Lebanon 2nd Round

Evidence for Oil Generation

Geoscience Department August 2018

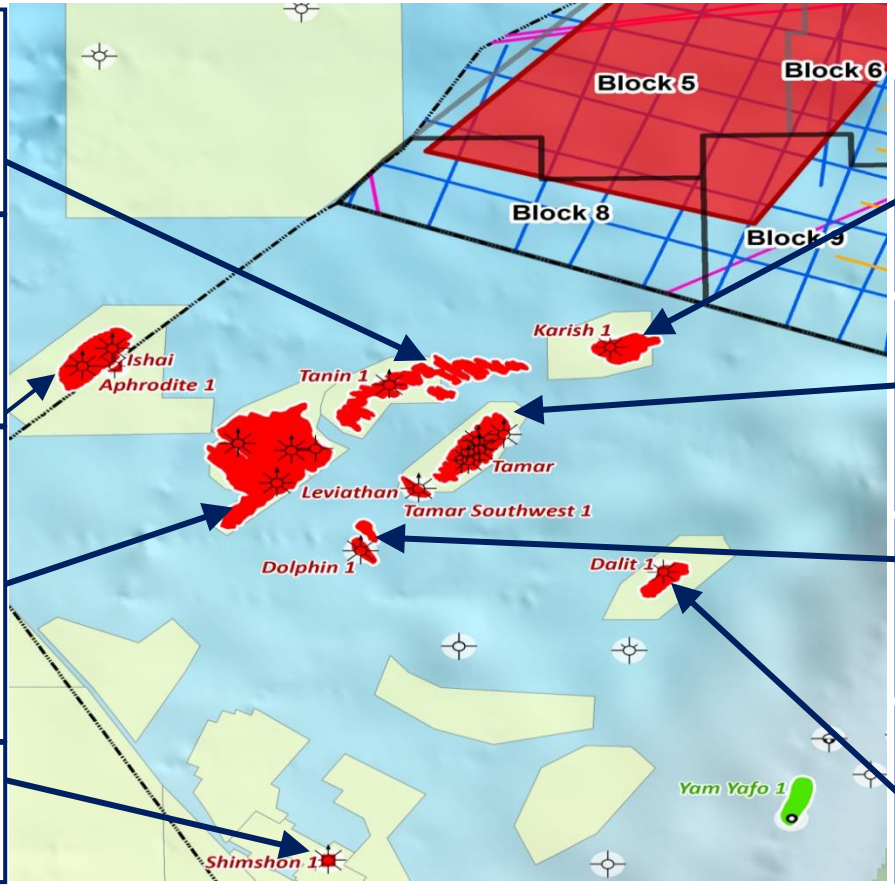
South Levant Discoveries > Biogenic Gas

Tanin
2011 Gas Discovery,
130ft net pay
Lower Miocene 'Tamar' sands.
Reserves: Mean 1.1 TCF

Aphrodite
2011 Gas Discovery
310ft net pay
Miocene sands
Reserves: Mean 7 TCF

Leviathan
2010 Gas Discovery
220ft net pay
Lower Miocene sands
Reserves: Mean 17 TCF.
***Reported deeper thermogenic gas zone at 21,000ft**

Shimsom
2012 Gas Discovery
Reserves: Mean 1 TCF.



Q: Where is the thermogenic light oil in Karish coming from?

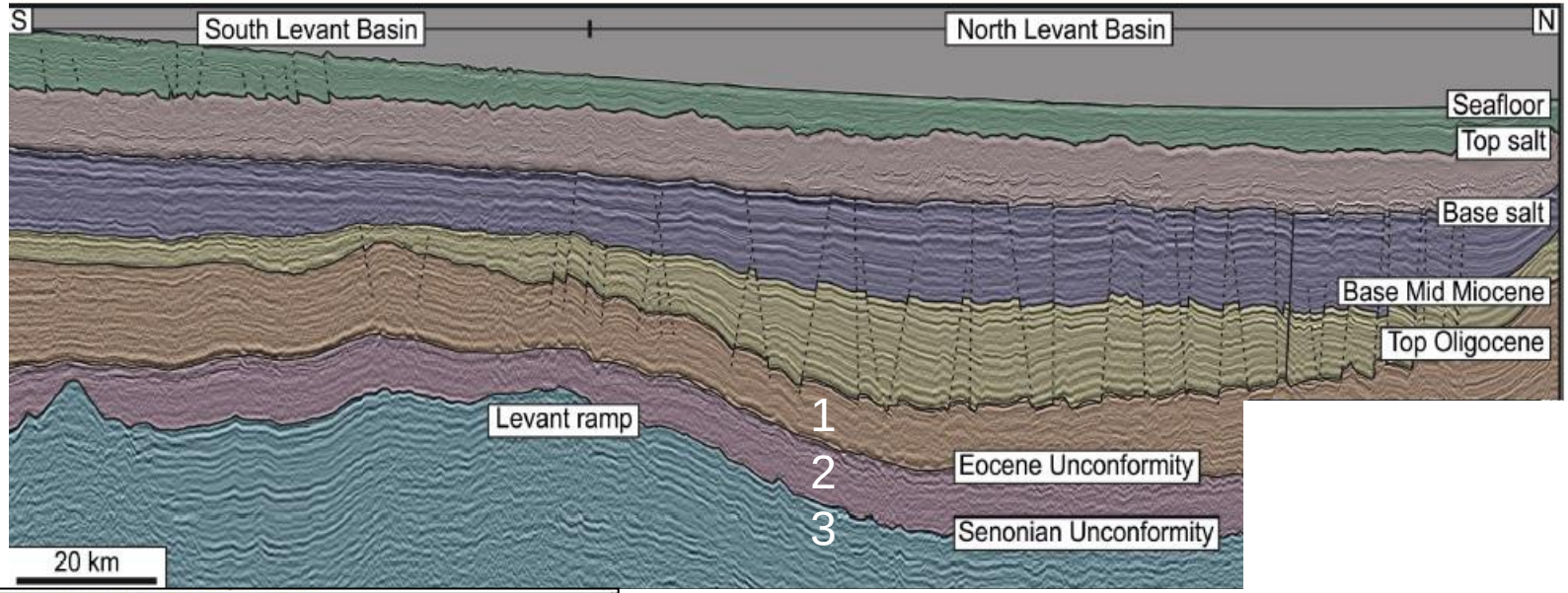
Karish
2013 Gas Discovery
180ft net Lower Miocene sands
Reserves mean 2-3 TCF
*** Producing thermogenic light oil**

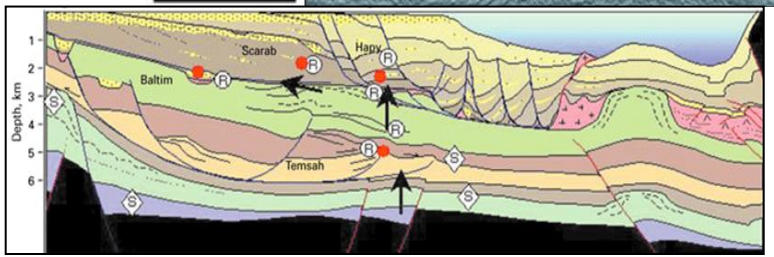
Tamar
2009 Gas Discovery **2012 onstream.** 460ft net Mid- Lower Miocene sands
Reserves Mean 9 TCF

Dolphin
2011 Gas discovery
'Tamar' sands
Reserves: Mean ca 0.5 TCF

Dalit
2009 Gas Discovery
Lower Miocene Sands
Reserves: Mean 0.5 TCF

Stratigraphy of the Levant Basin





Source Rocks
1. Oligocene
2. Paleocene – Eocene
3. Cenomanian-Turonian
4. Jurassic

