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HYDROGEOPHYSICAL STUDY TO EVALUATE THE NUBIA SANDSTONE AQUIFER OF THE AREA BETWEEN SIN EL KADAB AND GEBEL UM SHAGHER, WEST LAKE NASSER, WESTERN DESERT-EGYPT

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دراسة هيدروجيوفيزيقية لتقييم خزان الحجر الرملى النوبى للمنطقة بين سن الكداب

وجبل أم شاغر– غرب بحيرة ناصر– الصحراء الغربية – مصر.

الخلاصة: تقع منطقة سن الكداب بالجانب الغربى لبحيرة ناصر وحوالى ١١٠ كم جنوب غرب مدينة أسوان بين النهاية الجنوبية الشرقية لهضبة سن الكداب شمالا وجبل أم شاغر جنوبا. وتشغل مساحة ٣٥٠كم٢ تقريبا. هدف تلك الدراسة توضيح الوضع الهيدروجيولوجى للمنطقة وظروف تواجد المياه الجوفية وتأثير التراكيب الجيولوجية عليها وتحديد أنسب الأماكن لحفر آبار مياه جوفية جديدة لتنمية تلك المنطقة الهامة. ولتحقيق تلك الأهداف أستخدمت طرق المسح المغناطيسى الأرضى والمقاومة الجيوكهربية الرأسية. وقد تم المسح المغناطيسى الأرضى على شكل بروفيلين بطول ٣٢ و٢٢ كم فى إتجاه شمال غرب–جنوب شرق وغرب شرق على الترتيب وعمل٢١ جسه جيوكهربية بطريقة شلمبرجير موزعة على هيئة ثلاثة بروفيلات بالمنطقة موازية للطريق (شمال غرب–جنوب شرق) وأقصى مسافة بين الأقطاب الكهربية (أب) تصل الى ٢٠٠٠م.

وقد أظهرت تفسيرات بيانات المسح المغناطيسى وجود إنخفاضات وإرتفاعات فى قيم المغناطيسية أمكن منها تحديد تضاريس صخور القاعدة والتى تتمثل فى منخفضات ومرتفعات وصدوع بسطح تلك الصخور. ومن تفسير الجسات الكهربية تم عمل أربعة قطاعات جيوكهربية. ويتكون التتابع الجيوكهربى من ثلاثة نطق جيوكهربية. النطاق العلوى (أ) الجاف يتكون من أربعة طبقات رمال مفككة ورواسب الحجر الرملى الخشن وتداخلات الرمل والرمل الطينى والطفلة الجافة ويتكون النطاق الثانى المشبع (ب) من خمسة طبقات جيوكهربية للحجر الرملى النوبى (حجر رملى وطفلة وطين رملي) وهى حاملة للمياه. بينما النطاق الثالث (جـ) يمثل قاع التتابع الجيوكهربى ويتكون من طبقتين (الطين وصخور القاعدة). وقد تبين أن المنطقة تأثرت بثلاثة صدوع أثرت فى التتابع تحت السطحى وبالتبعية أثرت فى تواجد المياه الجوفية فى المنطقة.

ويمثل النطاق الحامل للمياه (ب) خزاناً حبيساً فى الجزء الشمالى الغربى لوجود سمك كبير من الطبقة الحابسة أعلاها والتى تتكون من الطين والطفلة. الإمكانيات المائية للمنطقة جيدة وأفضل المواقع لحفر الآبار تكون ناحية الشمال الغربى والجزء الشرقى للمنطقة وعلى مسافة لا تقل عن ٥٠٠ متر من الصدع بينما تقل هذه الإمكانية فى الجزء الغربي.

ABSTRACT: *The study area is located at the western side of Lake Nasser province, 110 km to the southwest of Aswan city. It lies from the southern part of Sin El Kadab plateau to Gebel Um Shagher southwards, covering a surface area of about 350 Km^2. The objectives of this study are the determination of the main aquifer and the effect of the subsurface structures on it by using geophysical methods, as well as clarifying the hydrogeological setting in the area to select the best sites for drilling new wells.*

Two land magnetic profiles were carried out with a unit station separation of 100m and 21 Vertical Electrical Soundings (VES) of Schlumberger configuration with a maximum distance between the current electrodes (AB) of 2000m. The magnetic interpretation shows that the South east profiles of the area has high magnetic values which represent high structures, while the North and North West portions represent structural depressions.. The interpreted results of the geoelectric survey show that the succession consists of three geoelectric zones ("A", "B" and "C"). The surface zone "A" is composed of dry alluvium of Quaternary deposits and dry sandstone, clayey sand and sand intercalations and shale. Zone "B" is the saturated unit which consists of Nubia sandstone, clay, clayey sand interbeds. While zone "C", is composed of clay followed by basement rocks. The area is influenced by several faults, which resulted in uplifting of the basement rocks at different levels that affected the succession and hence the water bearing aquifer.

The potentiality of groundwater is good in the north western part of the study area due to presence of thick saturated sandstone and clayey sand beds, while it is limited in the southern part due to the up-lift of basement and thinning of the water bearing formation.

INTRUDUCTION

Detailed groundwater exploration would yield significant information necessary for the regional development of agricultural, mineral exploitation and transport in such arid areas of Egypt. The area under study covers 350 Km^2, between Latitudes .23° 15’- 23° 30’N and Longitudes 32° 15’- 32° 35’ E. It lies to the southwest of Aswan city, about 110 km along Aswan-Abu Simble road (Fig. 1) and between Sin El Kadab plateau from the north and Gebel Um Shaghir to the south. The study area is characterized by regular flat wavy plains limited to the north by the carbonate plateau that rises more than 500 m above sea level. The younger Cretaceous to Eocene rock units of the Sin El-Kadab plateau represent the southern part of the huge limestone plateau that covering most of the Western Desert plateau areas. To the south of the area, the basement rocks outcrops at Gebel Um Shaghir.

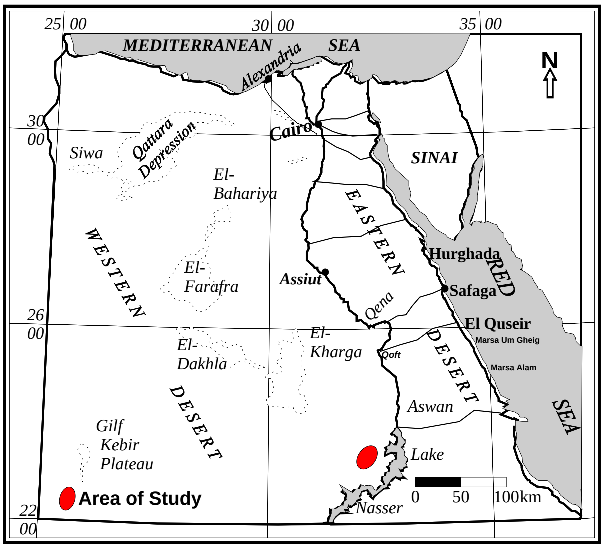

Fig. (1): Location map of the study area.

