

Zohr Giant Gas Discovery – A Paradigm Shift in Nile Delta and East Mediterranean Exploration*

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Abstract

The story of Zohr started during mid 2012 when EGAS launched a competitive bid round over 15 offshore/onshore blocks in the Nile Delta. At that time, after more than 40 years of exploration, the Nile Delta plays (mostly clastic and gas-prone) from the HP/HT Oligocene pre-salt to the DHI-supported Plio-Pleistocene post-salt, were creamed. An innovative play was needed to restart exploration and to renew IEOC (Eni's affiliate company in Egypt) exploration portfolio. The opportunity was offered by several blocks on auction located along the Egypt-Cyprus border in deepwater/ultra-deepwater, previously explored during a 12 years period (1999-2011) without commercial success. While looking for the extension into Egypt of the multi Tcf, biogenic gas, Levantine play that had been proven in 2009-2011 in both Israel and Cyprus waters by the Noble-Delek JV (Leviathan, Tamar, and Aphrodite discoveries), IEOC explorers identified something profoundly different and yet similar. Instead of the Lower Miocene clastic deep-water sandstones sealed by the overlying shales and Messinian evaporites in anticlinal traps, a structural high linked to the Eratosthenes Seamount crustal block showed geometries typical of a shallow water isolated carbonate build-up immediately lying below the Messinian Salt onto which the Miocene clastics were laterally abutting. Two targets were initially inferred for the Zohr prospect, of Miocene and Lower Cretaceous age in analogy with what found by several ODP cores drilled on the adjacent Eratosthenes Seamount. Zohr-1 discovery well (2015, 1450m WD) was the first to target a carbonate play in offshore Egypt and in the East Mediterranean. It found Miocene and predominantly Lower Cretaceous shallow-water carbonates facies with a total of 654m of continuous vertical biogenic gas column. Subsequent appraisal wells (Zohr-2,3,5) confirmed the initial volumes in place estimated at 30 Tcf. Only two years after the discovery the gas of Zohr will be coming onstream in Q4 2017, a record for a deep-water development project, reshaping the energy scenario of the whole East Mediterranean and providing the O&G sector with a newly discovered play to be further pursued in the area.

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Gardosh, M.A., Y. Druckman, and B. Buchbinder, 2009, The Late Tertiary Deep-Water Siliciclastic System of the Levant Margin - An Emerging Play Offshore Israel: AAPG Convention, Denver, Colorado, June 7-10, 2009, [Search and Discovery Article #10211 \(2009\)](#). Website accessed January 2018.

MacGregor, D.S., 2012, The Development of the Nile Drainage System: Integration of Onshore and Offshore Evidence: Petroleum Geoscience, v. 18, p. 417-431.



Zohr Giant Gas Discovery – A paradigm shift in Nile Delta and East Mediterranean exploration

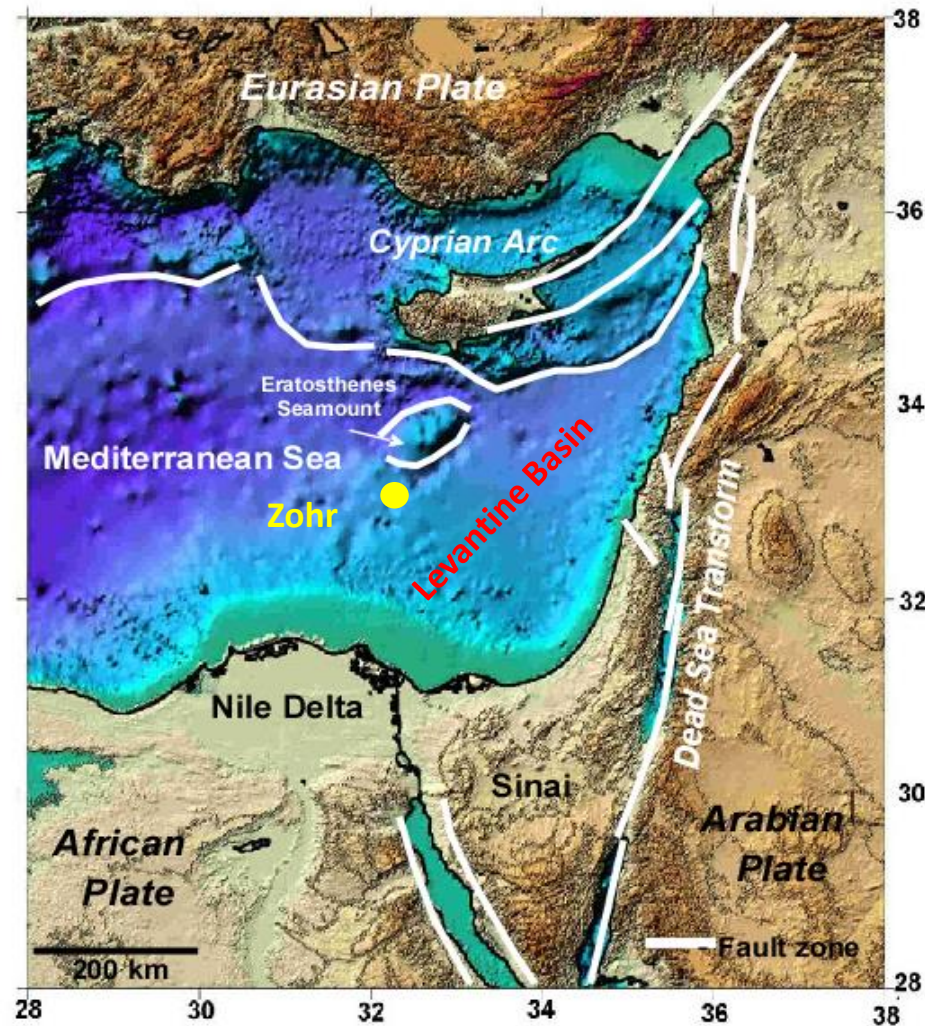
Cozzi A., Cascone A., Bertelli L., Bertello F., Brandolese S., Minervini M., Ronchi P., Ruspi R., Harby H.

Discovery Thinking Forum, AAPG/SEG International Conference & Exhibition 2017, London 16th October 2017

Zohr Giant Gas Discovery (2015) is the largest ever made in the Mediterranean



Levantine Basin and 2000-2011 Gas discoveries



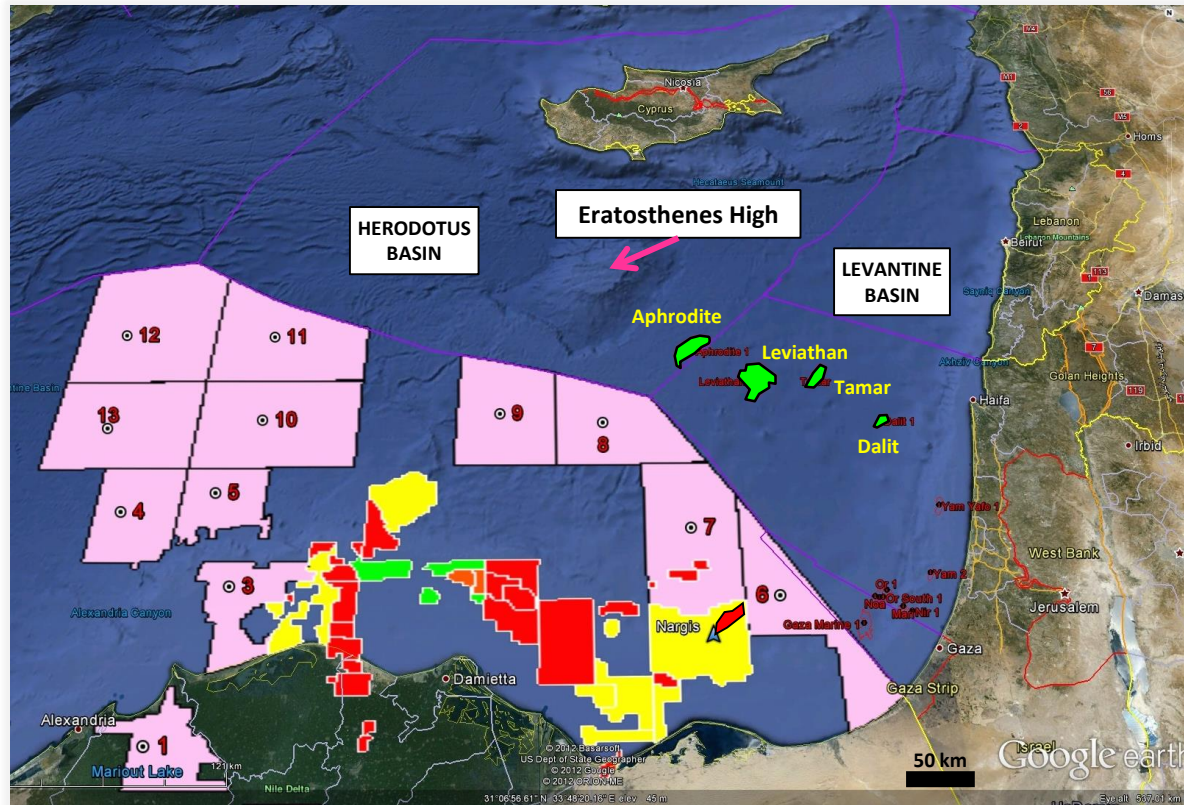
Modified after Gardosh (2009)

- **2000:** Gaza Strip; several gas discoveries in the **Pliocene sandstones** in Gaza Strip offshore (Noa, Mari B, Gaza Marine)
- **2009:** Israel; **Tamar** Discovery (Noble Op.), **Miocene turbidites**
- **2010:** Israel; **Leviathan** Discovery (Noble Op.)
- **2011:** Cyprus; **Aphrodite** discovery (Noble Op.)