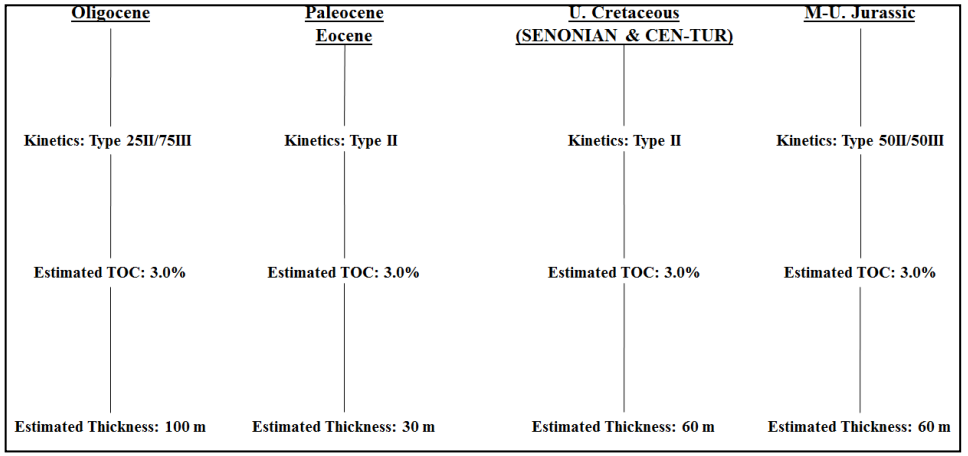
Basin Modelling

Evidence for Oil Generation

Basin Modelling: South to North Levant

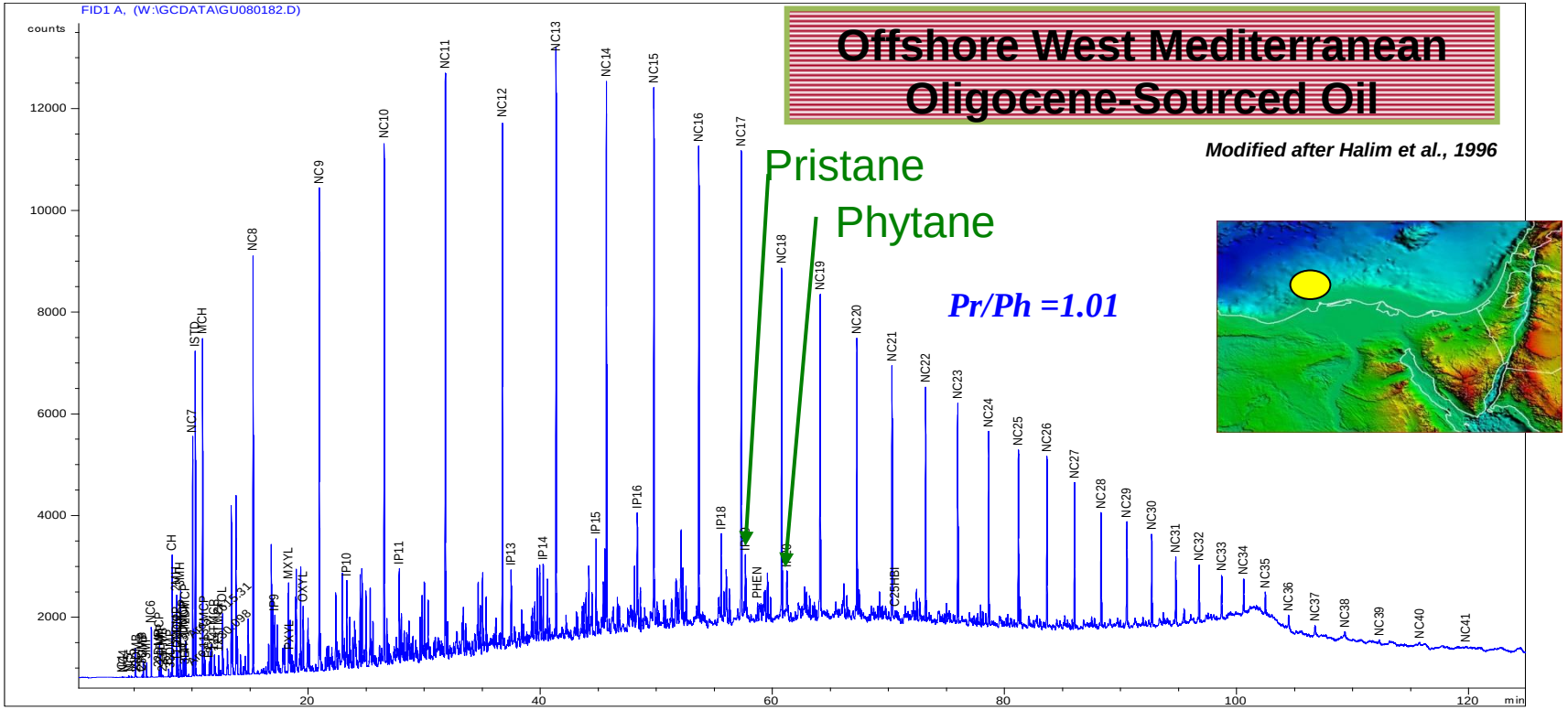
- Evaluate the hydrocarbon potential of defined source rocks
- Investigate the likely pathways of hydrocarbon migration and accumulation
- Evaluate the petroleum system(s) considering timing of generation, expulsion, and migration of hydrocarbons related to the basin's tectonic history

Flowchart for the input geochemical data to the basin modeling



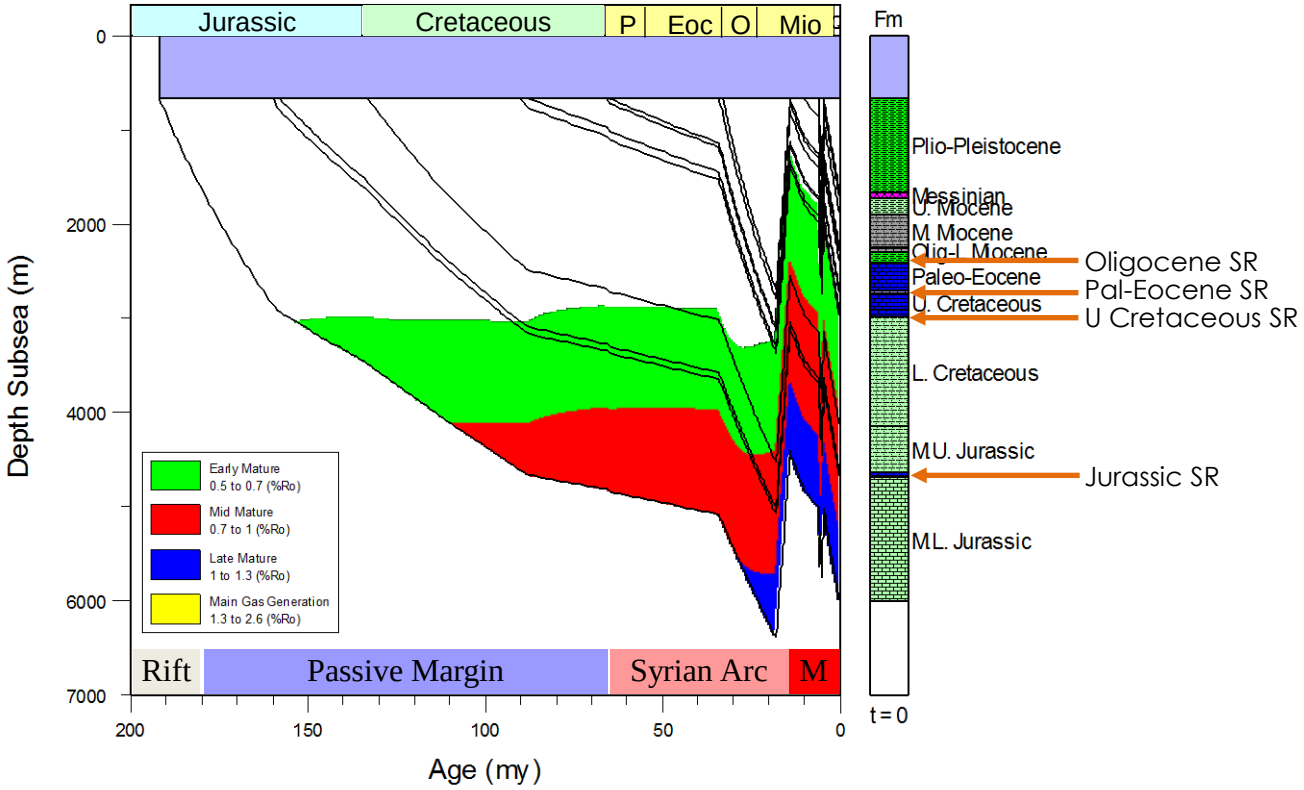
Oligocene-sourced oil

Oligocence source rock encountered at Amathusa and Onasagoras ENI wells



Whole oil gas chromatogram

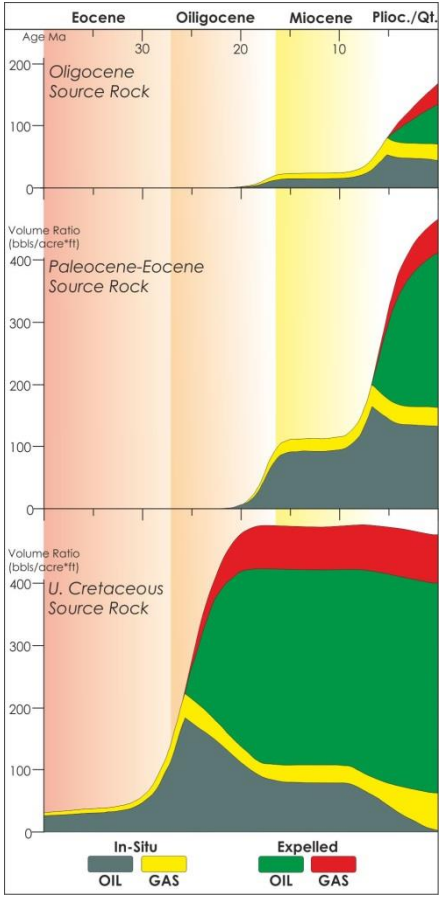
Burial History & Thermal Maturity for Example Well



