

# Pre-Messinian Petroleum System and Trapping Style, Offshore Western Nile Delta, Egypt\*

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## Abstract

Exploration in the offshore Nile Delta province has revealed several hydrocarbon plays. Deep marine Turbidites is considered one of the most important plays for hydrocarbon exploration in the Nile Delta. These turbidites vary from submarine turbidite channels to submarine basin floor fans. An integrated exploration approach was applied for a selected area within West Delta Deep Marine (WDDM) Concession offshore western Nile Delta using a variety of geophysical, geological and geochemical data to assess the prospectivity of the Pre-Messinian sequences. This paper relies on the integration of several seismic data sets for a new detailed interpretation and characterization of the sub-Messinian structure and stratigraphy based on regional correlation of seismic markers and honoured the well data. The interpretation focused mainly on the Oligocene and Miocene mega-sequences. The seismic expression of stratigraphic sequences shows a variety of turbidite channel/canyon systems having examples from West Nile delta basin discoveries and failures. The approach is seismically based focusing on seismic stratigraphic analysis, combination of structure and stratigraphic traps and channels interpretation. Linking the geological and geophysical data together enabled the generation of different sets of geological models to reflect the spatial distribution of the reservoir units. The variety of tectonic styles and depositional patterns in the West Nile delta provide favourable trapping conditions for hydrocarbon generations and accumulations. The shallow oil and gas discoveries in the Pliocene sands and the high-grade oils in the Oligo-Miocene and Mesozoic reservoirs indicate the presence of multiple source rocks and an appropriate conditions for hydrocarbon accumulations in both biogenic and thermogenic petroleum systems. The presence of multi-overpressurized intervals in the Pliocene and Oligo-Miocene Nile delta stratigraphic column increase the depth oil window and the peak oil generation due to decrease of the effective stress. Fluids have the tendency to migrate from high-pressure zones toward a lower pressure zones, either laterally or vertically. Also, hydrocarbons might migrate downward if there is a lower pressure in the deeper layers. Well

data and the available geochemical database have been integrated with the interpreted seismic data to identify potential areas of future prospectivity in the study area.

### **Reference Cited**

Abdel Aal, A., A. El Barkooky, M. Gerrits, H-J. Meyer, M. Schwander, and H. Zaki, 2001, Tectonic evolution of the Eastern Mediterranean Basin and its significance for the hydrocarbon prospectivity of the Nile Delta deepwater area: *GeoArabia*, v. 6/3, p. 363-384.

# Pre- Messinian petroleum system and trapping style, offshore Western Nile Delta, Egypt.

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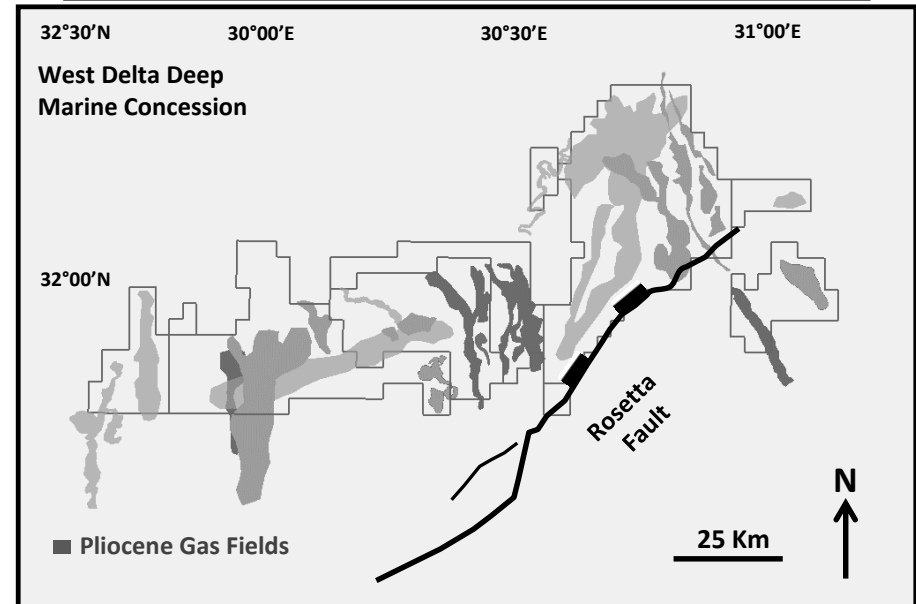
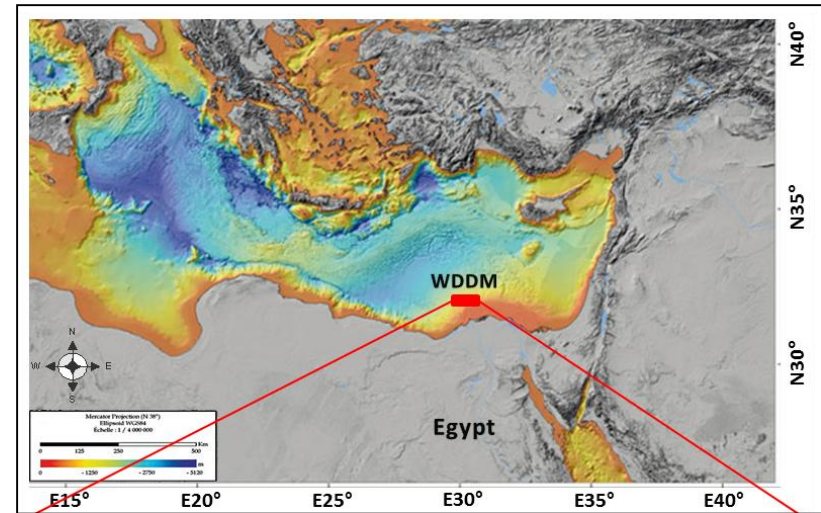
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## Introduction and Area of Study

- WDDM concession is located in the western basin offshore Nile Delta.
- 100Km to NE of Alexandria
- Water depth varies from 150 – 1200m.
- WDDM area is about 1366Km<sup>2</sup>



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★ Reservoir   
 ▲ Biogenic Source Rock   
 ▲ Thermogenic Source Rock

## Nile Delta Stratigraphy

- Hydrocarbon fields / discoveries are proved at all levels
- Oligocene is the main source rock in the Nile Delta
- Significant biogenic gas potential within the Pliocene – Pleistocene interval
- Few penetrations of the Pre-Tertiary sequence
- The Deepest onshore well penetrated the Upper part of Jurassic Sequence
- The deepest offshore well reached a TD of c.a. 7200m (in the Oligocene)

