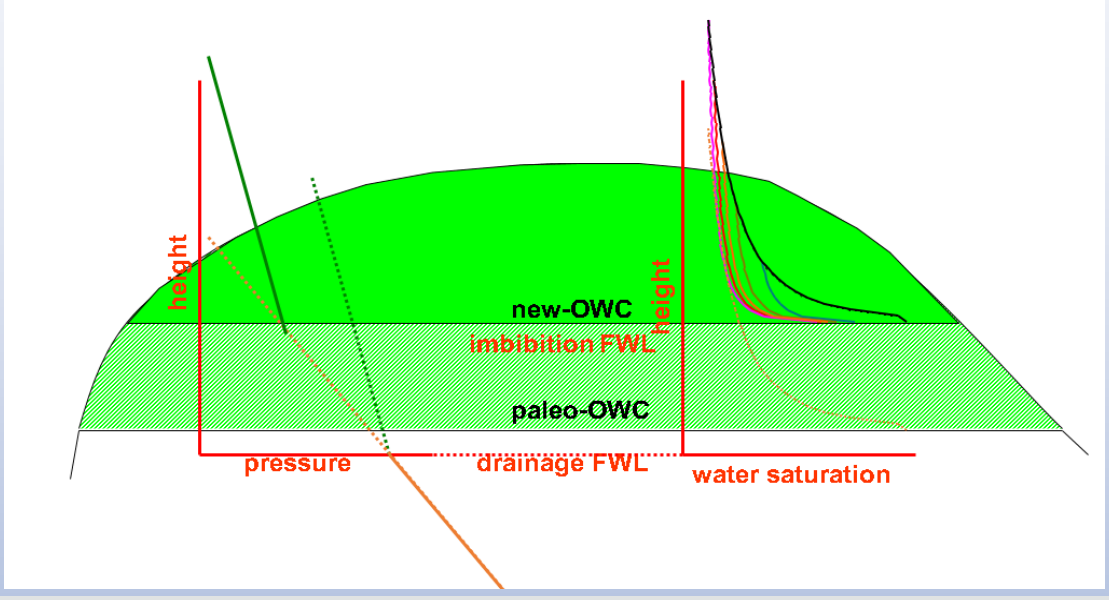
Short Course 2.10

Saturation-Height Modelling for Reservoir Description



presented by

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A TRAINING COURSE WITH "EVERYTHING YOU NEED TO KNOW ABOUT CAPILLARY PRESSURES AND SATURATION-HEIGHT"

Water saturations (Sw) in conventional oil & gas reservoirs are controlled by capillary pressures. Wireline logs can approximate what Sw may be, but do not actually measure Sw directly. Hence, when it comes to building reservoir models and estimating volumes in-place, capillary pressure based saturation-height models are used to describe Sw. For unconventional reservoirs, even if capillary pressures are not controlling Sw, saturation-height modelling provides a means to describe Sw variations in reservoirs using property variations. Note too that CO2 "saturations" in underground Carbon Capture and Sequestration projects are also initially controlled by capillary pressures, enabling likely storage volumes to be estimated using saturation-height modelling techniques.

COURSE OBJECTIVES

The course provides best practice guidelines to create meaningful saturation-height functions from capillary pressure measurements and log interpreted Sw. Both drainage and imbibition modelling and the reasons for discrepancies between saturation-height and log-derived water saturations. Will be covered. Implementation of appropriate models in log interpretation, static and dynamic modelling, unconventionals and carbon capture will be addressed.

AUDIENCE

Geologists, Geophysicists, Reservoir & Production Engineers and others involved in formation evaluation and/or reservoir modelling are the most likely audience. In particular, people who work with hydrocarbon saturations in their models will find this course of considerable benefit . Reserves Auditors may also find this course beneficial.

VALUE PROPOSITION

Participants will save hours to days of time in experiment selection, interpretation, saturation-height modelling and implementation at the very least. Likely they will also get better definition of in-place volumes and reserves ranges potentially resulting in millions to billions of dollars in increased project value.

