Iraqi National Journal of Earth Science

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The Geological Approach to Predict the Abnormal Pore Pressures in Abu Amoud Oil Field, Southern Iraq

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Article information

Received: 09- -June -2023

Revised: 18- Aug -2023

Accepted: 06- Sep -2023

Available online: 31- Dec – 2023

Keywords:
pore pressure
abnormal
formation
prediction
hydrostatic pressure

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ABSTRACT

Anticipating pore pressures are essential for the operation of drilling success for oil and gas wells in particular that may anticipate encounter abnormal pressure, i.e. higher than normal pressure. Drilling problems such as blow out or kick due to not considering the abnormal pressure where the formation pressure become greater than hydrostatic pressure, and vice versa in the case of differential pipe sticking because of sub normal pressure. Thus, drilling cost can be significantly reduced by early recognition the abnormal high pore pressures. The normal range for pressures attain to 0.433 and 0.50 psi/ft. The usual muds density is about 9 ppg. (pounds per gallon) which exerts a bottom hole pressure of about 0.47 psi/ft. Meanwhile, a well is in the process of being drilled, there are several parameters that indicate the presence of abnormal pressure, such as a sudden increase in penetration rate (ROP), a sudden increase in the temperature of the drilling mud, and a decrease in the density of the shale fragment. The producing wells which are used in this study are (AAm-5, AAm-4, AAm-3, AAm-2, and AAm-1.) There are many methods for predicting the abnormal pore pressures. The current study focuses on three methods, which are used: the ratio (d- exponent) method; acoustic probes method; and the shale density method. This study is conducted in Abu Amoud oil field located in the northwestern part of DhiQar Governorate. This oil field includes five oil wells, each well production is from four units. More than one method was used to find intervals of abnormal pressure for the Zubair Formation, Nahr Omar and other formations. Stratigraphic and lithological colum of the study area had the greatest influence on the pressure values. The results show that the ratio (d-exponent) method is considered as the best method for indication of the abnormal pressure intervals. The abnormal pressure intervals are (2875-4022) m. Up to this end, this study can mitigate so many problems while drilling new wells at selected formations within Abu Amoud oil field.

DOI: 10.33899/earth.2023.140601.1088, ©Authors, 2023, College of Science, University of Mosul.

نهج جيولوجي للتنبؤ بضغوط المسام غير الطبيعية في حقل أبو عامود النفطي جنوب العراق

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معلومات الارشفة

تاريخ الاستلام: 09- يونيو -2023

تاريخ المراجعة: 18- أغسطس -2023

تاريخ القبول: 06- سبتمبر -2023

تاريخ النشر الالكتروني: 31- ديسمبر -2023

الكلمات المفتاحية:

ضغط المسام

غير طبيعي

تشكيل

تنبؤ

ضغط هيدروستاتيكي

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الملخص

يعد توقع ضغوط المسام أمرًا ضروريًا في نجاح عمليات الحفر لآبار النفط والغاز على وجه الخصوص التي قد تواجه ضغطًا غير طبيعي، أي أعلى من الضغط الطبيعي. يمكن تقليل مشاكل الحفر مثل الاندلاع بسبب عدم اخذ الضغط فوق الطبيعي بنظر الاعتبار حيث سيكون ضغط التكوين اكبر من الضغط الهيدروستاتيكي، والعكس صحيح. في حالة استعصاء الانابيب التفاضلي بسبب الضغط تحت الطبيعي، وبالتالي تكاليف الحفر، بشكل كبير سوف تقل عن طريق التحديد المبكر لضغوط المسام العالية بشكل غير طبيعي. النطاق الطبيعي للضغوط يكمن في 0.43 و 0.50 رطلاً لكل بوصة مربعة/قدم. كثافة الطين المعتادة حوالي 9 (رطل لكل غالون) والتي تماثل ضغط اسفل قاع البئر البالغ حوالي 0.47 رطلاً لكل بوصة مربعة/قدم. عندما يكون البئر في طور الحفر، هناك العديد من العوامل التي تشير إلى وجود ضغط غير طبيعي، مثل الزيادة المفاجئة في معدل الاختراق، وزيادة مفاجئة في درجة حرارة طين الحفر، وانخفاض في كثافة شظية الصخر. الآبار المنتجة التي تمت دراستها من هذا الحقل هي خمسة ابار. هناك العديد من الطرق للتنبؤ بضغوط المسام غير الطبيعية. في هذا البحث تم استخدام ثلاث طرق وهي طريقة النسبة، والطريقة المعتمدة على المجسات الصوتية، وطريقة الكثافة الصخرية. أجريت هذه الدراسة في حقل أبو عامود النفطي، وهو أحد حقول الواقعة في الجزء الشمالي الغربي من محافظة ذي قار. يحتوي الحقل على 4 وحدات، واستخدمت أكثر من طريقة لإيجاد فترات ضغط غير طبيعي لتكوين الزبير ونهر عمر والتكوينات الأخرى. كان العمود الصخاري لمنطقة الدراسة التأثير الأكبر على قيم الضغط. أظهرت النتائج أن طريقة النسبة (الأس د) تعتبر أفضل طريقة للكشف عن فترات الضغط غير الطبيعية. فترات الضغط غير الطبيعي كانت (2875-4022) م. أخيرًا، يمكن لهذا العمل أن يخفف العديد من المشاكل أثناء حفر آبار جديدة في تشكيلات مختارة لحقل أبو عامود النفطي.

DOI: 10.33899/earth.2023.140601.1088,

Introduction

Abnormal high pressure is defined as those pressures that exceed the hydrostatic pressure and are present usually in sediments. Also, there is an abnormal pressure rise in non-porous and impermeable rock units with closed pores. No Pores is one of the indicators of abnormal pressure (Bradely, 1975). The fluid through the subsurface, domains already with permeable rocks; and thus, the two issues that must be taken into consideration are: the nature of the seal rocks or mainly evaporate layers which prevent seepage, and the reason for the pressure buildup. The permeable barrier preventing pressure release may be a common artificial permeability that is evaporate rock and boulders are among the least limestone, and structural permeable barriers may be provided by faults (Selley, 1998).