Present Day

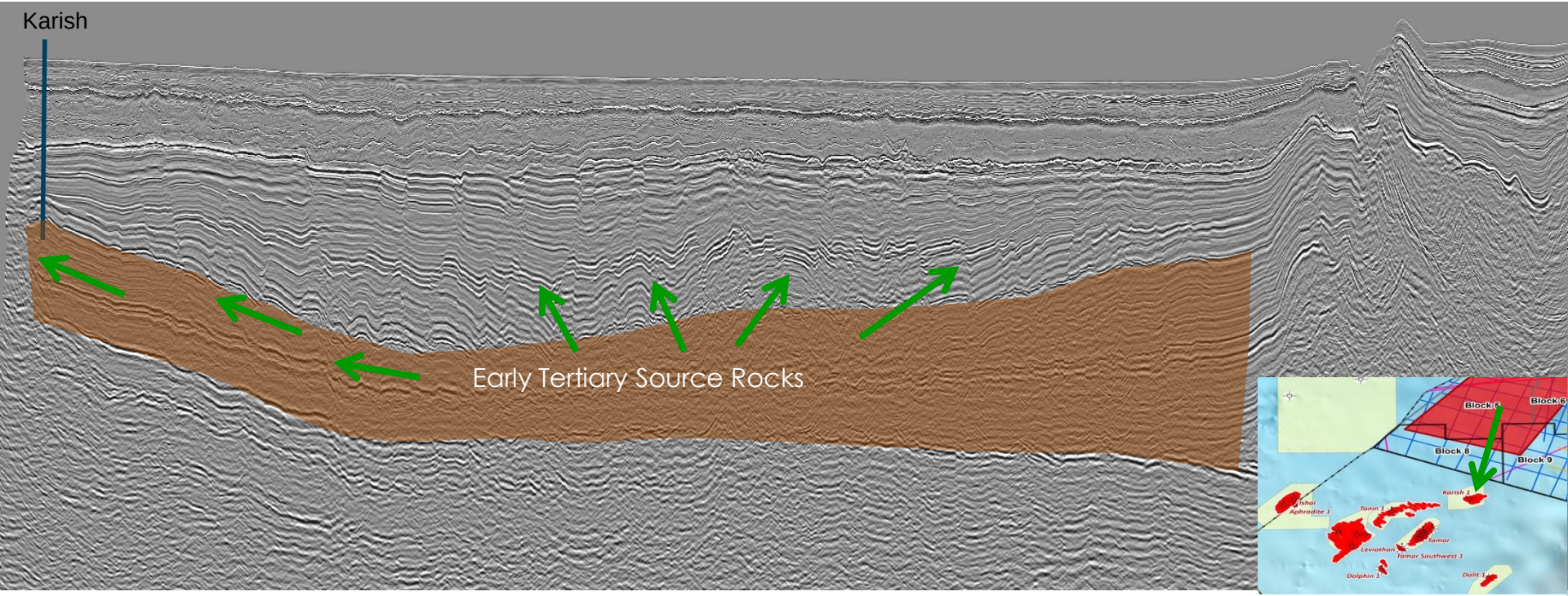
- U. Cretaceous to Oligocene source rocks modelled as Early Mature.
- Jurassic source rock modelled as Late Mature

3D Basin Modelling: North Levant



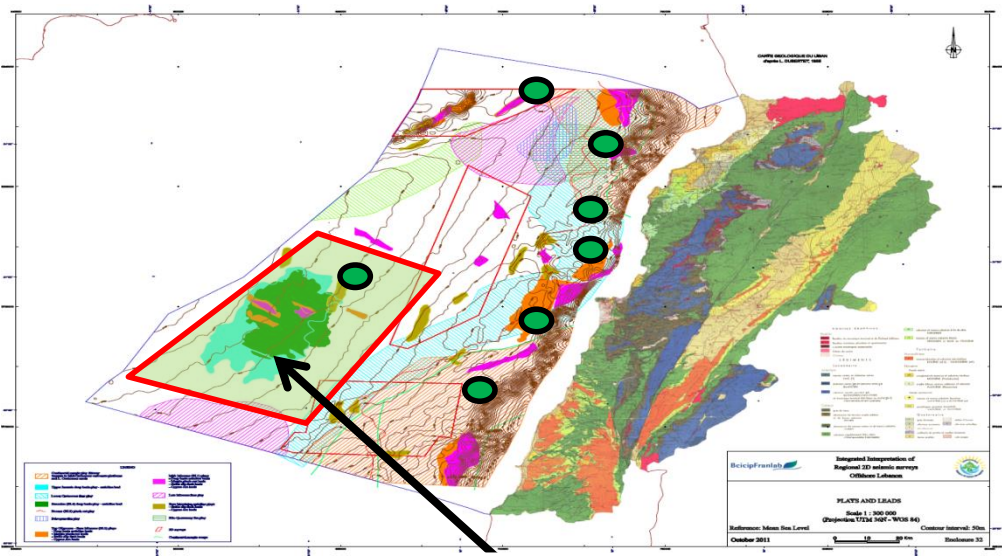
- Oligocene Source Expelling **oil** from Messinian times to Recent
- Oligocene and Paleocene-Eocene source rocks are currently in the “Mid-Mature” stage (0.7-1.0% Ro)

Karish Oil from Oligocene Source Kitchen?



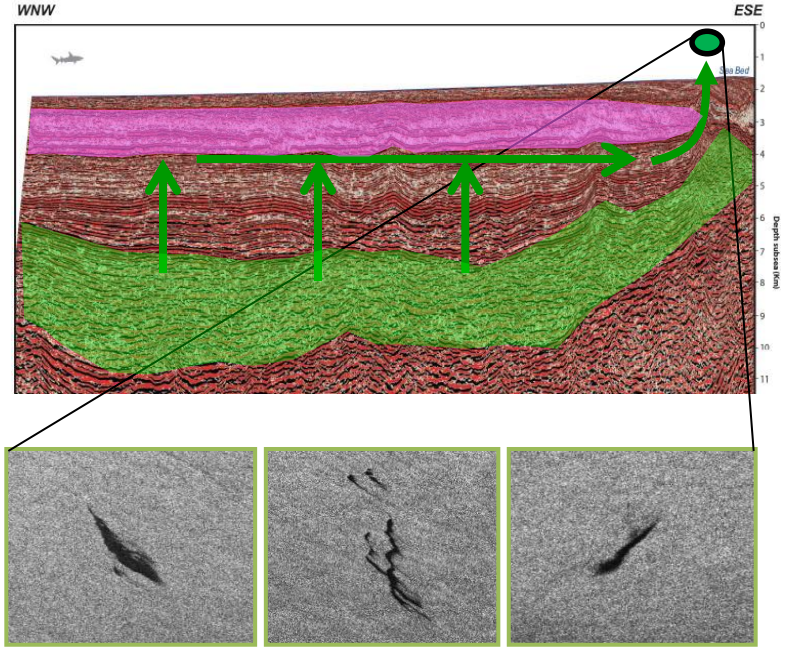
- Long distance oil migration from Oligocene source kitchen in North Levant Basin explains light oil in Karish
- Karish is the South Levant Field nearest to the North Levant oil kitchen