Epoch	Age		Formation	Lithology		Fields/ Discoveries
				South	North	
Pleistocene-Holocene	1.8 M.Y.		Bilqas / Mit Ghamr			Rosetta, WDDM, Ha'py, Temsah area
			El Wastani			★ ▲
Pliocene	Late	Piacenzian	Kafr El Sheikh			Sapphire, Silva
	Early	Zanclean				★
Miocene	Late	Messinian	Abu Madi Rosetta			Abu Qir/El King Abu Madi/Baltim
		Tortonian	Qawasim Wakar			★
						★
	Middle	Serravallian	Sidi Salim			Temsah/Akhen El Tamad
		Langhian				★
						★
Lower	Burdigalian	Qantara			Raven Qantara	
	Aquatinian				▲	
Oligocene	Late	Chattian	Tineh			Tineh Salamat Atoll Satis Hedwa Notus
	Early	Rupelian				▲
Eocene						<b>Base Tertiary</b>
Paleocene						
Cret.						
Jurassic						Zohr (Western Desert)

Nile Delta Tertiary stratigraphy mainly consists of clastic deposits



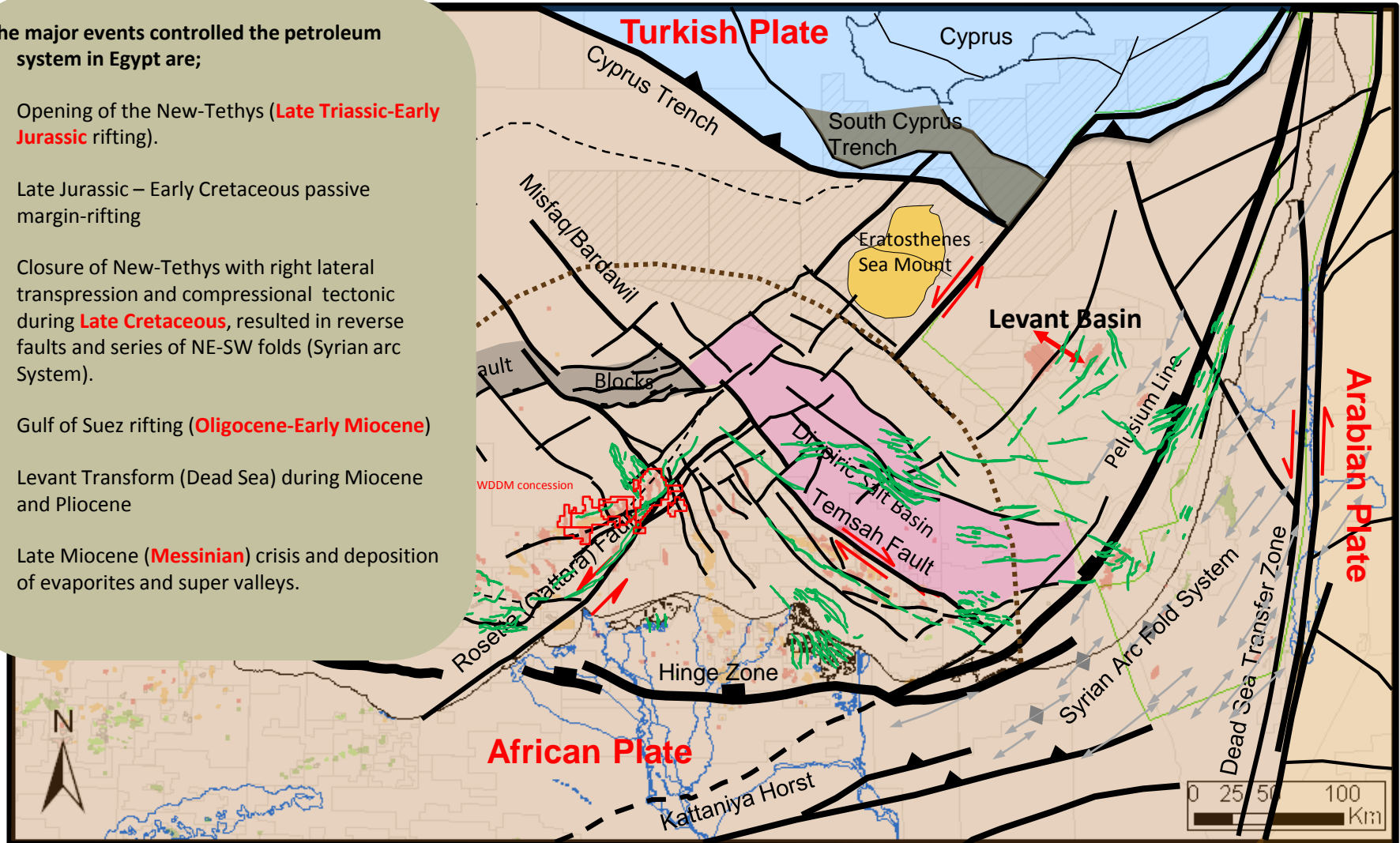
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## Regional Structural Framework

The major events controlled the petroleum system in Egypt are;

- Opening of the New-Tethys (**Late Triassic-Early Jurassic** rifting).
- Late Jurassic – Early Cretaceous passive margin-rifting
- Closure of New-Tethys with right lateral transpression and compressional tectonic during **Late Cretaceous**, resulted in reverse faults and series of NE-SW folds (Syrian arc System).
- Gulf of Suez rifting (**Oligocene-Early Miocene**)
- Levant Transform (Dead Sea) during Miocene and Pliocene
- Late Miocene (**Messinian**) crisis and deposition of evaporites and super valleys.

