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Using of Deferred Logging for the Determination of Petrophysical Parameters of the Aquifers of the Ourno Sector in the Iullemenden Basin (South Western Niger)



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ABSTRACT

This study is related to the characterization of the aquifers of the Ourno sector in the the Iullemenden basin (South-West Niger). Thus, the analysis of the results of the deferred logging allowed us to highlight, in the study area, two (2) main aguifers located respectively between 465-480m (Aquifer 1) and 535-565m (Aquifer 2) of depth. Interpretation of the drilling data and logs (Spontaneous Polarization, Gamma Ray and Resistivity) allowed the determination of the petrophysical parameters of these aquifers. These include porosity ($Ø_1$ =11% for Aquifer 1and $\phi_2 = 27\%$ for Aquifer 2), permeability (K₁ = 8.715 mD and K_2 =10.277 mD), saturation (Sw₁ = 100% and Sw₂ = 100%), transmissivity ($T_1 = 130.725.10^{-3}m^2/s$ and $T_2 =$ $308.31.10^{-3} \text{ m}^2/\text{s}$), and clay percentage (V_{sh1} = 10% and V_{sh2} = 7.5%). This study shows that the petrophysical characteristics of the aquifers in the Ourno area are good to very good, characterizing a high water potentiality and being ready for sustainable production.

INTRODUCTION

To meet the increasing demand for human activities for water, the search for potential aquifers is necessary. Thus, the production of water, in quantity and quality, through hydraulic drilling has proved to be essential throughout the world. This imperative is accompanied by multiple obstacles that have consequences for the recurrent problem of a decrease in exploitation flow or even drying up of the wells, especially in rural areas. This has highlighted the need to place special emphasis on understanding the characteristics of aquifers to improve the population's drinking water satisfaction. To achieve this objective, Niger is no exception. The Ourno sector (southwestern Niger) is special in Niger because previous work shows that it hosts one of the largest aquifers in the country (Boureima, 1988; Dady, 1993; Abdou, 2012). However, access to drinking water remains precarious in this area (Abdou, 2012). The objective of the present work is to determine the characteristics of the aquifers in the Ourno area to assess their water potential. In recent years, considerable efforts are being made by the government and its partners to improve the supply of drinking water to rural populations through the construction of hydraulic boreholes. Nevertheless, the success of this water drilling infrastructure requires meticulous geophysical studies and mastery of drilling techniques. Also, a good knowledge of the petrophysical parameters of the aquifers will allow the determination and the prediction of their behaviors (hydraulic potential, filtration rate, flow)in natural conditions and under the disturbing effect of human intervention. To achieve this objective, the results of drilling (description of cuttings) and deferred logging(resistivities, spontaneous polarization, gamma ray) were interpreted to determine the petrophysical parameters of the aquifers in the Ourno area.

I. GEOLOGICAL CONTEXT

The Ourno sector occupies the western part of the Iullemenden basin (Figure 1). This vast basin, located between longitudes 1° and 8° E and latitudes 10° and 21° N, covers about 75% of Niger's territory (Greigert and Pougnet, 1967). It extends from North to South over 1100km and over 800 km from East to West. It is limited by the crystalline massifs of Liptako-Gourma, Adrar des Iforas, Hoggar, Aïr, Damagaram-Mounio, and Nigeria. The sediments of this basin are of Paleozoic to Tertiary age. The thickness of these sediments varies between1500 and 2000m. The sedimentary fill includes:

> At the base of the Intercalary Continental deposits, of Permian to Lower Cretaceous age;

Relayed by of sediments presenting alternately of facies marine and continental facies, of Upper Cretaceous to Eocene age;

> At the top, is the Terminal continental series (post-Eocene and anti-quaternary).



Figure no 1: Geological map of Iullemenden basin (Greigert and Pougnet, 1967, modified)

The deposits show several types of facies (Dady, 1993) (Figure 2):

> To the north, Tegama sandstones with silicified woods and bariolated mudstones.

➤ In the Maggia there is an alternation of clay and marl with medium to coarse clay and sandstone, as well as alternating clay and limestone with siltstone at the base.

> The Ader-Doutchi presents facies with woody argillites and sandstones. Whereas a little to the north, at Garadaoua, limestone and papyracteous mudstones are found.

> In the Dallols and Zarmaganda region, low sandstone plateaus of the Continental

Terminals are found. The rigidity of these plateaus is ensured by the frequent presence of a ferruginous cuirass. One also meets ancient ergs fixed by thorny trees or doum palms.

