Tunisia: Evaluation of the Hydrocarbon Exploration Potential and Promotion: Main Results and a Way Forward

By Marc Blaizot
Four out of six global exploration “themes” or conditions exist in Tunisia

1. Foothills
2. Unconventional
3. Rifts
4. Presalt and carbonates
Northern, Central, and East Atlas regions should offer high potential

**North Offshore and Onshore**

- High risk and high potential region
- Uncertainty persists due to poor data and the lack of analyses on hydrocarbon systems.

  • New technical studies are needed to explain poor data quality and to develop new analyses based on available data. It will be cheaper than drilling operations.

**Central and East Atlas**

- Complex tectonic history
- Exploration activities resulted in negative, dry wells despite possible high potential structures.

  • New analyses are needed to align exploration methodology with current global themes and to analyze past drilling results again.
## Inventory of existing resources: the “Prospect Book”

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rationale</th>
<th>Preliminary results</th>
<th>Status</th>
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<tbody>
<tr>
<td>- Build a full inventory of all hydrocarbon prospects in Tunisia recognised by ETAP and operators.</td>
<td>- It is necessary to weigh the pros and cons of the prospects. - Review and compare risks and reserves in a uniform manner. - Create unique description of prospects across ETAP for hierarchization and promotion activities.</td>
<td>- A prospect sheet, preferably in an electronic format, was prepared detailing parameters, stakes, and risks.</td>
<td>The Prospect Book for Tunisia was finished in 2018, but it must be finetuned and continually updated.</td>
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</tbody>
</table>
## The Prospect Book

### Reasons for arbitration:

1. Limited size (< 10 Mmboe, in place onshore), or <100 MMboe in place offshore)
2. Lack of seismic coverage and field data allowing for a definition of the prospect closure
3. Prospect interpretation in progress in 2020
4. New seismic or 2D reprocessing, not available in 2020

<table>
<thead>
<tr>
<th>Nb of Prospects scheduled (Review &amp; QC)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total investigated</td>
<td>123</td>
<td>30</td>
<td>24</td>
<td>14</td>
<td>5</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Nb of Prospects selected for the 2018 Prospect Book (Prospect Sheet and Resource and Risk Assessment Table)</td>
<td>65</td>
<td>18</td>
<td>13</td>
<td>8</td>
<td>3</td>
<td>13</td>
<td>7</td>
</tr>
</tbody>
</table>
Prospect Book results: gas prospects

Small size and good probability of success
Prospect Book results: oil prospects

Small to medium size and good probability of success
Similar conditions

Subthrust fields in carbonates: Mt. Alpi, Mt, Grosso, Tempa Rossa. Total: 1 Gbo in reserves and production; 80 Kbopd in 2014.

Foredeep basin gas fields in Miocene-Pliocene sands: Pisticci, Gagliano, Luna. Total: 1.3 Tcf gas and 1 bcf/d production.

Foreland carbonate oil fields: Gela/Ragusa/Perla/Vega/Nilde in Sicily.

Map from Caldarelli and Smith 2012. The offshore thrust belt links the Tunisian Atlas thrust belt with the onshore Sicilian thrust belt.

There are similar conditions in Northern Tunisia, Southern Italy, and the Egyptian Zohr Fields.
How to discover new potential and enhance exploration promotion?

Key challenges:
- Poor data quality and density yield low interpretation results.
- There is a need for review of data from previous drillings: postmortems.
- There is a need for multiple interactive interpretations.

Priority needs:
- Improve geophysical and geological data.
- Improve knowledge of potential hydrocarbon resources in line with current global exploration themes.
- Generate new prospects.
- Build an inventory of hydrocarbon prospects to enhance sector value and to share as a strategic tool with the ministry and ETAP.
Compilation of prospects

Identification of oil seeps from satellite images as evidences of an active petroleum system, offshore North (2 studies)

1) Definition of a strategy for the improvement of the available seismic data, onshore and offshore north
2) Gravimetry merge and interpretation