The study area is located within the dry arid belt of North Africa. It is characterized by scarcity of rainfall, high temperature and low humidity (an average yearly humidity of 30%)). Temperature is typical as that of desert; where the average temperature throughout the year is around 27^{o}C with a maximum of 50^{o}C in summer. Wind regimes depend upon temperature and presence of high and low pressures cells. High wind speeds carrying sand granules may cause serious damage to agricultural land and infrastructure. Few clouds appear in winter. Prevalence of present aridity is manifested in the formation of sand dune accumulation and sand sheet, scarcity of natural vegetation and lack of inland surface water.

This work aims to study the subsurface layering in terms of the lithologic variation of the encountered rock succession and to delineate the subsurface geologic structures including the occurrence of aquifers in order to locate the best sites for drilling water wells. To achieve these objectives, a detailed geophysical survey (land magnetic and geoelectric soundings), has been carried out.

GEOMORPHOLOGY AND GEOLOGY

Geomorphologically, the area is distinguished mainly into five units namely the wide plain to the west of Lake Nasser, drainage lines (as Wadi Kalabsha), remnant conical hills; Gebels (Um Shaghir and Bargat El Shahab) and Sin El Kadab plateau with its escarp towards the northwest of the area, (El Shazly et al, 1980, and CONOCO, 1987). The plain, which normally ranges in width from 20 to 30Km, has been the scene of activity of the older Nile in the Quaternary and Tertiary ages (Butzer and Hansen, 1968). It is sometimes called Kalabsha plain to the south where the bed rock is mainly Nubian sandstone. Sin El Kadab plateau and its continuation-starts from the plain and extends north-westwards to El Kharga Oasis depression. The wadis which are running from the plateau towards the Nile, are mainly controlled by the ENE-WSW and E-W fractures, although their tributaries are controlled to a considerable extent by the other fractures and rock texture. The branches of Lake Nasser are formed by water back filling the wadis draining the desert to the east and west of the River Nile. At Kalabsha the branches of the lake are particularly well developed and they are controlled by the NNW-SSE, ENE-WSW and E-W faults.

Geologically, the area is dominated by a sedimentary succession ranging from Cretaceous to Quaternary unconformably overlies the Precambrian basement rocks. The igneous-metamorphic rocks are represented by the exposures of Umm Shagher granite and associated rocks (CONOCO 1987). From oldest to youngest these sedimentary formations are Nubia, Dakhla, Kurkur, Gara and Dungul formations (Fig.2). These formations are overlain by a variety of Quaternary deposits. The whole area is belonging to the so-called Arabio-Nubia massif.

The escarp at the western side of the Nile starts at the base with the Lower Esna Formation, followed upwards by the essentially Paleocene Gebel Garra Formation and the Lower Eocene Upper Esna Formation and Gebel Serai Formation Gebel Garra Formation is made up of chalk and limestone with subsidiary marl and shale (Issawi, 1968). Conglomerate accumulated on the southern part of the escarp slope, while playas are superimposed on the Nubian sandstone plain near Kalabsha. The tufa and calcite are originally related to the hydrothermal activities of the tectonic movements of the late Pliocene-early Quaternary, which have been partly mobilized and re-deposited by the climatic conditions prevailing in the later Quaternary (Butzer and Hansen, 1968).

El Shazly et al. (1977) differentiated the Nubia Sandstone into three main litho-stratigraphic members. The oldest is the white to purple sandstone member (fine to medium grained sandstone beds intercalated with thin clayey and shaly bands). In some places, this member is conformably overlain by a thin succession of alternating beds of clays, shale, sandy clay and sandy shale which constitute together the red clay member. The uppermost litho-stratigraphic unit of the Nubia Sandstone is the brown ferruginous cross-bedded sandstone member, commonly intercalated with thin beds of grey shale and clays. On the other hand, some kaolin deposits are found to be intercalated with the lowermost sandstone beds near its lower contact with the underlying granite as observed at Wadi Kalabsha. The Phanerozoic Volcanics are found as sheets covering or interbedded with the Nubia Sandstone beds.

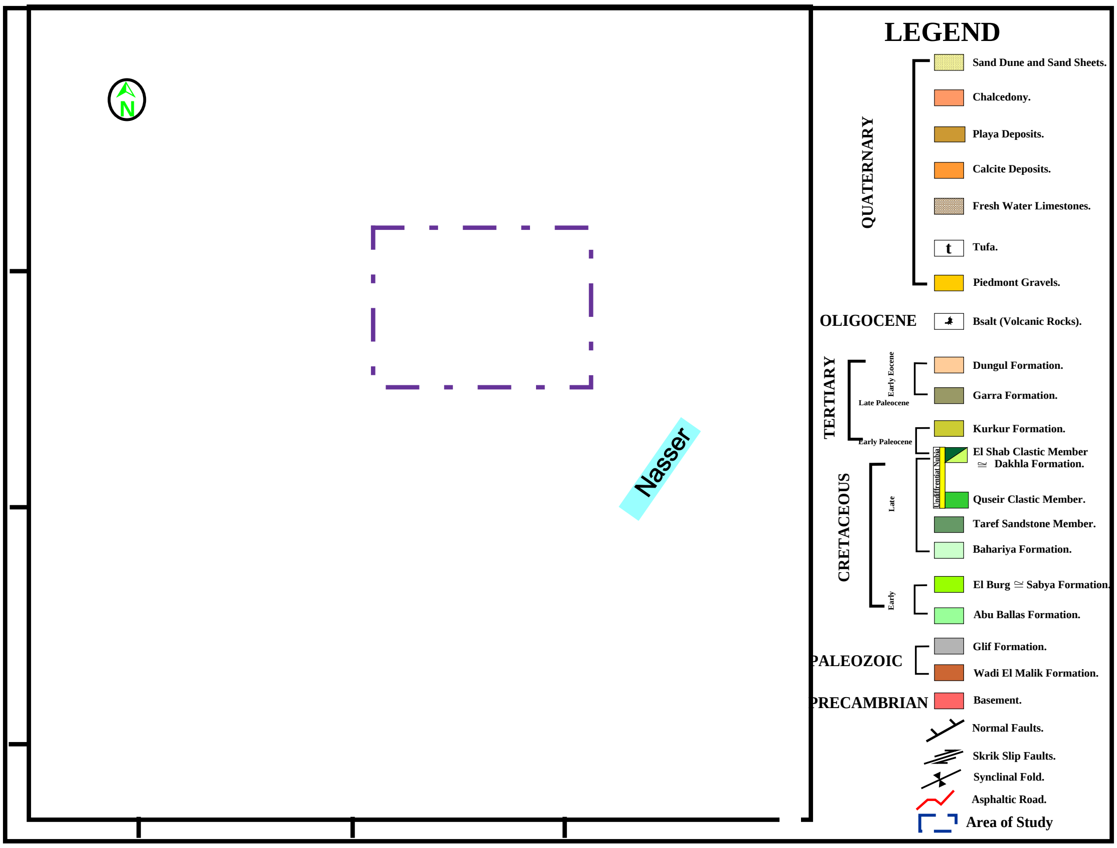

Fig. (2): Geologic map of the study area and its vicinities (CONOCO, 1987).

