AREAS OF INTEREST FOR THE HYDROCARBON EXPLORATION INDUSTRY

Recommendations Dominican Republic
October 2016
Schlumberger is the world's leading provider of technology for reservoir characterization, drilling, production, and processing to the oil and gas industry.

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- Schlumberger supplies the industry's most comprehensive range of products and services, from exploration through production and integrated pore-to-pipeline solutions for hydrocarbon recovery that optimize reservoir performance.
Topics

• Objectives

• Creation of the BNDH

• Methodology for identifying areas of interest

• Identifying Areas of Interest by Basin:
  - Enriquillo Basin
  - Azua Basin
  - San Juan Basin
  - Ocoa Bay
  - Cibao Oriental Basin
  - San Pedro de Macorís Basin
Project Objectives

• Create the National Hydrocarbon Database (BNDH) and make this information available for query

• Interpret all available information with purpose of developing geological models

• Analyze Petroleum Systems found in the sedimentary basins of the Dominican Republic

• Identify the areas with the greatest potential to acquire new data
Creation of the National Hydrocarbon Database (BNDH)

http://ps.bndh.gob.do/ProSourceFrontOffice/Logon.aspx?ReturnURL=/ProSourceFrontOffice/
Developing Geological Models - Stages

Petrophysics

- Data collection and integration
- Layered Tops Homologation and Estimation
- Petrophysical Evaluation

Seismic Interpretation and Static Model

- Seismic interpretation
- Velocity model and conversion to depth
- Structural model
- Properties Scaling
- Spreading of facies and petrophysical properties

Petroleum Systems Modeling

Analysis of Elements in the Petroleum System
Petrophysics

- Data Collection and Integration
- Layered Tops Homologation and Estimation
- Petrophysical Evaluation
Seismic Interpretation and Static Model

**Seismic Interpretation**
- Data loading and conditioning
- Synthetic Seismogram Generation
- Horizons-faults Interpretation

**Velocity Model and conversion to Depth**
- Velocity Model Construction
- Conversion to Depth

**Structural Model and Properties**
- Structural Model
- Facies Model
- Properties Model
The assessment of the exploration risk within a basin implies the understanding of elements and processes of the Petroleum System.
Summary of Studies in the Dominican Republic Basins

- San Juan Basin: PetroMod 2D
- Azua Basin: PetroMod 3D
- Llanura Oriental Basin: PetroMod 1D
- Enriquillo Basin: PetroMod 3D
- Cibao Oriental Basin: PetroMod 3D
- Ocoa Bay: Interpretation in Time
- San Pedro de Macorís Basin: Interpretation in Time

Static 3D Model
PetroMod Model
Seismic Lines
Interpretation in time
Methodology – Prospects Definition

1. Petroleum Systems Modeling
   • Source rocks maturity
   • Migration and hydrocarbon charge

2. Seismic Interpretation
   • Identification of Potential Traps

3. Result Integration
   • Prospects identification
Enriquillo Basin
Enriquillo Basin – Source Rocks Maturity

Stratigraphic Column

- Eocene
  - Plioceno
  - Oligoceno-Mioceno
  - Plioceno
- Complejo Igneo
- Plaisance
- Neiba
- Trinchera
- Angostura
- Salinas

- Play Mioceno
  - Roca sello
  - Roca almacén
  - Roca generadora

- Play Oligoceno-Mioceno
  - Roca sello
  - Roca Almacén
  - Roca generadora

- Play Eoceno (Hipotético)
  - Roca sello
  - Roca Almacén
  - Roca generadora

- Jimani

- Charco Largo-1: 0.55%
- Charco: 1.13%
- Trinchera: 0.35%
- Sombrerito: 0.81%
- Plaisance: 0.64%
- Palo Alto-1: 0.73%
- Boca Cachon-1: 0.27%

Sweeney&Burnham(1999)_EASY%Ro [Rq%]

- Immature (0 - 0.55)
- Early Oil (0.55 - 0.70)
- Main Oil (0.70 - 1.10)
- Late Oil (1.10 - 1.30)
- Wet Gas (1.30 - 2.00)
- Dry Gas (2.00 - 4.00)
- Overmature (>4.00 - 5.00)
Enriquillo Basin – Seismic acquisition recommendations

- An example of a Structural High identified in a seismic profile
- A tighter net in the central area is recommended to verify the existence and closure of structures.
- Considering basin dimensions and other lines, it could have a length between 20-30 kms
Enriquillo Basin – Recommendations

- Plaisance formation goes up structurally to NW of the basin, finding its shallowest position in the area of the Boca Cachón well.

