Introduction to Subsurface Pressures (G085)

Tutor(s)

Richard Swarbrick: Manager, Swarbrick GeoPressure.

Overview

This course introduces attendees to subsurface fracture pressures and fluid pressures, their relevance to subsurface phenomena and assessing risk in deep boreholes. An understanding of pressure is critical for subsurface industries including oil/gas exploitation, carbon sequestration, geothermal energy, waste disposal and hydrogeology, as well as surface aspects such as slope failure. The course teaches the details of what data can be collected and how it can be visualized and interpreted, underpinning more detailed geological and engineering studies.

Duration and Logistics

Classroom version: A 2-day course comprising a mix of lectures, case studies and exercises. The manual will be provided in digital format and participants will be required to bring a laptop or tablet computer to follow the lectures and exercises.

Virtual version: Four 3.5-hour interactive online sessions presented over 4 days. A digital manual and exercise materials will be distributed to participants before the course. The course is rich in exercise material to build up participants' understanding and confidence in a variety of techniques.

Level and Audience

Fundamental. Intended for all hydrologists, geologists, geophysicists and geomechanical and reservoir engineers. Knowledge of subsurface geology is not required but would be an advantage. Highly relevant to all who are studying the subsurface and especially those engaged in deep drilling and storage.

Objectives

You will learn to:

1. Understand how fluid pressure and fracture pressure are relevant to subsurface geology.
2. Evaluate the types of pressure data and measurements possible in the subsurface.
3. Create plots and maps of pressure data to solve subsurface puzzles (e.g. compartmentalization of reservoirs; distinguishing between hydrodynamic vs hydrostatic flow conditions; and recognition of abnormal pressures).
4. Appreciate the link between fluid pressure and fracture pressure, and appropriate coupling values.
5. Recognize how and where pressure data relate to specific events (e.g. slope failure; surface fluid release phenomena; earthquakes and other ground movements).

Course Content

Session 1: Fluid pressures

- Course context
- Fluid pressures, including measurements, datum reference for fluids and rocks
- Pressure gradients
- Typical data plots
- Differences in datum and interpretation between onshore and offshore environments

Session 2: Fluid pressures continued

- Recognising fluid type related to density and gradients
- Identification of fluid contacts
- Recognition of abnormal pressures with emphasis on overpressure
- Hydrodynamic vs hydrostatic conditions
- Mapping pressures and overpressures
- Recognition of fluid barriers – vertical and lateral
- Identification of pressure cells / compartments and their significance
- Appreciation of geological vs human timescale for barriers and baffles

Session 3: Fracture pressures

- Context for fracture pressures – rock stress and tectonic setting
- Conditions for rock failure – shear vs tensile
- Vertical / total stress
- Differential stress and effective stress magnitudes and significance
- Measurement of fracture strength in the subsurface – leak-off tests and other techniques

Session 4: Relationship between fluid and fracture pressure, and case studies

- Plotting fluid and fracture pressures on multi-well plots
- Evidence for fluid and fracture coupling
- Case studies – slope failure, both onshore and offshore
- Fluid expulsion phenomena, including seeps, geysers and mud volcanoes
- Modelling pressures through time (palaeopressures) and impact of climate change on subsurface fluids and impacts