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The Fundamental Role of Electrostatic Forces Within Pore Systems and Their Effects on Resource Evaluation and Reservoir Performance

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Part 3: CFT-based resource evaluation: a framework for understanding the effects of electrostatic forces on fluid saturation distributions and reservoir performance.

Fluid contacts

Reservoirs with different capillarity can be in direct contact with no distinct break, contain different fluid saturations, and both be at equilibrium conditions [1]. The understanding of emplacement forces means the CFT model potentially provides a more realistic expectation of saturations for the explorationist and simple fundamental explanation of anomalous fluid contacts because saturation is a function of the rock and fluid combination.

Log analyses

The high concentration of cations in the capillary film can make it more conductive than the bulk pore brine. This masks the resistivity contrast typically seen when non-conductive hydrocarbons replace conductive brines [2–5]. While basic Archie[6] water saturation values are incorrect, there is typically still a contrast between readings in water saturated versus partially saturated reservoirs. This contrast can be seen on Pickett Plots and is a useful guide for determining which opportunities merit further work. The CFT model predicts that very low SP readings may indicate the reservoir is at S_{irr} despite high calculated S_w because ion mobility is increasingly restricted as the capillary film is compressed. Since fluid saturations are a function of both rock and fluid properties, cutoffs based on gas cause oil to be missed.

Drillstem and completion tests

Outward flow of imbibed water interferes with ΔP flow of free fluids towards the wellbore during drillstem or completion tests. Flow pressure curves appear tight while the buildup curves indicate good reservoir. The flow and buildup response of a given reservoir are very different when single phase water is present versus partial saturations. Capillary bridges in the near wellbore region re-establish.

Core Analyses

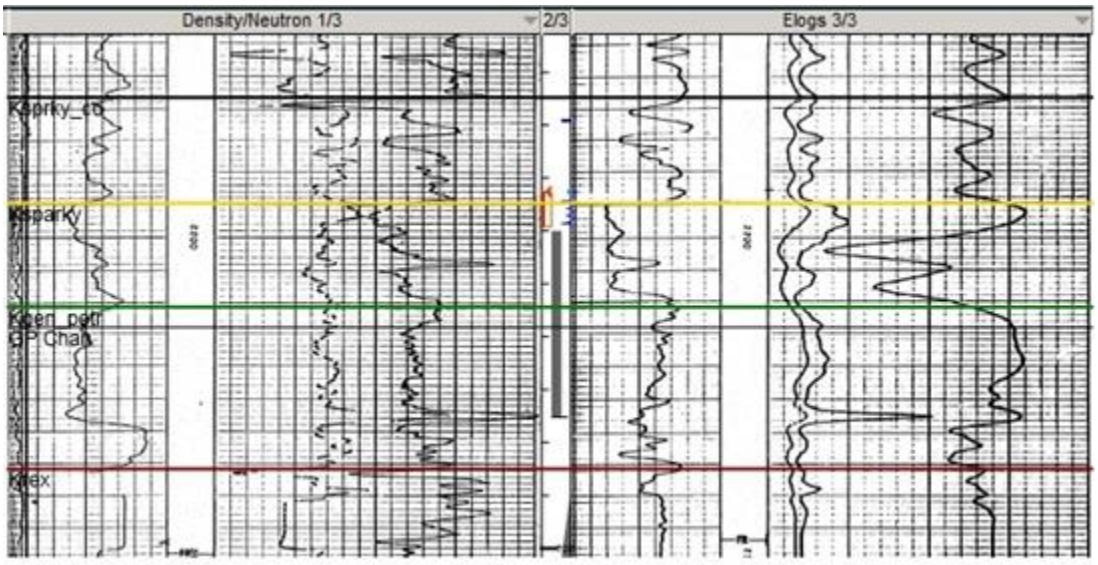
The typical core recovery operation is the ultimate recovery scheme but outflow and influx of fluid volumes is not measured. Pressure depletion of the free pore space and imbibition of filtrate significantly expands the capillary film. This means the residual oil saturation, lost fluid, and a portion of the residual water saturation are, very likely, all oil volume at in-situ conditions.

Production

Significant volumes of condensed, fresh water will adsorb onto pore system surfaces ahead of steam fronts. The hot water can change wettability and reduces thermal efficiency.

The primary conundrum with semi-conventional resources is the combination of reservoir and in-situ fluid properties results in low effective permeability to the free fluid, potentially orders of magnitude lower. Flow response to pressure gradients is highly restricted. The 1:1 displacement of free fluid in reservoir affected by imbibition means very high recovery

factors in those regions [7]. There may be a continuum from fully ΔP to fully imbibition drive as effective permeability to the free fluid decreases.



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