Structurally, the area is dominated by the ENE-WSW folding of the open type occurring on a regional and minor scale, while the fractures and faults belong to several trends and are either extending for long distances or they may be short and grouped together in parallel arrangement echoing the major fractures. These are characterized by three main fault trend (NW-SE, N-S and W-E directions). (El Shazly et al., 1980).

The previous geological and geophysical studies, carried out in the area, show the presence of a set of faults crossing the Nubian formations and possibly the basement complex. The largest of which is the Kalabsha and Seial faults, trending mainly in an E-W direction. Geological, seismological, geomorphological and geodynamical evidence indicate that Kalabsha fault is a right lateral slip fault (Issawi, 1968, 1978 and others).

DATA ACQUISTION AND INTERPRETATION

a– The Land Magnetic Survey:

The magnetic measurements are used to determine the basement relief, thickness of the sedimentary rocks and subsurface structure. Two units of proton magnetometers model Envimag from Centrex Company with a sensitivity of 1 gamma, were used to collect the field data measurements. The first unit was fixed as a base station for further corrections, while the second unit was used for measuring the field data at different stations with interval between each two successive stations of 100 m.

The accuracy of magnetic measurements is expressed in term of the mean quadratic error that attaining ±0.9 gamma. Also 10% repetitions of the total measured points were fulfilled. The total intensity of the earth's magnetic field (TMI) was measured at 1162 stations along two profiles m_1-$m_{1'}$ (32 km) and m_2-$m_{2'}$ (22 km) in Northeast–Southwest and Wes-East directions respectively, as shown in Fig. (3).

The total magnetic field measurements must be corrected for diurnal variation, where the magnetic intensity varies with time and causes distortion of the earth's magnetosphere. The corrected field data at any station is estimated by subtracted or added the correct values of the base station at the corresponding time. These corrected data are used to produce two total intensity magnetic profiles. The corrected data is reduced to the magnetic pole process as Reduced to the Pole process (RTP), by using Geosoft program, 1994.

Qualitative interpretation of magnetic data:

It is a rapid and rough description of the recorded anomalies and explanation of the anomalies that may give a primitive imagination about the characteristics of the causative bodies. The magnetic anomalies have characteristic shapes, which depend essentially on strike and dip of the bodies, their depths of burial, inclination and declination of the inducing magnetic field.

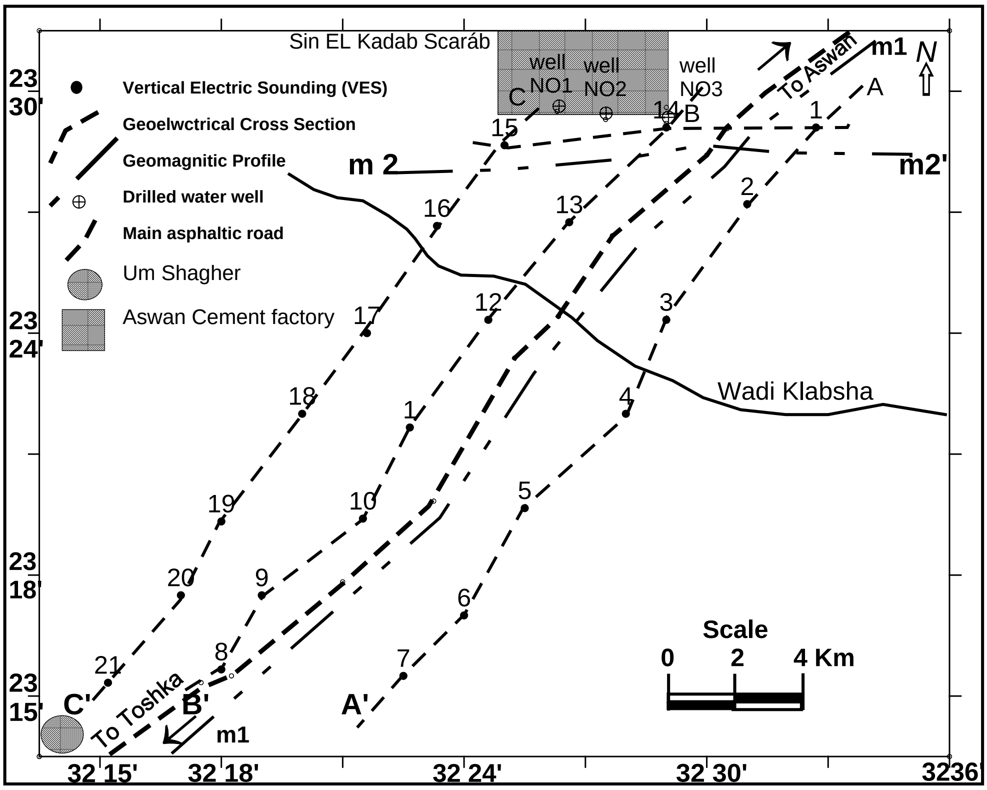

Fig. (3): Location map of the Wells, Land Magnetic profiles, VES stations and geoelectric cross sections in the study area.

Quantitative interpretation:

The main target of the quantitative interpretation is the computation of the depth to the basement rocks. The modeling procedure assumes different polygons, which represents the proposed structure along the modeled profile (Figs. 8 and 11). The upper parts of the model represent the observed and the calculated curves. The modeled cross sections are extrapolated in the two sides to control the edge effects. Changing the depths and susceptibilities of different polygons could be carried out until a best fit is obtained between the observed and calculated curves.