- While structures of interest are not observed in that area, it is recommended, with new seismic data, to search for opportunities to the NW, given that the entire stratigraphic column could be broken and test the hypothetical producer Play in a shallower position (less than 6000 mts).
Enriquillo Basin – Area of Interest

<table>
<thead>
<tr>
<th>CUENCA</th>
<th>AREA</th>
<th>Extremo 1 X</th>
<th>Extremo 1 Y</th>
<th>Extremo 2 X</th>
<th>Extremo 2 Y</th>
<th>Extremo 3 X</th>
<th>Extremo 3 Y</th>
<th>Extremo 4 X</th>
<th>Extremo 4 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENRIQUILLO</td>
<td>179.160 Km2</td>
<td>253533.22</td>
<td>2043025.54</td>
<td>245475.72</td>
<td>2029479.23</td>
<td>255300.72</td>
<td>2023864.36</td>
<td>263285.22</td>
<td>2037298.86</td>
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</table>
Azua Basin
Azua Basin – Source Rocks Maturity

Stratigraphic Column

- **Cretaceous Superior**
  - Ventura
  - Jura
  - Ocoa
  - Sombrerito
  - Trinchera

- **Oligocene**
  - Arroyo Seco / Arroyo Blanco
  - Roca Almacén
  - Roca Sello
  - Roca Generadora

- **Miocene**
  - Vía
  - Roca Almacén
  - Roca Sello

- **Pliocene**
  - Vía

- **Holocene**
  - Depósitos recientes
    - Roca Almacén

Play Conocido
- **Trinchera**
  - Maleño DT-1
  - Maleño 1-SEA
  - Higuerto 1-SEA
  - 0.29 %
  - 0.33 %
  - 0.30 %

Play Hipotético
- **Jura**
  - Maleño DT-1
  - Maleño 1-SEA
  - Higuerto 1-SEA
  - 0.86 %
  - 1.07 %
  - 0.93 %
  - 0.73 %

Legend:
- Immature (0 - 0.55)
- Early Oil (0.55 - 0.70)
- Main Oil (0.70 - 1.00)
- Late Oil (1.00 - 1.30)
- Wet Gas (1.30 - 2.00)
- Dry Gas (2.00 - 4.00)
- Overmature (>4.00 - 5.00)
Azua Basin – Seismic acquisition recommendations

- Some structural highs can be observed which should be confirmed with new seismic data.
- It is recommended the acquisition of a net of 2D seismic lines, perpendicular to the existing ones.
Azua Basin – Exploratory well recommendations

- Jura formation goes up structurally to WE in the basin ends, finding its most shallow positions around the Maleno (W) and Higuerito (E) wells.

- It is recommended, with new seismic data, to search for opportunities towards these basin areas, given that the entire stratigraphic column could be broken and test the hypothetical producer Play Jura in a shallower position (~5000 mts)
Azua Basin – Area of Interest

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<th>Extremo 4 Y</th>
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</thead>
<tbody>
<tr>
<td>AZUA</td>
<td>13.470 km²</td>
<td>308924.22</td>
<td>2047707.98</td>
<td>308568.97</td>
<td>2045546.79</td>
<td>314966.72</td>
<td>2046850.79</td>
<td>314814.97</td>
<td>2044879.17</td>
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</tbody>
</table>
San Juan Basin
San Juan Basin – Source Rocks Maturity

Stratigraphic Column

- Holoceno
  - Depósitos recientes
    - Vía
      - Roca Almacén
    - Arroyo Seco / Arroyo Blanco
      - Roca Almacén
      - Roca Sello
    - Trinchera
      - Roca Almacén
      - Roca Sello
      - Roca Generadora

- Plioceno
  - Sombrero
    - Roca Sello
  - Neiba
    - Roca Almacén
    - Roca Generadora
  - Ocoa
    - Roca Generadora

- Cretácico Superior
  - Complejo Igneo

Play Conocido

- Immature
- Early Oil

Play Hipotético

- Immature
- Main Oil
- Early Oil

Legend:
- Immature (0 - 0.55)
- Early Oil (0.55 - 0.70)
- Main Oil (0.70 - 1.00)
- Late Oil (1.00 - 1.30)
- Wet Gas (1.30 - 2.00)
- Dry Gas (2.00 - 4.00)
- Overmature (4.00 - 5.00)
San Juan Basin – Seismic acquisition recomendations

• Considering the area dimensions with well control, it is recommended to close the 2D lines net.
• Towards the north of the area of interest, some structural highs can be observed which could be attractive.
San Juan Basin – Area of Interest

- Area with the highest exploratory potential corresponds to the area with well control.
- Outside this area, uncertainty increases because well information is not available.

