Stratigraphic Cross-Section of Ratcliffe Interval through the Foreman Butte Field Using Neutron-Density Logs with the Distribution of Moveable Hydrocarbons and Water Saturation

by

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Wireline analysis of the Ratcliffe subinterval in the Foreman Butte Field

The Archie equation (Archie, 1952) is used to estimate the amount of water and thus the amount of hydrocarbons that are present in formation $S_o$. Based on the case in which electrical current passes through the water-saturated rock ($R_t$). The complexity of the current path through the fluid-filled pore space is described by the tortuosity factor “a” and the conductivity factor “m” and the fraction of the rock occupied by pore space ($\phi$).

Where:

- $R_o$: Resistivity of the flushed zone
- $R_w$: Resistivity of the formation water
- $n$: Saturation exponent (assumed to be 2)
- $m$: Cementation factor (assumed to be 2)
- $a$: Tortuosity factor (assumed to be 1)
- $\phi$: Porosity

The Archie equation can be expressed as:

$$ S_o = \frac{a}{m} \left( \frac{R_o}{R_w} \right)^{1/n} $$

The resistivity of the mud filtrate in the Borstad 3-3 well was 0.048 ohm-m at 76 oF. The raw resistivity data is corrected for the influence of the flushed zone. The resistivity of the formation water (Rw) in the West Tioga Field is, from the water catalogue, 0.46 ohm-m at 75 oF. The raw resistivity data is corrected for the influence of the flushed zone.

The shaded zones correspond to intervals that could be expected to produce oil. The logs used are a dual laterolog – microspherically focused log and neutron-density porosity log. A moveable hydrocarbon index (MHI) can be used to indicate the presence of producible hydrocarbons through the calculation of the moveable hydrocarbon index (MHI) which is defined as the ratio of water saturation in the flushed zone ($S_{xo}$) to water saturation in the uninvaded zone ($S_w$). The MHI can therefore be found from:

$$ MHI = \frac{S_{xo}}{S_w} = \left( \frac{R_{xo}}{R_t} \right)^{1/2} \left( \frac{R_{mf}}{R_w} \right)^{1/2} $$

Table: Moveable Hydrocarbon Index (MHI)

<table>
<thead>
<tr>
<th>Zone</th>
<th>MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.46</td>
</tr>
<tr>
<td>B</td>
<td>0.58</td>
</tr>
<tr>
<td>C</td>
<td>0.72</td>
</tr>
<tr>
<td>D</td>
<td>0.88</td>
</tr>
<tr>
<td>E</td>
<td>1.00</td>
</tr>
<tr>
<td>F</td>
<td>1.14</td>
</tr>
</tbody>
</table>

The moveable hydrocarbon index (MHI) is greater than or equal to 1 then no hydrocarbons were moved during invasion. When (Sw/Sxo) is:

- Greater than or equal to 1 then no hydrocarbons were moved during invasion.
- Less than 1 then moveable hydrocarbons were indicated.
- Between 0 and 1 then semi-movable hydrocarbons were indicated.

References:


The resistivity of the formation water (Rw) in the West Tioga Field, from the water catalogue, is 0.46 ohm-m at 75 oF. The raw resistivity data is corrected for the influence of the flushed zone. The moveable hydrocarbon index (MHI) is greater than or equal to 1 then no hydrocarbons were moved during invasion. The moveable hydrocarbon index (MHI) is between 0 and 1 then semi-movable hydrocarbons were indicated. The resistivity of the formation water (Rw) in the West Tioga Field is consistent with the oil produced from this interval.