ONSHORE / OFFSHORE & NEW SHALE POTENTIAL OF MOROCCO

Mr M. NAHIM
Mrs N. ESSALLOUMI
Key aspects of Morocco

- Political and economic stability;
- Economic policy of integration at regional and international levels;
- Growing and developing infrastructure projects;
- Energy policy based on developing partner’s activities in the petroleum research;
- Favourable and attractive hydrocarbon’s terms.
ONHYM Perspectives

- Opening of new frontier areas for exploration;
- Use of new technology tools in the exploration phase (onshore and offshore);
- Exploration and development of new resources (Oil Shale, Shale Gas & Shale Oil).
Geological Snapshot: Onshore

Paleozoic:
- Zag (N), Boudenib (K),
- Ouarzazate (L), and Tadla (H)

Triassic:
- Essaouira (J), Souss (M), Guercif (E), High Plateaux (F) and Missour (G)

Jurassic:
- Laayoune (O), Tarfaya (O),
- Essaouira (J), Prerif (B)

Cretaceous:
- Tarfaya (O), Boujdour (O)

Tertiary:
- Gharb (D)

Updated: 31/12/2010
Geological Snapshot: Offshore

**MAIN OFFSHORE PROVINCES**

- **Alpine Thrust and Fold Belt Province:** Cretaceous and Tertiary (Pre and Post Prerifene Nappe)
- **Mobile Salt Province:** Mesozoic and Cenozoic. (Supra-Salt and sub-salt plays)
- **Platform Province:** Jurassic and Cretaceous Mixt Platform (Platform, slope and basin plays)
- **Paleozoic and Triassic:** (Structures and fault tilted blocs)
Exploration History

Seismic acquired between 1961 et 2011

Total of 2D seismic: 196 000 Km
Total of 3D seismic: 21 938 Km²

Beginning of 3D seismic acquisition
Exploration History

Evolution of wells numbers between 1950 and 2011

308 exploration wells drilled between 1950 and 2011
Exploration Status

- 08 blocs offshore
- 13 blocs onshore
- 10 blocs under negotiation

PA & RL
- 26 Petroleum Agreements offshore & onshore
- 08 Reconnaissance Licences (5 onshore and 3 offshore)
Petroleum System Summary

• The Essential elements to a working Hydrocarbon systems have been proven in the Onshore and Offshore Moroccan sedimentary basins;
• Evidence from hydrocarbon occurrences (discoveries, shows, surface oil seeps), outcrops and seismic indicators (HDIs, BSRs);
• Source rocks: Silurian-Devonian, Toarcian, Oxfordian, Aptian-Albian, Cenomanian-Turonian, Eocene-Miocene;
• Reservoir rocks: Devonian, Triassic, Jurassic, Lower Cretaceous, Coniacian, Miocene, Oligocene;
• Sealing Rocks: Triassic salt, Jurassic anhydrites, Cretaceous and Tertiary shale.
800 Prospects & Leads in onshore and offshore Moroccan basins
Example of play concepts
Offshore Atlantic
Boujdour Offshore I

Lower Cretaceous Lead

- **Traps**: Stratigraphic (Amalgamated Channels)
- **Reservoirs**: Lower Cretaceous sandstones
- **Source rocks**: Aptian and Jurassic
- **Seals**: Tertiary & Upper Cretaceous marls and shales

Development of deltaic system within the Lower Cretaceous
Safi Deep Offshore

- **Traps:**
  - Structures related to salt tectonics
  - Stratigraphic: ponded sand

- **Reservoirs:**
  Lower Cetaceous sandstone turbidites

- **Source rocks:**
  Aptian and Lower Jurassic (Toarcian)

- **Seals:**
  Upper Cretaceous marls & shales

« Dip of maximum similarity » 

Time slice at 4500 ms of the « Dip of maximum similarity » attribute

« Shale indicator » attribute map extracted at the Lower Cretaceous (H_5)
Example of play concepts
Onshore
Abda Block

Triassic Prospects

- **Traps**: Faulted block and accommodation anticlines
- **Reservoirs**: Triassic sandstones (TAGI)
- **Source rocks**: Silurian graptolitic hot shale & Frasnian shale
- **Seals**: Triassic and Liassic interbedded shale & salt

Areal closure:

- **D1**: 9 Km², Gas Reserves: 3,513 Mm³, Condensate Reserves: 113 Mbbls
- **D2**: 36 Km², Gas Reserves: 7,463 Mm³, Condensate Reserves: 278 Mbbls
Asilah Block

Tertiary leads

**Friska-1 Lead**

- **Traps**: Faulted anticline structures
- **Reservoirs**: Cretaceous & tertiary turbidites
- **Source rocks**: Cenomanian-Turonian Shale
- **Seals**: Tertiary shale

Areal closure: 8.1 Km²
Recoverable oil (MMBBLs): 43.4 Mmbls

Line 09-ASL-11, through the Friska-1 Lead

Line 08-ASL-05, imbricated and folded Miocene play concept
Unconventional hydrocarbons: Shale potential
Oil shale potential in Morocco

- The efforts of research started during the Eighties. They are resumed by national and foreign partners in concordance with the Moroccan global strategy.

- Morocco has important oil reserves contained in the oil shales (approximately 50 billion barrels, Timahdit & Tarfaya).
Oil shale potential in Morocco

**Tarfaya onshore**

Cenomanian-Turonian Tarfaya oil shale: 50 m thick source rock interval, with 2-19% TOCs

Shallow depth: 0 to 1000 m

Area: ~ 200 X 50 Km²
Timahdit Upper Cretaceous oil shale: Up to 250m thick interval in an area of 900Km²
Shale gas potential in Morocco

Paleozoic system

- First geological and geochemical appraisal of the Paleozoic depositional systems;
- Other basins worth a deep exploration work;
- The Mesozoic and Tertiary sediments have a good potential and should be considered for shale gas development plans.
## Shale gas potential in Morocco

### Paleozoic system

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<th>BASIN</th>
<th>AREA (Km²)</th>
<th>FORMATION</th>
<th>TOC (%)</th>
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<td>Carboniferous</td>
<td>1 – 1.6</td>
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</table>
Shale gas potential in Morocco

Eastern Anti-Atlas

Silurian organic rich shale:
- Thickness > 200 m
- Depths 0 to 1000 m
- 2-12% TOCs (Lower most hot shale interval)
- Dry gas to over maturation window
Conclusions

- Moroccan sedimentary basins, both onshore and offshore, remain under-explored;
- Exploration drilling activity, although limited, and outcrops have proven the presence of viable petroleum systems;
- New 3D seismic data have permitted to increase the rate of success and to delineate new prospects;
- Developed play concepts are ranging in age from Paleozoic to Tertiary, and are of different types;
- In term of unconventional hydrocarbons, Moroccan basins are believed to have a good potential and worth a deep exploration work.
Future exploration orientations

• Resumption of intensive exploration of the untested plays, both onshore and offshore, with new ideas;
• Reevaluation and upgrade of the previously indentified prospects and leads to go ahead for drilling;
• Acquisition of high quality seismic data and use of new reprocessing techniques and modelling to accurately assess and test the delineated plays and prospects;
• Intensive exploration programs to prove the unconventional hydrocarbon potential of the Moroccan basins.

Conclusions
THANK YOU

Other material at boot

N° 535

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