N496: Advanced Special Core Analysis

Instructor(s): Martin Kennedy

Format and Duration

Classroom - 4 Days
Virtual - 8 Sessions

Summary

Participants on this course will learn to understand and evaluate the results of special core analysis (SCAL), and apply this to static and dynamic reservoir modelling. The most widely used SCAL measurements made in commercial core analysis laboratories will be covered.

Learning Outcomes

Participants will learn to:

1. Understand the purpose of electrical parameters, capillary pressure curves and relative permeabilities.
2. Quality control the different measurements and assess how representative they are.
3. Propose saturation parameters for input to a petrophysical model (including low and high-side realisations).
4. Define excess conductivity and using appropriate measurements, incorporate it into a shaly-sand interpretation; Assess whether a shaly-sand equation is necessary.
5. Understand what controls the shape of a capillary pressure curve and model individual curves with a curve fit.
6. Use a set of capillary pressure curves to build a saturation-height function.
7. Understand the concept of Wettability and how SCAL measurements relate to it.
8. Understand the concepts of Relative and Effective permeability.
9. Understand the difference and advantages/disadvantages of steady and unsteady state relative permeability measurements; Fit curves to raw data using Corey exponents.
10. Integrate saturation-height functions with relative permeability curves to predict water cut in the transition zone.

Training Method

This is a classroom or virtual classroom course comprising lectures, discussion, case studies, and practical exercises. Real data will be used wherever possible. All exercises can be completed using calculators and graphs or in Excel.

Who Should Attend

The course is designed for anyone interested in the application of SCAL, whether as a geologist, petrophysicist, or reservoir engineer. Familiarity with basic petroleum geology and engineering is assumed. Participants should be able to define the basic petrophysical properties: porosity, permeability, and saturation, how these are measured, and understand how these relate to in-place volumes.

Special core analysis produces numerical data and understanding the measurements and applying them requires some basic mathematical skills.

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Course Content

Introduction & Objectives of the Course

Cores and Coring

- History
- Coring equipment
- Biography of a core: from reservoir to laboratory
- Comparing logs and cores
- Preparation for measurements: plugging, cleaning and drying

Special Core Analysis

- What is SCAL?
- Purpose
- Sample selection
- Designing a program: constraints

Description of the Measurements

- Electrical properties (a, m, and n)
- Excess conductivity
- Capillary pressure
- Relative permeability
- Wettability
- Others: NMR, residual gas saturation, compressibility

Electrical Measurements

- The Archie Equation
- Pickett plots and the Cementation Exponent (m)
- Saturation Exponent (n)

Saturation Model

- Objective
- Selecting m, n values for the model
- Variable m models
- Uncertainty analysis

Excess Conductivity

- Definition and consequences
- Hill and Millburn's experiments

- Cation Exchange Capacity and its relation to excess conductivity
- Co-Cw measurement
- 3 'Wet Chemistry' methods

Shaly-Sand Models

- Waxman-Smits Method
- When should a shaly-sand method be used?
- Other shaly-sand equations
- Health warning!

Saturation-Height

- Fluid distribution in porous rocks
- The saturation-height function (SHF)
- Applications of the SHF
- Derivation of the SHF

Capillary Pressure

- Capillary rise
- Capillary pressure
- Capillary effects in real rocks

Wettability

- Interfacial tension (IFT)
- Wettability and contact angle
- Oil wetness

Fluid Distribution

- Buoyancy vs. capillary forces

Capillary Pressure Curves

- Porous plate
- Centrifuge
- MICP and pore size distribution
- Qualitative information from Pc curves

Developing a Saturation Height Function

- Data Collation and QC
- Selecting a function

- Curve fitting
- Accounting for changes in rock and fluid properties
- Comparison to log analysis and other data

Elaborations

- Imbibition and residual oil
- EOR

Wettability Index

- Contact angle (re-visited)
- USBM method
- Amott method
- Interpreting the WI

Relative Permeability

- Absolute and effective permeability
- End point saturations and effective permeability
- Relative permeability
- Permeability to water

Relative Permeability Curves

- Steady State Method
- Unsteady State Method
- Corey Exponent

Interpreting Relative Permeability

- Producing from the transition zone
- Consequences for fluid sampling
- Basin centre gas

Conclusion

- Is SCAL really necessary?
- Alternatives to SCAL and value of information