In the extreme southwest, the basin covers part of the granitic basement of the LiptakoGourma; further south, in the Kandi basin, fine siltstone deposits, as well as sandstone and conglomerates, are found.



Figure no 2: Simplified stratigraphic scale of the Iullemenden basin (Dady, 1993)

II. MATERIALS AND METHODS

II.1. Implementation of the drilling

II.1.1. Drilling technique used

The rotary technique was used exclusively for drilling operations. A trillium tool is rotated from the surface of the ground utilizing a string of rods. The advancement of the tool is done by abrasion of the ground, without shock, only by rotation and thrust. This is provided by the power of the machine but especially by the weight of the rods above the tool. The circulation of the drilling mud allows the cuttings to be brought to the surface.

II.1.2. Drilling mud used

Depending on the nature of the terrain crossed, two (2) types of drilling muds were used during the drilling operation:

▶ Poly-col: it is a polymer widely used in rotary drilling. For this work, it is necessary to dose between 2.5 and 5 kg of this product per m3 of water. Poly-col is used in well-consolidated soils.

Bentonite: it is a clay powder that must be dosed with 15 and 30 kg per m3 of water. Its role is to maintain the walls of the hole and to bring the cuttings to the surface.



Figure no 3: Mud preparation

II.2. Survey of cuttings

The geological analysis of the cuttings (Figure 4) allows the identification of the formations crossed and the location of the aquifer. During the drilling of the Ourno borehole, sampling was done every meter. The description of the cuttings (cuttings survey) consists of determining the following parameters: Depth; Color; Mineralogical composition; Grain size; Grain shape; Water sign; Rock name.

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Figure 4: Rock samples (cuttings)

II.3. Methodology for log data acquisition

II.3.1. Different types of logs recorded

Three logs were measured simultaneously with a speed of 3 m/min:

Spontaneous polarization log (PS)

Calibration of the probe was first performed. It consists of testing it on the surface, to ensure that it works properly. Then the hole is filled with drilling mud, then the negatively charged electrode is fixed on the surface (mud pit) and the other positively charged electrode is lowered to the bottom of the hole. The PS is recorded when the probe is brought up.

➢ Log gamma ray (GR)

The gamma-ray probe or scintillator (natural gamma-ray detector) measures the natural radioactivity existing in rocks. The recording is done on the gamma rays, emitted by the ground crossed by the drilling. The result is translated by curves of variation of the gamma radiation according to the depth of the drilling. The gamma log allows:

• to estimate the percentage of clay in the sandy formations.

• to bring lithological information, it highlights the coals, the evaporites, and especially the clay levels which often constitute the limits of the aquifers in the basement.

Unlike the log PS which has the same function, it can be used in cased boreholes, in the presence of resistant sludge, and in boreholes filled with any type of fluid.

➢ Resistivity log (R)

The resistivity probe measures the natural resistivity of the rocks and the fluids contained in them. It is a powerful tool to highlight aquifer zones and the presence of water. However, the calculation of resistivity depends very much on the nature of the drilling fluid and its invasion(Chapellier, 1987; Schlumberger, 1994; Jun 2002) into the borehole (Figure 5). Thus, the following parameters can be determined:

• In the washed area:

Rxo = F.Rmf

Rxo: the resistivity of the rock

Rmf: resistivity of the filtrate filling the pores of the rock

F: it is a factor linked to the formation

a: constant related to the lithology (example: sandstone a= 0.62 and 1 for limestone) m: constant related to the cementing, it is supposed to be about 2.

 $F=a/Ø^m$

Ø: The porosity of the rock

• In the blank area :

Rt = F.Rw

Rt: the resistivity of the virgin zone not invaded by the mud.

Rw: resistivity of the soaking water.





II.3.2. Setting up the acquisition

Before switching on the probe, the system must be parameterized. The different parameters to be introduced in the software and to be checked are:

- Importing the tool file of the connected probe,
- > Adjust the voltage of the probes (100 mV),
- Enter the sampling step in time: 150 ms,
- > Enter the depth sampling step: 10 cm,
- > The use of calibrators for resistivity and conductivity measurements.

