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.
References Cited


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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

- **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

Modified after Gardosh (2009)
EGAS 2012 Bidround: Timeline and Blocks offered

- **June 2012**: Bid Round Announcement
- **Original Closing Date**: 14 Nov 2012
- **New Closing Date**: 13 Feb 2013

### Blocks offered
- **LEvantine Basin**: Tamar, Aphrodite, Leviathan, Dalit
- **Herodotus Basin**: Eratosthenes High

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**Map Highlights**
- **Blocks**: 1, 4, 5, 7, 8, 9, 10, 11, 12
- **Regions**: Levant, Herodotus, Tamar, Dalit, Aphrodite, Leviathan

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**Technical-Economic Evaluation**

**Closing Date**

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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)

Oligo-Miocene Isopach from public domain data (McGregor 2012)
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

Available Data Package Quality (Time)

Eni’s Pre Stack Depth Seismic Imaging

Four 2D lines
PSDM reprocessing

Old Closing Date: 14 Nov 2012
New Closing Date: 13 Feb 2013

Top Carbonate Depth Map
ODP data suggested Miocene and Cretaceous reservoir targets

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**
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

- 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

- **Miocene**
  - Reservoir 1
    - tidal flat facies association
  - Reservoir 2
    - reef-related facies association
  - Reservoir 3
    - tidal flat facies association

- **Cenomanian**
  - Reservoir 1
    - tidal flat
  - Reservoir 2
    - patch-reef related
  - Reservoir 3
    - tidal flat

- **Turonian**
  - Reservoir 1
    - Phi: poor to fair
  - Reservoir 2
    - Phi: good to excellent
  - Reservoir 3
    - Phi: moderate to good

- **Albian**
  - Reservoir 1
  - Reservoir 2
  - Reservoir 3

- **Aptian**
  - Reservoir 1
  - Reservoir 2
  - Reservoir 3

**Reservoir:**
- Res. 0
- Res. 1
- Res. 2
- Res. 3

**Facies types:**
- evaporites
- diatomaceous marls
- marly limestones with Globigerinids

**Time Periods:**
- Aptian
- Albian
- Cenomanian
- Turonian
- Miocene
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

El Gamil Plant
Wd = 1500 m

New control platform
(WD ~ 100 m)
150km from field

New Onshore Plant

Deck
1,8 ktons
85 m

26”, 2.15 km pipeline
4 x 150 km umbilical
2 x export pipelines

Zohr Project Development Scheme

3 x 350MMSCFD
Accelerated start up

4th Train 1 x 350MMSCFD
3 Trains 3 x 350MMSCFD

TEMP CONSTRUCTION AREA FOR FUTURE PLANT EXPANSION

EPF Early Production Facilities

Wd = 1500 m

Jacket
1,85 ktons

85 m

4 x 150 km umbilical
2 x export pipelines

26”, 2.15 km pipeline

Deck
1,8 ktons
85 m

New control platform
(WD ~ 100 m)
150km from field

New Onshore Plant
Zohr: count down to first gas

- **Aug. 2015** to **Feb. 2016**: POI and FID
- **February 2016** to **December 2017**: 2.3 years from discovery

### Exploration & Drilling
- **1.3 years**
- **Zohr 1** to **Zohr 8**

### Reservoir studies
- **Mar. 16** – Site preparation
- **Feb. 17** – Onshore Plant
- **Aug. 17** – Platform
- **Sept. 17** – Offshore Hook up

### Engineering
- **Basic/FEED/Det.Eng.**

### Construction & Installation
- **Long Lead Item**
- **Progress 86%**

- **Site preparation**
  - Mar. 16
- **Start piling**
  - Apr. 16
- **Start piping install. and sealine laying**
  - Set. 16
- **Start piping fabric.**
  - Dec. 16
- **Start piping erect.**
  - Jan. 17
- **Platform installed**
  - Jul. 17
- **14"/8″ installed**
  - 2 wells connected
  - Sept. 17

### Procurement
- **Basis of Design**
- **Plot Plan**
- **Piling Plan**
- **LLI Supply Spec.**

### GSA
- **Commitment**
- **22 months**

### Status
- **First gas**

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**Notes:**
- Drilled well
- Completed well
- Eng. deliverable
- Contract award/PO
Shukran!

Fayum Whale Valley

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