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تأثير الضغط المحصور على المقاومية التكوينية

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Influence of confined pressure on formative resistivity

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الملخص:

.تبحث هذه الدراسة في كيفية تأثير الضغط المحصور على مقاومة التكوين. ويتم تحديدها عن طريق المعادلة او عن طريق التجارب المعملية .أُجريت بعض هذه الاختبارات في حوض سرت بليبيا.مختبرات معهد البترول الليبي (LPI طرابلس – ليبيا)؛ ساعدت العديد من التجارب التجريبية في تقييم تأثير الضغط المحصور على المقامية للطبقة . باستخدام عينات لُبِّية مختارة من ثلاثة حقول نفطية مختلفة.وإيجاد المعادلات باستخدام الرسم لتبيان تاثير الضغط على مقاوميه الطبقة لتحديد كيفية تأثير ضغط الحبيبات المحصورة على مقاومة التكوين.

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الكلمات المفتاحية: مقاومية الطبقة ،معادلة ارشي .

Abstract:

This study examines how confined pressure affects formation resistivity.

Generally discovered experimentally or using the factor . Forming resistivity factor

approach based on experience, using core samples chosen from three different oil fields.Some of these tests took place in the Sirte Basin of Libya.

Laboratories of the Libyan Petroleum Institute (LPI Tripoli-Libya); many empirical

Correlation helped to evaluate how restricted pressure impacted creativity.

Resistor factor The best correlation coefficients are found using the best fit curve to ascertain how confined grain pressure influences formation resistivity factor. (Times New

Keywords: resisitvity ,pressure confined , Archie equation **.**

2-intorduction

The effective porosity with the salinity of formation water, and quantity of hydrocarbons trapped in the pore space (pirson, 1963) define the resistivity of reservoir rocks; relations among these parameters show that resistivity falls with increasing petroleum content. Moreover, measurements of resistance are helpful.

formation stress, rock composition, interstitial dependent, pore geometry Resistance therefore is a practical tool for judging the temperature and fluids; Archie described the formation resistivity factor Fr as (Archie, 1942).

$F_r = \frac{R_o}{R_w}$, where R_o is the formation resistivity which is totally saturated with water , R_w is the water resistivity. R_o will be more than oneness. The wettability significantly affected the fluid flow inside the rock space (Keller, 1953), by altering the

relative location of The electric behavior of sandstone would likewise vary depending on the conducting fluid with respect to the rock surface.

the formation resistivity variable,

$F_r = a\, Ø^{-m}$ (1.1)

Theoretical origin is found in some recent literature and manuals about well logging interpretation and core data analysis. Most published derivations begin with the basic definition of formation resistivity factor.

$F_r = R_o / R_w$ (1.2)

Ro is the formation resistivity of the 100% saturated material with a conductive fluid (water); Rw is the conductive fluid resistivity.

Every derivation calls for a simplified model of the porous media using geometric forms of pore, pore throat, and bulk volume that they are easily explained. Regarding the conduction of ions over the model in terms of length and cross-sectional area.

A typical derivation comparable to [Amyx et al ,1960] is shown here; thus, resistivity (R) of several substances is calculated.

$$R = \frac{rA}{L} \quad (1.3)$$

Where r = the material resistance.

A = the cross sectional area which is perpendicular to ionic flow.

L = Length of the ionic flow path.

By using a cube of salt water, the resistance of the cube could be described as

$r_w = R_w\, L/A$ (1.4)

Where L and A represent the dimensions of the cube of water. While a cube of porous media of the same dimension of the cube of water would have a lesser volume available for water. The matrix is regarded to be an insulator as such the portion of the cube that can conduct ionic flow is only the pore space.

Thus, an apparent cross sectional area (Aa) and apparent flow path (La) are used.

The cube's resistance is

$r_2 = R_w L_a/Aa$ (1.5)

By defining, the resistivity of the cube of core saturated with water is

$R_o = r_2 A/L$ (1.6)

Substituting of the last two equations yields the following:

$R_o = R_w L_a A/AaL$ (1.7)

By using this definition of R_o in the F_r equation gives:

$$F_r = \frac{L_a / L}{Aa / A} \quad (1.8)$$

What is the ratio of the apparent flow path to the cube's length compared with the ratio of the projected cross-sectional area to the cube's cross sectional area? Given the letter (a) the tortuosity factor, the ratio of the lengths is proportional to the tortuosity (a). Based on this definition, the product of the porosity of the porous medium (ØA) and the real area is presumed to be equal to the apparent cross sectional area.

