

# **Evidence of Petroleum System Evolution of the Southern Bredasdorp Basin, South Africa: A Multi-Dimensional Approach\***

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## **Abstract**

The southernmost Bredasdorp Basin, offshore South Africa, remains only partially understood with respect to petroleum systems evolution when compared to the northern and central flanks of the basin. The southern flank of the basin has been unsuccessful for hydrocarbons with most of the wells drilled to date yielding insignificant oil and gas shows. Incomplete integration of data in the southern area is a possible reason for the oil and gas search being hitherto unsuccessful. In this study, we apply a two-dimensional, later up-scaled to a three-dimensional, modeling approach in order to advance our understanding of the petroleum systems evolution in the southern flank of the Bredasdorp Basin.

The model is based on the interpretation of 64,490 m two-dimensional seismic-reflection profiles, as well as the analyses of well logs and cores that constrain the sedimentary facies distribution and the units' age. Four main source rock intervals (Barremian, Aptian and Turonian) were modeled for maturity and hydrocarbon generation.

Different scenarios of erosion and heat flow histories were considered for model calibration. The best calibration with vitrinite reflectance data is achieved when an erosive event, removing up to ~ 800 m of Maastrichtian to early Paleogene sediments, is accounted for in the model. Maturity predictions suggest that the Barremian and Aptian source rocks are currently mature and started generating hydrocarbons at about 80 Ma, whereas the Turonian source rock is immature. Present-day modeled transformation ratios for both mature source rocks are higher than 50%. Nevertheless, petroleum generation seems to be halted at about 69 to 35 Ma and 12 to 0 Ma due to minimal burial depth of sediments.



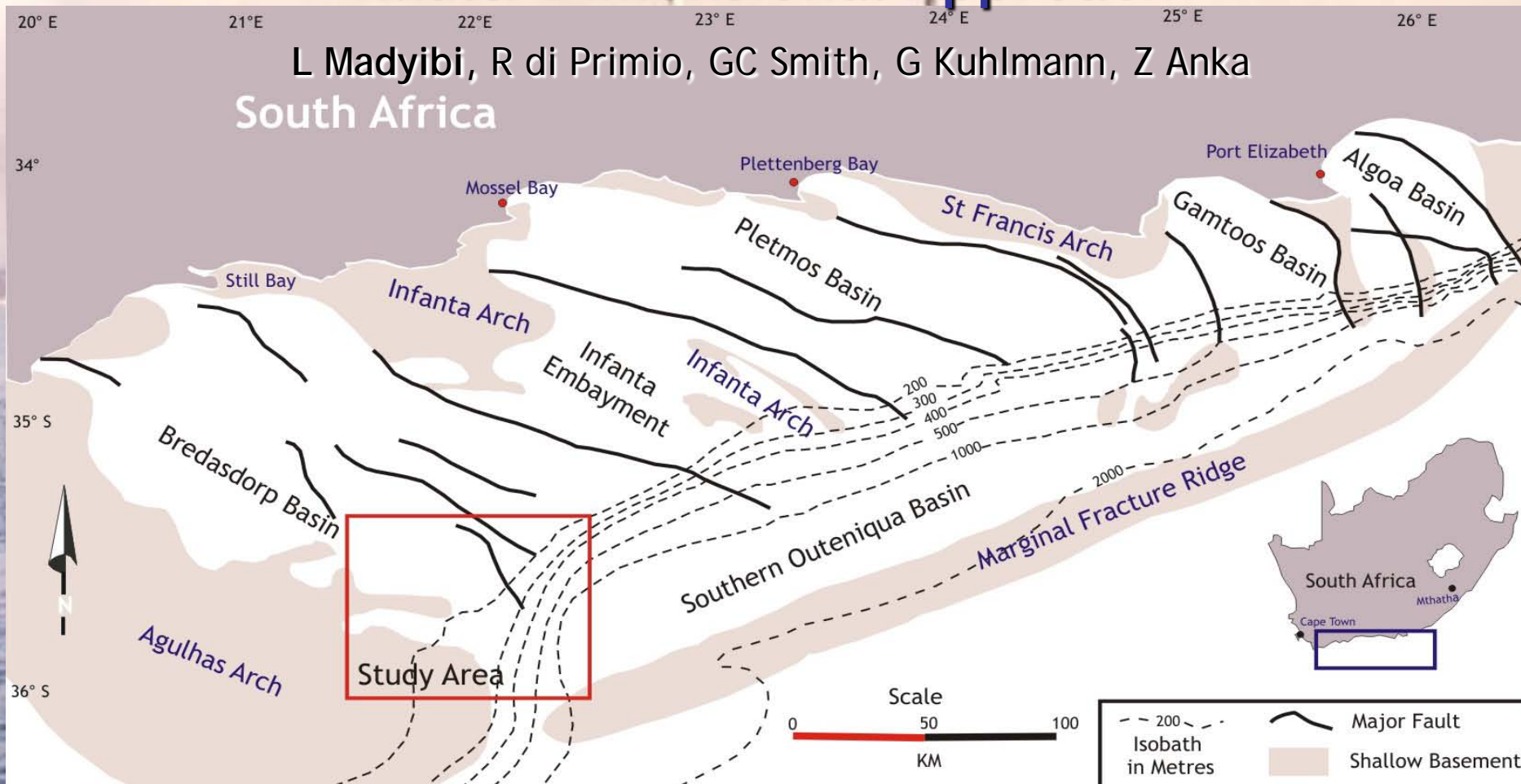
UNIVERSITY OF CAPE TOWN

Geological Sciences



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L Madyibi, R di Primio, GC Smith, G Kuhlmann, Z Anka  
South Africa





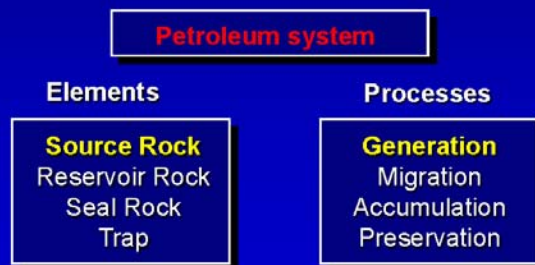
# Outline of the presentation

- Background and aims of the study
- Geological background
  - Sequence stratigraphy of the Bredasdorp sub-basin
- Methods used in the study
  - Seismic and well log data interpretation and integration
  - Depth conversion
  - 3D basin modelling
- Petroleum system evolution
  - Source rock maturity
  - Presence of reservoirs
- Concluding remarks



## Background and aims of the study

*The general aim of this study was to investigate the evolution of the petroleum system in the southeast flank of the Bredasdorp Basin.*



"A petroleum system exists wherever these essential elements and processes are known to occur or are thought to have a reasonable probability to occur", **Magoon 1992**

Notes by Presenter: The southernmost Bredasdorp Basin, offshore South Africa, remains only partially understood with respect to petroleum systems evolution when compared to the northern and central flanks of the basin.

The southern flank of the basin has been unsuccessful for hydrocarbons with most of the wells drilled to date yielding insignificant oil and gas shows.