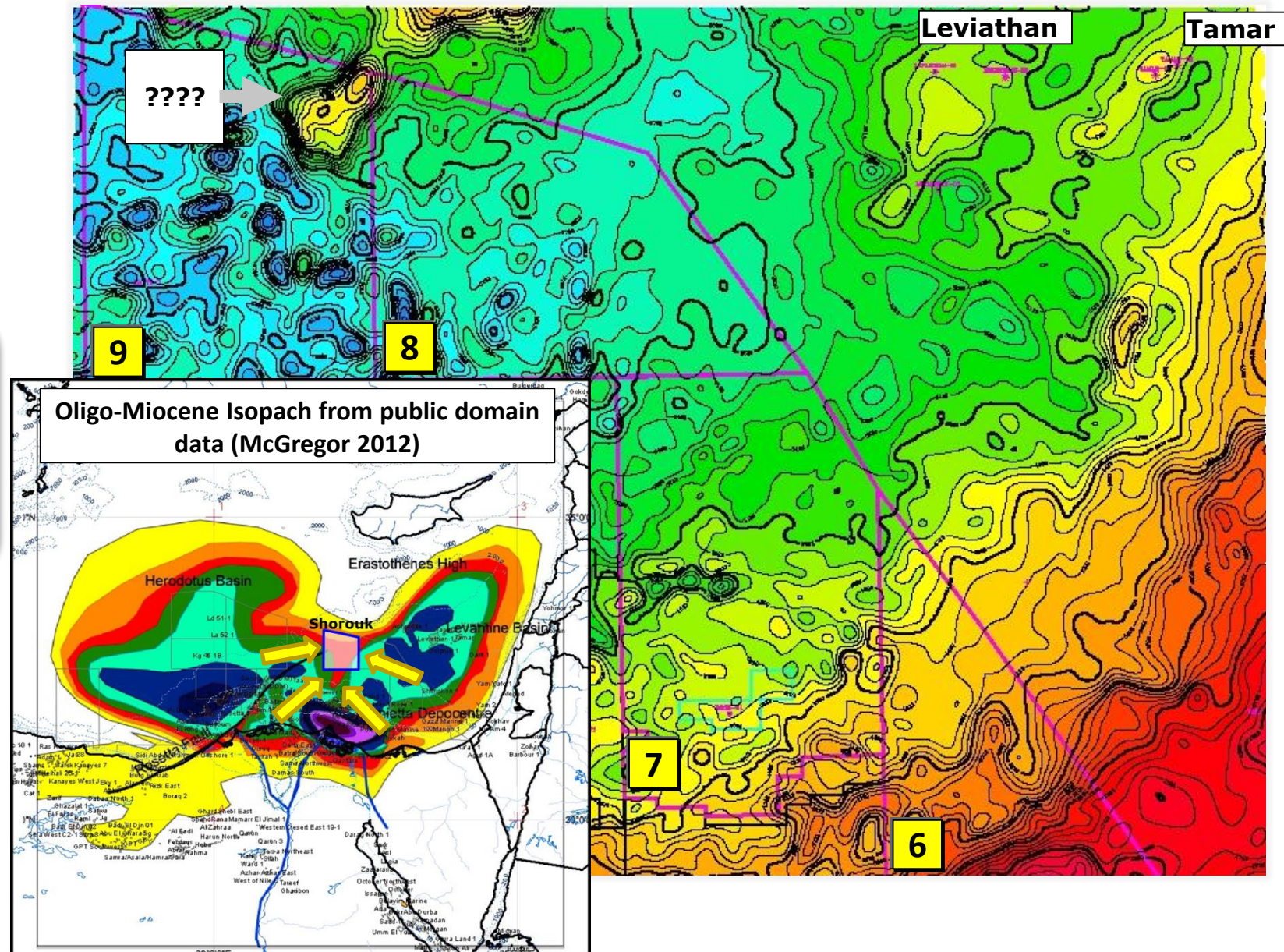
- **2010** Eni started a strategic project covering all Eastern Mediterranean Areas

EGAS 2012 Bidround: Timeline and Blocks offered

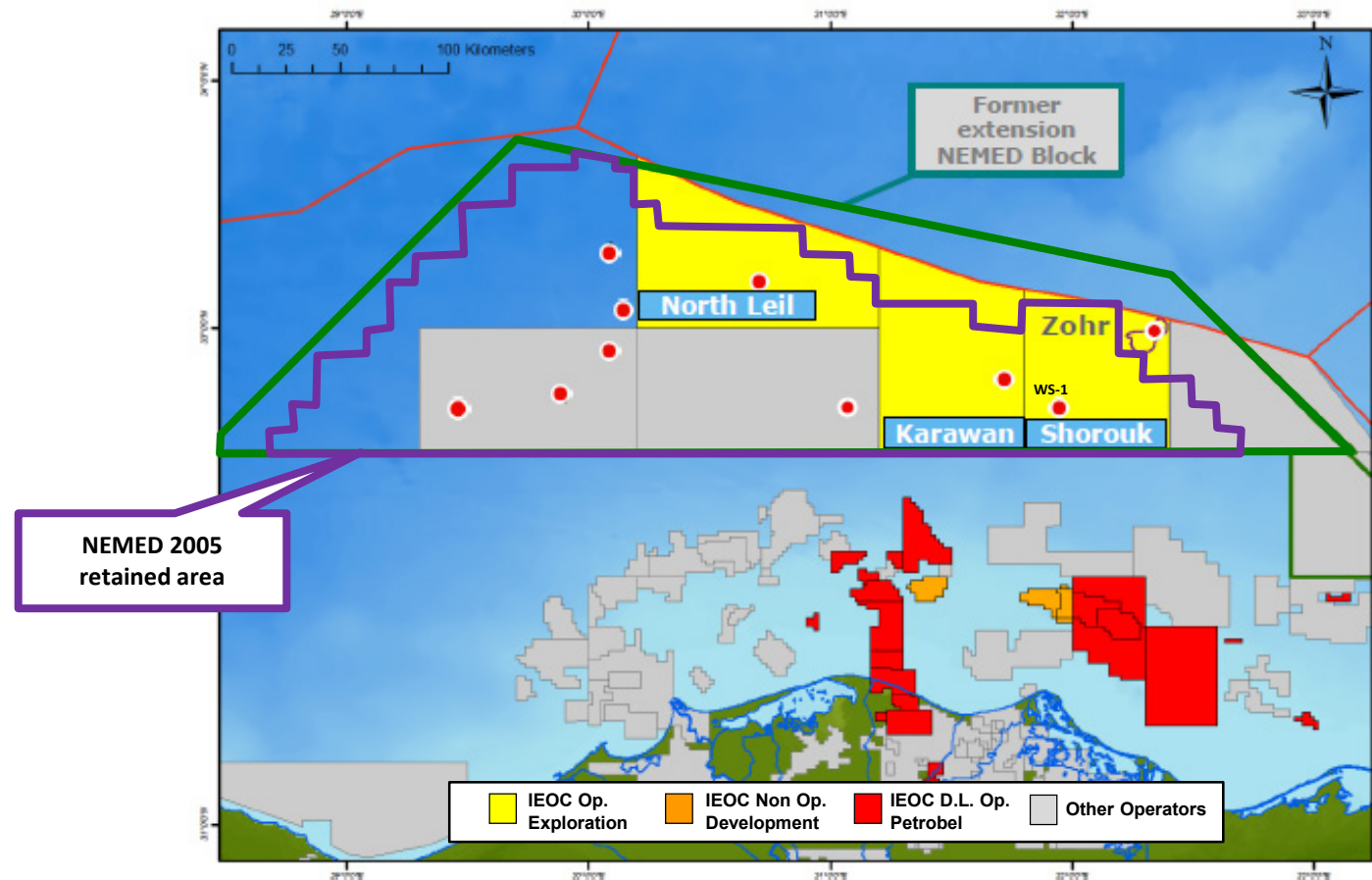


Did we have the Levantine Play in Egyptian waters?

Zohr Prospect is located on the structural divide among the Herodotus (W), Nile Delta (S) and Levantine Basin (E)



Nile Delta DW & UDW - previous exploration history



- The Egyptian DW and UDW were extensively explored between 1999 and 2011 in the wide NEMED Block operated by a O&G Major through a massive 2D/3D seismic campaign and the drilling of **10 exploration wells**
- The Operator was targeting the extension of the classic Tertiary clastic play of the Nile Delta, which turned out to be **not commercial**. One well (Wadi Sura-1) was drilled inside the current Shorouk Block and was unsuccessful

Geological intuition and powerful Eni proprietary seismic imaging technology

SW

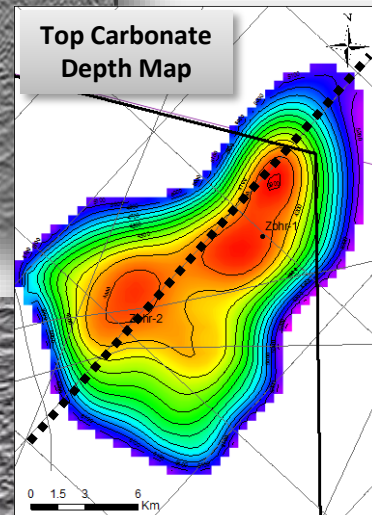
NE

?