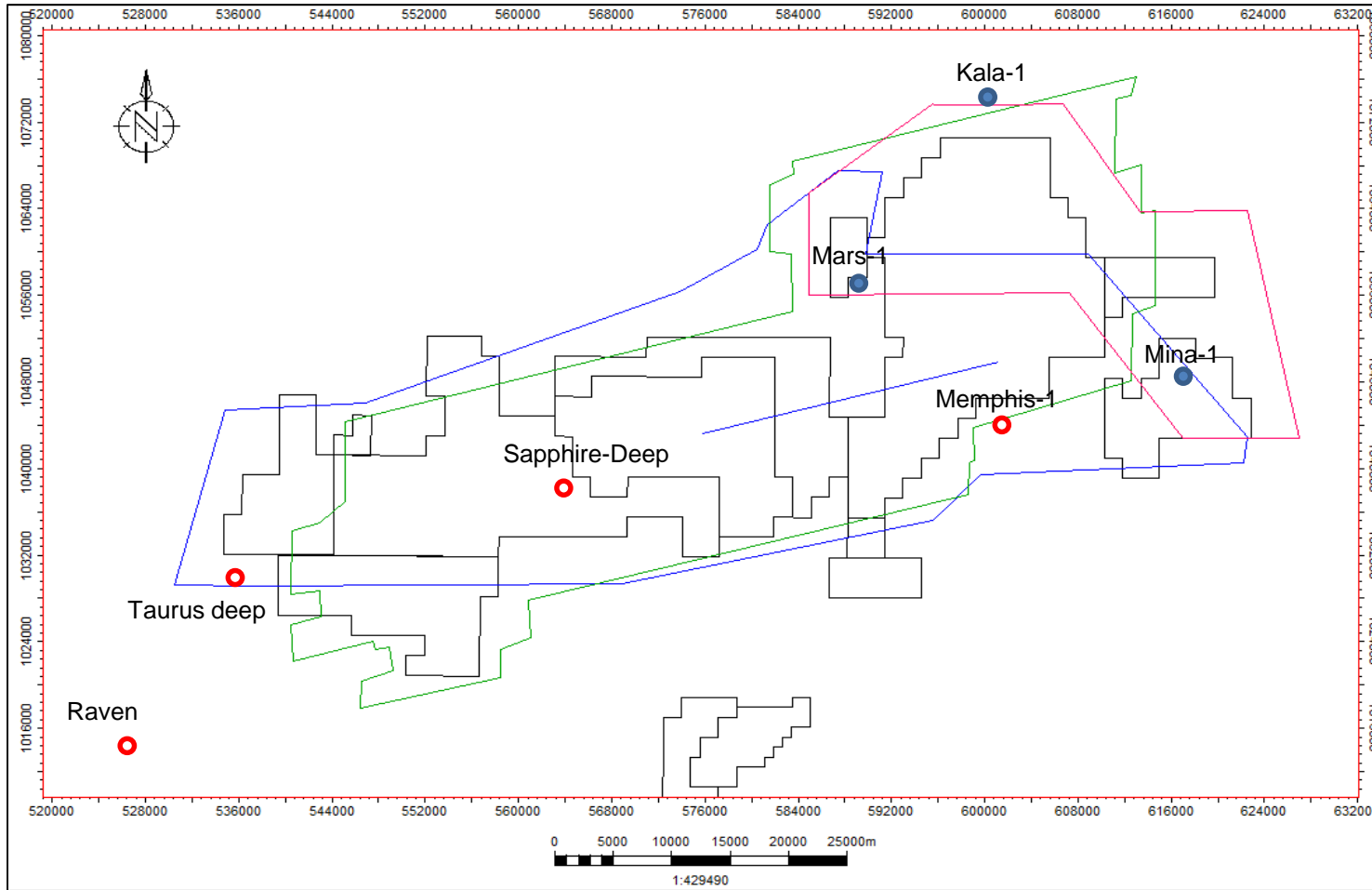


Modified after Abdel Aal, et.al, 2001

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# Seismic Vintages and Well Data