$F_r = a/Ø$ (1.9)

Porosity has no power where (m) can be seen as one.

2.2 formation resistivity factor Fr and porosity:

The porosity in clean sedimentary rocks conduct electricity by the salinity of water retained in their voids which makes it as one of the most important factors regulating electric current flow
One would naturally expect the present conductance to be no more than that indicated by the fractional porosity, for instance as a preliminary estimate. Assuming a formation with 80% oil saturation and 20% connate water saturation would be expected to transfer no more than 20% of the current that would if the same amount of mass carried as the water [Calhoun, 1960]

$$F_r = \frac{1}{Ø} \quad (1.10)$$

• Well surving companies indicated the connection between

(Fr) and porosity as: [Shlumberege, 1994]

$$F_r = \frac{0.81}{Ø^2} \quad (1.11)$$

- Based on superior sandstone specimens [Zaafran et al. 1960], found the forming resistivity coefficient would probably correlate to porosity and proposed this equation.

$$F_r = \frac{1.48}{Ø^{1.66}} \quad (1.12)$$

From Atkins, ER findings of laboratory experiments. Et al. [1961] finds that Archie equation has a form factor or porosity exponent Determined by the particle shape in the construction, this characteristic is influenced only by it. Overburden pressure, solution Individual grain overgrowth and cementing.

Commonly they describe their equation as:

there general equation is written as :

$$F_r = \frac{a}{Ø^m} \quad (1.13)$$

For the specified structure, it might be beneficial to a particular composition just when the values of a, m have been determined. They also pointed out that monographs might be used to get porosity after formation resistivity factor is found. The sort of clay identifies or may be expected the form of sand, clay content, and particle form of clay; well logging tools let one assess the relationship between formation resistivity factor and porosity.

• [Perez Rosales, C. et al., 2002] offered a new definition for the fracture porous media's formation resistivity factor. They tried to fit the exploratory results to an Archie type equation. They established that finding a good fit is impossible. Based on physical thinking, they developed a fresh paradigm using which they derive d the next formula:

$$\mathbf{F_r} = \frac{1}{1 - (1-Ø)^{0.78}} \quad \mathbf{(1.14)}$$

• [Hamada. G. M. et al., 1996]. Concluding two methods—conventional and 3-D—by supposition fixed values, the water saturation exponent has quite big influence on estimation of water saturation. Use the form factor and tortuosity factor to adjust the water saturation exponent.

Many factors, including wettability and clay, which enhance oil wetness, will also overemphasize the saturation exponent. Where for on wettability the water saturation exponent depends on the dispersion of the conducting phase in the core sample.

• [Tabibi and Emadi, 2003] found that the cementation factor impacts pore space and so also the estimated water saturation. (water volume into pores divided by entire pore volume).

Objective of the paper

To investigate the influence of confined pressure on formation resistivity factor.

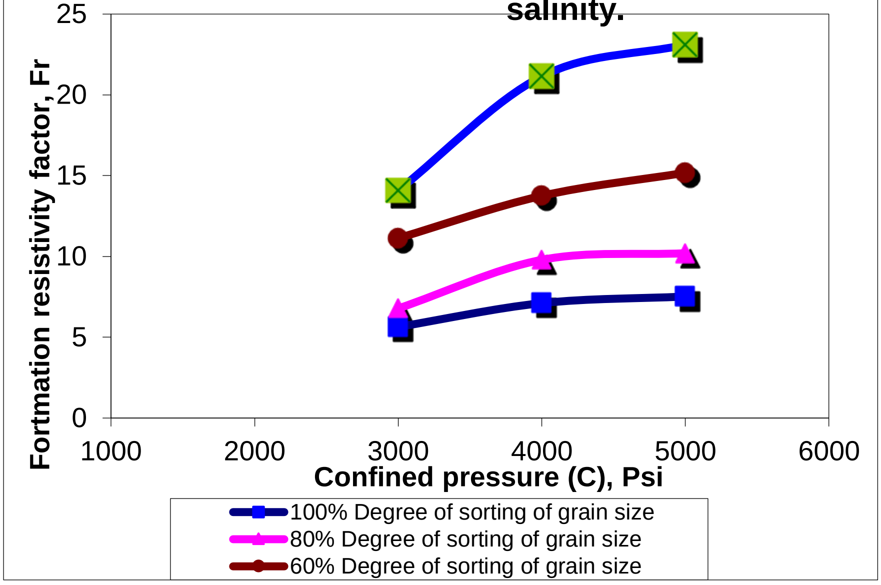
Experimental Measurements:

