



# **HYDROCARBON EXPLORATION**

# **CONCEPTS IN MOROCCO**

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# **STATUS OF THE HYDROCARBON EXPLORATION**

### SEISMIC & WELLS ACHIEVEMENTS (February 2019)

Seismic Acquisition:

#### Onshore

- 2D Seismic: 56 131 Km
- 3D Seismic: 2 336 Km<sup>2</sup>

#### Offshore

- 2D Seismic: 174 267 Km
- 3D Seismic: 70 242 Km<sup>2</sup>
- In addition to 13 300 Km of 2D Multi-clients acquired by the end of 2017 in the Offshore

Atlantic Morocco

Most of the open blocks are covered by either 2D & 3D Seismic

**Exploration Drilling :** 

- 44 wells offshore (42 in the Atlantic & 2 in the Mediterranean)
- 307 wells Onshore



## **STATUS OF THE HYDROCARBON EXPLORATION**

- Development of different plays widely extending in space and geological time:
  - Salt Related Play
  - Platform Play
  - Turbidite Play
  - Thrust Related Play
  - Pre-Salt Play
- These plays have been developed thanks to intensive
   2D and 3D seismic acquisitions, processing and
   reprocessing during the last 2 decades
- Only few structures related to some of these play types were tested leading to limited hydrocarbon discoveries.



#### TO DATE EXPLORATION RESULTS

- More than 800 prospects & leads of various plays have been identified in the onshore and the offshore. Some of these prospects were tested successfully
  - Pre-Salt and Salt related Play
    - Gas and condensate fields
    - Paleozoic Source Rocks
  - Jurassic carbonate Platform Play
    - Oil fields and sub-commercial accumulations
    - Jurassic Source Rocks
  - Turbidite Play
    - Gas and condensate shows and sub-commercial accumulations
  - Thrust and Sub-thrust Play
    - Oil fields and numerous oil seeps
    - Jurassic Source Rocks
- Still considerable number of mature prospects deserves to be drilled.



### **STATUS OF THE HYDROCARBON EXPLORATION**

#### **Licensing status**

#### **Exploration permits**

- 20 offshore 34 971,97 km<sup>2</sup>
- 30 onshore 45 830,43 km<sup>2</sup>

#### **Reconnaissance licenses**

• 1 onshore 4 989,90 km<sup>2</sup>

#### **Exploitation concessions**

- 8 Exploitation 161,14 km<sup>2</sup>
- 1 ONHYM 38,71 km<sup>2</sup>

#### **Open blocs**

- 17 offshore
- 13 onshore



# **UNTESTED PRESALT PROSPECTS/LEADS AND ANALOGS**

#### Positevely tested presalt play (Meskala gas and condensate field in Essaouira basin)



#### Untested Presalt play related prospects in the Dokkala basin







Presalt Play in the Atlantic Rift Basins

## **UNTESTED PRESALT PROSPECTS/LEADS AND ANALOGS**

#### Positively tested presalt play in Tendrara Area



#### **Untested Presalt play related prospects in the Prerif Ridges**





Pre-salt: 1

Triassic fluvial sandstones

### **Subthrust Play main drivers**

#### Hydrocarbon occurrences:

- Oil seeps (Aïn Hamra)
- Oil fields (Sidi Fili)
- Biogenic and thermogenic gas
- Gas seeps associated with mud volcanos.

#### Four (4) proven marine and organic rich source rocks :

- Miocene up to 10% Toc
- Cenomanian-Turonian 0.6 to 10.7%Toc
- Toarcian 0.5 to 2.5 % Toc
- Domerian 0.5 to 1.2 % Toc

### Four (4) proven reservoir intervalles:

- Miocene turbidite sandstones
- Mid. And Up. Jurassic deltaic and turbidite sandstones
- Low. And Mid. Jurassic carbonates
- Triassic fluvial sandstones



Hydrocarbon Occurrences in the Moroccan Alpine (Rif) folded and thrust belt



#### **Onshore Line A: Jurassic play positively tested in overthrust structures**

#### **Offshore Line B: Untested Jurassic play**



- Onshore overthrust structures positively tested: Tselfet, Bou Draa, Ain Hamra, Baton etc...
- Source Rock: is lower Jurassic black shales (TOC up to 8%)
- Offshore Overthrust (A), subthrust (B) and salt related structures (C) remain untested



# SALT RELATED PLAY: UNTESTED INVERTED MINI BASINS

### **RAK-1 & FA-1 WELLS DRILLED IN OFFSHORE AGADIR**



#### RAK-1/2004 (WD : 1967.3m)

Either Oil and Gas shows (C1 to C5 along more than 400m column in FA-1 well)

FA-1/2014 (WD: 600m)

Thin sand beds in the Upper and Lower Cretaceous

intervals

Open bloc Lead Prospect

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# SALT RELATED PLAY: UNTESTED INVERTED MINI BASINS

### **LESSONS LEARNED**

Thick turbidite sands would be deposited in intra growing salt diapirs minibasins, thus only thin

bedded and fine grained sands were penetrated by the wells, on the flanks of the diapirs.



Final PreSDM Depth, FA-1 Well

### **NEXT SALT RELATED PLAY FOCUS**

Sand bearing Inverted minibasins would be the focus in the next phase of the exploration in the salt province (example of Apto-Albian fan complex).



## JURASSIC PLATFORM PLAY

- Oil field (Sidi Rhalem), heavy and light oils accumulations (Cap Juby and Sidi Moussa) are associated with the Jurassic platform play and give strong evidence of working petroleum systems.
- New focus on down faulted blocs, reefs and oolite shoals sealed by Cretaceous shale.



## **CURRENT PLAYS**

- Biogenic and thermogenic gas in the Miocene turbidite sandstones.
- Alpine tectonics related structures, involving Mesozoic strata within the accretionary wedge "Nappe" and underneath, show up on adequately reprocessed 3D seismic, to constitute new play in the area.





# **CURRENT PLAYS**

#### **Upper Cretaceous Turbidite Play**

Stratigraphic traps and slope tectonics related structures involving the Upper Cretaceous (Coniacian) turbidite sandstones to be sourced from underlying organic rich Cenomanian Turonian source rocks.



### **UNCONVENTIONALS HYDROCARBONS**



# **ONHYM: ONGOING WORKS**

#### **ONGOING WORKS**

- ONHYM Internal basins evaluations
  - Integration of the new well results into regional studies (Reservoir distribution & geochemical modelling)
  - G&G Evaluation of the open blocks
  - Data room organization in ONHYM Offices (16 data room in 2018)
- Seismic reservoir characterization in offshore Agadir
  - (CGG/Started in February 2019)
- Multi-client long offset 2D seismic interpretation and margin evaluation
- Seismic Reconstruction of the Moroccan & Nova Scotian margins (MOU between ONHYM and OERA of the province of Nova Scotia)
  - Data sharing agreement
  - Joint effort to explore geology and petroleum opportunities in both margins



### **CONCLUSION**

- The Moroccan geology is, by its sedimentary and tectonic diversity, considerably favorable for oil and gas generation and production
- Strong evidences for the existence of several working petroleum systems, through producing fields, oil and gas accumulations or shows and oil or gas seeps;
- Myriad of play concepts are developed in different sedimentary basins and different geological times in Morocco;
- The so far drilled wells have tested two plays and encountered modest hydrocarbon or

shows even though some did not penetrate thick reservoir intervals;

 The flagship exploration plays are driven by hydrocarbon occurrences in their neighborhood and their analogies with successful cases in Morocco;

