TETRA TECH RPS ENERGY | TRAINING

# N267: Petrophysics for Shale Gas Reservoirs

Instructor(s): Mike Lovell

**Format and Duration**

Classroom - 3 Days

## Summary


Shale gas reservoirs present a significant petrophysical challenge compared to conventional oil and gas reservoirs. The basis of petrophysical evaluation in conventional reservoirs involves the simple separation of solids and fluids, but is problematic when considering fine grained successions of mudstones, or shale gas plays.This is due to complex mineralogy, high organic content, proportion of adsorbed versus free gas and very low permeabilities. Participants will explore how the physical and chemical nature of shale gas constrain our petrophysical approach and how core measurements integrated with log analysis can help develop an appropriate petrophysical model.

This seminar-style course will present an overview of mudstones, and how in shale gas plays the physical and chemical properties are central to any petrophysical evaluation. The course starts from the conventional petrophysics viewpoint, considers the nature of mudstone systems, and then uses a variety of approaches appropriate for evaluating shale gas using core and log data within a geological framework. The course focuses on shale gas, although liquids are briefly considered.


## Learning Outcomes

Participants will learn to:

1. Characterise the geologic nature of shale reservoirs, and how the geological environment and history affect the physical and chemical properties.
2. Assess the effect of the variability of the physical and chemical properties on the petrophysical properties of shale gas.
3. Assess how the petrophysical analysis of conventional reservoirs applies to unconventional shale gas, and judge those components of the analysis that may be applied and those that require modification.
4. Assess the range of core analyses that can be applied to shale gas and the importance of the outputs from these measurements, including an estimation of any uncertainties in the data.
5. Assess the range of open hole and LWD log measurements that can be applied to shale gas and the importance of the outputs from these measurements, including an estimation of any uncertainties in the data.
6. Evaluate both core and log data in an integrated approach to optimise the petrophysical interpretation in a shale gas reservoir.
7. Estimate the gas in place in a shale gas reservoir, separating out free and adsorbed gas components.
8. Consider at an elementary level the geomechanical properties of a shale gas play and how they may be quantified from core and log data.

## Training Method

A seminar-style classroom course comprising a mixture of lectures, discussions, break-out groups, and exercises using calculators and Excel.

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## Who Should Attend

Anyone involved in shale gas petrophysics, including geologists, geophysicists, petrophysicists and engineers. The course aims to review shale gas petrophysics and provide an awareness of the complexities faced in developing appropriate shale gas petrophysical models.

## Course Content

### 1. Introduction to shale gas reservoirs and petrophysical models for shale gas; case study 1.

- Introduction: Shale gas resources and shale gas petrophysics.
- Shale gas reservoirs. Mudstones: what do we mean by the term shale? Grain size, shape, mineralogy, pore sizes and shapes. Depositional environments, compaction, dewatering, diagenesis, temperature and pressure. TOC, kerogen, organic maturity, chemical and physical properties.
- Petrophysical models for shale gas. Introduction to shale gas petrophysics. Adsorption and desorption. Mineralogy, chemistry and physical properties. Calculating gas in place.
- Shale gas: case study 1.

### 2. Review of petrophysics and introduction to shale gas core analysis.

- Review of petrophysics as applied to conventional reservoirs. Petrophysical properties; porosity, saturation, density, permeability, capillary pressure; gross, net and pay. Review of core analysis procedures. Review of geophysics and petrophysical relationships. Review of downhole logs.
- Shale gas core analysis. Coring, core handling and core preservation. Porosity, permeability and saturation. Core sub-sampling. Desorption tests. Langmuir isotherms. Total organic carbon, kerogen, thermal maturity, gas analysis. Geomechanical properties.

### 3. Shale gas log analysis, petrophysical models revisited, geomechanical properties, and an integrated workflow.

- Routine log analysis and new approaches (e.g. induced gamma ray spectroscopy, NMR, imaging, stress and dielectric measurements). TOC from logs. Density and porosity. Saturation from Archie, from shaly sand resistivity models and from mineral models. Integrated analysis of core and log data.
- Worked example: case study 2.
- Petrophysical models revisited; shale gas in place calculations.
- Geomechanical properties.
- Integrated workflow. Review of possible steps, problems, pitfalls, and future directions. Summary of how shale gas varies from conventional reservoirs, and how the variable nature determines the petrophysical approach.