2014 Acquisition

Total 2010

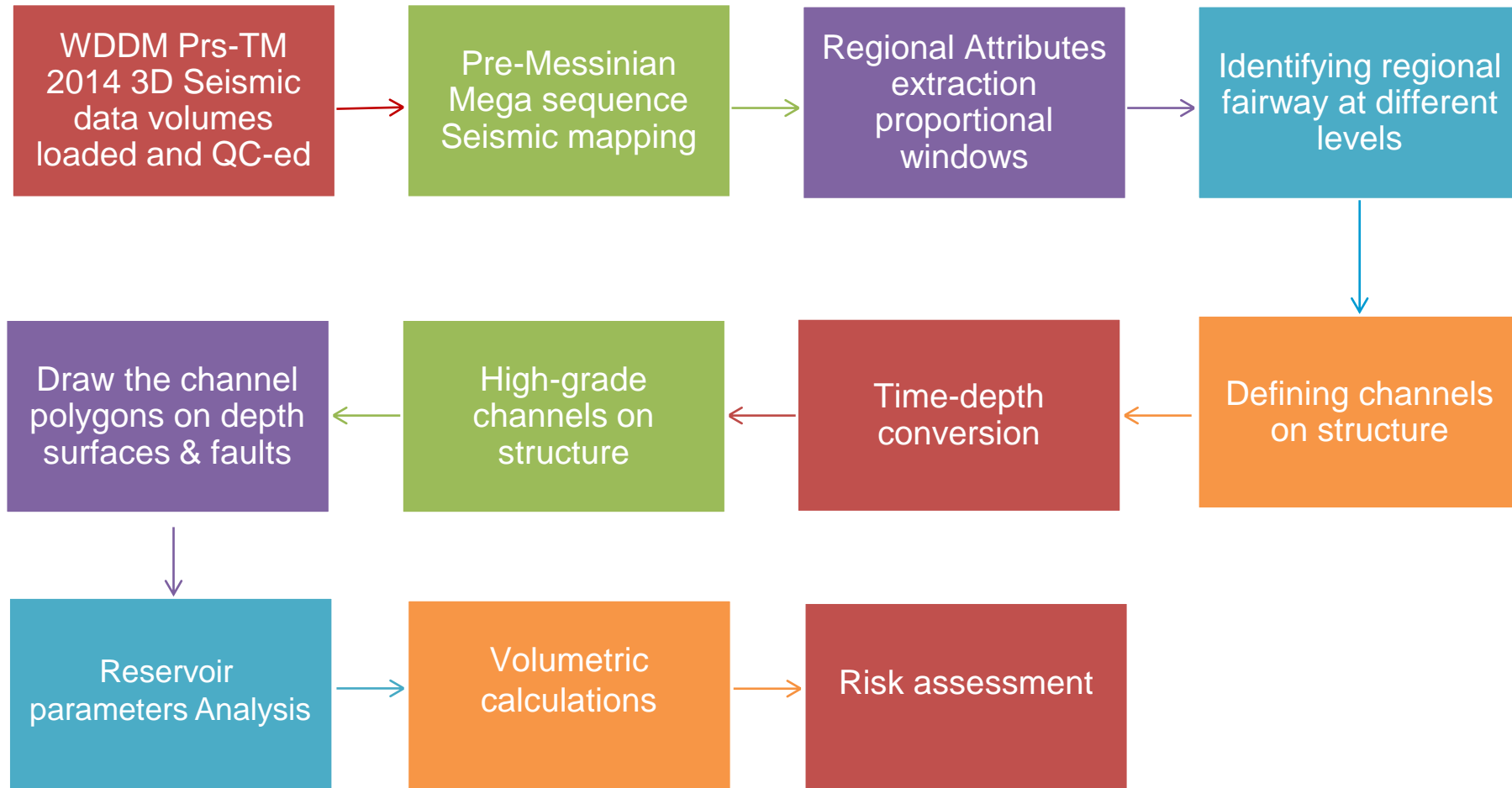
2006 Acquisition

● Pre-Messinian well ● Messinian well

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## Methodology and Workflow

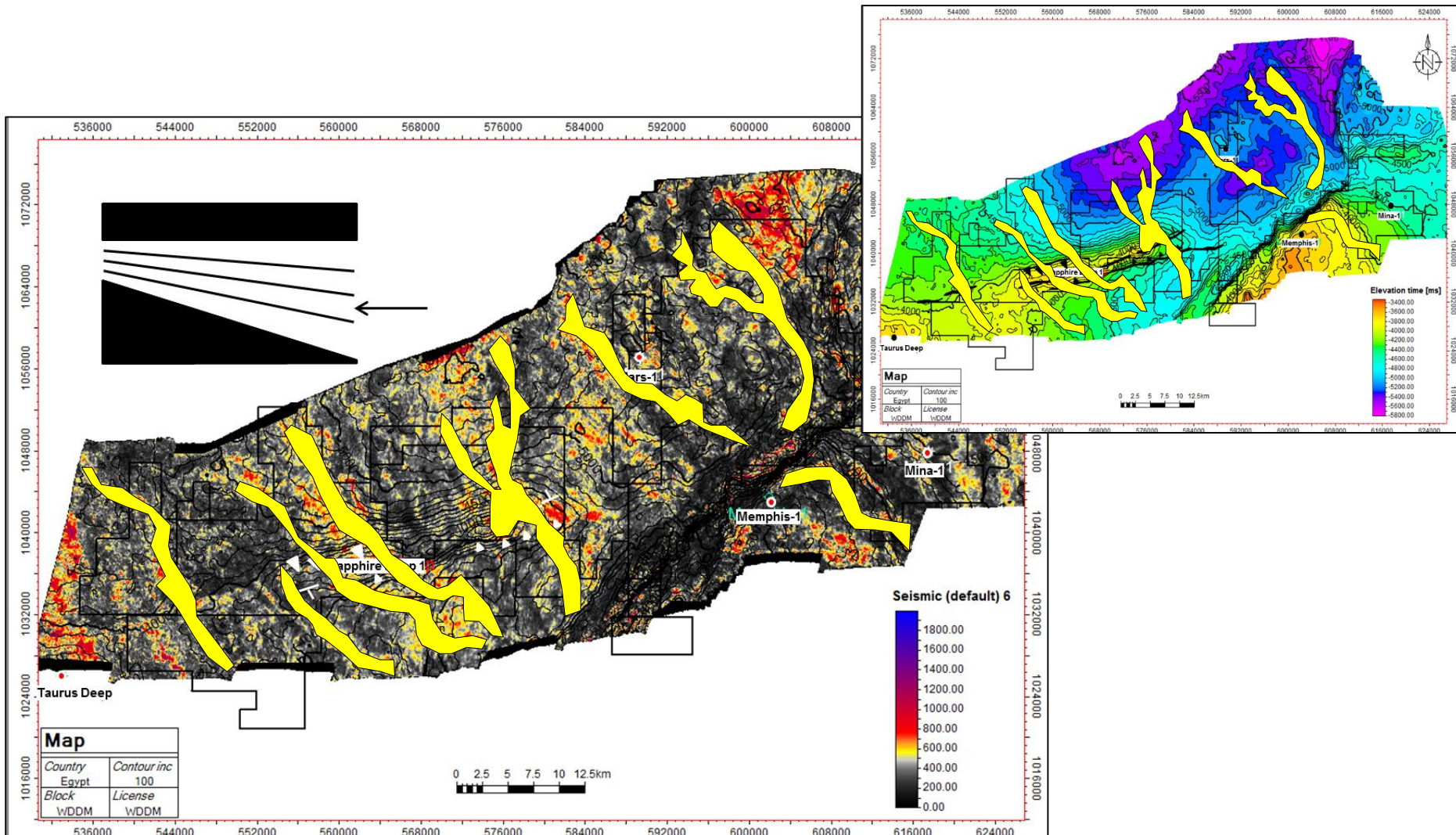


