TETRA TECH RPS ENERGY | TRAINING

N360: Quantitative Log Analysis and Petrophysics

Instructor(s): Martin Kennedy

Format and Duration

Classroom - 5 Days
Virtual - 10 Sessions

Summary

The course introduces the principles and practice of petrophysics as applied to conventional reservoir rocks (clastics and carbonates). It defines the petrophysical properties: porosity, permeability and water saturation and goes onto explain what controls them and how they can be reliably estimated. The course also considers some of the more artificial properties that are based on the above and shows how they are used to characterize petroleum reservoirs.

Business Impact: Attendance on this course will provide participants with an understanding of how the key petrophysical properties are defined and the ability to perform calculations to define these. These reservoir properties are important through the E&P lifecycle for reservoir characterisation and quantitative estimation of hydrocarbons in place.

Learning Outcomes

Participants will learn to:

1. Be able to define porosity, water saturation and permeability and appreciate the difference between total and effective porosity models.
2. Understand how porosity is measured in the laboratory and how it can be estimated from density and other physical properties measured by logging tools.
3. Have a qualitative understanding of how porosity tools work: density, sonic, neutron porosity and NMR.
4. Define electrical resistivity and what determines it in porous solids (Archie equation).
5. Understand how resistivity is measured in the borehole and how resistivity measurements can be used to estimate water saturation.
6. Appreciate what controls permeability, how it is measured and how it determines deliverability in wells.
7. Calculate reservoir average properties and use them to characterize reservoirs.
8. Have a qualitative understanding of what controls the distribution of oil and gas in a reservoir.

Training Method

This is a classroom or virtual classroom course comprising lectures, discussion and practical exercises. Most exercises will use real data from a variety of different reservoir types.

All exercises can be completed using calculators and graphs.

Who Should Attend

Anyone who uses petrophysical properties in their day to day work would benefit from attending, including reservoir modellers, geologists, geophysicists, reservoir engineers, and early career petrophysicists.

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Course Content

The course starts with an introduction which includes an overview of the course and some useful tools and techniques. The rest of the course goes through the outputs of a petrophysical interpretation in the order they are typically generated: shale volume, porosity, saturation, and permeability. Each property is defined, before explaining how it is measured on rock samples, and why it is important. The most commonly used logs to estimate it are introduced and the way(s) they are transformed described.

1. Introduction

- Petrophysical properties and data
- Physical Properties of Rocks
- Measuring porosity and permeability on core samples
- Fundamentals of Logs and Log Analysis
- Some Useful Tools and Techniques

2. Gamma-ray, SP and Shale Volume

- Clay minerals and why they are important in petrophysics
- Shale and Clay Volume
- Natural Gamma-ray Activity
- SP

3. Density and Porosity

- Introduction
- Density and the density log
- Porosity from Density
- More on Porosity

4. More Porosity Logs

- Neutron Porosity
- Sonic
- NMR
- Estimating porosity and shale volume from sonic and neutron logs
- Combining Measurements

5. Resistivity and Saturation

- Introduction
- Resistivity Tools
- Water Saturation

- Resistivity and Saturation: Archie equation
- Modifications to the Archie equation (conductive minerals)

6. Hydrocarbon Effects on Logs

- Specific effects of hydrocarbons on logs
- Accounting for Hydrocarbon Effects
- Accounting for Invasion
- Fluid Substitution

7. Permeability

- Introduction, diff erent types of permeability
- Controls on permeability
- Estimating Permeability from Logs

8. Net, Pay and Averaging

- Why Average?
- Cut-offs and how they are chosen
- Problems
- Brief introduction to uncertainty

9. Fluid Distribution: Controls and Models

- Introduction and Fundamentals
- Water in Porous Rocks
- Measuring Capillary Pressure Curves
- Real Fluids in Real Rocks
- Contacts and Free water Level
- Saturation Height Functions

10. Conclusion and the Future