In general, salt strata are the main cause of formation approaching the entire overburden layer thicknesses. Evaporates is unique strata if compared to shale; it is impermeable, while shale is semi-permeable. Abnormal pressures are, for applied determinations, pore pressures that are adequately larger than the normal hydrostatic to have an obvious consequence when drilling, and to necessitate special precautions (Al-Baldawi1, 2021). Generally, there are three types of pressures that are dealt with during drilling operations: the hydrostatic pressure, which is caused by the weight of the fluid column used, and the overburden pressure, caused by the joint height of (Idan et al., 2020). The last type of pressure is the pore pressure of the fluid within the pore volume of the rock layer. The gradient represents 0.465 pounds per square node of the normal layer pressure gradient and any deviation from this gradient is considered an abnormal pressure either above normal or below normal (Al-Fandi and Hadi, 2020). As it is recognized that the hydrostatic pressure must be the same as the pore pressure of the formation at a certain depth, and the value is from (8.33 $lb./gal$) 0.43 psi/ft in the freshwater up to (9 $lb./gal$) 0.47 psi/ft in the saltwater with 200,000 ppm sodium chloride content, it was fixed that in some reports that the normal pore pressure may be greater than (9 $lb./gal$) 0.47 psi/ft. However, the value of the overburden pressure is 1.0 psi/ft with the density of 19.2 lb/gal. Those numbers are used for the general calculations. If the diffraction is in the direction of the higher value, then it is called the abnormal pressure, but if the diffraction is in the direction of the lower value, then it is called the subnormal pressure (Al-Majid, 2021). The abnormal pressures are found in the subsurface or in depths of 20,000 feet. The high supernormal pressures are found in successive shale-sand sections. In general, the normal pressure layers are open hydraulic systems with high permeability and good conductivity for the layer fluid. On the contrary, it is found that the above normal pressure layers are non-porous with obstacles that prevent the contact of the layer fluid called pressure rivets such as shale layers, silt, faults and limestone layers (Beydoun, 1991). There are many factors that cause abnormal pressures, which are related to geological, geochemical, and mechanical variables. In general, the geological structures that allow the transfer of pressure from deep to shallow areas are lenticular reservoirs and severe stratigraphic slope. Transmission of normal pressures from deep areas to shallow depths in the reservoir, also causes the formation of abnormal pressures. Also, rapid sedimentation leads to large deposits and an increase in the load of the superstructure over time, which are abnormal pressures in the rocky layers (James and Wynd, 1965). Tectonic activities such as faults, raptures, fissures, and shale flow may cause a complete blockage of the reservoir rocks by hard, high-density, impermeable rocks. This blockage in turn leads to the formation of abnormal pressures. There are many other reasons that lead to unusual pressures, such as the infiltration phenomenon, that is, the flow of fluids from the low-saline medium to the high-salinity medium, in addition to the compaction of layers due to sedimentation processes. Magara (1978 stated that the high-pressure increase is a result of the agglutination phenomenon caused by the combined actions of the following three factors: lack of permeable layers, fast sedimentation rate and rather fast sedimentation aggregation (Salman and Ahmed, 2017). There are many methods available to predict the abnormal pore pressures such as the seismic information method, which includes three geophysical methods: the gravitational-, magnetic-, and seismic method, and the last one, seismicity, is the most common. There are methods based on basic drilling parameters, such as the exponent-d method (the standard penetration modifier method). In addition to the modified exponent- d method and the sigma log method. Magara (1978) relied on acoustic palpation information to predict unusual pressures, such as the equivalent depth method, which depends on the time of transition through the record in terms of time change (Karim and Al-Aaraji, 2021). Eaton (1976) proposed mathematical equations that could be used to determine reliable values of pressure gradient and fluids in a formation based on well log data including (Acoustic, Resistivity, and Conductivity records). Assi (2022) mentioned that the reflective seismic device measures the time between the earth's surface and the multiple reflective planes located under the surface. The study pointed out that most geophysicists have agreed that the velocity during a certain section and a certain period of time changes fundamentally with depth. Samara and Thamer (2018) presented a method for predicting the abnormal pressures of the layers, which is the most common and most widely used, where the effect of the weight applied to the hoof for each node was studied, taking into account the speed of rotation on the rate of penetration by relying on the Bingham equation. Abnormally high-pressure intervals can be encountered at shallow depths if the rock formations are permeable and contain fluids whose pressures are higher than the normal pressure gradient for the area in which the fluid penetrates. Whereby mud must be used to fit this unusual pressure. Assi and Haiwi (2021) found that measuring the properties of the mud inside and outside the well bore is a preliminary warning sign of changes in gas or chloride. The sudden increase in the yield point or the sudden decrease in the value of slope (n) will indicate the occurrence of self-agglomeration of the drilling mud. The reason for the agglomeration is attributed to the contamination of the drilling mud with layer fluids or to the increase in solids and a sudden rise in temperature (Assi and Almahdawi, 2020). The main objective of this study is to identify the areas of abnormal pressure in Abu Amoud oil field. Forecasting the presence of such pressures can be implemented and placed during planning for the drilling program, this problem always occurs in the drilling of exploratory wells. The study area (Abu Amoud oil field) is located in the southeastern part of Iraq, about 26 km away from Al-Rifai district as shown in Figure (1). Abu Amoud field represents an important part of the oil region of Abu Amoud basin in southern Iraq, which is characterized by its potential global hydrocarbons.

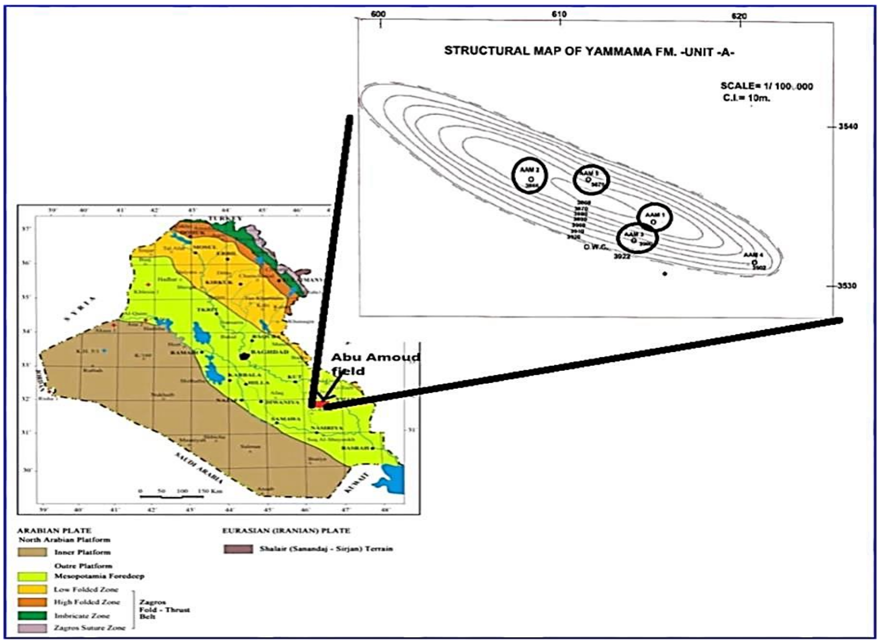


Fig. 1. The location of the studied area (Al-Baldawi1, 2021).