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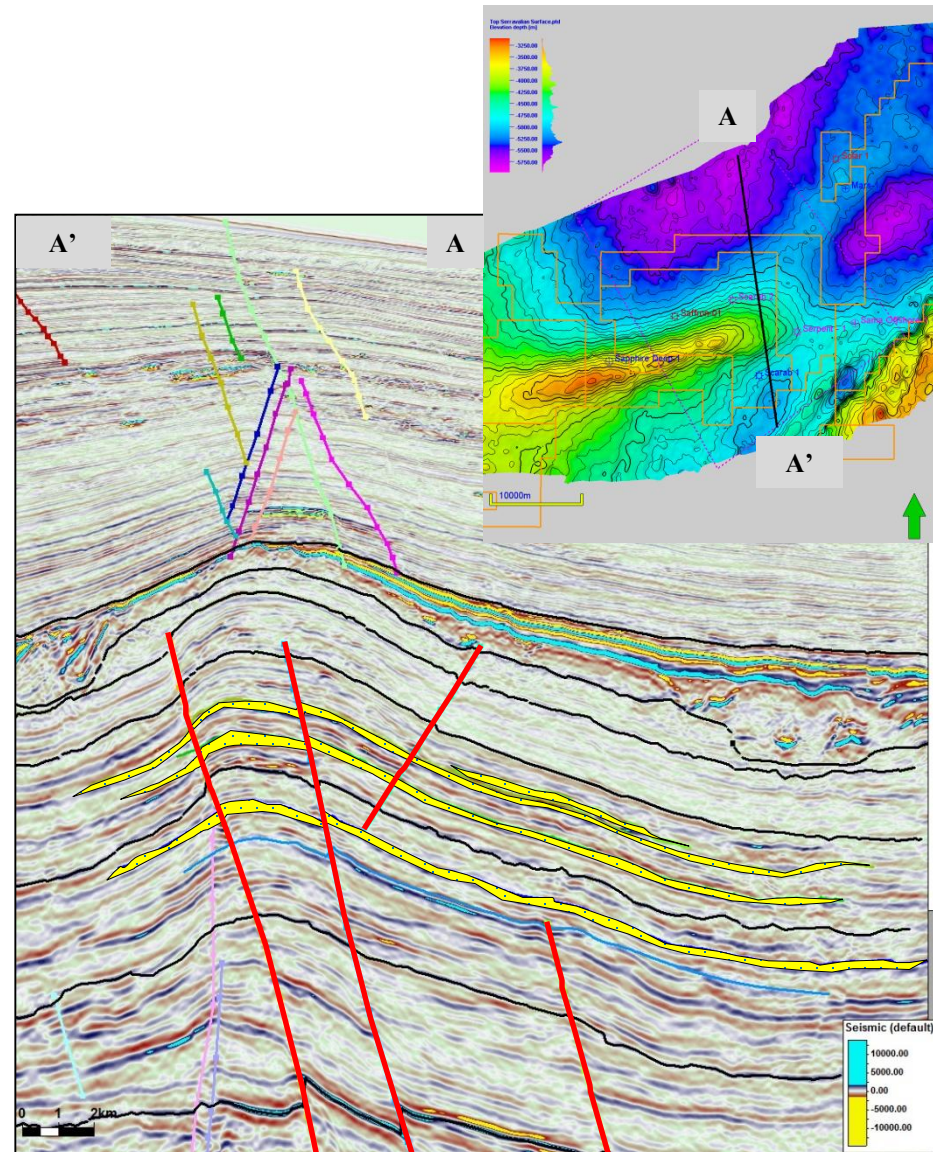
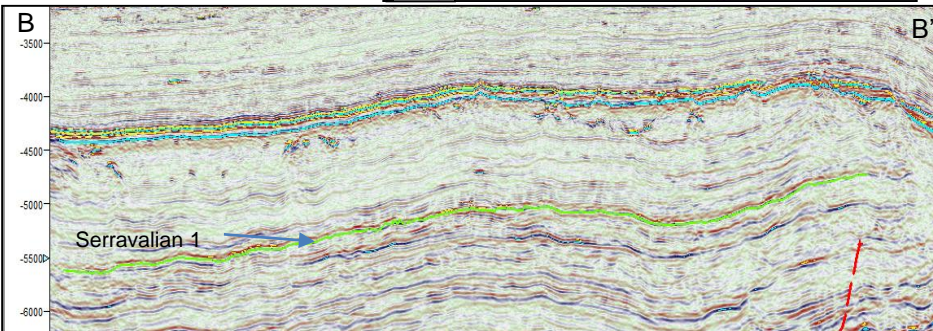
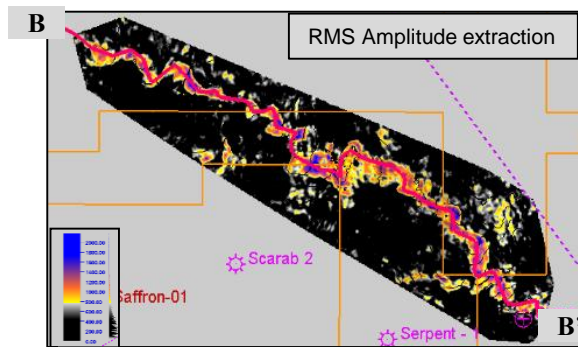
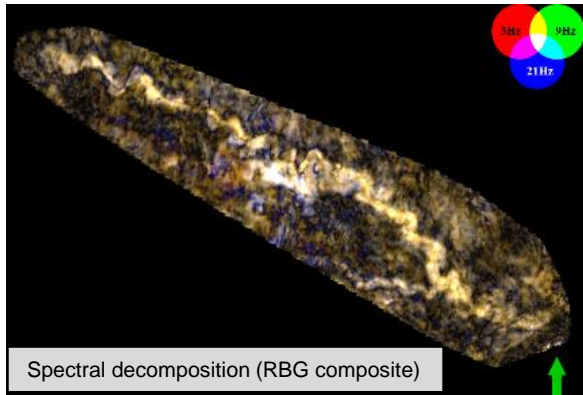


