

## N013: Overpressure in Petroleum Systems and Geopressure Prediction

Instructor(s): Alex Edwards/Sam Green/Jakob Heller/Niven Shumaker

Format and Duration

Classroom - 4 Days

Virtual - 8 Sessions

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### Summary

**Business Impact:** This class will supplement the prospector's toolbox in **sweet spot identification**, develop awareness of concepts and techniques associated with **completion design, unconventional reservoir development**, and practical aspects of **pore pressure data collection and interpretation**. Understanding subsurface pressures and their effects on the hydrocarbon system is a key input into developing successful exploration strategies, efficient well planning and ensuring the safe and effective exploration and exploitation of petroleum reservoirs.

This course addresses the origin and distribution of overpressure in the subsurface with emphasis on practical applications to the geoscientist and petroleum engineer. Geoscientists and engineers will learn how to measure, estimate and model pore pressure as an aid to production sweet spot identification, pre-drill well planning, evaluation of seal breach risk, recognition of lateral drainage and hydrodynamics, and assessing the uncertainty of the pre-drill pressure interpretation. The course includes geopressure analysis in unconventional systems and expanded content on the use of seismic data in pressure prediction.

### Learning Outcomes

Participants will learn to:

1. Calculate pressure gradients and interpret the position of fluid contacts from pressure vs. depth plots.
2. Calculate lithostatic profiles and evaluate methods of calculating fracture profiles.
3. Illustrate the relationship between compaction, effective stress and the development of pressure.
4. Apply a variety of techniques to predict pore pressure including the Eaton Ratio Method and the Equivalent Depth Method, and identify the data types that may be used (e.g., seismic data, drilling parameters and porosity data).
5. Differentiate between primary and secondary overpressure mechanisms and their relative magnitudes.
6. Use pressure data to interpret pressure compartments, fluid types, trap integrity, lateral drainage and hydrodynamics.
7. Recognize and apply analogs when interpreting pressure in the unconventional system.
8. Appreciate practical vs. theoretical pore pressure and geomechanical concepts.
9. Use the seismic velocity method to calculate and interpret derived pore pressure estimates.

### Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures and practical sessions drawing on examples from overpressured basins from around the world.

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### Who Should Attend

All geoscientists and engineers who require an understanding of geopressures. This could be applied to a wide-range of subsurface projects from basin analysis to well planning.

### Prerequisites and Linking Courses

Prerequisites - none. Individuals with 2 or more years experience in pore pressure prediction should consider taking our Skilled Application Level course N249 (Advanced Pore Pressure Prediction Workshop: Concepts, Mechanisms, and Workflows). Persons who want to understand the impact of geopressure on petroleum generation and migration can take the Basic Application Level course N010(Petroleum Geochemistry and Basin Modelling).

### Course Content

Overpressure is experienced in most sedimentary basins where reservoirs are associated with fine-grained lithologies (such as shales), in particular at depths of 2.0 km or greater below sea-bed. Recent advances in the understanding of overpressure, in particular the magnitude of overpressure resulting from each of the main mechanisms under realistic basin conditions, give improved confidence in estimating pore pressure. There is also a range of tools with improved capability (1) to display and interpret overpressure (and its relationship to the petroleum system) and (2) to estimate pressure through time using basin modelling. All of these tools can help with prospect exploration, well-planning and commercial evaluations.

#### 1. Pressure

- Definitions and units of measurement
- Pressure gradients: fluid pressure, hydrostatic pressure, lithostatic pressure and pressure transition zones

#### 2. Pressure measurement

- Direct and indirect ways of measuring/estimating pore pressure
- Fracture pressure: principles, estimation and fracture gradient

#### 3. Principles of subsurface pressure analysis

- Pressure versus depth plots: normal pressure, overpressure and underpressure
- Fluid pressure gradients: water and hydrocarbon
- Fluid contacts: determination from pressure data

#### 4. Mechanisms for generating overpressure

- Overpressure as a function of stress, increases in fluid volume, fluid movement and buoyancy,

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permeability, flow rate and fluid type

### 5. Overpressure prediction

- Porosity-based pressure prediction: Terzaghi principle, Eaton ratio method, equivalent depth method
- Pressure detection during drilling
- An outline of pore pressure prediction from seismic velocity data
- Challenges of porosity-based pressure prediction

### 6. Overpressure in petroleum systems

- Influence of overpressure on trap/seal integrity, reservoir quality, maturation of source rocks and primary hydrocarbon migration
- Mapping overpressure: excess pressure maps and pressure gradient maps
- Pressure compartments: recognition from pressure vs. depth plots combined with structure maps
- Recognition of lateral drainage and hydrodynamic hydrocarbon systems

### 7. Unconventional Hydrocarbon Systems

- Basin types and examples
- Applied geomechanics
- Difficulties in pressure detection
- Pressure prediction in tight rock