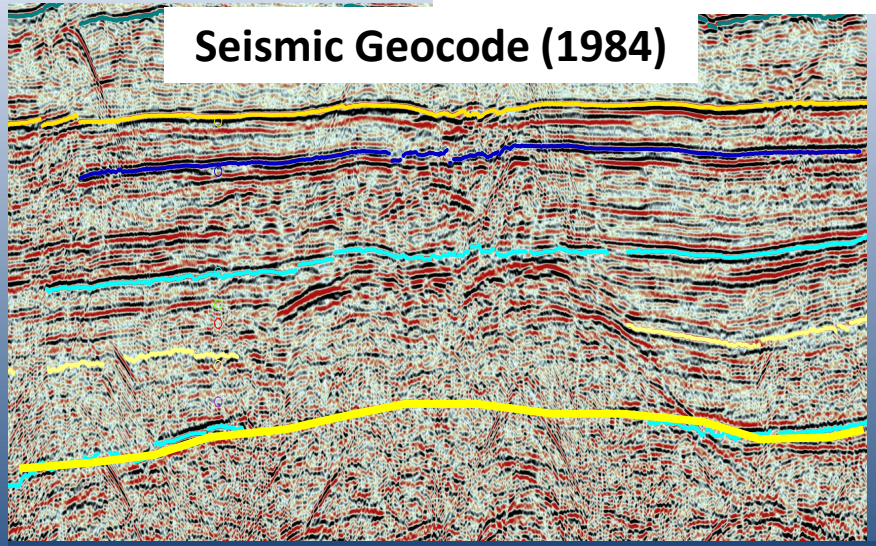


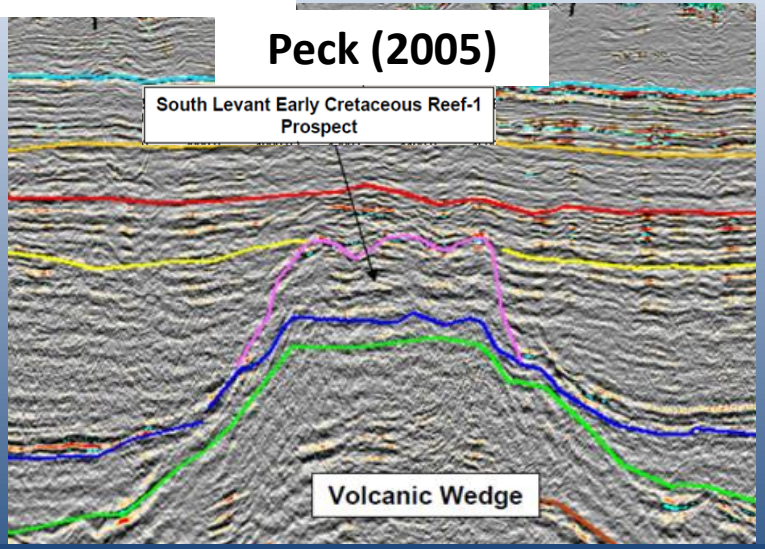
Fig. 10 – Speculative Oligocene carbonate build-up/reef of the Myra Prospect over a reduced Cretaceous-Jurassic interval cored by deeper basement or volcanic high

Summary of suggested models

Seismic Geocode (1984)

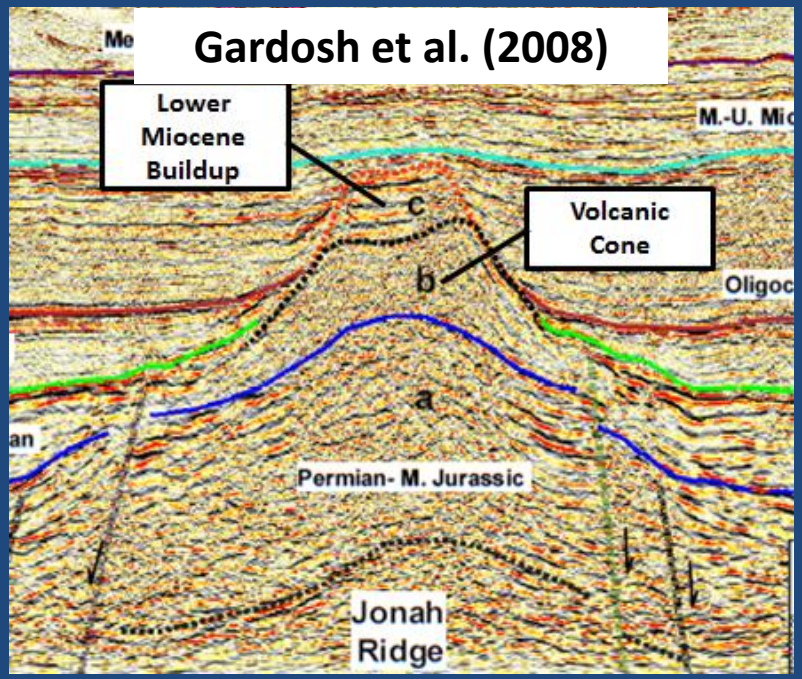


Peck (2005)

