Petroleum & Coal
ISSN 1337-7027

Available online at www.vurup.sk/petroleum-coal
Petroleum & Coal 57(5) 466-469, 2015

ELECTRICAL ROCK PROPERTIES DETERMINATION USING WELL LOG ANALYSIS

Khulud Rahuma, Ahmed Sedeg, Yosef Salah

University of Tripoli, Libya

Received February 27, 2015; Accepted September 4, 2015

Abstract

Vertical distribution of fluid saturation is very necessary in determination of volumetric volume of oil originally in place. Therefore it is necessary to find a method for determining saturation distribution with depth. Capillary pressure method as well as the well log method are both utilized for vertical water saturation calculations. The main objective of this study is investigation of best values of cementation factor, and saturation exponent for three wells. Vertical saturation curve were constructed from well log data and values of cementation factor and saturation exponent were obtained using Pickett plot.

Key words: saturation; cementation factor; well log; core; analysis.

1. Introduction

Capillary forces in a petroleum reservoir are results of the combined effect of surface and interfacial tensions of the rock, fluids, pore size, geometry, and wetting characteristics of the system [1,4]. Any curved surface between two immiscible fluids has the tendency to contract into the smallest possible area per unit volume. This is true whether the fluids are oil and water, water and gas (even air), or oil and gas. When two immiscible fluids are in contact, a discon-tinuity in pressure exists between the two fluids, which depend upon the curvature of the interface separating the fluids. this pressure difference known as the capillary pressure and it is referred to capillary pressure. The tendency of one fluid to spread on or adhere to a solid surface in the presence of other immiscible fluids called wettability. The tendency of a liquid to spread over the surface of a solid is an indication of the wetting characteristics of the liquid for the solid and can be expressed more conveniently by measuring the angle of contact at the liquid-solid surface. The forces acting on the interface of liquid and gas known as surface tension, while the forces acting on the interface between two liquids are called interfacial tension.

The most common equations that used to calculate water saturation are Archie, Simandoux, Schlumberger 1972 laminated, Bussian, and Indonesia. The parameters include capillary pressure, pore throat aperture radii, height above the free water table and bulk volume of water used in Picket plot to obtain values of petrophysical exponents (m, n and a) which were used to calculate the accurate value of water saturation in both clean and shaly rocks and then adjust estimation of hydrocarbon saturation [2]. The integration of these petrophysical parameters on a log–log graph of porosity versus resistivity gives the importance for Pickett plot to be used in reservoir interpretation. One of most important physical rock properties that used to calculate water saturation is rock resistivity that can be defined as the electrical resistance of a cube of material [5].

Rock resistivity can be measured by several methods, the first one; is laboratory measu-rement that require a knowledge of the dimension of the rock, the fluid saturation of the rock, the resistivity of the water contained in the rock, and a suitable resistivity cell in which to test the sample and the second one; from well logging tools measurements such as Dual Laterolog - R_{xo} Log.

2. Methodology and analysis

Resistivity - porosity relationships were derived from well logs, and Pickett method was applied.

2. 1 General Procedure to Analysis "Log Data" for each Well

- Plotting the values of the depth versus the resistivity log on semi log paper (ILD), then plotting the values of the depth versus the gamma ray log on linear paper [3].
- Calculate the shale volume (V_{sh}) from plotting of GR-log versus complete depth, using equation:

$$V_{sh} = \frac{GR_{log} - GR_{min}}{GR_{max} - GR_{min}}$$

- porosity was calculated using neutron log for the water zone using followed equation:

$$\phi_N = \frac{\phi_{n.log} - \phi_{n.m}}{\phi_{n.f} - \phi_{n.m}}$$

In shale rocks, porosity determined by:

$$\phi_N = \frac{\phi_{n.log} - \phi_{n.m}}{\phi_{n.f} - \phi_{n.m}} - V_{sh} \times \left(\frac{\phi_{n.sh} - \phi_{n.m}}{\phi_{n.f} - \phi_{n.m}} \right)$$

- Determination of density porosity (ϕ - density) at water zone depth:

$$\phi_D = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_f}$$

- Density porosity need to be corrected due to shale effect using the following equation:

$$\phi = \phi_D \times (1 - Vsh)^2$$

3. Results and discussion

From our study the values of (a) coefficient, (m) factor, and (n) exponent are close for three wells. From figures results show cementation factor is between 1.2 and 1.51 but the most frequency of these values is equal to 1.37 in average. Coefficient factor is in the range from 0.5 to 0.98 where most frequency of these values equal to 0.71 in average , and saturation exponent is between 1.36 to 1.69, where most frequency of these values is equal to 1.51 in average. The values of (a), (m) and (n) are listed in the following table.

