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GEOPHYSICAL STUDY FOR THE GROUNDWATER POTENTIALITY FOR THE UPSTREAM PART OF WADI EL KHARIT–SOUTH EASTERN DESERT-EGYPT

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دراسة جيوفيزيقية على إمكانيات المياه الجوفية للجزء الأعلى لوادى الخريط–جنوب الصحراء الشرقية– مصر

الخلاصة: تقع منطقة الدراسة فى الجزء الأعلى لوادى الخريط – جنوب الصحراء الشرقية. و يصب هذا الوادى فى نهر النيل على بعد ٤٠ كم شمال مدينة أسوان. الغرض من الدراسة هو تقييم إمكانياتها من المياه الجوفية ومن ثم تحديد أفضل المواقع لحفر أبار للمياه. ولتحقيق ذلك فقد تم عمل قياسات لثلاثة بروفيلات مغناطيسية أرضية ومسح كهربى بطريقتى الجسات الكهربية الرأسية (٢٨ جسة)، وخمسة بروفيلات الكهربية ثنائية الأبعاد.
بتحليل نتائج القياسات الجيوفيزيقية تبين إن التتابع الجيوكهربى يتكون من ثلاثة نطاقات. وتتكون هذه النطاقات من رواسب العصر الرباعى والتى تتمثل فى رواسب الوديان الجافة ويليها إلى الأسفل النطاق المشبع بالمياه والذى يتكون من رواسب الوادى المشبعة مع / أو صخور القاعدة المتشققة المشبعة بالمياه وأخيراً صخور القاعدة الجافة غير المتشققة. وقد بينت النتائج أن المياه الجوفية تتواجد فى كل من رواسب الوديان ببعض المواقع وصخور القاعدة المتشققة. بينما يوجد كلا النوعين من الخزانات بسمك إجمالى يبلغ عشرة أمتار تقريبا بالجزء السفلى من الوادى (مواقع الجسات_٩، ١٠، ١١، ١٢ ، ٢٤، ٢٥، ٢٦ ، ٢٧) فأن النوع الثانى فقط من الخزانات هو الذى يوجد أعلى الوادى (مواقع الجسات ١......٦ ، ١٣ ،١٤، ١٥، ......٢٣ ، ٢٨) بسمك يتراوح من ثلاثة الى خمسة أمتار. أما بالجزء الأوسط من الوادى (مواقع الجستين ٦، ٧) تختفى عنده المياه الجوفية نظرا لوجود فالقين يحصران بينهما كتلة مرتفعة صاعدة من صخور القاعدة.

ABSTRACT: *The concerned area (the upstream portion of Wadi El Kharit) has been geophysically studied applying of Land Magnetic, Vertical Electrical Sounding and Electrical Resistivity Imaging techniques. The aim of this study is to evaluate the groundwater potentiality along the main channel of Wadi El Kharit.*
The land Magnetic Survey was accomplished through measuring 1740 stations along 3 profiles. Its interpretation revealed the configuration of the upper surface of the basement and faults that affect the basement blocks along these profiles.
The geoelectric resistivity survey includes 28 vertical electrical soundings and five resistivity imaging profiles (2-D). The subsurface succession downward consists of three geoelectric zones: dry wadi deposits composed of silt, sand, gravel and rock fragments as well as two water-bearing layers, the first layer is composed of wadi deposits (detected only at some sites) and the second is the saturated fractured basement rocks and the last zone is dry massive basement rocks.
The results of interpretation revealed that many faults affect the main stream of Wadi El Kharit. The two water bearing layers are; the upper layer consisting of wadi deposits (at VES No's 9, 10, 11, 12, 24, 25, 26 and 27) and an underlying layer consisting of fractured basement. In the upstream of the wadi, the only water bearing layer is the fractured basement (at VES No's 1, ….., 6, 13, …..23 and 28). While no groundwater is detected at the sites of VES No 7 and 8 due to a horest block of the basement at these sites. The results showed also that the basement relief and dykes as well as intersecting faults control the groundwater occurrences in the area. It was concluded that the promising parts of the area as to groundwater occurrences are those covered by VES stations 2, 6, 6, 10, 11,13, 16, 24, 25 and 26, where groundwater was detected at a depth of 8–18m.
Keywords: *geophysical techniques, Land Magnetic, Vertical Electrical Sounding, 2-D resistivity.*

INTRODUCTION

Wadi El Kharit lies in the southern part of the Eastern Desert of Egypt, between longitudes 34° 25'-35° 05' E and latitudes 23° 50'- 24° 15' N, occupying an area of about 1300 km^2 (Figure 1). It includes one of the promising areas of the Eastern Desert as to the future sustainable development in the fields of land reclamation, animal production and tourism. The area faced a series of drought periods that strongly affected the daily life of the nomadic community living there. So, it was highly recommended to carry out geophysical and hydrogeological studies in the area with purpose of exploring its groundwater possibilities.

Wadi El Kharit (19100 km^2) represents the largest basin in Egypt *(El Shamy, 1992)*. It is a Nile drainage basin. The main heads of Wadi El Kharit are on the Nile-Red Sea water divide between G. Ras El Kharit and G. Mikbi at altitude of > 600 m.a.s.l. Wadi El Kharit lies about 40 km to the south west of Hamata. The rocks constituting its cliffs are mainly composed of older granitoids, exhibiting weathered boulders (water mellion and potatoes like boulders).

This part of Wadi El Kharit is selected due to the existence of talc as economic mineral and to its vital importance for bedeones community and water wells

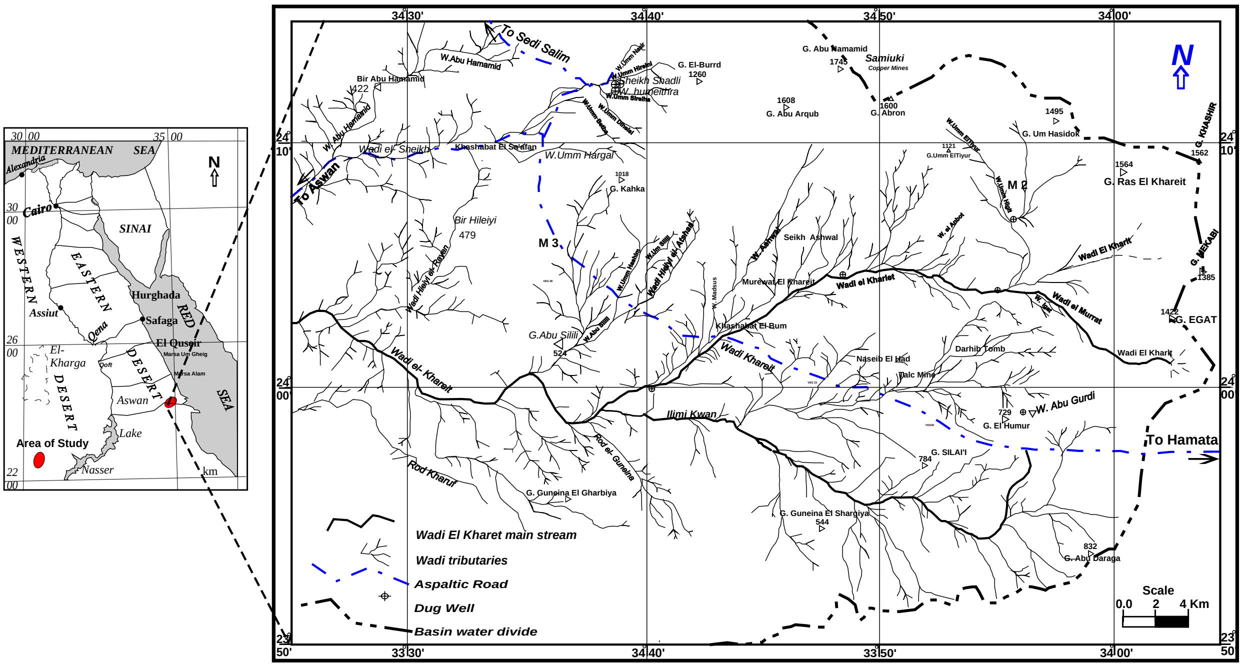

Fig. (1): Location map of the study area (Wadi El Kharit and its tributaries).

which represent the main source of fresh water suitable for drinking for the area and the new main road recently constructed between the Red Sea and Aswan beside; the presence of Sheikh Shadli Tomb. The climate of this area is characterized by extreme aridity with low and erratic rainfall; sometimes with flash floods, high evaporation rates, high summer temperature and generally vigorous winds.