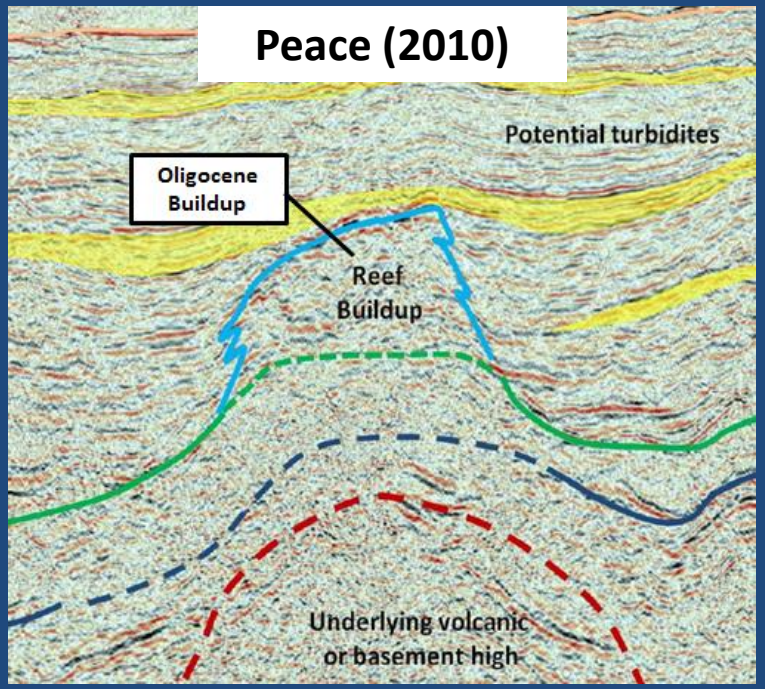


The Common Denominator:
The Core is Contemporaneous with the Background

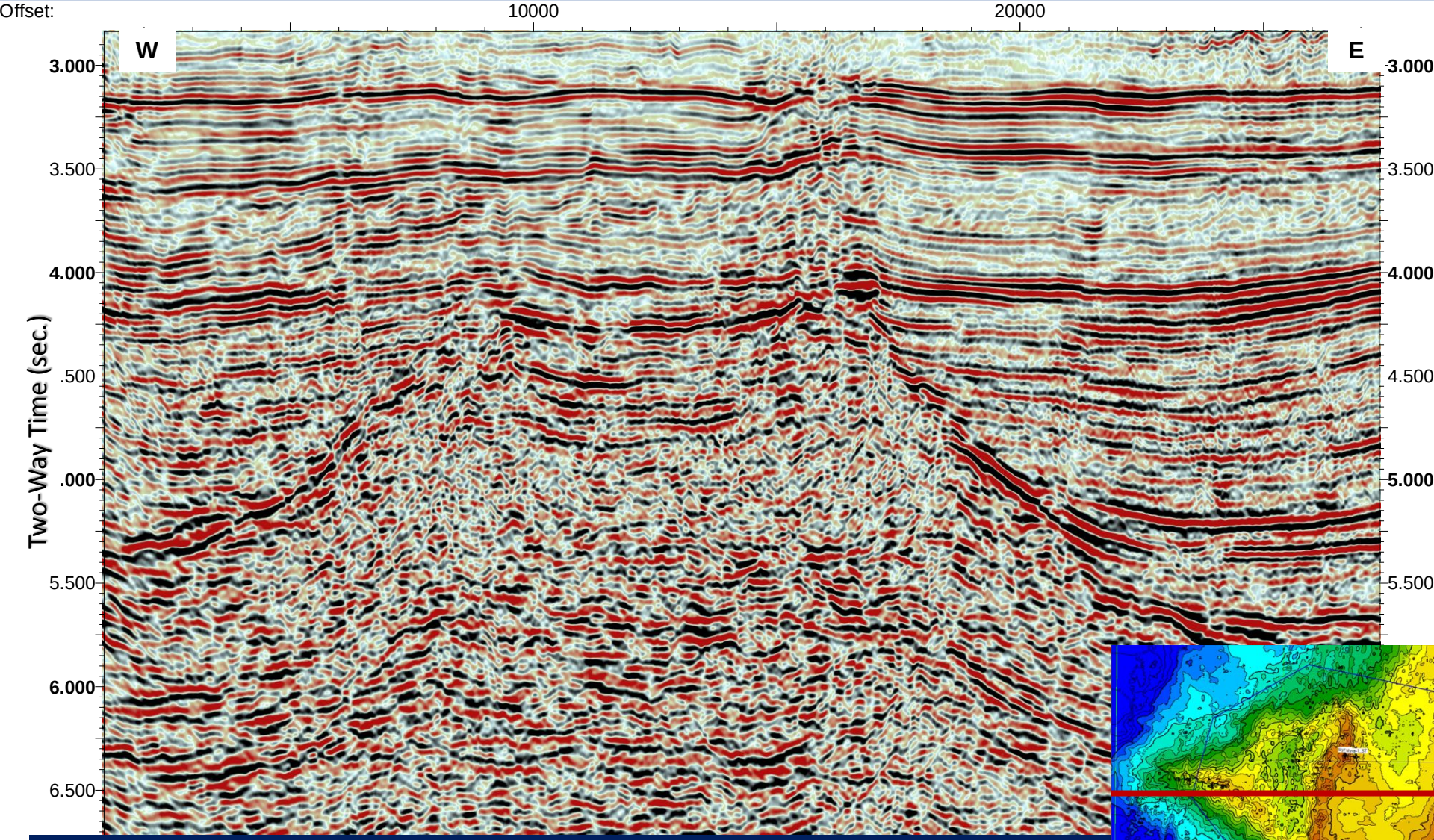
Gardosh et al. (2008)



Peace (2010)