Some parameters must be defined for this program as that the area inclination (32.39°) declination (2.35°), magnetic field strength (40429 gamma), and height of the instrument sensor from the ground surface (1.6m). Use was made of the data obtained from the drilled wells in the area. To outline and confirm the regional structure framework of the area of study, magnetic profiles were modeled (profile m_1-$m_{1'}$ and profile m_2-m_2) from the derived total magnetic field, reduced to the pole by using Geosoft Program (Potential Field Modeling/GM–SYS Interactive Modeling) (Figures 5 and 8).

b- The Vertical Electrical Sounding (VES):

A total of 21 Vertical Electrical Soundings were carried out in the study area (Fig. 3). They are distributed along three parallel profiles (AA\`), (BB’) and (CC’) in the NE-SW direction.

The Schlumberger 4-electrode array was applied with a current electrode separation (AB) as maximum as 2000m. This separation was sufficient to reach the required depth that fulfills the aim of the study in view of the geologic and hydrogeologic information. Use was made of the digital earth resistivity meter (Terrameter model SAS 1000) that directly measures the resistance (R) at each electrode separation with high accuracy. In order to parameterize the geoelectric result, VES No.14 was measured near to new Cement Factory (MEDECOM ASWAN) well No.3. Figure (4) illustrates the lithologic and well-logging of that well and the field geoelectric curve of VES No.14.

Interpretation of the VES curves was carried out using computer program RESIST (Interpex, 1996). It is an interactive, graphically oriented, forward and inverse modeling program for interpreting the resistivity curves in terms of a layered earth model. The interpretation revealed that the geoelectric succession in the area consists of three geoelectric zones; A, B and C (11 beds) as shown in figures (6, 7, 8 and 9) and table 2.

The lithologic succession penetrated in drilled well No.3 (32º 28´ 33.1,″ E – 23º 29´ 51,6″ N, Fig. 3) is given in Fig. (4). The Nubia Sandstone shows, as a general rule, rapid and extensive change in facies both vertically and laterally, and hence its petrophysical properties are notably variable.

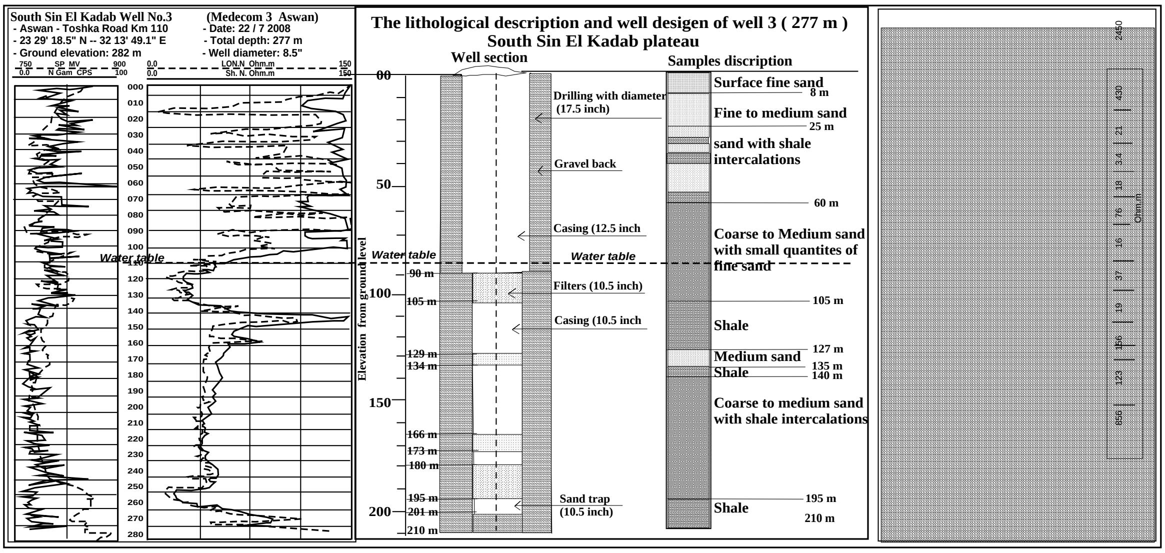

Fig. (4): Well logging chart, lithology of the Nubia sandstone succetion at drilled well No.3 km 110 and field curve of VES No. 14 , Aswan - Abu Simble road Km 110.

Hasan and Radwan, (1996), used the Bouger anomaly map to estimate the depth to surface of the basement in the area to the NW of Lake Nasser. Nine profiles used for depth estimation.

DISCUSSION OF THE RESULTS

a- Magnetic Results

The computer program (Geosoft, 1994) which used for the calculation of the magnetic model along a given profile presents the results in the form of a graph consisting of two parts; an upper part representing the observed and calculated magnetic curves and lower part showing the corresponding basement cross sections (Fig's 8, and 11). In the following, the results displayed by each of the four modeled cross sections are discussed:

Modeled magnetic cross section (m_1-$m_{1'}$):

This magnetic cross section (Fig. 8) extends along the NE-SW direction of the study area. The basement surface seems to be generally slopping towards the northeast, as the depth from the ground surface increases northward from about 220m to about 260m. Two major faults F_1 and F_2 (Kalabsha fault) could be detected along this profile. They are normal faults cutting the basement section that play an important role in the occurrence of groundwater within the overlying sedimentary section.

Modeled magnetic cross section (m_2-$m_{y'}$):

This cross section extends (22 km long) in the W-E direction (Fig.11). The magnetic susceptibility of the basement polygon is assumed to be 0.02 nT. There is a fault (F_3) near the eastern end of the profile, with its down throw to the east direction. The basement surface slopes gently to the east where the depth to basement increases from 250m to 300m eastwards.

b- The Vertical Electrical Sounding:

From the interpreted results the resistivities and the corresponding thicknesses of the different geoelectric layers at each VES station were used to construct four geoelectric cross sections. A A’, B B’, C C’ (NE-SW) and D D’ (W-E). (Figures 8 to 11 and table 2). This interpreted results revealed that the geoelectric succession is composed of 3 main zones (11 layers). A generalized description of this succession is given as follows:

- The dry geoelectric zone “A” (differentiated into 4 beds):

The first geoelectric layer is formed of dry wadi deposits and drift sand with high resistivity values ranging from 200 to 1100 Ohm-m. Its thickness ranges from 1.5 m at VES No.7 to 3.8 m. at VES No.3. The low resistivity values may be due to the presence of silt or sandy soil, while the higher resistivity values are mainly attributed to the presence of boulders and gravels.

The second geoelectric layer is characterized by transverse resistivity values ranging from 10 Ohm-m at VES No.3 to 300 Ohm-m at VES No.7. It is composed of dry coarse sandstone, with variable thickness ranging from 6 m at VES No.7 to 7.5m at VES No.3. The lower resistivity values are attributed to the presence of shale that recoded at sounding no’s 12, 13, 14 and 15.

