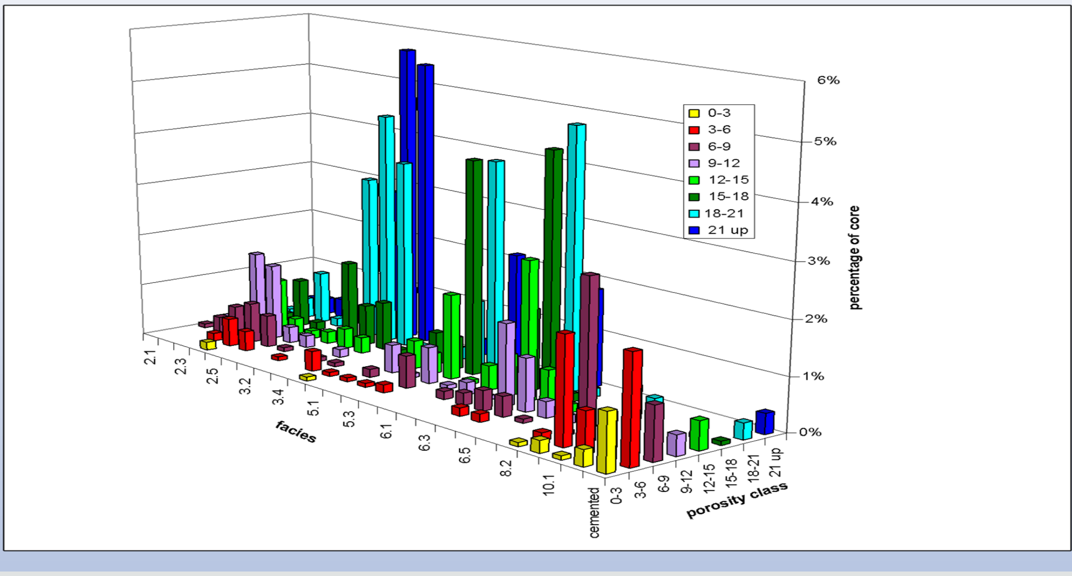
MercatEnergy

Short Course 2.21

TPL
The Petrophysicist Limited

Best Practices in Petrophysical Inputs for Static & Dynamic Modelling



presented by

Stephen Adams
The Petrophysicist Ltd.
&
Colin McPhee
Mercat Energy Ltd.

WHAT COMES AFTER THE LOG EVALUATION? - HOW TO FACILITATE MODELLING

Petrophysics doesn't stop at log evaluation; Petrophysically derived reservoir properties are the foundation of all static & dynamic models. This course has been constructed to make the provision of this data more straightforward and to facilitate the implementation of appropriate functions in such models. Checking the validity of models is also addressed.

COURSE OBJECTIVES

This course describes how to create the necessary inputs for Static & Dynamic modelling from both log and core data. Methodologies to include resulting reservoir properties and relationships in models are discussed and best practices described. Once data has been incorporated, checks must be made to ensure the models remain representative of the original data. These checks are outlined and include volumetric calculations.

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

AUDIENCE

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

VALUE PROPOSITION

Following the best practice guidelines in this course, participants will make more effective use of the log and core data derived from petrophysical interpretation. They will understand its limitations and uncertainties. More geologically reasonable reservoir models will result along with more representative development/re-development scenarios. Improved definition of in-place volumes and reserves ranges potentially resulting in millions to billions of dollars in increased project value are possible.

SKILL PROPOSITION

Participants will gain a greater understanding of the uses of Petrophysically derived properties and functions further along the value chain. As a consequence, they will be better placed to deliver the right data at the right time and to be prepared for internal and external technical reviews and audits.

COURSE PROGRAMME

The following outline describes an intensive 2 day course covering theory and hands-on interpretation skills in both log and core analysis interpretation. The subject will be covered by alternating between lecturing and exercises with real data from clastic and carbonate oil and gas reservoirs. 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 & Definitions - Petrophysical Products: Quality controlled logs, net, porosity, permeability, Sw, Sor, Krh, Krw, saturation-height, fluids, contacts, uncertainty, summations, documentation, flow diagrams.

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

Part 1 – Uncertainty

In RCA: Base porosity, gas and Klinkenberg permeability and fluid saturations - what does the lab measure, impact of different test methods and conditions. Recognising induced textural and petrophysical property damage.

In SCAL: How to select samples, prepare and characterise fluids and calculate reservoir stress. QC and diagnostics for porosity and permeability at stress. Electrical properties , capillary pressure methods, pore volume compressibility. Wettability and how it is altered during coring, core recovery and sample preparation. How to restore and "measure" wettability on core samples?. Advantages and disadvantages of relative permeability test methods. Common measurement pitfalls and how to avoid them.

