



N437: Geomechanics for Unconventional and Tight Reservoirs

Instructor(s): Neal Nagel

Format and Duration

Classroom - 4 Days

Virtual - 8 Sessions

Summary

The application of geomechanical knowledge has become critical to the successful drilling and completion of unconventional plays. This course presents the basics of oilfield geomechanics (including stress/strain, pore pressure, and rock behavior) and then focuses on the geomechanical characterization and application of geomechanics to unconventional reservoirs, with a primary application to hydraulic fracturing.

Business Impact: Improving **recovery and volume** in horizontal wells by **optimizing multistage hydraulic fracturing operations** in the most productive intervals.

Learning Outcomes

Participants will learn to:

1. Understand, assess, and specify the components of a geomechanics evaluation program; specify a geomechanics testing program.
2. Assess in-situ stresses from field, log and laboratory data.
3. Assess and understand critical geomechanical properties; understand the means to determine these parameters.
4. Build and calibrate 1D geomechanical models as a starting point for geomechanical analyses; evaluate the need for, and QC, 3D geomechanical models.
5. Assess the key shale geomechanical properties needed to determine the effectiveness of hydraulic fracturing in Unconventionals.
6. Gauge the effect of operational parameters in different geological/ geomechanical scenarios on hydraulic fracturing success.
7. Assess the role of Stress Shadows on hydraulic fracturing effectiveness.
8. Gauge the role of natural fractures and weak planes on the overall behavior during hydraulic fracture stimulations and decide which type of analysis/model is needed in each case.
9. Assess the differences and limitations of available modeling tools for hydraulic fracturing.
10. Understand the value and geomechanical effectiveness of multi-well completions.
11. Evaluate the value of hydraulic fracture monitoring methods including microseismic data and the effects of geology, geomechanics, and pore pressure on these methods.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.



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Who Should Attend

The course is intended for geoscientists, reservoir engineers, drilling engineers, and completions engineers currently working in unconventional resources and for managers seeking to understand geomechanics.

Course Content

The first portion of the course will address the fundamentals of oilfield geomechanics, including stress, mechanical properties and failure. Common near-wellbore and reservoir-scale geomechanics applications will be introduced. The second part of the course will focus on the characterization of unconventional reservoirs (heterogeneous rock masses with the presence of discontinuities and weakness planes) and present the tools and models that can be used to optimize single- and multi-well hydraulic fractures in these intervals. Examples from a variety of unconventional plays will be discussed.

Part 1: Geomechanics Fundamentals

Module 0. Introduction to Unconventional Geomechanics

- What makes a good play – geomechanics point of view
- Unconventional Play scenarios
- What is geomechanics? Definitions, history, relevance

Modules 1 - 2. Principles of Stress and Strain - Field Stress Measurements

- Basic of stress-strain and Mohr circles - influence of natural fractures
- Effective stress concepts; role of pore pressure
- Field stress variations; structural effects
- Stresses around boreholes
- Stress determination and calibration

Module 3. Pore Pressure Evaluation

- Basic concepts and causes of overpressure
- Pore pressure analyses – Eaton, Bowers', NCT, effective stress methods
- Analysis workflow
- Challenges in unconventional; field examples

Modules 4. Mechanical Rock Behavior

- Mechanical properties; elasticity, plasticity, poro-elasticity, visco-elasticity
- Failure in rocks; failure criteria



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- Influence of faults and fractures; anisotropy
- Laboratory testing, measurements, and interpretation
- Use of logs for mechanical properties, calibration, correlations

Modules 5. Rock Fabric Characterization and Geomechanical Behavior

- Description and quantification of rock fabric attributes
- Mechanical behavior, hydraulic behavior, testing in Unconventionals
- Critically stressed fractures and hydraulic conductivity
- Geometry and spatial occurrence; DFN models
- Examples of evaluation in unconventional plays

Part 2: Geomechanics for Unconventionals

Module 6. Hydraulic Fracturing Fundamentals

- Objectives and scenarios
- Frac containment; net pressure
- Injection testing; DFITs
- Horizontal wells
- Perforating
- Proppants; 100 mesh and proppant transport
- Fracturing fluids

Module 7. Stress Shadows

- Mechanics of stress shadows
- Effect on multi-stages and clusters
- Multi-well stress shadows
- Tip shear stresses; modeling examples

Module 8. Unconventionals Myths and Magic

- Myths to debunk – brittleness, complexity, SRV and microseismic, sand volume per lateral length
- Geomechanics of interfaces – HF interaction with interfaces, effect of fracture toughness
- Shale properties static and dynamics examples from different plays – elastic parameters, time dependency, frictional properties
- Shale and Shale-like behavior – mineralogic content; shale and flow

Module 9. Hydraulic Fractures (HFs) and Natural Fractures (NFs)

- HFs propagation with NFs – effect of NF orientation



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- Dual HF propagating in a fractured media
- Pressure Diffusion – coupled effects – stimulation benefits
- Interaction HF – NF; crossing rules.
- Influence of NF characteristics – Dense vs sparse DFN, stress anisotropy, NF connectivity, parametric studies.
- Modeling examples
- Influence of operational parameters; effects of fluid viscosity, injection rates/injection time
- Influence of the stress field and in-situ pore pressure on HF behavior
- Microseismicity response with anisotropic stresses – dry and wet MS events
- Effect of initial aperture of the NFs

Module 10. FDI's, Frac Monitoring and Refracs

- Depletion effects on HF's; depletion and in situ stresses.
- Parent-child evaluations; cluster efficiency; drainage volumes
- Frac hits - types
- Microseismic depletion delineation; Cube evaluations
- Refracturing – candidates, case histories, lessons
- Geomechanics of refracs
- Refracs economics; refrac activity; refracs methods, engineered refracs

Module 11. Multi-well completions and Casing Deformations

- Zipper fracs, stress perturbations, induced shear around zipper fracs
- Interaction of HF's; overlapping HF's, models
- Zipper fracs stress shadows
- Effect of multiple well completion in fractured rock mass – sheared fabric – friction angle effect, geometry of zipper fracs
- Effect on fabric stimulation
- Casing deformation occurrence, prediction and remediation in Unconventionals

Optional Course Examples and Exercises

- Development of a 1D vertical stress profile
- Evaluation of LOT and mini-frac/DFIT results
- Pore pressure prediction from NCTL and Bowers
- Evaluation of laboratory data for YM and PR
- Estimation of S_{hmin}
- Stress evaluation from the Stress Polygon
- Back-analysis of S_{Hmax}
- Laboratory evaluation of UCS and friction angle



TETRA TECH
RPS ENERGY

TRAINING 

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