Area of the Study

Abu Amoud oil field covers about 208 km2 and has a structural orientation of northwest to southeast. The area is between longitudes 45.30 to 46.30 degrees, at latitude 31 degrees (Hussain, 2018). Tables (1 and 2) represent the geology and lithological composition of the studied area. Five wells information has been studied and analyzed in this work. Abu Amoud field represents an important part of the oil region of Abu Amoud basin in southern Iraq, which is characterized by its potential high hydrocarbons (Khorshid and Khaleel, 2021). The study area is located in the southeastern part of Iraq, which represents the north and northeastern part of the Arabian plate, and the two continental blocks adjoining it from the north the Turkish block (Bitlis block) and from the east of central Iranian block. The Zubair Formation is one of the main deposits of Abu Amoud oil field, which is bounded from the top by the formation of the Shuaiba and from below is the formation of Al-Ratawi. The geological composition for Zubair unit in Abu-Amoud oil field is a shaly sand. The range of granular limestone rocks (carbonate sand), which forms an important part of the Yamama Formation, is an exploratory target (Sadooni, 1993). Within the deposits of the early Cretaceous period, the presence of oil was proven in this range in the fields of southern Iraq. As for the Mishrif Formation, it is rich in hydrocarbons, as the thickness of the Mishrif Formation increases towards the east, which means that it increases from the Abu Amoud field in Nasiriyah towards the east of the Abu Amoud field in Maysan Governorate. It is also noted that the pattern of the distribution of the faults in Abu Amoud field is of the type of faults that are associated with the convex structures formed as a result of vertical forces. The source of these vertical forces is the combination of the bedrock and the rise of salts (Aqrawi et Al., 2010). The fault systems affecting Mishrif Formation are of the transverse type as shown in Figure (2). When the fault happened in the subsurface make sediments to be cross over each other, and making barriers for the fluid to move because the permeable zones will be conflicting the impermeable zones. That will prevent the fluids in the pours to be expelled out, that will lead to a rise in the value of porosity and the pressure to be abnormal (Mohammed and Hussein, 2021).

Table 1: Lithology including formations depths, ages, thickness, and log depths.

AGE	Formations	logging depth(m)	Subsea depth(m)	Thickness(m)
Early-middle Miocene	Lower Fars	850	830.1	**339**
	Ghar	1189	1169.1	**6**
Middle Oligocene	Bejawan	1195	1175.1	**24**
	Baba	1219	1199.1	**54**
	Tarjil	1273	1253.1	**31**
Early Oligocene	Palani	1304	1284.1	**32**
Late-middle Eocene	Dammam	1336	1316.1	**131**
Paleocene- Early Eocene	Rus/Umm.er-radhuma	1467	1447.1	**161**
Middle cretaceous	A'aliji	1628	1608.1	**348**
	Shiranish	1976	1956.1	**57**
Late cretaceous	Hartha	2033	2013.1	**139**
	Sadi	2172	2152.1	**149**
	Tanuma	2321	2301.1	**52**
	Khasib	2373	2353.1	**585**
	Mishrif	2431.5	2411.6	**293.5**
	Rumaila	2725	2705.1	**56**
	Ahmadi	2781	2761.1	**18**
	Mauddud	2799	2779.1	**246**
	Nahr umr	3045	3025.1	**137.5**
Early cretaceous	Shuaiba	3182.5	3162.6	**111.5**
	Zubair	3294	3274.1	**409**
	Ratawi	3703	3683.1	**132**

	Yamamma	3835	3815.1	**283**
Late Jurassic	Sulaiy	4118	4098.1	**257**
	Gotnia	4375	4355.1	**261**
	Najma	4636	4616.1	**261**

Table 2: The lithology of Abo Amoud oil field (Assi, 2022)

Formation name	**Top of vertical depth(m)**	**Formation Lithology**
Dammam	1335	Dolomite: buff - light. grey at top, buff-beige, porous, vuggy; fractured Limestone
Rus	1460	Anhydrite; white, massive, interbedded with Dolomite buff, porous vuggy
Umm Er Radhuma	1470	Dolomite and dolomitic Limestone interbedded with thin Anhydrite
A'aliji	1600	Bituminous thin Shale layer at the top, Dolomite; grey buff and vuggy. Anhydrite locally
Shiranish	1900	Marl and Limestone; ash grey plastic
Hartha	2030	Dolomite; buff-brown, porous, locally vuggy. Limestone (chalky); grey
Sadi	2170	Limestone; chalky, porous
Tunumma	2320	shale
Khasib	2370	Limestone
Mishrif	2430	Limestone
Rumaila	2720	Limestone
Ahmadi	2760	Shale and limestone
Mawdud	2800	Limestone porous
Nahur Omar	3040	Shale and sandstone
Shaiba	3180	Limestone shaley
Zubair	3290	Shale and sandstone
Ratawi	3700	Limestone porous
Yamamma	3833	Carbonate sand
Sulaiy	4110	Carbonate sand
Gotnia	4370	Shaly limestone
Najma	4630	Shaly sandstone

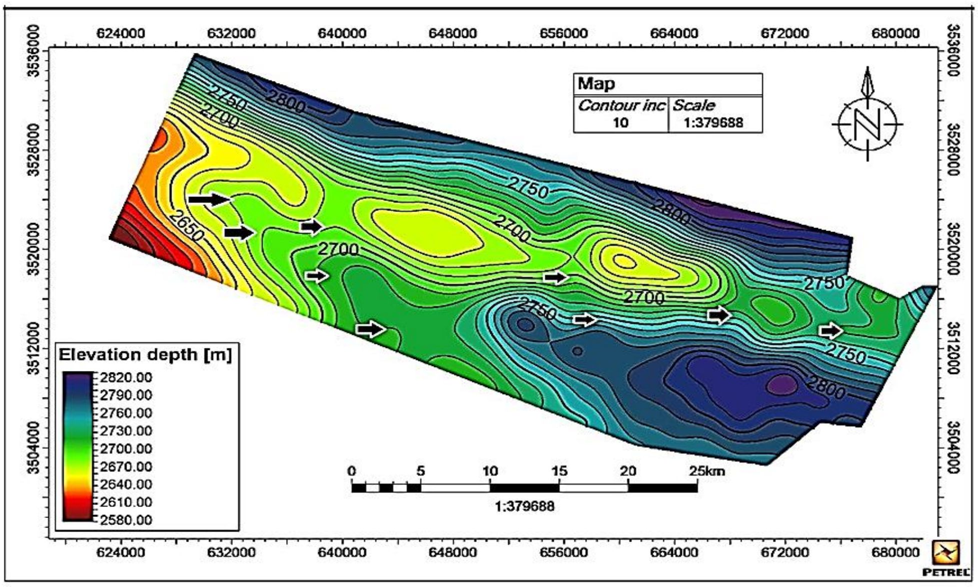


Fig. 2. Faults at the top of Mishrif Formation for the depth domain (Mohammed and Hussein, 2021).