Petroleum trap post-mortem study in northern Tunisia from discovery and duster wells
## Technical studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Evaluation of seismic data quality</td>
<td>Check the reasons for the poor quality of existing seismic data. Propose an ideal new processing sequence.</td>
<td>Completed</td>
</tr>
<tr>
<td>Review of satellite oil seep data</td>
<td>Confirm a potential hydrocarbon system offshore.</td>
<td>Two studies completed</td>
</tr>
<tr>
<td>Creation of new gravimetric maps from the Office National Tunisien des Mines (ONM) and ETAP data</td>
<td>Create new gravimetric maps for North on- and offshore regions. This will offer data for qualitative and quantitative interpretations.</td>
<td>Completed, final report in progress</td>
</tr>
<tr>
<td>Reinterpretation of structural geological exploration wells data</td>
<td>Conduct geological reinterpretation and determination of main structural domains and calendar.</td>
<td>Completed</td>
</tr>
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</table>
## Oil seep data study in the Northern offshore region

<table>
<thead>
<tr>
<th>Objective</th>
<th>Rationale</th>
<th>Results</th>
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</table>
| - Review satellite data (ESA data) for the existence of oil seeps. The presence of oil seeps indicates active oil generation underground. | - The absence of oil seep inventories reduces the attractiveness of Tunisia for exploration activities.  
- An inventory of oil seeps offshore is key to renewing interest in exploration.  
- Oil seep inventories offer a good indication for oil versus gas.            | - The two studies (one based on hydrocarbon data and the second on redundancy) confirm that there are moderate oil seeps in the northeast offshore, which are not due to maritime transport pollution.  
- The seeps suggest the existence of a hydrocarbon system in the northeast offshore region of Tunisia. |
It is difficult to differentiate between pollution and seeps. The shape of the seeps are similar, but repetitive patterns reveal sharp differences.

In Tunisia, there are indications of a petroleum system in the northeastern areas.

Anomaly 1: Details
# Quality review of 2D seismic data in the Northern region

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| - Identify reasons for the poor data quality and propose new data parameters. | - The Onshore/Offshore data is of poor quality.  
- It does not provide the reliable data needed to  
1. Realize the accurate and comprehensive inventory of Tunisian prospectivity, and/or  
2. Promote exploration and encourage investors to start new seismic campaigns. | - The results confirm that poor data quality are not linked to acquisition data parameters.  
- Poor data is due in part to a lack of quality assurance in archiving the work and in bad processing parameters.  
- Propose an ideal processing sequence. | - Completed  
- Implement two test lines with a new processing sequence for improvements on data  
- Reprocess all of the onshore/offshore lines. |
Offshore reprocessing

Improve dip visibility and the identification of stratigraphic traps.

**Vintage**

**Reprocessed data**

Possible stratigraphic trap:
- A buried hill below
- No conformity

- Steep Dips
- No conformity

5km
Onshore reprocessing

With better fault definition, is there a new prospect?

Structural Prospect:
Nice tilted block below the fault
Offshore reprocessing: costs and timing estimates

For 9000 km 2D lines

- Total turnaround would take between 8 and 12 months.

- Selection of priority lines is to be **completed in two months in order to promote the area internationally.**

- Reprocessing: Highlight the importance of careful selection, the challenges of geometric reconstruction, and the comparison of vintage to new data, zone by zone.

- A geologist must supervise the reprocessing.

- Cost estimation:
  - For time processing 2D marine data, the price can drop below 100$/km due to the large volume of data.
  - **Reprocessing about 9,000 km of lines will cost about $550K.**
  - The project management and supervision, with expert geological and data management advice (1.5 days/week) will cost about $75K.
Onshore reprocessing cost and timing estimates for 1,500 km 2D lines