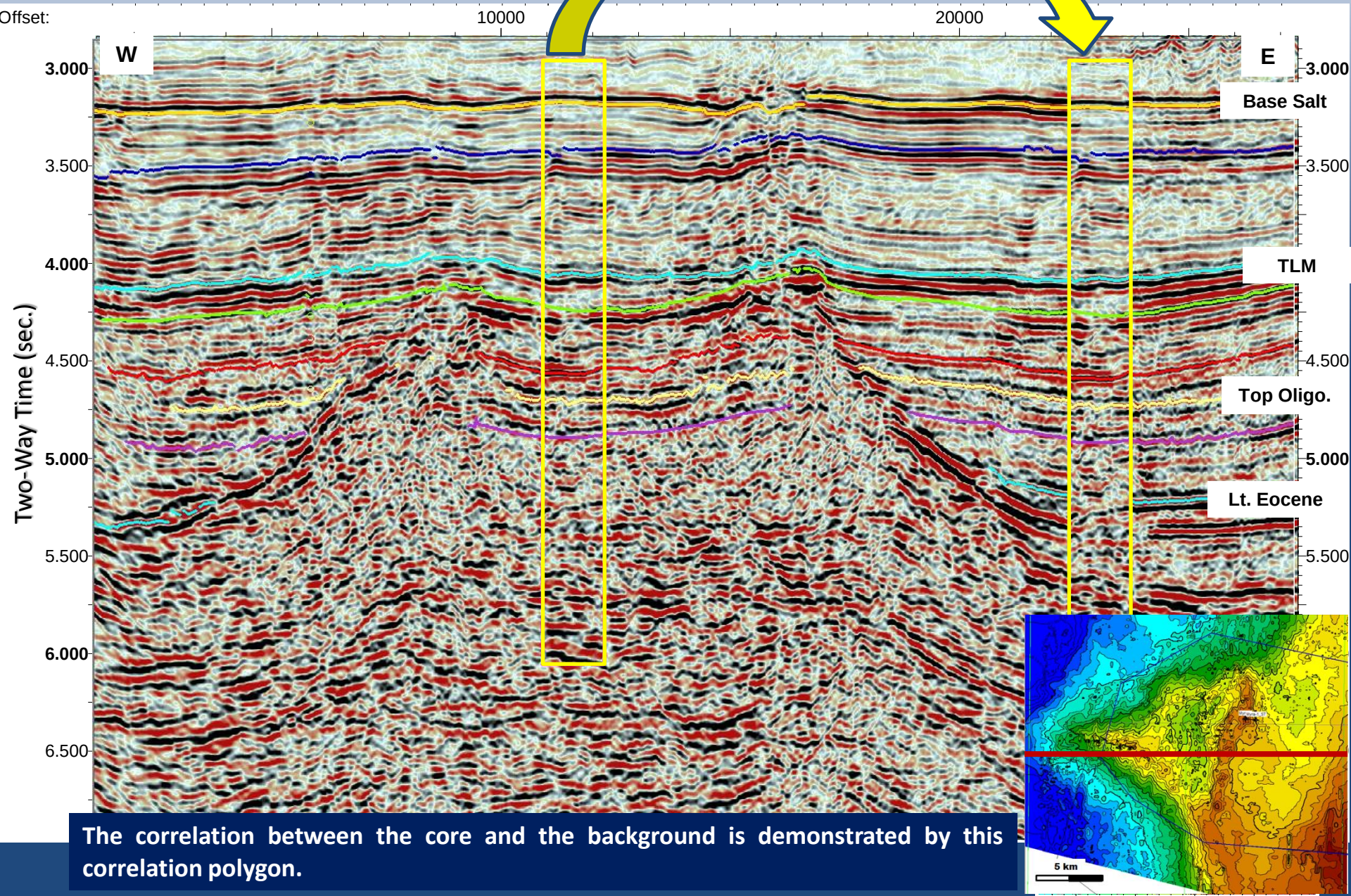


3D PSTM Inline 900



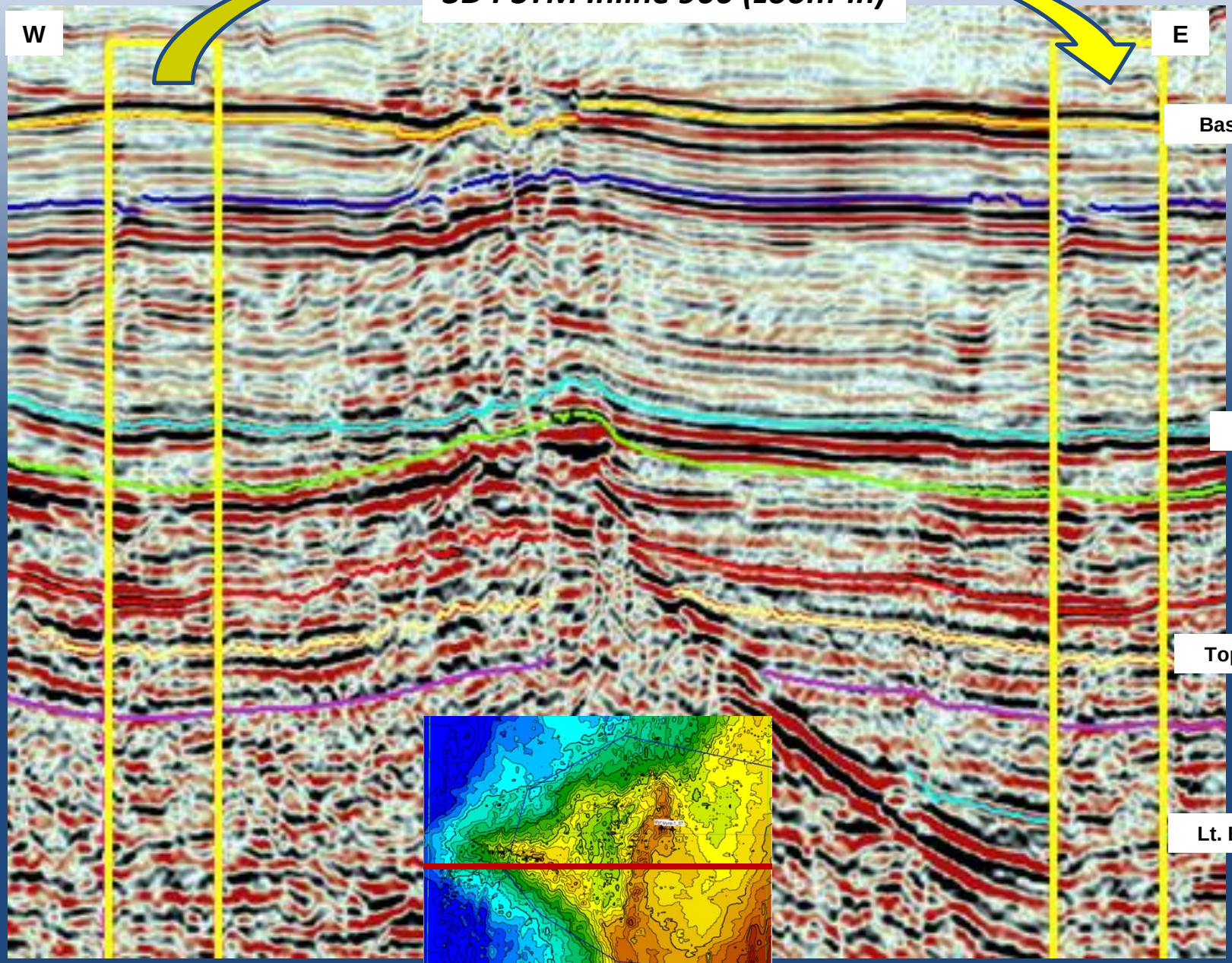
An inline from the 3D cube is used to examine the correlation between the core and the background. When comparing the strength and dip of the internal Jonah reflectors to the four previous models, it becomes obvious that the 3D data has re-opened the discussion of the true nature of the feature.