The third dry geoelectric zone attains transverse resistivity values ranging from 165 Ohm.m (recorded at VES No.15) to 263 Ohm.m (recorded at VES No.7. It may be made of intercalated of sandstone, clayey sand and sandy clay. Its thickness ranges from 53 m at VES No.4 and 12 to 80 m. at VES No’s.14 and 16. The iso-resistivity contour map of this layer (Fig.5) indicates that the electrical resistivity increases south westwards of the area where coarser deposits occur.

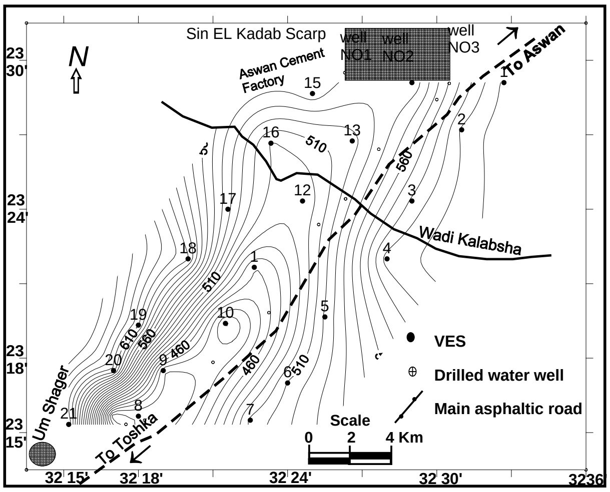

Fig. (5): Isoresistivity contour map for the dry sandstone bed (no.3) in the area.

The fourth geoelectric layer which attains relatively low resistivity values ranging from 23 Ohm-m at VES No.11 to 30 Ohm-m at VES No.8 and may be formed of shale. Its thickness ranges from 19 m at VES No's 2, 11 and 17 and 27 m at 1, 7 and 15. Figure (6) illustrates the isoresistivity distribution within this layer.

- The second geoelectric zone "B" (the saturated zone differentiated into 5 beds):

The first geoelectric layer composed of coarse sandstone which attains resistivity varies from 54 Ohm.m at VES No.6 to 121 Ohm.m at VES No.2. Its thickness ranges from 12m at VES No. 21 to 15 m at VES No.7.

The second geoelectric layer has low resistivity and may be composed of shale which attains resistivity ranges from 21 Ohm.m to 29 Ohm.m. Its thickness ranges from 14 m. at VES No's.3, 10, 18 and 19 to 18 m at VES No.15. Its distribution is spatially illustrated as an iso-resistivity contour map (Fig. 6). It shows that the resistivity values increase south west wards which may be due to increase of sand percent in that shale bed to become sandy shale.

The third geoelectric layer composed of saturated sandstone and clayey sandstone with resistivity ranges from 37 Ohm.m at VES No.17 to 72 Ohm.m at VES No.6 Its thickness ranges from 38 m at VES No.11 to 44 m at VES No. 8.

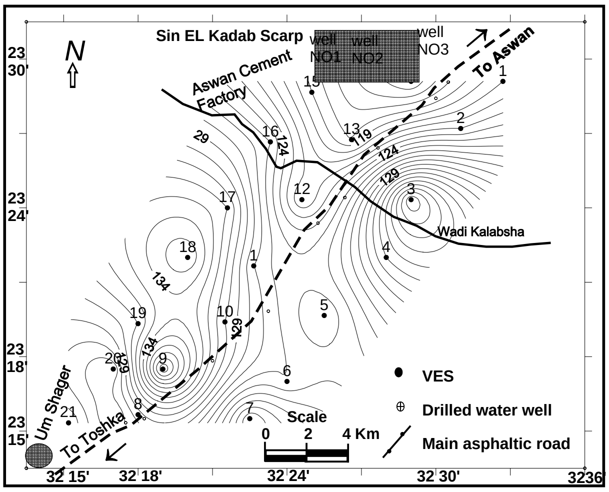

Fig. (6): Isoresistivity contour map for the upper sandstone water bearing bed in the area.

Table (1): Resistivity ranges, thickness variations and corresponding lithology of the detected geoelectric layers.

Zone	Layer No.	Resistivity (Ohm-m)	Thickness (m)	Corresponding lithology
Dry zone "A"	1	200-1100	1.5 – 3.8	Dry wadi deposits (boulders and gravels)
	2	10-300	5 – 7.5	Dry fine to coarse sandstone
	3	165 -263	53 – 80	Fine sandy clay and fine to medium sandstone
	4	23 - 30	19 - 27	Shale
Saturated zone "B"	5	54 - 121	12 - 15	Coarse sandstone (water bearing)
	6	12 - 17	14 - 18	Shale
	7	21 - 29	38 - 44	Fine sand and clayey sand (water bearing)
	8	12 - 21	19 - 22	Shale
	9	63 - 126	43 - 48	Coarse sandstone (water bearing)
Lower zone "C"	10	13 - 26	13 - 17	Black clay
	11	>1500	----	Basement

The fourth geoelectric layer is formed of shale deposits with a resistivity ranges from 12 to 23 Ohm.m and its thickness ranges from 19 m at VES No.13 (section B B') to 22 m at VES No.11 (section B B')

The fifth geoelectric layer is coarse sandstone (water bearing). Its thickness varies from 43 m recorded at VES No.s 9 and 10 to 48 m at VES No's 12, 13, 14 (section B B'), 15, 16, and 17. (section C C'). Its resistivity varies between 63 Ohm-m at VES No.14 to 126 Ohm-m at VES No.9.

- The bottom dry geoelectric zone "C" (2 beds)

The first geoelectric layer has a resistivity ranging from 13 Ohm-m at VES No.11 to 26 Ohm-m at VES No.3. Its thickness varies from 13m at VES No.3 to 17m at VES No.11. This layer is believed to be black clay.

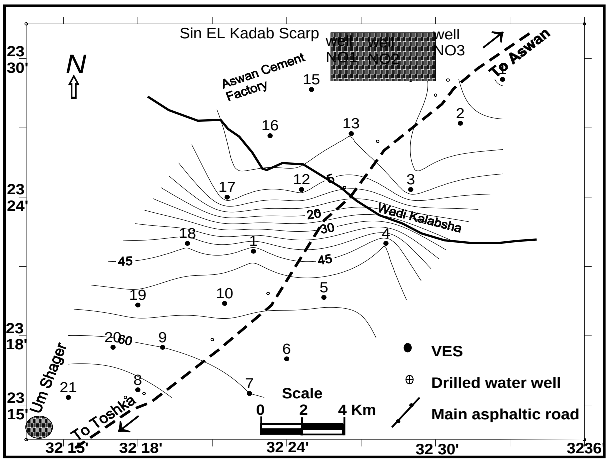

Fig. (7): Isoresistivity contour map for the clay bed in the area.