II.3.3. Recording technique

The recording is done as the probe is brought up. The combination (stack) of probes: Spontaneous Potential (SP), Gamma Ray (GR), and Resistivity (R), is lowered into the borehole (Figure 6) at the end of a cable that provides the link with the surface instruments controlling the operations, and grouped in a vehicle. The good log data are acquired at a rate of 3 meters/minute. The telemetry cable allows, thanks to an optical system, to know at any moment the coast or depth reached by the probes. Also, the physical phenomena (resistivities, conductivities, radio

activities) of the crossed formations, measured by the sensors of the probes are transmitted to the logger via the cable of the winch. These data are then collected, visualized, and stored on a computer by the acquisition software.



Figure 6: Logging tool lowered into the borehole

III. RESULTS AND DISCUSSION HUMAN

III.1. Borehole data interpretations

The analysis of the cuttings allowed us to identify the formations crossed by the drillings (Table I). These formations are generally clayey except for the water-bearing environments (sandstone) with low clay content. The lithological description allowed us to distinguish two (2) main aquifers. Aquifer 1 is found to have a sheeted clay roof and a plastic clay wall, all of which are impermeable. This suggests a captive aquifer. The latter would give a good exploitation rate. Aquifer 2 has a gravelly clay roof and a sandy clay wall, all semi-permeable. This gives a semicaptive aquifer that could give a medium to strong flow.

Table I:

pp Profondeur Description		Coupe lithologique	
0m - 21m	Cuirasse latéritique marron	Terrains Coupe Lithologique Cuirasse latéritique	
21m - 35m	Calcaire	25 Calcaire blanchatre 35.00 50 Argile gris noiratre	
35m - 62m	Argile gris-noirâtre	75 Argile compacte gris	
62m - 125m	Argile compacte gris-foncé	125 125.00	
125m - 393m 393m - 425m 425m -	Argile en feuillets gris Argile plastique bariolée à passage sableux	150 175 200 225 250 Argile en feuillets 300 325 350	
465m	Argile en feuillets gris	375	
480m	grès fin-moyen (aquifère 1)	400 Argile bariolée à passage sableux 425 425.00	
480m - 515m	Argile plastique à trace de calcaire	450 Argile gris	
515m - 535m	Argile gravel use	485.00 Grès fin moyen	
535m - 565m	Grès moyen-grossier (aquifère 2)	500 Argile plastique à trace de calcaire (gris, verdatre,blanc, marron)	
565m - 600m	Argile sableuse	525 Argile et gravier 535.00 Gres moyen-grossier 575 Argile sableuse 600 600.00	

III.2. Interpretation of logging data

III.2.1. Logging results

The logging results are for three (3) types of recordings: Resistivity (small normal and large normal), spontaneous polarization (SP), and gamma-ray (GR), all represented on the same log(Figures 7 and 8). These results allowed us to identify the aquifer zones. Thus, two (2) main aquifers were identified in the Ourno area (Figures 7 and 8). To better understand the characteristics of these aquifers for sustainable exploitation, it is imperative to know their petrophysical parameters. To determine these parameters, this study was based on the results of the logs, namely the resistivity (small normal and large normal), the spontaneous-polarization (SP), and the gamma-ray (GR) in the aquifer intervals. Empirical formulas were used to calculate these petrophysical parameters.







Figure 8: Results of delayed logs from 525 to 595 m.

III.2.2. Determination of the petrophysical parameters of aquifers

(i) Calculation of the Spontaneous Polarization (SP) value

- > PS deflection value at aquifer 1 (Figure 7)
 - $5 \text{ cm} \rightarrow 15000 \text{ mV}$

 $2.025 \text{ cm} \rightarrow \text{PS}_1$

$$PS_1 = \frac{15000 \times 2.025}{5} = 6075 \text{ mV} \to PS_1 = 6075 \text{ mV}$$
(1)

> PS deflection value at aquifer 2 (Figure 8)

 $5 \text{ cm} \rightarrow 15000 \text{ mV}$



$$PS_2 = \frac{15000 \times 2.025}{5} = 6075 \text{ mV} \rightarrow PS_2 = 6243 \text{ mV}$$
(2)

(ii) Calculation of the gamma-ray value

- ➢ Gamma Ray value (GRx₁) for the Aquifer₁:
- $5 \text{ cm} \rightarrow 200 \text{ API}$

 $0.5 \text{ cm} \rightarrow \text{GRx}_1$

 $\operatorname{GRx}_1 = \frac{200 \times 0.5}{5} = 20 \operatorname{API} \rightarrow \operatorname{GRx}_1 = 20 \operatorname{API}$ (3)

➢ Gamma Ray value (GRx₂) for the Aquifer₂:

$$0.45 \text{cm} \rightarrow \text{GRx}_2$$

 $GRx_2 = \frac{200 \times 0.45}{5} = 20 \text{ API} \rightarrow GRx_2 = 18 \text{ API}$ (4)

(iii)Calculation of the percentage and index of clay

It is recalled that the calculation of the percentage of clay is done using the formula:

$$V_{sh}(\%) = \frac{PSS - PS \text{ au point } X}{PSS} \times 100 \text{(Chapellier, 1987)}$$
(5)

With V_{sh} : volume of clay in %;

PSS: maximum value of the PS deflection in the considered interval, the value that corresponds to the sand baseline;

PS read at point X: the value of the PS deflection at the chosen depth.

