**ENCLOSURE 2. PETROPHYSICAL ANALYSIS**

# iNTRODUCTION

The wireline data for Tarlee-2 was acquired by Schlumberger in the open hole over intermediate and TD sections. **Table 1** below summarises all the logs were acquired in open hole sections.

**Table 1. Tarlee-2 Open Hole Logs Summary**

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| **Logs for 8.719” Open Hole Section** | |
| Logging Run | Service |
| Run #1 | Gamma Ray (GR)  Spontaneous Potential (SP)  Laterologs, Micro-resistivity  Photo electric / Density / Caliper (Pe-Den-Cal)  Neutron  Sonic  Maximum temperature |
| **Logs for 6-1/8” Open Hole Section** | |
| Logging Run | Service |
| Run #2 | Gamma Ray (GR) & Spectral Gamma Ray (HNGS)  Spontaneous Potential (SP)  Laterologs, Micro-resistivity  Photo electric / Density / Caliper (Pe-Den-Cal)  Neutron & Pulse Neutron (APS)  Maximum temperature |
| Run #3 | Deviation Survey  Resistivity Imager (FMI)  Dipole Sonic (SonicScanner) |
| Run #4 | Nuclear Magnetic Resonance (CMR)  Spectral Lithology (LithoScanner) |
| Run #5 - #7 | MSCT |
| Run #8 | Checkshot Survey |
|  | |

The middle Velkerri “B” Shale and Kyalla Shale were the primary and secondary target of Tarlee-2.

Petrophysical analysis was performed across these zones to build multi-mineral models using the Multi-Minerals Modules within the Interactive Petrophysics (IP) software. At the time of this report, the petrophysical model was based on the core calibrated model in Birdum Creek-1.

**Figure 1** presents the open hole wireline data with advance logging suite data (including CMR, LithoScanner data). The wireline logs agreed with the Total Gas (track #18) response during drilling/coring.

The middle Velkerri “B” shale where Total Gas was elevated to ~1500 units corresponded with elevated Total GR (GR – red and SGR – green curves in track #3), increased Resistivity (track #4), strong cross-over between Density (RHOZ – red, track #5) and CMR-porosity (MRP – fuchsia, track #5), indicating the presence of kerogen and hydrocarbons (gas).

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|  |
| **Figure 1.** Tarlee-2 6-1/8” Open Hole Wireline Log |

The Total Gas in the Kyalla Shale increased to around 500 units, however, the cross-over between Density (RHOZ – red, track #5) and CMR-porosity (MRP – fuchsia, track #5) was not as significant as compared to the middle Velkerri “B” shale. This indicates the presence of kerogen and hydrocarbons (oil) within the Kyalla, however, it has a higher clay content compared to the middle Velkerri “B” shale.

# Interpretation MODELS

## Middle Velkerri “B”

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| **Figure 2.** Tarlee-2 Middle Velkerri “B” Multi-Mineral Model |

The Simandoux equation was used to calculate water saturation within the following parameters:

* a = 1, m = n = 2
* Rw = 0.0533 Ωm @ 25°C (~ 200kppm NaCl equivalent).
* Rshale = 6.0 Ωm
* PhiTClay = 0.05

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| --- |
|  |
| **Figure 3.** Tarlee-2 Middle Velkerri “B” Interpreted Plot |

## Kyalla Shale

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| --- |
|  |
| **Figure 4.** Tarlee-2 Kyalla Shale Multi-Mineral Model |

The Simandoux equation was used to calculate water saturation within the following parameters:

* a = 1, m = n = 2
* Rw = 0.13 Ωm @ 25°C (~ 60kppm NaCl equivalent).
* Rshale = 13.0 Ωm
* PhiTClay = 0.05

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| **Figure 5.** Tarlee-2 Kyalla Shale Interpreted Plot |

# Pay Summary and discussion

**Table 2: Tarlee-2 Reservoir and Net Pay Summary**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Zone** | **Top**  **[m]** | **Bottom**  **[m]** | **Gross**  **[m]** | **Net**  **[m]** | **N/G** | **Av. Phi**  **[%]** | **Av. Sw**  **[%]** | **Av. VClay**  **[%]** | **Av. Hyd. Porosity**  **[%]** | **Av. TOC**  **[wt%]** |
| **Reservoir** | | | | | | | | | | |
| Kyalla Shale | 569.51 | 664.41 | 94.9 | 24.54 | 0.259 | 5.2 | 68.2 | 42.3 |  | 1.077 |
| M. Velkerri “B” | 1016.16 | 1068.90 | 52.74 | 51.40 | 0.975 | 6.4 | 32.4 | 36.4 |  | 2.182 |
| **Net Pay** | | | | | | | | | | |
| Kyalla Shale | 569.51 | 664.41 | 94.9 | 1.07 | 0.011 | 3.1 | 35.8 | 28.5 | 2.0 | 0.191 |
| M. Velkerri “B” | 1016.16 | 1068.90 | 52.74 | 41.34 | 0.784 | 6.5 | 28.3 | 37.5 | 4.7 | 2.246 |
|  | | | | | | | | | | |

**Table 3: Tarlee-2 Reservoir and Net Pay Cut-off**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Min. Thickness** | **Effective Porosity** | **Effective Sw** | **Clay Volume** |
| Reservoir | ≥ 1m | ≥ 2% |  | ≤ 50% |
| Net Pay | ≥ 1m | ≥ 2% | ≤ 50% | ≤ 50% |
|  | | | | |

In Tarlee-2, the majority of net pay was derived in the middle Velkerri “B” Shale with 41.34 m net thickness and an average of 4.7% (hydrocarbon) filled porosity. The Kyalla Shale was interpreted to have high clay content, consisting of higher Aluminium concentration derived from the LithoScanner and higher water saturation estimations. Therefore, only 1.07 m of net pay was calculated.

Nuclear Magnetic Resonance (NMR) porosity was used to control porosity output, and since NMR porosity is independent from lithology, this increased the level of confidence in the porosity measurement. The input minerals were selected based on the extensive XRD data available from the Birdum Creek-1 well. The log derived water saturation has the highest level of uncertainty, since default a, m & n parameters were used. No formation water sample was available at the time of the report, hence, the apparent water resistivity method was employed using adjacent water wet zones as a calibration point. To reduce the uncertainty of log derived water saturation, further work to determine a, m & n electrical properties could be pursued. An accurate formation water sample will be challenging to obtain in this shale gas play, since most of the formation water is believed to be clay bound and/or irreducible.