HC Indications - Seeps



High Potential for Oil

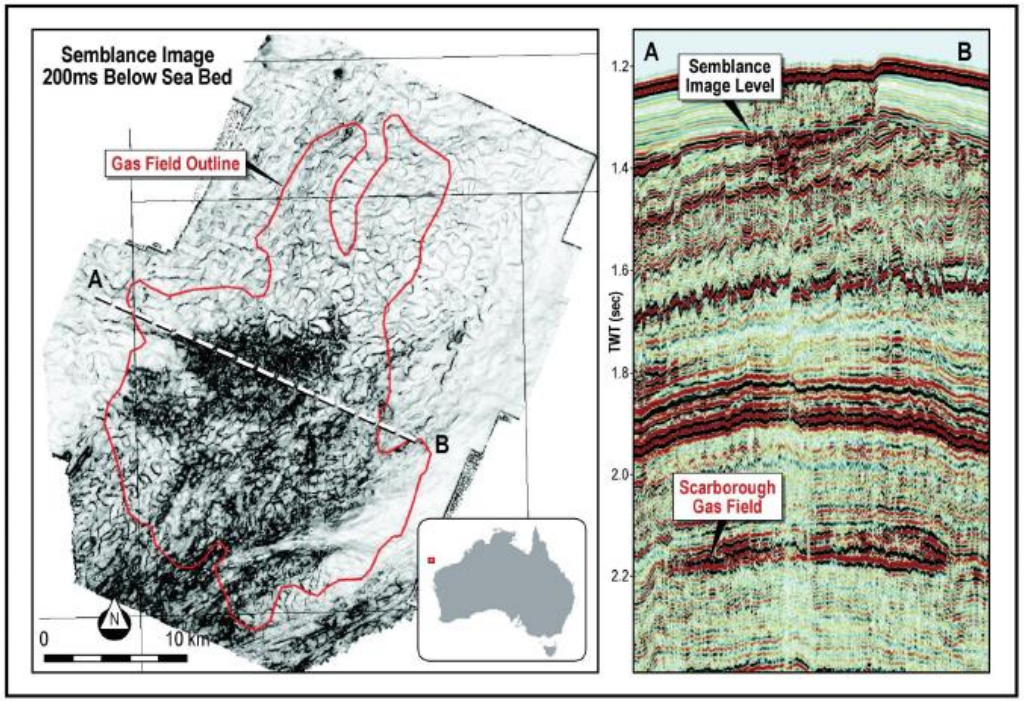
- **Seep**



Levant Basin
15 to 20ºC/km

Meaning of Seeps and Fluid Pipes

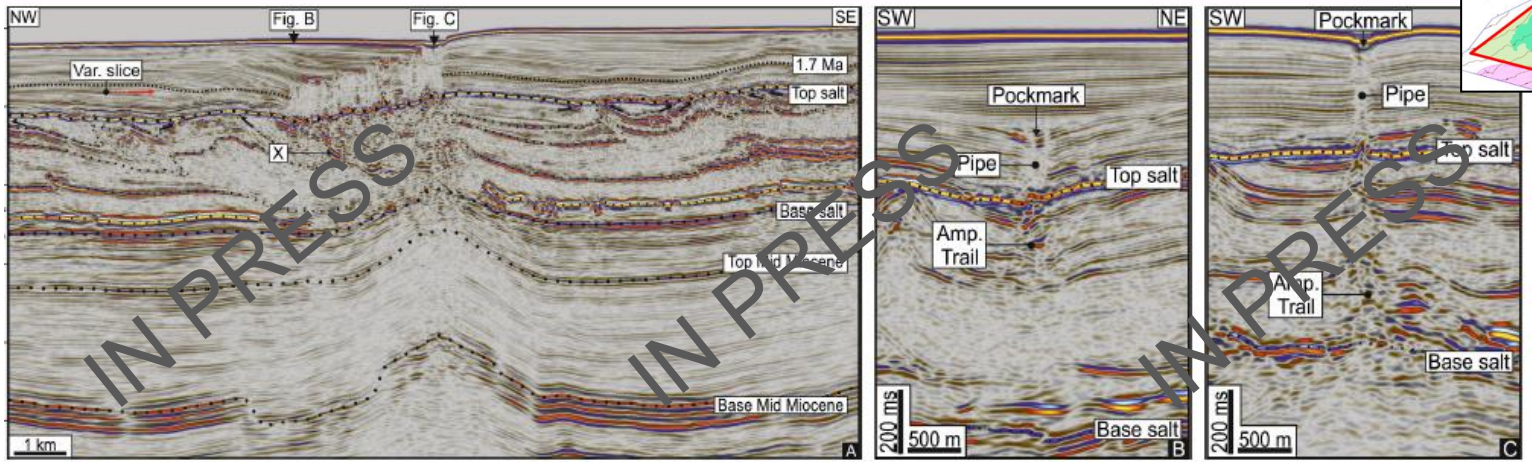
Cantarell 2nd largest
35 BBOIP

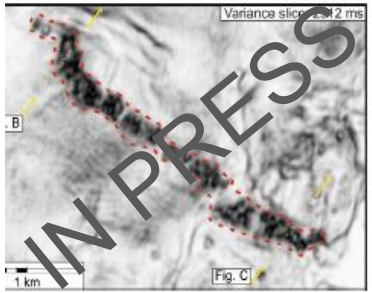


Scarborough, NW Carnarvon Basin, Australia (Jablonski et al., 2013)

Multi-Episode Focused Fluid Escape

Nearby oil seep





- Syrian arc related inversion structure associated with fluid pipe and pockmark at the seabed
- Reservoir has been recharged 20 times due to continued hydrocarbon generation over the last 1.7 Ma
- Indicates a working petroleum system
- Oil generation supported by nearby oil seep