The main objective of the present geophysical study is to study the subsurface layering in terms of the lithologic variation of the encountered rock succession and hence to delineate the subsurface geologic condition including the occurrence of aquifers and the affecting structures. This would lead help in locating the best suited sites for the drilling of water wells. To achieve these objectives, the following steps was followed up: (1) Reviewing the available previous information about the geomorphology, geology and hydrogeology of the area, (2) carrying out a detailed geophysical survey, (3) interpretation of the field measurements and presentation of the reached results and (4) discussion of the results and recommendations.

GEOMORPHOLOGIC AND GEOLOGIC SETTINGS

A- Geomorphologic setting:

Geomorphologically, Wadi El Kharit drains from Gebels Abu Hamamid (+1745m.a.s.l.), Abarun (+1600m.a.s.l.) and Umm Hasadak (+1496m.a.s.l.), Abu Arqub (+1608m.a.s.l.), Kahfa (+1018m.a.s.l.), Silai' (+784m.a.s.l.), Abu Daraga (+832m.a.s.l.) and El Humur (+1496m.a.s.l.). The upper part of Wadi El-Kharit contains many trees and bushes. Its total length is about 200 km. The upper part (25 km) has average slope of 8m/km.

The main tributaries of this basin are represented by Wadi El Sheikh, Wadi Hamamid, Wadi El Darahib, Wadi Abu Gurdi, Wadi Anbat, Wadi Abu Silili, Wadi Hileiyi and Wadi Halgit. Such wadis are temporary with regard to surface water runoff. The Red Sea mountains are the main source of floods which sometimes take place during October and April. The basin has an extended catchment's area about 10168 Km^2. The ratio of slope is of the rate 0.5%. The main ground elevation of the drainage ranges between 300 m to the west and 600 m to the east.

The area is built mainly of three geomorphologic units (DRC, 1984-1990) as follows:

1- The Red Sea Basement Mountains built up of igneous and metamorphic rocks; they represent the catchment's area of groundwater recharge for the aquifer in the area.

2- Hills and traces which scatter along both sides of the main stream.

3. The Hydrographic drainage basin and the water collectors of wadis and tributaries (Fig. 2), that drains the catchment area along the water divide between the Red Sea mountains and the Nile drainages area. It is built up mainly of Late Poroterozoic basement rocks.

B- Geologic setting:

Wadi El Kharit basin is occupied by basement complex and Quaternary deposits. The Precambrian rocks comprise Pre-Pan African Ophiolitic and Early to

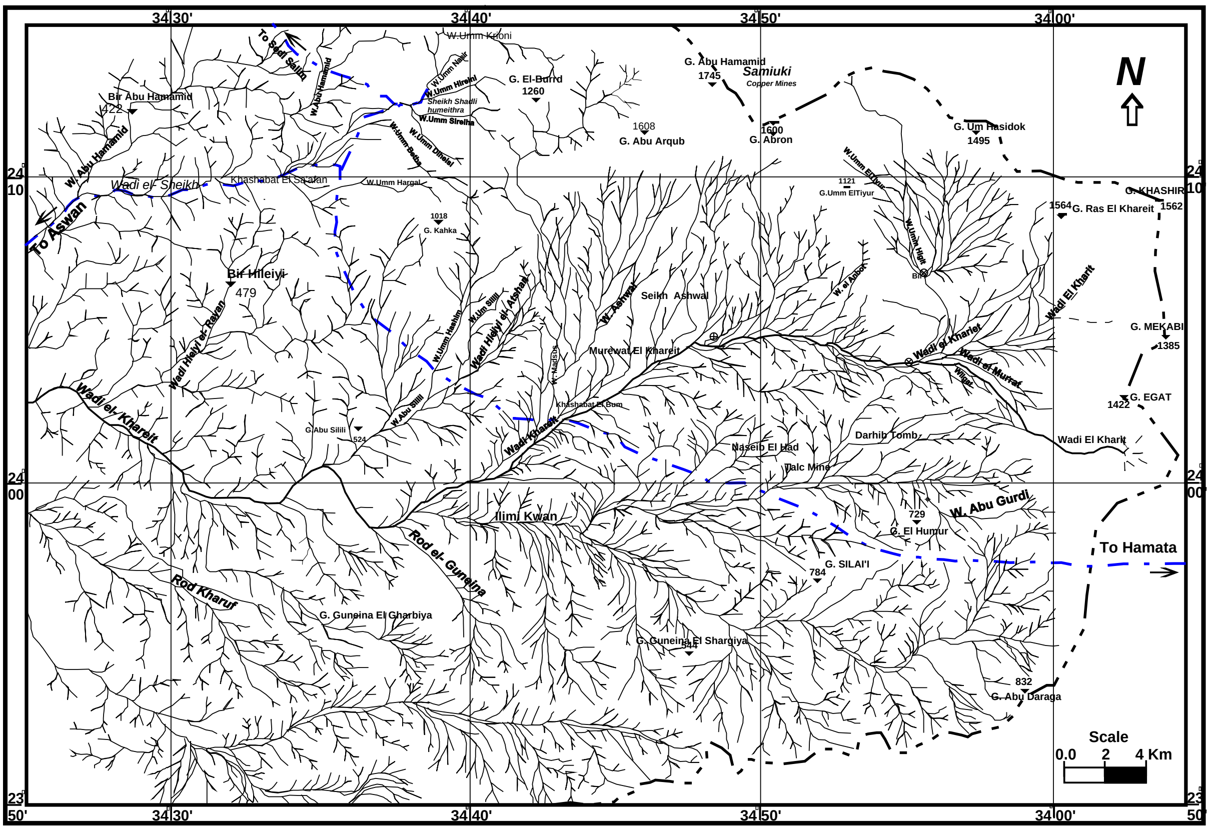

Fig. (2): The main drainage lines of the upstream portion of Wadi El Kharet.

Post Magnetic units. Alluvial wadi deposits are representing the Quaternary deposits (according to the geologic map "Conoco, 1987", Fig. 3). The geologic succession in Wadi El Kharit is illustrated in table (1).

Structurly, Wadi El Kharit basin is dissected by NS, NW and NE fault systems which control southern and western parts. Local dips appear to the east, north and west. Joints, fractures and dykes are secondary structures accompanying the major systems. These faults, folds and dykes affect the basement rocks and hence the groundwater occurrences (DRC, 1984-1990).