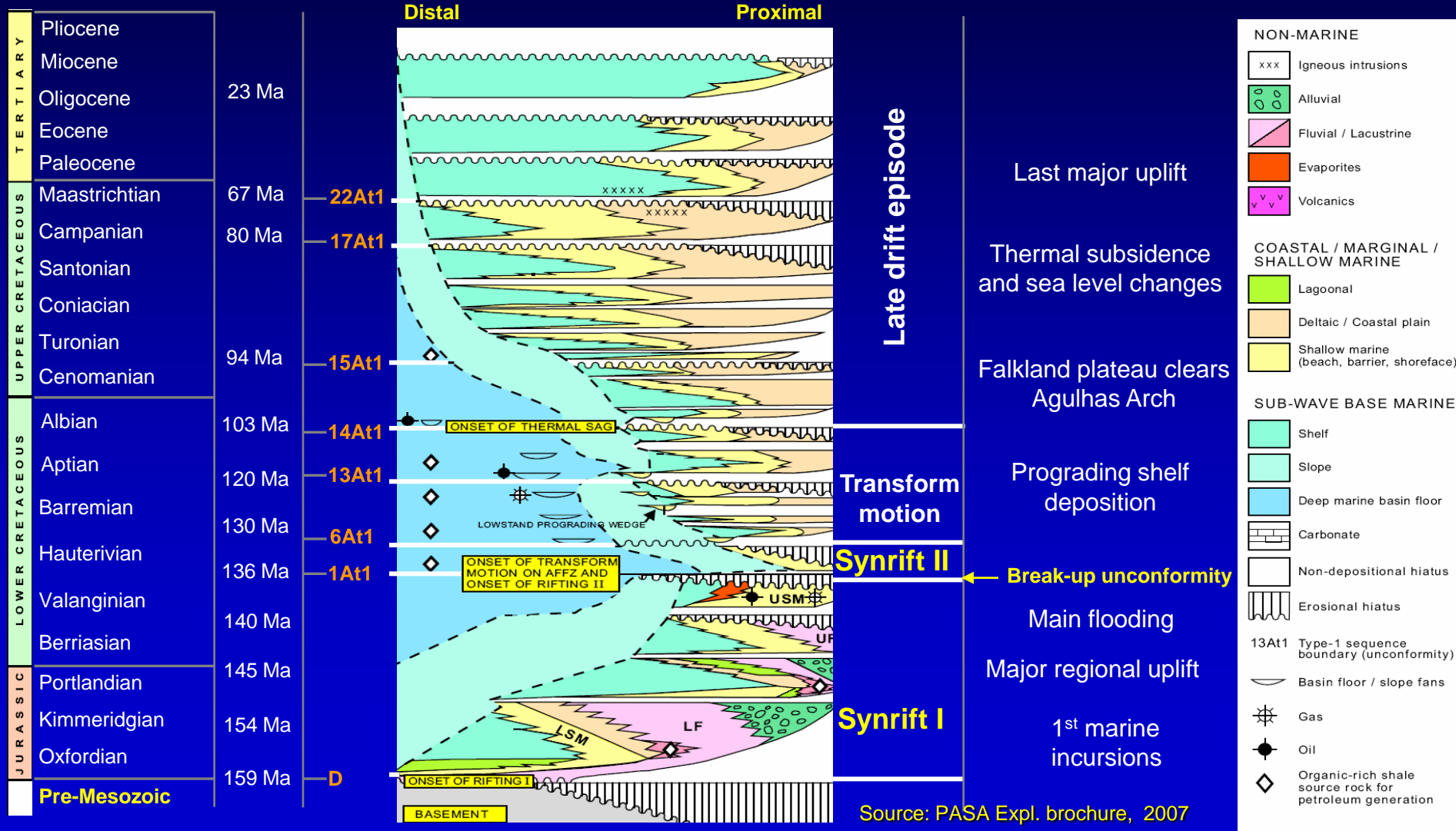
Incomplete integration of data in the southern area is a possible reason for the oil and gas search being hitherto unsuccessful.

In this study, we apply a three-dimensional, modeling approach in order to advance our understanding of the petroleum systems evolution in the southern flank of the Bredasdorp Basin.



# Geological Background

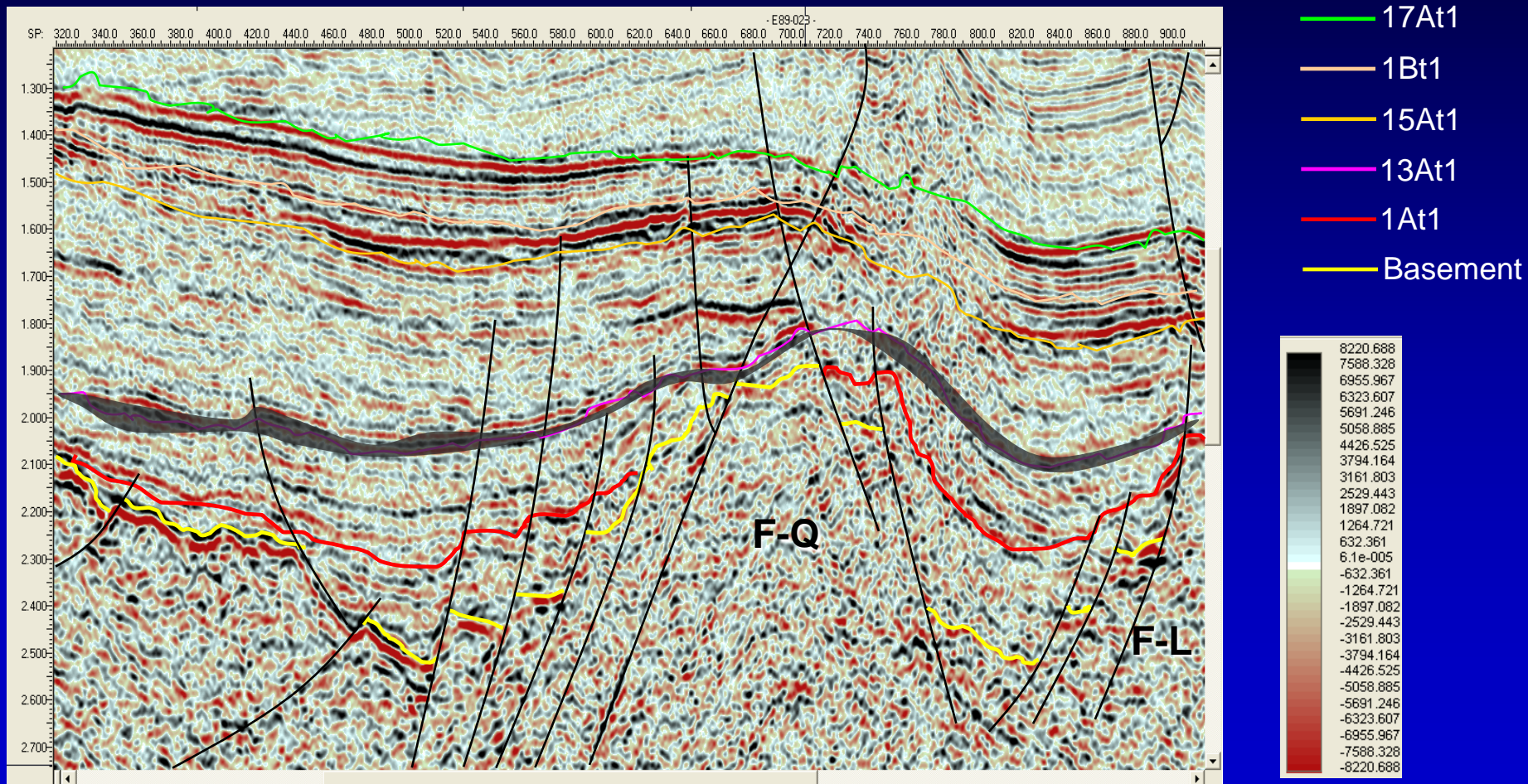
## Sequence chronostratigraphic framework of the Bredasdorp Basin