Table1 Results of wells properties

Well	Average Porosity (Ø)	Coefficient factor (a)	Cementation factor (m)	Saturation exponent (n)	Resistivity of clay (Rcl) Ohm-m
1	0.18	0.625	1.51	1.36	1.32
2	0.192	0.5	1.42	1.69	1.17
3	0.175	0.98	1.2	1.47	1.14

Plotting the resistivity versus porosity on log-log scale for each well shown in figures from 1 to 6 respectively.

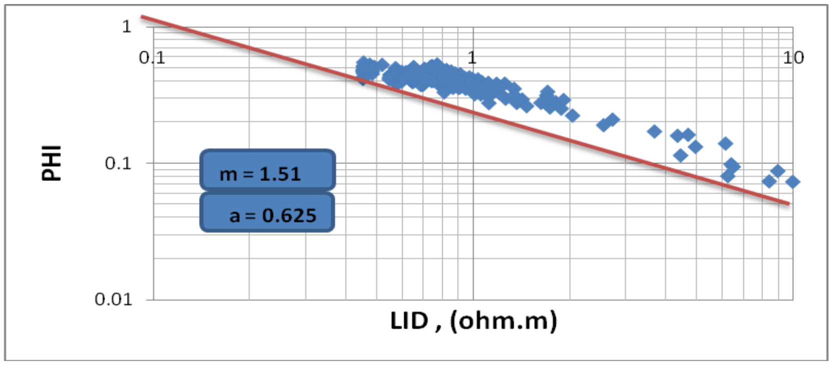

Figure 1 Well 1 Resistivity versus Porosity

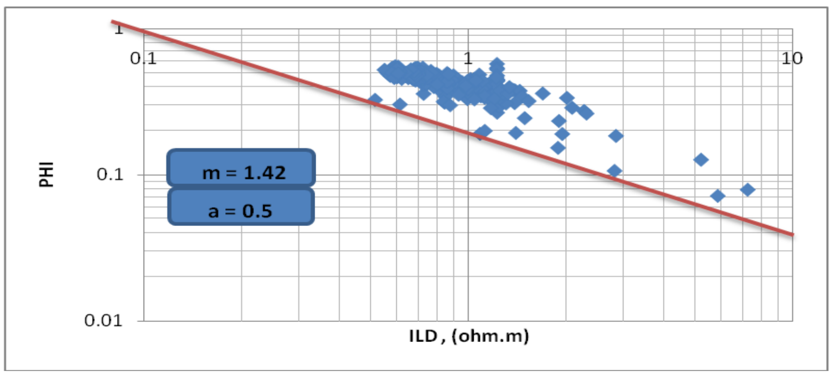

Figure 2 Well 2 Resistivity versus Porosity

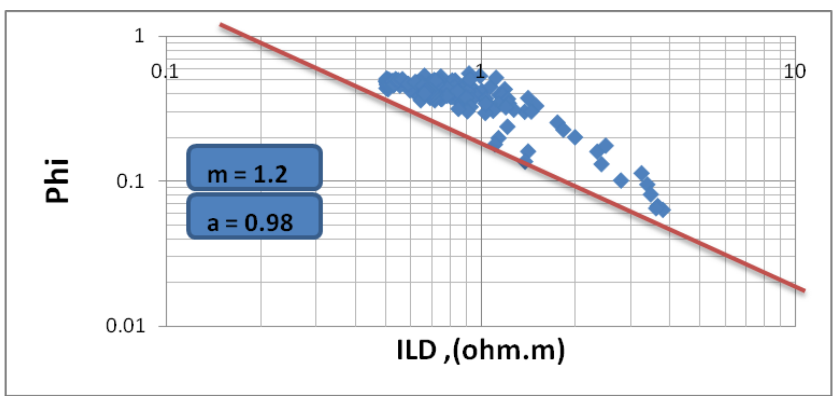

Figure 3 Well 3 Resistivity versus Porosity

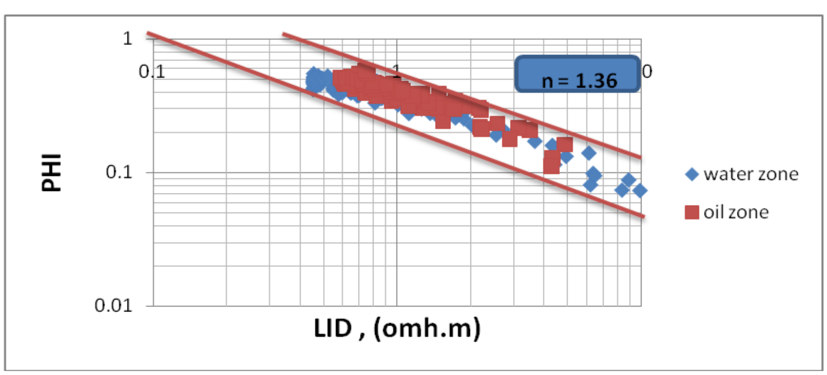

Figure 4 Well 1 Resistivity versus Porosity

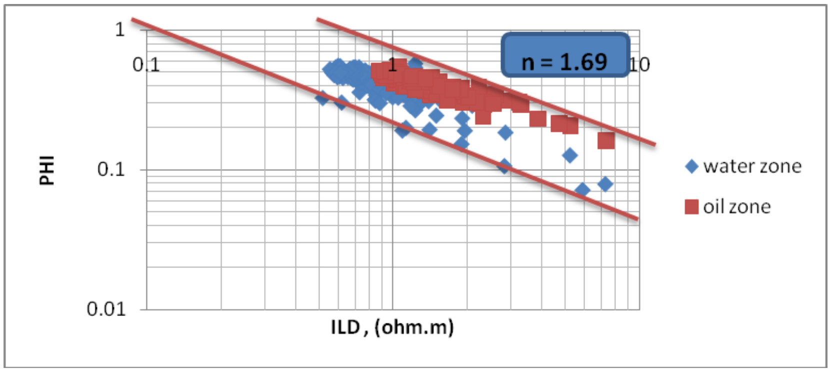

Figure 5 Well 2 Resistivity versus Porosity

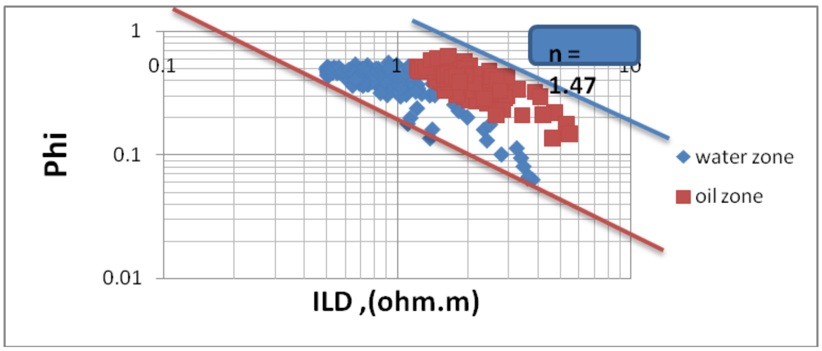

Figure 6 Well 3 Resistivity versus Porosity

4. Conclusions

The values of coefficient, cementation factors, and saturation exponent are function of the material and environment depositions. Data collected from logs always affected by the invaded fluid (mud filtrate), and solids such as clay particles and additives. Petrophysical properties depend on lithology, depth, and formation age. The average values obtained are 0.71, 1.37, and 1.51 for coefficient factor, cementation factor, and saturation exponent respectively.

References

[1] Helander DP, Fundamental of formation evaluation. Oil & Gas Consultants Intl.; 1983.
[2] Amyx JW, Bass DM Jr., Whiting RL. Petroleum Reservoir Engineering Physical Properties, McGraw-Hill Book Company, Inc.; 1960.
[3] Schlumberger. Applied open hole log interpretation. 1982.
[4] Cole F. Reservoir Engineer Manual Houston, TX: Gulf Publishing Co.;1969.
[5] Pickett GR. Pattern recognition as a means of formation evaluation, in: Society of Professional Well Log Analysts 14th Annual Logging Symposium Transactions Paper A, 1973.