The maximum value of the PSS deflection is calculated as follows:

 $5 \text{cm} \rightarrow 15000 \text{ mV}$

2.25cm→PSS

$$PSS = \frac{15000 \times 2.25}{5} = 6750 \text{ mV} \rightarrow PSS = 6750 \text{ mV}(6)$$

Calculation of the percentage of clay in Aquifer 1

$$V_{sh1} = \frac{PSS - PS_1}{PSS} \times 100 = \frac{6750 - 6075}{6750} \times 100 = 10 \%(7)$$

Calculation of the percentage of clay in Aquifer 2

$$V_{sh2} = \frac{PSS - PS_2}{PSS} \times 100 = \frac{6750 - 6243}{6750} \times 100 = 7.5 \%(8)$$

The calculation of the clay index is given by the formula: $I_{sh}(\%) = \frac{GRx - GRmin}{GRmax - GRmin} \times 100$ (9)

V_{sh}: clay index in percentage.

GRmin: minimum value of gamma-ray.

GRmax: maximum value of gamma-ray.

GRx: gamma-ray read at point x.

The maximum gamma ray value is calculated as follows:

$$5 \text{ cm} \rightarrow 200 \text{ API}$$

2.3 cm →GRmax

$$GRmax = \frac{200 \times 2.3}{5} = 92 \text{ API} \quad \rightarrow GRmax = 92 \text{ API}$$
(10)

The minimum gamma ray value is calculated as follows:

5cm → 200API

0.3cm →GRmin

 $GRmin = \frac{200 \times 0.3}{5} = 12 \text{ API} \rightarrow GRmin = 12 \text{ API}$ (11)



Calculation of clay index (I_{sh1}) for the Aquifer₁:

$$I_{sh1} = \frac{GRx_1 - GRmin}{GRmax - GRmin} \times 100 \qquad \rightarrow I_{sh1} = \frac{20 - 12}{92 - 12} \times 100 = 10 \% (12)$$

Calculation of clay index (I_{sh2}) for the aquifer₂:

$$I_{sh2} = \frac{GRx_2 - GRmin}{GRmax - GRmin} x \ 100 \qquad \rightarrow I_{sh2} = \frac{18 - 12}{92 - 12} \ x \ 100 = 7.5 \ \%$$
(13)

(iv)Calculation of the porosity

To determine the porosities of the two (2) aquifers, we calculated average values from empirical formulas. Scientific studies on the porosity of rocks reveal that the porosity of sandstone is between 3 and 35% (3 to 19% for fine to medium sandstone and 19 to 35% for medium to coarse sandstone) (Oberto, 1985). The analysis of the cuttings shows us that the size of the grains differs according to the aquifers. Thus, we have for aquifer 1 grains whose size varies from fine to medium, and for aquifer 2, the size of the grains varies from medium to coarse. Looking for the arithmetic mean between these two intervals we have:

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$$\emptyset_1 = \frac{3+19}{2} = 11\%$$
 for the Aquifer₁(14)

(v) Calculation of resistivity

On the log plot, the Long Normal curve corresponds to the rock resistivity values in the virgin zone not invaded by drilling mud (Rt) (Oberto, 1979; Schlumberger, 1994) and the Short Normal curve corresponds to the rock resistivity values in the washed zone (Oberto, 1979; Schlumberger, 1994), i.e., the zone invaded by drilling mud (R_{x_0}). These resistivities are functions of depth.