12 sandstone core samples were chosen from three oil fields in Sirte Basin, Libya, and laboratory measuring techniques were utilized. Some of these tests were done in labs in (LPI Tripoli – Libya). Porosities ranging from 0.19 % to 0.30 % were found in the chosen samples. Degree of sorting 100%, 80%, 60%, 40% was found.
[NaCl 0.3%) Fr between 6.51-3.15]; NaCl 1%) Fr between 13.06-5.80;
[NaCl 5%; Fr between 18.55 and 5.64]

Results and discussion

- From Fig.(1.1) to Fig.(1.3), the influence of the confined pressure on the formation resistivity coefficient for constant degree of grain sorting and salinity of water is shown.

Figure (1.1) Effect of compaction on the formation resistivity factor at 5 % NaCl salinity.



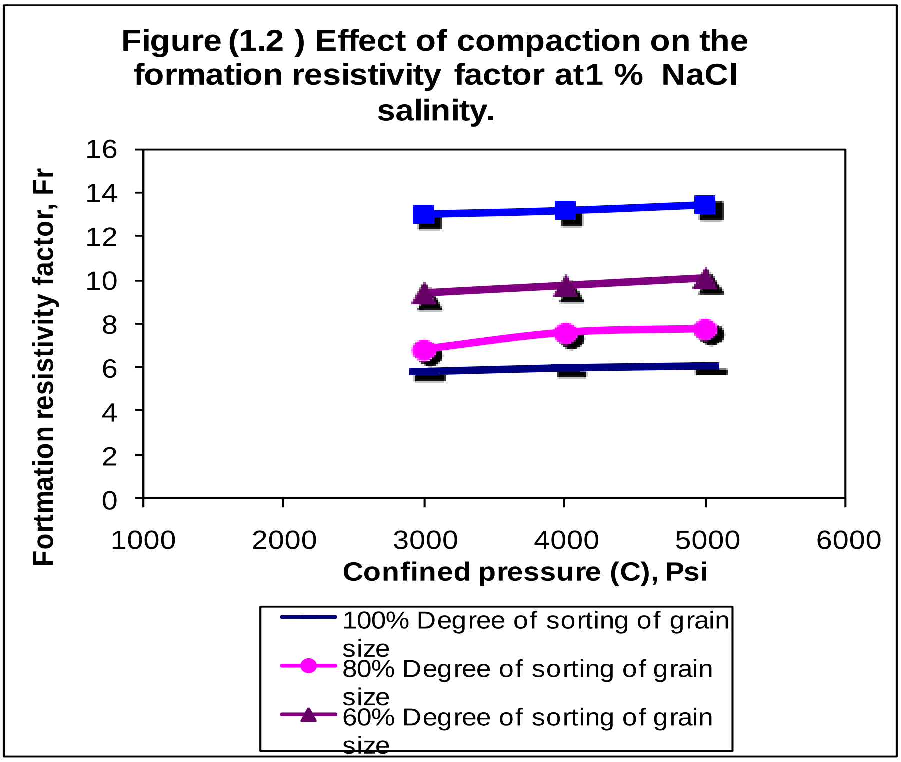


Figure (1.2) Effect of compaction on the formation resistivity factor at1 % NaCl salinity.
Formation resistivity factor, Fr
16
14
12
10
8
6
4
2
0
1000
2000
3000
4000
5000
6000
Confined pressure (C), Psi
100% Degree of sorting of grain size
80% Degree of sorting of grain size
60% Degree of sorting of grain size

