

PS Five Reasons for Carbonate Oil Production at High Archie Calculated SW*

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Abstract

Water free oil production from carbonates at high Archie calculated SW may occur when: (1) The calculated SW is not correct. (2) The calculated SW is correct, but the water is immobile. (3) A combination of the previous two. High SW is generally considered above 50%. Five reason for water free oil production at high Archie SW are: (1) Layer formation – Stacked layers of small pore size rock (micritic Wackestone) with coarse pore system rock (Grainstone) below the resolution of the resistivity tool. (2) Dual porosity system – Large pores surrounded by micritized grains. The large pores flow oil while the capillary bound water in the micrite grains is immobile. (3) Fractures – Fine grained matrix with capillary bound water combined with fractures flowing oil and a lowering of Archie's cementation exponent. (4) RT lowered due to deep conductive mud filtrate invasion. (5) Conductive minerals such as pyrite. Whether a porous rock at a given saturation produces water free oil depends on the assemblage of pore and pore throat sizes and the rock wettability.

Reference Cited

Ibrahim, M.K., P. Ferraris, and A. Dawoud, 2002, Integrated Saturation Monitoring with Cased-Hole Formation Resistivity and Reservoir Saturation Tools: Poster 222, 5th Middle East Geoscience Conference and Exhibition, April 15-17, Manama, Bahrain.

Five Reasons for Carbonate Oil Production at High Archie Calculated SW

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- 1) Sandwiches (laminations)
- 2) Microporosity
- 3) Fractures
- 4) Deep Invasion
- 5) Conductive Minerals

1

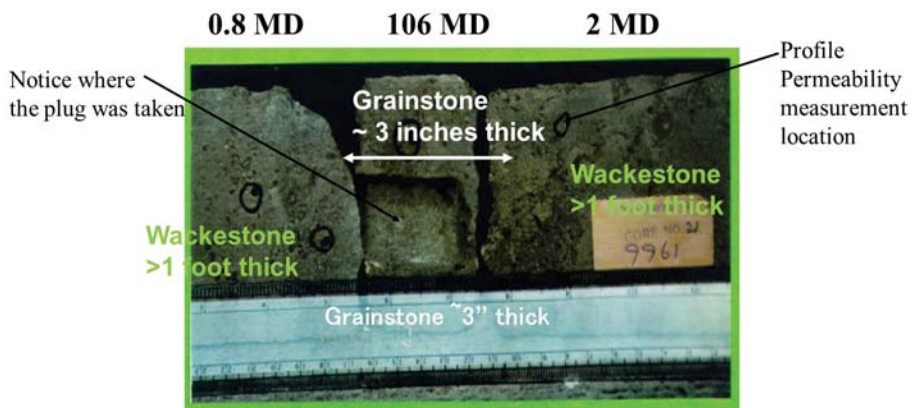
How Common is Low Resistivity Carbonate Pay?

In the Emirates, Low Resistivity Pay is encountered in at least 9 reservoirs.

- F. Field (Thamama)
- H. D. Field (Mishrif)
- N. Field (Thamama)
- N. Field (Arab)
- N. E. B. Field (Thamama)
- M. Field (Thamama)
- U. L. Field (Thamama)
- U. S. Field (Uweinat)
- U. Z. Field (Thamama)

