N590: Geomechanics for CCS Projects

Instructor(s): Kes Heffer and Nick Koutsabeloulis

Format and Duration

Classroom - 2 Days
Virtual - 4 Sessions

Summary

The course will begin with a review of potential geomechanical effects in CCS projects and the evidences for their possibility. It will then cover some core elements of geomechanics and draw the link between geomechanical and permeability changes, as indicated from laboratory experiments and from well tests, with its key consequences for CCS. The course will then progress to description and examples of sophisticated geomechanical modelling in the context of CCS. Field experience in some CCS projects is reviewed, emphasising any indications of geomechanical influence and ways of monitoring behaviour. The course considers Mechanical Earth Models (MEMs), why they are created, the pre-requisites and steps of how they are created. Operations can modify simultaneously pore pressures, temperatures, and stresses in the reservoir and surrounding formations. The techniques and software available to study the effect of these temporal changes in 4D will be reviewed. A case study application to the geomechanically active Gröningen gas field will be described to illustrate these principles.

Business impact: Geomechanical modelling is essential for prediction of likely effects from a planned CCS project, or to understand behaviour of an ongoing project. It is applied to assessment of **caprock integrity, fault reactivation, induced seismicity,** fracture influence on **reservoir flow, reservoir management, drilling and completion parameters**.

Learning Outcomes

Participants will learn to:

1. Appraise the critical importance of geomechanics to CCS projects.
2. Assess geomechanical aspects of caprock integrity, fault reactivation, induced seismicity, fracture influence, reservoir management, drilling and completion parameters.
3. Evaluate Mechanical Earth Models for their ability to predict geomechanical effects particularly as applied in a CCS context.
4. Determine the ways that operations can simultaneously modify reservoir pore pressures, temperatures, and stresses in the reservoir and surrounding formations.

Training Method

This classroom or virtual classroom course comprises a mixture of lectures, discussion, and case studies. A specific example of a high resolution 3D mechanical earth model from a gas field will be examined in detail. This course includes e-learning elements that provide background content on Carbon Capture and Storage that serves to provide an introduction to the subject matter:

- EC003 Fundamentals of CCS
- EC005 Behaviour of CO2 in Reservoirs
- EC006 Monitoring CO2 Storage

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Who Should Attend

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

Course Content

The self-paced e-learning elements of this course are

- Fundamentals of CCS
- Behaviour of CO2 in Reservoirs
- Monitoring CO2 Storage

Seminar Topics

Module 1: Importance of Geomechanics to CCS – An Overview

- Topic 1: Potential geomechanical issues associated with CCS
- Topic 2: Potential for leakage
- Topic 3: Natural hydrocarbon seepages
- Topic 4: Examples of leakage to surface
- Topic 5: Examples of Out-Of-Zone-Injection

Module 2: Basic Geomechanics

- Topic 1: Stress and Strain
- Topic 2: Elastic moduli – stiffness, compliance, Poisson's ratio
- Topic 3: Stresses in the earth
- Topic 4: Measurement of stresses
- Topic 5: Effective, poroelastic & thermoelastic stress
- Topic 6: Rock Failure

Module 3: Induced Permeability and Seismicity

- Topic 1: Geomechanically induced fault & fracture permeability changes
- Topic 2: Earth in a near-critical geomechanical state
- Topic 3: Flowrate fluctuation correlations
- Topic 4: Induced Seismicity

Module 4: Mechanical Earth Modelling Fundamentals

- Topic 1: Introduction to MEM - An Overview
- Topic 2: Definition of a MEM

- Topic 3: The Importance of MEM
- Topic 4: Core Testing, Rock Fabric and Rheology
- Topic 5: Shared Earth Model Workflow
- Topic 6: Importance of Knowing Stresses
- Topic 7: Conclusions

Module 5: Building and Running a 3D MEM

- Topic 1: Introduction and outline of process
- Topic 2: MEM workflow
- Topic 3: Application to Gröningen gas field: background

Module 6: Application of MEM to Gröningen Gas Field

- Topic 1: Building the ARTEMIS analytical model and results
- Topic 2: The FEM Apollo model of Gröningen
- Topic 3: Comparison of FEM results for Gröningen with analysis of historical flowrates.
- Topic 4: Course summary & discussion