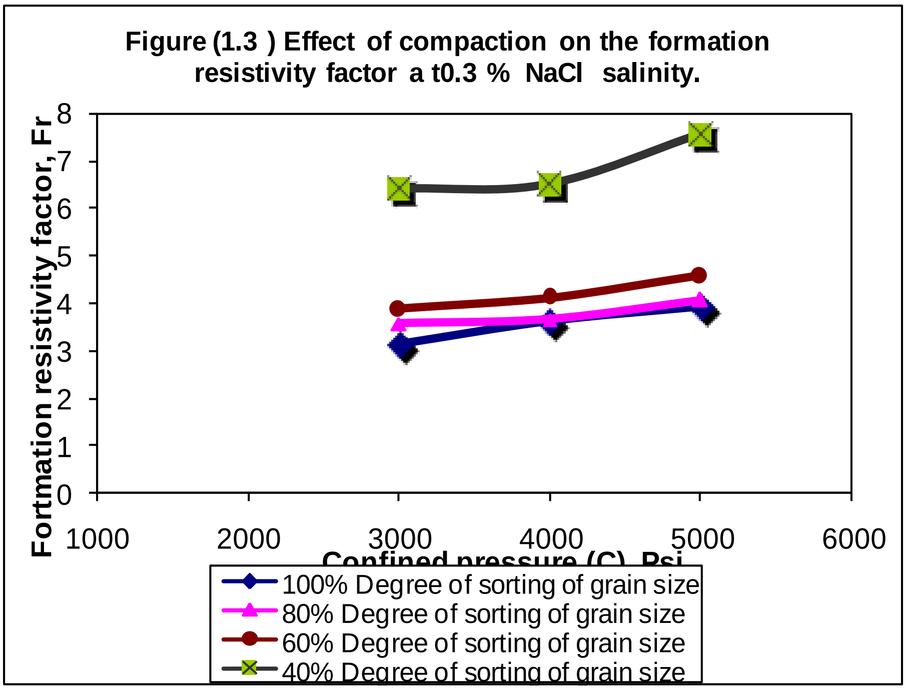


Figure (1.3) Effect of compaction on the formation resistivity factor a t0.3 % NaCl salinity.
Formation resistivity factor, Fr
8
7
6
5
4
3
2
1
0
1000
2000
3000
4000
5000
6000
100% Degree of sorting of grain size
80% Degree of sorting of grain size
60% Degree of sorting of grain size
40% Degree of sorting of grain size

These data demonstrate that for the same amount of grain sorting, the formation resistivity factor grows by raising the confined pressure. A decrease in the electric current path caused by an increase in the confined pressure which produces a rise in The formation resistance factor accordingly rises. Both the extent of sorting
and the salt concentration of the water affect the pace of rise of the resistivety factor. With great salinity and great degree of sorting more than at low values of these two indicators, the formation resistivity factor increases rate increases. The grain sorting degree influence, fig. (1.4) through fig. (1.6) projected the observed correlations using log-log plots; the effect of limited pressure on the production resistivity factor.

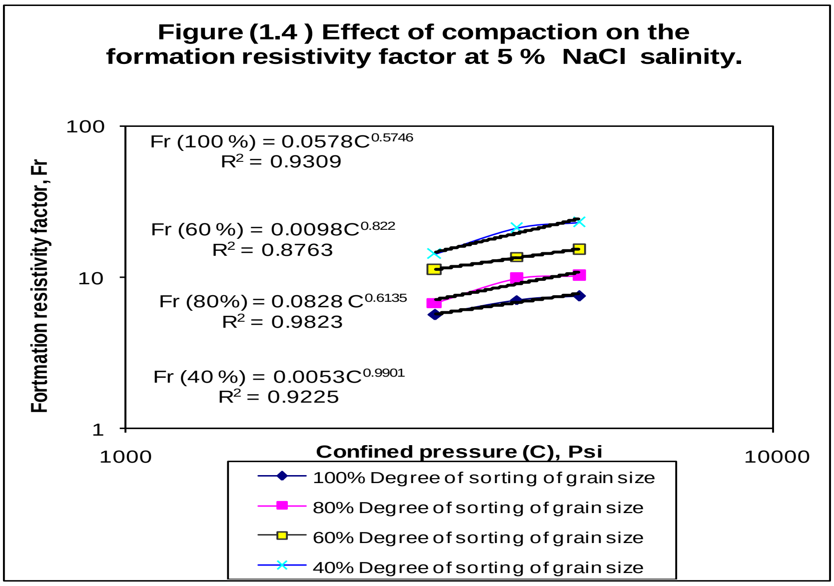


Figure (1.4) Effect of compaction on the formation resistivity factor at 5 % NaCl salinity.