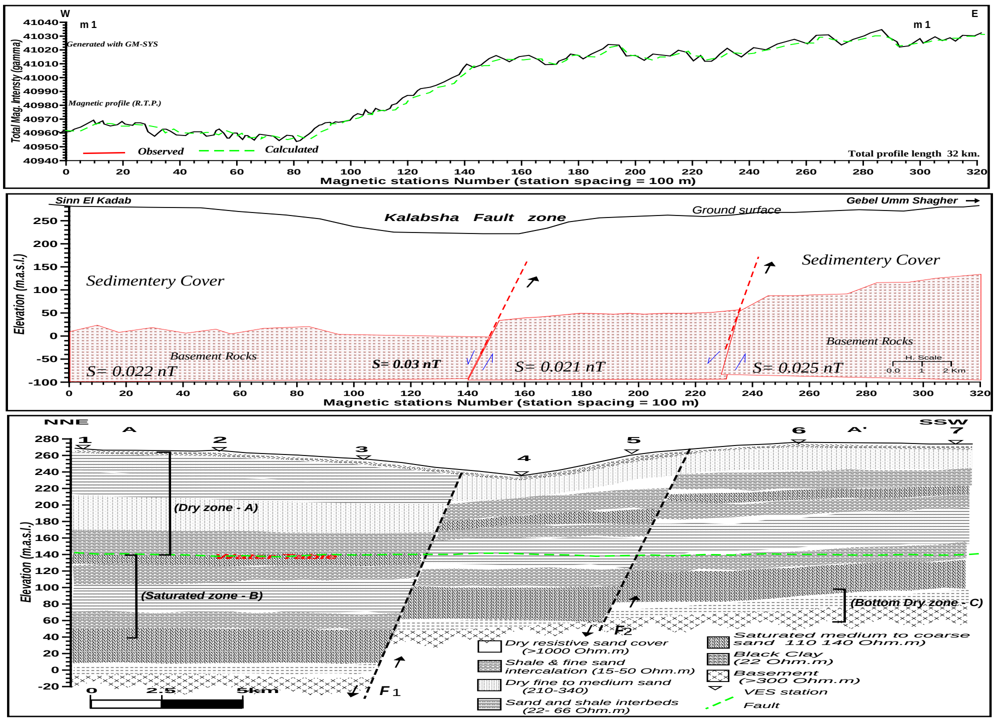

Fig. (8): Geomagnetic and Geoelctric cross section A A'.

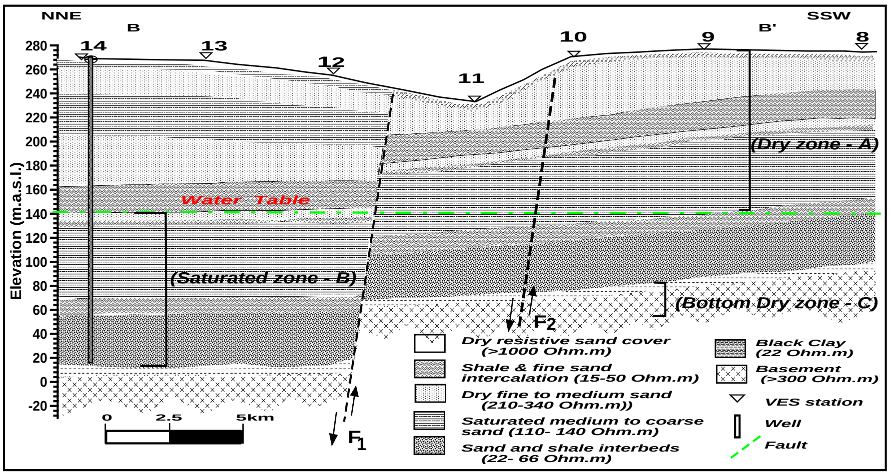

Fig. (9): Geomagnetic and Geoelctric cross section B B'.

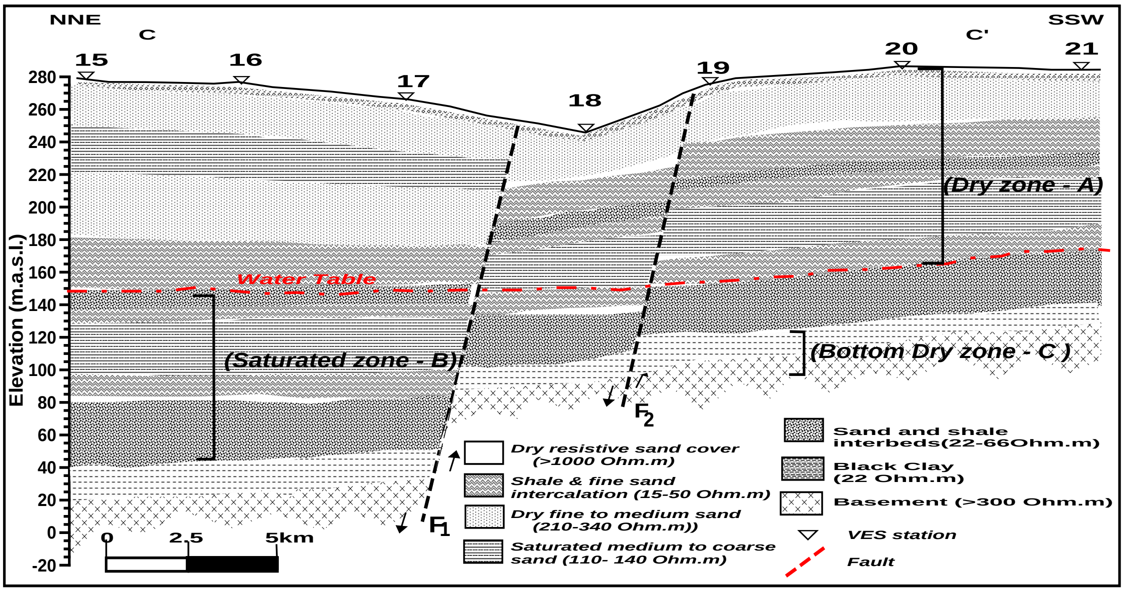

Fig. (10): Geomagnetic and Geoelctric cross section CC'.

