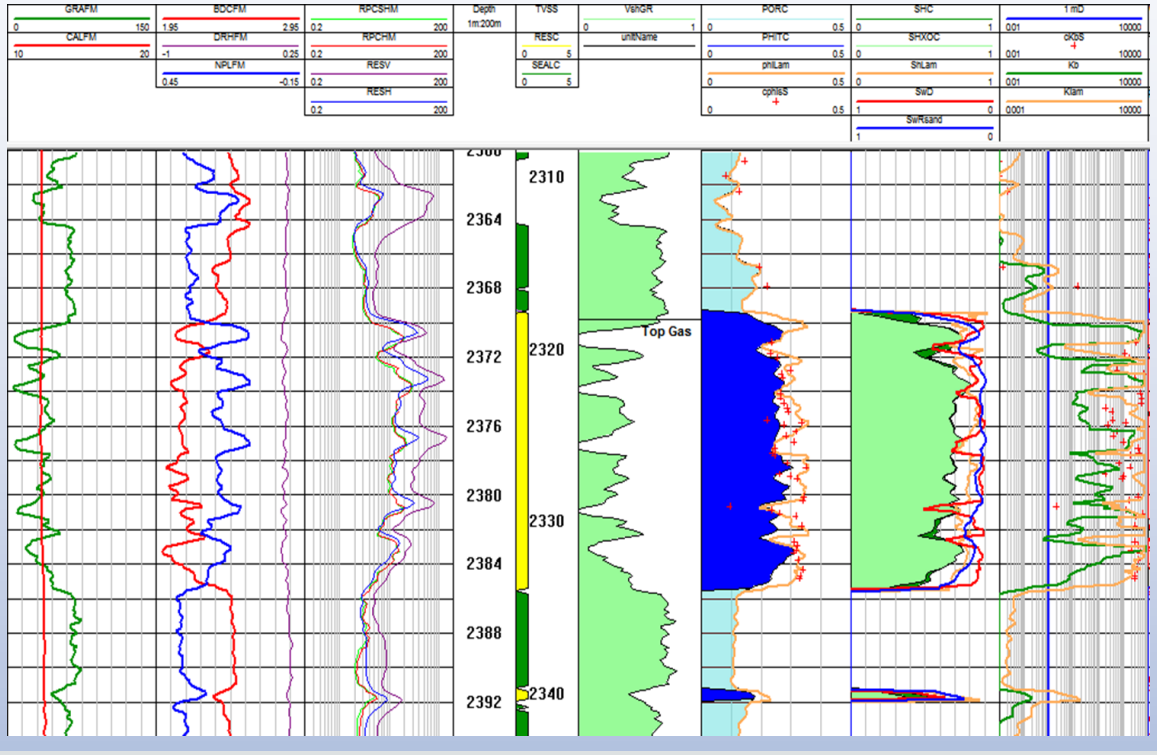
Short Course 2.00

The Petrophysicist Limited

Advanced Petrophysics



presented by

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BEST PRACTICE PETROPHYSICAL EVALUATION

Since wireline logs were first run, different ways to interpret the logs have existed. Some of these approaches are demonstrably incorrect, while others leave significant uncertainty. Nevertheless, there are ways to interpret all the available data to provide demonstrably reliable reservoir properties.

COURSE OBJECTIVES

This course provides a petrophysical workflow that is robust, consistent with all available data and straightforward to document. Reservoir property deliverables are consequently well supported and readily auditable. Properties such as net, porosity and log-derived water saturations are addressed, along with routine and special core analyses to additionally provide permeability, clay corrected Sw and saturation-height-based Sw. Implementation of reservoir properties in static and dynamic modelling will be addressed.

Emphasis will be placed on methodologies which can be satisfactorily audited by external technical experts and joint venture partners.

AUDIENCE

Petrophysicists, 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 reservoir properties and hydrocarbon saturations in their models will find this course of considerable benefit . Reserves Auditors may also find this course beneficial.

SKILL PROPOSITION

Participants will be provided a consistent methodology for Petrophysical evaluation. They will understand when changes from this methodology are appropriate and that they need to be documented. In addition, they will learn how to use the data available to extract additional insights regarding the past and present structure and fluid configurations.

VALUE PROPOSITION

Participants will save hours to days of time in petrophysical 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.

COURSE PROGRAMME

The following programme outline describes a 5 day 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

Part 1 – Introduction

The Basics: Documentation & audit trails, total & effective porosities, workflows, core Analysis programmes., LWD vs wireline.
Facies & Rock Types: Is this necessary? Reservoir Quality and data driven Facies.
Uncertainty: Input uncertainties, literature, recommended methodologies.

Part 2 – Porosity Interpretation

Core: Grain densities, ambient & stressed measurements., from 3D digital scans.
From Logs: density-only, density-neutron, density-Rxo, sonic, NMR, from GR (shale fraction), from neutron, from resistivity, from image logs.
Verification: Comparison with core. Why are there differences?

