Using Core to Define Net in a Complex Heterogeneous Reservoir

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Conventional Wisdom

- Net should be defined simply as rock that either contains, or is capable of containing hydrocarbons.

- A further refinement to this is that the rock containing hydrocarbons are within a connected pore system, and they are capable of responding to changes in pressure and hence moving or expanding.

- In the petrophysical realm this corresponds to a rock that has sufficient column height for the entry pressure for a non-wetting hydrocarbon phase to be exceeded

  - In log interpretation the above parameters are defined conventionally using Vshale, Porosity and Water Saturation cut-offs.

 - This definition of net should be easily calculated … in theory.

The Challenge

- Clair is a highly variable, heterogeneous reservoir with varying amounts of dispersed clays, with different minerology, and highly variable reservoir quality.

  - Even sands high in the oil column can be unstained.

- The large variability in dispersed clays and changeable sand mineralogy presents many challenges

  - Water saturation is inherently very uncertain.

  - Lack of a key marker bed makes calculating an accurate, quantitative, shale volume almost impossible.

  - A complex fill and spill history also means that logged / cored hydrocarbon are not necessarily producible.

- A conventional VSH / PHIT / SW cut off for defining net for volumetric is virtually impossible.

Heterogeneity
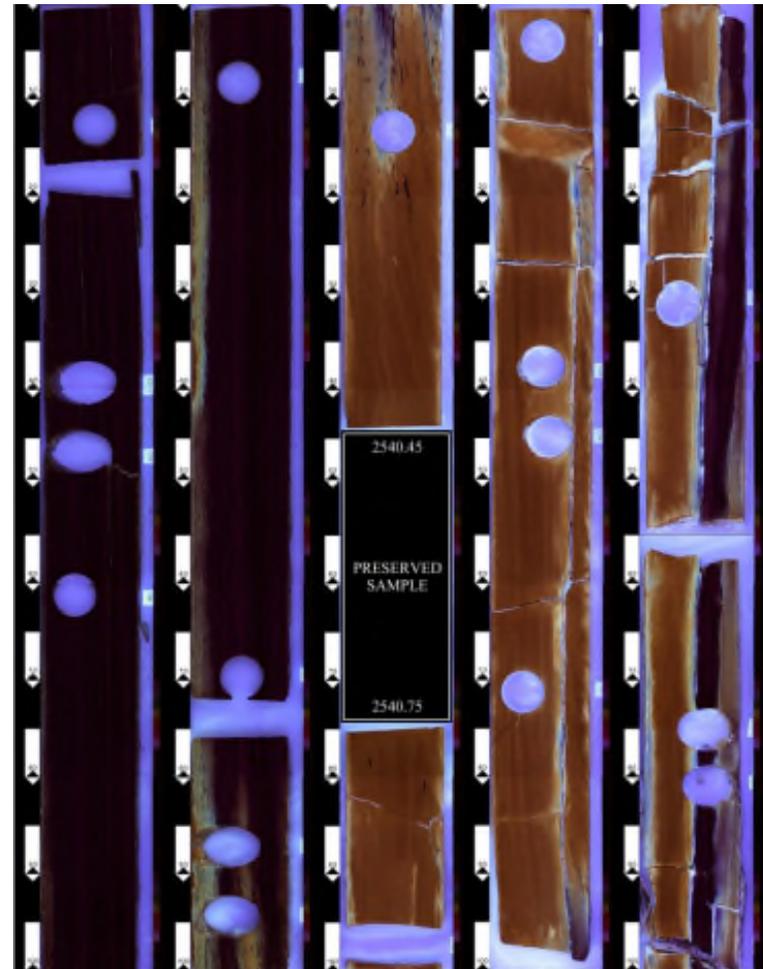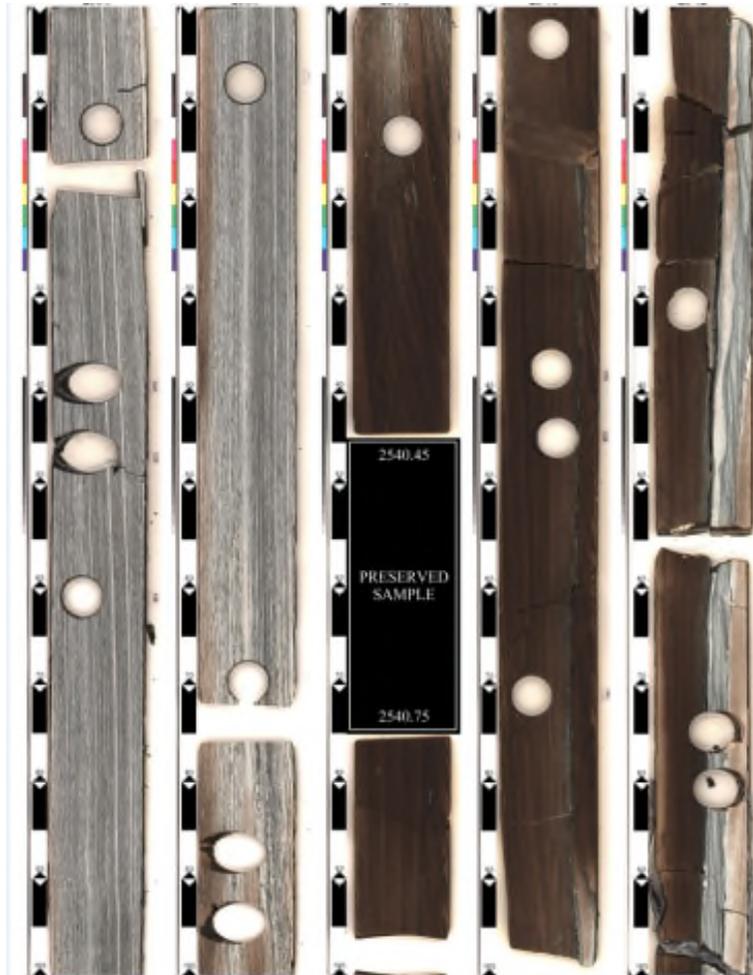
Interpretation Uncertainty
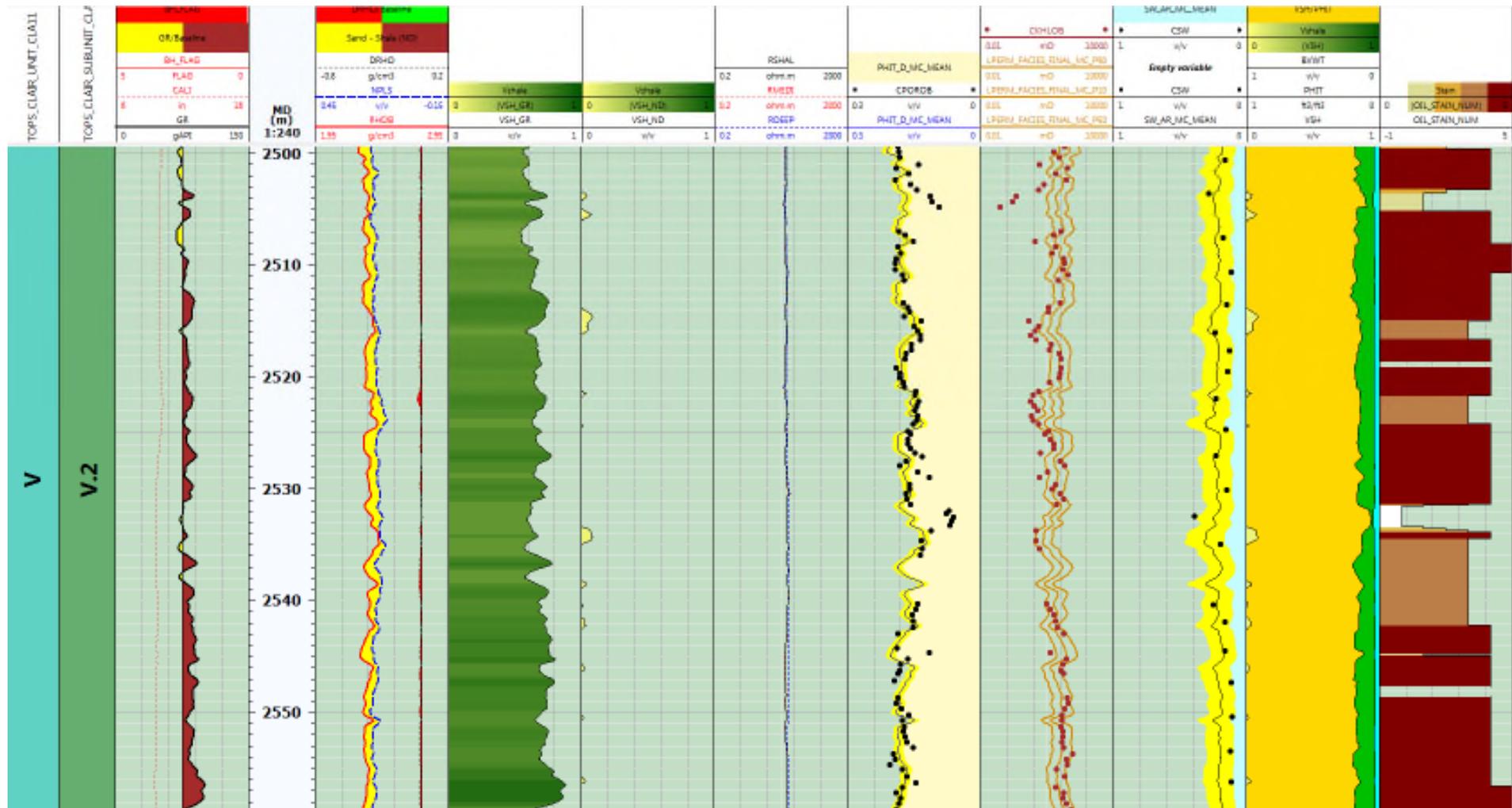
Rock Quality

