Geo-Mechanics and Wellbore Stability

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Course Description:

The integrity of the wellbore plays an important role in petroleum operations including drilling, completion and production. Borehole enlargement, stuck pipe, mud losses, casing collapse, compaction, subsidence, permeability reduction and sand control issues cost the oil and gas industry several billions of dollars a year.

Prevention of these issues requires understanding of the interaction between formation strength, in-situ stresses, and drilling practice. This multi-disciplinary course provides a concise overview of basic rock mechanics and its application to wellbore stability and lost circulation analysis.

Objectives:

Upon completion of the course, participants will:

- Understand the importance of geomechanics and its applications in oil and gas industry.
- Learn the theory of rock mechanics (e.g. theories of stress and strain, rock deformation and failure etc.)
- Learn the data requrement for geomechanical modeling.
- Be able to design rock mechancs testing program and QC the results
- Be able to bulid geomechanical models using Excel sheet (including stresses and rock properties calculations).
- Be able to define safe operating mud weight window.

- Be able to find the safest well trajectory to drill by generating polar plots.
- Understand the effect of rock anisotropy.
- Be able to verify and calibrate wellbore models.
- Learn about wellsite wellbore instability identification

Course Outline:

Module I: Geomechanical Modeling and the Applications

Introduction to Geomechanics

- Overview and history
- Importance
- Geomechanical model
- Anderson faulting theory and stress regimes

Theories and Background

- Principles of stress and strain
- Rock deformation and mechanical behavior models
- Rock failure mechanisms and criteria

Overview of Petroleum Applications

- Sand production prediction
- Hydraulic fracturing
- Fault seal analysis
- Production optimization from natural fractures
- Fractured reservoir modeling
- Compaction and subsidence
- Casing collapse and shear
- Salt bodies modeling
- Multi lateral junctions

Geomechanical Modeling

- Concepts
- 1D to 3D models
- Rock property modeling
- Pore pressure prediction
- Stress modeling

Module II: Wellbore Stability Analysis

Introduction and definitions

- What is wellbore instability
- Wellbore instability cost for industry
- Factors affecting wellbore stability
- General modes of instability
- Yielded zone and borehole breakouts
- How to control borehole breakouts
- Instability consequences

Analysis and outcomes

- Stability models- 3D linear elastic models
- - Poroelastic models
- - 2D linear elastic models
- - Elastoplastic models
- Prediction of yield zone dimensions around the borehole
- Calculation of collapse gradient
- Calculation of fracture gradients
- Safe operating mud weight window

- Casing and mud design
- Wellbore stability for deviated and horizontal wells
- Well trajectory optimization

Special cases

- Accounting for hydraulic communication effects
- Accounting for weak bedding planes
- Time-dependent wellbore instability
- Chemical wellbore instability
- Wellbore stability in fractured formations
- Wellbore stability in salt bodies
- Identifying wellbore instability on the rig
- Wellbore stability for UBD
- Field examples