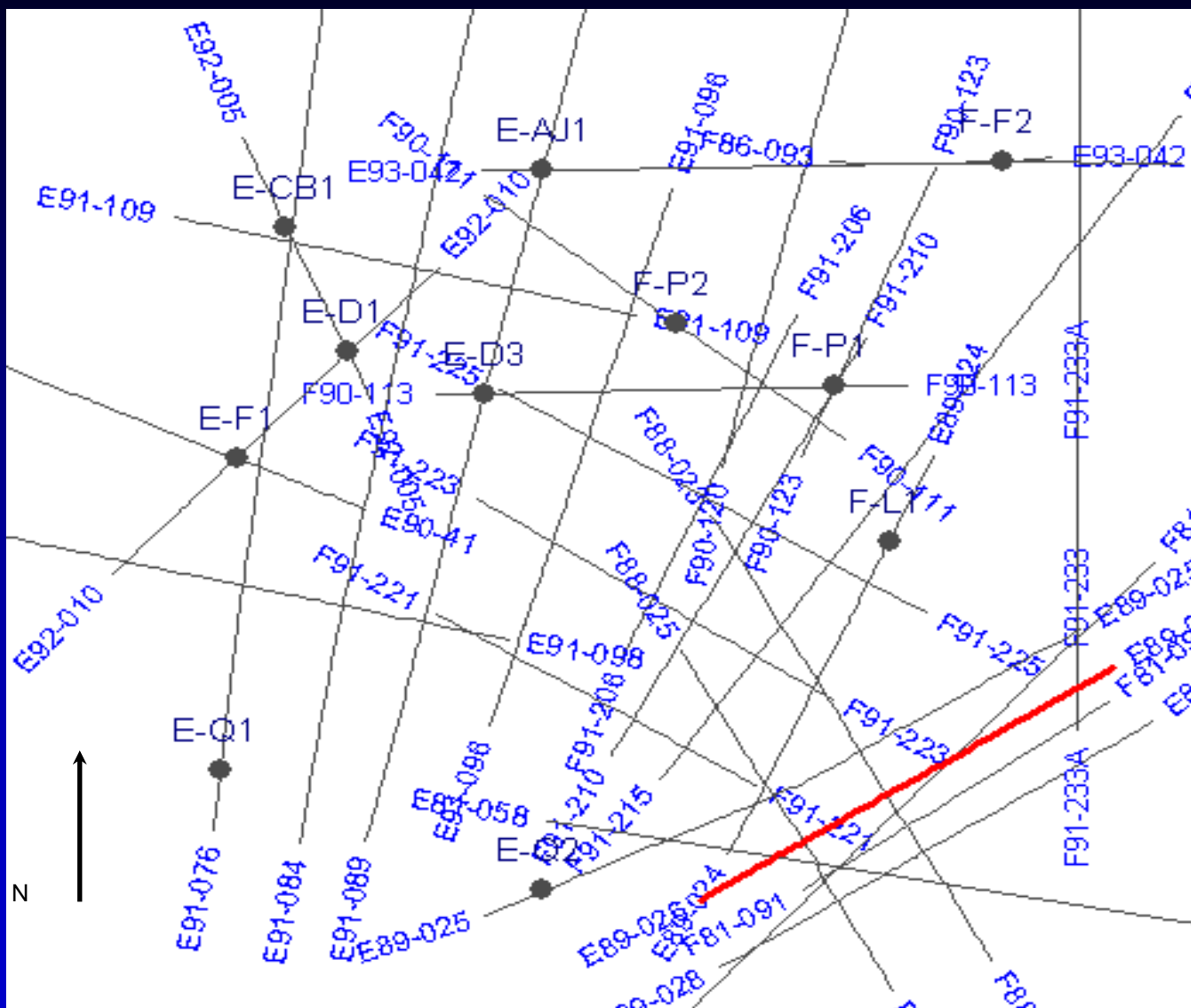


# Seismic Interpretation

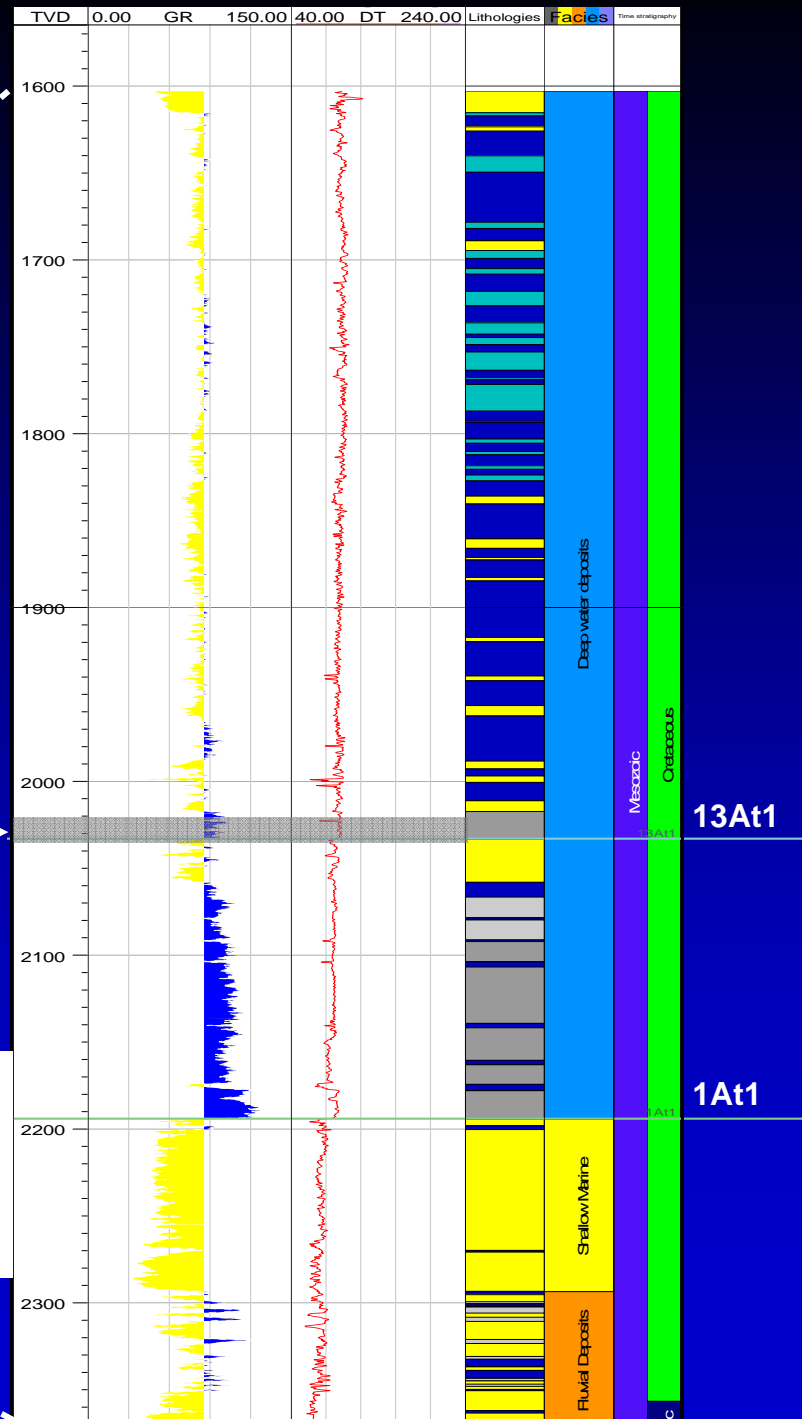
## Mapping horizons & faults



NB: Faults might have been the conduits that allowed migration of oil











# Depth Conversion

Depth Conversion performed using the Vo K method.

$$Z_n = \frac{V_o}{k} \left( e^{\frac{k}{2}(t_n - t_{n-1})} - 1 \right) + (Z_{n-1} - Z_{seafloor}) e^{\frac{k}{2}(t_n - t_{n-1})} + Z_{seafloor}$$