DATA AQUSITION AND INTERPRETATION TECHNIQUES

Field geophysical techniques:

The field work involved the use of three geophysical techniques for shallow subsurface investigation, namely, Land Magnetic, vertical Electric Sounding (VES) and 2-D electric imaging (Electric tomography). Land topographic survey was carried out by using geographic position system (GPS) in order to determine the accurate locations of the geophysical measurement points and their elevations relative to sea level by using of topographic map Scale 1:100000. Field measurements were carried out along the main channel of Wadi El-Kharit as shown in Figure (4). The application these techniques used is briefly given below:

- Land Magnetic Survey:

The magnetic measurements are used to determine the basement relief, thickness of the sedimentary cover and subsurface structure. The total intensity of the earth's magnetic field (Δt) was measured along three profiles. Two units of proton magnetometers model Envimag from Centrex Co. with a sensitivity of 1 gamma, were used for 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 50m interval between each two successive stations. 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 was measured at 1740 stations along three profiles M_1-$M_{1'}$ (35km), M_2-$M_{2'}$ (20km) and M_3-$M_{3'}$ (32km) in NE–SW, N-S and NW–SE directions respectively. (Fig.4).

The total magnetic field measured in profiles must be corrected from diurnal variation, where the magnetic field intensity varies with time and causes distortion to the magnetosphere of the earth. The magnetometer readings at the base station were used to construct a curve showing the variations of the magnetic field intensity with time. This curve was used to correct the field readings of the magnetic survey for diurnal variations.

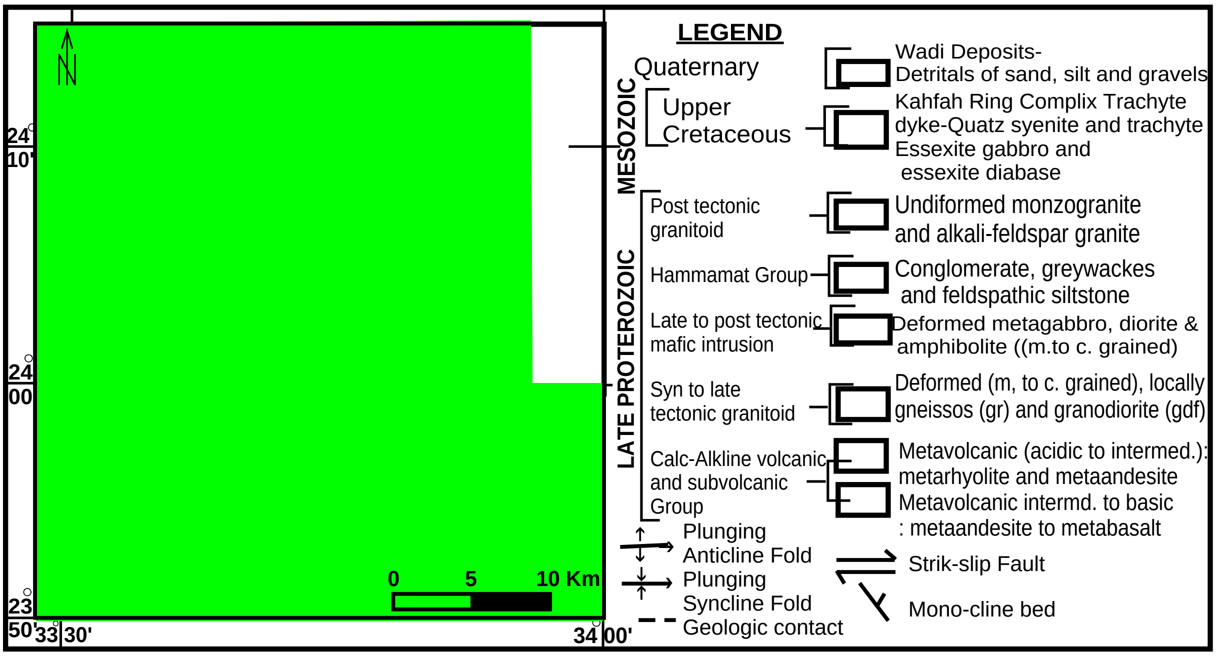

Fig. (3): Geologic map of Wadi El Kharit and its vicinities (After Conoco 1987)

Table (1): The geologic succession in Wadi El Kharit basin, (after Conoco, 1987).

Symb	Description	Stage	Epoch	Period	Era
Qd	Sand Sheets		Holocene Pleistocene	Quaternary	CENOZOIC
QW	Wadi deposits				
QP	Playas or mud fans				
Ks	Trachyte plug and sheets	Upper Cretaceous	Cretaceous		MEZOZOIC
Kv	Wadi Natash volcanics, mainly dolerites and andesites, intruded in Nubia sand stone at Wadi Natash area.				
Kn	Nubia group: include calstic beds above the basement rocks and below marine Upper Cretaceous.				
gy	Younger granitoids: Gattarian granite and all Post-tectonic granite				PRE-CAMBRIAN
ha	Hmmamat group: slightly metamorphosed conglomerated (breccia verde anticall), greywacke, arenite and siltstone.				
go	Older granitoids syntectonic to late tectonic polutonites essentially of granodioriteic composition previously referred to as grey granite, Shaitian granits or older granite.				PRE-CAMBRIAN
md	Metagabbro-diorite complex; gabbroid and doloritic masses, tectonized and affected by older granitoid.				
mv	Geosynclinal Shadli metavolcanics of surface or submarine effusives represented by regionally metamorphosed rhyolite, decite, andesite, basalt and pyroclastic rocks.				
gn	Migif-Hafafit paragnesses and migmatite, psmatic hornblende and biotite gneises.				

The correct field data at any station is estimated by subtracting or adding the correct values of the base station at the corresponding time. These corrected data are stored in the computer to carry out the griding by Geosoft Program, 1994, (Geosoft mapping and processing system) to produce total intensity magnetic profiles.

The corrected magnetic data have been presented in profile form. The corrected data is reduced to the magnetic pole process as Reduced to the Pole process (RTP). The presented profiles have been used for the qualitative interpretation. The magnetic anomalies that resulted from measured field 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. The regional configuration of the basement rocks, actually, reflects the general relief on the basement surface (magnetic highs or lows), the displacements across faults as structural depressions that might have been become local or regional sedimentary basins.

- Vertical Electrical Sounding (V.E.S):

In the present study, 28 Vertical Electrical Sounding stations of 4-Schlumberger configuration with maximum current electrode separation (AB) ranges from 400 to 600 m were conducted along the same locations of the magnetic profiles (Fig.4). This proved to be sufficient to reach the required depth that fulfils the aim of the study in view of the geologic and hydrogeologic information. The distance between the soundings ranges from 3 to 4 km. Use was made of the direct current resistivity meters (Terrameter SAS 1000) to carry out the geoelectric measurements. The instrument directly measures the resistance (R) at each electrode separation with high accuracy.

The measured apparent resistivities (Ohm.m) are plotted versus the corresponding AB/2 (m) values on bilograthmic paper in the form of VES curves (Fig.5) and Fig.6 shows the aerial distribution of some sounding curves in their locations. Interpretation of the VES curves was carried out using the computer Resist program (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.