For theAquifer₁:

Calculation of the Long Normal (R_{t_s}) 5 cm \rightarrow 2000 mV

2.1 cm \rightarrow R_t

$$R_{t_1} = \frac{2000 \times 2.1}{5} = 840 \Omega.m$$
 $R_{t_1} = 840 \Omega.m$ (16)

Calculation of the Short Normal $(R_{x_{ot}})$ 5 cm \rightarrow 2000 mv

 $1.5 \text{ cm} \rightarrow R_{x_{01}}$

 $R_{x_{01}} = \frac{2000 \times 1.5}{5} = 600 \Omega.m$ $R_{x_{01}} = 600 \Omega.m(17)$

For the Aquifer₂:

Calculation of the Long Normal (R_{t_n}) 5 cm \rightarrow 2000 mV

 $3.583 \text{ cm} \rightarrow \text{R}_{t_2}$

$$R_{t_2} = \frac{2000 \times 3.583}{5} = 1433.33\Omega.m \quad R_{t_2} = 1433.33\Omega.m \quad (18)$$

Calculation of the Short Normal $(R_{x_{02}})$ 5cm \rightarrow 2000 mv

 $2 \text{cm} \rightarrow \text{R}_{x_{n2}}$

$$R_{x_{02}} = \frac{2000 \times 2}{5} = 800 \Omega.m$$
 $R_{x_{02}} = 800 \Omega.m(19)$

(vi)Saturation calculation

The water saturation of an aquifer is the ratio of the pore volume it occupies to the total pore volume. To determine the saturation of rocks, Archie (1942) established a widely used formula (Chapellier, 1987; Jun 2002). We have for the pristine zone:

$$R_{t} = R_{w} \cdot a \cdot \emptyset^{-m} \cdot S_{w}^{-n} \Longrightarrow \frac{R_{t}}{S_{w}^{-n}} = R_{w} \cdot a \cdot \emptyset^{-m} \quad (20)$$

$$\frac{1}{S_{w}^{-n}} = \frac{R_{w} \cdot a \cdot \emptyset^{-m}}{R_{t}} \Longrightarrow \qquad S_{w}^{n} = \frac{R_{w} \cdot a \cdot \emptyset^{-m}}{R_{t}} \rightarrow \qquad S_{w}^{n} = \frac{a \cdot R_{w}}{R_{t} \cdot \emptyset^{m}} \rightarrow S_{w} = \sqrt[n]{\frac{a \cdot R_{w}}{R_{t} \cdot \emptyset^{m}}} \quad (21)$$

> Aquifer 1 saturation (S_{w_1})

According to Shell (Chapellier, 1987) the formula for m (case hardening factor) is written:

$$m = 1.87 + \frac{0.019}{\emptyset}$$
. $m_1 = 1.87 + \frac{0.019}{\emptyset_1} \implies m_1 = 1.87 + \frac{0.019}{0.11} = 2.04$ (22)

Remember: $\mathbf{R}_{t_1} = 840 \ \Omega.m$

The term formation factor F is generally used to describe the structure of the rock:

 $F = \frac{a}{\emptyset^m}$ or for compact formations like sandstone $F = \frac{1}{\emptyset^m}$ from which we deduce identification between the two previous formulas that a = 1 and in general n = 2 for most rocks.

$$F_1 = \frac{1}{\emptyset^{m_1}} \Longrightarrow F_1 = \frac{1}{0.11^{2.04}} = 90.27$$
 (23)

Or $R_{t_1} = F_1 \cdot R_{w_1} \Longrightarrow R_{w_1} = \frac{R_{t_1}}{F_1}$

$$R_{w_{1}} = \frac{840}{90.27} = 9.31 \ \Omega.m \qquad (24)$$

$$S_{w_{1}} = \sqrt[n]{\frac{a \cdot R_{w_{1}}}{R_{t_{1}} \cdot \theta_{1}^{m_{1}}}} \rightarrow S_{w_{1}} = \sqrt[2]{\frac{1 \times 9.31}{840 \times 0.11^{2.04}}} = 1.0002^{\otimes} 1 \rightarrow S_{w_{1}} = 100\% \quad (25)$$

> Aquifer 2 saturation (S_{w_2})

$$m = 1.87 + \frac{0.019}{\emptyset}$$
, $m_2 = 1.87 + \frac{0.019}{\emptyset_2} \implies m_2 = 1.87 + \frac{0.019}{0.27} = 1.94$ (26)

Remember : $R_{t_2} = 1433.33 \Omega.m$

$$F_2 = \frac{1}{\rho^{m_2}} \Longrightarrow F_2 = \frac{1}{0.27^{1.94}} = 12.68$$
 (27)

Or
$$R_{t_2} = F_2 \cdot R_{w_2} \Longrightarrow R_{w_2} = \frac{R_{t_2}}{F_2}$$

$$\mathbf{R_{w_2}} = \frac{\mathbf{1433.33}}{\mathbf{12.68}} = 113.0386 \ \Omega.m(28)$$

