EC031: Geomechanics for CCS Projects

Format and Duration
Self-Paced - 6 Hours

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. Learn the concepts, definitions and mathematical techniques used in geomechanics and how these apply to the Earth, with emphasis on CCS.
3. Assess geomechanical aspects of caprock integrity, fault reactivation, induced seismicity, fracture influence, reservoir management, drilling and completion parameters.
4. Learn about flowrate fluctuations, geomechanical modelling and flowrate correlation analysis.
5. Learn about global induced seismicity, magnitudes and causes and induced seismicity with relation to CCS.
6. Learn what a Mechanical Earth Model (MEM) is, why it is needed and how it can be developed.
7. Evaluate Mechanical Earth Models for their ability to predict geomechanical effects particularly as applied in a CCS context.
8. Determine the ways that operations can simultaneously modify reservoir pore pressures, temperatures, and stresses in the reservoir and surrounding formations.
9. Gain an appreciation of the geomechanical aspects of the Gröningen field through extensive case study.
10. Develop an appreciation of the ARTEMIS software and how this can be used to build geomechanical models to assess and predict geomechanical behaviour.

Training Method

This is a self-paced e-learning course consisting of 6 Modules. Through the extensive use of visual examples and interactive content the course will provide participants with a comprehensive knowledge of

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Geomechanics and the application of this to CCS projects. Real world examples and case studies will be investigated for application to current and proposed CCS projects. The Groningen field will provide a case study for building and assessing the validity of a Mechanical Earth Model. Each module has a scored quiz at the end to provide the learner with their learning progress. The course is approximately 6 hours learning time.

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

Importance of Geomechanics to CCS – An Overview

This module will look at the importance of Geomechanics in the context of a CCS project. The learner will develop an appreciation of the potential for leakage and study examples of natural hydrocarbon seepages, leakage to surface and out of zone injection.

Basic Geomechanics

This 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.

Induced Permeability and Seismicity

In this module we will look at geomechanically induced fault and fracture permeability changes and develop an understanding of the Earths geomechanical state and the evidence that supports this. Flowrate fluctuations, geomechanical modelling and flowrate correlation analysis will be introduced. The learner will study global induced seismicity and the causes and magnitudes of this and finally look at induced seismicity at CCS sites by looking at relevant case studies.

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

This module describes what a Mechanical Earth Model (MEM) is and why they are needed. The learner will develop an understanding of how MEM's are created and how they can be used for prediction in a CCS project.

Building and Running a 3D MEM

This module will start by explaining the workflow for creating a 3D Mechanical Earth Model (MEM) and giving the learner an appreciation of the ARTEMIS software. The geology and stress state of the Gröningen Gas Field will be covered and finally this information will be applied to building an analytical MEM for the Gröningen Gas Field.

Finite Element MEM and Course Summary

In this final model the learner will become familiar with the FEM APOLLO model for the Gröningen Gas Field. The module will compare seismic and FEM results for Gröningen with interpretated fractures from historical flow rates. The module will conclude by summarising the course content.