?

Available Data Package Quality (Time)

Top Carbonate
Depth Map



Eni's Pre Stack Depth Seismic Imaging

14 Nov 2012

13 Feb 2013

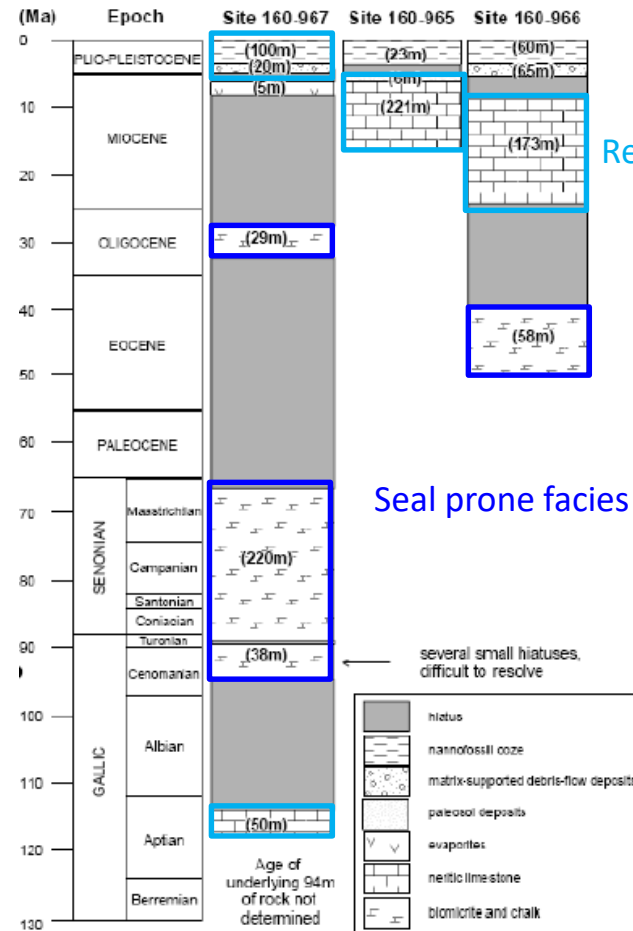
Old Closing
Date

New Closing
Date

Four 2D lines
PSDM reprocessing

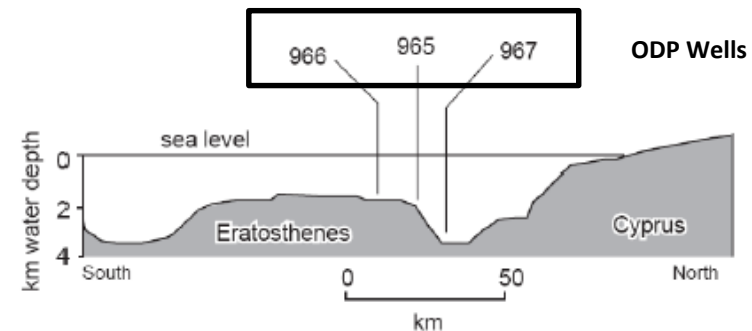
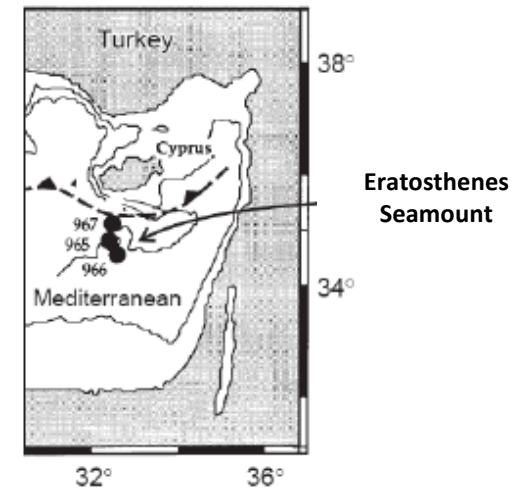


ODP data suggested Miocene and Cretaceous reservoir targets



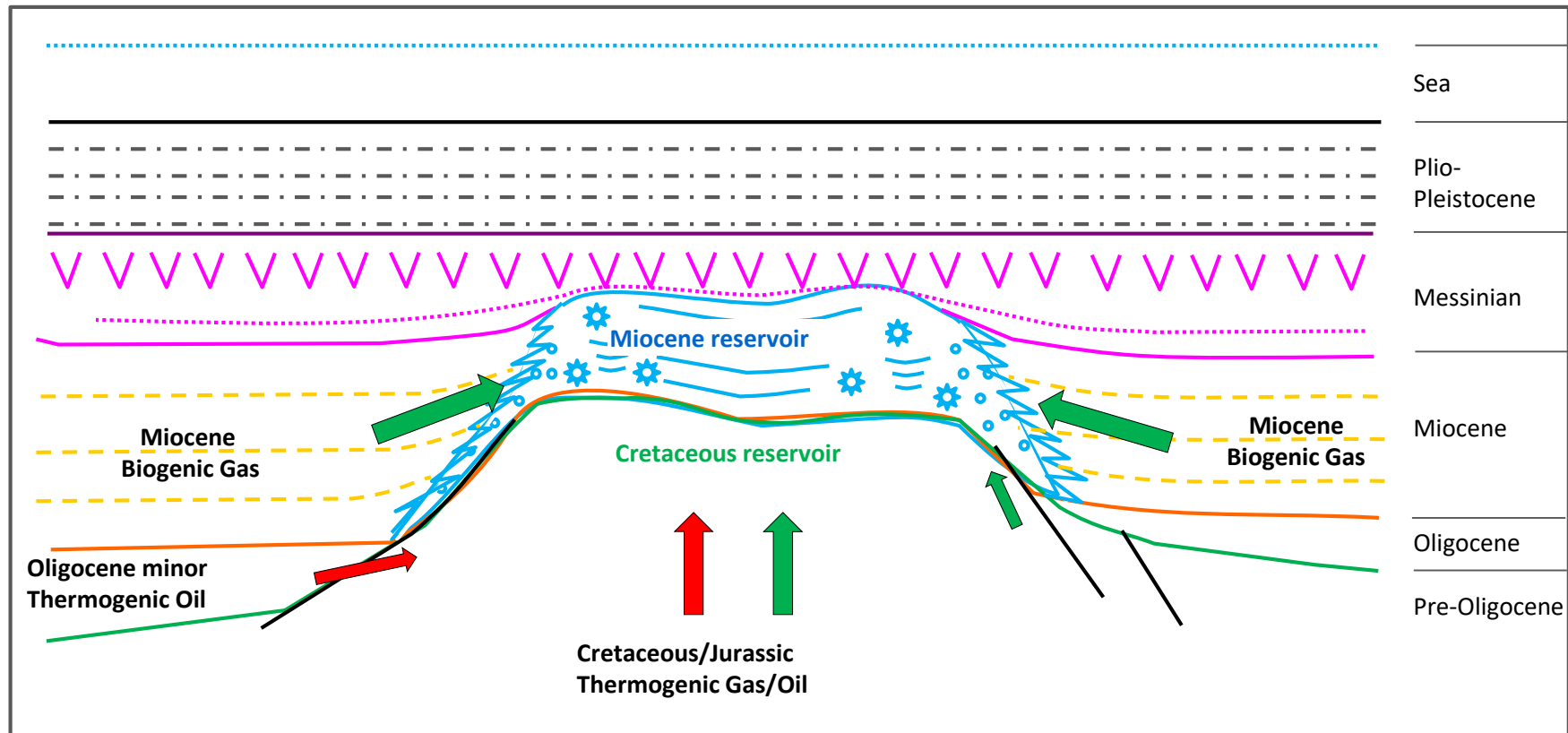
Reservoir prone facies

Seal prone facies



After Flecker et al. (1998)

