Integration of Special Core Analysis and Well Log Data for Reservoir Characterization (G119)

Tutor(s)

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Overview

This course describes routine and advanced well core analysis techniques and how they are acquired, corrected, quality controlled and interpreted to provide inputs to petrophysical log calculations and/or calibrate log analysis results and describe and infer reservoir quality. Other core-based building blocks of static and dynamic reservoir models and shared earth models will be introduced and discussed.

Duration and Logisitics

Classroom version: A 3-day course comprising a mix of classroom lectures and discussion (80%), and exercises (20%). 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, which will be performed in MS Excel.

Level and Audience

Fundamental. The course is designed for early career geoscientists and petroleum engineers, including petrophysicists who have a basic grasp of well logging i.e. logging tools, basic petrophysical interpretation for clay volume, porosity and fluid saturations. Some knowledge of concepts like permeability, and core versus log versus reservoir scales is useful.

Objectives

You will learn to:

1. Understand the planning and operations behind the well coring process and how the rock is affected by it, both downhole and at surface prior to transportation to the lab
2. Appreciate how core is prepared for analysis i.e. scanning, slabbing, plugging, cleaning, drying at the laboratory and its effect on the subsequent analysis.
3. Implement routine and advanced core analysis workflows, including petrophysical properties, fluid interactions, rock mechanics, drilling and completion tests.
4. Illustrate how porosity and permeability can be measured and predicted at the core scale, then upscaled to log and reservoir scales.
5. Demonstrate how electrical properties are measured as input to log saturation equations.
6. Establish how capillary pressure data is measured and used to build models to distribute fluids in reservoir models for in place and reserve calculations.
7. Integrate workflows with other data sources i.e. petrophysical well logs, cuttings, gas logs, pressure tests and flow tests.

Course Content

Session 1: Coring and Core Analysis Overview

- Overview of the well coring process: planning, identifying coring depth, coring operations, tripping and wellsite operations to QC, describe and stabilize core prior to lab transfer.
- Lab preparation: scanning and slabbing**,** plugging and preservation, cleaning and dying.
- Lab Analysis: High level discussion of lab workflows for petrophysical, geomechanics and completion studies.

Session 2: Routine Core Analysis – Porosity, Permeability, Grain Density

- “Routine” core analysis deliverables.
- Dean-Stark fluid extractions.
- Gas porosity and permeability.
- What do these represent?
- Stress Corrections to reservoir conditions.
- Input and comparison to well log results i.e porosity.
- Porosity/Permeability relations and rock/facies typing.
- *Exercise 1: Poroperm function building in Excel.*

Session 3: Core Electrical Properties for Log-Based Water Saturation

- SCAL studies for formation electrical factors and indices.
- What options do we have?
- What can we say about “electrofacies” or “rock type” from these?
- What do they represent in terms of pore morphology?
- *Exercise 2: FF and RI plotting in Excel.*

Session 4: Air Brine Capillary Pressure for Saturation vs. Height Calculations

- Basic drainage and imbibition capillary pressure theory for fluid distribution in oil and gas reservoirs.
- FWL vs OWC.
- What formation testing tells us.
- How to integrate well and core data to build saturation vs. height functions, accounting for variations in rock quality i.e. facies.
- *Exercise 3: Air Brine Pc data, building a Leverett J Function in Excel.*

Session 5: Integrating Mercury Data, well logs and pressure data

- High pressure mercury injection studies for pore size distribution.
- Common deliverables and how to understand them.
- Integration with Capillary Pressure studies.
- Drawbacks and limitations.
- Corrections required to utilize fully.
- *Exercise 4: Integrating HPMI data with the Air Brine Data Pc based J functions in Excel.*

Session 6: Building the “Big Picture” for Reservoir Characterization

- Upscaling from the core and log scale to the grid block and reservoir scale.
- Statistical tests, corrections of log means.
- Checks for volumetric accuracy.
- How hydrocarbons can “hide”.
- How averaging can be a mistake.
- How wrong could we be?
- Final thoughts and summaries.