Part 3 – Permeability Interpretation

Core: Which permeability to model? Core permeability corrections, including stress & Klinkenberg.. Mini-permeameter. Porosity to permeability transforms.
Applying to Logs: Dependent on Facies & porosity to permeability model requirements. Upscaling.
Verification: Comparison with core. Why are there differences?

Part 4A – Water Saturation

Log-Derived: Cementation & saturation exponents, clay conductivity, formation water, Archie, Waxman-Smits/Dual Water, Other Sw equations & NMR. Fluid Types.

Part 5 – Net & Pay

Definitions: No Industry agreement—what shall we use?
From Core: Photographs, mini-perm, relative permeability, shows.
From Logs: image logs, cross-plots, cumulative EHC plots.
Verification: Comparison with core. Why are there differences?

Part 4B – Water Saturation for Modelling

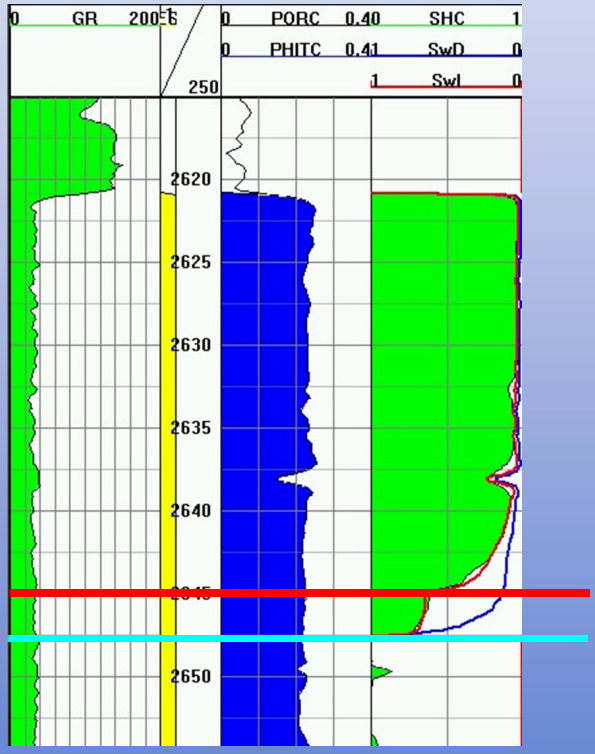
Core Saturation-Height: Swirr, Sw vs. porosity, Sw vs. permeability, Sw model creation, uncertainty quantification, checking for "Good Behaviour"..Drainage & Imbibition.
Verification: The importance of permeability, reconciliation with log evaluation, what is an acceptable match, saturation-height functions 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.

Part 6 – Investigation

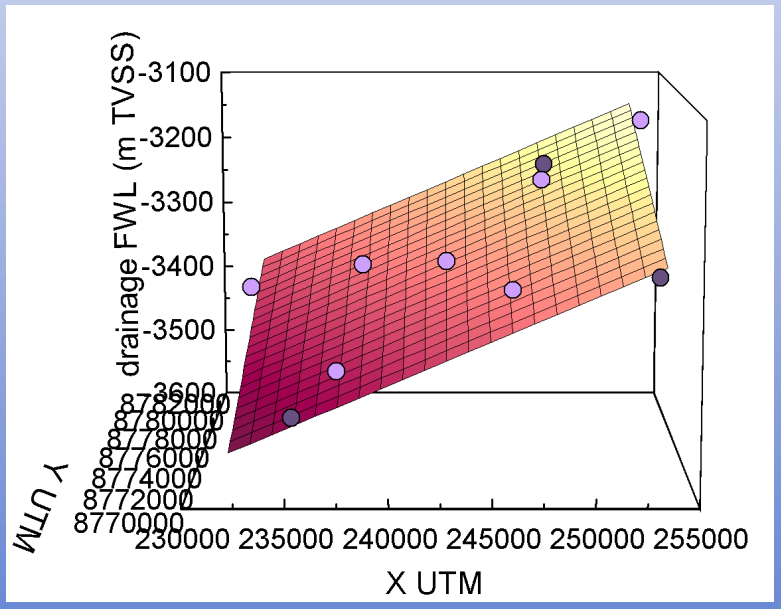
Saturation-Height Uses: Identifying reservoir & seals, current and original FWL Location, thin beds, dodgy or missing resistivity logs, pore throat size distributions, permeability prediction.
Residual Hydrocarbons: Identifying & quantifying from core and logs.
Relative Permeability: Single to two-phase transforms, normalisation & Corey exponents.
Formation Pressure Tester: Interpretation guidelines. Static & Dynamic systems.
Special Areas: Identifying & quantifying in thin bedded & heterogeneous systems. Fractured reservoirs.

Part 6 – Reporting

Documentation: Report, LAS, Plots, Summations..



Original/Drainage FWL Plane



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 capillary pressure 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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