SKILL PROPOSITION

Participants will gain a greater understanding of the processes controlling hydrocarbon distribution in reservoir rocks. The reasons for varying oil-water or gas-water contacts in reservoirs with the same Free Water Levels are just one example of the insights provided by an understanding of capillary pressures.

COURSE PROGRAMME

The following programme outline describes an intensive 2day course covering theory and hands-on interpretation skills. The course will cover the subject by alternating between lecturing and exercises with real data from clastic and carbonate oil and gas reservoirs, worldwide. A training manual will be provided to facilitate learning and use of the techniques. The exercises are intended to reinforce the methodologies discussed. MS-Excel will be used for the exercises rather than dedicated Petrophysics software so that the participants understand which algorithms they should use and why. Attendees will be encouraged to take their spreadsheets with them to use in the future.

COURSE SYNPOSIS

Introduction - Capillary Pressure: why does this matter?, basic forces, fluid contacts, nomenclature, drainage and imbibition, basic formulae, relative permeability. Unconventionals & CO2 Storage overview.

Phase 1 – Experiment & Sample Selection

Experimental Measurement: sample preparation and selection, principal test methods.

Base Measurements: ambient and in-situ conditions and fluids for porosity, permeability, stressed conditions, fluid densities, wettability., clay conductivity.

Saturation-height Planning: Sample preparation and selection, principal test methods, outline of QC concepts, saturation-height function selection, workflow.

Phase 2 – Measurement Interpretation and Quality Control

Representative Data: Testing for representative sampling, correcting for unrepresentative sampling, determining weighting factors for model fitting.

Data Collation and Formatting: Which data to extract from core reports, data formats to facilitate workflows.

Corrections & Conversions: Closure or conformance (Mercury Injection), clay-bound water (Mercury Injection), stress, impact of corrections, converting fluid systems, pressure to height conversion, combined fluid and pressure to height conversion.

Phase 3 – Saturation-Height Model building

Model Input Data Quality Control: Comparing different measurement types, quality control of baseline datasets.

Irreducible Water Saturation: Sw vs. porosity, Sw vs. permeability, uncertainty quantification.

Saturation-Height Model Creation & Quality Control: Which models to choose & why, model fitting, individual curve correlation method, all data smultaneously using Excel Solver, problems with parameter selection, recommended initial parameters for the Solver, sub-groupings, uncertainty quantification, checking for "Good Behaviour". Unconventional & CO2 Storage approaches.

Imbibition Modelling: Column previously at irreducible Sw, column previously in transition zone and/or Irreducible Sw, examples of imbibition modelling, volumetric Impact of Imbibition vs Drainage.