• Total turnaround between four and six months
• Possible selection of priority lines to be completed in two months, to promote the area internationally
• Reprocessing: in a CFT, highlight the importance of statics, of careful and iterative velocity picking, and the challenges of geometry reconstruction.
• Geological supervision of processing required
• Cost estimation:
  • For 1500km of foothills land data, the price range can be large: in a CFT prices between 250$/km and 1000$/km could be received. High-end contractors might charge 100$/km for the geometry only.
  • A reprocessing cost of 300k$ can be considered for a budget to get an accurate reprocessing. Plus expertise and supervision 50k$.
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<tr>
<td>- Create a complete and coherent series of gravimetric maps for the Northern onshore and offshore region.</td>
<td>- Determine if the onshore hydrocarbon data acquired by ONM could be used to map deep geological structures and tectonic elements of the Tunisian onshore.</td>
<td>- ONM data is excellent. It can be used for hydrocarbon exploration.</td>
<td>- Qualitative and quantitative interpretations of data, completed</td>
</tr>
<tr>
<td>- New maps will help to determine geological features and determine which exploration activities should be considered.</td>
<td>- Determine if the sparse offshore data is key to recognize structural features and geological elements.</td>
<td>- New maps indicate thick prospective “grabens” onshore.</td>
<td></td>
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<td></td>
<td>- New gravimetric maps of the offshore indicate a possible large extension of volcanic bodies.</td>
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Gravity maps

**Red Crosses** = OMN land gravity stations
- 46,112 stations
- Average density of coverage = 1stn/km²
- Bouguer density used = 2.40 g/cc

**Green Lines** = Repsol airborne gravity survey
- 18,695km line data
- 1km x 4km flight lines
- Bouguer density used = 2.20 - 2.40 g/cc
Results: qualitative maps / quantitative interpretations

- Confirmation of tertiary grabens extensions with thickness, possible netx prospective areas onshore.
- Existence of dense and magnetic bodies offshore, which are probably detrimental to exploration in the offshore.
- 3D inversion phase shows the depth of horizons that satisfy the observed gravity data.
- Seismic time horizons provided by ETAP were depth converted and used to build a 3D earth model.
- The inversion permitted modification of the Top Abiod and Base Numidian, indicating that in this complex area data should be used to obtain an earth model.
Postmortem and reinterpretation of the structural geology in the Atlas region

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<tbody>
<tr>
<td>Reinterpret exploration wells (dusters and discoveries) with the seismic data of 15 key wells, to be supplied by ETAP.</td>
<td>Available seismic data is difficult to interpret. Several scenarios are possible.</td>
<td>New geophysical picking based on four domains has been proposed.</td>
<td>Completed but needs to be used!</td>
</tr>
<tr>
<td></td>
<td>Propose different geological interpretations on prospects that have already been drilled to open geological opportunities in the remaining prospects.</td>
<td>Particularly promising discoveries:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• A large inverted domain</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• A thick presalt series.</td>
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Postmortem study

Discoveries and/or Producing fields
1) Guebiba
2) Gremda
3) Sidi El Kilani
4) Baraka
5) Cosmos
6) Douleb
7) Cap Bon

Duster wells
1) Limaguess
2) Chorbane Est
3) El Jem
4) Jemmal
5) Zeremidine
6) Alouane
7) Sidi Djedidi
8) El Haroun
Many dusters are structural failures: 70% of the drillings are not well located.

<table>
<thead>
<tr>
<th></th>
<th>RESERVOIR</th>
<th>STRUCTURAL</th>
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</thead>
<tbody>
<tr>
<td>LIMAGUESS</td>
<td></td>
<td>No closure at well location</td>
</tr>
<tr>
<td>CHORBANE E</td>
<td>Aleg and Bireno Zebbag are nonreservoir</td>
<td></td>
</tr>
<tr>
<td>EL JEM</td>
<td>Several wells with bad porosity and permeability</td>
<td></td>
</tr>
<tr>
<td>ZEMEDINE</td>
<td></td>
<td>No closure at well location</td>
</tr>
<tr>
<td>JEMMAL</td>
<td>Erosion of reservoirs</td>
<td>Erosion of reservoirs</td>
</tr>
<tr>
<td>ALOUANE</td>
<td></td>
<td>No structural trap</td>
</tr>
<tr>
<td>SIDI DJEDIDI</td>
<td></td>
<td>Faulted, shallow structure</td>
</tr>
<tr>
<td>EL HAROUN</td>
<td></td>
<td>No closure at well location</td>
</tr>
</tbody>
</table>
Postmortem results

In the Hammamet Gulf and Atlas province, one can observe the inversion of grabens oriented perpendicularly to the short direction. The Cosmos producing field is the archetype of the inverted grabens.