Materials and Methods

The abnormal pressure is defined as any pressure that deviates from this normal pressure gradient (Figure 3). The normal hydrostatic value is 0.433 psi/ft for the fresh water while it is about 0.465 psi/ft for the salty water.

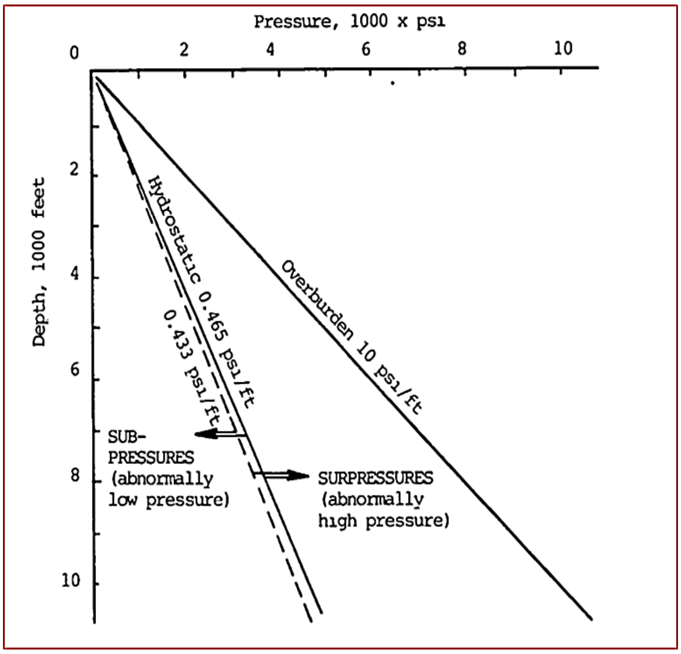


Fig. 3. abnormal pressure concept (Jordin and Shirlay, 1966)

Equivalent depth methods:

One instance of analysis by the trend line is the equivalent depth method as shown in Figure (4). This technique first assumes that there is a depth segment over which the pore pressure is hydrostatic, and the sediments are generally compressed since the systematic rise in active stress with depth. As soon as the log of the measured values is strategized by means of a function of depth, the Normal Compaction Trends (NCTs) are displayed as straight lines formfitting to the information over the typically compressed interval. Since the measured physical property value is a unique function of the effective stress, the pore pressure at any depth at which the measured value is not NCT can be calculated from Equation (1). The normal pressure trend (NCT) is a straight line in a linear logarithmic space that is fitted to slow down as a function of depth at which sediments are normally compressed. The effective pressure at depth (Z) is equal to the effective pressure at depth (A); therefore, the pore pressure at depth (Z) is simply (Al-Baldawi1, 2021) calculated:

$$Pz = Pa + (Sz - Sa)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where:

Pa: effective pore pressure at a, psi.

Pz: pore pressure at z, psi.

Sa: the stress at a, psi.

Sz: the stress at z, psi.

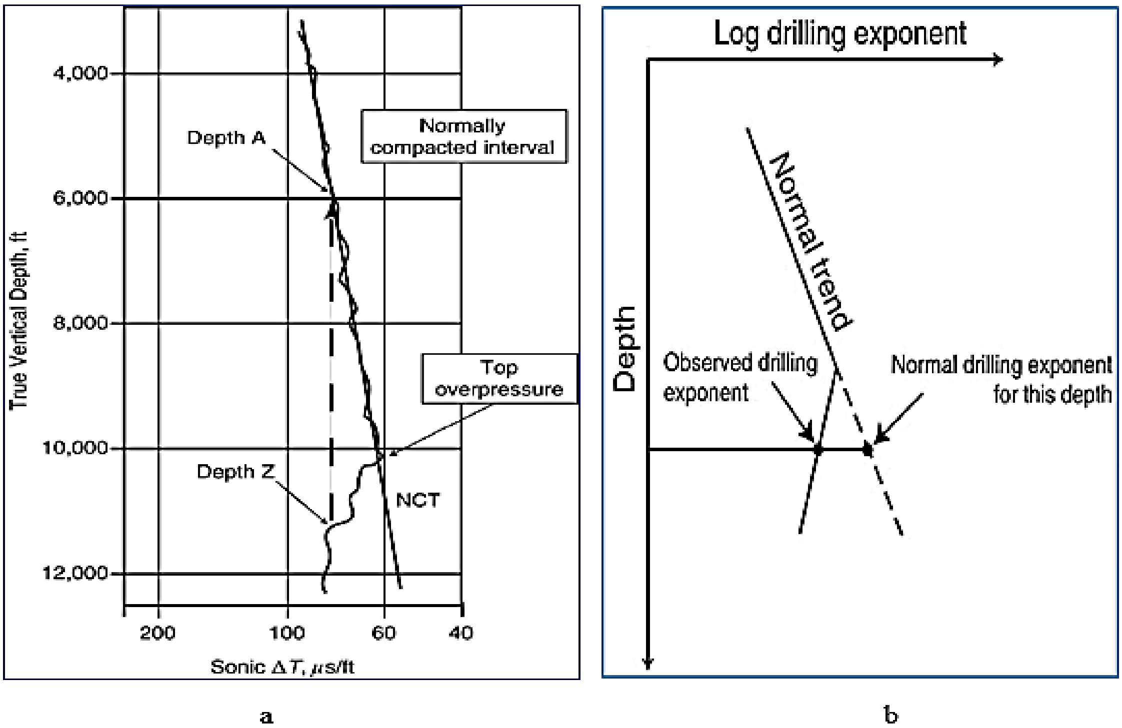


Fig .4. a:Equivalent depth method and b: ratio method (Swarbrick, 2002)

The ratio method (Moos et Al., 2001):

It is also called the exponential (d) method or the standard rate of penetration method, and it is considered one of the most common used methods. This method depends on the effect of the weight on bit (WOB), hole size (Dh), rate of penetration (ROP), and revolution per minute (RPM) as in Equation (2). The ratio method is also useful for analyzing pore pressure from exponential drilling as in Figure (3b).

$$\boldsymbol{ROP = a\left(\frac{W}{Dh}\right)^{d} N^{e}} \ldots\ldots\ldots\ldots..(2)$$