- Porosity is calculated as total porosity

    - However this does not reflect whether it is macro or micro porosity.

- Vsh (as well as being uncertain) cannot distinguish the type or habitat of the clays

    - These are the main controllers of the reservoir quality, rather than the absolute volume.

- Permeability is a much more direct, and better indicator of rock quality.

    - Can be compared directly to core stain to determine net.

Core Stain
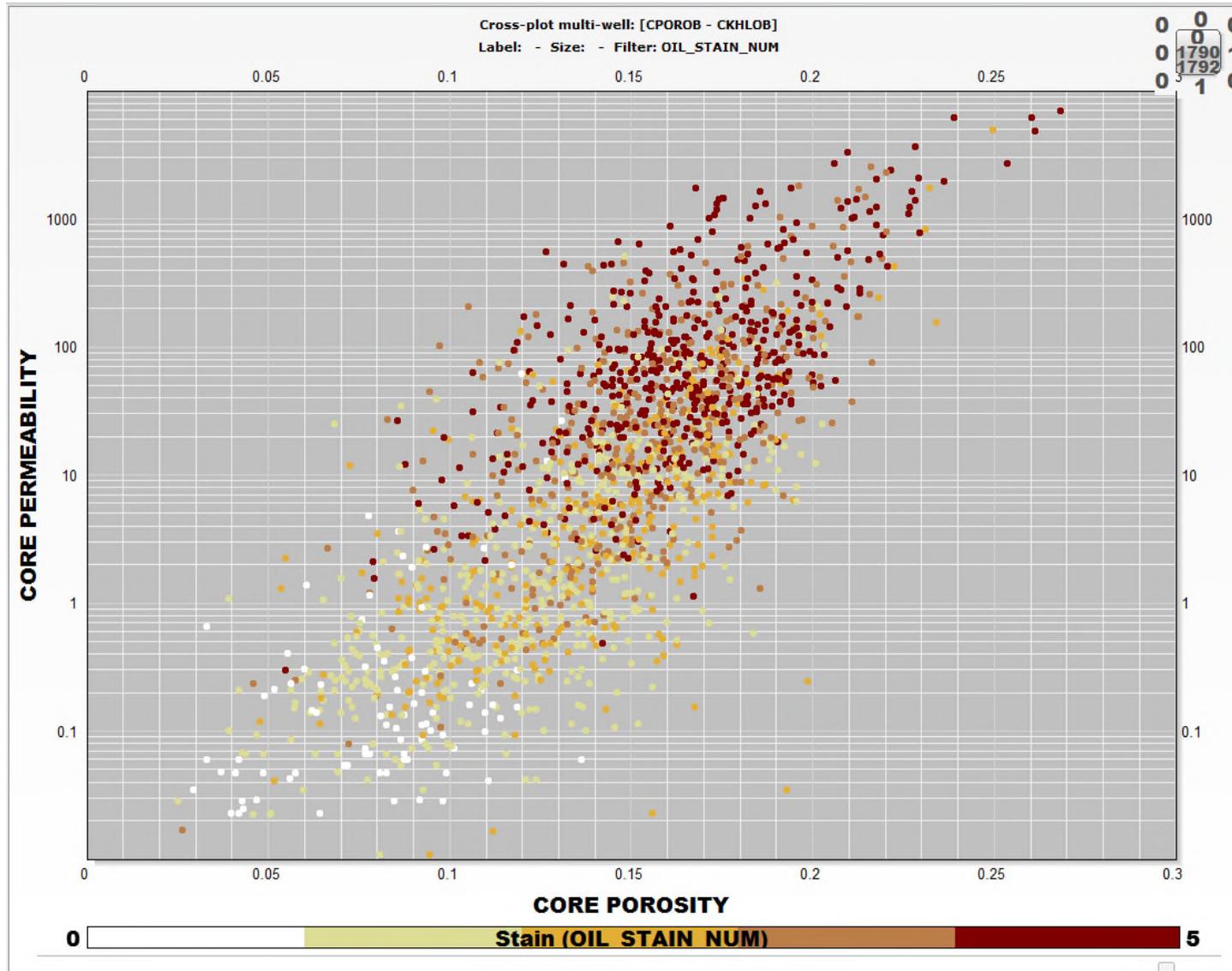
Calculation