A large inverted domain

N-S seismic line is extracted from the 3D seismic data of the Cosmos concession.
What is the pre-Triassic salt potential in the Tunisian Atlas? Several seismic profiles (Sidi El kilani, Cap Bon) show well-organized reflectors below the salt to suggest sedimentary units over deep gas-bearing reservoirs below the Triassic.
Recommendations

Promote new data (seismic reprocessing) and interpretation methods based on the 2018 studies and key findings to generate new prospects on the four global exploration “themes” or conditions.

Set up a special Exploration Committee to review and update the Prospect Book.

Set up a special Promotion Committee to list the permits and technology available for investors as they become available.

Promote Tunisian exploration in key worldwide congresses.

Redefine resource acreage splits to reflect current potential: size, delimitations and duration of exploration permits, work programs, and fiscal terms based on potential resources and the type of exploration—frontier, deep, unconventional, or nearby.
The Directorate of Exploration Studies (DEE) is responsible for two areas: studies related to free blocks and their promotion to investors. Method: ETAP allows oil companies to see the data available on the free blocks requested and makes engineers, geologists, and geophysicists available to assist them at the time of evaluation. ETAP’s role ends there. The Directorate General of Hydrocarbons is the regulator and is responsible for all permit applications.

The Directorate of Exploration is responsible for two areas: tracking and managing the permits allocated to operators (Permit Tracking Division) and the Technical Division for Exploration (geology, geophysics, and petrophysics). The Technical Department for Geophysics plays an advisory role for all the geophysical information related to production concessions such as determining the location of a new development well. Therefore, it does some work for the Directorate of Production Operations.

The Directorate of Petroleum Services is responsible for two areas: the petroleum database and the laboratories.

Conclusion
In principle, the organizational structure is based on the two major objectives of the Directorate: promoting free permits and tracking the allocated permits.
 peny of ETAP (2018)

Redundancies and conflicts
• The organizational structure of ETAP leads to the separation of studies conducted in the same geographical area, because they are conducted by two teams (two directorates). Conflicting interpretations may emerge. In principle, this is not problematic but should be discussed and settled.
• There is a lack of external communication.
• The DEE does not benefit sufficiently from the work and results obtained by operators with the permits granted.

Limitation of concession-based exploration
• The Directorate of Exploration does not exercise authority over concession holders in terms of promoting exploration (under fields, for example). Concessions are managed by the Central Directorate of Production. Although ETAP is generally supportive of the desire to explore deep (or unconventional) targets in the context of concessions, its mission is not to inventory and validate all the potential prospects of this nearby exploration.
Organization of ETAP (2018)

• Currently, there are no postmortem studies conducted after each well project. Such studies facilitate an understanding of the success achieved and the reasons for failure, which would pave the way for improvement of the prospect generation and validation process.

• No single prospect sheet (Prospect Book) exists. The Prospect Book is an essential tool for internal strategy, for communication with the Ministry of Industry, and for promotional activities targeting international companies.
  o Drafting the Prospect Book has started through the ETAP-World Bank project. An initial version comprising 65 prospects has been finalized (December 8, 2018).
  o In the future, the preparation of prospect sheets should apply to all prospect evaluations for all types of permits (free block, allocated permits, and concessions).

• In ETAP, there is a lack of geoscience expertise.
Proposal to reorganize ETAP

• Future organization should take the form of a matrix, with a “geographical” area and an “expertise” area.

• The “geographical” area will be composed of three districts (North, Center, and South to cover the current seven zones) responsible for multidisciplinary interpretations, prospect generation, promoting free permits, and monitoring operators.

• The “expertise” or specialty area will supervise specific monodisciplinary studies (for a particular district), human resources (research, hiring, training, careers, annual evaluation, etc.), and assignment to each district based on the need for studies.
The table portrays preliminary figures and personnel expertise covering three districts, needed only for the projects listed, and subject to change depending on the studies.

