3D SIMULATION OF STIMULATED RESERVOIR VOLUME EVOLUTION DURING HYDRAULIC FRACTURING

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KEY DESIGN PARAMETERS OF FRAC OPERATION

▪ What’s the optimal stage spacing, well spacing, and frac intensity?

▪ Containments and geological variability?

▪ Depletion and SRV growth?
HF creates a Stimulated Rock Volume (SRV) in naturally fractured shale rocks and not a single fracture!

Ref: National energy board of Canada

Need Geomechanical Model to understand MS
1. Hydraulic fracturing does not create only single fracture but a network of fractures (or, fracture swarm)

2. The fracture swarm will create a stimulated region of enhanced permeability which can laterally span over several meters (supported by production data)

3. This can create a smeared representation rather than a single fracture shape
SRV is represented by poro-elasto-plasto-damage continuum zone of enhanced permeability.

Details at the discrete level are translated to:

1. Degradation of rock cohesion and material stiffness
2. Energy dissipation is controlled by characteristic length scales
3. Permeability evolves as function of damage
CASE STUDY: A MONTNEY WELL

\[ \sigma_v = 44 \text{ MPa} \]

\[ \sigma_{\text{min}} = 32 \text{ MPa} \quad \sigma_{\text{max}} = 65 \text{ MPa} \]
Model Set-Up

- Depth (m): 300 m
- Doig
- Doig phosphate
- Montney
- DFit closure: 32 MPa
- Overpressured: 12.5 KPa/m

Montney Model Set-Up

Effective Stress

- $\sigma_V = 44$ MPa
- $\sigma_{min} = 32$ MPa
- $\sigma_{max} = 65$ MPa

Microseismic

- $\sigma_{max}$
- $q(t)$
- $\sigma_{v}$
SRV Evolution

Doig

Target Zone

$\sigma_V$

$\sigma_{\text{Max}}$

$q(t)$

$q$
Doig
Target Zone

$\sigma_V$

$\sigma_{\text{Min}}$

$q$

$q$

$\text{Min}$
Pressure Contours

Min q

Target Zone

ISIP = 14 MPa

3 MPa

5 MPa

10 MPa

50 MPa

1 MPa

10 MPa

ISIP = 14 MPa
Pressure Contours
Pressure Contours
Pressure Contours
CONCLUSIONS

- Physics are most important
- Geological variability impacts the frac performance
- HF stimulation - the size and properties of SRV are of the first-order importance
- We need robust models to capture the SRV behaviour