## Reservoir Potential





# Reservoir Potential

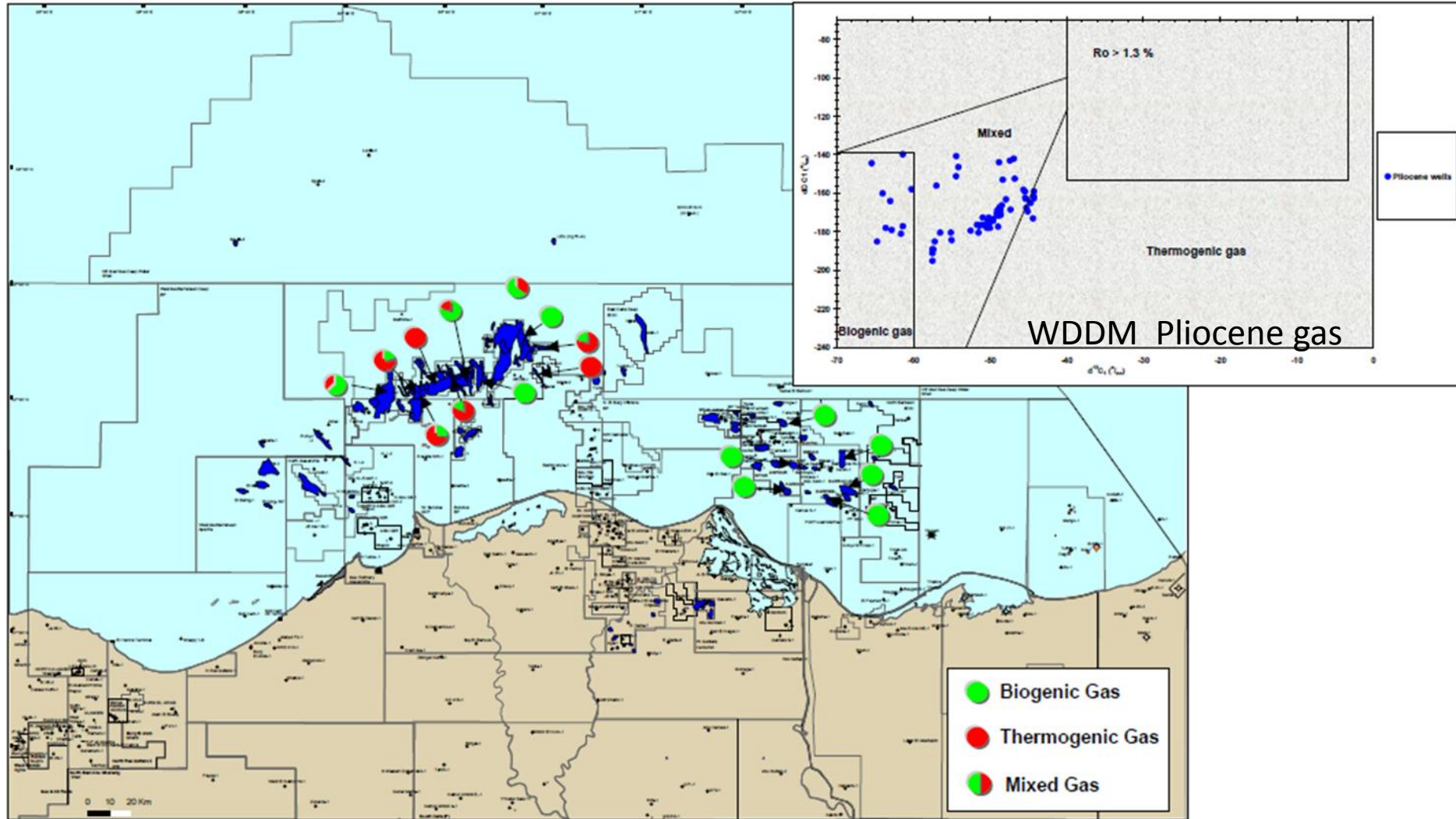


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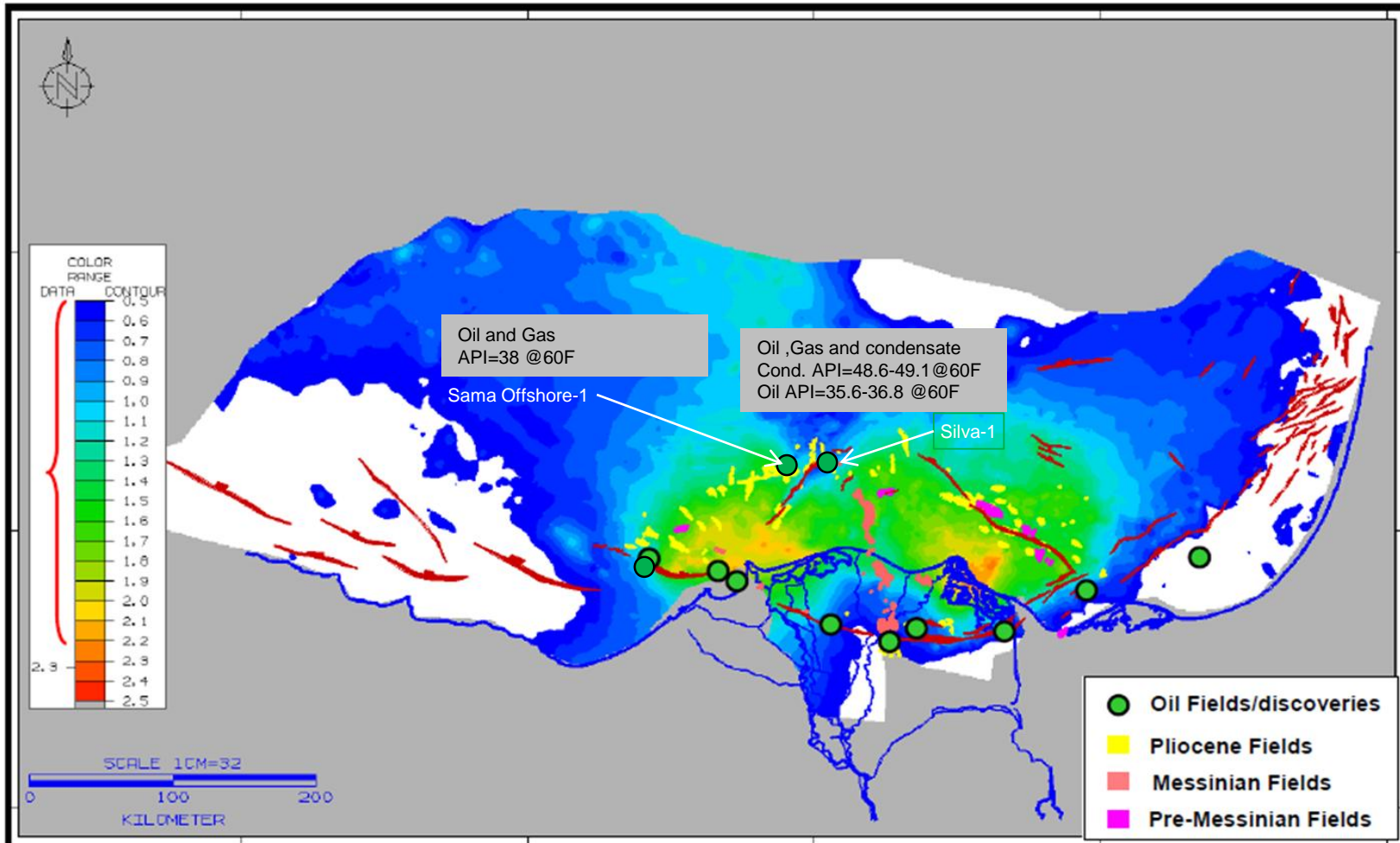


# Hydrocarbon types and source rock



West Nile delta basin comprises various hydrocarbons types; Biogenic dry gases, thermo-genic dry, wet gas and condensate, Mixed Biogenic, thermogenic gases and Oil