3D PSTM Inline 900

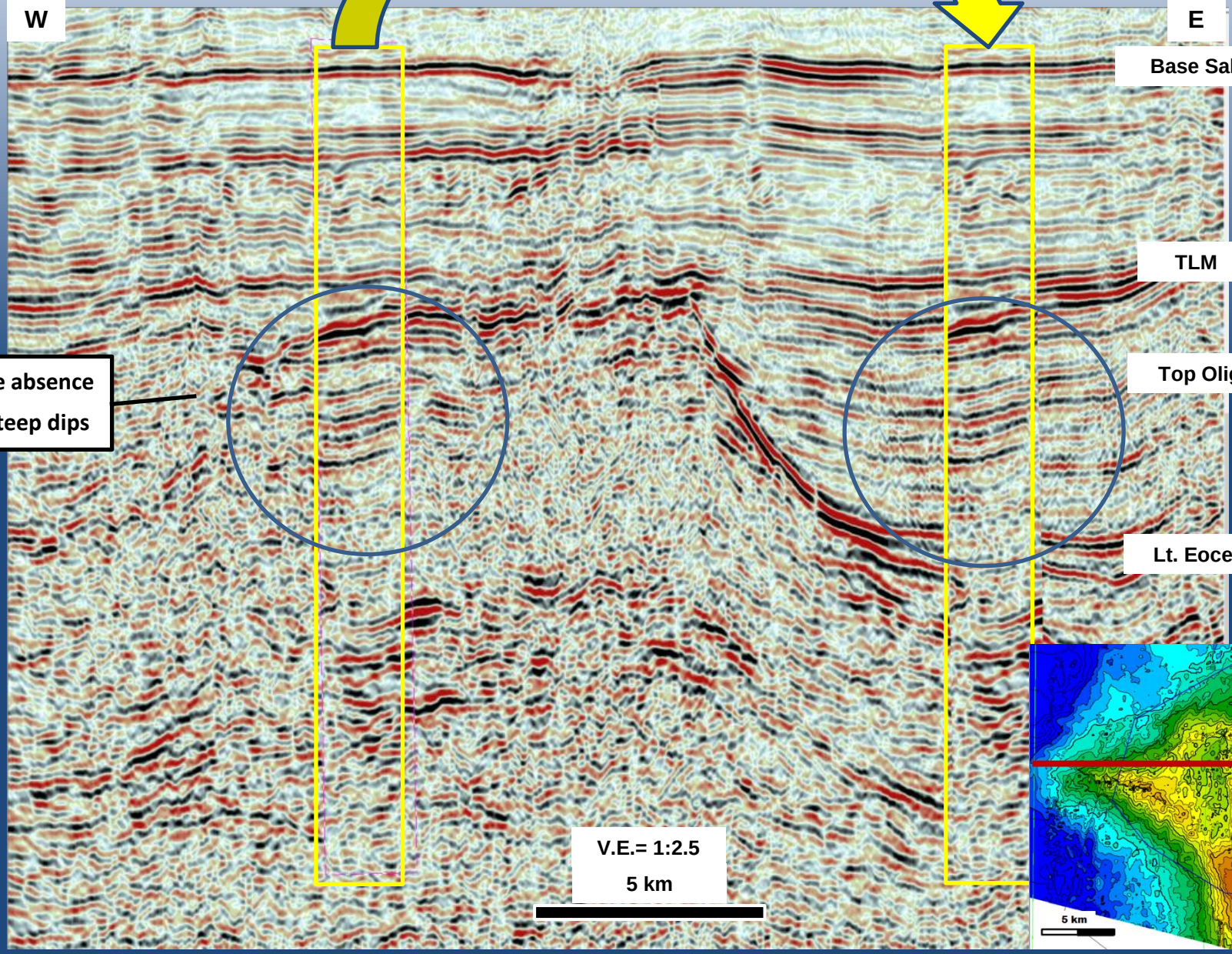


The correlation between the core and the background is demonstrated by this correlation polygon.

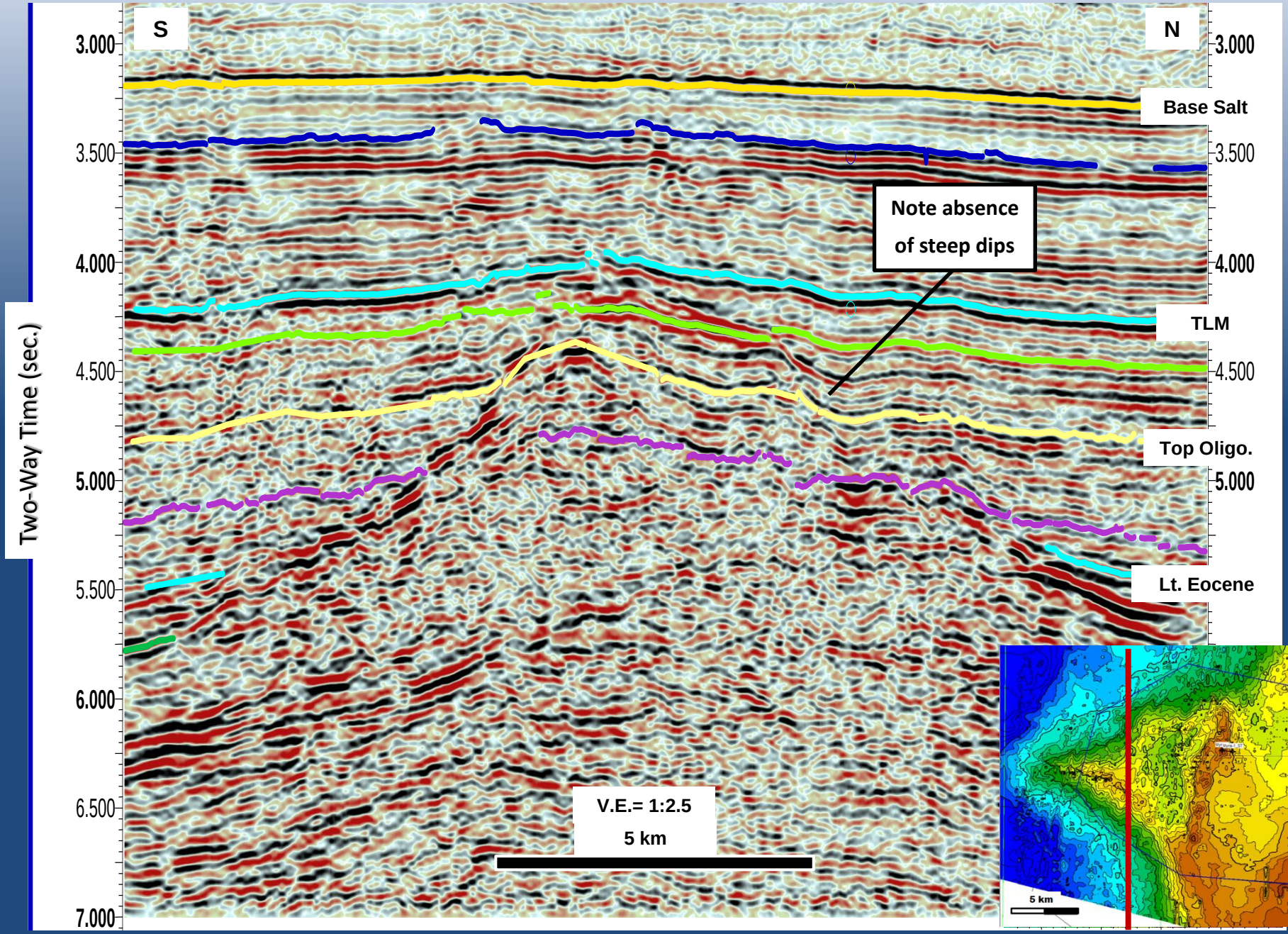
3D PSTM Inline 900 (zoom-in)



