OFFSHORE LEBANON: GEOLOGY, PLAY TYPES & 2ND LICENSING ROUND

AAPG San Antonio
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Wissam E. Chbat
LPA Board Member – Head of GnG
OUTLINE

- Regional Exploration activities
- Play types mapped offshore Lebanon
- Prospectivity examples
- Open blocks for the 2\textsuperscript{nd} licensing round
- Conclusion
REGIONAL EXPLORATION ACTIVITIES

Estimated Reserves for Sandy Targets

- Pliocene Sands: 2.5 tcf (7%)
- Miocene/Oligocene Sands: 35 tcf (93%)

Total Estimated Reserves

- Pliocene Sands: 2.5 tcf (4%)
- Miocene/Oligocene Sands: 42 tcf (52%)
- Carbonate: 35 tcf (44%)

*Source: IHS Market*

- Offshore Lebanon embeds all the proven play types in the East Med and many more
EXPLORATION PLAYS OFFSHORE LEBANON

Various play types identified offshore Lebanon

- 6 clastics play types (offshore Lebanon)
- 4 carbonates play type (offshore Lebanon)
- 4 of 6 clastics play types proven in Levantine
- 1 of 4 Carbonate play types proven in East Med
Carbonate reservoirs sealed by intraformational shale and sourced by Biogenic or Thermogenic source rock

- Localized on the Levant margin
- Analogous in age to carbonate discoveries in the East Mediterranean
- An additionally deeper Carbonate play type is possible
- Found as carbonate buildups
Pliocene Play - Offshore Lebanon

Pliocene
Age Range: 5.3 ma – present
Depth Range: 1600 – 2300 meters MSL

- Plio-Quaternary Sand sealed by Pliocene shale and sourced by Pliocene Biogenic source rock
- Proven in Egypt and Gaza
- Extends across the whole basin
- DHIs identified on seismic data
- Primarily Stratigraphic
Oligo- Miocene Play - Offshore Lebanon

Oligo-Miocene
Age Range: 33.9 ma – 5.3 ma
Depth Range: 3500 – 6500 meters MSL

- Miocene Sand sealed by intraformational shale and Messinian salt and sourced by Oligo-Miocene Biogenic source rock with a possible deeper Thermogenic Component

- Proven in South Levant Basin and Eastern Mediterranean
- Extends Across the Majority of the Basin
- Found in 3-way dip (fault blocks), 4-way dip anticlines and Pinchouts
Eocene Play - Offshore Lebanon

Oligo-Miocene
Age Range: 33.9 ma – 5.3 ma
Depth Range: 3500 – 6500 meters MSL

- Eocene Sand/calciturbidite limestone? reservoirs sealed by Eocene intraformational shale and sourced by Eocene and Mesozoic Thermogenic source rock
- Localized NW of the basin
- Flatspots and DHI indicators identified on seismic data
- Found as 4 way dip anticlines
40 Companies have Licensed Lebanese Offshore Data
CAMPANIAN SOURCE ROCK EXPELLED OIL PROBABILITY (IFPEN)

Probability that expelled oil > 1000kg/m²

P10 (Worst Case)  P50  P90 (Best Case)

Probability(%) that expelled oil > 2500kg/m²

Deep basin
Onshore

Kg/m²  %

Ducros, Nader et al. 2019
MULTI-EPIODE FLUID ESCAPE

- Reservoir has been recharged 20 times due to continued HC generation over the last 1.7 Ma.
- Indicates a working petroleum system.
- Oil generation supported by nearby oil seep.
SEDIMENTS THICKNESS OFFSHORE LEBANON

Southern to northern Levantine (Source: Spectrum)
SEDIMENTS THICKNESS OFFSHORE LEBANON

- Amathusa 1
- Very thin interval Cyprus side
- LEBANON Offshore
- Thick sand in Lebanon

West to East Levantine (Source: Spectrum)
TIMELINE FOR 2ND LICENSING ROUND

<table>
<thead>
<tr>
<th>Months</th>
<th>2019</th>
<th>2020</th>
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</thead>
<tbody>
<tr>
<td>Marketing the 2nd Licensing Round</td>
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<tr>
<td>Receiving Bid Round Applications</td>
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<tr>
<td>Evaluating Prequalification Applications</td>
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<td>Evaluating EPA Applications</td>
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<td>Negotiations</td>
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<td>CoM Decision to Award Blocks</td>
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</tbody>
</table>

★ Declaring Prequalification Results
BLOCKS OPEN FOR 2ND LICENSING ROUND
2nd Licensing Round – Blocks Opened (geologic zones)
<table>
<thead>
<tr>
<th>Geological Zones</th>
<th>Trap</th>
<th>Lithology</th>
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<th>Trap</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>B#1 Latakia Ridge</td>
<td>Anticline</td>
<td>Silici-clastic</td>
<td>B#2 Latakia Ridge</td>
<td>Anticline</td>
<td>Silici-clastic</td>
</tr>
<tr>
<td>Margin</td>
<td>Stratigraphic</td>
<td>Carbonate Buildup</td>
<td>Margin</td>
<td>Stratigraphic</td>
<td>Carbonate Buildup</td>
</tr>
<tr>
<td>B#5 Latakia Ridge</td>
<td>Anticline</td>
<td>Silici-clastic</td>
<td>B#8 Latakia Ridge</td>
<td>Anticline</td>
<td>Silici-clastic</td>
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<tr>
<td>Margin</td>
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<td>Margin</td>
<td>Stratigraphic</td>
<td>Carbonate Buildup</td>
</tr>
<tr>
<td>B#10 Latakia Ridge</td>
<td>Anticline</td>
<td>Silici-clastic</td>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Basin</td>
<td>3 – Way Dip (Fault Blocks)</td>
<td>Calci-clastic</td>
<td>Latakia Ridge (block 1)</td>
<td>Anticline (block 1)</td>
<td>Silici-clastic (blocks 1,2,5,8)</td>
</tr>
<tr>
<td>Margin</td>
<td>Stratigraphic</td>
<td>Carbonate Buildup</td>
<td>Deep Basin (blocks 5,8)</td>
<td>3 – Way Dip (Fault Blocks) (blocks 5,8)</td>
<td>Calci-clastic (blocks 1,5,8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Margin (2,10)</td>
<td>Stratigraphic (blocks 2,10)</td>
<td>Carbonate Buildup (blocks 2,10)</td>
</tr>
</tbody>
</table>
CONCLUSION

Biogenic

- **Structural traps**
  - Oligo-Miocene anticlinal closures sourced and biogenic Oligo-Miocene SR
  - Oligo-Miocene faulted anticlines sourced biogenic Oligo-Miocene SR

- **Stratigraphic plays**
  - Pliocene sourced by Pliocene biogenic SR
  - Oligocene and Miocene pinchouts sourced by Oligo-Miocene biogenic SR
  - Cretaceous to Miocene carbonate reservoirs sourced by biogenic SR

Thermogenic (Oil and Gas)

- **Structural traps**
  - Late Cretaceous anticlinal closures sourced by Jurassic thermogenic source rocks
  - Oligo-Miocene anticlinal closures sourced by thermogenic Oligo-Miocene SR
  - Oligo-Miocene faulted anticlines sourced thermogenic Oligo-Miocene SR

- **Stratigraphic plays**
  - Lower Cretaceous pinchouts sourced by Triassic and Jurassic thermogenic source rocks
  - Lower to Mid Cretaceous carbonate reservoirs sourced by Triassic and Jurassic thermogenic source rocks
  - Oligocene and Miocene pinchouts sourced by Oligo-Miocene thermogenic SR
THANK YOU