$$V_i = V_o + KZ$$

Where

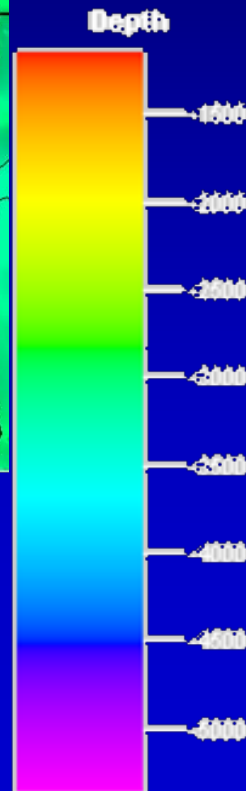
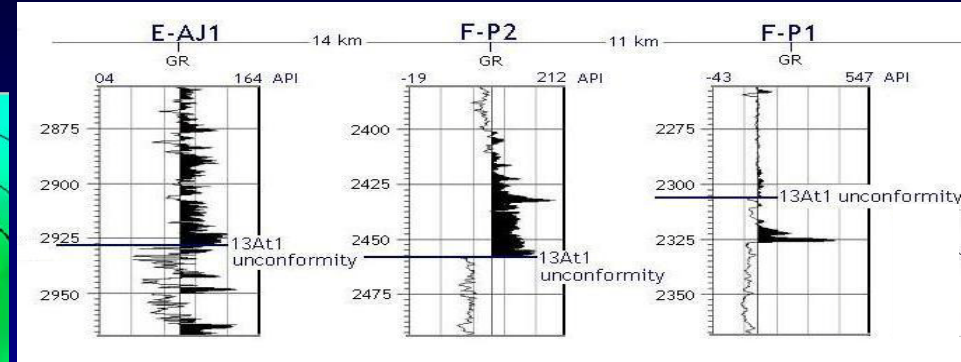
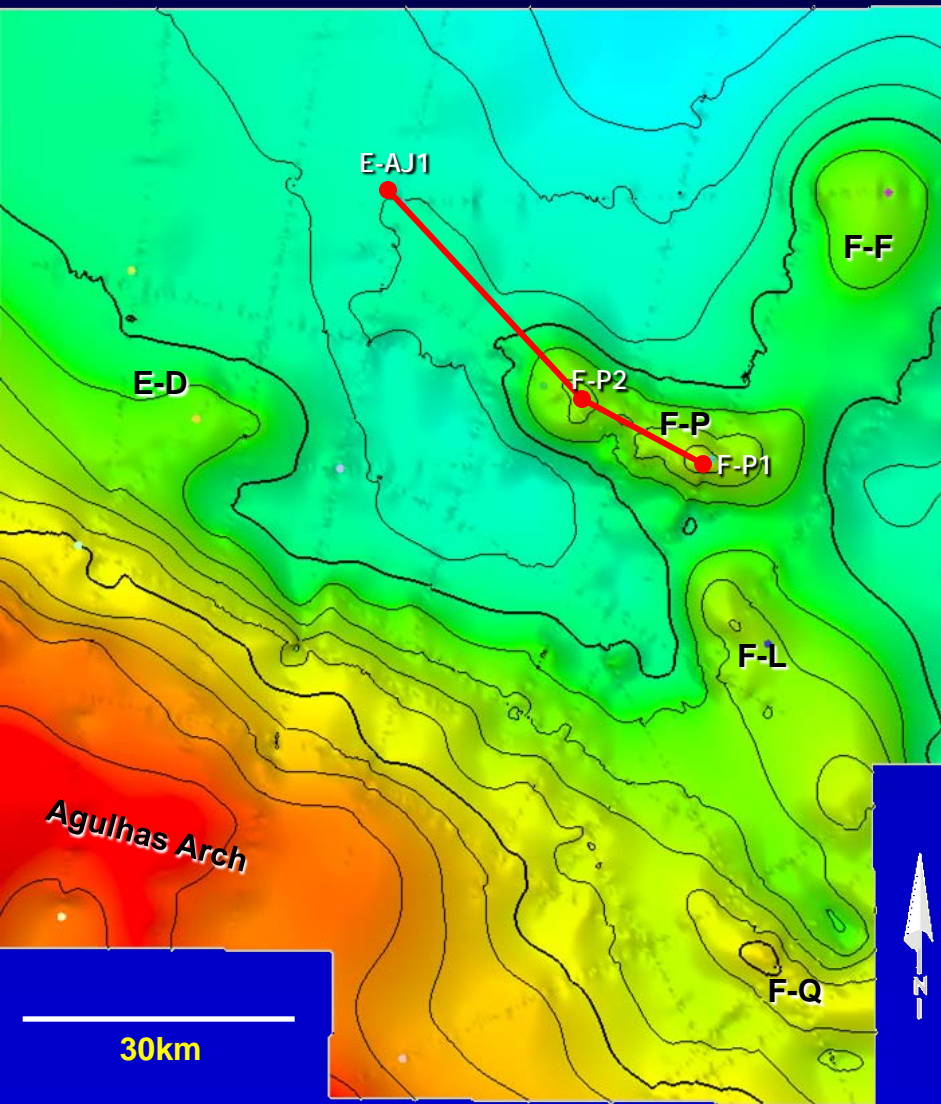
- $V_i$  = Interval velocity
- $V_o$  = Surface velocity (at seafloor)
- $K$  = Velocity gradient
- $Z$  = Depth

Where

- $t_{n-1}, t_n$  = two-way time (twf) to top and base of interval in seconds.
- $Z_{n-1}, Z_n$  = depth to top and base of interval.
- $Z_{seafloor}$  = depth to seafloor



# Depth Conversion



13A source rock was deposited in the Aptian times

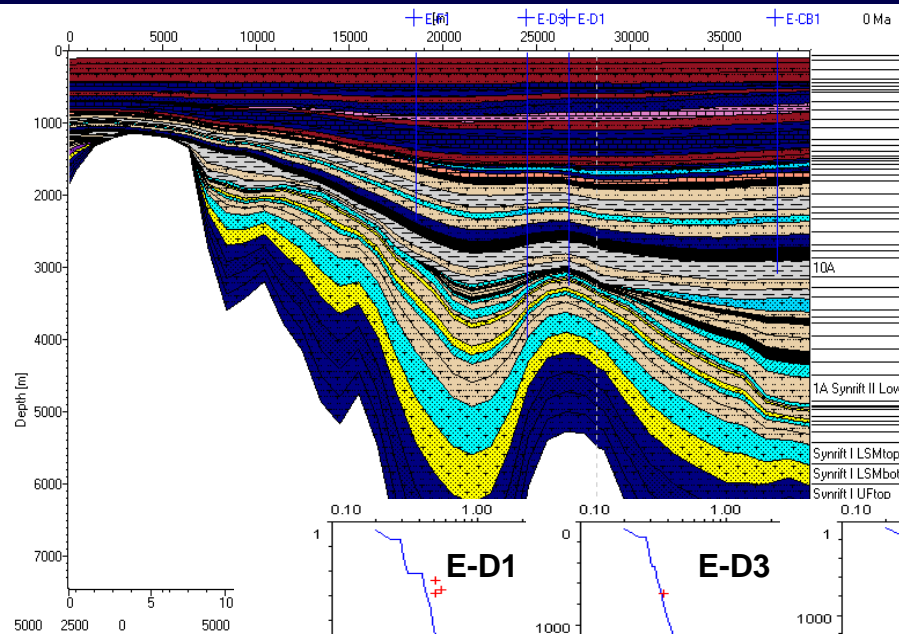
Structural highs formed during rifting phase are still prominent

Depth map to 13At1



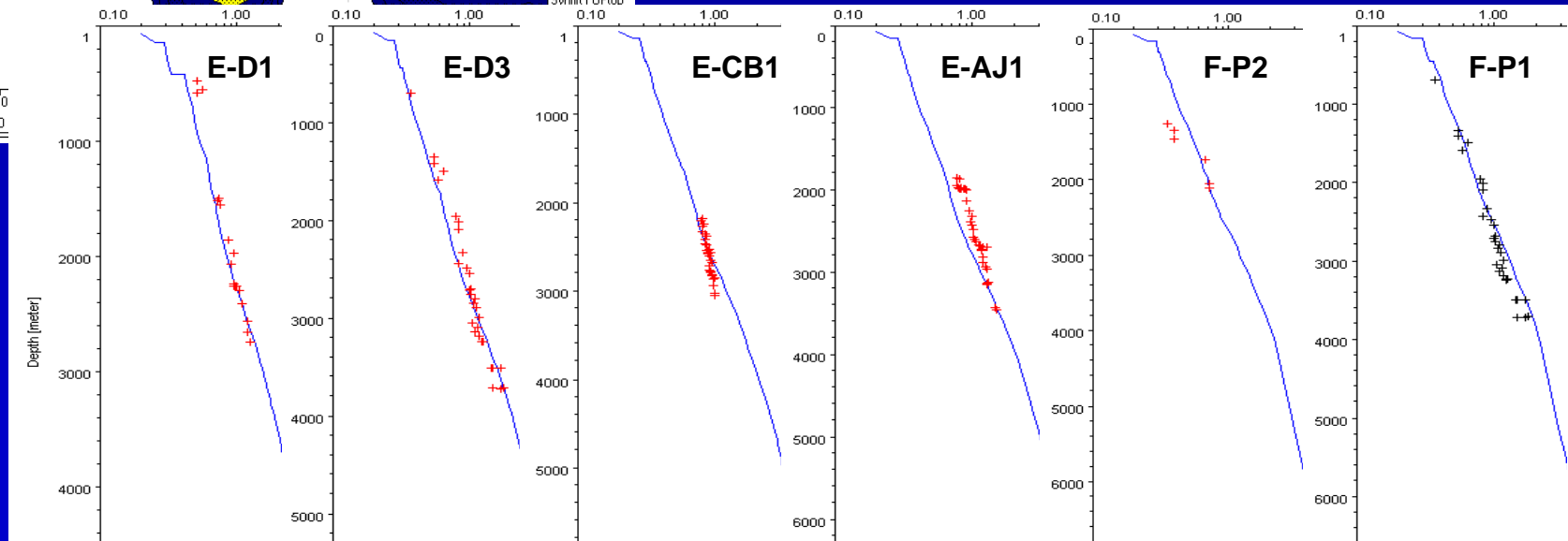
# 3D Basin Modelling

## Model building and calibration



Source rock interval	TOC (wt. %)	HI (mg HC/g TOC)	Kerogen type	Source rock quality
Turonian	4.00	400.00	II	Very good
<b>Aptian</b>	<b>2.00</b>	<b>250.00</b>	<b>II</b>	<b>Good</b>
Barremian	2.00	250.00	II/III	Good