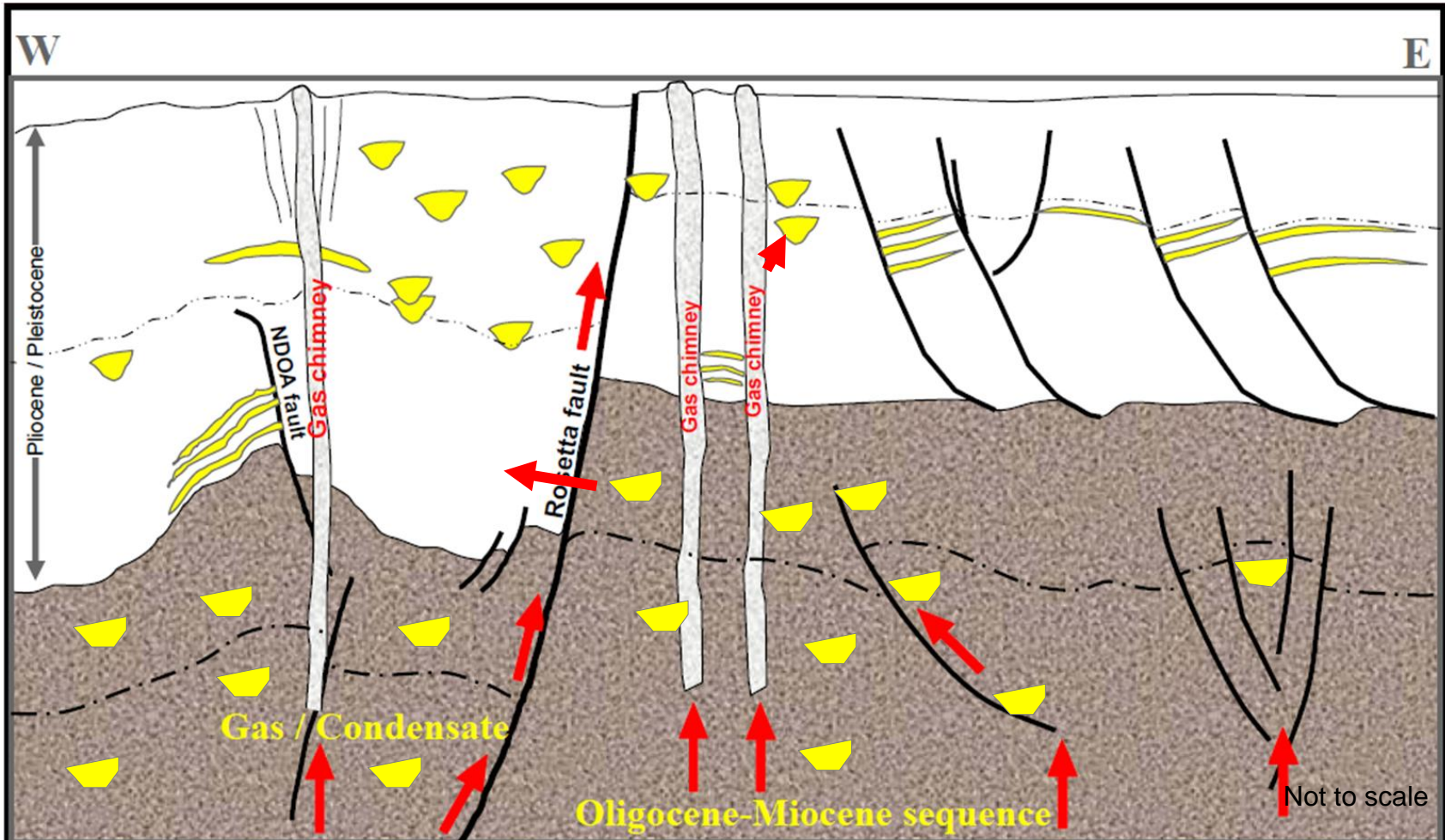
## Hydrocarbon types and source rock



- The majority of Nile delta oil occurrences are located close to hinge zone.
- Two oil discoveries in WDDM are located in both the hanging wall and foot wall of Rosetta fault.
- They are believed to be charged from Oligocene sources or deeper Source rock in Cretaceous or Jurassic.



## Hydrocarbon Migration



- Hydrocarbons migrate from source rocks to shallower reservoirs via deep seated faults or/and gas chimneys. Or laterally when the reservoir lays within the source rock intervals
- Isolated Pliocene channels have mainly biogenic gas.
- Isolated Miocene and Oligocene channels have mixed thermogenic and biogenic gases.