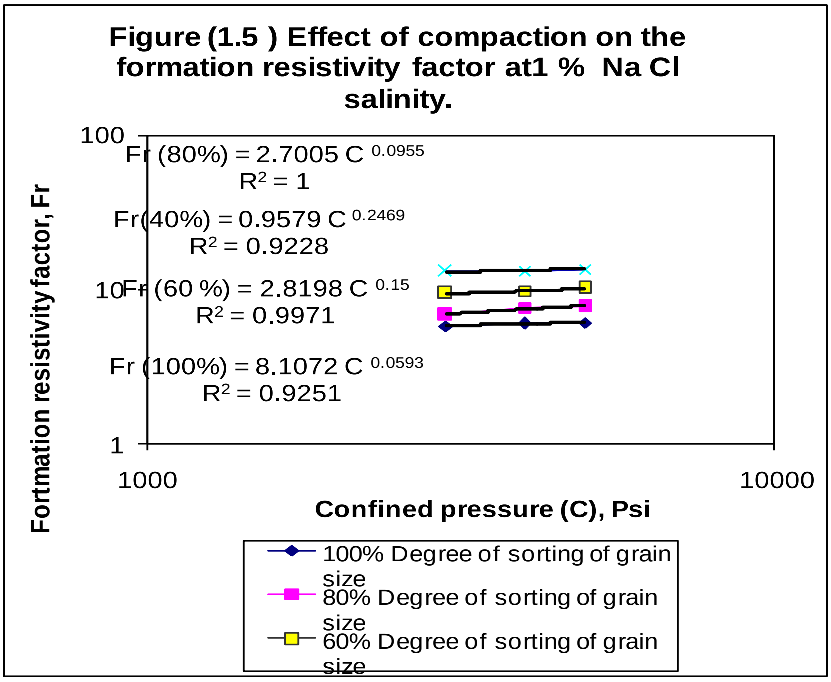


Figure (1.5) Effect of compaction on the formation resistivity factor at1 % Na Cl salinity.

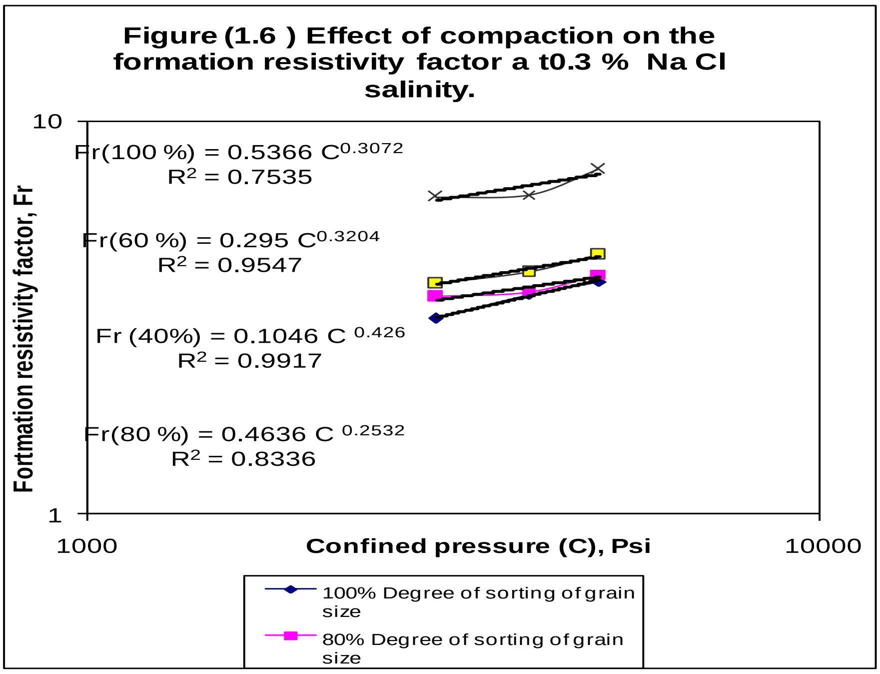


Figure (1.6) Effect of compaction on the formation resistivity factor a t0.3 % Na Cl salinity.
10
1
Fr(100 %) = 0.5366 C0.3072
R2 = 0.7535
Fr(60 %) = 0.295 C0.3204
R2 = 0.9547
Fr (40%) = 0.1046 C 0.426
R2 = 0.9917
Fr(80 %) = 0.4636 C 0.2532
R2 = 0.8336
Formation resistivity factor, Fr
1000
Confined pressure (C), Psi
10000
100% Degree of sorting of grain size
80% Degree of sorting of grain size

These correlations are given as shown in table (1.1) for different values of salinities as follows:-

Table (1.1). effect of confined pressure on formation resistivity factor.