<table>
<thead>
<tr>
<th>Expertise/Geographical Area</th>
<th>NORTH</th>
<th>CENTER</th>
<th>SOUTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geophysics XXX</td>
<td>****</td>
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<td>*</td>
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<tr>
<td>Geochemistry XXXX</td>
<td>*</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Structural Geology XXXX</td>
<td>**</td>
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<tr>
<td>Sedimentology XXXX</td>
<td>*</td>
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<tr>
<td>Reservoir Geology XXXX</td>
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<tr>
<td>Geoinformation XXX</td>
<td>*</td>
<td>**</td>
<td>***</td>
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<tr>
<td>Operations Geology XXXX</td>
<td>*</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Overall Expertise NNNN</td>
<td>10</td>
<td>16</td>
<td>14</td>
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</table>
Decision-Making Entities

CODIR DEX: Headed by the Exploration VP and Deputy, this entity will be composed of the nine heads of the department (six specialty areas and three districts) and will be responsible for approving studies, serving as the arbitrator between specialty areas and districts, providing summaries of the evaluations (objectives and annual discussion with the supervisor), determining which permits to offer to investors, and preparing an annual report for the CEO of ETAP.

These nine officials will be selected by an external consultant from the current team, based on the expertise identified and an in-depth interview. Invitations will be issued for external applications if the expertise needed is unavailable.

EXPLORATION COMMITTEE: Four or five people will be chosen for their expertise and extensive experience in exploration and, in particular, prospect validation. The committee will meet once a month to validate interpretations and post-mortems.

PERMIT PROMOTION COMMITTEE: This committee will be responsible for the technical and commercial presentations of free permits, as well as participation in conferences or road shows and data rooms. It will be assisted by district officials as well as the geoinformation official and will be attached to the CEO of ETAP. A member of DEX and the Strategy Directorate will sit on this committee.
Proposal for studies to generate new prospects

NORTH:
Reprocessing of all offshore and onshore seismic data followed by interpretation of these data through mapping, infilling, and geochemical assessment of tertiary grabens

CENTER:
Alternative interpretation (inversion model) of the entire Atlas
Interpretation of the Triassic subsalt time horizons
Preparation of a cableless seismic test
Offshore satellite seeps study

SOUTH:
Summary of all unconventional data (Frasnian, Silurian) and recommendations
Summary and prospectivity of the Triassic (Jeffara)
Proposal for access to exploration data for investors

Web:
The Geoinformation Department could improve its current electronic database by providing easier and direct access via a link to well and seismic logs, production tests, photos/descriptions of core samples, petrophysical data, and geochemical data.

Policy on access to information:
This policy should outline and manage confidentiality and the provision of access to recent information in a transparent manner. In particular, it should specify confidentiality periods and the costs to access information.
Short-term proposals to assist with reforms and exploration

Oil and Gas Production Gap Analysis (PGA)

Gas Management Plan (GMP)
Goal of the PGA:
To have a comprehensive document that makes it possible to understand the potential to boost the production of developed fields

Key data:
1) Production history (flow, pressure) of oil and gas fields (of each well, if possible)
2) Water injection history (flow, pressure) of oil fields (of each well, if possible)
3) List of wells closed by field, with an indication of the reason for the closing (scales, wax, water cut, surface lead, etc.) and production gap
4) List of recent work and results (cost, timing, additional production, etc.)
5) Map of the drainage systems used and the actual usage
6) Main constraints with attention to health, safety, and environmental (HSE) concerns in Tunisia because of sour gas

Results:
A field-by-field list of projects under consideration, with the potential increase in production in the short term and related investments (types and cost)
**Goal of the GMP:**
To have a comprehensive document that makes it possible to understand the potential to develop gas for direct domestic use or the generation of electricity

**Key data:**
1) Map and list of gas fields under production, along with the production history and projection, as well as the flows and nature/composition of the gas
2) Map and list of oil fields with routine flaring: projected flows and composition
3) Map and listing of undeveloped gas reserves (DRO), along with the size and composition of the reserves and an estimate of potential flows
4) Map and list of gas-prone prospects with prospective reserves and projected composition
5) List of possible oil fields where a blowdown is possible/under consideration: El Bormah
6) Network maps (gas pipes) used with their actual usage
7) Current and future demand, gas potential with takeoff amount, and place of use
8) Main constraints (Tunisia: HSE because of sour gas)

**Results:**
Possible increase in gas production and potential short-term use (stop flaring, connection of marginal fields to networks, etc.); gas profiles and related long-term investments (plants, networks, drilling, etc.)