Structural Geology and Geomechanics in Reservoir Management

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Introduction:

This 5-day course provides participants with an overview of rock deformation processes that is appropriate for understanding how reservoirs respond – in terms of their geohistory, and in terms of how production activities induce new geomechanical effects. The material is aimed at an advanced audience, and is designed to suit both geoscientists and engineers.

Participants will learn some of the standard techniques for predicting fluid flow effects in deformed rocks, along with leading-edge ideas related to the reactive reservoir concept. Attendees should learn new approaches to managing structurally-complex reservoirs.

Course requirement:

Participants will gain most from the course if they have previously had some training in rock mechanics or experience in reservoir management. However, people without this background, but who have a broad industrial experience-base, can also benefit from the course.

Who should attend?

Geoscientists and Reservoir Engineers who have an interest in learning how things work, and how to develop better management plans that take account of the natural and induced reactivity of hydrocarbon reservoirs.

Course Outline

Day 1: Key Concepts and Basic Understanding

- Relevance of structural geology and rock mechanics
  - Basins
  - Creation of traps and impacts on reservoirs
  - Seals (pressure/hydrocarbon)
  - Drilling/production
- Structural geology basics
  - Definitions and terminology
  - Structural families
  - Motivations for understanding mechanics
- Imaging and depicting structural features
  - Outcrops, geological maps
  - Wells, subsurface maps and cross sections
  - Seismic surveys
- Practical: Completion of cross section and structure contour map
- Basics of seismic imaging
- Practical: Seismic interpretation exercise

Day 2: Practical Rock Mechanics

- Rock mechanics and structural geology
  - Stress, strain, and their relationships
  - Laboratory testing
  - Effective stress
  - Yielding and post-failure behaviors

- Textures of deformed rocks and relationship to deformation mechanisms
- Practical: estimation of petro physical properties of deformed rocks
- Finite deformations / plasticity theory
- Successes and failures of 20th Century rock mechanics
- What are the issues? sealing, trapping, flow / shapes, sequences, patterns
- Why are rocks deformed?
- Where are rocks deformed?
- Role of modelling
- Physical
- Mathematical
- Practical: simple stress states

Day 3: Geomechanical Models

- Fracture processes
- Fracture and fault distributions
- Fractured reservoirs
- Practical: fractured reservoirs
- Fault zones
- Fault seal predictions
- Practical: fault seal assessment
- Role of basement and its relationship to the sedimentary cover
- Flexural-slip folding
- Practical: simple stress states

Day 4: Geomechanical Systems

- Basin formation
- Caprocks
- Overpressure
- The reactive reservoir
- Poro-mechanics
- Petrophysics and rock mechanics links

- Time-lapse responses
  - Review of seismic principles
  - Rock physics and rock mechanics links
- Practical: time-lapse predictions
- Emergent behaviours and non-linear systems: order out of the chaos

Day 5: New Concepts and Ways to Use Them

- The poro-visco-plastic model
- Applications:
  - Compaction
  - Rop seals
  - Fault seals
  - Energy considerations
  - Transport properties

- Localisation processes
- Role of deformation in the Hydrocarbon System
  - Basin scale
  - Reservoir scale
- Practical: design of geomechanical appraisal for fractured reservoir
- Discussion and summary