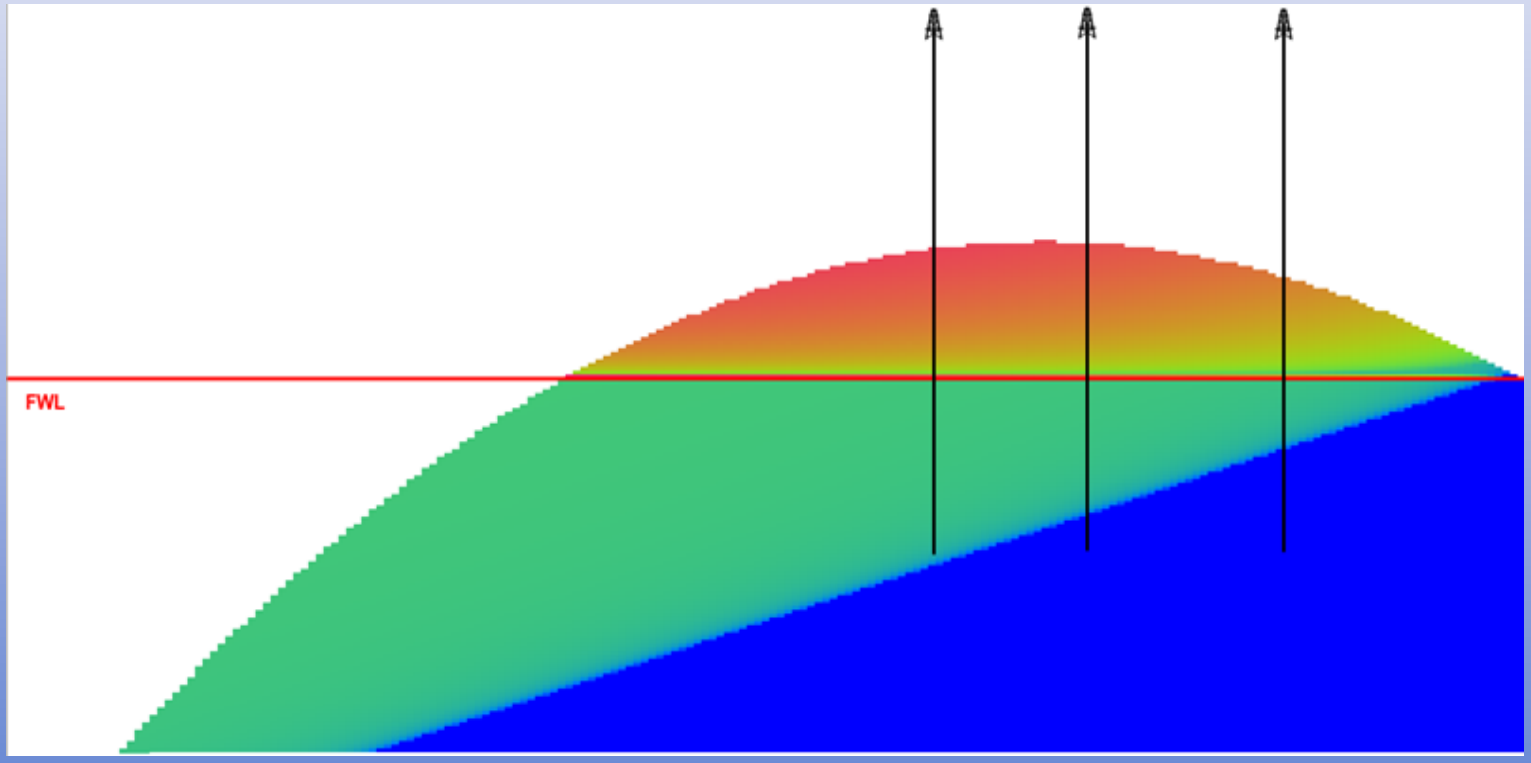
Phase 4 – Saturation-Height Model Implementation & Reconciliation

Reconciliation with Log Data: The importance of permeability, reconciliation with log evaluation, what is an acceptable match, example matches & comments, saturation-height functions from logs.

Special Situations: Perched Contacts, Dual (or More) Porosity Systems, Oil or Mixed-Wet Systems, Gas-Oil-Water Systems.

Implementation in Reservoir Modelling: Practical Implementation, the Effect of Scale on Saturation-Height, Porosity-to-Permeability Transforms, water saturation averaging, implementation in Petrophysical Modelling, implementation in Static Models, implementation in in Dynamic Models.

Additional Uses: Identifying reservoir & seals, current and original FWL Location, thin beds, dodgy or missing resistivity logs, pore throat size distributions, permeability prediction.



Stephen Adams

Steve has been a Petrophysicist since 1987. Following training and an initial 7 years with Shell, he has worked as an independent consultant with clients in Australasia, Asia, the Middle East and elsewhere. He has been providing petrophysically focussed training courses since 2001.

Steve has more than 19 papers published and is well known in the industry as a Specialist in Saturation-Height Modelling. His 2016 book "Saturation-Height Modelling for Reservoir Description" has been well received by the Industry.

During his career, Steve has had a great deal of exposure to some challenging problems involving saturation-height modelling in different lithologies. Much of this work has been "leading edge" in that similar cases have not been described in the literature previously. Some of these examples will be referred to in the training where the work has been published or permission has been otherwise received.

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