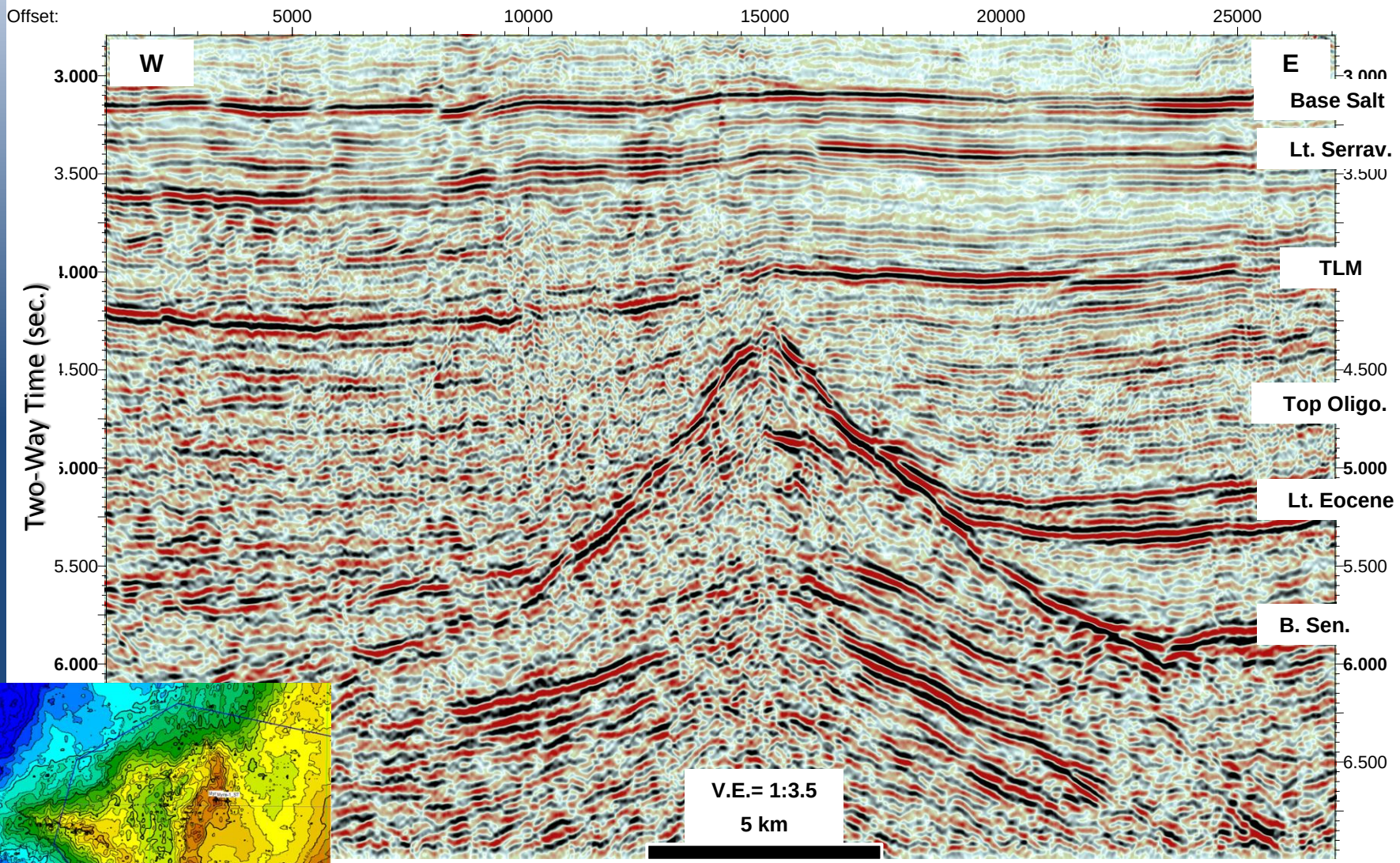
Correlation on another 3D PSTM Inline (980)



