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

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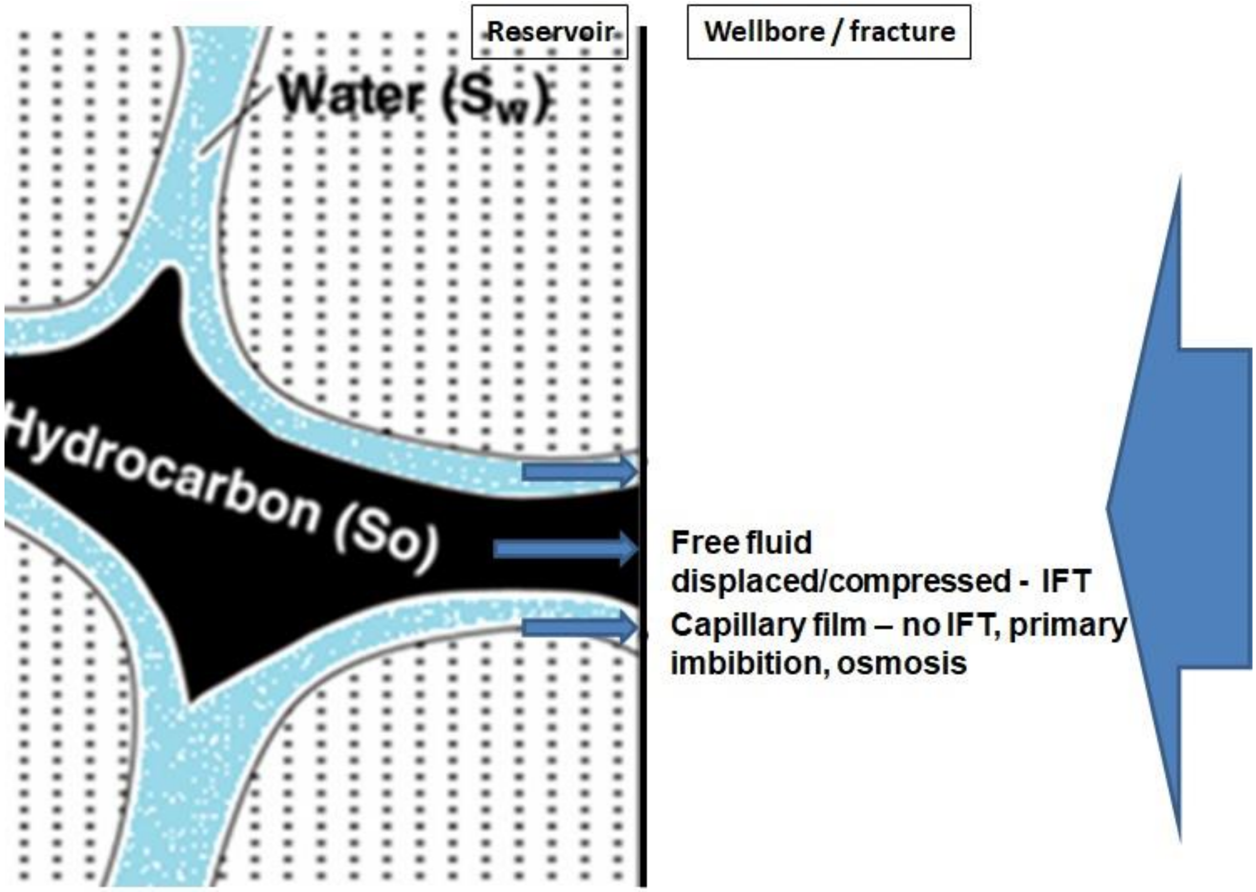
## Part 2c: Capillary Forces Theory: a model for understanding the electrostatic forces and their effects within pore systems.

### Response to natural change

From the electrostatic viewpoint, several changes in conditions can be predicted to occur within reservoirs along with natural uplift. Generation from source beds ceases upon cooling so generation of overpressure and primary high-pressure expulsion would also stop. Decreasing lithostatic stress allows pore throat apertures to decompress somewhat during uplift. This results in decreasing capillarity for any given reservoir. Where pore throat aperture expansion reduces adsorption field overlap, the capillarity would decrease exponentially. Pore throats that held tightly bound water during deeper burial could open enough to allow free fluid flow and facilitate leakage of overpressure [1]. This changes the electrostatic/pressure balance within resource accumulations. Spontaneous (PIP) and forced ($\Delta P$) imbibition of previously expelled water back into the capillary film begins. Fundamentally, imbibition is the adsorption onto pore system surfaces of layers of hydrated cations and water in response to electrostatic imbalance. In every laboratory experiment, imbibition displaces equivalent volumes of mobile pore fluids by countercurrent and/or cocurrent flow [2,3]. Because of this, the regional imbibition related to uplift can affect basin flow. This understanding has also led to a new dynamic model of capillary trapping called imbibition trapping. This means today's basin-centred deposits are decaying relics of larger ancient deposits.

### Response to induced change

Drilling, testing, completion, and production operations typically induce changes to the reservoir face. The reservoir is exposed to higher hydrostatic pressure, above lithostatic with fracing, and fresh water influx. This results in imbibition, diffusion, and, potentially, osmotic forces pulling water into the capillary film as it equilibrates to the change. Diffusion and osmosis forces drive the concentrations of water and ions in two contrasting liquids towards an intermediate, equilibrium concentration. The capillary film shares traits with semi-permeable membranes in that cations are held by adsorption while water is relatively free to move. Osmosis can generate significant force. Since the free fluid is immiscible with introduced fluids, it is primarily subject to pressure gradient displacement. Imbibition drives thickening of the capillary film and compression and/or countercurrent displacement of free fluid. Viscous coupling shear effects on each side of the fluid interface plus anchoring by natural surfactants that bridge the interface interfere with free fluid mobility. Imbibition changes fluid saturations at the reservoir face. Unlike the applied pressure, electrostatic forces are regionally pervasive, so the imbibition process will continue until the water supply is depleted, the pore system surface charges are balanced to a new equilibrium, or resistance by another force stops it. In the subsurface, the resistant force would most likely be determined by the free fluid which must be compressed or displaced for the capillary film to expand.

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**References**

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