

Integration of Rocks and Petrophysical Logs (G059)



Tutor(s)

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Overview

This course will focus on a simple petrophysical workflow entailing the determination of rock properties from conventional logs and core analysis data. Lithology, porosity, permeability and saturations will be determined using a variety of different analytical and simple modelling methods. Emphasis will be placed on understanding the importance of calibration, integration, and validation of the results of each method, based on a fundamental understanding of the geological controls on petrophysical properties.

Duration and Logistics

Classroom version: 3-days with a mix of lectures 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: Five, 3.5-hour interactive online sessions presented over 5 days. The course will focus on problem-solving using real-world data and use a series of Excel workbooks. A digital manual and exercise materials will be distributed to participants before the course.

Level and Audience

Fundamental. This course is intended for non-petrophysicists who require a grounding in the petrophysical determination of lithology, porosity and saturation from conventional and special core analysis, and conventional open-hole logs.

Objectives

You will learn to:

1. Understand the fundamental geological controls on reservoir properties.
2. Describe how these properties are measured in the laboratory using conventional and special core analysis methods.
3. Characterize the ways in which lithology and porosity are determined from well logs and calibrated with core analysis, and how permeability may be estimated in the subsurface away from core control.
4. Evaluate how the Archie equation is used to determine saturation in cores and from well logs, and the uncertainties and limitations with this method
5. Investigate how saturation-height models can be created from special core analysis data, thereby avoiding some of the limitations of the Archie method.
6. Interpret typical conventional log and core analysis data using Excel spreadsheets.
7. Experiment with the sensitivities of input parameters for various determinations, such as V-Shale, porosity and saturation.

Course Content

Course Details

It is important to become familiar with all the different analytical approaches available and consider all the possibilities, enabling the interpreter to make a sound judgment as to the accuracy and validity of the analytical results they achieve. The sections below provide a more detailed outline of the program.

Session 1: Fundamentals of Rock Properties

Lectures

- **Fundamentals of Rock Properties:** Fluid-Rock Interactions and Their Geological Controls. What are the fundamental rock properties that control reservoir quality? If we are going to validate the accuracy of our reservoir parameter measurements, which must understand the fundamentals of the properties we are measuring. Understanding these fundamentals will enable us to constrain predictions away from well control. We must keep our models of the pore systems grounded in the geology.

Activities

- **Group Discussion:** The nature of pore systems in the trainee's reservoirs. Collaborative mind-mapping exercise using Mural.

Session 2: Measurement of Rock Properties

Lectures

- **Measurement of Rock Properties:** Fundamentals, Limitations and Uncertainties in Conventional and Special Core Analysis. How are the key petrophysical rock properties measured in core? How reliable and comparable are the data? How do we validate the measurements?

Activities

- **Group Discussion:** Consider the nature and reliability of core analysis in the trainee's reservoirs. How are your cores collected, managed, processed and analyzed? What are the uncertainties and limitations of your data? Are there discrepancies between methods? Collaborative mind-mapping exercise using Mural.

Session 3: Lithology, Porosity and Permeability

Lectures

- **Determination of Lithology, Porosity and Permeability from Conventional Open-hole Logs.** Conventional Open Hole Logging Tools: Function, Limitations and Uncertainties. Which tools do we use to determine lithology and porosity? How do we determine permeability? What are the tools really measuring and how can we validate the results by calibrating to core measurements?
- How can advanced logs such as Borehole Images, Electron Capture Spectroscopy and NMR help us to refine our interpretations?

Exercises

- Lithology, Porosity and Permeability Determination Case Study in an Excel Workbook.

Session 4: Archie Water Saturation

Lectures

- **The Archie Equation:** Application and Limitations in Core and Log Analysis. Where do all the inputs for the Archie equation come from? Do we believe them? What can we do when different analytical methods give different values for key input parameters? Should we rely on the core measurements or the log measurements? What can we do when Archie fails in shaly lithologies? What alternatives are offered by advanced logging techniques such as NMR and Dielectric Logs?

Exercises

- Saturation Determination Case Study in an Excel Workbook using the Archie equation and Pickett Plots.

Session 5: Saturation-Height Analysis and Reservoir Summation

Lectures

- **Determination of Saturation vs. Height in the Reservoir.** Creating a saturation model based on special core analysis. Many petrophysicists prefer to determine saturation using a saturation-height model based on special core analysis which is independent of fluid properties.
- **Reservoir Summation:** What is the difference between net rock, net sand and net pay?

Exercises

- Saturation-Height Case Study in an Excel Workbook. Determination of Net, Rock, Net Sand and Net Pay.