Brine, salinity	Degree of Sorting Of gain size (G)	Correlations
5% NaCl	100%. 80% 60% 40%	$F_r=0.0578C^{0.5746}$ (1.1) $F_r=0.0828C^{0.6135}$ (1.2) $F_r=0.0098C^{0.822}$ (1.3) $F_r=0.0053C^{0.9901}$ (1.4)
1% NaCl	100%. 80% 60% 40%	$F_r=8.1072C^{0.0593}$ (1.5) $F_r=2.7005C^{0.0955}$ (1.6) $F_r=2.8198C^{0.15}$ (1.7) $F_r=0.9579C^{0.2469}$ (1.8)
0.3% NaCl	100%. 80% 60% 40%	$F_r=0.5366C^{0.3072}$ (1.9) $F_r=0.4636C^{0.2532}$ (1.10) $F_r=0.295C^{0.3204}$ (1.11) $F_r=0.1046C^{0.426}$ (1.12)

A general relationship between the formation resistivity factor and the confined pressure considering the influence of both formation water salinity and Degree of sorting is also offered as:
$F_r = a\ C^b$

salinity of forming water. Following two figures drawn using the correlations of table (1.1), these two constants may be discovered. Bearing in mind the level of sorting and water salinity, where (a) and (b) are constants depends on the extent of sorting (G) and the formation resistivity factor (Fr) as a function of contained pressure follow these stages:
- Calculate values of constants (a) and (b) using figs. 1.7 and 1.8 given the degree of sorting noted.

- Employing equation $F_r = a\ C^b$ at the formation constrained pressure (C), you can calculate the formation resistivity factor (Fr).

Figure (1.7) effect of Compaction

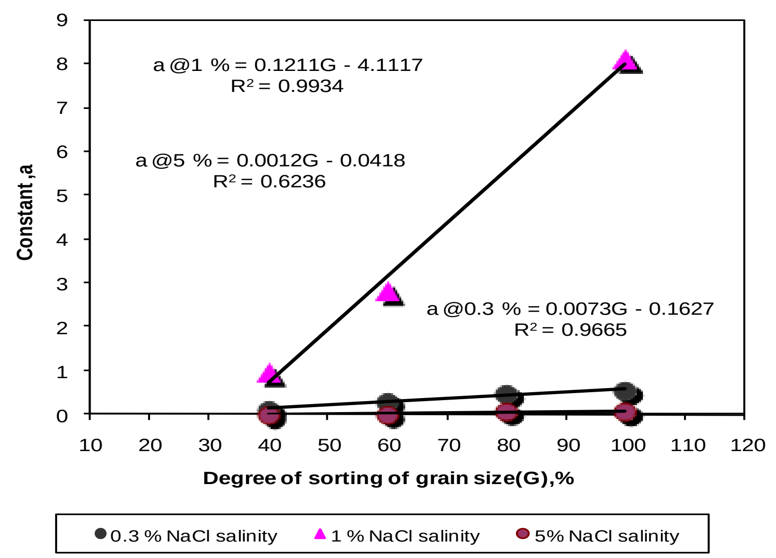
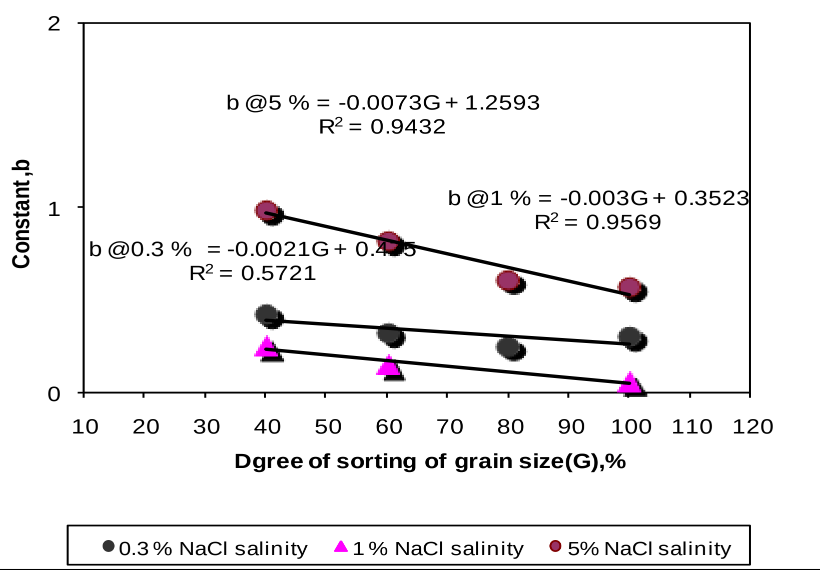


Figure (1.8) effect of Compaction



Conclusion-

The confined pressure increases the formation resistivity factor increases . also an empirical formula was predicted as $Fr=aC^b$, where a and b are constants depend on each of degree of sorting and salinities .

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