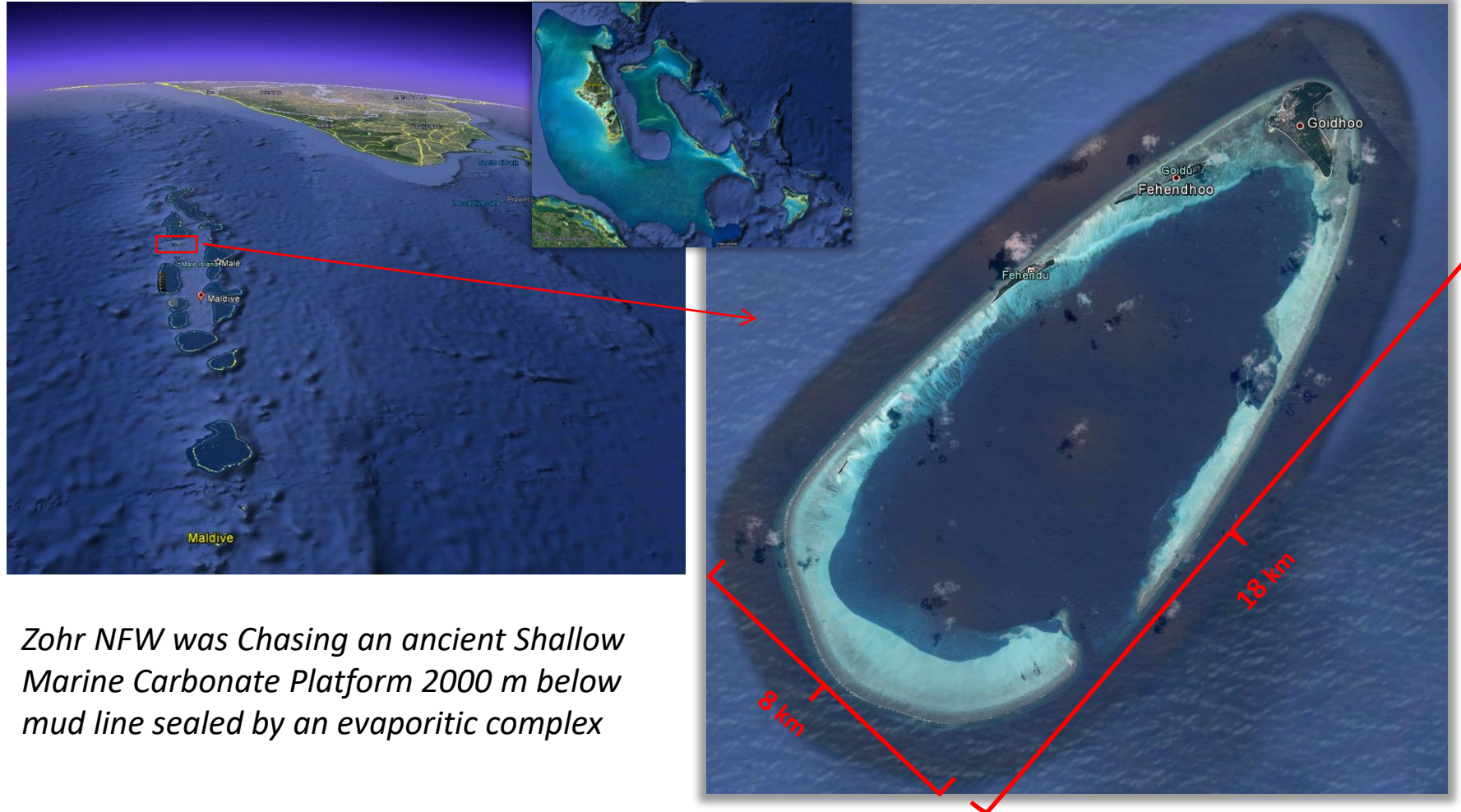
The Zohr Play conceived



- *Untested Play*
- *High Risk – High Reward but it could change the future of EXP in Egypt and East Mediterranean in general*

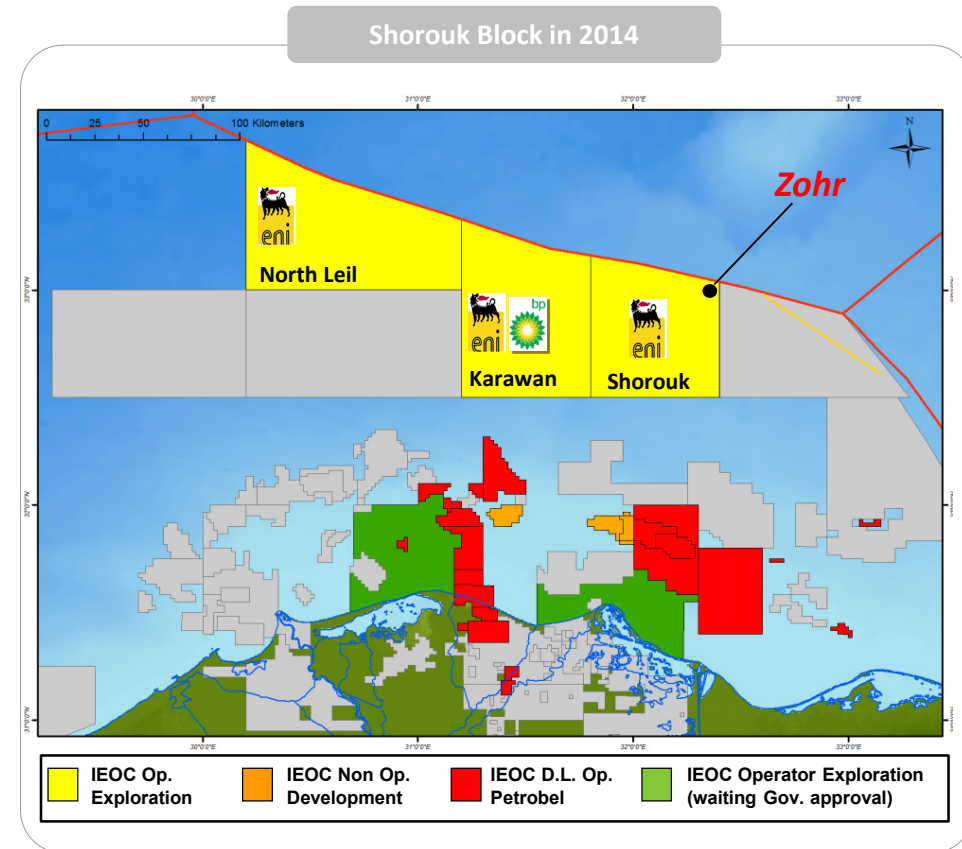
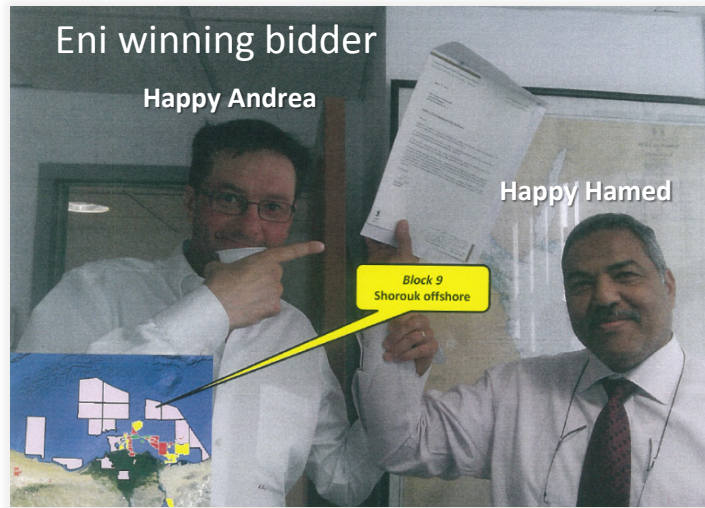
Shallow Marine Carbonate Platforms - Today Analogues

Atolls in the Maldives?? The GBB??