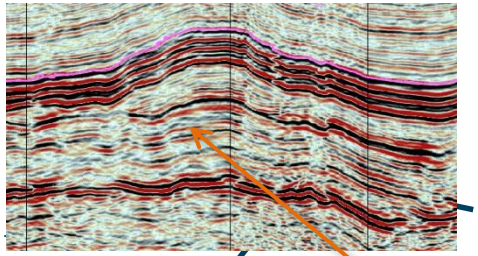
HC Indications

Early Miocene Reservoir Provenance

Nile: Prograding
Deltaic Packages

Southern Levant:
Deep Marine Clastic
Transport systems

Northern Levant:
Basin Floor Depocenter
Basin Floor Fan Complex

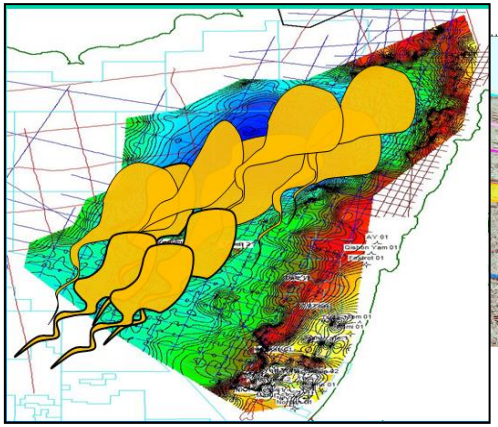


1 km sand

SW

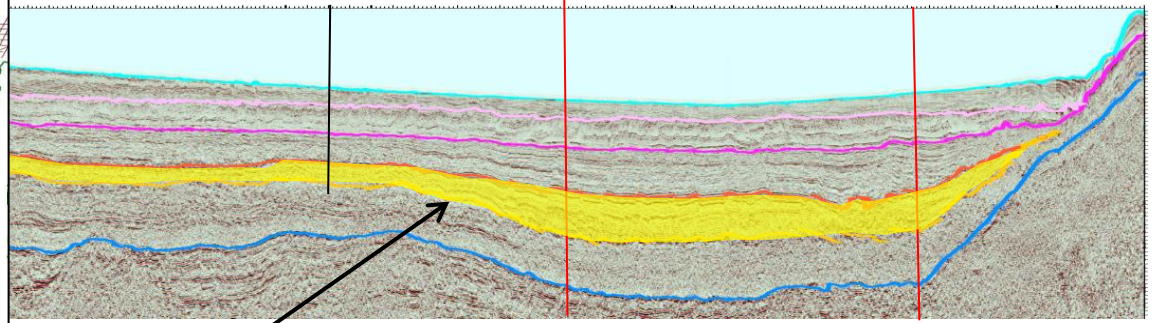
260Km

NE



Tamar

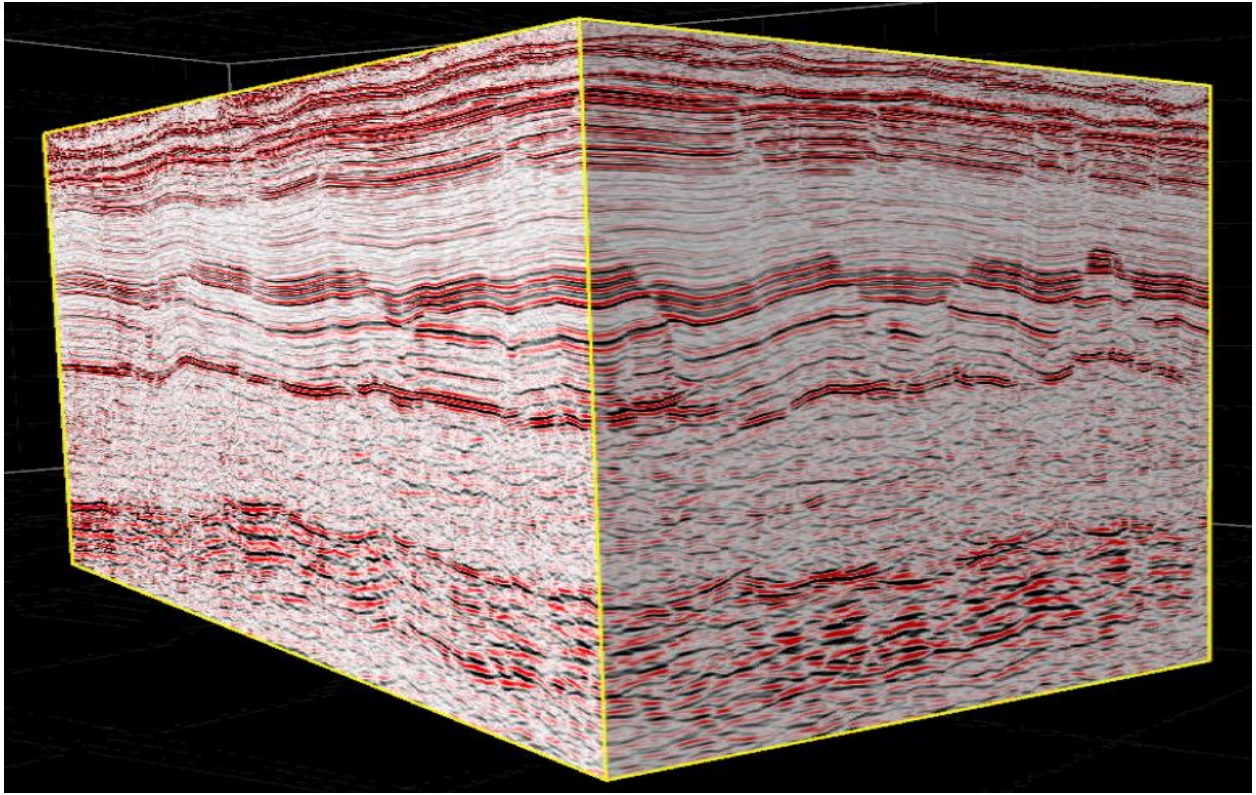
290 km 2D line



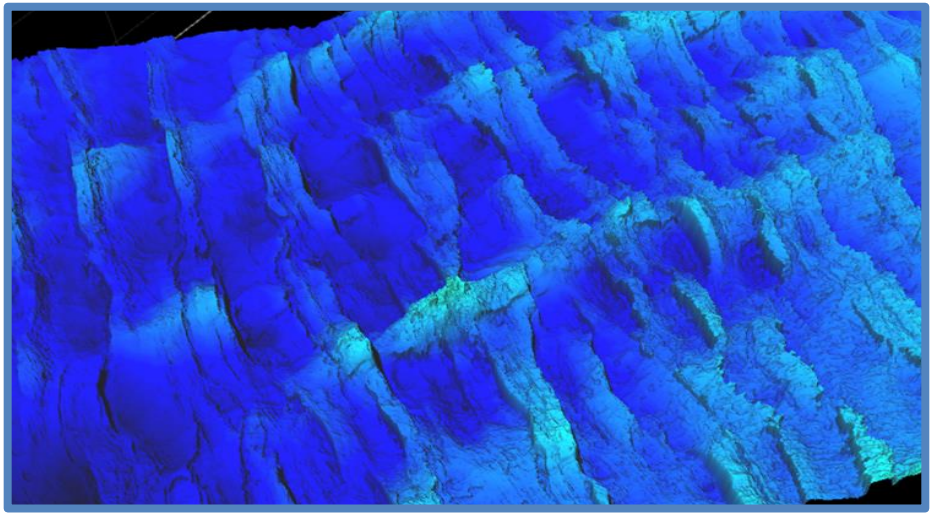
Levant
Ramp

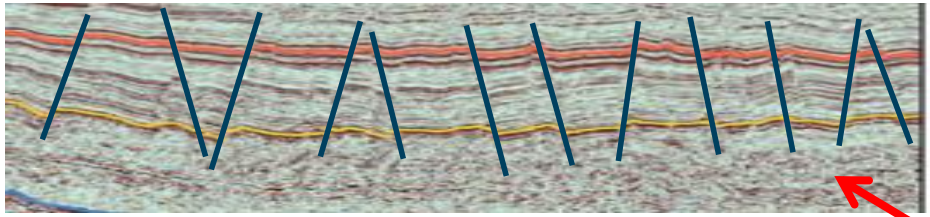
50Km

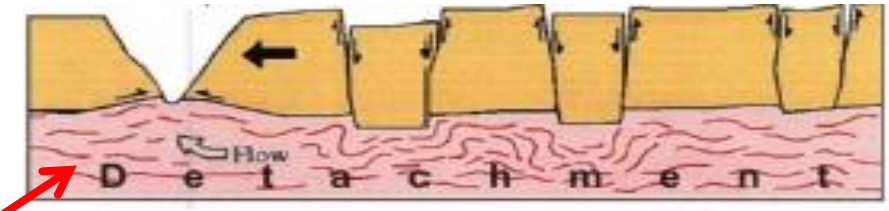
Trap 3D Cube View



Meaning of Layer Bound Faults





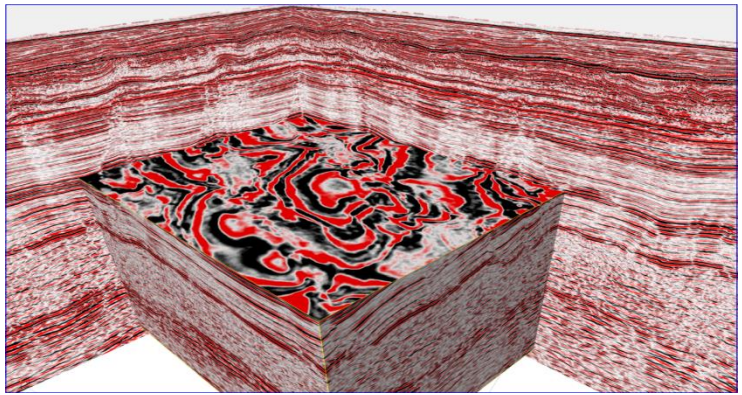


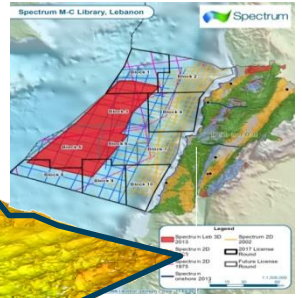
Lebanon 3D –
Mature source rock = Ductile

Ductile layer

Canyonlands, Utah
(Tari et al, 2012)