TOC, total organic carbon; HI, hydrogen index

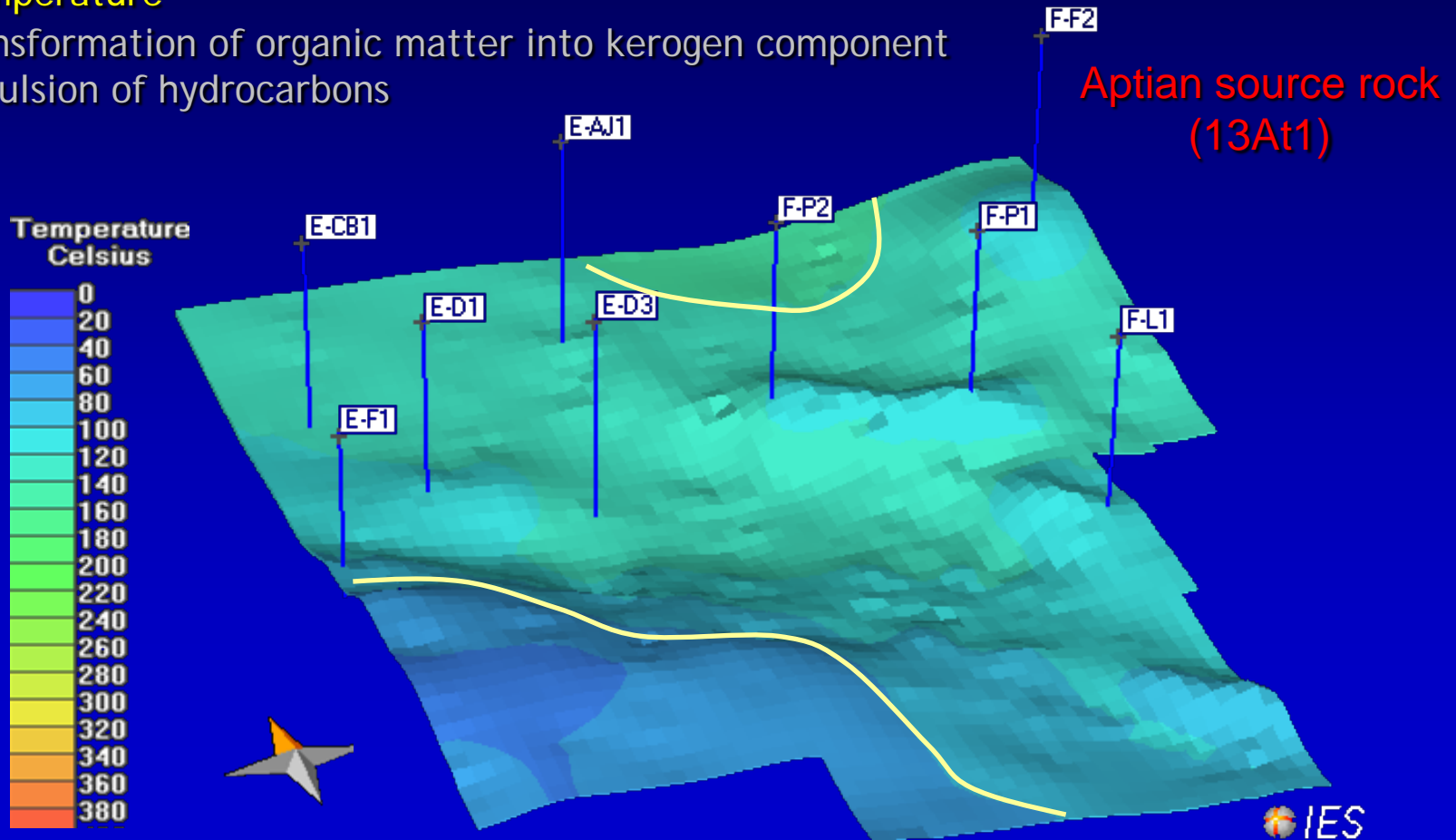




# Petroleum System Evolution

## Source rock maturity

- Temperature
- Transformation of organic matter into kerogen component
- Expulsion of hydrocarbons