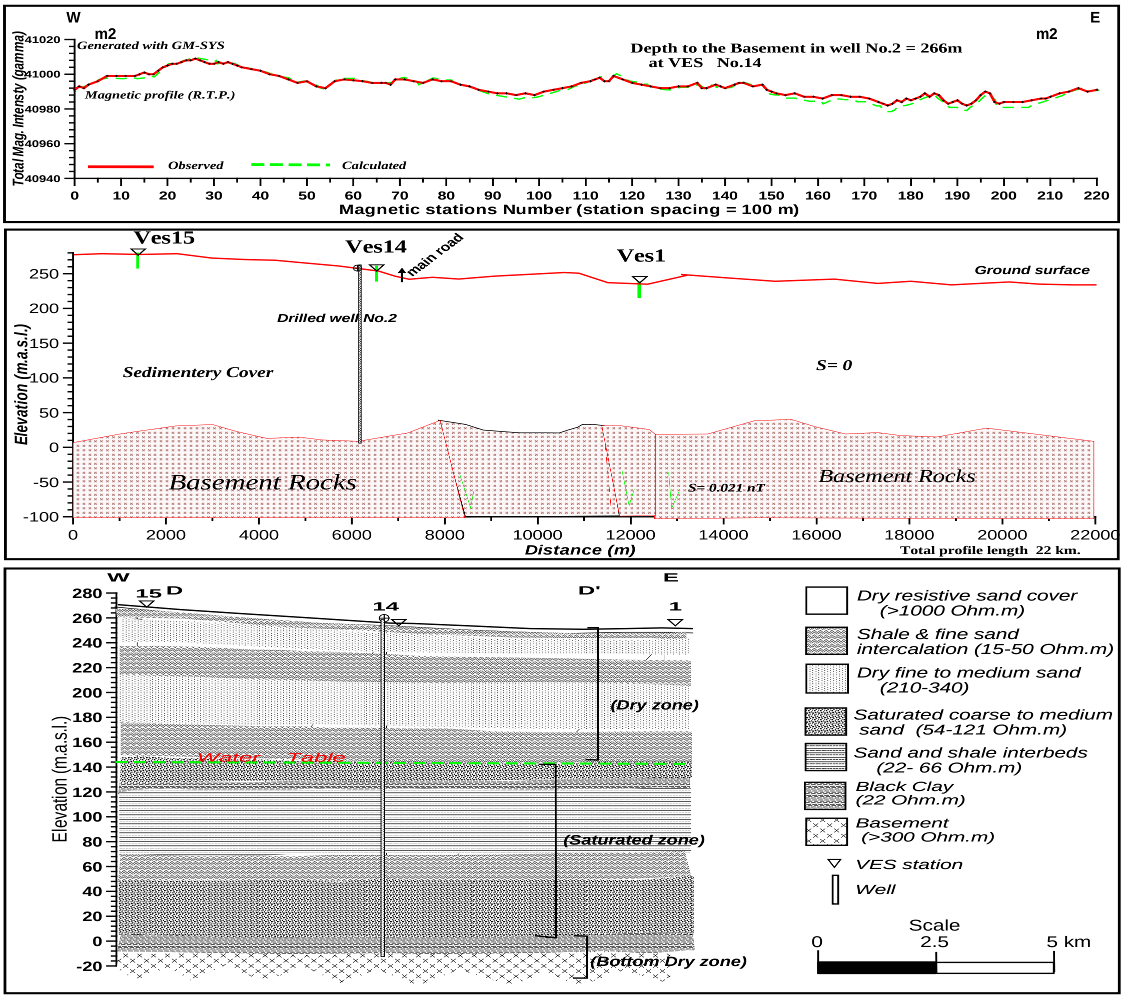

Fig. (11): Geomagnetic and Geoelctric cross section DD'.

The lowermost geoelectrical layer has been detected at all the soundings which represents composed of the basement rocks. It layer attains very high electrical resistivity values that greater than 1500 Ohm-m

The vertical and horizontal extensions of the above described geoelectrical successions are indicated on the geoelectrical cross sections. From these cross sections, it is clear that three normal faults affect the succession (F_1, F_2 and F_3), which are confirmed by the geologic information available for the study area.

The first two faults directed NNW with down thrown towards the north. While, the third fault was detected in the second magnetic profile m_2-$m_{2'}$ directed north-south, with down thrown towards the east. The surface of the basement was recorded in all soundings, which ranges from 160 m to 240 m.

From the previously mentioned discussions the area of study is of good groundwater potentiality. The first priority for the recommended new water wells is the locations of soundings to the north of the fault (F_2) and the second priority is the location at the area between the two faults F_1 and F_2.

HYDROGEOLOGY

- Depth to water bearing contour map:

For practical purposes, the depth to the water bearing formation contour map (fig.12) was constructed by using the interpreted depths to top of the upper water bearing formation across the area. It is useful in predicting the depth to water in the area where new water wells intended to be drilled. This is quite necessary for the agricultural or industrial development of the area based on its groundwater resources. The map indicates that the middle part of the area is the place where a minimal depth to water (120-125m) is expected, while it increases gradually to reach 140m in the northern edge of the area which must be due to the change in surface topography of the area.

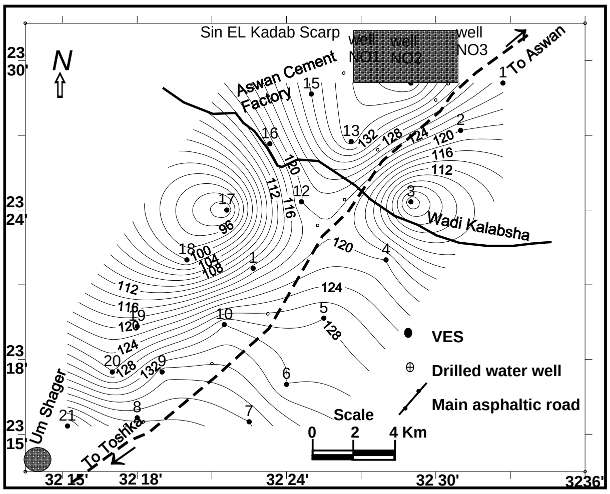

Fig. (12): Depth to the water bearing formation.

- The Isopach map of the cumulative thickness of the water bearing sandstone layers:

This map was drowen by using the total saturated thickness of the water bearing sandstone geoelectric beds at all soundings (Fig.13). It. shows the increment of the thickness towards the north of the area. The saturated thickness reached its maximum value at the northwestern corner (i.e. 143.7m), while it reachs about 55.2 m at the south east corner.

- The depth to the basement rocks:

A contour map for the upper surface of the basement rocks has been generated (fig. 14). This map indicates that the configuration of the basement rocks coincides reasonably with that calculated from the total magnetic intensity measurements (Figures 7 and 10). The average estimated depth to the basement surface is 263m.