Where:
ROP: Rate of penetration, ft./hr.
N: Revolution per minute, RPM
W=Weight on bit
Dh=Bit or hole size, inch
d: (d-exponent)
e: exponent rotation speed, e=1
a: formation drillability

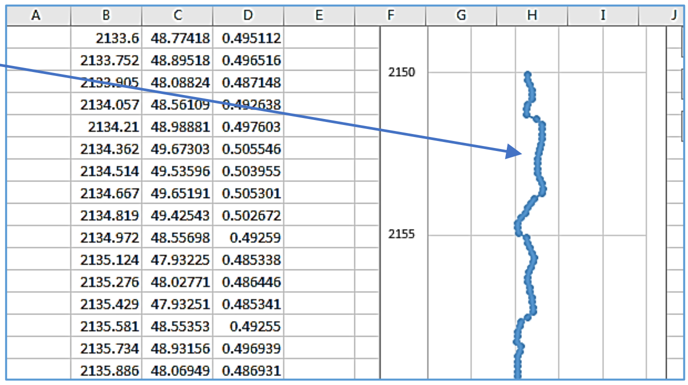
Shale density method (Bruce and Bowers, 2002):

The normal trajectory of compacted shale density increases with increasing depth. When the actual values of shale density deviate from the normal path, i.e. deviation to the left, this means that the increase in porous pressure in the shale layers has prevented their compaction or reduced their density, which caused their deviation towards lower values. This method is considered very good in theory, but from a practical point of view, the value of density remains unclear because of the difficulty in making accurate measurements and the difficulty in choosing shale that represents rock crumbs. Therefore, in this research, the shale size was compensated for instead of its density, and this relationship is reflected, due to the possibility of calculating the shale size. The following is the necessary calculations for this method:

V_{Sh} Calculation:

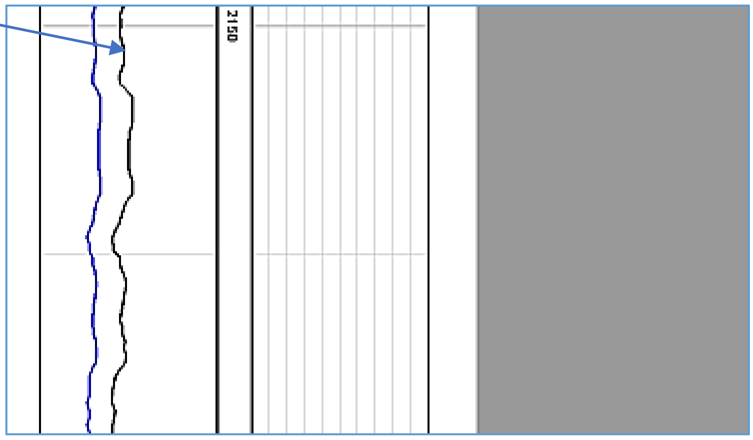
The calculation of V_{Sh} which can be done in many different ways including:

1-Using Microsoft Office Excel Sheet; by Open LAS, find min., and max. values of GR then insert V_{sh} eq. to calculate V_{sh} to the entire depth and then draw V_{sh} curve.



A	B	C	D	E
	2133.6	48.77418	0.495112	
	2133.752	48.89518	0.496516	
	2133.905	48.08824	0.487148	
	2134.057	48.56109	0.492638	
	2134.21	48.98881	0.497603	
	2134.362	49.67303	0.505546	
	2134.514	49.53596	0.503955	
	2134.667	49.65191	0.505301	
	2134.819	49.42543	0.502672	
	2134.972	48.55698	0.49259	
	2135.124	47.93225	0.485338	
	2135.276	48.02771	0.486446	
	2135.429	47.93251	0.485341	
	2135.581	48.55353	0.49255	
	2135.734	48.93156	0.496939	
	2135.886	48.06949	0.486931	

2-Calculating V_{Sh} using Neuralog; Open LAS, Calc. new curves from existing curve formula. The result is a new curve designed by the user. Recognize the variation you have get it in this figure. In what depth and in what kind of lithology and what about the other figure on the right.



The Volume of shale (VSh) can be calculated by another softwares such as Geolog and IPetrophisics…etc. It should be noted that the result of calculating VSh using Excel, Neuralog, or any other software shows the same results always because of the mentioned and unmentioned software above use the same digital data from the same LAS file that exported by the software to be used initially in this study is Neuralog. Therefore, the quality or the correct calculation and results of VSh depend on the digitizing process at the first place. Figure (5) shows logs used in this study. The second column of Figure (5) represents the light blue color readings of the porosity sensor, while the dark blue color is of the density sensor; as in the normal case, the density increases with depth, but in the areas of abnormal pressures, the opposite is observed, i.e. a decrease in density with depth. Also, the presence of slate can lead to a decrease in the recorded porosity value from the density sensor recording. The third column represents the recording of the spontaneous effort, where in front of the layers containing the shale, a fixed line is recorded, but in front of the sandy formations, it deviates towards the positive line. The fifth column represents the specific resistance, as this recording is useful in determining the type of liquid present in the formation. Where if the resistance is high, this means the presence of hydrocarbons, and vice versa. In the case of salt water, where it is approximately 0.1 ohms. meter. The fourth and sixth columns represent gamma ray sensors to predict the presence of radioactive materials to detect shale layers, where the reading of the gamma ray sensor is recorded as large as possible in front of the layers containing the shale. The first column represents the cement bond log, i.e. the sonic log. It is used to identify areas of abnormal pressure because the sound transmission time is faster because it is less compact and contains salty water.

