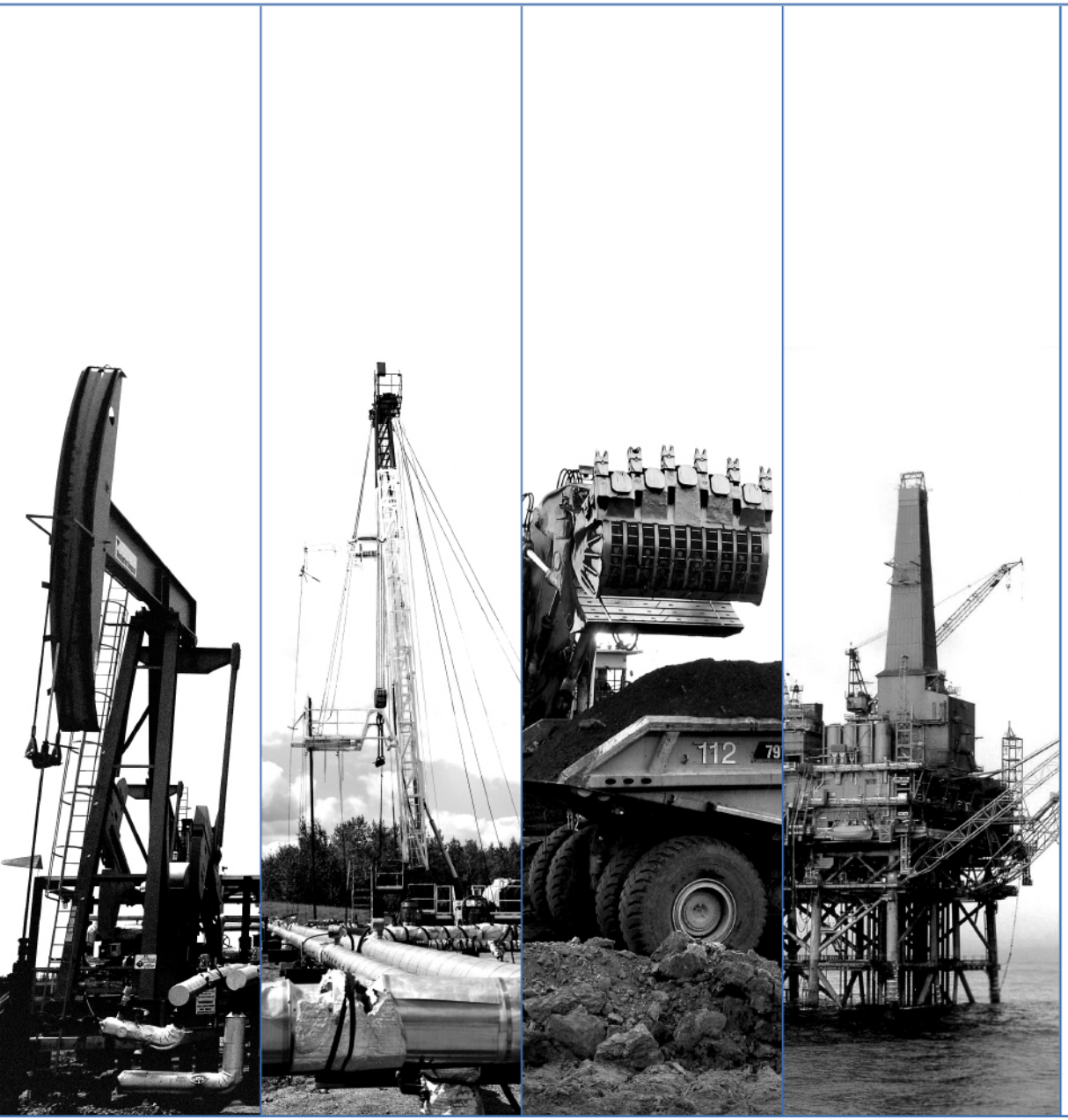

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Saturation vs. Height

Concepts

Richard Fairbairn

Talk Overview

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- A few words on why we model Sw vs. Height
- Introduce the concept of capillary pressure
- Transpose that model onto hydrocarbon reservoirs
- Avoid equations first thing in the morning
- Consider the data sources for core experiments
- Offer practical uses of Sw-Height modelling
- Leave some awkward questions hanging for the other presenters…

Why Model Sw vs Height ?