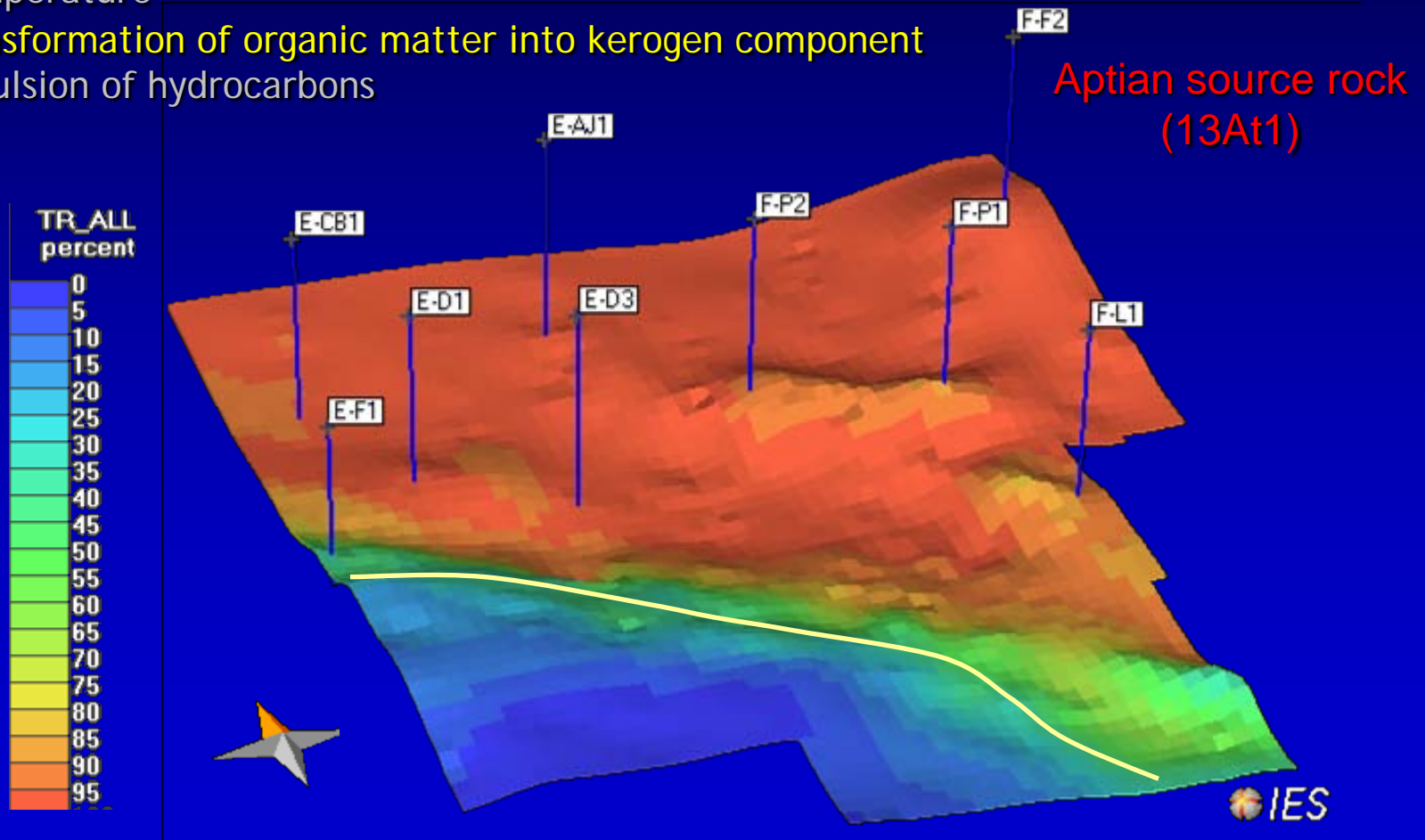




# Petroleum System Evolution

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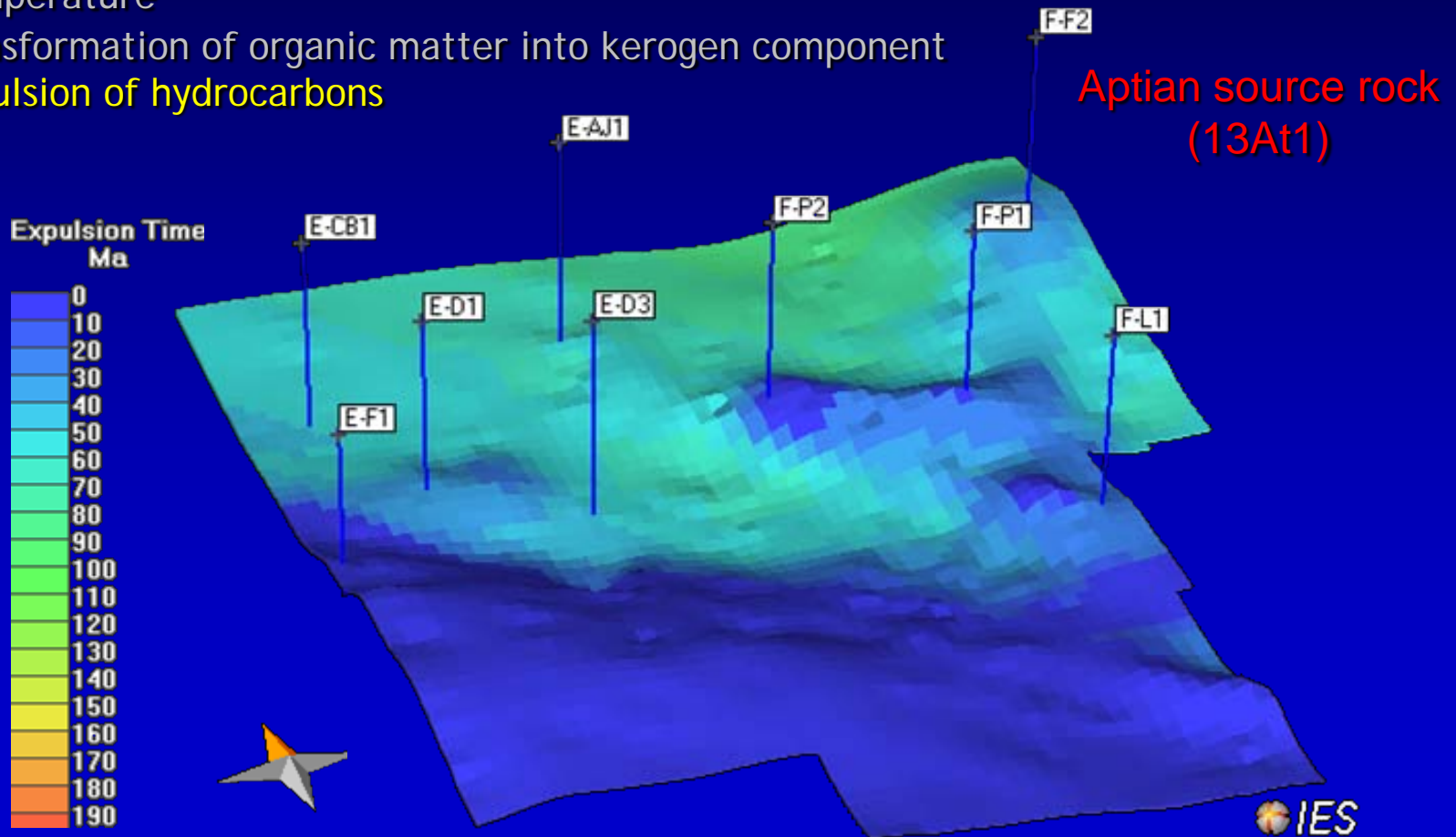




# Petroleum System Evolution

## Source rock maturity

- Temperature
- Transformation of organic matter into kerogen component
- **Expulsion of hydrocarbons**

