Fundamentals of Petroleum Geomechanics

Training Program

Introduction:

This course discusses the fundamental theories that are critical in current well designs and well instability problems. It looks at the issues of rock properties, subsurface stresses and methods for the prediction of rock behavior under varying operational conditions. The impact of rock and well instability on well economics is emphasized. This course covers the necessary fundamentals of Geomechanics for wellbore applications; the origin of stresses in the subsurface and how in situ stresses can be understood from wellbore data; mechanical properties such as rock strength, the Mechanical Earth Model, and the origins of pore pressure and how it is measured and estimated. The course then proceeds to show how these data are applied through the Mechanical Earth Model to critical problems in exploration and field development. There are detailed case studies on wellbore stability sand production and hydraulic fracturing. The course also includes an introduction to reservoir Geomechanics, showing the Geomechanical influence of pressure changes in the reservoir.

Who Should Attend?

Geologists, Geophysicists, Geomechanics Engineers, Drilling Engineers, Production Engineers, Completion Engineers, Petrophysicists, Reservoir Engineers, Petroleum Engineers, Exploration Supervisors and managers concerned with the Geomechanics challenges of field development and exploration, Supervisors and managers concerned with wellbore stability

Course Objectives:

By the end of this course, delegates will be able to:

- Use routinely collected and specialized data to make basic Geomechanical calculations for wellbore stability, sand production and hydraulic fracturing
- Select and design data acquisition for Geomechanical studies
- Interpret image data to identify basic Geomechanical behavior
- Explain the Mechanical Earth Model and how it is used
- Understand the origin of stresses in the subsurface and how in situ stresses can be understood from wellbore data
- Explain the mechanical properties such as rock strength, and the origins of pore pressure and how it is measured and estimated
- Explain the importance of rock mechanics and identify the key terms and concepts that are used in studying them
- Define the differing characteristics and uses of rock strength tests
- Explain the wellbore stability, sand production and hydraulic fracturing

Course Outline:

Introduction to Geomechanics

- What is Geomechanics?
- Mechanical earth model
- Principles of stress and strain
- Basics of stress and strain
- The relationship between stress and strain
- Principle of earth stresses
- Overburden stress
- Mohr circles
- Elasticity and elastic properties
- Effective stress concepts and the importance of pore pressure
- In-situ stress tensor

- Stress field variations –structural effects
- Stress measurements and analysis

Rock Mechanical Properties

- Rock strength and weakness
- Hardness vs. strength
- Hardness scale
- Chemical composition

Porosity and Permeability

- Porosity definition
- Permeability definition
- Permeability illustration
- High porosity and low permeability
- Low porosity and high permeability
- Porosity illustration
- High porosity and high permeability

Mechanical Properties

Elasticity and Other Stress- Strain Behaviour

Failure and Beyond

Thermal Effects

Influence of Faults and Fractures

Rock Mechanics Testing

Pore Pressure

- Basic definitions
- Origins of pore pressure
- Causes of over pressure
- Pore pressure and the mechanical earth model
- Leak-off tests
- Fracture gradients
- Reservoir compartmentalization
- Mechanisms of overpressure generation
- Estimating pore pressure at depth

Reservoir Geomechanics

- Compaction
- Thermal
- Depletion effects
- Well integrity
- Plasticity

Petroleum Applications

- Well planning
- Wellbore stability
- Drilling optimization
- Reservoir stress management
- Hydraulic fracture design
- Structural permeability
- Fault seal analysis
- Sand prediction

Sanding Evaluation

- Impact of sand production
- Nature of sand production