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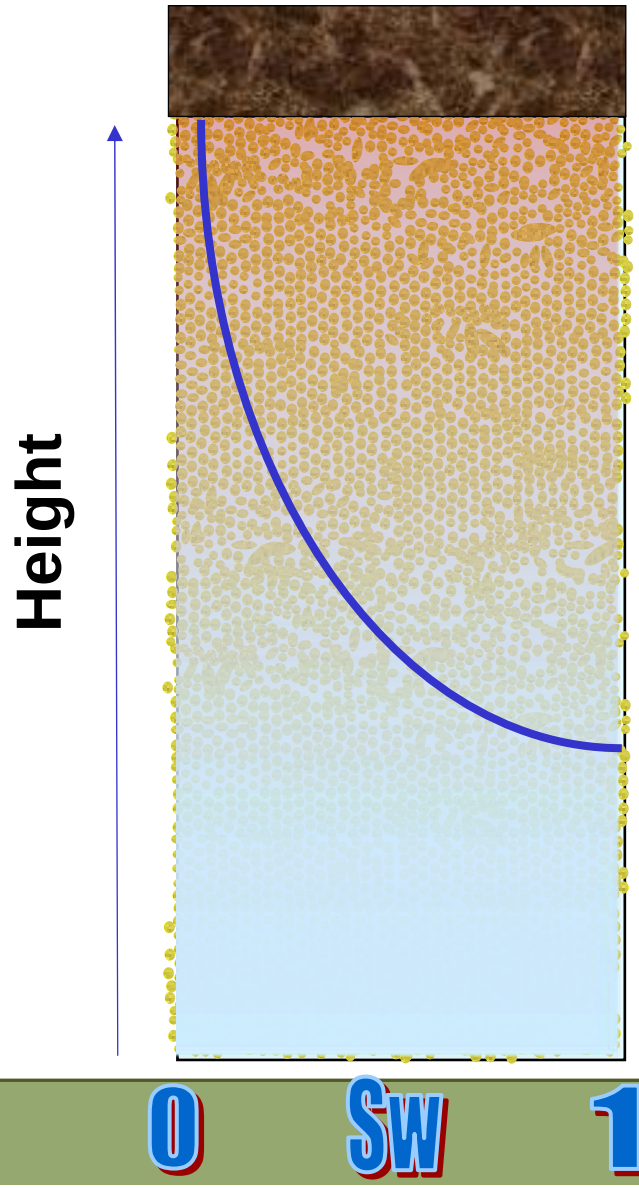
- Simplified saturation model, typically parameterised using one input property and height above free water level
- Volumetrics use petrophysical properties to define STOIIP/GIIP
- Sw-Height Modelling allows spatial distribution of Sw, aerially and vertically - reflecting rock quality variations
- Impractical to map Archie* inputs and parameters around the field – Mapping Sw may introduce unintended consequences (could be used for quicklook STOIIP, not dynamic models)
- Common saturation model can be applied to dynamic simulation, maintaining equilibrium with rock properties

Hydrocarbon charge



- Tank of sand filled with water overlain by sealing clay layer
- Hydrocarbons introduced and move to most crestal point due to density contrast, or buoyancy
- Hydrocarbons displace water from largest pore spaces
- Additional hydrocarbons create greater displacement pressure, enabling oil to get through smaller pore throats
- Displacement pressure is greatest at the top of the reservoir

Capillary pressure (P_c)

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- Capillary pressure is the pressure of the fluid phase within the pore space

- Function of:
  - FLUID DENSITY CONTRAST (Buoyancy)
  - PREFERENCE OF PORE SURFACE FOR EACH FLUID (Wettability)
  - SIZE OF THE PORE THROATS

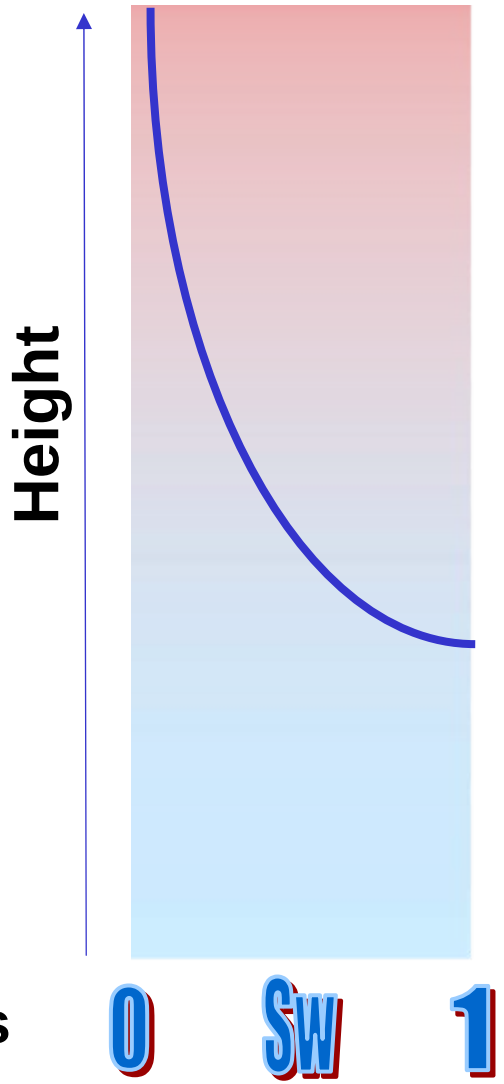
- Experiments performed on core plugs, or even core end trims measure displaced volume of one fluid versus another as the displacement pressure increases

- These result in a plot of P_c vs. Saturation. Does NOT measure Sw vs Height

- Requires conversion of Pc to Height

Modelling Process

- In-situ measurements quantify Sw from logs
  - May be affected by production
- Sw-Height attempts to characterise the post-charge fluid system
- Modelling is simply Curve fitting to the characterise the Capillary Pressure - Sw relationship
- The various fitting equations attempt to represent the transition zone, entry pressure and irreducible water saturation
- Validated by match to log-derived Sw in wells



Uses of Sw-Height Model

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- STOIIP assessment
- Dynamic simulation
- Up dip (exploration) volumetrics
- Confirmation of sweep
- Validation (or otherwise) of contacts
- Check on both Resistivity derived Sw and wider static characterisation

Questions to ask yourself during the day

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- What rock properties control the shape of saturation height functions?
- How accurate is the conversion from Pc to Height?
- From log data, what hints may there be that rocks may be oil-wet or water-wet ?
- Is wettability accurate ? Is it repeatable? Does it change with time?
- What dictates the difference between oil-water contact and Free Water Level ?
- How many core plugs (or end trims) do you need for a valid dataset ?
- Is Excel the best place to store and interpret raw data ?
- Why not use an in-situ characterisation of Sw (i.e. logs) to derive Sw vs. Height ?