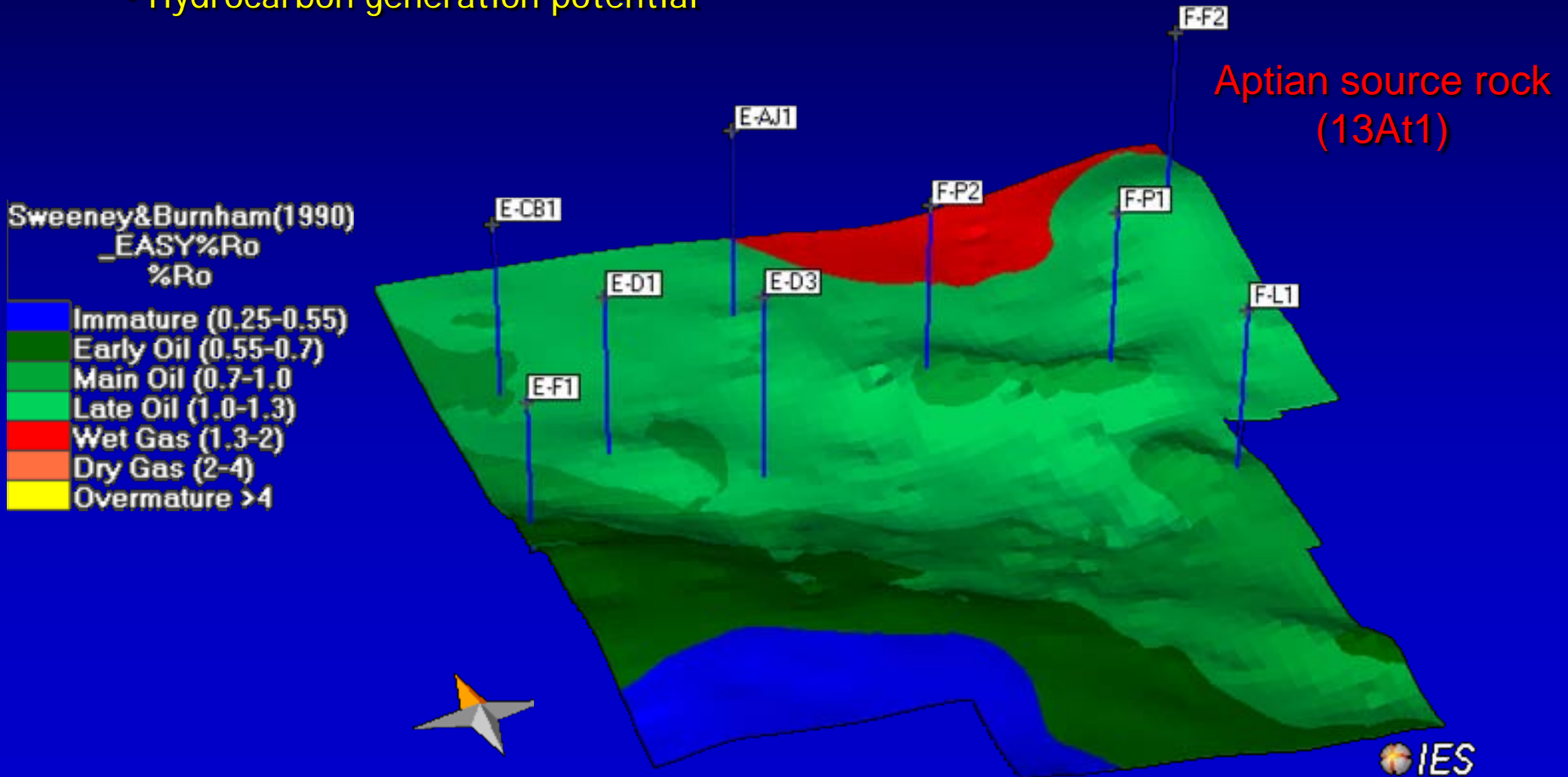




# Petroleum System Evolution

## Source rock maturity

- Hydrocarbon generation potential

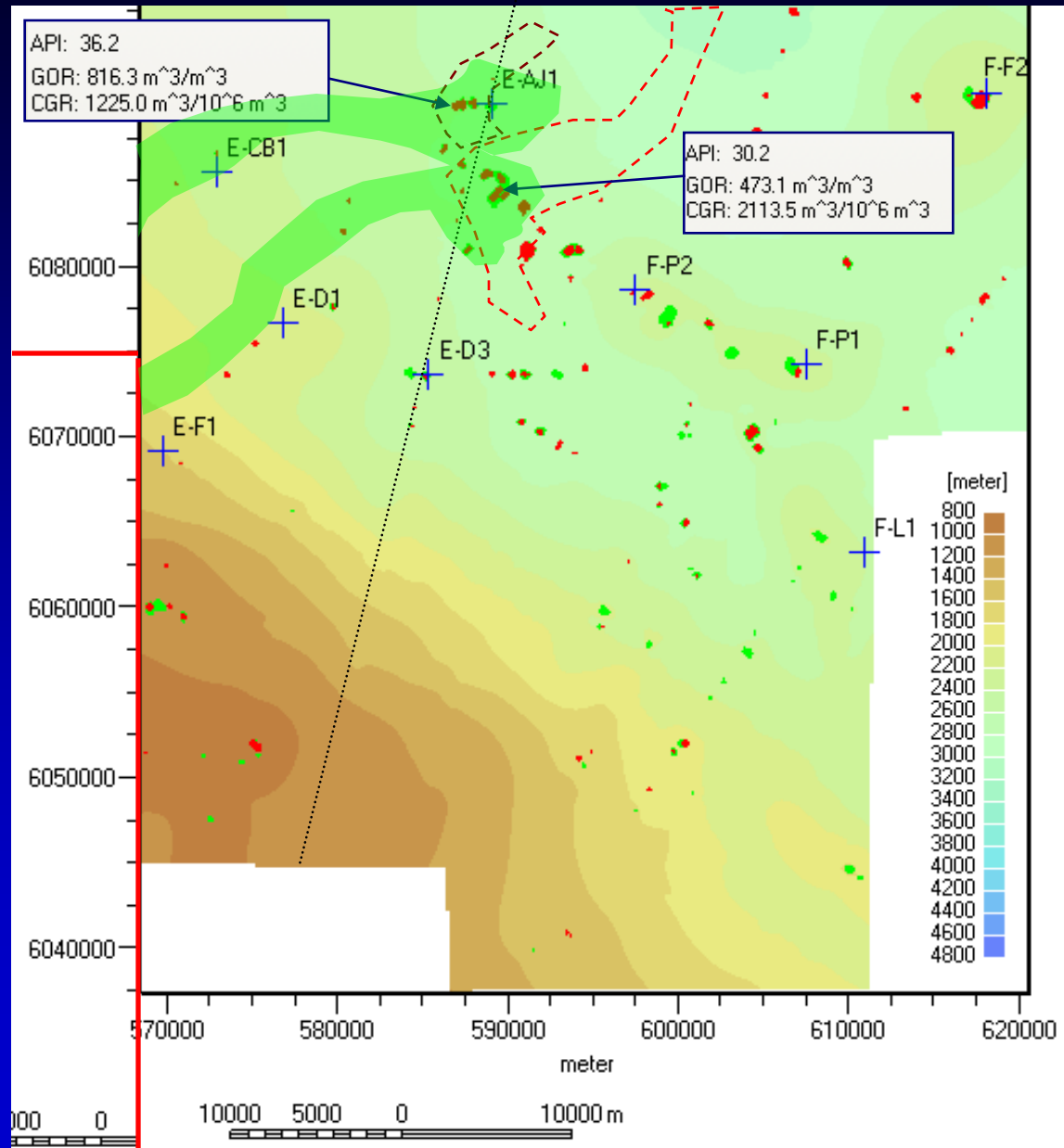




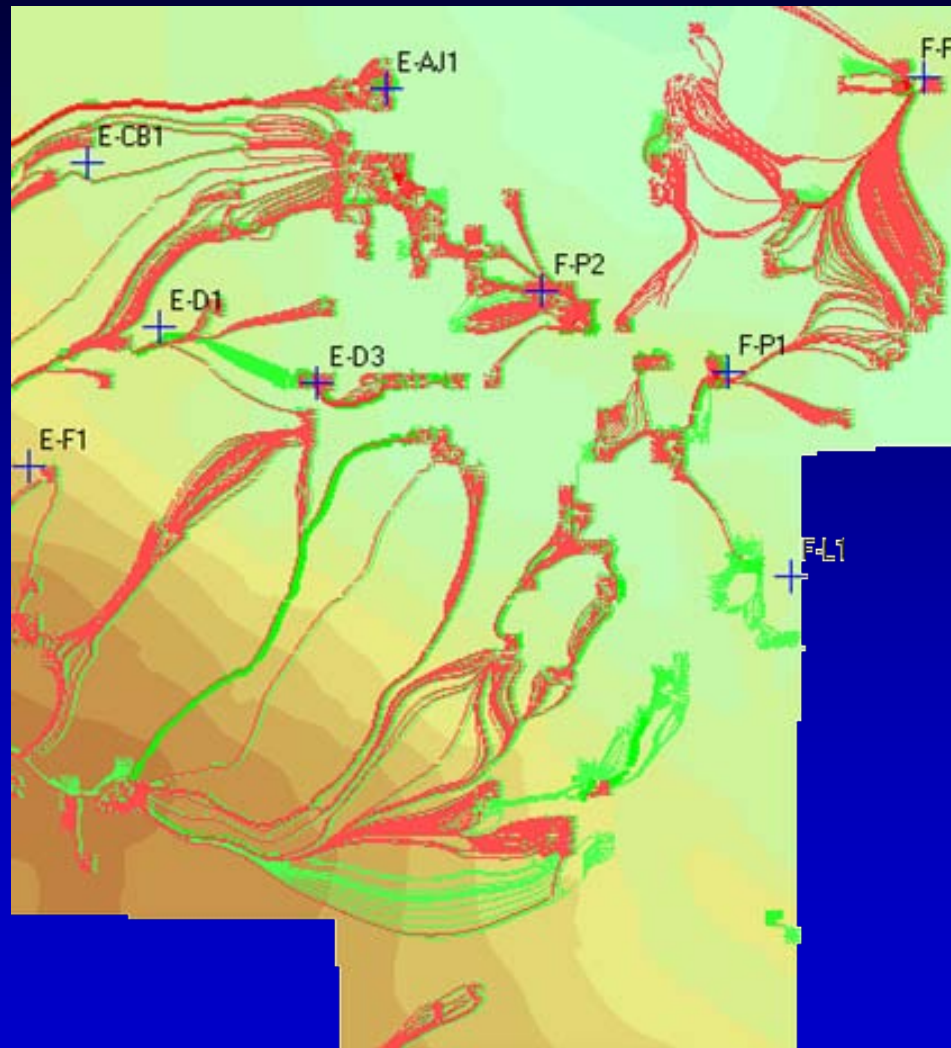
# Petroleum System Evolution

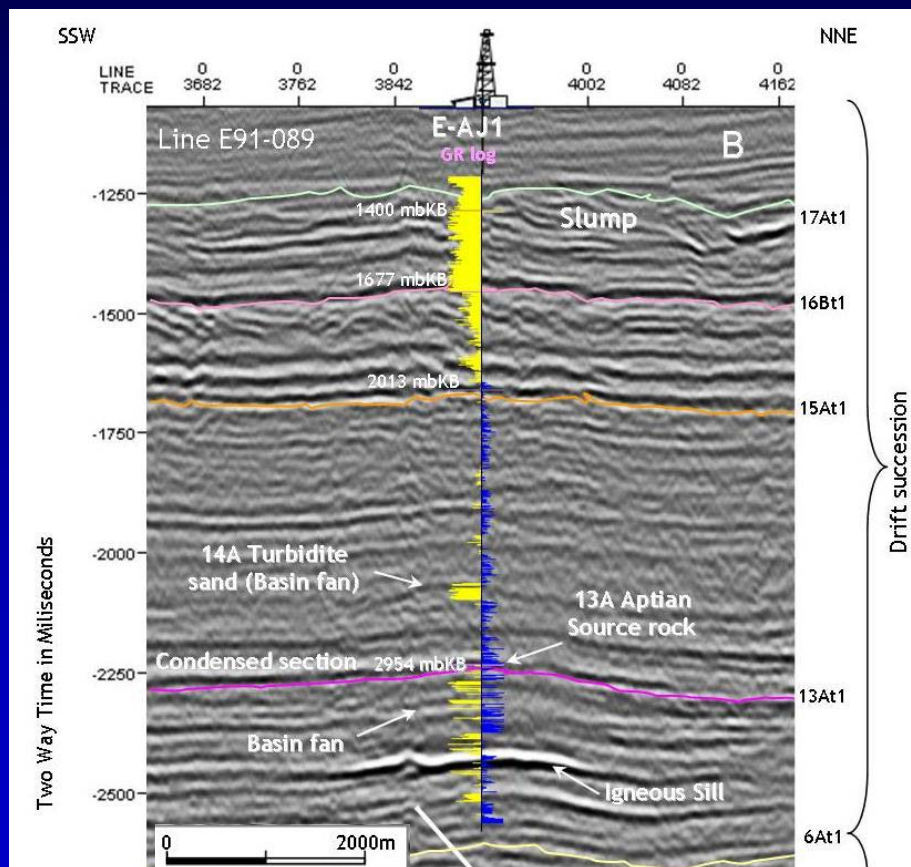
## Reservoirs

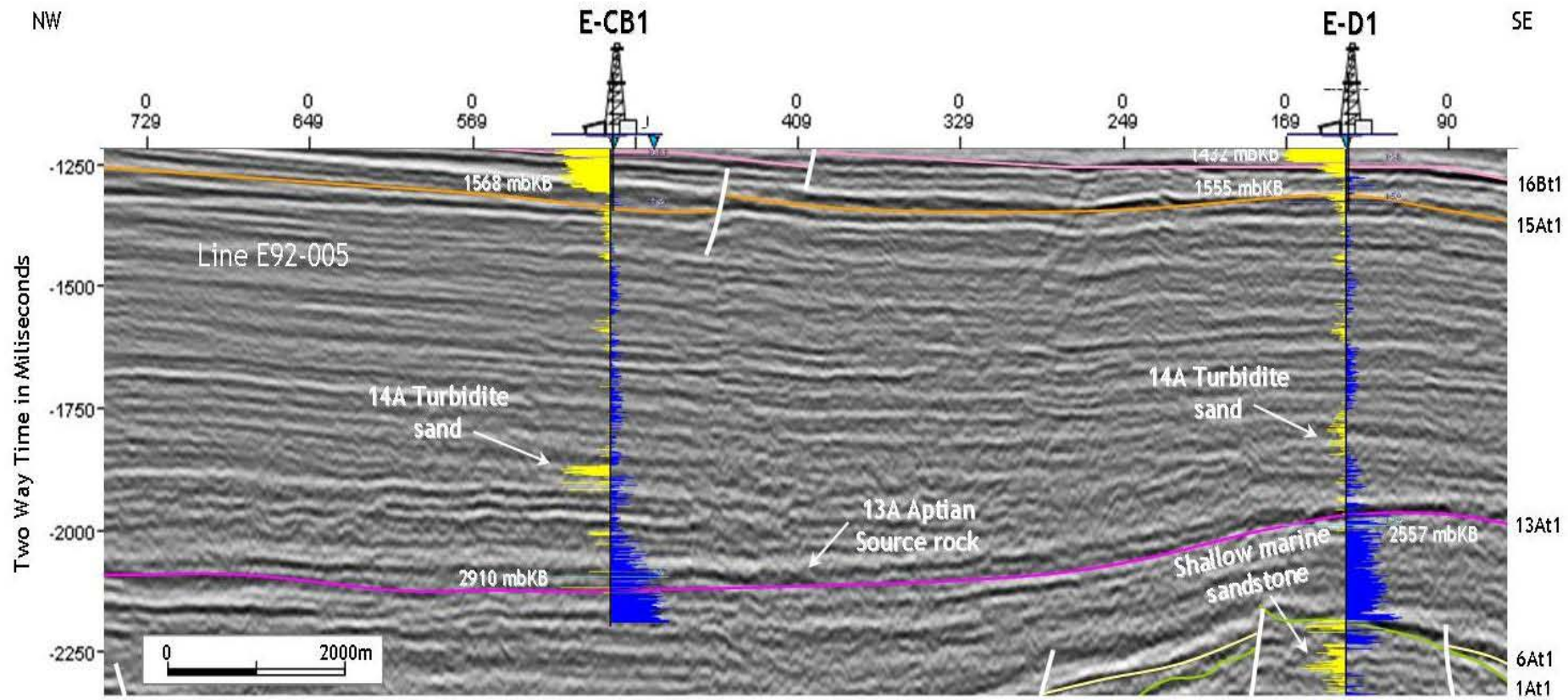
- Accumulations







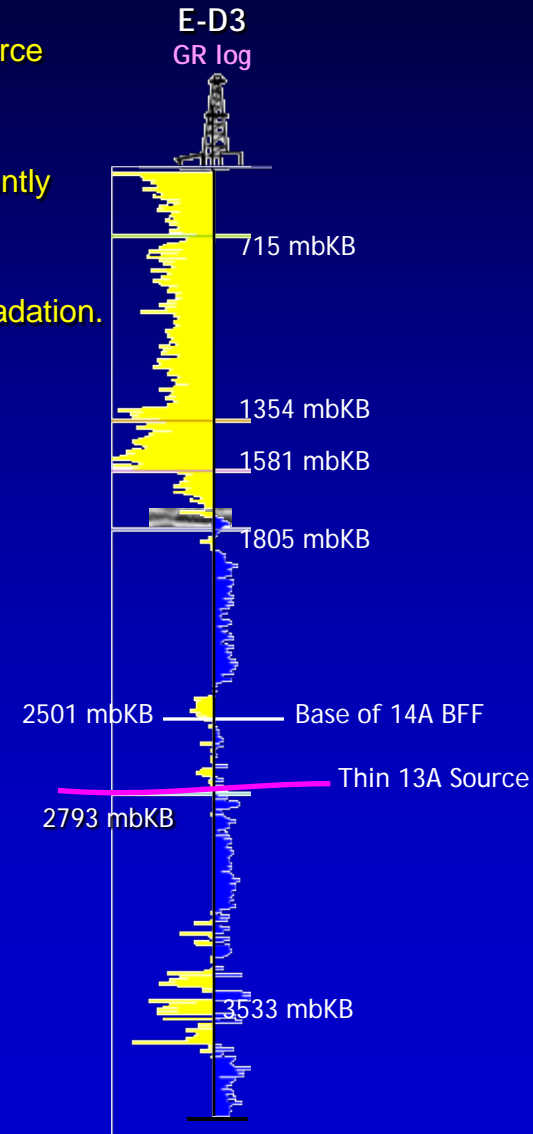
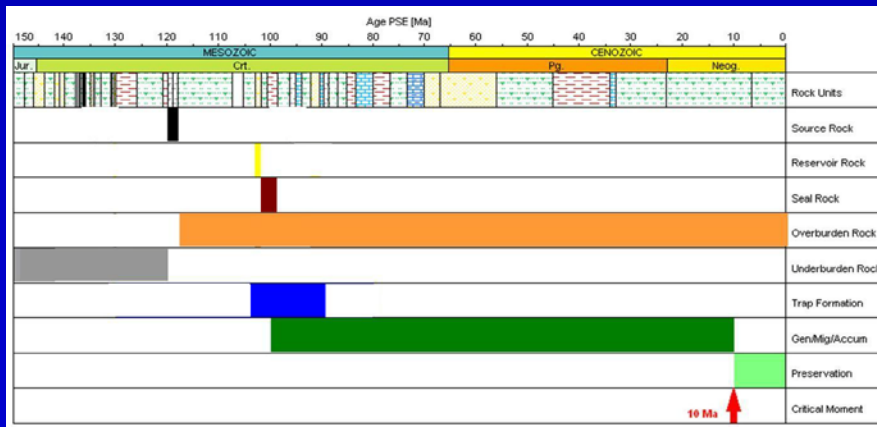
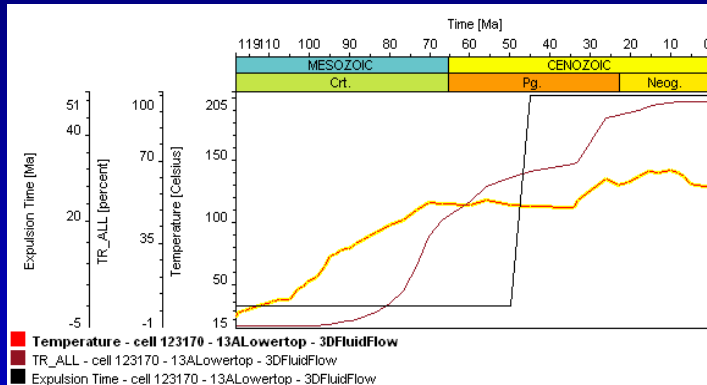






# Concluding Remarks!!!

- The results of petroleum generation modelling show different maturity levels within the source rock interval 13A.
- The modelled burial history records major episodes of erosion that seems to have significantly affected the generation of petroleum during the Tertiary period.
- Oil and gas generated and accumulated before 67 ma is lost due to inversion and biodegradation.





## Acknowledgements:



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**Schlumberger**



# Thank you for your attention