All are Limestone Reservoirs except the Arab (Dolomite / Limestone) 2

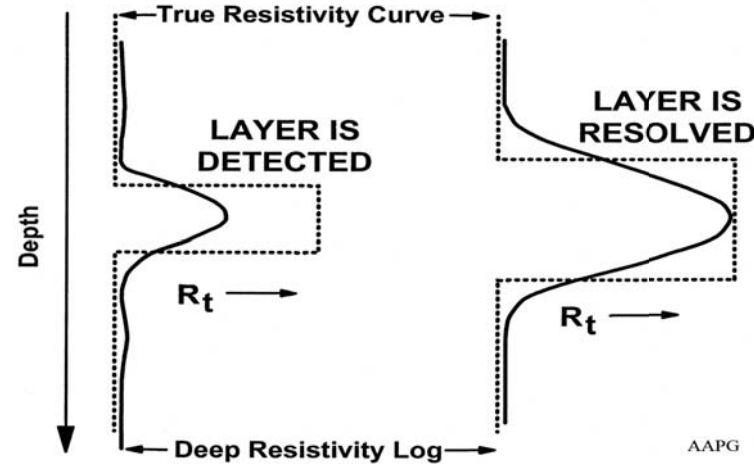
1 The Sandwich



A three inch thick grainstone sandwich between two thicker (> 1 ft.) wackestones. The two facies are equal in porosity. The grainstone has low SW and likely produces the oil. The wackestones contain a high percentage of capillary bound water. They likely produce little or no fluid. Resistivity logging tools are unable to resolve the differing rock water saturations of these rock layers.

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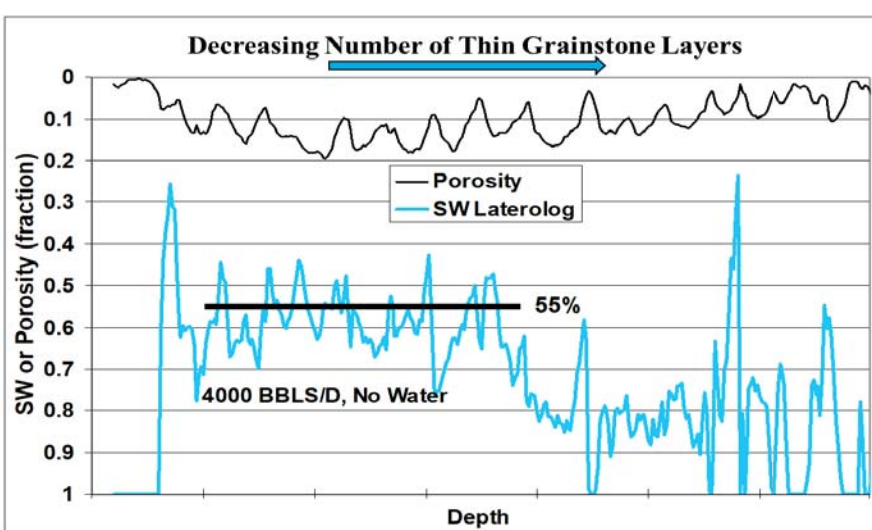
Tool Resolution Impacts Calculated Water Saturation



Porosity tools resolve beds about 2 vertical feet thick. Resistivity tools resolve beds about 1 to 4 vertical feet thick.