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<th>Extremo 4 X</th>
<th>Extremo 4 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAN JUAN</td>
<td>13.852 Km²</td>
<td>216243.97</td>
<td>2109359.98</td>
<td>213203.72</td>
<td>2092163.36</td>
<td>229784.97</td>
<td>2089147.04</td>
<td>232763.22</td>
<td>2106487.29</td>
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Ocoa Basin
• Anticlinal structures in contact with reverse faults were identified.
• The lack of well information and the quality of available seismic data, makes the identification of structures with exploratory potential extremely difficult.
• It is suggested that current seismic lines be reprocessed or that new 2D seismic lines perpendicular to the existing ones be acquired, in order to confirm the closure of some structural highs.
Ocoa Bay – Area of Interest

- Due to the lack of well information and poor seismic data quality throughout the basin, the same degree of uncertainty exist in terms of its potential.
- The area of interest is virtually equal to the area where seismic data is available.

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</thead>
<tbody>
<tr>
<td>OCOA*</td>
<td>436.931 Km²</td>
<td>301744.47</td>
<td>2023242.73</td>
<td>306495.22</td>
<td>2008625.23</td>
<td>333450.47</td>
<td>2017600.36</td>
<td>328560.22</td>
<td>2032181.54</td>
</tr>
</tbody>
</table>

*Basin without well information. Seismic interpretation in Time only.
Cibao Oriental Basin
Cibao Oriental Basin – Seismic acquisition recommendations

- Anticlinal structures were identified in a shallow part of the sections (red and blue circles), which could act as traps for hydrocarbon charge.
- It is suggested that new 2D seismic lines, perpendicular to the existing ones, be acquired, in order to confirm the closure of some structural highs.
Cibao Oriental Basin – Area of Interest

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</tr>
</thead>
<tbody>
<tr>
<td>CIBAO 1</td>
<td>62.286 Km²</td>
<td>364652.97</td>
<td>2130895.92</td>
<td>360911.97</td>
<td>2124691.17</td>
<td>368289.97</td>
<td>2120278.67</td>
<td>371999.72</td>
<td>2126480.17</td>
</tr>
<tr>
<td>CIBAO 2</td>
<td>114.837 Km²</td>
<td>347143.97</td>
<td>2149339.98</td>
<td>342272.47</td>
<td>2140966.54</td>
<td>352469.97</td>
<td>2135005.79</td>
<td>357339.47</td>
<td>2143397.73</td>
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</table>
San Pedro Basin
San Pedro Basin – Seismic acquisition recommendations

- Some interpretation suggests possible submarine fans with a turbidite regime.
- It is suggested that new 2D seismic lines perpendicular to existing ones be acquired, in order to better define the deepest part of the basin.
San Pedro Basin – Area of Interest

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<th>Extremo 4 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAN PEDRO*</td>
<td>7917.210 km²</td>
<td>404117.72</td>
<td>2038202.54</td>
<td>402171.72</td>
<td>1969716.73</td>
<td>516625.22</td>
<td>1965684.73</td>
<td>519499.97</td>
<td>2034813.36</td>
</tr>
</tbody>
</table>

*Seismic interpretation in Time only
General recomendations

• New seismic acquisition, especially in areas identified with the most potential
• In conjunction with new seismic interpretation, the drilling of deep Exploratory Wells to collect lithological data, chronostratigraphic, well logging, temperature data, pressure and porosity, etc.
  • Identification of deeper generator levels.
  • Geochemical analysis to define the quality of the source rocks (COT, IH)
  • Specialized laboratory analysis to generate a transformation kinetics of "organic matter-hydrocarbon" from a immature source rock sample
• Updating Petroleum System models with the newly collected data.