- Core staining has been extensively logged across all of Clair (~6 km), by a single interpreter.

  - An extensive and definitive database of what rock can contain hydrocarbon!

- A progressive iteration of the permeability cut off is applied and the log derived net-to-gross is compared back to the core stain net to gross.

- The three main permeability data types were compared; core permeability, NMR permeability and log derived permeability.

Calculation
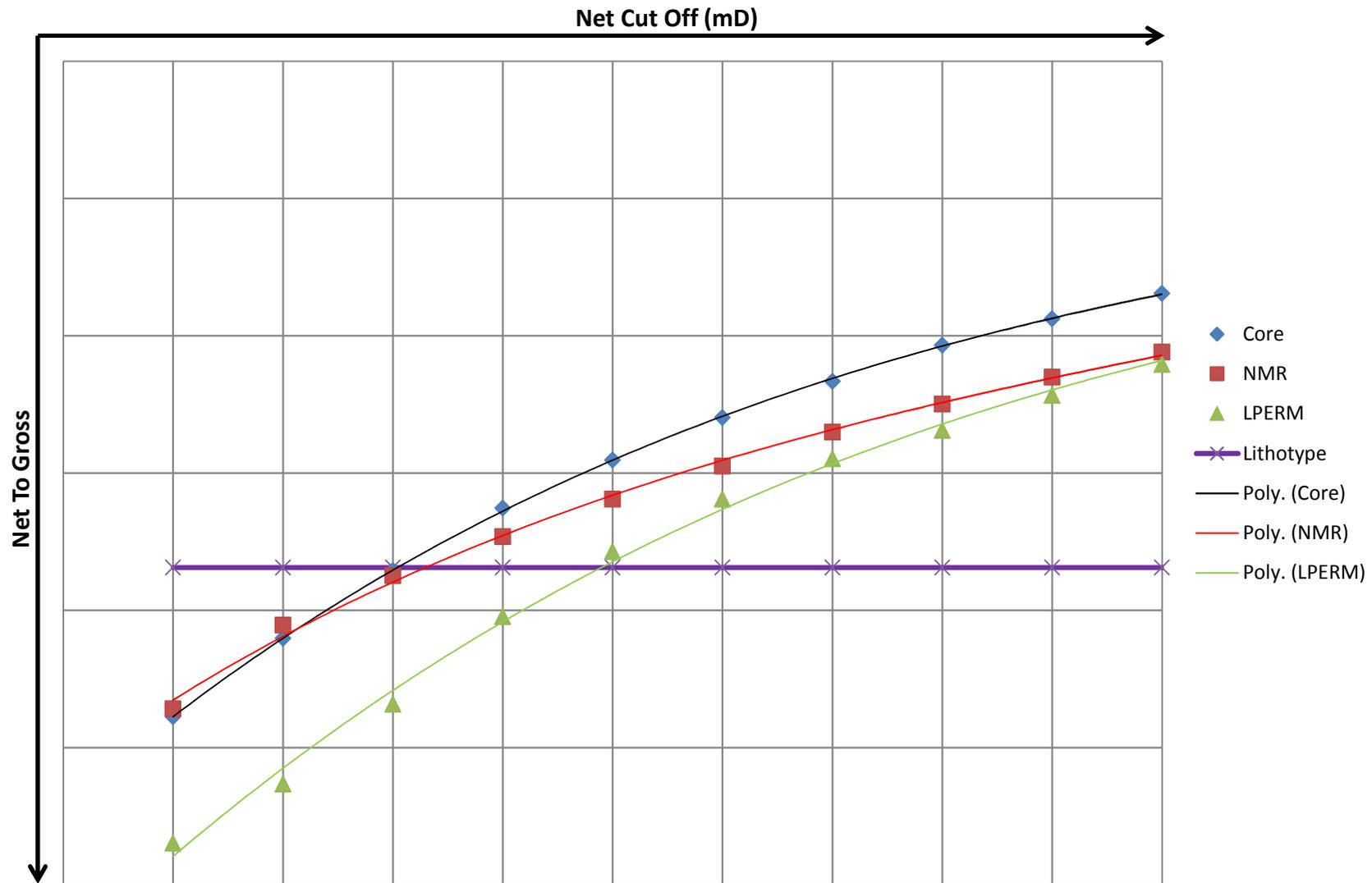
Which Net Is This?