Lower Miocene Structures Map from 3D

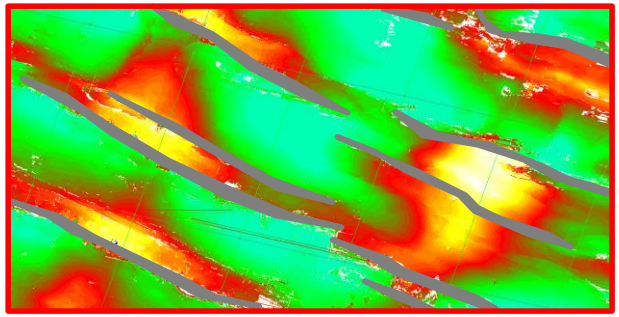




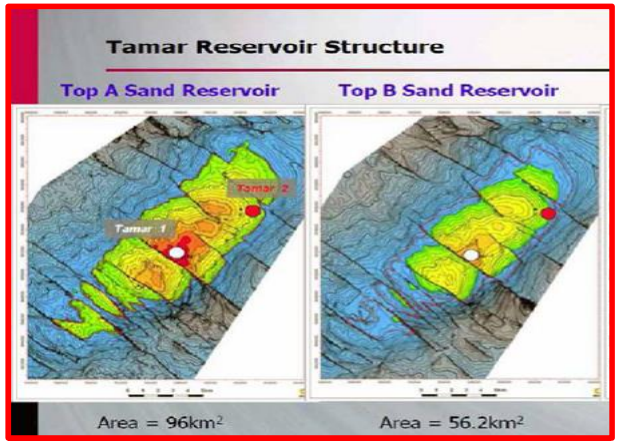
Phoebe

Trap

Structures North and South Levant Basin

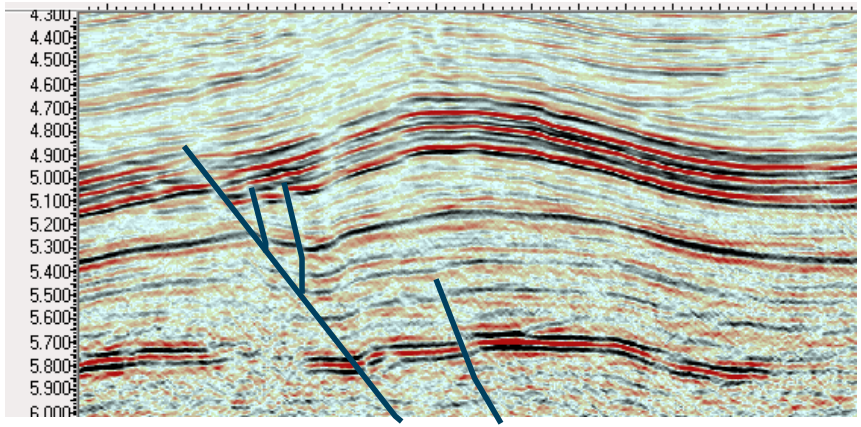


Same scale



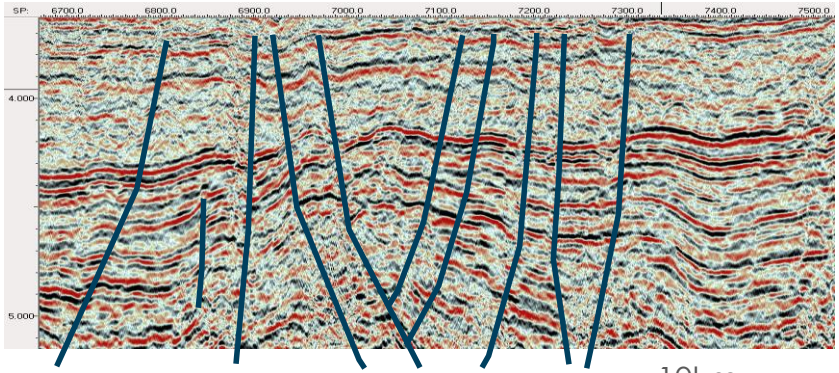
Ref: Noble Website

15km



Phoebe

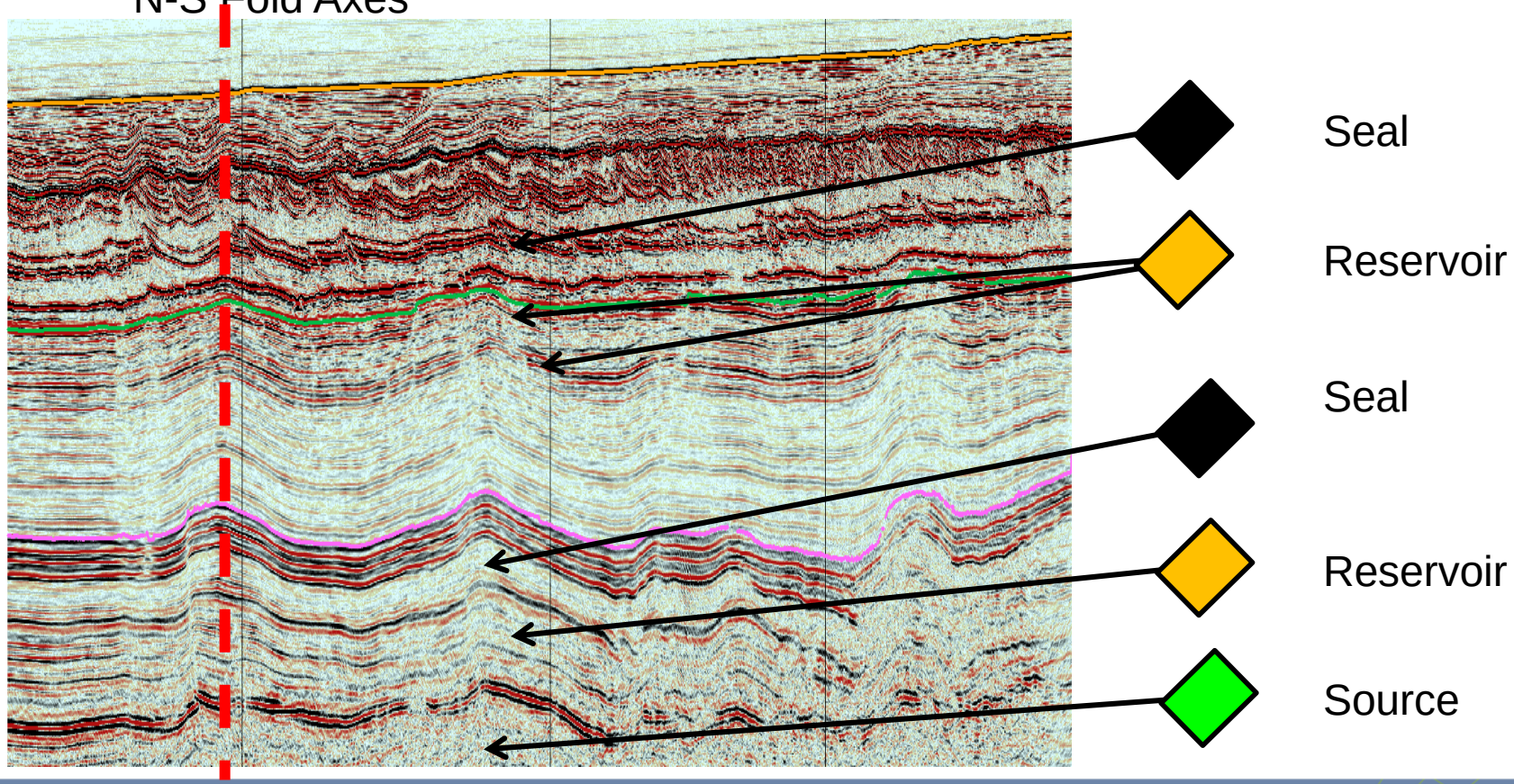
Far less complex than compressional structures in South Levant