DISCUSSION OF THE RESULTS

Use was made of the computer program "GEOSOFT", ver. 4.00.3 (1994) to carry out the quantitative interpretation of the magnetic data along the 3 magnetic profiles. The inclination and declination of the earth's magnetic field distort the magnetic fields created by geologic bodies Some parameters must be defined for this program as the area inclination (32.39°) declination (2.35°), magnetic field strength (40429 gamma), and height of the instrument sensor from the ground surface (1.6 m). It is 2-D modeling program that receives corrected and filtered magnetic data along profiles in gms format. The total intensity magnetic data has been reduced to the pole. The program depends on the comparison between the measured data and calculated data from a given initial model. The construction of the initial model is based on a control points (as wells and interpreted results of the geoelectric soundings along each profile), magnetic susceptibility and the IGRF (International Geomagnetic Reference Field) parameters. The iteration process is carried out until best fit is reached between the measured and calculated values of the total intensity magnetic field. The calculated data of the IGRF used for the date of survey shown in table 2:

Table (2): The IGRF calculated data at 15. 5. 2009 (the date of survey)

Date of survey: 15.05.2009	N. Component : 31811 gamma
Elevation : 22.7	E. Component : 1473.89 gamma
Latitude : 24 02.975 N	Down Component : 28475.02 gamma
Longitude : 34 30.283 E	Inclination : 41.80^o
Total Field : 42719.3 gamma	Declination : 2.65^o

The measured and calculated data obtained from these magnetic models profiles (Figs.7, 8, & 9) are reached can be summarized as follows:-

1- There are 16 detected faults; 5 faults crossing the main stream portion of the wadi (profile M_1-M_1), 4 faults along the M_2-M_2 profile and 7 faults along the M_3-M_3 profile.

2- Two horst structures were detected between the two faults F_7 & F_8 in the western portion of the modeled profile M_2-M_2 (Fig.8) and the two faults F_{12} & F_{13} of the profile M_3-M_3 (Fig.9).

3- The structural faults caused different uplifted the basement blocks in different localities of the studied area and others of down throw along the three magnetic profiles.

4- There are 7 field observed (self detection) dykes in some locations of the measured profiles.

Vertical Electrical Sounding:

The qualitative and quantitative interpretation of the 28 VES curves was carried out making use of the existed hand dug wells data available, beside the VES stations 2, 6, 11, 13 and 16. Qualitatively, the higher apparent resistivity the H-type at the end of the field curves indicates detection of highly resistive layer that corresponds to the basement rocks. The interpretation model was followed up for all VES stations where it was possible to construct 3 geoelectrical cross sections. It revealed that the geoelectric succession in the area consists of three geoelectric zones as shown in table (3) and figures (7, 8 and 9).

Table (3) Resistivity ranges, thickness variations and corresponding lithology of the detected geoelectrical layers.

Zone No.	Resistivity (Ohm-m)	Thickness (m)	Corresponding lithology
1	365-1100	0.5-1.5	Dry wadi deposits (boulders and gravels)
	112- 300	4 – 12	Dry wadi deposits (fine sediments)
2	30 - 59	4.6 – 9.8	Saturated wadi deposits (water bearing)
	85 - 260	13 - 15	Saturated fractured basement (water bearing)

3	>500 Ohm-m	----	Massive basement

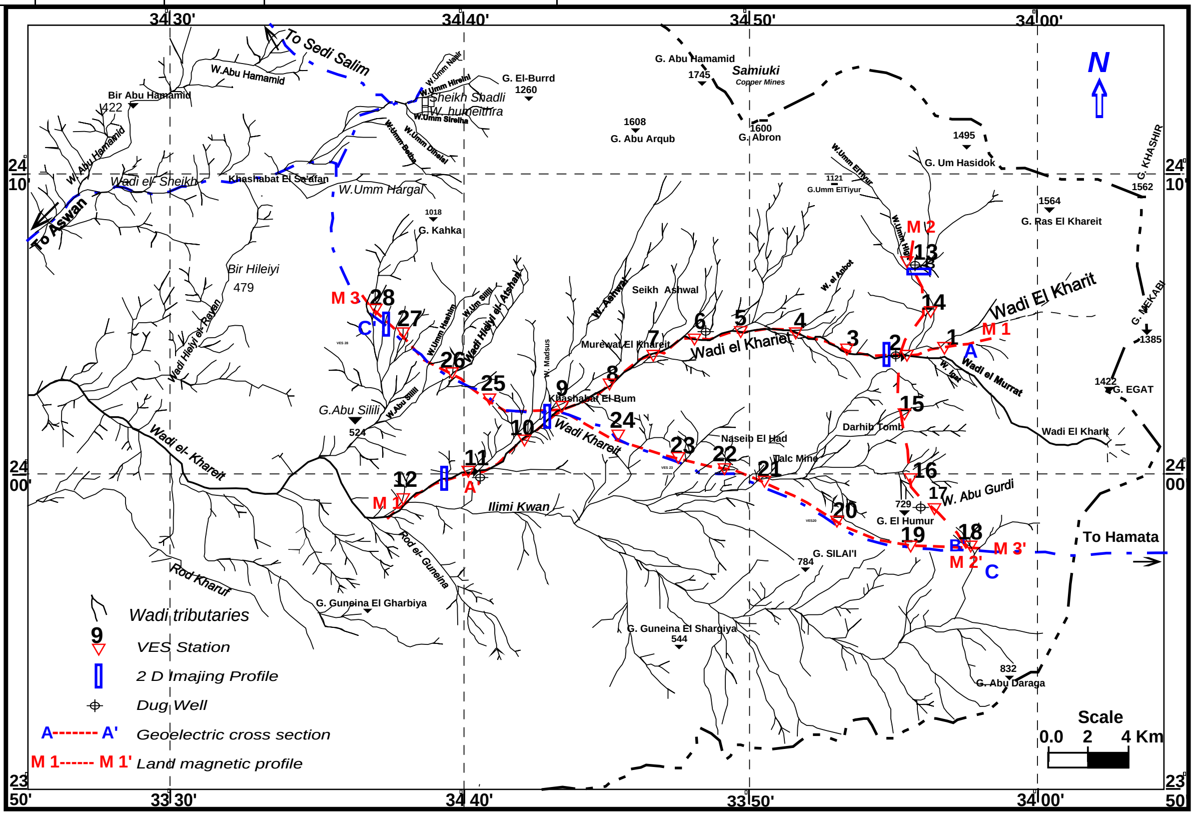

Fig. (4): Location map of the Wells, Land Magnetic profiles, VES stations and 2-D electrical resistivity imaging profiles along Wadi El Kharit