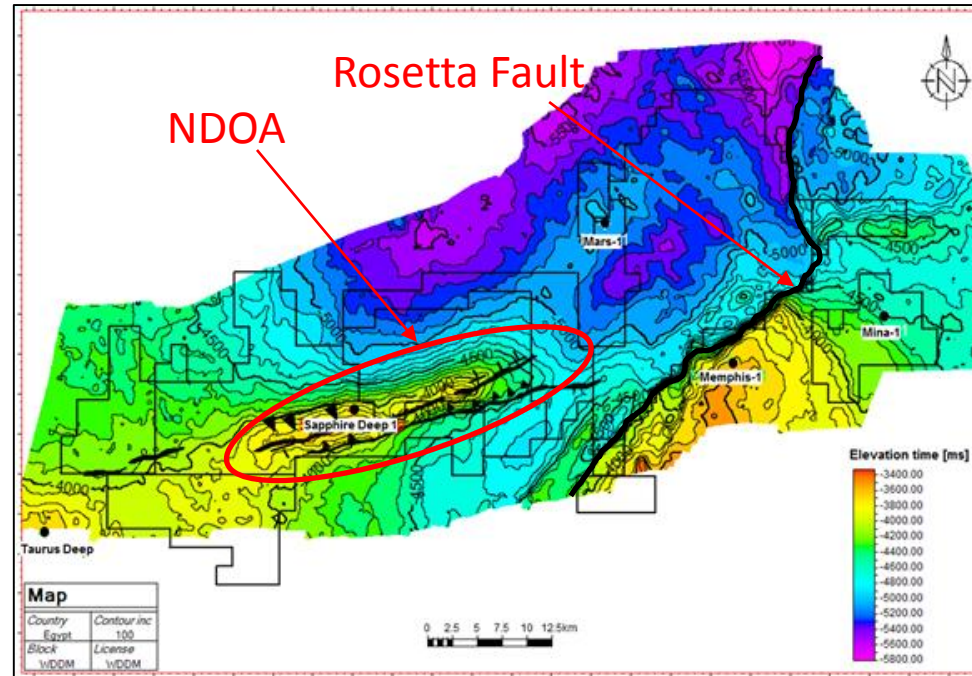
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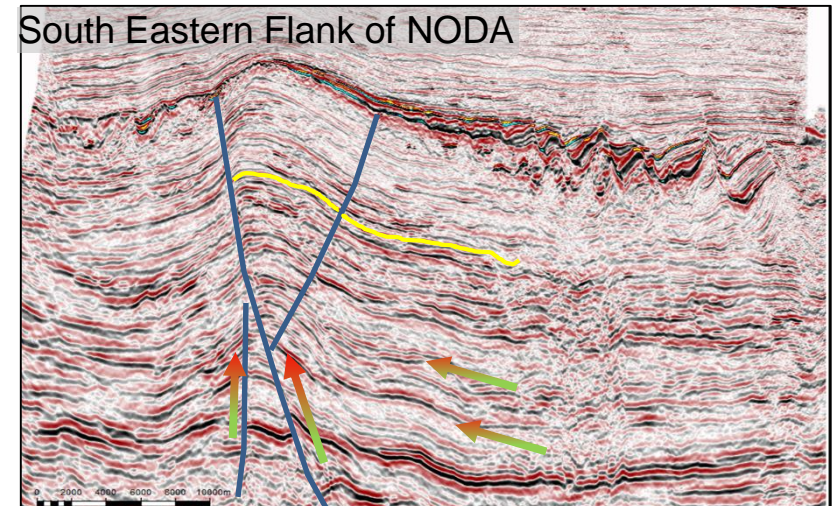
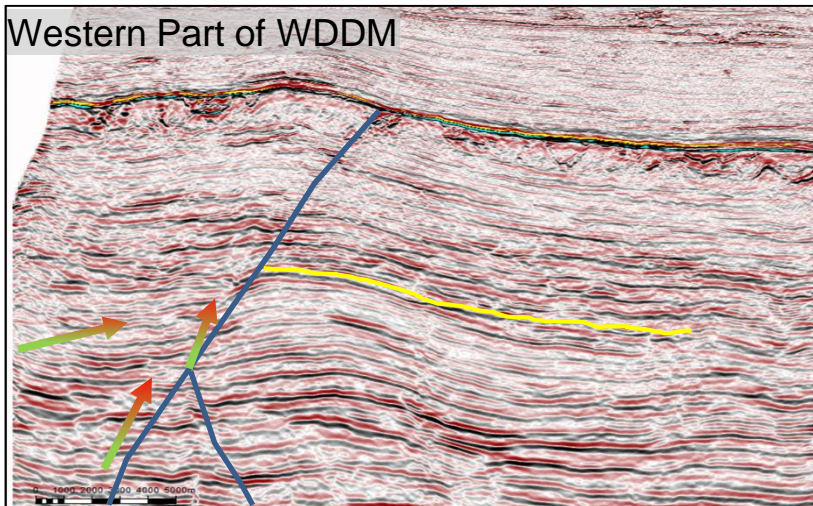
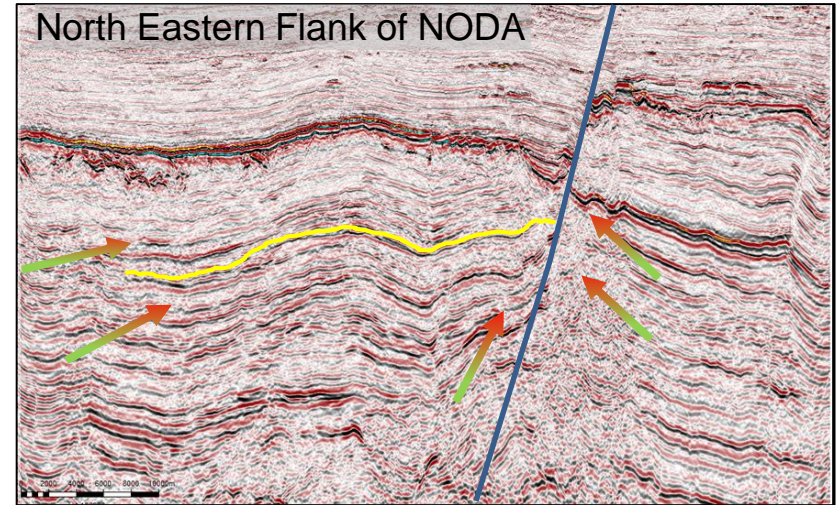
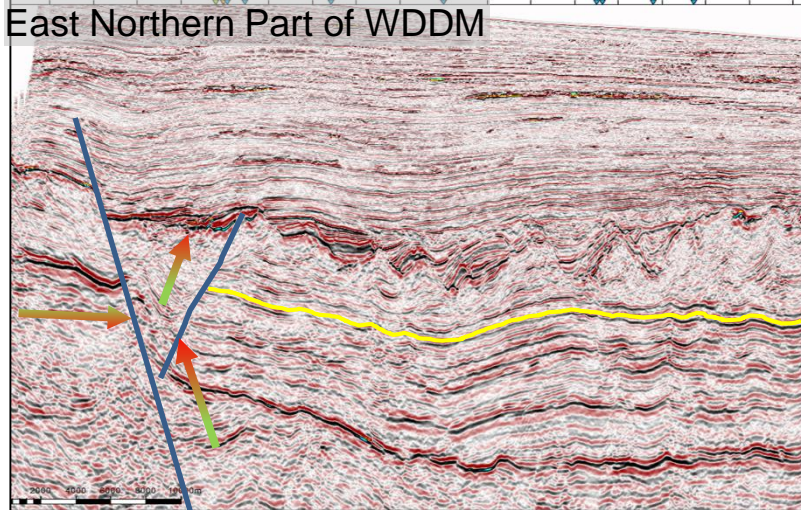
## Trapping style and trapping mechanism.

- The main Structural element which affects on WDDM concession is Rosetta fault and NDO-anticline and its fault system.
- The trapping mechanism is a combined structural and stratigraphic elements.
- Miocene and Oligocene channels are draped over anticlinal features forming two way dip and two way stratigraphic traps.
- Lessons Learnt from previous failures and nearby successes
  - **Avoid high relief and breaching structures.**
  - **Use Geochemical data to understand the overlaying shallower Pliocene gas field fluid composition and type.**
  - **The presence of pure BIOGENIC gas field on top of un-faulted Messinian is a key driver to de-risk the trap effectiveness in WDDM.**





## Trapping styles



Different structural styles , low relief anticlinal features associate with the late Miocene compressional regime



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## Summary and Conclusions

- An integrated exploration approach was applied for a selected area within WDDM Concession offshore western Nile Delta.
- The interpretation focused mainly on the Oligocene and Miocene sequences. The seismic expression of stratigraphic sequences shows a variety of turbidite channel/canyon systems having examples from West Nile delta basin discoveries and failures.
- Few offset Pre-Messinian wells in the vicinity of or nearby WDDM such as; Sapphire deep-1, Memphis, Habbar, Rosetta-NW1 and Raven. These wells has been considered in reservoir parameters, depths and Chance Of Success.
- Most of the Offshore Nile Delta hydrocarbons discoveries share a common source rock of Tertiary age.
- The variety of tectonic styles and depositional patterns in the West Nile delta provide favorable trapping conditions for hydrocarbon generations and accumulations. The trapping mechanism in WDDM concession Pre-Messinian prospects is a combined structural and stratigraphic traps.

## Acknowledgement

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