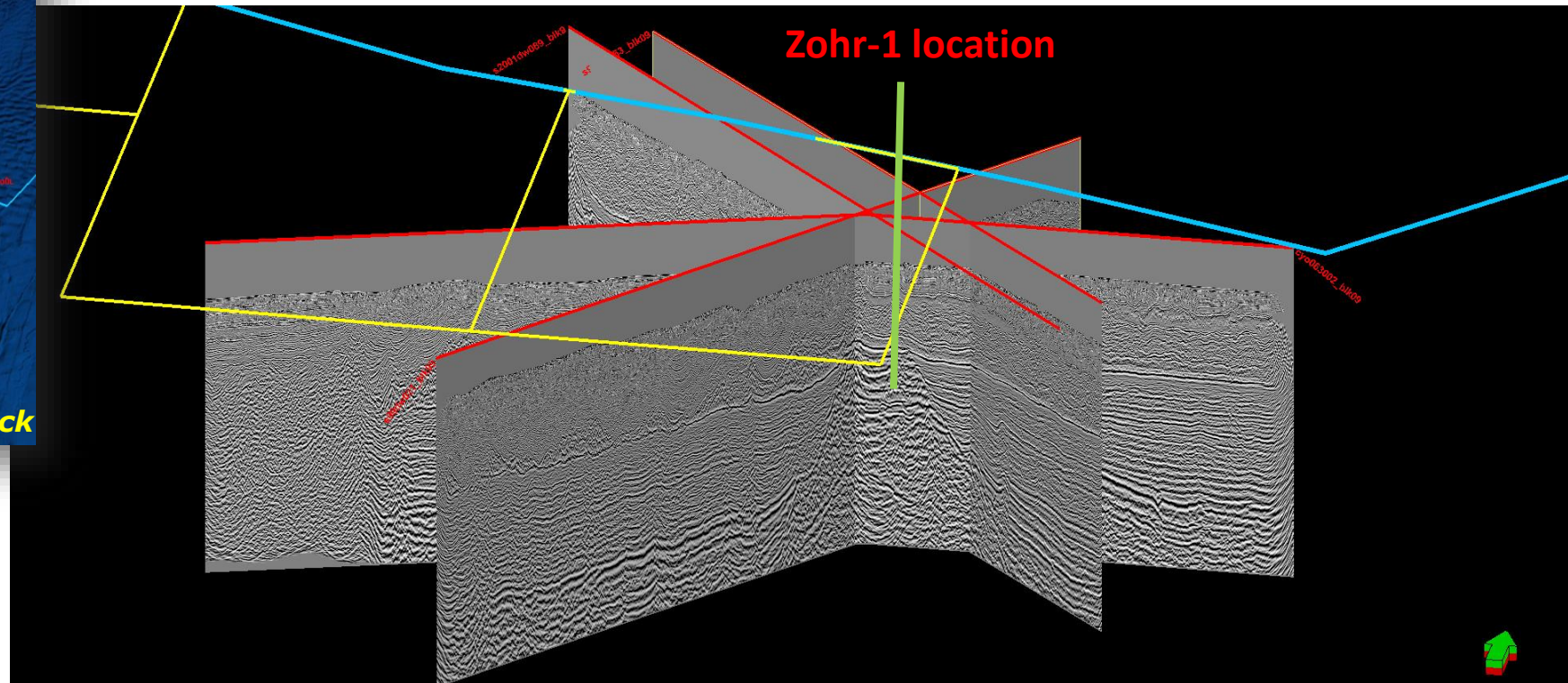
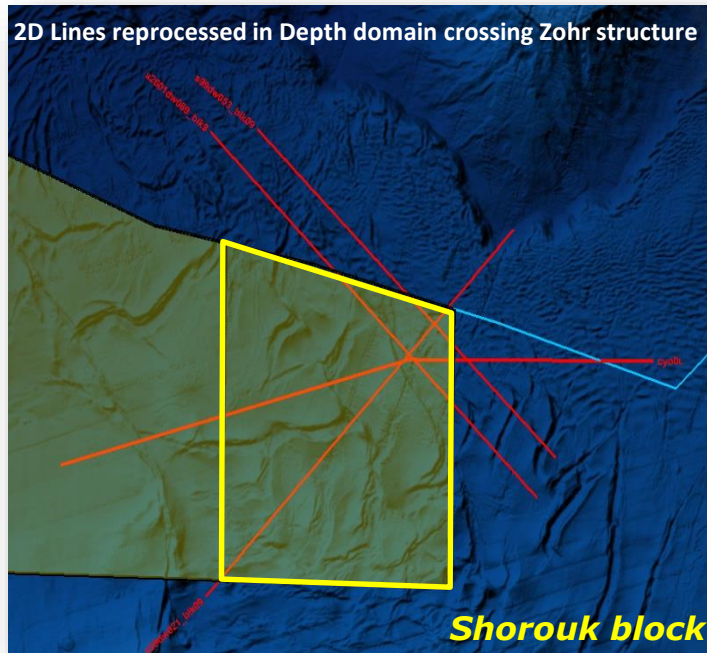


Zohr NFW was Chasing an ancient Shallow Marine Carbonate Platform 2000 m below mud line sealed by an evaporitic complex

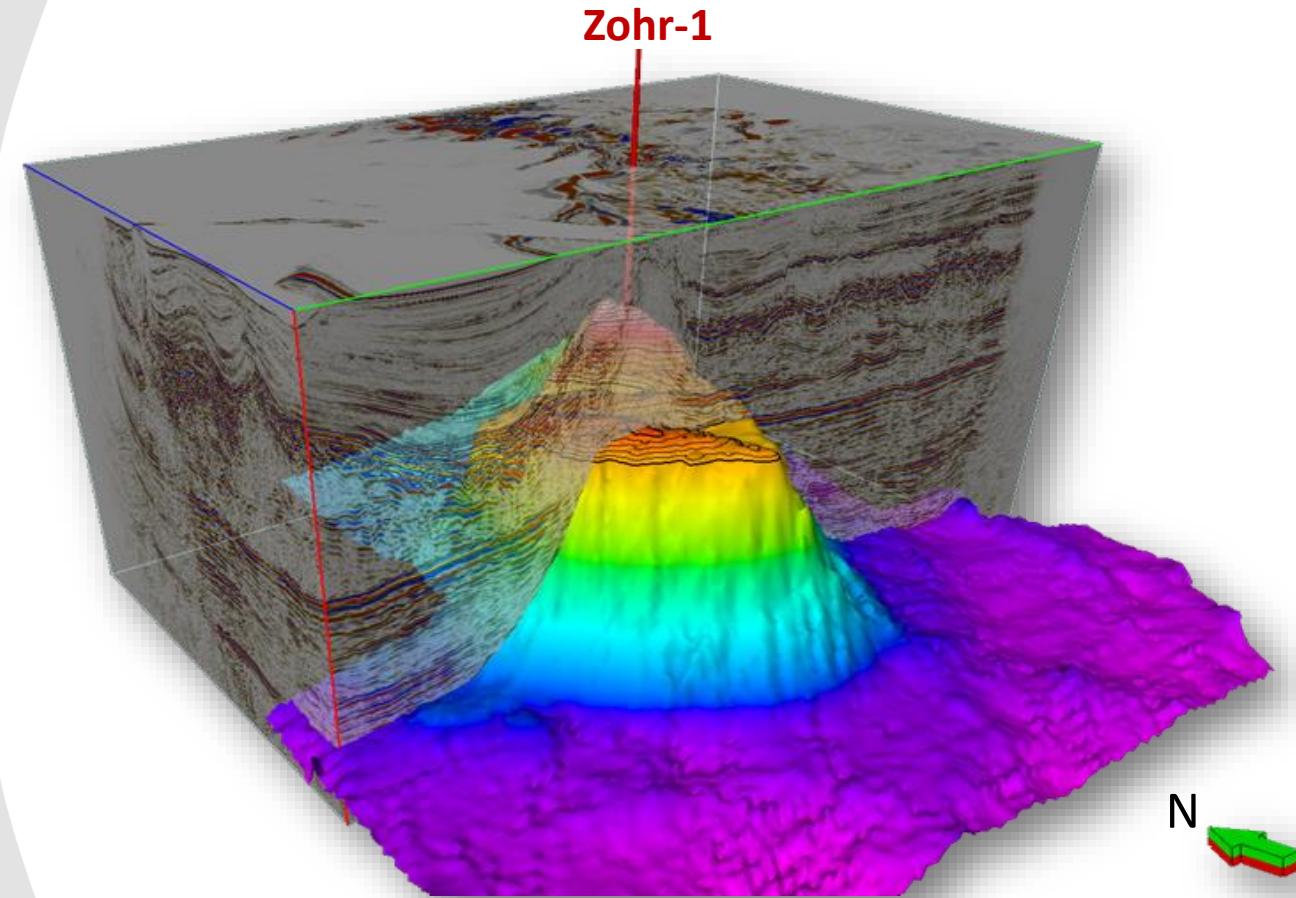
Shorouk Block Eni winning bidder in April 2013, signed in January 2014



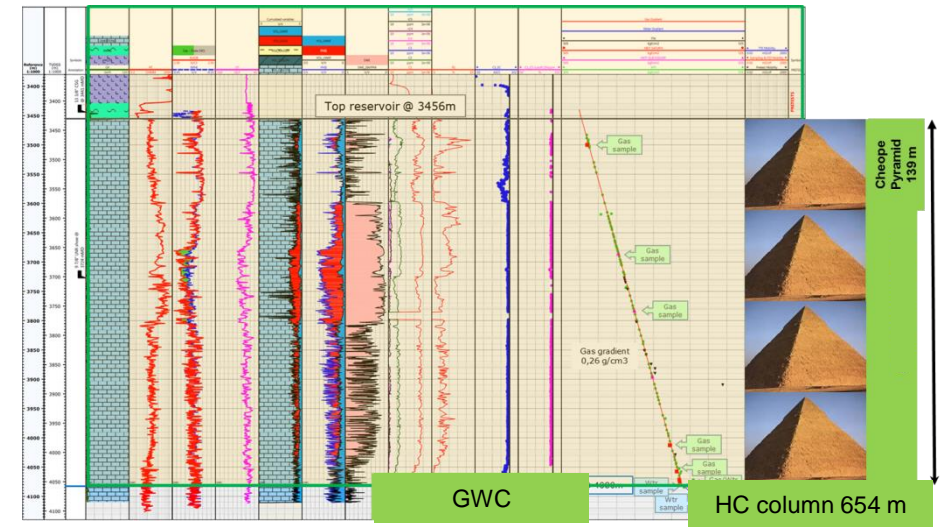
The four 2D PSDM seismic lines used to locate Zohr-1 discovery well