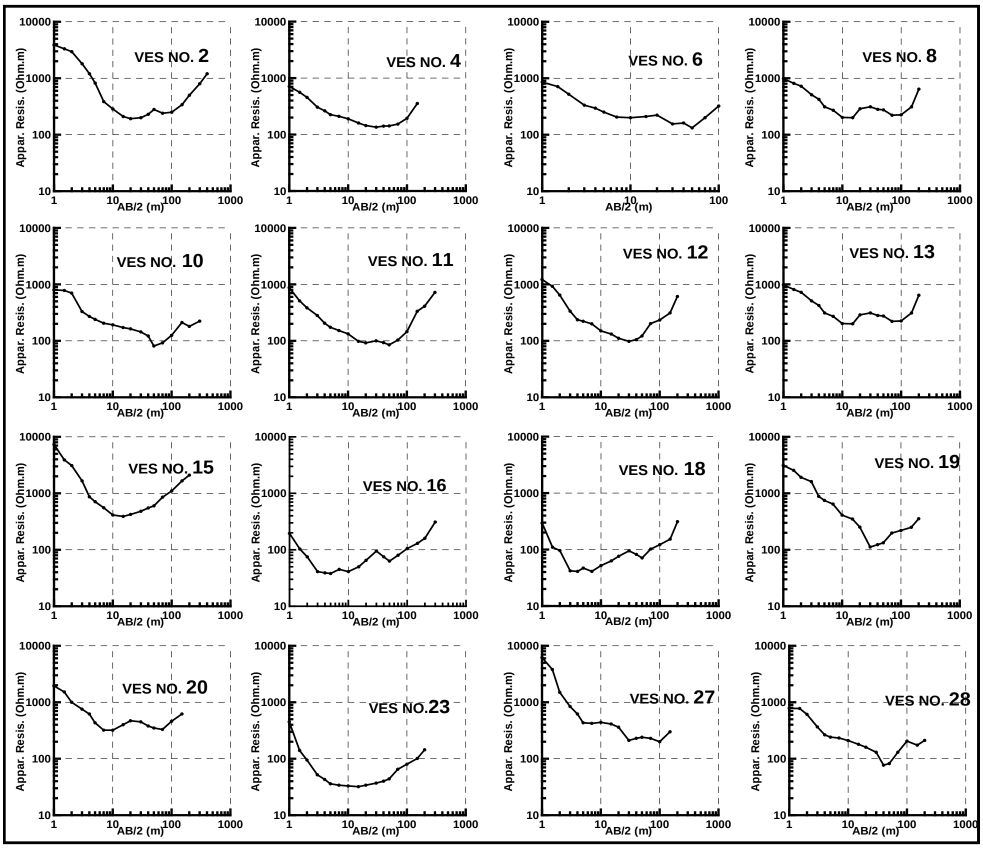

Fig. (5): The field curves of some of the vertical electrical soundings in Wadi El kharit.

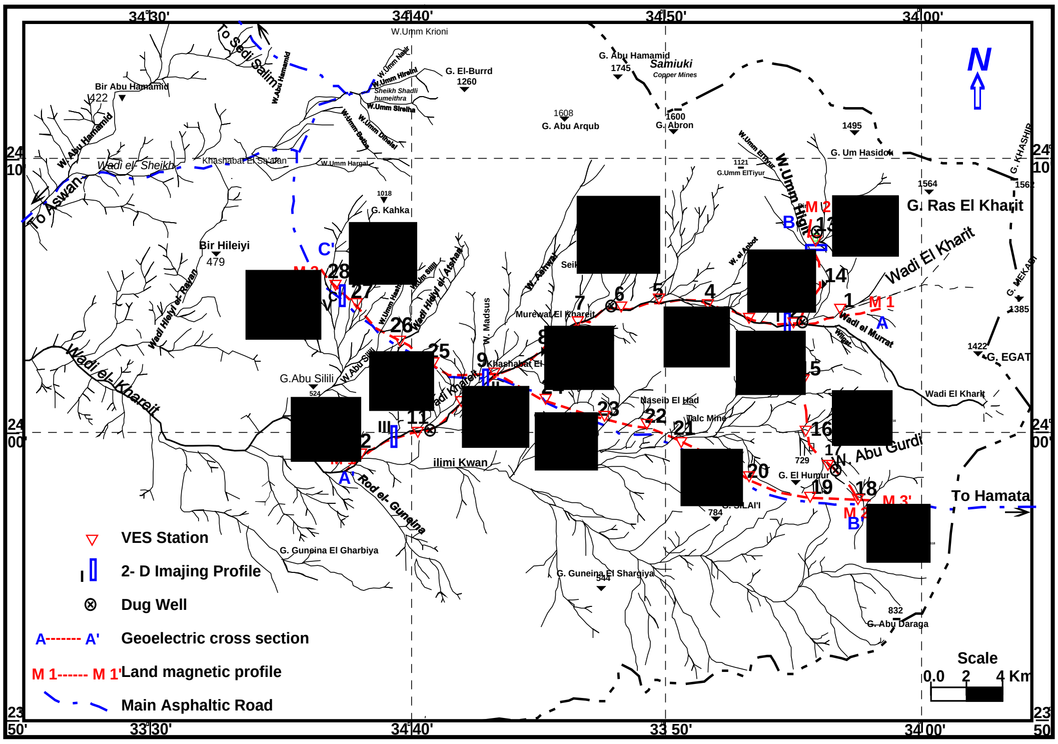

Fig. (6): The field curves of the vertical electrical soundings in Wadi El kharit.

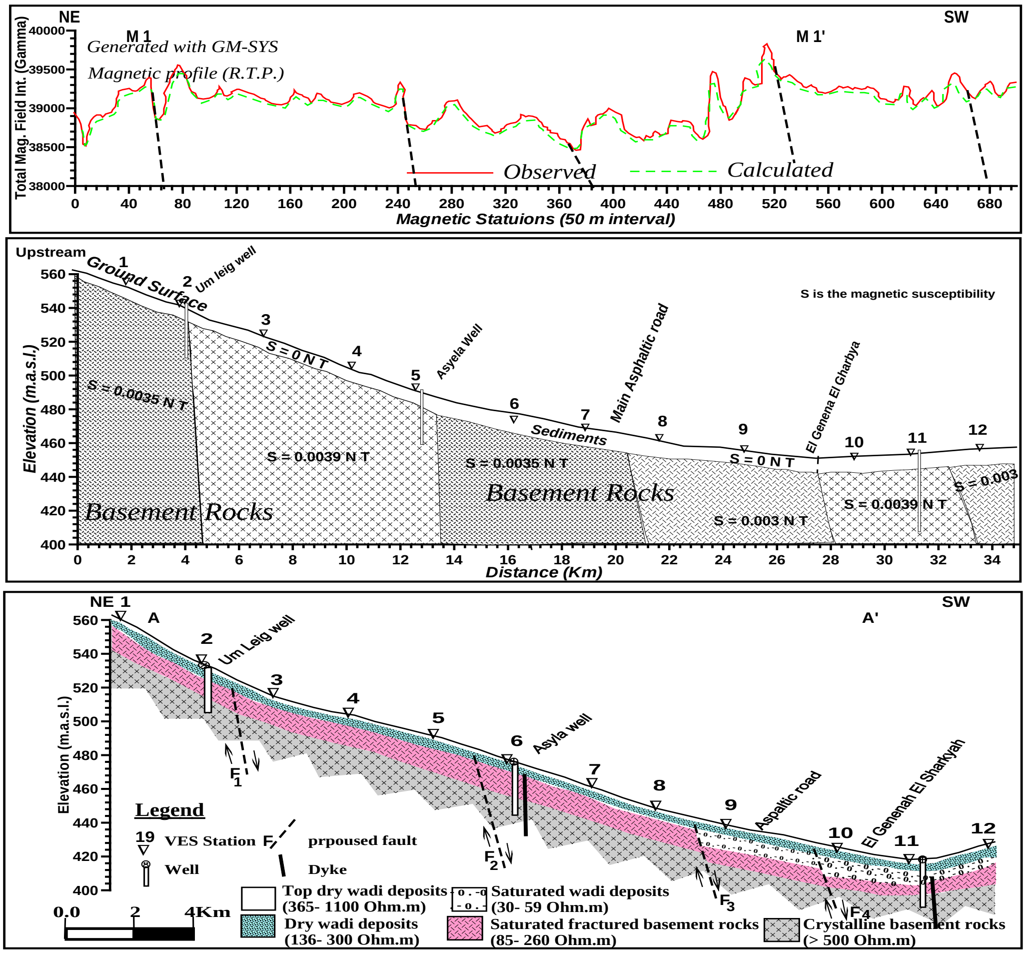

Fig. (7): Two dimensional magnetic profile M_1 - $M_{1'}$ and Geoelectric cross section (A-A'), along the upstream area of Wadi El kharit.

