Reservoir Monitoring Consortium (RMC)

Reservoir permeability characterization based on microseismic data for a heterogeneous, anisotropic reservoir

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Los Angeles, CA
October 21, 2014
Permeability Estimation

Seismicity Based Reservoir Characterization (SBRC)

From Rothert and Shapiro, 2003

From Guerin, 2000
The Difference Between Our Model and Previous SBRC Models

- Microseismic Data
- Reservoir Geomechanics
- Permeability Estimation
Shear Failure Mechanism

- Effective Stress
- Shear Stress
- Pore Pressure
- Increase
- Failure Envelope

Shear Stress

Failure Envelope

Pore Pressure

Increase
Pressure Diffusion

\[ \Delta P = \frac{-q\eta}{2\pi kh} \left[ -\frac{1}{2} Ei \left( -\frac{r^2 \varphi \eta c_t}{4kt} \right) \right] \]

Pressure front associated with \( \Delta P \sim 5 \text{ MPa} \)

Pressure front associated with \( \Delta P \sim 0 \text{ MPa} \)
German Continental Deep Drilling Program (KTB)

Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland
German Continental Deep Drilling Program
KTB Microseismic Data

\[ \Delta P = \frac{-q \eta}{2 \pi kh} \left[ -\frac{1}{2} \text{Ei} \left( -\frac{r^2 \varphi \eta c_t}{4kt} \right) \right] \]

\[ r = C \sqrt{t} \]

\[ \Delta P = \frac{-q \eta}{2 \pi kh} \left[ -\frac{1}{2} \text{Ei} \left( -\frac{C^2 \varphi \eta c_t}{4k} \right) \right] \]

From Hosseini and Aminzadeh, 2013
KTB Stress Regime

From Hosseini and Aminzadeh, 2013
KTB Permeability Estimation

From Hosseini and Aminzadeh, 2013
### KTB Estimated Permeability

<table>
<thead>
<tr>
<th>Estimated by The Proposed Method</th>
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</thead>
<tbody>
<tr>
<td>$\mu = 0.6$</td>
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<tr>
<td>$10^{-17} \text{ m}^2$</td>
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### Other Reported Estimates

<table>
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<tbody>
<tr>
<td>$2.5 \times 10^{-17} \text{ m}^2$</td>
<td>$10^{-17}$ to $10^{-16} \text{ m}^2$</td>
<td>$10^{-17} \text{ m}^2$</td>
<td>$10^{-16} \text{ m}^2$</td>
</tr>
</tbody>
</table>

From Hosseini and Aminzadeh, 2013
Conventional Permeability Estimation Using Random Criticality

Random Criticality

Random Reservoir Rock Friction Factor

Poor Assumptions

Results in

Poor Characterization
SAIGUP (Sensitivity Analysis of the Impact of Geological Uncertainties on Production) Data Set

log-permeability realization (m²)

MATLAB Reservoir Simulator Toolbox (MRST)
SAIGUP Injection and Production Scenario

Pressure (bar)

MATLAB Reservoir Simulator Toolbox (MRST)
Conclusions

• New technique for seismicity based permeability estimation
• Geomechanical properties are included
• Anisotropy and heterogeneity are included.
• Realistic reservoir characterization
• Fracture network is characterized
Thank you for your attention!
Questions?