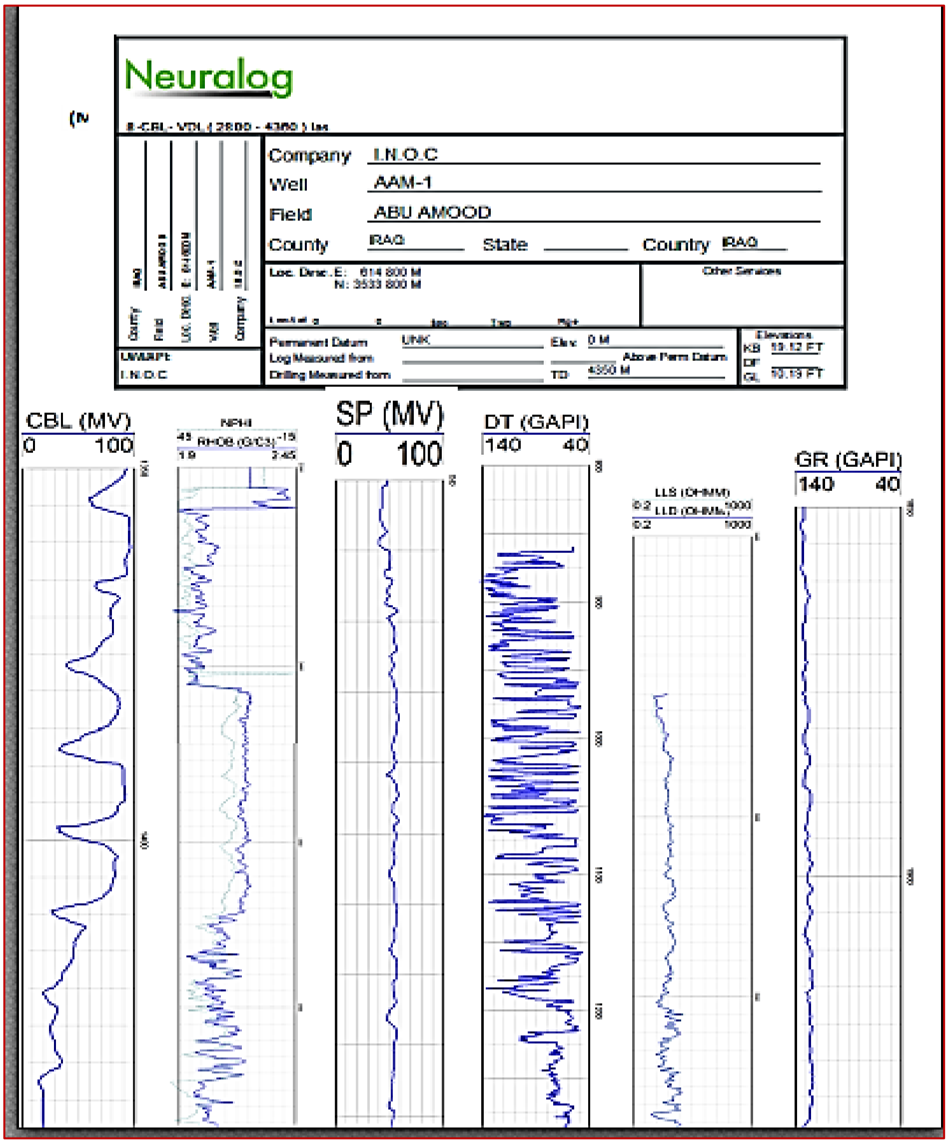


Fig. 5. The different logs for Abo Amoud Field

The tectonic activity considered one of the main reasons for the occurrence of abnormal pressures, and this is due to the fact that this phenomenon may cause a total blockage of the reservoir rocks by hard, high-density, impermeable rocks, and thus the unusual pressures occur. Mohammed and Hussein (2021) showed the two main directions of the transverse fault systems of the Abu Amoud field. The eastern trend, which is most dominant in east and northeastern parts of Iraq, while the northeastern trend, dominates the east and north parts of Iraq.

Results and Discussion

It is clear from the figures the exponent (d) in terms of depth and rate of penetration that there is a decreasing path with depth, that is, a decrease in penetration rate with depth. In transitional regions or high-pressure regions, it is noted that the calculated d values deviate from the normal path towards lower values, i.e. to the left. This deviation from the normal path indicates the presence of an area of high pressure (or unusual pressure) as shown in figures (6 and 7). Continuous drilling indicates the formation compaction will rise. That leads to low (ROP) if all other factors are held constant. The rock features within the abnormal zones, that are with less compressed rock in comparison with the normal zones. In this case, subsequently, ROP will rise. Also, this will reduce the difference between the hydrostatic pressure and the pore pressure, which will lead to an increase in the rate of penetration.

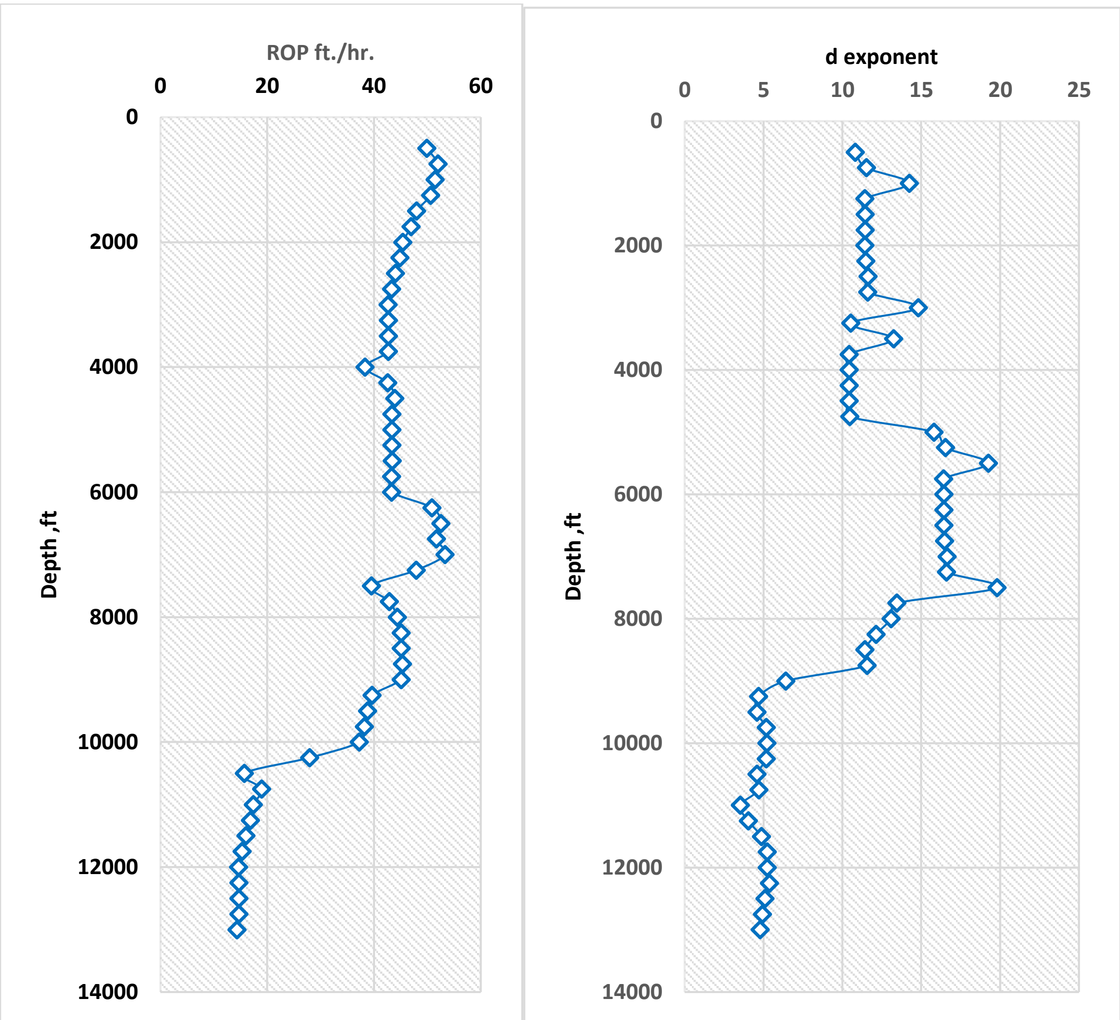


Fig. 6. The relation between rate of penetration (ROP), d- exponent and depth.