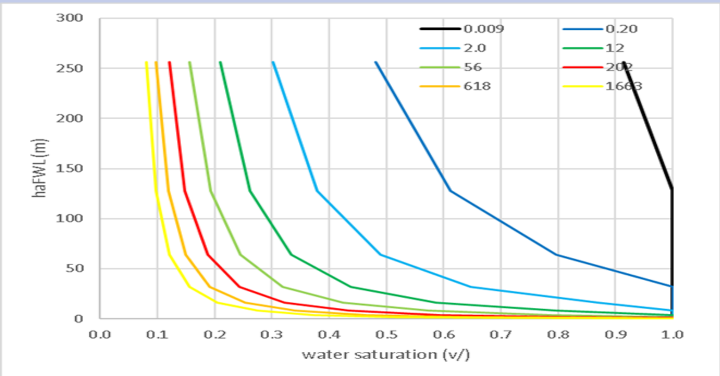
In Measurements: properties from interpretation of measurements., so what uncertainties are in measurements?

In Derived Properties: how to derive uncertainties in porosity, permeability, fluid densities, clay conductivity, log-derived Sw and Saturation-Height. What values are typical? And what about the equation/model uncertainty?

In Average Properties: And when data are averaged, what happens to uncertainty?

Part 2 – Static Modelling

SCAL Data Interpretation: Protocols to process lab data: porosity & permeability at reservoir stress and saturations; Archie and Waxman-Smits parameters and validation against core Sw ; capillary pressure and QC for saturation-height.



Input Data: net, porosity, permeability, sand fraction (thin beds/heterolithics), secondary porosity (vugs & fractures)., Facies (geological) may also be required. Log vs. model scale.

Input Formulae: saturation-height, drainage FWL, imbibition FWL, residual hydrocarbons. Implementation.

Common Problems: Are properties upscaled correctly? Propagated in a geologically sensible manner? Do water saturations match logs?

Part 3 – Dynamic Modelling

SCAL Data Interpretation: Why analytical relative permeability solutions are invalid! How to get reliable and representative relative permeability data. Pore volume compressibility – ensuring data are representative of reservoir stress evolution on depletion.

Input Data: Net, porosity & permeability from geological model after upscaling. Initial Sw also available.

Input Formulae: Saturation-height in form of look-up tables. Relative permeability, using Corey exponents and de-normalisation parameters.

Common Problems: Drainage or Imbibition? How best to initialize in latter case? Is reservoir at static equilibrium initially? If not, what is happening and how to model?

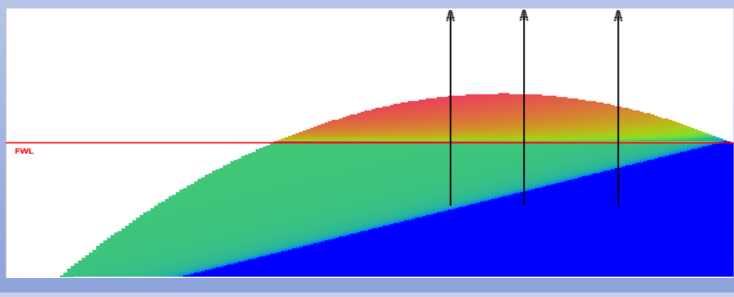
Part 4 – Independent Checks

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

Property Checks: Representativeness. Check static & dynamic models match upscaled log properties at well locations. Do average properties by unit / Formation match well averages – if not are differences justified?

Volumetric Checks: Check volumes of hydrocarbons by unit in static & dynamic models are similar to those using well averages with the same bulk rock volumes. If not, determine why and if differences can be justified.

Documentation: Ensure all steps required to produce inputs, input formulae, their uncertainties and model validations are written in reports suitable for internal and external review. Work should be described in sufficient detail to enable it to be reproduced by someone skilled in the areas of expertise required.



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 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.

Colin McPhee

Colin has over 40 years' experience in petrophysics, core analysis, geomechanics, formation damage and sand management. Before becoming a Director of Mercat Energy Colin was Global Head of Rock Properties with LR Senergy. He previously worked for Helix-RDS, Edinburgh Petroleum Services, Heriot Watt University and Wimpey Laboratories. Colin has worked on over 500 major integrated petrophysics and geomechanics projects in Asia, Middle East, Europe, Africa and elsewhere.

Colin is peer-recognised as an industry expert on rock properties and core analysis testing and interpretation for input to static and dynamic reservoir models .

He is the author or co-author of over 20 technical papers and co-author of the 2015 "Core Analysis: Best Practice" textbook, published by Elsevier.

The Petrophysicist Limited

438 Urquhart Road, RD1 Karaka, Auckland 2580, New Zealand
http://www.thepetrophysicist.com
Email: steve.adams@thepetrophysicist.com
+64.21.760.858 tel.

Mercat Energy Limited

86/2 Chesser Crescent, Edinburgh, EH14 1SE, UK
http://www.mercatenergy.com/
Email: info@mercatenergy.com
+44.773.880.3700 tel.