Leviathan

10km

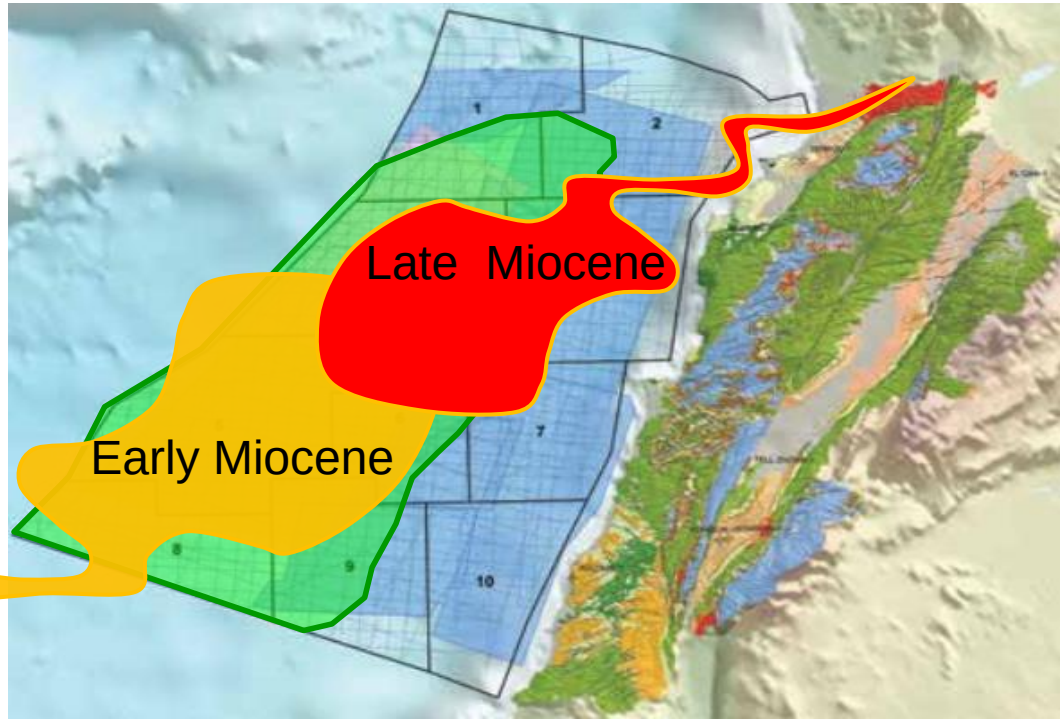
Play Concepts



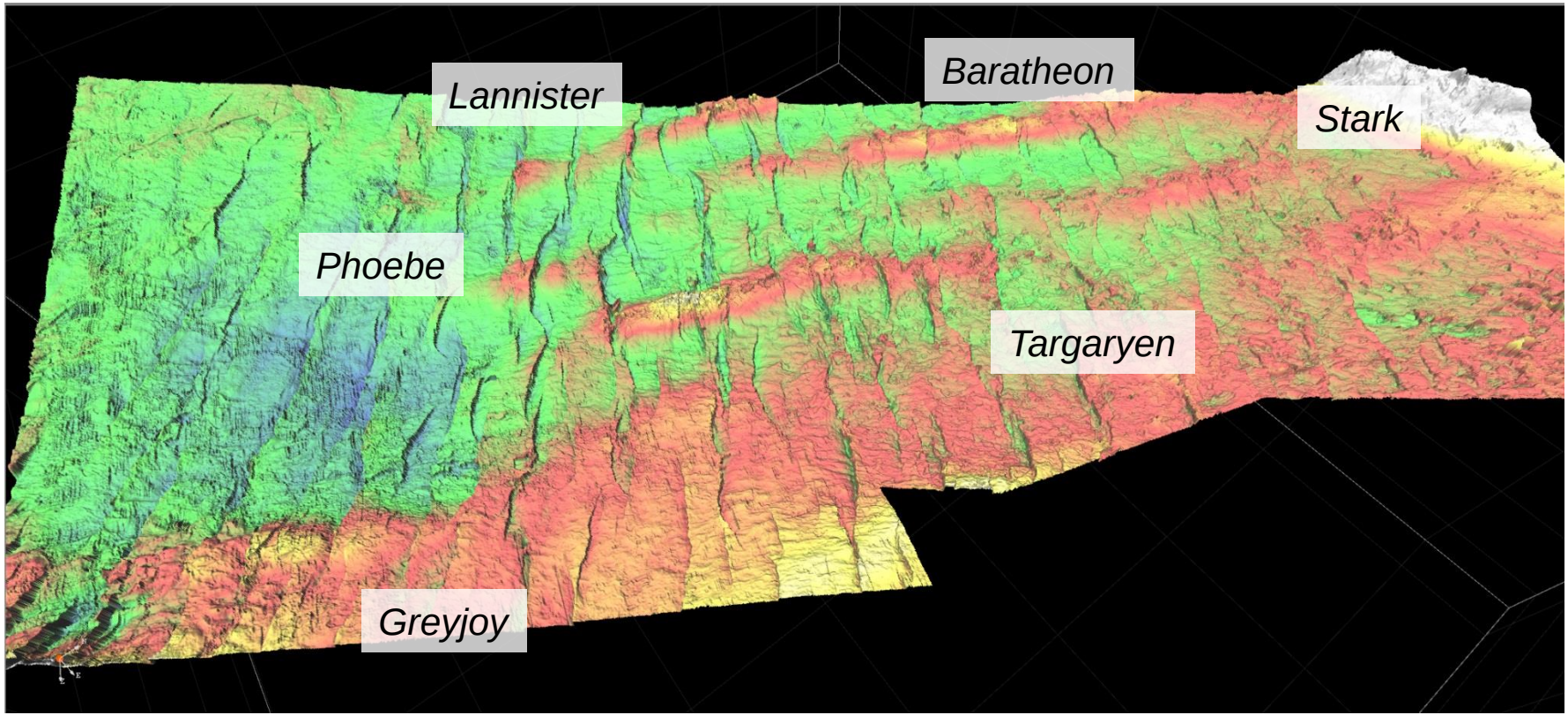
Early vs Late Miocene Provenance?

As the Early Miocene seaway through to the Persian Gulf closed, so no eastward sediment drift from the Nile.

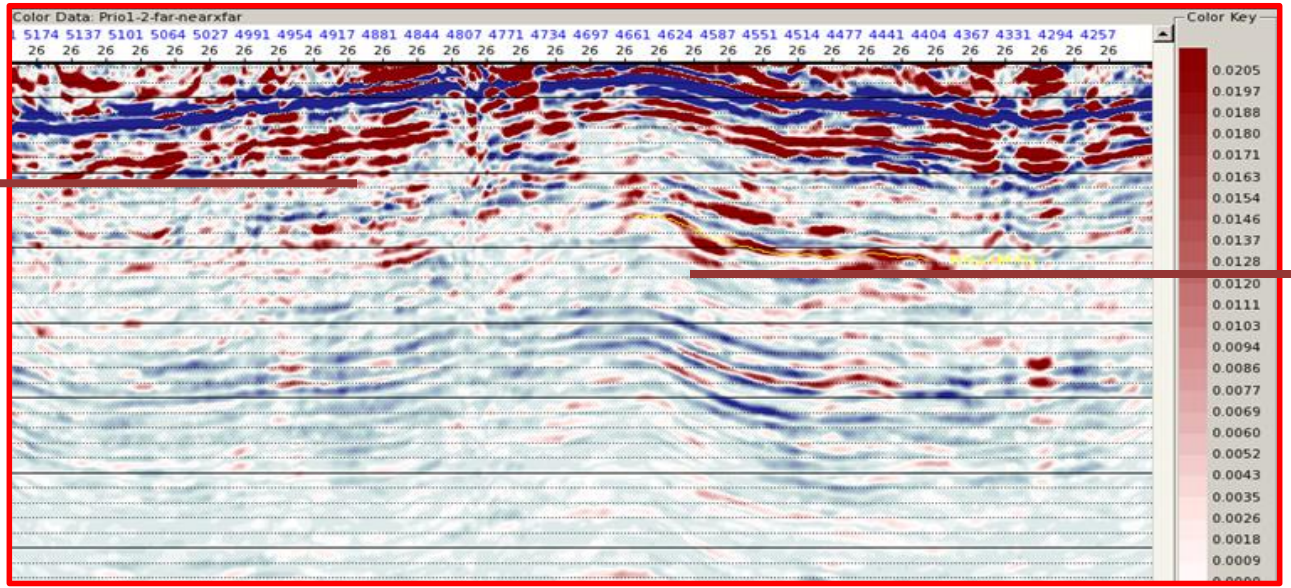
The northward collision of the Arabian plate caused the Palmyride Inversion, which may have created a local source for the Late Miocene.



Base Messinian Evaporites depth



“AVO” quick-look ; (Far-Near)*Far angle stacks

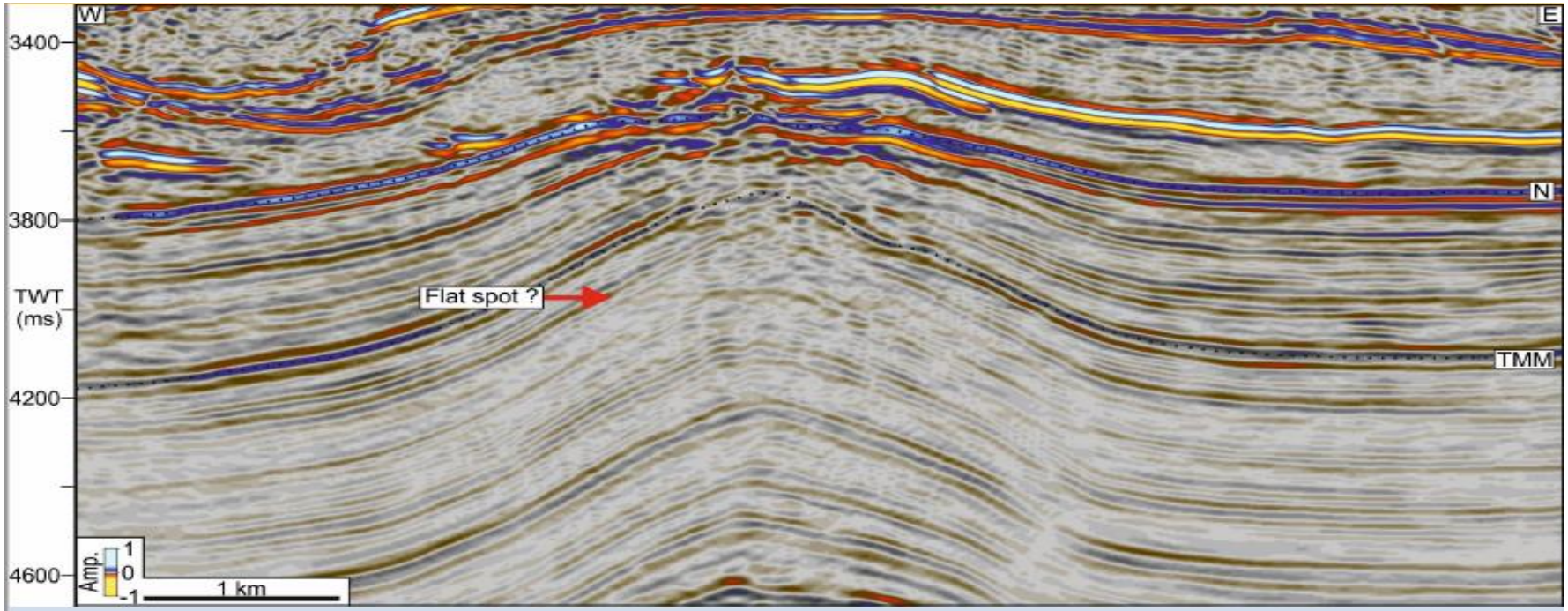


?Shut off 1

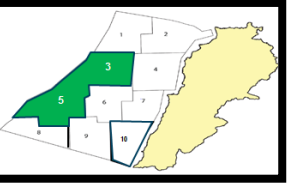
?Shut off 2

Very positive AVO responses at Late Miocene level.