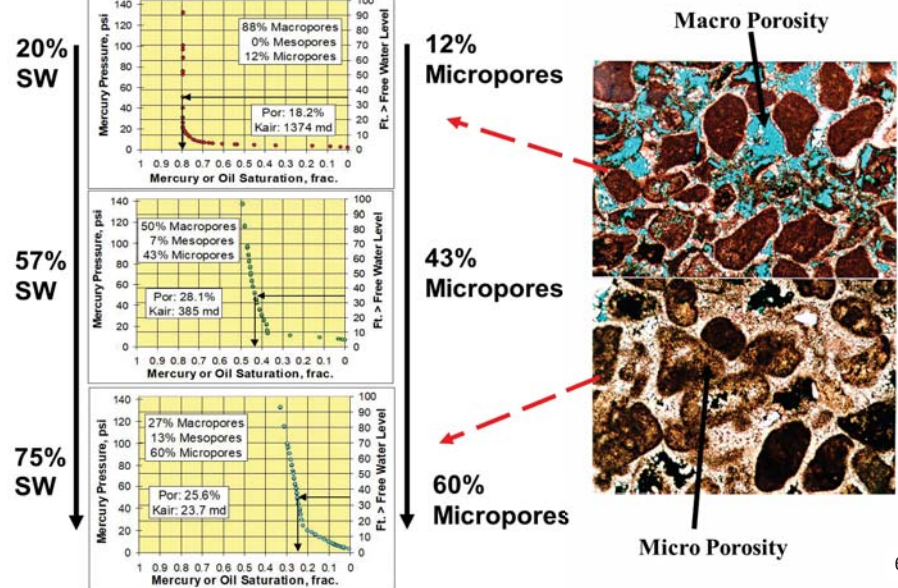
4

The Sandwich



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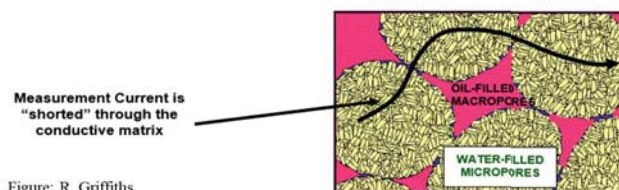
2 Microporosity



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Microporosity

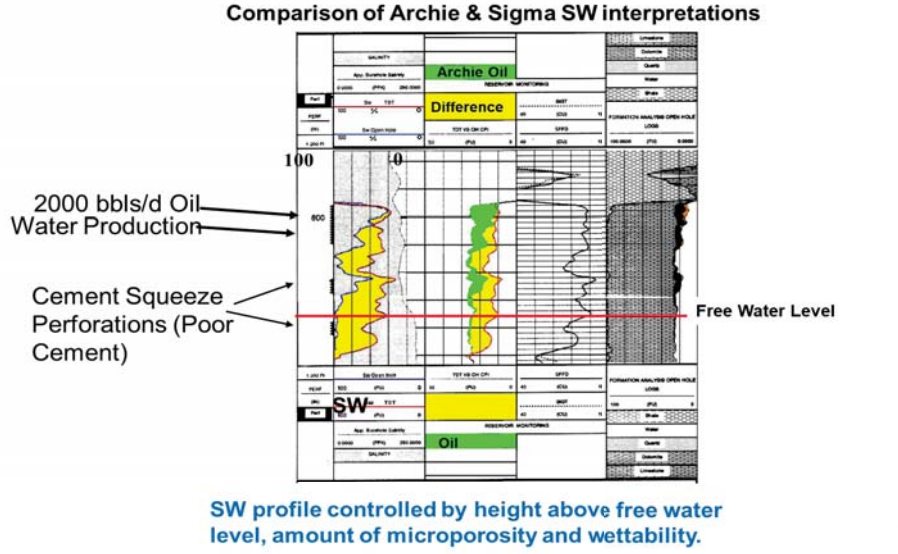
Wells	Water Saturation (Archie Equation)		Core	Formation Test Tool		Production Test Results
	M=2	M=1.7		Pressure Gradient	Sampling	
Well01	100%	80%	Oil Shows	0.267 psi/ft	None	4810 BOPD, 0% Water
Well02	97%	70%	No Core	Oil Gradient	None	No Test
Well03	100%	78%	Oil Shows	0.38 psi/ft	None	No Test
Well04	100%	-	No Core	0.33 psi/ft	None	1906 BOPD, 45.6° API, GOR 386, No Water
Well05	100%	78%	Oil Shows	0.45 psi/ft	Oil No Water	5450 BOPD, 39° API, GOR 125, No Water



Existence of Microporosity Can Result in Missed Oil Unless an Integrated Program is Employed.

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Microporosity



SW profile controlled by height above free water level, amount of microporosity and wettability.

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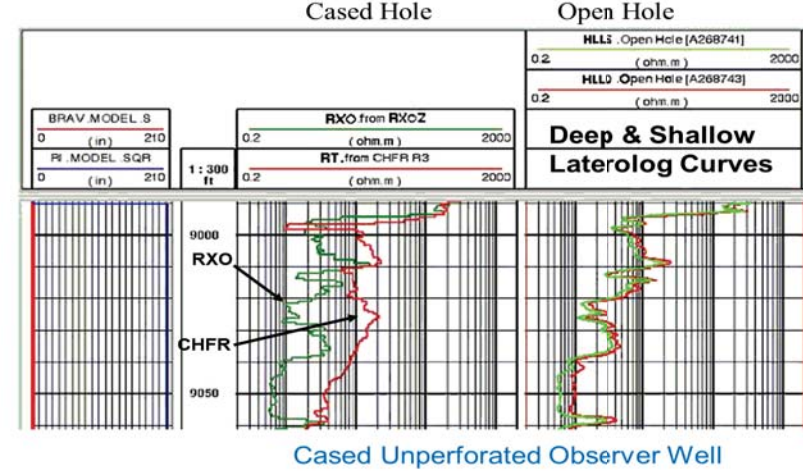
3 Fractures