Zohr Discovery – main facts



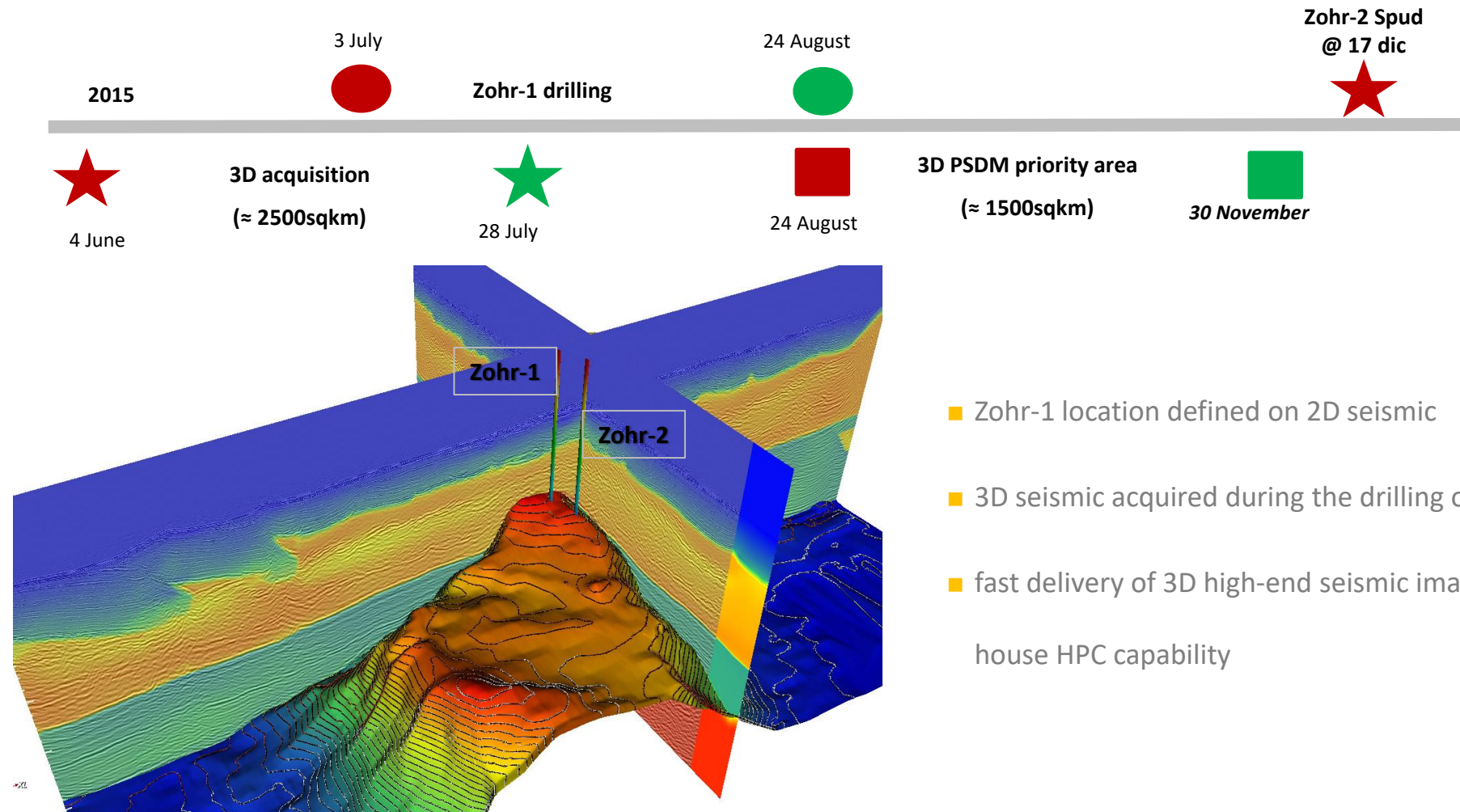
Zohr 1 Main results



- ❑ Outstanding biogenic gas accumulation in a Miocene-Cretaceous carbonate platform complex
- ❑ Gas area extends for about 100 sqkm
- ❑ The gas accumulation is fully contained in the EEZ of Egypt
- ❑ World class carbonate reservoir with excellent petrophysics
- ❑ Discovered Volumes estimated at 30 TCF of GOIP
- ❑ Innovative "Play" not recognized in previous exploration campaigns



3D high-end seismic imaging for Zohr appraisal campaign

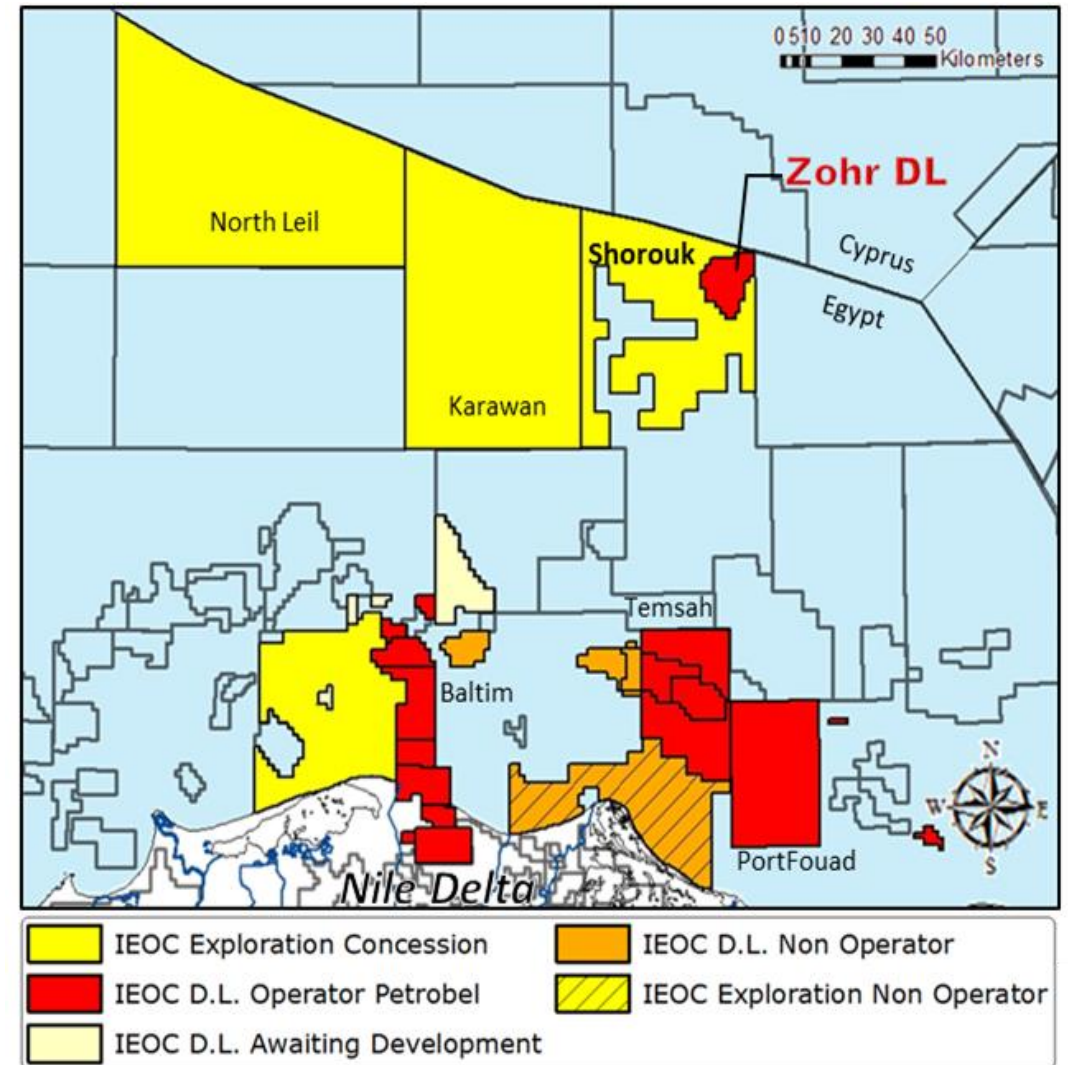


- Zohr-1 location defined on 2D seismic
- 3D seismic acquired during the drilling of Zohr-1
- fast delivery of 3D high-end seismic imaging thanks to in-house HPC capability

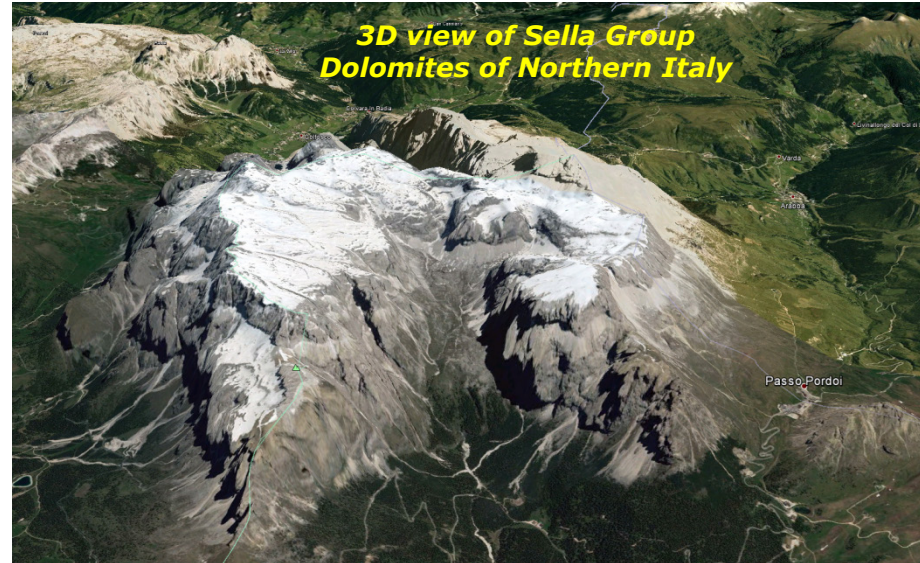
3D Depth Volume for Appraisal Campaign delivered in less than 3 months!