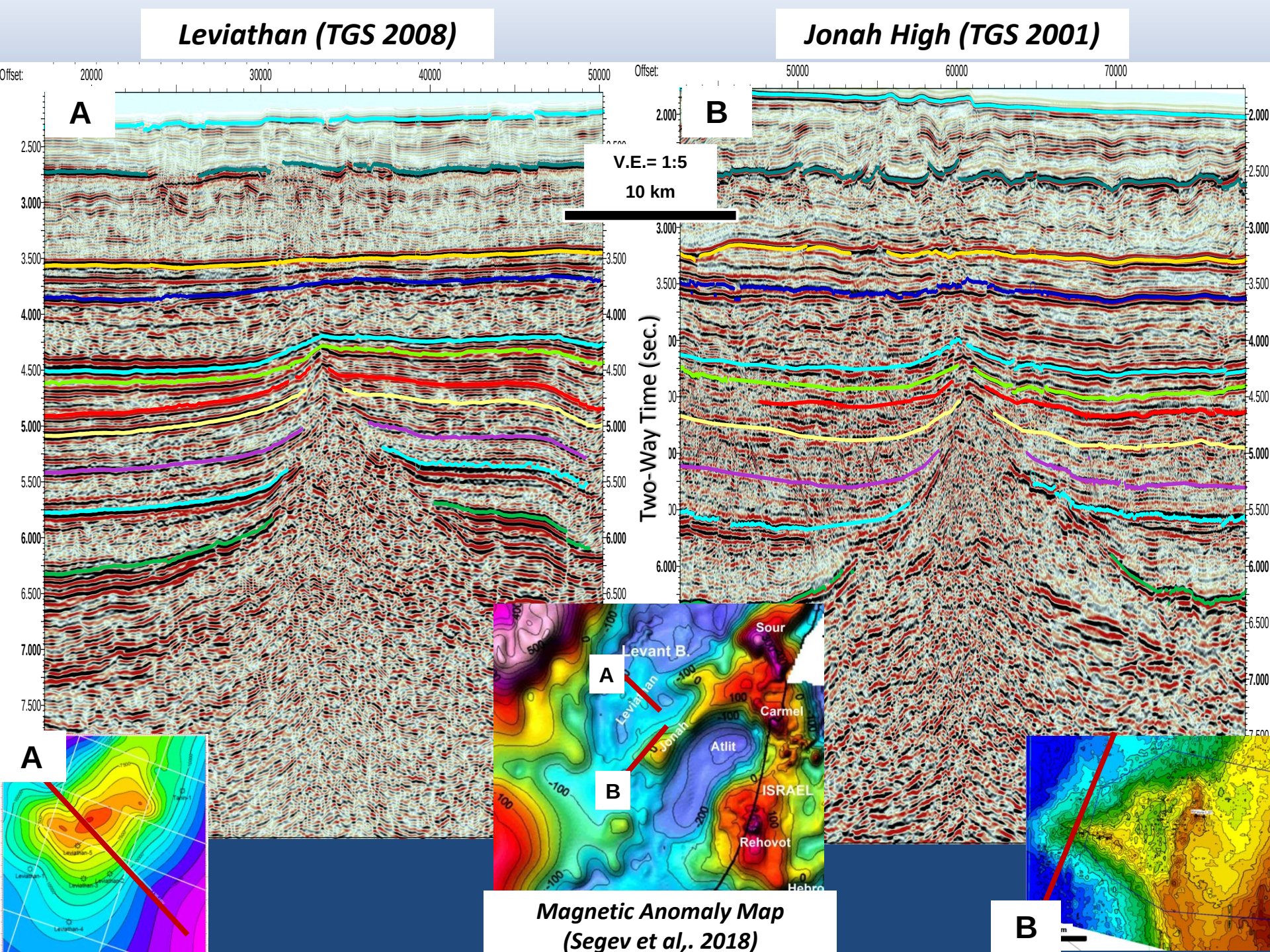
3D PSTM Crossline 2697



3D PSTM Inline 620

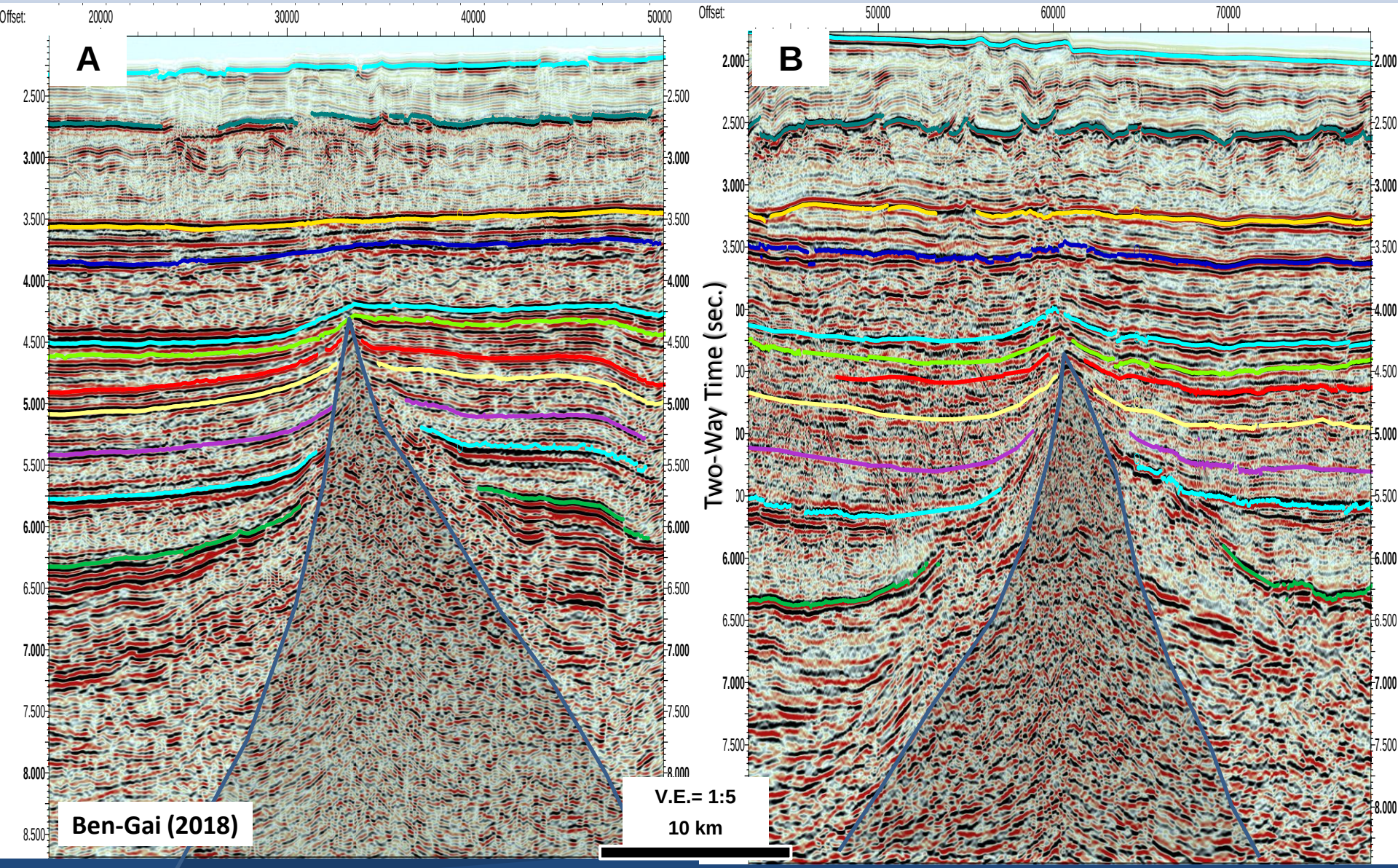


Section across the “root” of the intrusion

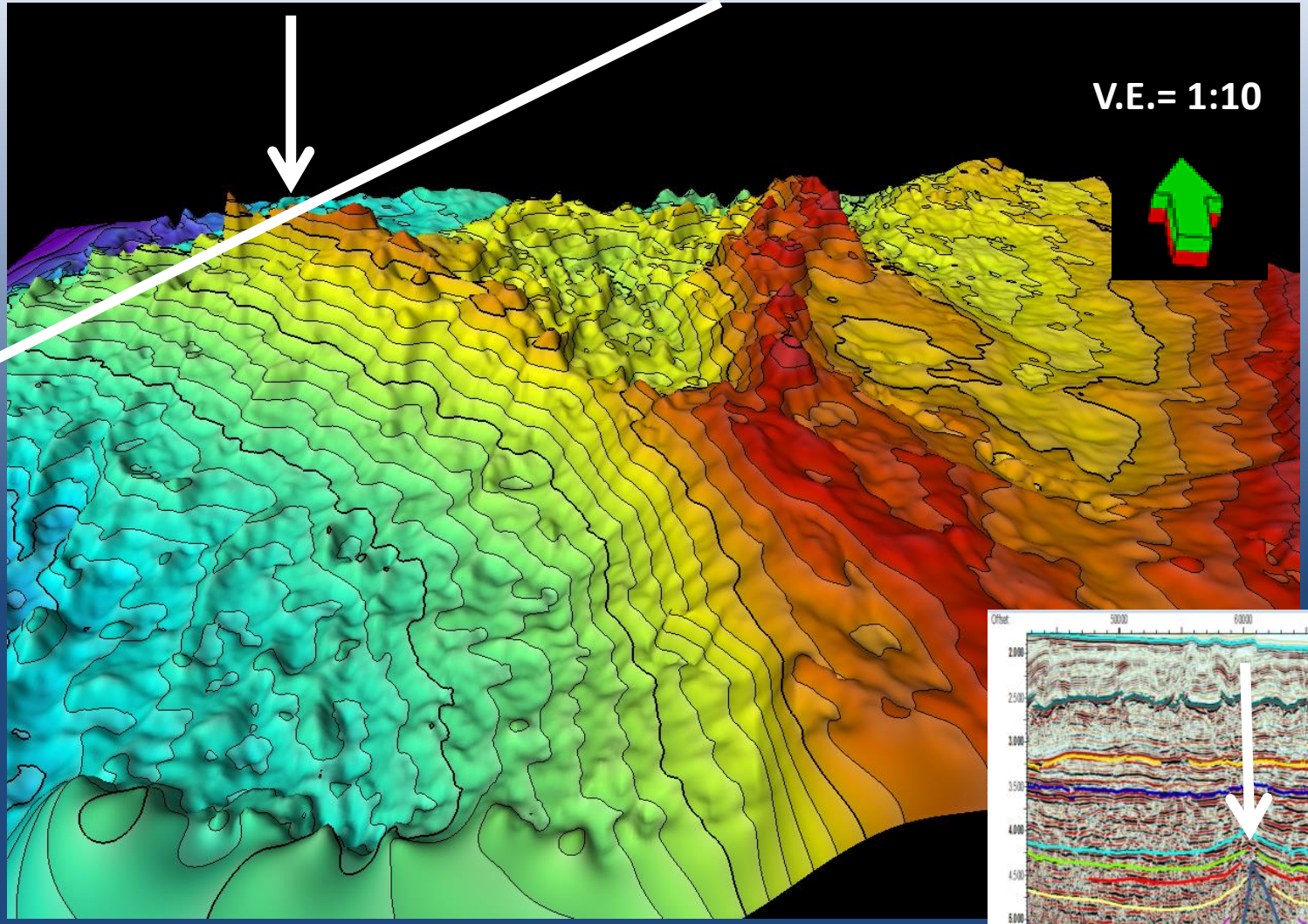

Leviathan (TGS 2008)
Jonah High (TGS 2001)
Offset:
