EC014: Petrophysical Tools

Format and Duration

Self-Paced - 12 Hours

Summary

This course builds a working understanding of the common open-hole logging tools and measurements used in the traditional petrophysical analysis; the measurement principles and the main qualitative and quantitative aspects of their analysis are considered for each individual log type. In combination with the Foundation course, the overarching objective is to increase familiarity with the language, concepts, and tools used in the field of petrophysics.

Learning Outcomes

Participants will learn to:

1. Explain the measurement principles and how data from open-hole logging, mudlogging, and core analysis are integrated.
2. Describe the principles and measurements of traditional open-hole logs, Gamma Ray, Spontaneous Potential, Bulk Density, Neutron, Sonic, Nuclear Magnetic Resonance, and Resistivity logs.
3. Calculate shale volume, porosity, and water saturation from traditional open-hole logs.

Training Method

This is a self-paced e-learning course. Learning materials are structured into short sections, each including interactive text and image content, animations, video and audio. An end of course quiz is scored to provide the learner with their learning progress. Approximately 12 hours learning time.

Who Should Attend

This course is designed for those wanting an understanding of the petrophysical tools used in open-hole logging. For geoscientists, EC013 (Foundation Petrophysics) is a prerequisite for this course, introducing the principles and concepts that underpin traditional petrophysical analysis. EC015 (Petrophysical Tools for Geoscience) covers the same core content but with additional application to geological interpretation. For reservoir engineers, EC016 (Petrophysical Tools for Reservoir Engineering) covers the same core content but with additional reservoir engineering applications.

Course Content

Gamma-Ray Fundamentals

In this module, we will cover the use of natural radioactivity logging tools for the determination of lithology and mineralogy: gamma-ray. This module starts with the principles, goes through practical issues, like units and vertical resolution, and ends up describing how the tools can be used to estimate how much clay is in the formation and even the interpretation of depositional facies and trends using logs motifs.

Gamma-Ray Advanced, Spectral GR, and SP

This module will cover the use of 'Spontaneous Potential' and Spectral Gamma Ray tools. We start with their measurement principles and practical issues before integrating the SP and GR logs to aid in understanding lithology and estimates of shale volume in the subsurface.

Density Logs

This measurement responds to average porosity within the volume of investigation and is indifferent to its form: e.g., intergranular, fracture, or vuggy. It also depends on what fluid is in the pore space: water, or water and hydrocarbon.

Neutron Logs

This measurement responds to average porosity within the volume of investigation and is indifferent to its form: e.g., intergranular, fracture, or vuggy. Having said that, neutron porosity also responds strongly to clay and the presence of heavy elements. It also depends on what fluid is in the pore space: water, or water and hydrocarbon.

Special Lithologies, Minerals, and Fluids

In this module, we consider how density and neutron logs can be integrated to provide qualitative lithology indicators. We also discuss how clay and the presence of heavy elements impact these logs.

Sonic Logs

The sonic log is a continuous record of sonic velocity along the wellbore. This has a number of applications besides estimating porosity, but it is the latter that is of interest here. There is no universal relationship between velocity and porosity, as generally the fabric of the rock and the nature of the fluids in the pore space can both have a strong influence. Nevertheless, some equations linking porosity and sonic slowness (the reciprocal of velocity) have been proposed that do sometimes give reliable estimates.

Nuclear Magnetic Resonance (NMR) Logs

In this module, we look at the basic principles underlying the tool and try to understand how to interpret typical T2 distributions. We explore how different fluid systems affect NMR responses and we interpret NMR logs to define their potential reservoir quality.

Resistivity Logs

In this module, we will introduce you to the key principles associated with resistivity measurements and how rocks and fluids in the subsurface interact with electrical currents. We will also introduce the main types of resistivity tools and how their measurements are presented for analysis.

Resistivity & Fluids

In this module, we deepen our understanding of how fluids interact with electrical currents. We then begin to explore Archie's famous equation for calculating water saturation, and how the Archie parameters a and m are related to pore morphology, and how they can be estimated.

Resistivity & Saturation

In this module, we continue to explore Archie's equation and its parameters. We then consider resistivity measurements in non-Archie rocks and other ways of estimating water saturation.