

A Brief History of Low Resistivity Pay and How it was Overcome *with examples from Carbonates, Shaly Sands, and Unconventionals*

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Abstract

Low Resistivity Pay - production from zones with substantially lower resistivity than the main producing intervals in a well or field – is mentioned in the literature as early as 1955. Today, LRP is recognized across the world, in sandstones, carbonates and unconventional reservoirs. Driven by field examples, this talk reviews both the underlying causes of Low Resistivity Pay and the techniques and technologies used to evaluate it.

During the 20th century the focus of LRP technology was on shaly sands. The development of NMR to quantify bound water, Logging While Drilling to reduce sensitivity to mud filtrate invasion, and high-resolution logging & 3D induction tools for thinly bedded reservoirs have gone a long way towards solving the problem of LRP in shaly sands.

Since the early 2000's, Low Resistivity Pay became widely recognized across the Middle East. It was clear that some reservoirs with complex micro porous pore systems produce oil with minimal water close to the OWC. Technologies applied to evaluate these zones include 3D resistivity, Sigma while drilling, and innovative resistivity-saturation equations driven by NMR porosity partitioning.

More recently, Low Resistivity Pay has popped up in gas bearing regions of unconventional reservoirs in Argentina and across the United States. Observations of unusually high dielectric constants, unveiled by novel advances in induction tool inversion and supported by laboratory experiments suggest that maturation of kerogen into graphite plays a key role, but research continues!

Biographical Sketch:



David Allen became fascinated by Low Resistivity Pay as a logging engineer along the Texas Gulf Coast in 1979. His early papers on Low Resistivity Pay included Laminated Sand Analysis in 1984, and a 1987 SPWLA Best Paper on deep filtrate invasion. David then worked on Logging While Drilling developments and co-authored with Jim Klein, *The Petrophysics of Electrically Anisotropic Reservoirs*, (another SPWLA Best Paper). This work motivated development of 3D induction tools.

David was Chief Petrophysicist for Schlumberger from 1995 to 1998. At Schlumberger-Doll Research, 1998 to 2006, David led studies unraveling micro porous carbonates using NMR and Image logs and co-organized an SPWLA Topical Conference on carbonate Low Resistivity Pay.

David is now an Advisor at the Schlumberger Houston Formation Evaluation Center. He participates in 3D induction developments, NMR developments, and interpretation of unconventionals. He co-developed CIPHER software for carbonate microporosity analysis, a joint development between Schlumberger and Saudi Aramco. He has coauthored 54 papers including three SPWLA Best Papers and holds 7 patents. He was a distinguished lecturer for SPWLA in 1991 and for SPE in 2021.