20000
30000
40000
50000
60000
70000
A
B
V.E.= 1:5
10 km
Two-Way Time (sec.)
Levant B.
Sour
Carmel
Atlit
ISRAEL
Rehovot
Hebro
Leviathan
Jonah
Magnetic Anomaly Map
(Segev et al,. 2018)

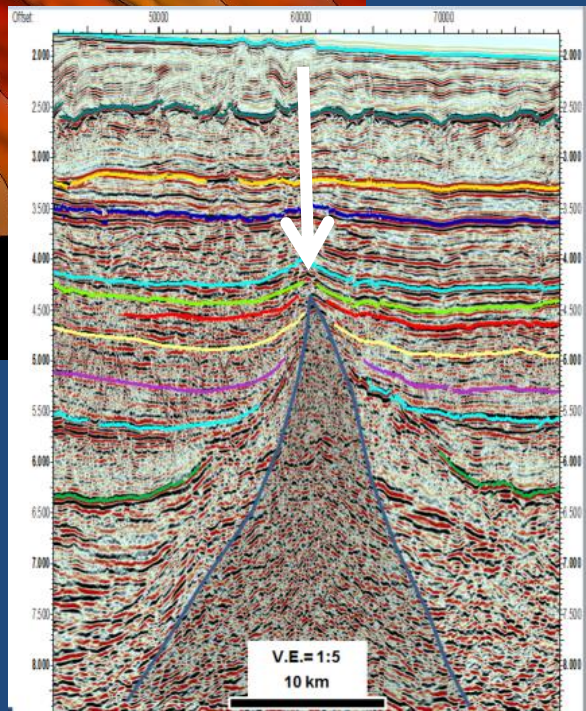
Leviathan (TGS 2008)

Jonah High (TGS 2001)