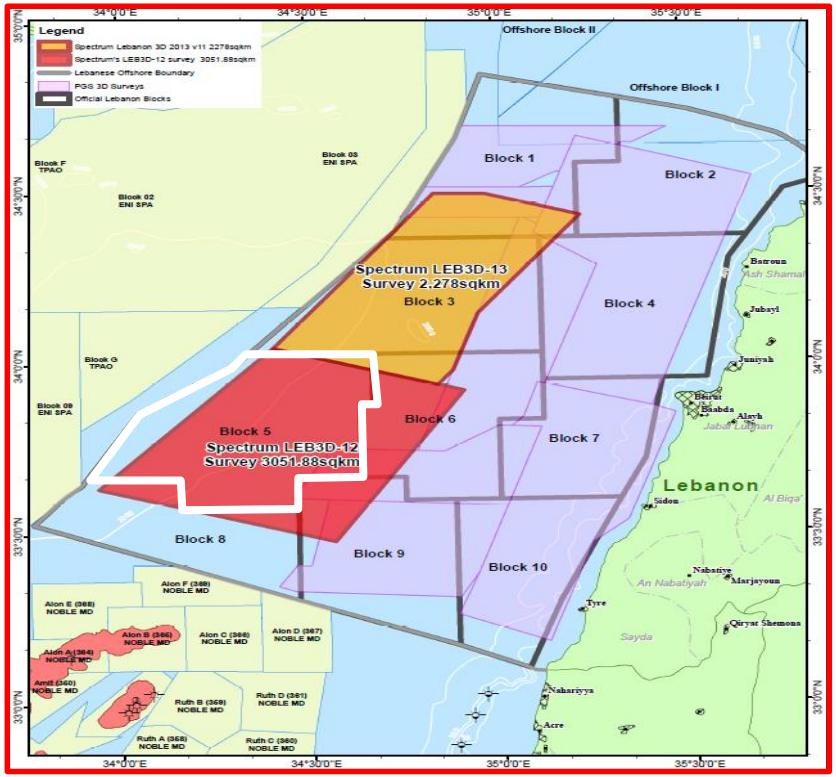
Base Messinian Structures and DHIs?



- Hard reflection that is discordant with the geometry of the anticlines reflections.
- The discordant reflection terminates against the inner side of the anticline.

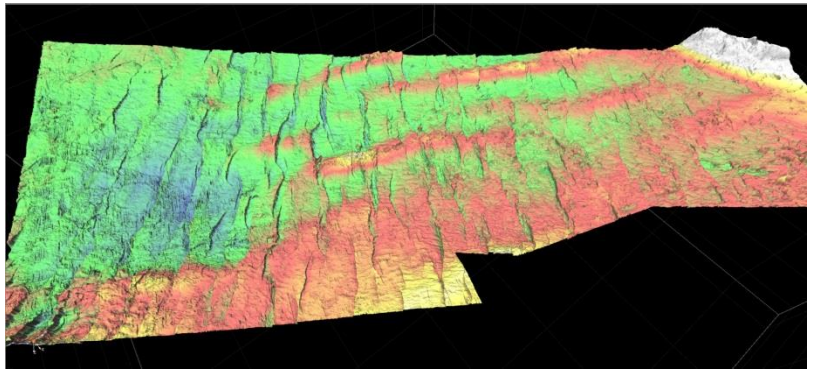


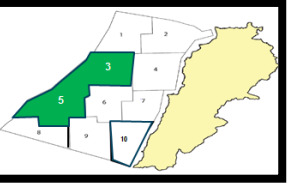
Block 5 : Resource Potential



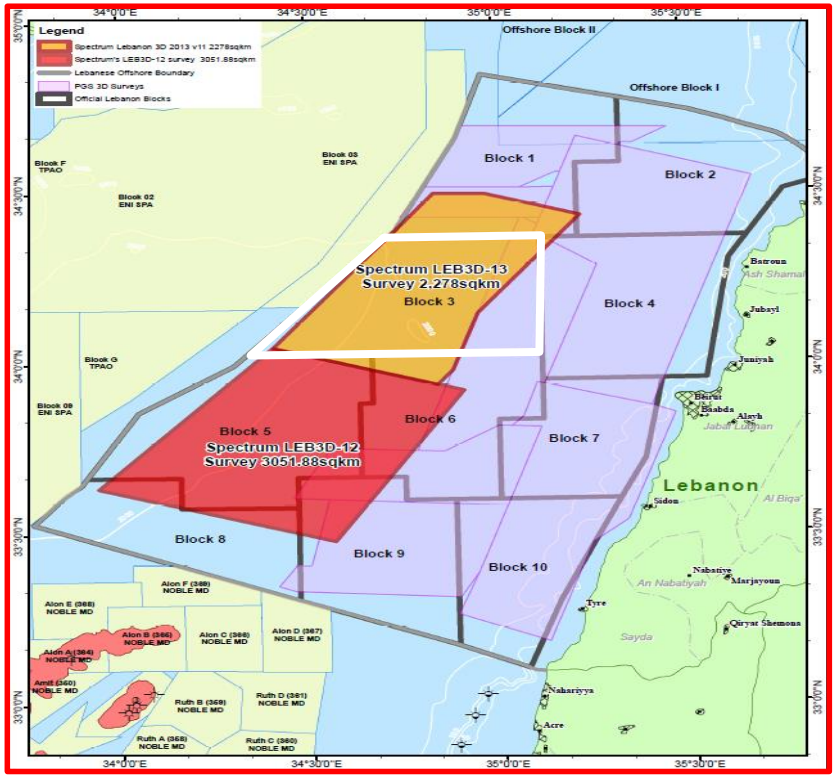
1) 25 + structures Lower Miocene
   30-50 TCF or **5 to 8.3 BBOE**

2) 2 large low relief structures Upper Miocene Level (three plays)
   8 -15 TCF or **1.3 to 2.5 BBOE** potential resources



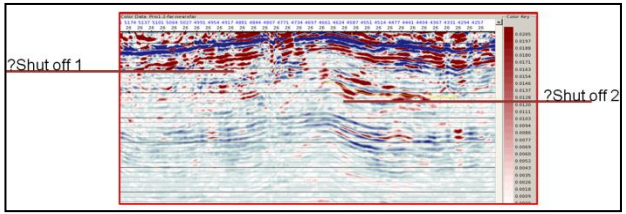


Block 3 : Resource Potential



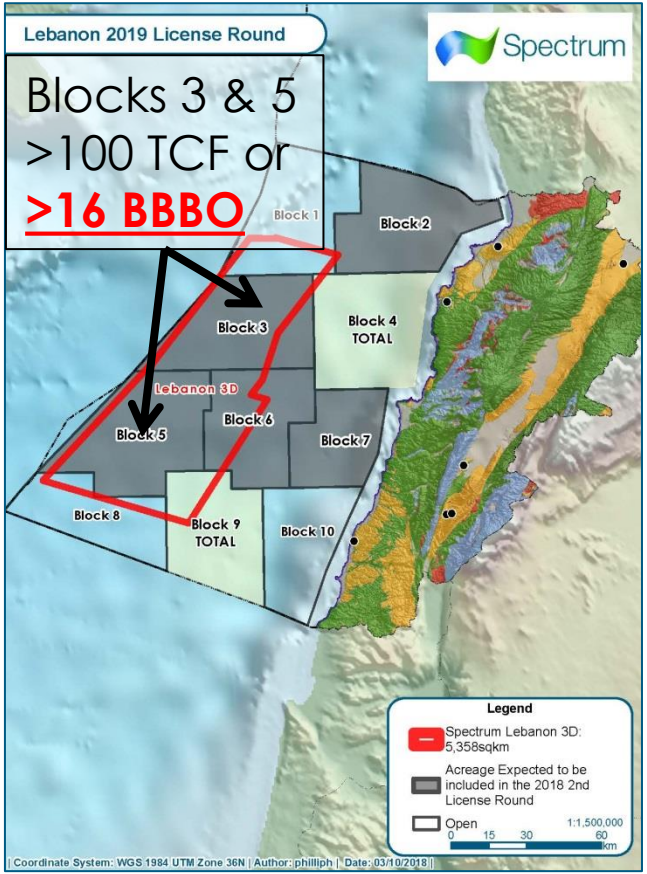
1) 17 + structures Lower Miocene
   15-35 TCF or **2.5 to 6 BBOE** potential resources.

2) 2-3 large low relief structures at Upper Miocene
   8 -15 TCF or **1.3 to 2.5 BBOE** potential resources



3) Block 1 Pinch-out play in north unquantified.

Lebanon 2019 License Round Opportunity



Blocks announced Nov '18

Pre qualification Q1 '19

Bidding from May to Oct '19

Awards 4Q '19