- The purpose of this work is to provide a net rock that contains, or has the potential to contain hydrocarbon.

- There is no assertions as to whether or not this is all contributing to flow or producible over a well life.

- Indeed, Clair has a complex fill and spill history, whereby a paleo stain may be present, but will only produce water under todays conditions.
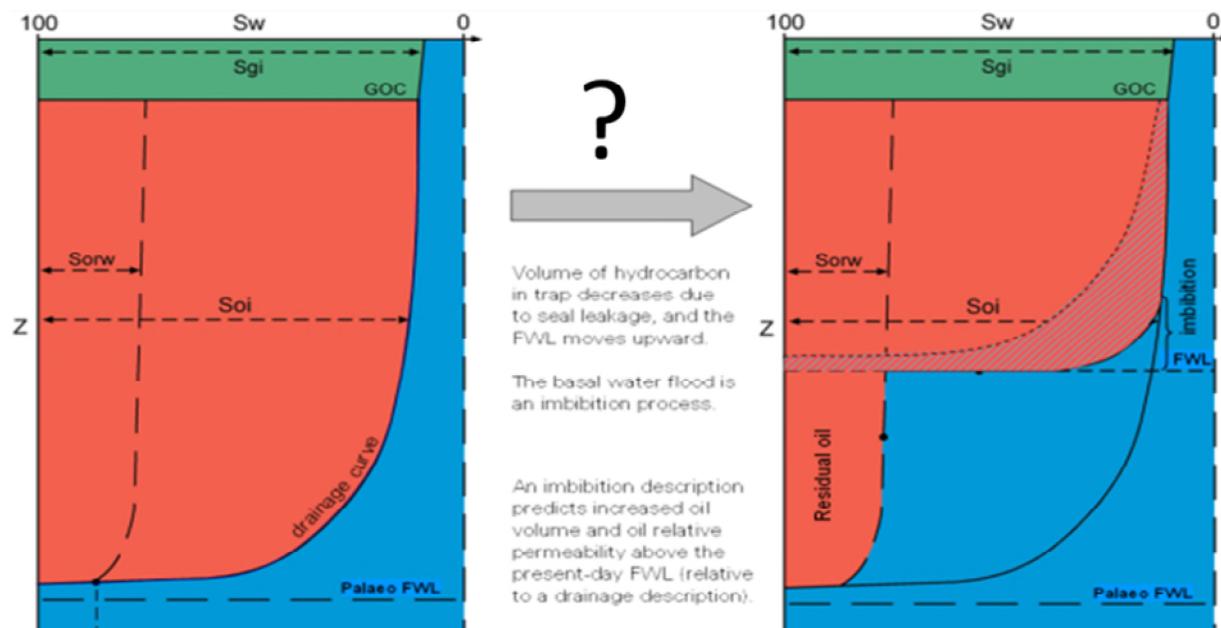
Conclusion

- Net is defined as rock with the ability to store hydrocarbon for STOIIP purposes.

- Taking a permeability based cut off results in a match to the lithotype defined net 87 % of the time.

- Leverage the large amounts of core and use it to your advantage!

- The uncertainty in the cut off due to the permeability types is considerably less than the uncertainty in the permeability itself.

- Vshale and porosity only loosely correlate to observed stain, whereas permeability more accurately represents the observed net to gross from core.