 $S_{w_2} = \sqrt[n]{\frac{a.R_{w_2}}{R_{t_2}\phi_2^{m_2}}} \to S_{w_2} = \sqrt[2]{\frac{1 \times 113.0386}{1433.33 \times 0.27^{1.94}}} = 1.000040 \approx 1 \to S_{w_2} = 100\%$ (29)

(vii) Calculation of the permeability

A porous medium allows the flow of fluids if the pores are connected and if the pressure drops are not too high. Permeability represents the ease with which a fluid of a given viscosity can flow through a formation. It can be defined by the permeability formula of Jun (2002):

$$K = 8.7096 \times 10^{4 \frac{0^{5.78}}{V_{\text{Sh}^{1.57}}}}$$
(30)

Permeability of the Aquifer 1 (K₁)

$$K_{1} = 8.7096 \times 10^{4 \frac{\emptyset_{1}^{5.78}}{V_{Sh_{1}^{1.87}}}} K_{1} = 8.7096 \times 10^{4 \frac{\emptyset.11^{5.78}}{9.1^{1.87}}} = 8.715 \text{ mD}$$
(31)

Permeability of the Aquifer 2 (K₂)

$$K_{2} = 8.7096 \times 10^{4 \frac{0.2}{V_{8}h_{2}^{1.78}}} K_{2} = 8.7096 \times 10^{4 \frac{0.27^{5.78}}{0.075^{1.87}}} = 10.277 \text{ mD}$$
(32)

(viii) Calculation of the Transmissivity

The transmissivity represents the flow of an aquifer over its entire thickness per unit width l and under a unit hydraulic gradient. According to Jacob (Chapellier, 1987), it corresponds to the product of the average permeability K (m/s) and the thickness of the level e (m), i.e: T = K.e with e: thickness, also called the power of the aquifer.

Aquifère 1transmissivity (T₁)

$$T_1 = K_1.e_1$$
 (33)

(with e₁ the thickness of the first Aquifer).

Aquifer 1 is located between 465 m and 480 m, i.e. 15m thick $\rightarrow e_1 = 15m$

$$T_1 = 8.715 \times 10^{-3} \times 15 = 130.725 \cdot 10^{-3} m^2/s.$$

Aquifère 2Transmissivity (T₂)

$$T_2 = K_2 \cdot e_2$$
 (34)

(With the thickness of the second Aquifer).

Aquifer 2 is located between 535 m and 565 m, i.e. 30 m thick $\rightarrow e_2 = 30$ m

 $T_2 = 10.277 \times 10^{-3} \times 30 = 308.31.10^{-3} m^2/s.$

CONCLUSION

The analysis of the log results (logs) shows mainly two aquifer zones located respectively between 465-480m (Aquifer 1) and 535-565m (Aquifer 2) depth. Opposite these aquifers, the resistivity (great normal) curves ($R_{t_1} = 840\Omega$.m et $R_{t_2} = 1433.33\Omega$.m) and spontaneous polarization (SP) curves (SP₁ = 6075 mV and SP₂ = 6243 mV) produce deflections that tend toward their greatest values. At the level of these aquifers, we observe variations of the gamma Ray (GR) curve. It has the smallest values ($GRx_1 = 20 \text{ API et } GRx_2 = 18 \text{ API}$), which proves that we are in the presence of sandbanks which in their nature are not very radioactive. All these indicators have allowed confirming on t h e one hand the nature of the lithology of the zones favorable to the presence of water(sandy formations) and on the other hand the presence of water in these areas. The petrophysical parameters of the aquifers give average porosities ($\emptyset_1 = 11\%$ and $\phi_2 = 27\%$), good permeabilities (K₁= 8.715 mD and K₂ = 10.277 mD), exceptional saturation $(S_{w_1} = 100\% \text{ et } S_{w_2} = 100\%)$, medium transmissivities $(T_1 = 130.725 \cdot 10^{-3} \text{m}^2/\text{s et } T_2 = 100\%)$ $308.31.10^{-3}$ m²/s), and low clay percentages ($V_{sh1} = 10\%$ et $V_{sh2} = 7.5\%$). These results highlight the presence of two (2) aquifers of high water potential whose expected yield would be satisfactory for sustainable production. This study shows that the petrophysical parameters of the aquifers in the Ourno area are good to very good.

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