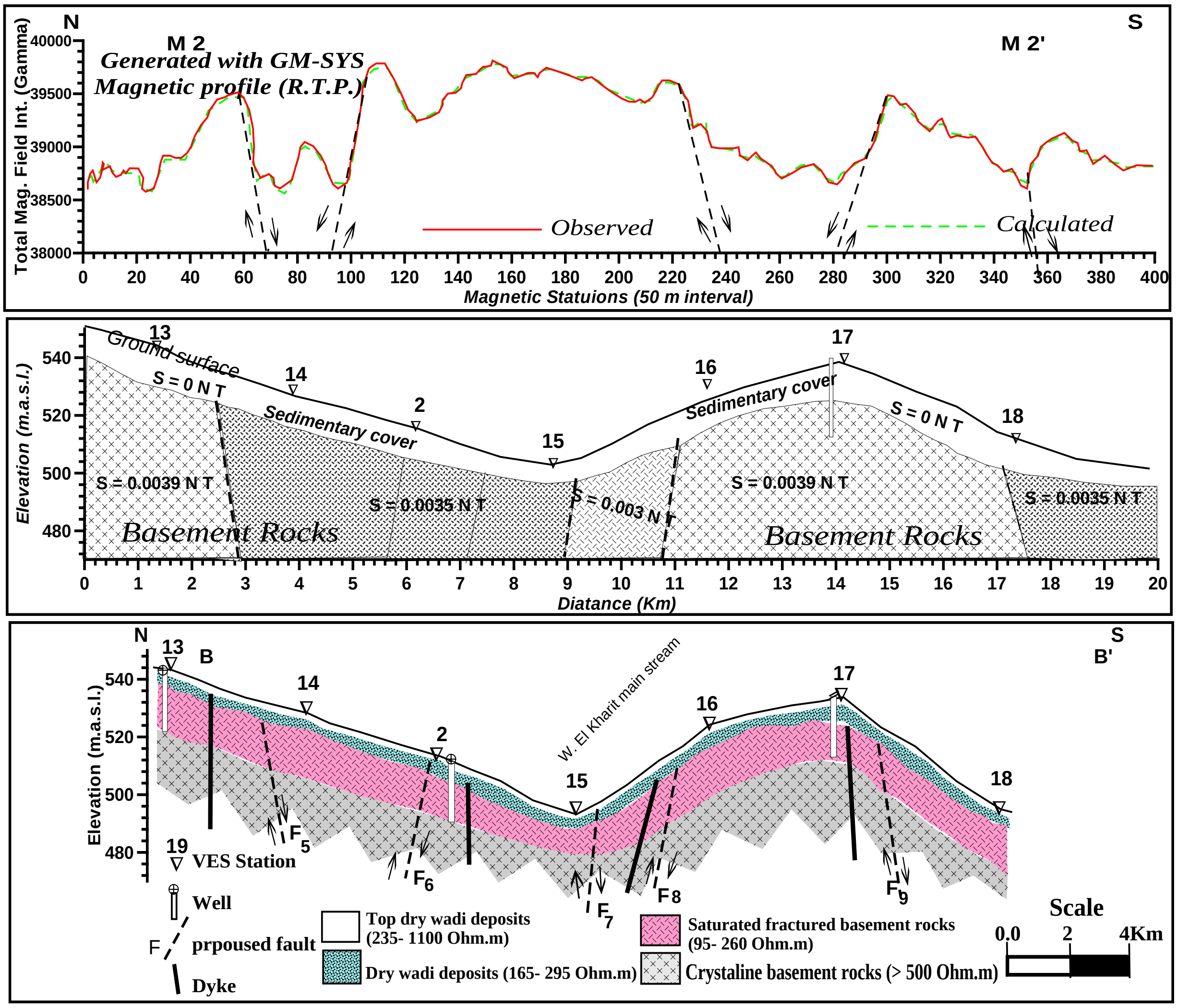

Fig. (8): Two dimensional magnetic profile M_2 - $M_{2`}$ and Geoelectrical cross section (B-B'), along the upstream area of Wadi El kharit.

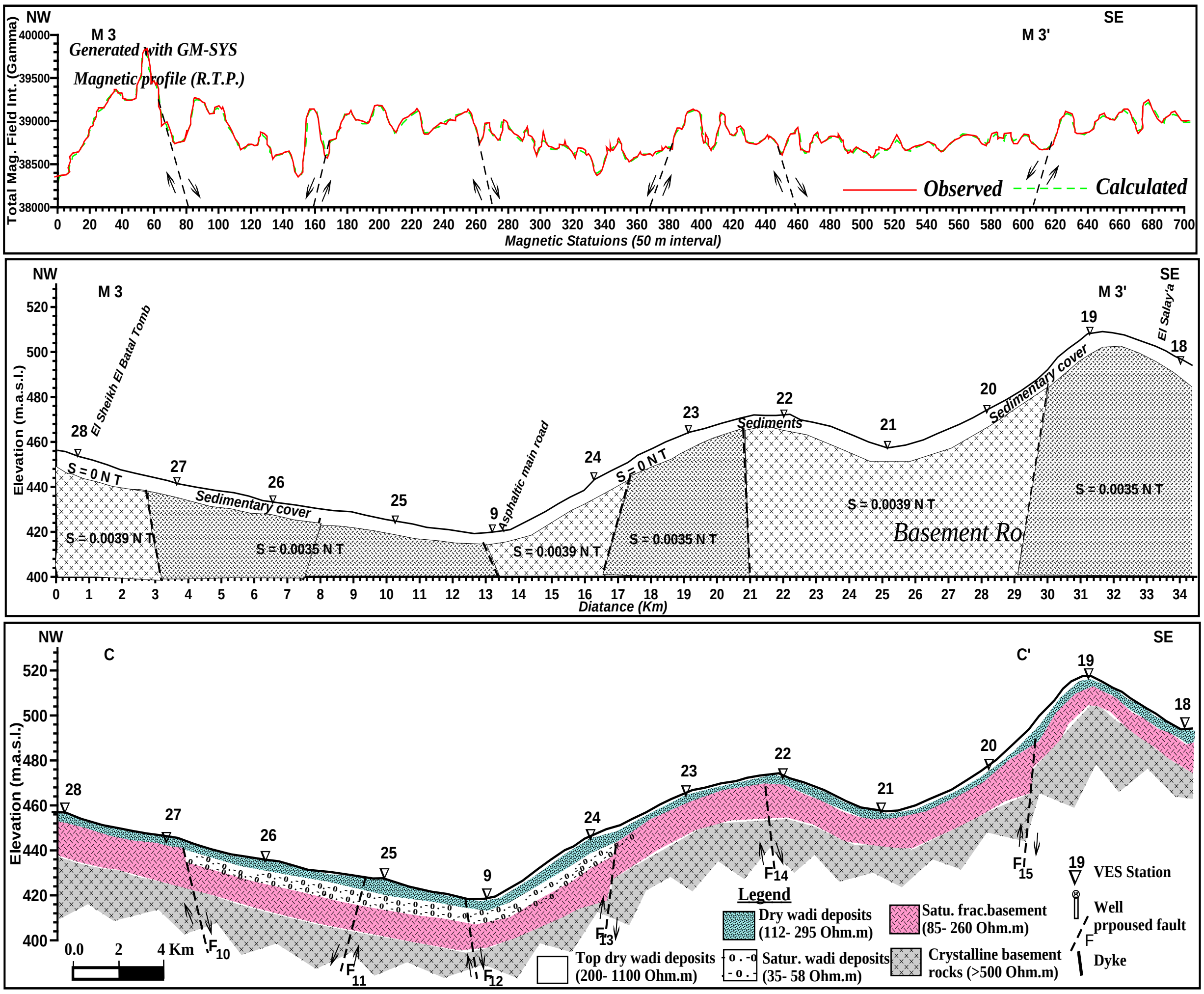

Fig. (9): Two dimensional magnetic profile M_3 - $M_{3'}$ and Geoelectrical cross section (C-C'), along the area of Wadi El kharit.

