EGI Energy & Geoscience Institute AT THE UNIVERSITY OF UTAH

Since 1972

TRAINING COURSES

Petroleum Geomechanics: Fundamentals & Applications

Available to EGI Corporate Associate Members

Instructors:

John McLennan, PhD
Senior Research Scientist,
USTAR Associate Professor
Chemical Engineering

Ian Walton, PhD
Senior Research Scientist

Course Structure
Lectures, presentation materials

Duration
1–2 days

Location
EGI's Salt Lake offices or Member's Location

EMAIL:
ContactEGI@egi.utah.edu

PHONE: (801) 585-3826

INTRODUCTION

As the industry moves from the era of easy oil/gas to challenging oil/gas, especially at the time of petroleum recession, lowering the operational cost, improving production, increasing the return of investment, and continued adherence to safety are becoming far more important than any time before. Thus a geomechanics specialist or engineer with a knowledge of geomechanics can play a significant role in improving field operations. However, petroleum geomechanics as an interdisciplinary course encompasses the fields of structural geology, logging interpretation, pore pressure prediction, rock-fluid interaction, rock mechanics, fracture mechanics, etc. Efficient integration of geomechanical fundamentals, laboratory testing and field observations, and proper interpretation and implementation of the results in the field are vital to assure positive outcomes. Therefore, we have tailored an in-house petroleum geomechanics course, and attempt to strike a balance between the theoretical and practical parts, and aim to maximize the practitioners' benefits by properly implementing geomechanics techniques in daily operations.

At the end of the course attendees will be able to:

- Design the data collection and testing plan for wellbore stability, lost circulation, sand production, and hydraulic fracturing.
- Diagnose potential risks from the well history of offset wells.
- Gain the know-how on mitigating unscheduled drilling & completion events.
- Gain practical solutions to improve hydraulic fracturing efficiency and mitigate negative impacts of solid production.

Syllabus*

Day 1 Fundamentals of rock mechanics and data collection and interpretation

- **Principles of mechanics:** aim to teach the "dry" concepts in the context of the oilfield. It will cover the stress tensor, units, principal stresses, strain, resolving stresses on a plane, construct Mohr's Circle and analyze stress, elasticity and elastic properties, effective stress, internal friction, cohesion, modes of rock deformation, unconfined compressive strength, and Mohr-Coulomb failure.
- **Experimental Geomechanics:** conventional and unconventional geomechanics testing, cover fundamentals and include shale and unconsolidated sand.
- **Borehole Geophysics:** pore pressure prediction, rock strength prediction, in-situ stresses calculation, natural fractures characterization.
- **Cutting Characterization:** interpret events from the size, shape of cuttings and cavings.
- **Field Tests:** Leak-off test, formation integrity test, mini-frac test, DFIT analysis.
- **Calibration:** build more reliable correlations by calibrating the predicted results with laboratory and field results.

Day 2 Practical Training of Drilling Geomechanics & Completion Geomechanics

- Wellbore Stability: describe the diagnosis, approaches and industry practice of wellbore instability mitigation.
- Lost Circulation: describe the diagnosis approaches and industry practice of lost circulation mitigation.
- Hydraulic Fracturing: introduce the role of natural fractures in hydraulic fracturing, describe the methodologies of enhancing the hydraulic fracturing efficiency in terms hydraulic fracturing mechanics, and suggest best practices of pumping schedule.
- Solid Production: describe the diagnosis approaches and industry practice of solid production prediction, mitigation, and treatment; perforation stability and frac-packing.

*Course content can be modified.

John McLennan, PhD

Associate Professor Chemical Engineering

Email
jmclennan@egi.utah.edu

Phone
801-587-7925

Research Interests

Energy extraction related to:

- Exploration
- Drilling
- Completion
- Stimulation
- Production

John is a USTAR Associate Professor in the Department of Chemical Engineering at the University of Utah. He holds a Ph.D. in Civil Engineering from the University of Toronto, Canada (1980). His experience extends to petroleum service and technology companies. He worked for Dowell Schlumberger in Denver, Tulsa and Houston; later, with TerraTek in Salt Lake City, Advantek International in Houston, and ASRC Energy Services in Anchorage. He has worked on coalbed methane recovery, mechanical properties determinations, produced water and drill cuttings reinjection, as well as casing design issues related to compaction. John's recent work has focused on optimized gas production from shales and unconsolidated formations.

Shale Gas Phase 2

The three key elements for a successful low permeability reservoir play are gas-in-place, heterogeneities providing permeability in excess of the matrix, and successful stimulation. EGI has been addressing the first of these directly, performing fundamental measurements to indicate the formation and reservoir parameters that govern recoverable gas-in-place. Storage mechanisms (adsorption, compressibility, and dissolution) were determined as functions of gas species, pressure history (reliable lost gas measurements), moisture content, and mineralogy. Without reliable gas-in-place forecasts, and the ability to identify desirable settings in advance, play development is expensive and prolonged.

Stimulating Low Permeability Reservoirs

In any low permeability formation – shale, tight sands, oil shale, geothermal, etc. – effective stimulation entails developing extensive, interconnected fracture systems with adequate conductivity. This effort leverages from projects awarded to the Department of Chemical Engineering by RPSEA for development of new generation simulators. This simulation methodology interrelates formation heterogeneity (stresses, fractures, high permeability streaks) with simulations of the growth of fracture systems during injection; and represents production from this specific, complex fracture network – next generation integrated geologic and production simulation.

Enhanced Geothermal Systems

EGI's geothermal group is engaged in development work for Enhanced Geothermal Systems. Hydraulic injection (either above or below fracturing pressure) is one method to develop an enhanced fracture system, providing surface area for exposure of liquids to elevated temperature en route to producing wells and subsequent conversion to usable energy. The key element of these systems is that they are engineered. Fractures are created with optimal morphology by exploiting the *in-situ* stresses and natural heterogeneity – engineering fracture growth for heat extraction.

DEPARTMENT OF Chemical Engineering
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