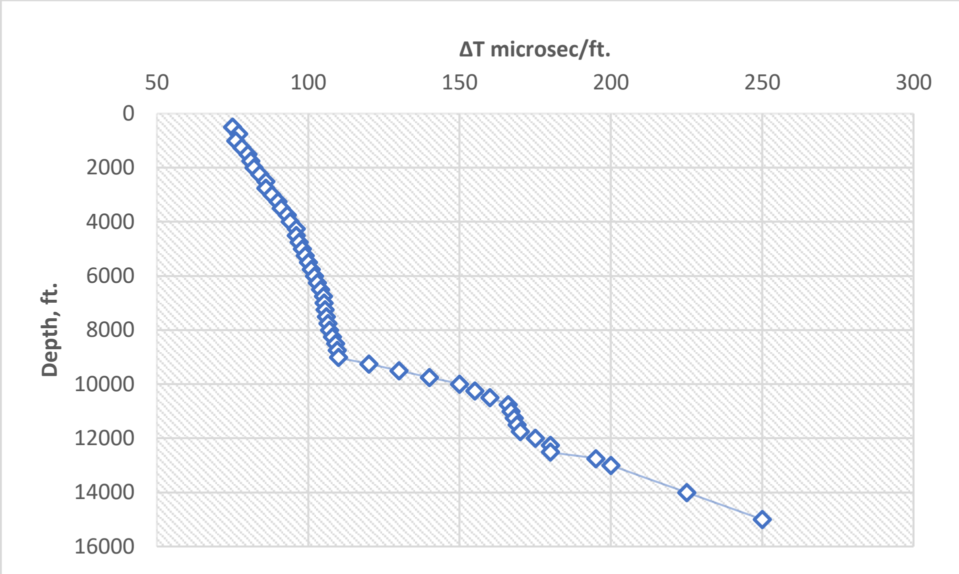


Fig. 7. The relation between sonic wave time and depth.

Figure (8) shows the relationship between porosity and the permeability to porosity, where some depths recorded a low permeability to porosity ratio compared to a somewhat high porosity, especially in shale layers, which is an indication of the presence of abnormal pressure zones at intervals (2330, 2460, and 2500) meters. The high increase in pressure comes from the phenomenon of layer compaction as a result of (the presence of a low permeability layer and a rapid sedimentation rate), meaning that the possibility of forming rock layers with unusual pressures increases with the increase in the sedimentation rate and the increase in the total thickness of the deposited layers.

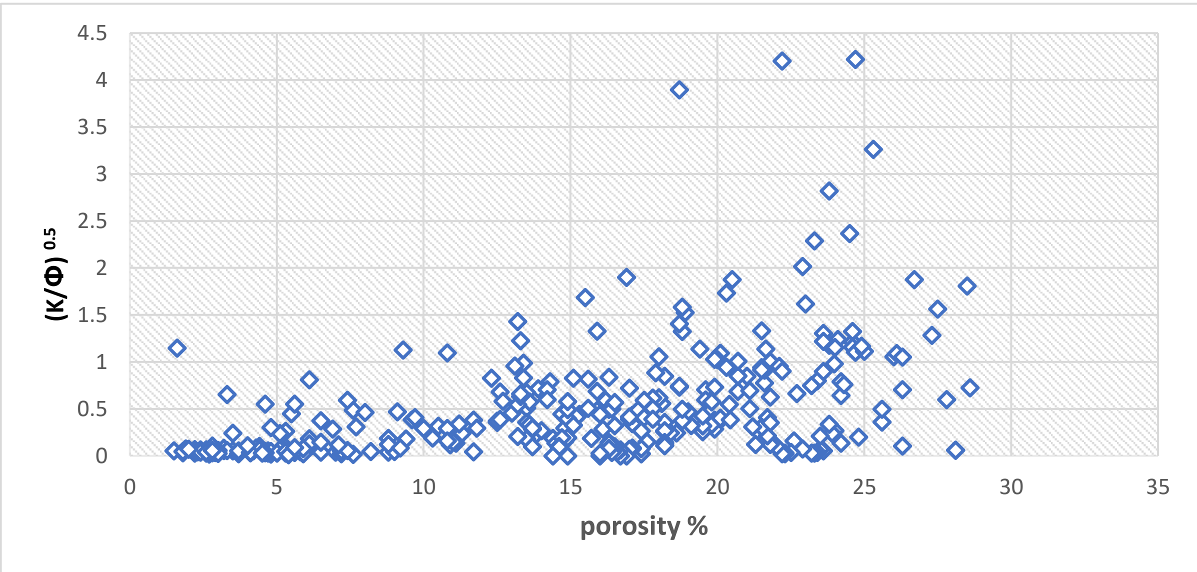


Fig. 8. The relation between porosity and the root of permeability to porosity.

The relationship of shale density with depth is proportional, which means that volume decreases. If the actual values of the density or volume of oil shale deviate from the normal values, this means that the pore pressure in the layers of oil shale has increased and its volume has increased. The pressure was prevented (reduced its intensity, causing it to deviate from lower values) as in figure (9). Table (3) shows formations with pore and fracture pressure, where the presence of abnormal pressure was concentrated in the upper and lower regions of the five studied wells. Since it has been proven that the normal pore pressure may be equal to (9 $lb.$ / gal) 0.47 psi /ft. (Swarbrick, 2002), where some formations gave less than the normal level, and vice versa in other formations as documented in Table (3). The Lower Fares Formation is exposed to an abnormally high pressure of about 2.28 g/cc especially at a depth of (850-930) meters, due to its geological composition of Anhydraite and the probability of salty water flowing is expected. Dammam Formation gave subnormal pressure about 0.454 psi/ft. Umm-ERadhuma Formation principally has high abnormal pressure because of its sulfur water content. The Saadi Formation also gave an abnormal pressure because it contains salty water, where the pressure gradient is about 0.5781 psi/ft. As for the rest of the formations in Table (3) (Ghar, Haritha and Tanumma), they gave pressures slightly greater than the normal pressure, but they are included in the previous table for the sake of accuracy.

