ANALYSIS OF BHP DATA AND PRODUCTION IN TBR RESERVOIRS

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Block Diagram Showing Reservoir Complexity

- Bounding Fault (Heavy Lines)
- Primary Fractures (Solid Lines)
- Secondary Fractures (Dashed Lines)

Shown in Pink:
- Dolomitization of Matrix and Pore Size Enhancement in Grainstone and Packstone Facies Near Faults and Fractures

No Scale
Fluid Flow Periods

Fracture Dominated Flow

Matrix Transient Linear Flow

Matrix Pseudosteady-State Flow
Matrix-Dominated Flow, Hyperbolic Decline

Transition from Fractures to Matrix

Excess Deliverability, Fracture Dominated
Typical BHP Buildup Curve

\[ \frac{T\Delta t}{\Delta t} \]
### BHP Buildup Interpretation Technique

**Formula:**

\[
S = 1.151 \left\{ \frac{P_{1hr} - P_i}{m - \log\left( \frac{k}{(\Phi \mu c_t r_w)^2} \right)} + 3.2275 \right\}
\]

**Units:**

- \( k \): \( 162.6 \times q \times B \times \mu \) in \( m^2 h \)

**Variables:**

- \( \omega = 10^{\delta p / m} \)
- \( \omega = t_1 / t_2 \)
- \( \omega = \frac{\Phi_2 c_2}{(\Phi_1 c_1 - \Phi_2 c_2)} \)

**Rearranging and assuming:**

\( \Phi_2 = \omega \Phi_1 / (1 + \omega) \)

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k = 75.6 md  
S = -4.39  
ω = 0.20  
Φ2 = 1.3%
Predicted correlation

\[ y = -3.289 \ln(x) + 1693.7 \]

\[ R^2 = 0.9986 \]

\[ P^* = 1,693.7 \text{ psi} \]

\[ m = 2.303 \times 3.289 = 7.575 \text{ psi/cycle} \]

\[ \delta P = 0.8 \text{ psi} \]

\[ P_{1hr} = -3.289 \ln(395.89) + 1693.7 = 1674.0 \text{ psig} \]

Data:

- \( k = 31.4 \text{ md} \)
- \( S = -4.24 \)
- \( \omega = 0.79 \)
- \( \Phi_2 = 2.6\% \)
Effect of $\omega$ on the Shape of the Buildup Curve


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# Comparison of 4 Napoleon Field Analyses

<table>
<thead>
<tr>
<th>Well #</th>
<th>K, md</th>
<th>S</th>
<th>ω</th>
<th>Φ₁, %</th>
<th>Φ₂, %</th>
<th>% in Fractures</th>
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<td>0.31</td>
<td>6.9</td>
<td>1.6</td>
<td>18.9</td>
</tr>
</tbody>
</table>

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What Happens When a Well Crosses Two Reservoir Compartments?

First Well on Production

Lateral Drainhole Drilled After Initial Well Was Placed On-Line

Fracture Set B

Fracture Set A

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Heterogeneity Due to Penetrating Multiple Reservoirs

Napoleon Field
(Partial)

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Conclusions

- Trenton Black River reservoirs can be very complex, requiring considerable study for proper evaluation.
- Combination of reservoir porosity types can materially effect the evaluation.
- Hydrocarbons stored in fractures represent about 20% of the total hydrocarbons initially in place.
- Compartmentalization also affects the pressure behavior of the wells.
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