Three geoelecric cross sections were constructed from the interpreted data of the electric soundings. Geoelectric cross section A A' was taken in the E-W direction and contains 12 VES stations (Fig.7) while cross section B B' is directed in the N-S direction and contains 7 VES stations (Fig.8) and cross section C C' was taken in the W-E direction and contains 11 VES'es (Fig. 9). A generalized description of that succession over the investigated area can be stated as follows:

1- The dry zone that detected in all geoelectric cross sections and composed of two units:

a) The top highly resistive dry cover composed of wadi fill deposits of sand, gravel and rock fragments. Its thickness ranges from 0.5m at VES No.4 to 1.2m recorded at VES station No.14 and resistivity from 265 Ohm-m at sounding station No.4 to 1100 Ohm-m at VES station No.12.

b) The dry wadi deposits with thickness ranges from 2 m recoded at VES No. 2. to 5 m at VES No. 19 and resistivity from 112 at VES No. 14 to 300 Ohm.m at VES No.27 It is composed of the wadi deposits consists of sand and rock fragments of the basement country rocks.

The second geoelectric zone is characterized by relatively low to moderate resistivity values and composed of two units:

a) The upper unit was recorded only at 7 soundings No.'s 9, 10, 11, 12, 24, 25, 26 and 27. Its resistivity varies from 30 to 59 Ohm.m recorded at VES No.'s 10 and 25 respectively. It composed of saturated wadi deposits with variable thickness ranges from 4.6 m at VES No.11 to 9.8 m at VES No.10 .

b) The second water bearing geoelectric layer attains moderate resistivity values, which ranges from 85 Ohm-m at VES No.2 to 260 Ohm-m at VES No.7. It is composed of saturated weathered and fractured basement rocks with variable thickness (ranges from 13 m at VES No.4, to 15m at VES No.13.

c) The third geoelectric zone composed of the dry dense crystalline basement rocks which acts as the base detected succession (aquifuge). This unit is characterized by extremely high resistivity values that exceed 500 Ohm-m Its base is not detected.

The vertical and horizontal extensions of the above described geoelectric successions are indicated on the geoelectric cross sections. From these cross sections, it is clear that 15 normal faults affect the succession (F1, F2, F3 … F15), besides the field observed 7 dykes. These faults and dykes are confirmed by the field observations, land geomagnetic results and geologic information available for the study area. The movement of the groundwater along the main channel of wadi is controlled by both the configuration of the basement relief in the subsurface, meandering and the existence of buried dykes traversing the stream. The dykes act as natural barriers resulting in accumulation of water behind them. At Gurdi well (VES 13), the high relief of the basement resulted in decreasing the alluvium thickness and consequently, decreasing the water column.

C- The 2-D electrical tomography:

Five imaging profiles were measured crossing Wadi El Kharit (Fig.4) with different lengths (120m, 120m, 330m, 150m and 300m respectively) at selected sites (gates) according to width of the main channel of the wadi. Every profile plotted and interpreted as three plots; the measured apparent resistivity pseudo-sections, calculated apparent resistivity pseudo-section and inverse model section.

- The 2-D imaging profile No. 1

The first profile is located at the site of VES No.2 with north-south direction and its length is 120m (Fig.10). This image is the true resistivity plot obtained after 7 iterations of the inversion program. Examination of this section indicates the domination of high resistivity zones (>2000 Ohm.m) extending along the upper parts of the profile. The high resistivities correspond to dry wadi fill deposits consisting of rock fragments derived from the surrounding mountainous rocks. Beneath the first datum the image shows some low resistivity (to a value <242_Ohm.m) zones that extend and attributes to saturated fractured basement. The image shows zones of high resistivity (> 1655 Ohm-m) downwards at the lower part of the profile section most probably attributed to the crystalline basement rocks.

Accordingly, it can be concluded that the whole geologic succession at that location of measurements consists of dry wadi deposits underlain by saturated fractured basement rocks and the bottom represents the fresh basement rocks. The topography of the basement is detected to be shallower in the mid of the channel, while the saturated zone is thick at the left side of the channel. It is noted that a dike was observed in the field at the southern side of the wadi.

- The 2-D imaging profile No. II

This imaging profile is located at the location of VES No.9 and its north-south direction with length is 120m (Figure 11). It shows that the crystalline basement rocks are detected down at about 25m and the saturated thickness is the thickest location for groundwater accumulation. The depth to the saturated zone is about 10m, while its resistivity ranges from 118 to 308 Ohm.m.

- The 2-D imaging profile No. III

This imaging profile is located at the location of VES No.11 and its with north-south direction with length is 330m (Fig.12).and directed north -south It shows that the crystalline basement rock may be shallower at southern side of the channel (about 15m), while it was not detected in northern side may be due to fault dislocation of the wadi.

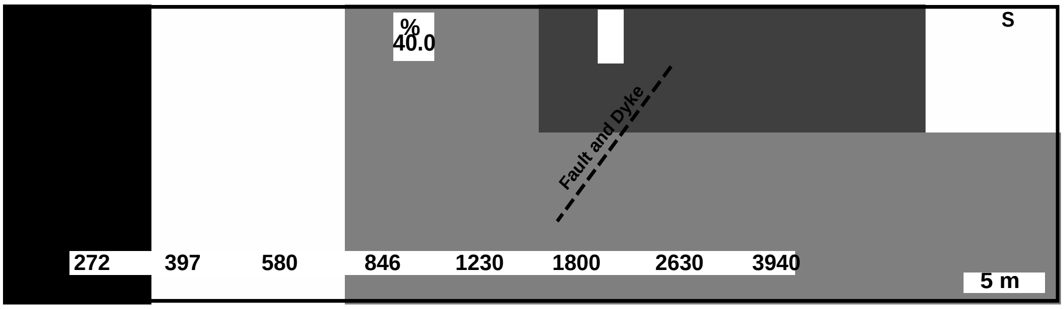

Fig. (10) The electrical resistivity imaging profile No.I

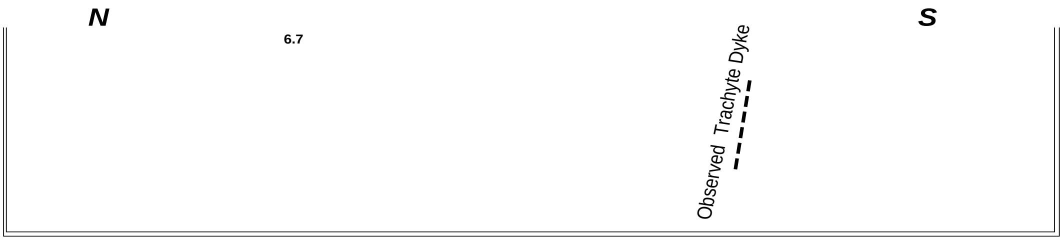

Fig. (11) The electrical resistivity imaging profile No.II

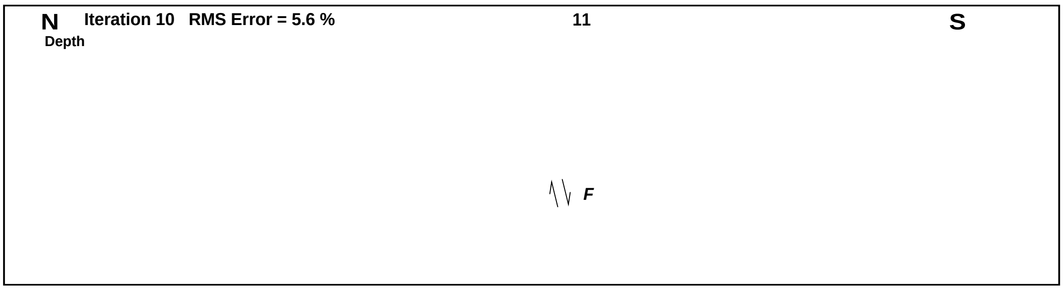

Fig. (12): True resistivity 2-D imaging of profile No.III.