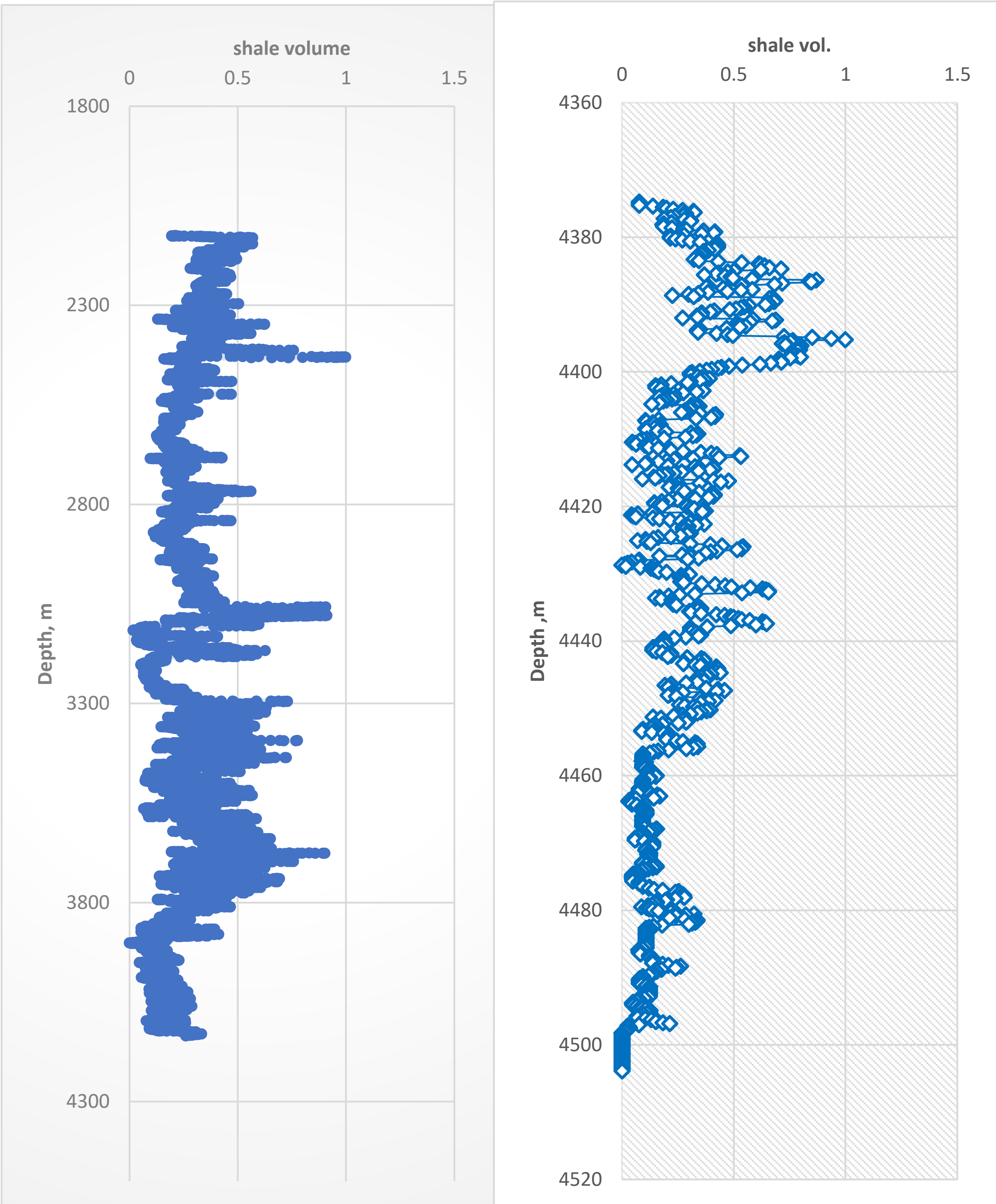


Fig. 9. The relationship between shale volume and depth (1800-4500) m.

Table 3: Formations with pore and fracture pressures

Formation and Lithology	Top MD m	Bottom MD m	Frac. Top ED SG	Pore Top ED SG	Remarks
Lower fars Anhydraite,limestone	850	1120	2.34	2.28	Abnormal high-pressure comparison with upper and lower layers. (18.99 > 9) ppg
Ghar loose sandstone	1050.0	1088.0	1.58	1.16	Abnormal pressure comparison with upper and lower layers. (9.66 > 9) ppg.
Dammam dolomite	1330.0	1690.0	1.72	1.04	sub normal pressure (8.66< 9) ppg.
Shiranish plastic	1840.0	2034.0	1.71	1.08	sub normal pressure 8.99<9
Hartha dolomite	2034.0	2182.0	1.72	1.11	Abnormal pressure (9.25 > 9) ppg.
Saadi limestone	2182.0	2227.0	1.70	1.23	Abnormal high pressure (10.245 > 9) ppg. (Salt water)
Tanumma shale	2327.0	2560.0	1.80	1.12	Abnormal pressure (9.33 > 9) ppg.

Conclusions

The prediction and control of abnormal pore pressure are useful to avoid many serious drilling risks. Abnormally high pore pressures can cause breakouts during drilling and also reflect the range of limits that must be set in relation to the total pressure in the annular space during the drilling process. Correct prediction of pore pressure secures and increases wellbore stability as well as reduces drilling risks, then gives a better representation of the mud program, and more accuracy in selecting the casing seat. The results of this research are obtained from the average data of five oil wells in Abu Amoud oil field in southern Iraq. Through the results of the shale volume method, it's found that the depths (450-750), (2300- 2500) m have abnormal pressure. As for the two other methods of exponential-d and the method of the acoustic probe, their consequences are that the depths (2875-4022) meters have unusual pore pressures, and they failed to predict the unusual pressures in the surface layers. This is indicated by the relationship between the rate of penetration and the depth, and it is found that the depths (1400-1600) m have subnormal pressures. The aforementioned three methods have proven the existence of areas of abnormal pressure in Abu Amoud oil field at different depths. The reason for the occurrence and formation of anomalous pressure zones is due to two main factors: the tightness factor as the availability of layers with little permeability represented by shale layers, and the tectonic factor due to fault in the field in the Mishrif Formation that lead to the transfer of the fluid from one depth to another. As predicting the pore pressure gradient is a very important factor in the design of oil wells, and it has a very effective effect on that.

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