Petrophysical Evaluation of the lower cretaceous gas bearing sandstone reservoirs of O-M field, Orange Basin South Africa

Opuwari Mimonitu\textsuperscript{1}, Escorcia Florangel\textsuperscript{2}, Paul Carey\textsuperscript{1}

\textsuperscript{1}Department of Earth Sciences, University of the Western Cape, Bellville, South Africa

\textsuperscript{2} Exploration Project, PetroSA, 151 Frans Conradie Drive, Parow, South Africa

Corresponding Author:
mopuwari@uwc.ac.za
Scope of the Project

- **Goal**
  - Generate an effective static reservoir model

- **Data available**
  - Suite of wireline logs, well completion reports, well test reports, core analysis data, petrography study report

- **Deliverables:**
  - Classification of lithofacies
  - Calibration of logs/cores
  - **Determination of petrofacies and Flow Zone Indicators**
  - Determination of fluid contacts
  - Net pay
  - **Volume Estimates**
**Volume of Clay Model:** The volume occupied by water confined to the shale per unit volume of reservoir rock

<table>
<thead>
<tr>
<th>Depth (M)</th>
<th>VCLGR (Dec)</th>
<th>VCLNS (Dec)</th>
<th>VCLND (Dec)</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>Clay</td>
</tr>
<tr>
<td>1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>Matrix</td>
</tr>
</tbody>
</table>

**Scale:** 1 : 240

**OP2**

**DEPTH (3442.82M - 3469.02M)**

8/28/2011 23:06

Geosynthesis 2011 (Cape Town)
## Porosity model

### Scale: 1 : 240

**OP2**

- **DEPTH (3443.87M - 3473.21M)**

### Porosity Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay</td>
</tr>
<tr>
<td></td>
<td>Matrix</td>
</tr>
</tbody>
</table>

### Porosity Input

<table>
<thead>
<tr>
<th>Layer</th>
<th>Gamma-Ray</th>
<th>Porosity Input</th>
<th>Density Porosity</th>
<th>Neutron Porosity</th>
<th>Sonic Porosity</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RHOB (OHMM)</td>
<td>150</td>
<td>6.18</td>
<td>0.5</td>
<td>0.5</td>
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</tr>
<tr>
<td></td>
<td>GR (GAP)</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>DTCO_E (US/FT)</td>
<td>140-200</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>TNPH (V/V)</td>
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<tr>
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<td>PE1FZ (B/E)</td>
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<td>0</td>
</tr>
<tr>
<td></td>
<td>SAND</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>SHALE</td>
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</table>

### Porosity Values

- **Porosity Model:** Geosynthesis 2011 (Cape Town)

### Additional Data

- **Scale:** 1 : 240
- **Date:** 2010/05/26 09:50
- **DB:** Petrophysical Studies (15)

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Geosynthesis 2011 (Cape Town)
Predicting an overburden corrected porosity in an uncored interval

Multi-Well

Overburden Corrected Porosity Vs Sonic Porosity

Overburden Porosity (v/v)

Wells:
- OP1
- OP2
- OP3

Sonic Log Porosity (v/v)

Overburden Corrected Porosity = 0.0097 + 0.9263 * PhiSonic

R² = 0.8707
Water Saturation Model:

Fraction of pore space occupied by water

<table>
<thead>
<tr>
<th>Scale</th>
<th>OP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:250</td>
<td>DEPTH (3443.87M - 3473.21M)</td>
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</table>

<table>
<thead>
<tr>
<th>DEPTH (M)</th>
<th>GammaRay</th>
<th>Resistivity</th>
<th>Saturation of Bound water</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>200</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>AT10 (OHMM)</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td>AT90 (OHMM)</td>
<td>200</td>
<td>1.00</td>
<td>CEC-Sw b (dec)</td>
<td>Sandstone</td>
</tr>
</tbody>
</table>

Geosynthesis 2011 (Cape Town)
Water Saturation Model: Irreducible & Free water saturation

Saturation versus Capillary Pressure Plot

- Capillary Pressure (psi)
- Plug Saturation (v/v)

Facies
- A1
- A2
- A3
- A4
- A5
- A6

Irreducible water saturation
Mobile water saturation

Geosynthesis 2011 (Cape Town)
### Water Saturation Model: Free water saturation (Sw)

**Scale: 1 : 250**

<table>
<thead>
<tr>
<th>DEPTH (M)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GR (gAPI)</td>
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<td>0.2</td>
<td>0</td>
<td>0.2</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>MIE</td>
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<td>3</td>
<td>Archie Model</td>
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<td>Sw Archit (Dec)</td>
<td>1</td>
<td>Sw Simandoux (Dec)</td>
<td>1</td>
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<tr>
<td>4</td>
<td>Vsh Models</td>
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<td>Sw Indo (Dec)</td>
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<td>5</td>
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<td>Sw DW (Dec)</td>
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<tr>
<td>6</td>
<td>Porosity/BVW</td>
<td>1</td>
<td>Sw Juh (Dec)</td>
<td>1</td>
<td>Sw Indosimandoux (Dec)</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Lithology</td>
<td>1</td>
<td>CoreSw w ()</td>
<td>1</td>
<td>CoreSw w ()</td>
<td>1</td>
</tr>
</tbody>
</table>

**Lithology**
- Clay
- Sandstone

**VCLGR (Dec)**
- 0

**BVWSXO (Dec)**
- 0.5

**BVW (DEC)**
- 0.5

**Water**

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**Geosynthesis 2011 (Cape Town)**
Prediction of Log permeability

**Scale:** 1 : 150

**Depth:** (3366.1M - 3380.25M)

**DB:** Petrophysical Ihbubesi (14)

<table>
<thead>
<tr>
<th>Depth (M)</th>
<th>GR (GAP)</th>
<th>Resistivity</th>
<th>Permeability</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>3370</td>
<td>0</td>
<td>200</td>
<td>0.001</td>
<td>Core K (mD)</td>
</tr>
<tr>
<td>3375</td>
<td>0.2</td>
<td>2000</td>
<td>1000</td>
<td>CO2, CH4</td>
</tr>
<tr>
<td>3380</td>
<td>0.2</td>
<td>2000</td>
<td>1000</td>
<td>CO2, CH4</td>
</tr>
</tbody>
</table>

**Core Klin (mD):**

- **Core Klin (mD):**
- **Core Klin (mD):**

**Log (K air) = -2.4284 + 20.8917 * Porosity**

**R^2 = 0.9201**

**Core Porosity (V/V):**

- **Core Porosity (V/V):**
- **Core Porosity (V/V):**

**All Well**

**Porosity-Permeability and Factor Plot**

Geosynthesis 2011 (Cape Town)
Net Pay: The thickness of reservoir rock containing producible oil or gas
Acknowledgement

- PetroSA
- PASA
- Forest Oil Exploration International
- Schlumberger
- Senergy