TETRA TECH RPS ENERGY | TRAINING

EC052: Geomechanics for Oil and Gas Projects

Instructor(s):

Format and Duration
Self-Paced - 6 Hours

Summary

This course provides a comprehensive understanding of geomechanical risks associated with hydrocarbon exploration and production. It begins with fundamental concepts in geomechanics, including stress, strain, and rock failure mechanisms. Learners will explore the geomechanical changes in fault and fracture permeability, essential for fluid movement in subsurface reservoirs, and examine the frequency, magnitude and implications of induced seismicity related to hydrocarbon activities. The course emphasises the development of Mechanical Earth Models (MEMs), which integrate geological, geophysical, and geomechanical data to predict subsurface behaviour and manage risks effectively. Participants will consider the workflow used to create a Mechanical Earth Model (MEM) using ARTEMIS software, with a focus on the Groningen Gas Field. The course culminates in the application of the FEM APOLLO model to simulate subsurface mechanical behaviour, enhancing the understanding of stress conditions and their impact on hydrocarbon operations.

Business impact: Geomechanical modelling is essential for the prediction of likely effects from planned or ongoing oil and gas operations. It is applied to the assessment of caprock integrity, fault reactivation, induced seismicity, fracture influence on fluid flow, reservoir management and drilling and completion parameters. This makes geomechanics a key tool for predicting hazards and mitigating risk as well as maximising the efficiency and productivity of a project.

Learning Outcomes

Participants will learn to:

1. Understand geomechanical risks associated with hydrocarbon exploration and production.
2. Gain insights into leakage and caprock breaches as warnings of potential hazards.
3. Learn fundamental concepts of stress, strain, and rock failure mechanisms.
4. Analyse geomechanically induced changes in fault and fracture permeability.
5. Develop skills in geomechanical modeling and flowrate correlation analysis.
6. Explore the creation and application of Mechanical Earth Models (MEMs).
7. Utilise ARTEMIS software for developing MEMs, focusing on the Groningen Gas Field.
8. Become familiar with the FEM APOLLO model to simulate subsurface mechanical behaviour under varying stress conditions.

Training Method

This is a self-paced e-learning course, approximately 6 hours learning time, consisting of 6 modules. Within each module the learning materials are structured into short sections, each including interactive text and image content, animations, video, and audio. Each module has a scored quiz at the end to provide the learner with their learning progress.

Who Should Attend

This course is aimed at subsurface oil and gas professionals who would like to understand the issues relating to geomechanics for oil and gas projects.

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Course Content

EM0197 Importance of Geomechanics for Oil and Gas Projects – An Overview

In this module, you will develop an understanding of the geomechanical risks associated with hydrocarbon exploration and production. You will gain insight into examples of leakages and caprock breaches, which serve as warnings of potential hazards. The module also includes case study examples to illustrate the relationship between geomechanics and hydrocarbon activities, enhancing your practical knowledge of the subject.

EM0198 Basics of Geomechanics for Oil and Gas Projects

This module will introduce you to the fundamental concepts used in Geomechanics. The module will begin by looking at stress, strain and elastic moduli and the concepts and definitions related to them. The learner will develop an understanding of stresses in the earth and how to measure them and learn about effective, poroelastic and thermoelastic strains. Finally, the module will consider the situations that may lead to rock failure and the differences between brittle and ductile failure.

EM0199 Induced Permeability and Seismicity – Oil and Gas Projects

In this module, you will learn about geomechanically induced changes in fault and fracture permeability, crucial for understanding fluid movement in subsurface reservoirs. You will develop an understanding of the Earth's geomechanical state and the evidence that supports this. The module covers flowrate fluctuations, geomechanical modelling, and flowrate correlation analysis, equipping you with skills to analyse and predict flow behaviour. You will also learn about global induced seismicity, its causes, and the range of magnitudes associated with these events. Case studies will be used to study induced seismicity specifically at oil and gas sites, providing real-world insights into the geomechanical impacts of hydrocarbon activities. Some investigation into CCS sites will also be included as this is recognised as increasingly becoming a part of the oil and gas field lifecycle.

EM0200 Mechanical Earth Modelling (MEM) for the Oil and Gas Industry

In this module, a Mechanical Earth Model (MEM) is introduced as a detailed, data-driven representation of the subsurface, combining geological, geophysical, and geomechanical information to predict the mechanical behaviour of rock formations. MEMs are important because they provide critical insights into subsurface conditions, helping to manage risks, enhance resource extraction, and ensure the structural integrity of underground operations.

EM0201 Building and Running a 3D MEM for the Oil and Gas Industry

In this module, you will learn the workflow for creating a Mechanical Earth Model (MEM) and gain an appreciation of the ARTEMIS software, which is instrumental in developing these models. You will also explore the geology and stress state of the Groningen Gas Field, one of Europe's largest natural gas fields, understanding the complexities of its subsurface environment. The module covers how to build an

analytical MEM specifically for the Groningen Gas Field, integrating geological data, stress analysis, and modelling techniques to create a detailed representation that aids in managing field operations and mitigating geomechanical risks.

EM0202 Finite Element MEM for the Oil and Gas Industry

In this module, you will become familiar with the FEM APOLLO model specifically developed for the Groningen Field, which uses finite element methods to simulate the subsurface mechanical behaviour. The module will compare the results obtained from seismic data and the FEM APOLLO model with interpreted fractures based on historical flow rates.