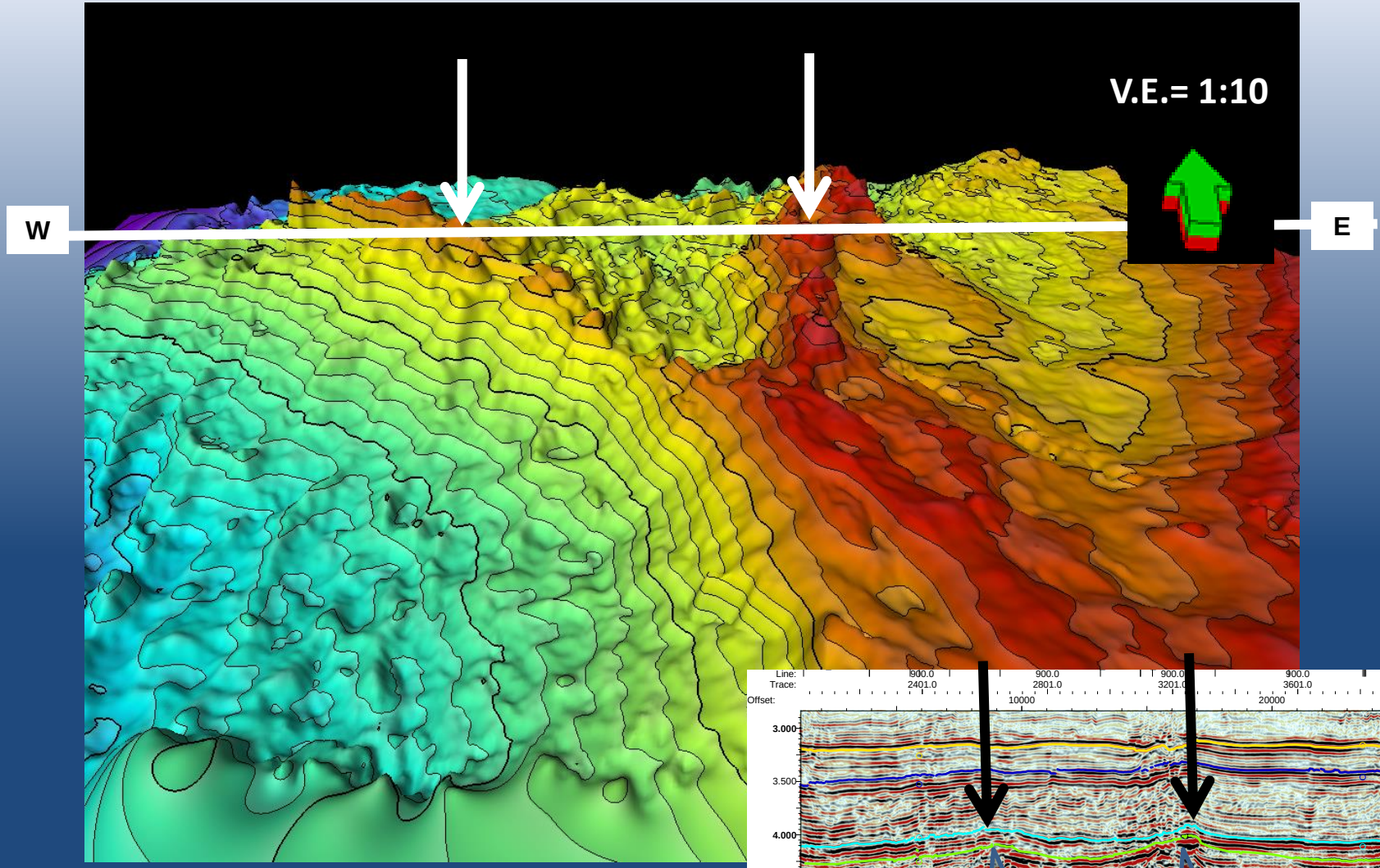


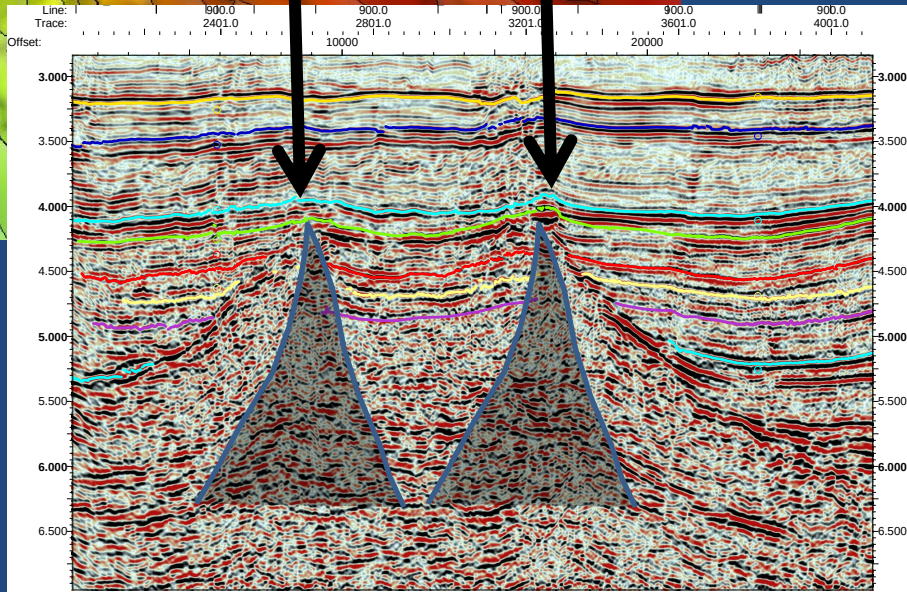
2D lines across the Jonah and Leviathan culminations show similar feature, although of conflicting directions. Jonah High is associated with magnetic anomaly. A shale diapir is suggested for both.





The TLM map is shown here in a 3D mode, with a highly exaggerated vertical scale. It is suggested to reflect an Early to Middle Miocene bifurcated intrusion that may explain the structure's enigmatic triangular shape.





The bifurcated intrusion shown on a W-E line across both arms

Concluding Remarks

- **Most of the structures we observe in the Levant basin are of Miocene age. Their understanding is a key to the deep part.**
- **Jonah High is suggested to be a bifurcated diapiric feature of Lower to Middle Miocene.**
- **Given the palaeoenvironment of its surrounding, is it possible that the top part of Jonah High is composed of a carbonate buildup?**
- **Many questions are still open regarding this and other structures of its kind, as none has yet been penetrated by drilling.**

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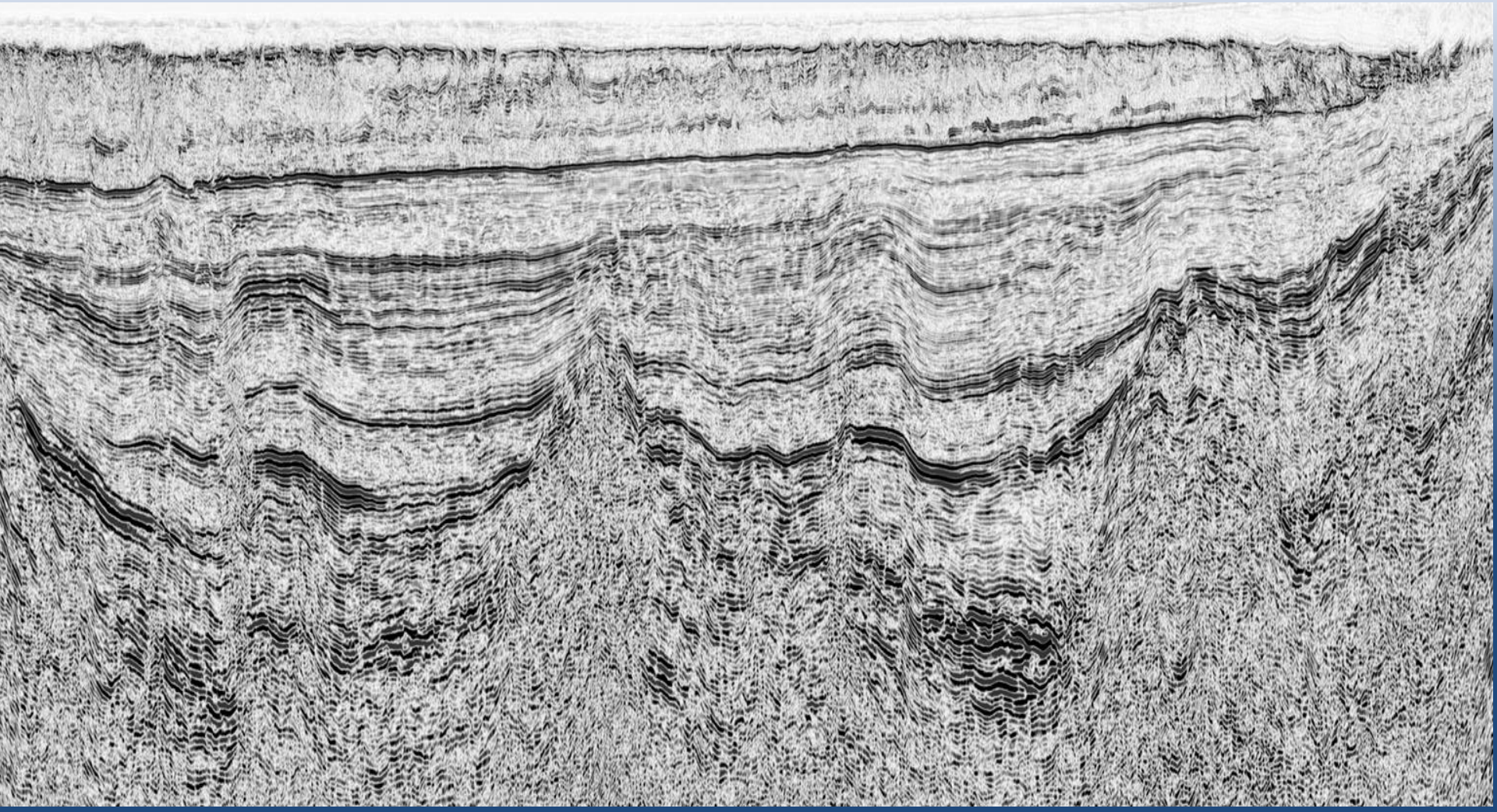

Thank You