Laterologs react to fractures by displaying a resistivity decline.

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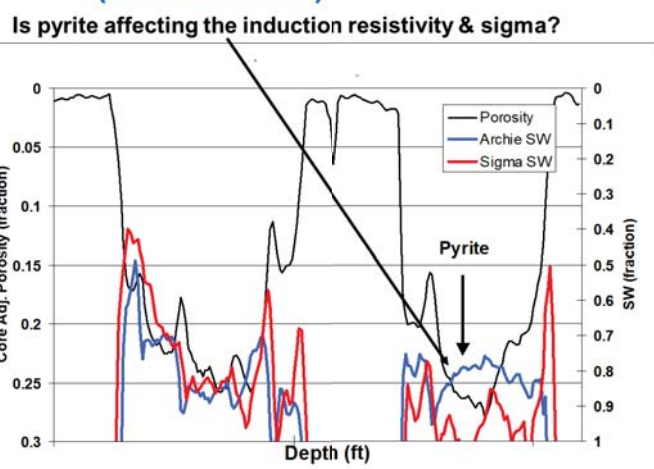
4 Deep Invasion



Ibrahim, M.K., Ferraris, P., and Dawoud, A., 2002. Integrated saturation monitoring with cased hole formation resistivity and reservoir saturation tools. poster 222, 5th Middle East Geoscience Conference and Exhibition, April 15-17th, Manama, Bahrain. Poster is an update to 2001 SPE paper 71716.

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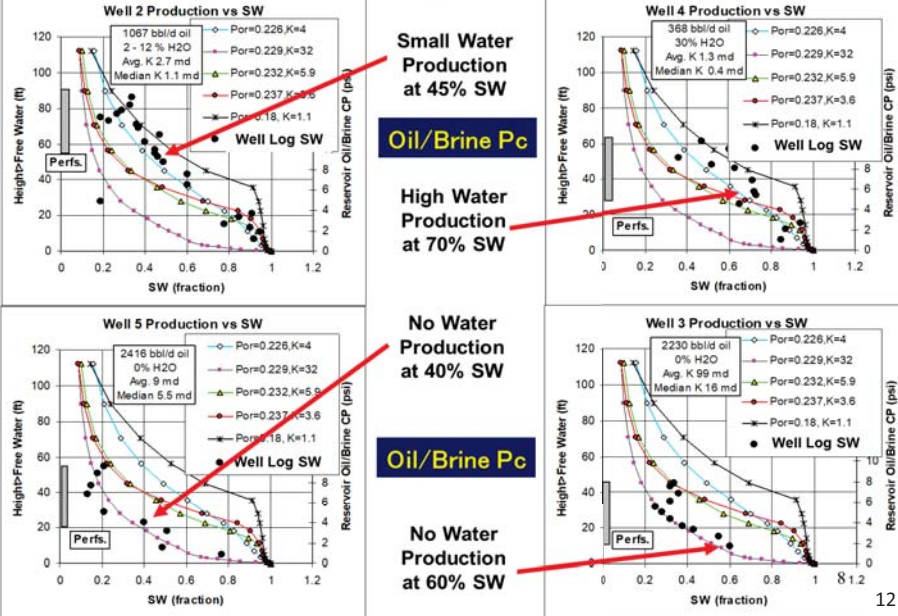
5 Conductive Minerals (not common)



It is possible to recognize pyrite using a high resolution Pe curve.

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Knowledge of SW is Not Enough to Predict Oil / Water Production



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