Zohr Development Lease today

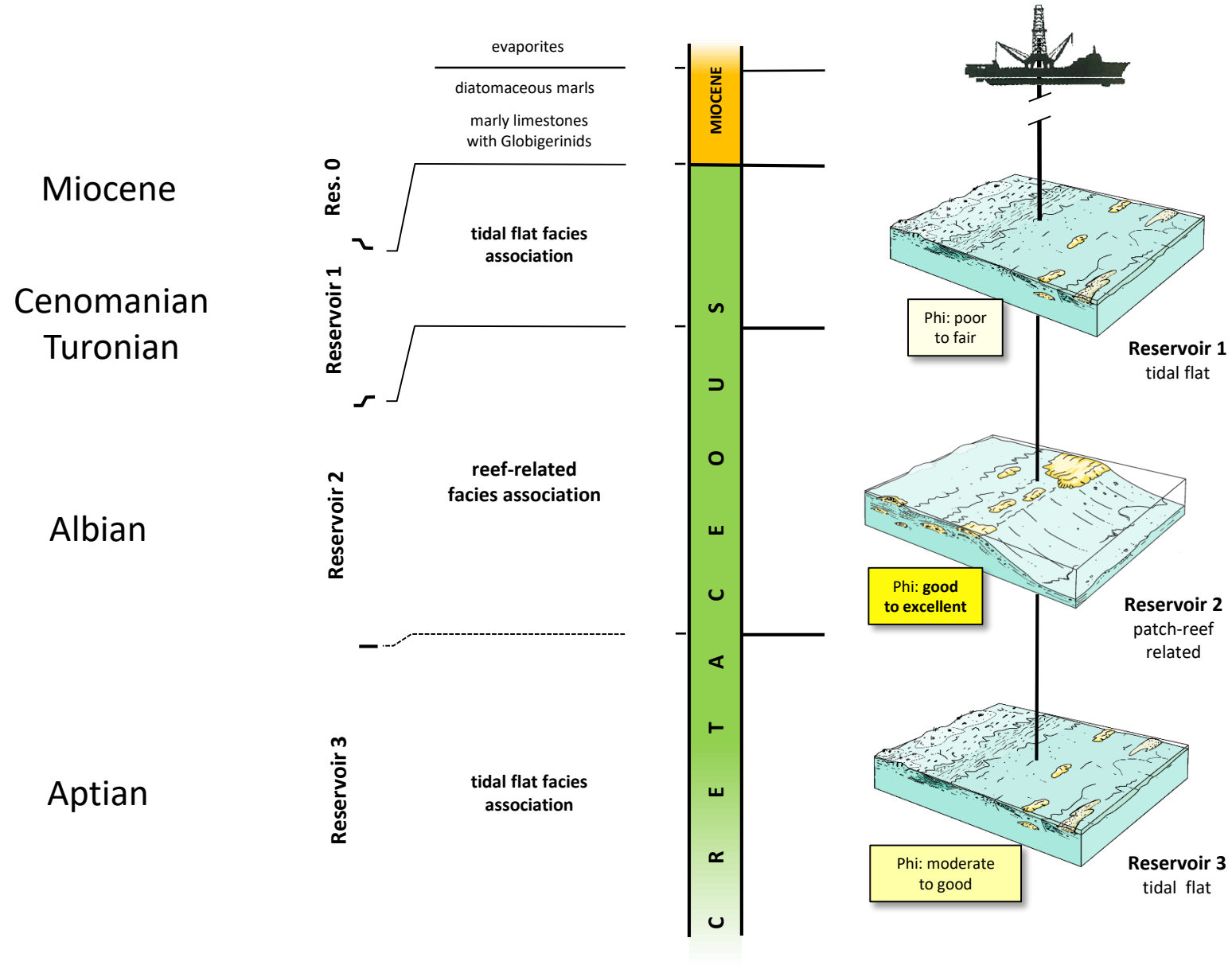
- Water depth: 1300-1650 m
- Total Area: 230 km²
- Distance from coast: 190 km
- Shorouk Block award: January 30th 2014
- D.L. granted: February 7th 2016
- ACHIEVED WORK:
 - ~3,000 km² of 3D Seismic acquired and processed
 - **Discovery well Zohr-1 drilled in Jul-Sep 2015, 3 years ahead of schedule**
 - **8 wells drilled**
 - **4 wells completed and flowed back for cleanup**



Zohr carbonate platform analog



Zohr-1: Reservoir zonation & Facies types



Zohr Project Development Scheme

Accelerated Start-Up:

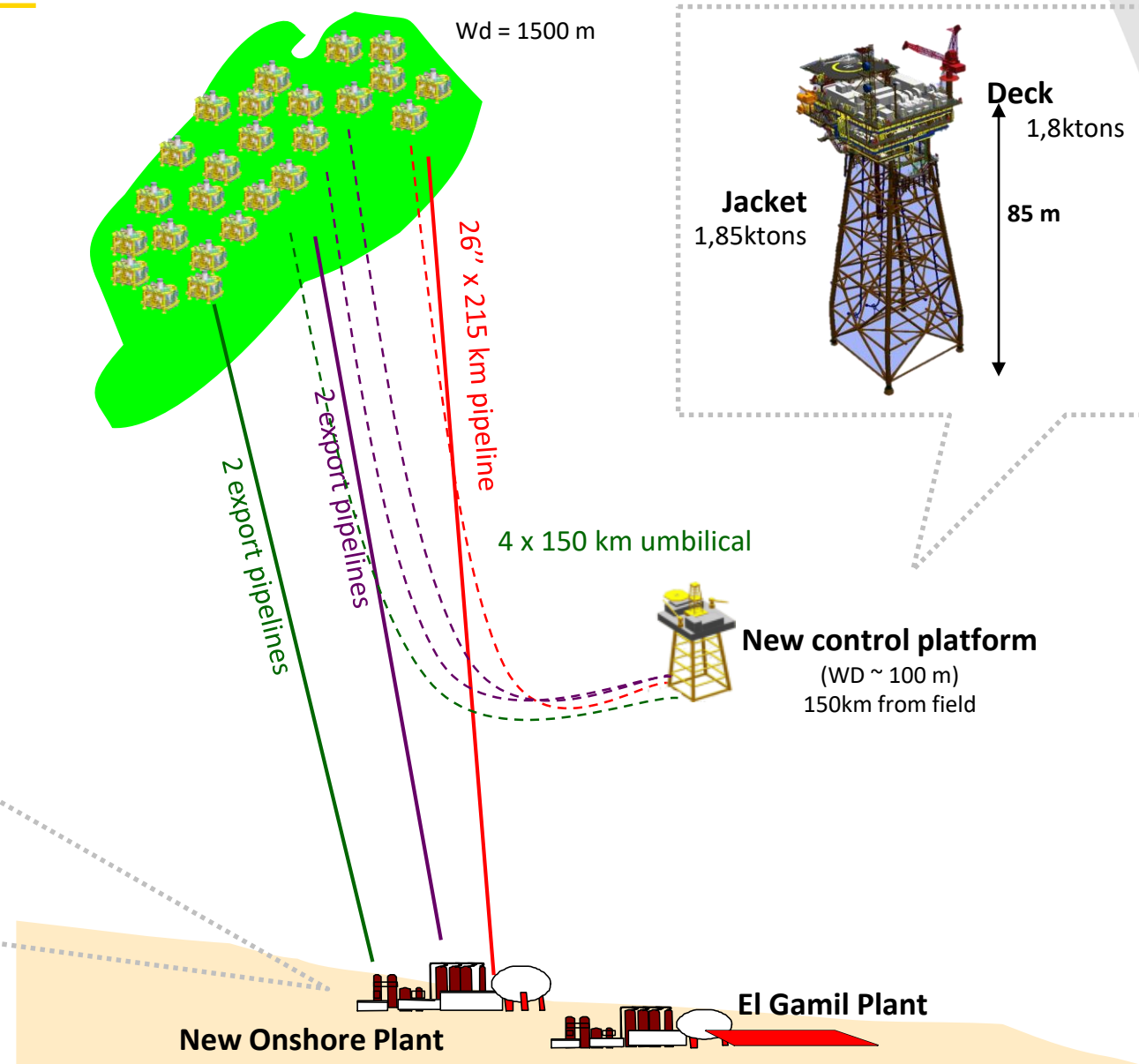
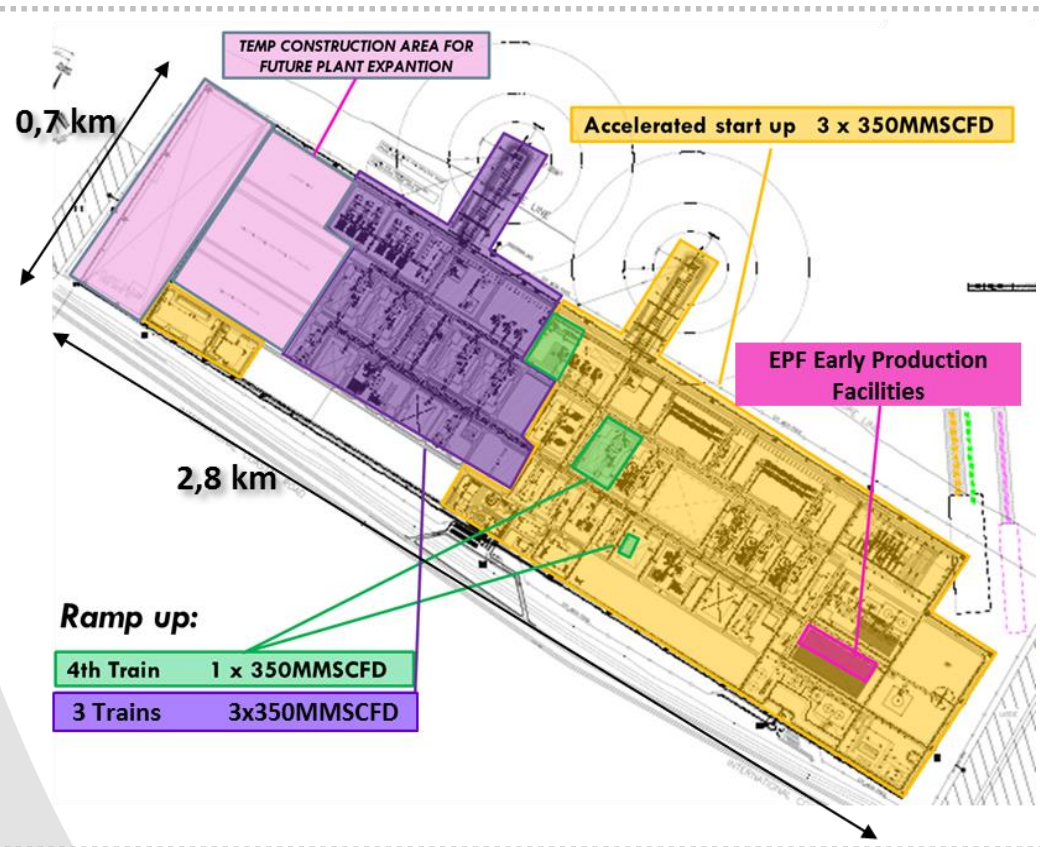
- 26" line
- DEG line (8") + service line (14")
- new control platform
- 1 umbilical
- new onshore plant

