N354: Geomechanics: Exploration to Field Rejuvenation

Instructor(s): David Castillo

Format and Duration

Classroom - 4 Days
Virtual - 8 Sessions

Summary

This course will provide participants with relevant concepts related to their own respective disciplines, presented as system of processes corresponding to the geomechanical processes operative in their asset or exploration blocks. Participants will learn to ask the right geomechanical questions and how to recognize a reliable geomechanical model before embarking upon an analytical process to design and assess exploration, development and rejuvenation operations.

Business impact: There is a growing body of evidence that accurate geomechanical models, serving to quantify the physical state of stress operative in the subsurface, have an **immediate impact** on reservoir **exploration**, **development**, **production**, and **rejuvenation**. Applications are widespread and include fluid injection for pressure maintenance, CO2 sequestration, and hydraulic stimulation for enhanced recovery in unconventional reservoirs.

Learning Outcomes

Participants will learn to:

1. Distinguish between a sound geomechanical model which makes sense versus one that does not.
2. Create value of information by integrating geological, geophysical and engineering data as part of a system of geomechanical processes.
3. Use modern geomechanical principles to evaluate exploration risks in the context of trap integrity and optimize well planning to maximize the value of exploration and appraisal wells.
4. Optimize development drilling and completions which take into account the stress evolution effects associated with hydrocarbon production, gas storage and CO2 sequestration and geothermal operations.
5. Better plan with new geomechanical insights how field rejuvenation should be executed to further maximize the value of the assets. These processes include water flooding, hydraulic fracturing, in-fill drilling and rock analysis.

Training Method

A virtual or classroom course, comprising a combination of classroom lectures, exercises and case studies.

Who Should Attend

This course is aimed at geoscientists and professionals from other disciplines (e.g., reservoir, production, and drilling engineers) who require an understanding of geomechanical principles and analysis guidelines to add value to their company assets.

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Course Content

Part 1:

- Geomechanics Overview
- Global Plate Tectonics
- Stress Regime Classification
- Elements of a Geomechanical Model
- Stress Analogues and Material Science
- Overview of Borehole Stresses in the Context of the Tectonic Setting
- Overview of Stresses Resolved along Faults and Natural Fractures
- Overview of Pore Pressure Prediction Complexities
- Overview of Engineering Data and Material Properties
- Overview of Exploration Geomechanics
- Overview of Appraisal Geomechanics
- Overview of Reservoir Geomechanics
- Overview of Development Drilling and Completions Geomechanics
- Overview of Reservoir Rejuvenation Geomechanics

Part 2:

- Thorough Review of Previous Concepts
- Constraining the Vertical or Overburden Stress (Exercises)
- Understanding Pore Pressure Generation Mechanisms (Exercises)
- Pore Pressure coupled with Geomechanics
- Earth Stresses Resolved onto Boreholes - Continued (Exercises)
- Geomechanics in a Plate Tectonics Context Revisited
- Frictional Constraints on Absolute Stress Magnitudes

Part 3:

- Thorough Review of Previous Concepts
- Frictional Strength Constraints on Stress Magnitudes- Continued (Exercises)
- Mohr Diagrams (Exercises)
- Stress Polygons Coupled with Mohr Diagrams (Exercises)
- Using Extended Leak-Off Tests to Constrain Minimum Principal Stress (S3)
- Using Material Science Principles to Constrain Stress Magnitudes (Exercises)
- Pitfalls of Using Rock Properties to Constrain Stress Magnitudes

Part 4:

- Thorough Review of Previous Concepts
- Bottom Hole Pressure to Constrain Changes in Borehole Environment (Exercises)
- Strength of Materials and Laboratory Rock Strength Measurements
- Rock Strength and Reservoir Completion Constraints

- Uniaxial Strength Test vs. Single-Stage Triaxial Test vs. Multi-Stage Triaxial Test
- Calibrating Empirical Rock Strength Equations Using Laboratory Strength Measurements

Part 5:

- Thorough Review of Previous Concepts
- Investigative Forensics While Constructing Geomechanical Models
- Drilling Operations in Time
- Drilling Problems in Time
- Logging While Drilling (LWD) Data in Time (Exercises)
- Hole Cleaning and Identifying Wellbore Stability Signals (or Instability)

Part 6:

- Thorough Review of Previous Concepts
- Engineering Interpretations of Image Data Analysis (Exercises)
- LWD Resistivity and Drilling Fluid Invasion Monitoring
- Coupling Engineering with Geomechanics for Stress Model Construction (Exercises)
- Rock Failure Criteria that Exploits All Three Principal Stresses
- Image Data Constraints on Estimating Absolute Stress Magnitudes (Re-visited)
- Vertical and Deviated Wells and Implications for Stress Magnitude Constrains

Part 7:

- Thorough Review of Previous Concepts
- Natural Fracture Stability (Exercises)
- Inducing Fracture Instability and Losses while Drilling (Exercises)
- Fracture Gradient vs. Natural Fracture Gradient

Part 8:

- Thorough Review of Previous Concepts
- Production/Injection-Induced Stress Evolution
- Using Geomechanics for Well Construction
- Using Geomechanics for Reservoir Development
- Using Geomechanics for Unconventional Reservoir Development
- Reservoir Stimulation-Induced Microseismicity
- Geomechanics and Directional Reservoir Permeability