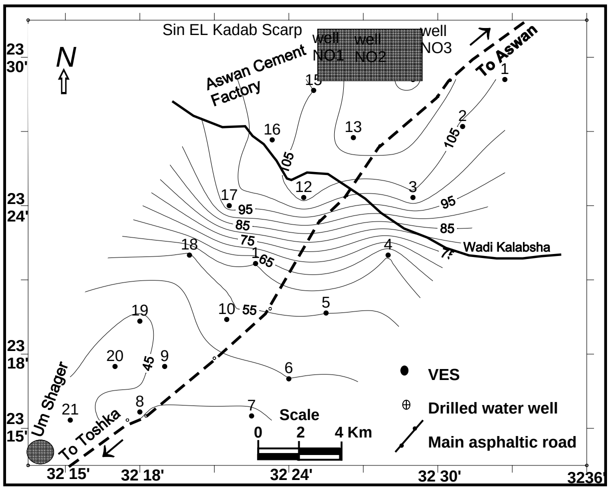

Fig. (13): Isopach aquifer map of the water bearing sandstone.

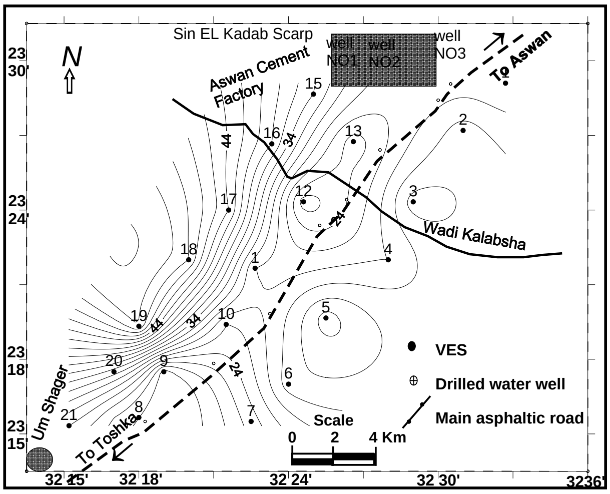

Fig. (14) Depth to basement bed rocks.

- The hydraulic parameters of the main aquifer:

Pumping tests were conducted in Aswan Cement Factory wells (MEDECOM) to deduce the hydraulic parameters of the Nubia sandstone aquifer.

Table (2): Well Data of Aswan Cement (MEDECOM) in the Study Area.

Well No.	Ground surface level (m)	Total depth (m)	Aquifer thick. (m)	Saturated thick. (m)	Depth to water (m)	Productivity m^3 / day	Salinity ppm
1	183	277	150	120	143	70	
3	167	250	140	115	130	70	

Table (3): Hydraulic parameter carried out of constant discharge pumping test.

Well No.	Well depth (m)	Discharge Q (m^3/h)	Drawdown (m)	Static Water depth (m)	T (m^2/h)	K (m/d) m^{-1} m/h	S
1	277	70	2	40	450	173	0.222×10^{-2}
3	250	100	3	40	700	186	0.230×10^{-2}

The Nubia formation in the study area varies in thickness from 85 m to 144 m. The hydraulic conductivity was estimated from two wells with discharge rates of 840 m^3 /day for a period of 24 hours with aquifer thickness of about 144 m thick. The modified non-equilibrium equation of Jacob method was used to analyse the data from pumping tests and analyse the data for recovery. Table (2) shows the well data in the study area.

The hydrogeologic characteristics of the detected water bearing Nubia Sandstone layers are presented in table (3) including transmissivity (T), hydraulic conductivity (K) and specific storage (S). The results are out of constant discharge pumping tests. The hydraulic conductivity is 1.73 m/day and transmissivity is 520 m^2/day. Specific storage is assumed to be 0.222. This value is much close to the effective porosity which ranges from 0.15 to 0.2 because the aquifer is approximately confined. From the lithology of these wells, the maximum depth to basement is about 265 m and the average depth to groundwater is 140 m and the saturated thickness is 144m. The quality of groundwater is good, (salinity is < 1500 p.p.m). Groundwater potentiality in the area is controlled by lithology of deposits, saturated thickness, depth to groundwater, groundwater extraction and the water quality in the area.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study area lies southwest of Aswan City, at Aswan Abu Simble main road (between Km 108 and Km 140). It lies to the southern part of Sin El Kadab ranges to Gebel Um Shaghir southwards covering a surface area of about 350 Km^2. To evaluate the hydrogeologic conditions of the area, geophysical including land magnetic and geoelectric measurements have been conducted along with the hydraulic evaluation of the aquifer.

Two land magnetic profiles were carried out with a unit station separation of 100m and 21 Vertical Electrical Soundings (VES) of Schlumberger configuration with maximum distance between the current electrodes (AB) reaching 2000m.

The magnetic interpretation reflected the basement topography that have high values in some locations, especially at SE portion of the area which represent the existence of high structure, while the N and NW portions represent structural depression.

The interpreted results of the geoelectric survey show that the succession consists of three geoelectric zones (“A”, “B” and “C”). The surface zone “A” is composed of dry alluvium of Quaternary deposits and dry sandstone, clayey sand and sand intercalations and shale. Zone “B” is the saturated units which consist of Nubia Sandstone, clay, clayey sand interbeds. While zone “C” is composed of clay, followed downwards by basement rocks. The area is influenced by several faults, which resulted in uplifting of the basement rocks at different levels that affected the succession and hence the water bearing aquifer setting.

The lithologic description of the sandy succession indicates the majority of hydrothermal iron-rich solutions affected the sandy nature of the area and played a great role in their hardness and cohesive properties of such rocks. In general, most of the studied area is suitable for agriculture, as there is a considerable soil thickness, good soil content and groundwater supply. The aquifer is mainly of confined type.

The aquifer system can be divided into three main sandstone units separated by intermediate confining clay and shale beds varying in thickness from few meters to tens of meters. It has a maximum thickness of about 140 m with an average value and the hydraulic conductivity of 1.73 m/day and transmissivity of 520 m^2/day. Specific storage is assumed to be 0.222. The bottom of the aquifer is mainly composed of black clay over lying the basement rocks. The aquifer zones are neary fresh.

Recommendations:

The following recommendations could be presented:

- The most favourable sites for drilling new water wells occupy the northern portion of the area where the aquifer thickness is relatively reasonable.

- Depth of drilling must reach the surface of the basement to use the full thickness of the aquifer and reach the maximum discharge (250 – 300m).
- It is important to carry out detailed hydrogeological studies for the whole area between Aswan and Toshka, west Nasser Lake to obtain a quantitative evaluation of the groundwater potentialities.
- New observation wells are to be drilled to monitor the aquifer behavior and more calibration is required when getting more field records.
- A theoretically sound representative model should be carried out for long term planning. Such model can be upgraded as additional information about the aquifer system become available.

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