Ramp-Up to plateau:

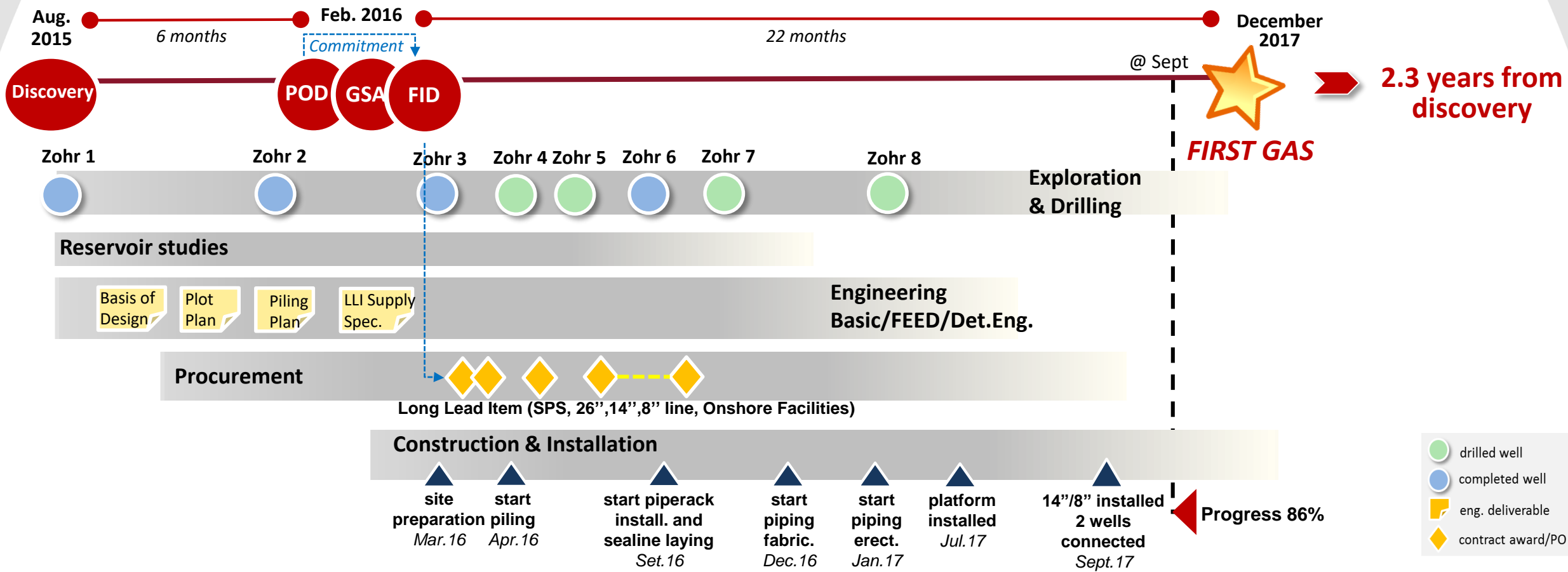
- additional 2 export lines (30")
- DEG line (8") + service line (14")
- 2 umbilicals
- onshore plant expansion

Plateau Extension:

- additional 2 export lines (30")
- 1 umbilical
- onshore compressors



Zohr: count down to first gas



Shukran!

Fayum Whale Valley

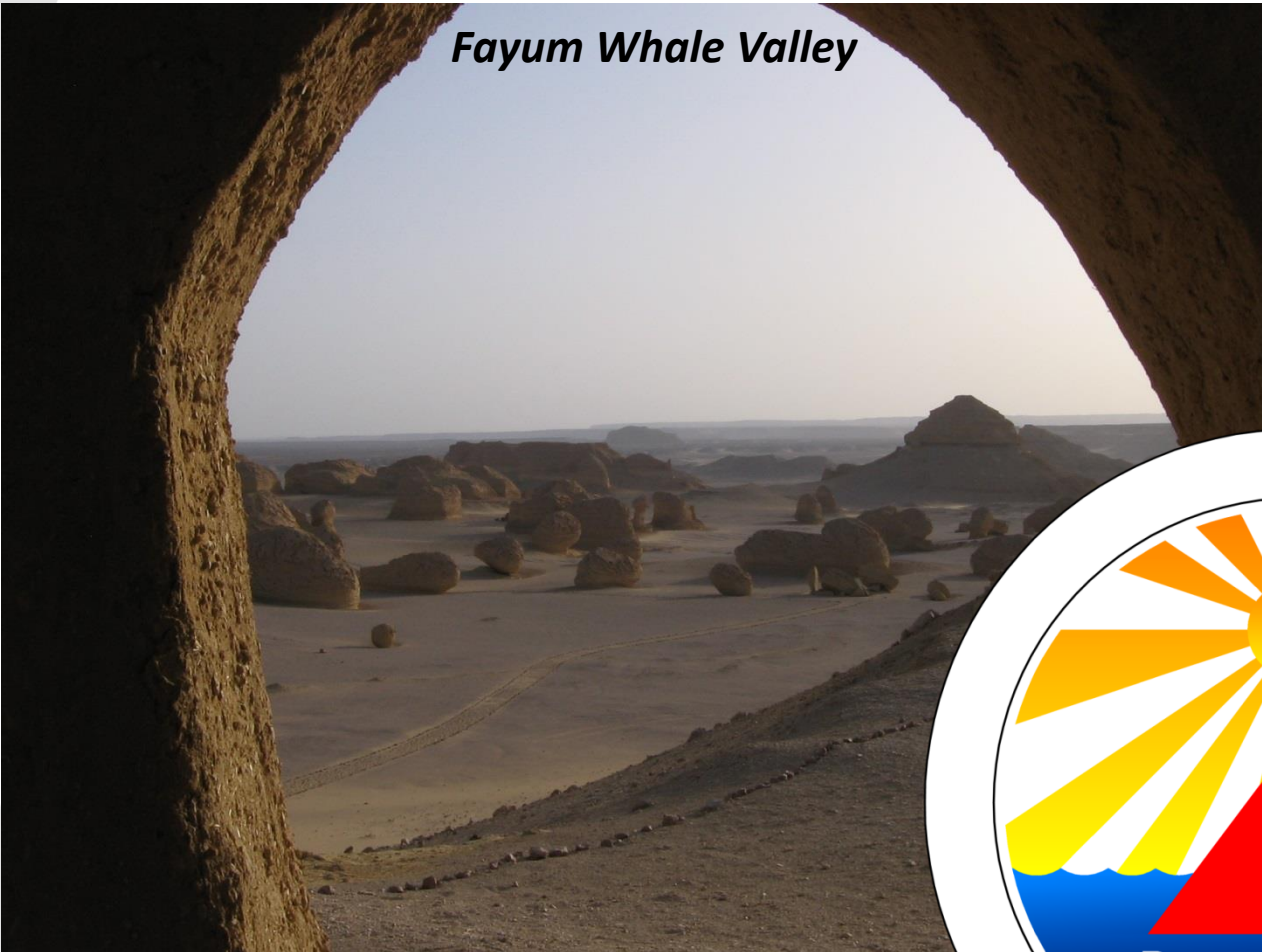


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*Abu Roash
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