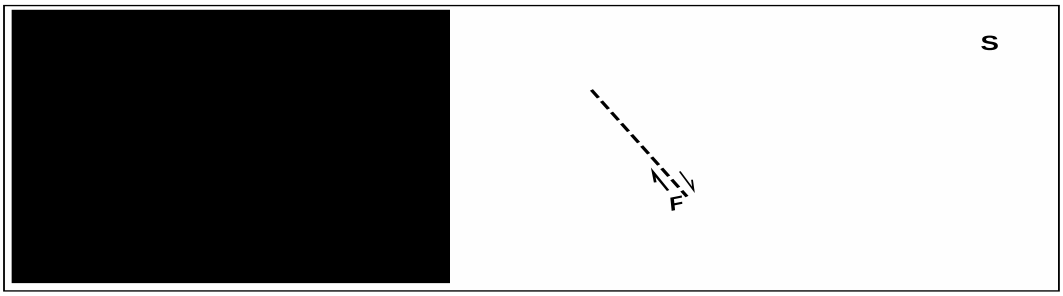

Fig. (13): True resistivity 2-D imaging of profile No.IV.

Fig. (14): True resistivity 2-D imaging of profile No.V.

- The 2-D imaging profile No. IV

This profile is located at the location of VES No.27 and its length is 150m with a north- south direction. This cross section (Fig.13) shows that the crystalline basement rocks were not detected at 28m depth at the southern side due to a fault throw and the saturated thickness is the thickest location for groundwater accumulation (about 17m). The depth to water is about 11m.

- The 2-D imaging profile No. V

This imaging profile is located crossing Wadi Umm Hilgit (tributary of El Kharit) at VES No.13; its length is 300m with west-east direction. This cross section (Fig.14) shows that the crystalline basement rocks were detected at about 16m from the ground surface but they not detected in its eastern side due to a fault dislocation. The depth to the saturated zone is about 15m.

GROUNDWATER OCCURRENCE

The processes for locating water accumulation in fractured basement rocks depend on studying carefully the surrounding structural elements, especially orientation, size and density of the intrusive dykes. Several hand-dug wells were dug in the upper parts of the wadi, at the junction point of tributaries, and dyke sites (as of Bir Halgit). These wells are productive ($1m^3$/hr) and of very good water quality. The depth to water of these wells ranges from 5.63m (Abu Gurdi well) to 12.65m (Abu Abrun well or Esila) and the salinity of their water range from 510 ppm (Abu Abrun well or Esila) to 4360 ppm (Umm Leig well)

The geoelectric survey revealed the existence of three geoelectric zones. These from top down-wards are: dry wadi fills, saturated wadi fill (water bearing) and/or saturated fractured basement rocks and the crystalline basement that representing the base of the detected succession. The saturated wadi fill deposits consist of sand, gravels and boulders and are recharged from the direct infiltration and from the fractured basement country rocks.

Hydrogeologically, the groundwater exists under unconfined condition. The groundwater aquifers along the investigated wadi suffer from lacking of recharge and continued dryness period and over pumping activities which appears as lowering of the depth to water in all water wells i. e. Hilgit well, Umm Leig well, Abu Gurdi well, Abu Abrun well or Esila well. For these, it is not recommended to drill new groundwater wells in the upstream area.

The suitable groundwater occurrences are detected at sites where the groundwater aquifer attains a reasonable thickness of saturated wadi fills and fractured basement. Accordingly, the most suitable areas for groundwater aquifers are the sites of the down stream portion of the studied part of the wadi. In the middle part of the study area of the wadi, the basement uplift forms a barrier against the hydraulic continuity through the wadi channel. At the upstream part, the water bearing zone is formed of fractured basement only with a thickness of 9-13m and resistivity of 85-360 Ohm.m (VES stations 1, 2, 3, 4, 5, 6, 13, 14 …., 23 and 28). Groundwater in the southern part of the wadi exists in two layers; the upper consists of wadi deposits with a thickness of 2.5-4m (VES stations 9, 10, 11, 12, 24, 25, 26 and 27) and resistivity of 63-260 Ohm.m.

SUMMARY AND CONCLUSIONS

The present study area lies in the southern part of the Eastern Desert along the upstream portion of Wadi El Kharit. The geophysical measurements were conducted along 3 land magnetic profiles, 28 geoelectric resistivity soundings and five Electric Resistivity Imaging Profiles (2-D Tomography). The available geological and hydrogeologic data used to aid in the interpretation of the geophysical measurements. The land magnetic survey, the total magnetic field 1740 stations were carried out along three profiles running in NW-SE, N-S and W-E directions. The corrected data used to construct magnetic models where constructed in the same direction of the field data. The depth to the basement varies from 5 to 25m increasing toward the southwestern portion of the study area. Many faults (16) were detected.

In the geoelectric resistivity survey, the conducted 28 V.E S. stations of Schlumberger configuration were interpreted qualitatively and quantitatively. The interpreted data used to construct three geoelelctric cross sections that matched with the magnetic models profiles. The general geoelectric succession is formed of three geoelectric zones as follows:-

The upper zone is dry wadi deposits. The second zone is water saturated wadi deposits which represented only at the down-stream portion of the wadi and saturated fractured basement rocks. The last zone is a crystalline basement representing the base of the detected succession. The succession was found to be dry at the middle part of the wadi channel due to a horst structure.

1- The upper geoelectric zone is dry wadi deposits composed of silt, sand, gravel and rock fragments with high resistivity >1500Ohm.m. Its thickness ranges from 9 m to 16m.

2- The saturated zone is composed of two units:

a) Saturated wadi deposits of low resistivity.

b) The saturated fractured basement of relatively moderate resistivity.

3- The third geoelectric zone is composed of fractured and massive basement rocks with resistvity >500 Ohm.m. The depth to this basement surface varies from 9 to 24m along the wadi.

Five (2-D) imaging profiles of Wenner configuration were conducted crossing the main channel of the wadi. The results of these imaging profiles were confirmed with those reached from the land magnetic and the electric soundings. The water bearing formations are saturated wadi fill deposits and/or fractured basements aquifer, where the depth to water varies from 12 to 23m (recorded in all VES locations except at VES No.'s 7 and 8).

The results of interpretation revealed that many faults affect the main stream of Wadi El Kharit. The two water bearing layers are; the upper layer consisting of wadi deposits (at VES No's 9, 10, 11, 12, 24, 25, 26 and 27) and an underlying layer consisting of fractured basement. In the upstream of the wadi, the only water bearing layer is the fractured basement (at VES No's 1, ….., 6, 13, ….., 23 and 28), while no groundwater is detected at the sites of VES No 7 and 8 due to a horest block of the basement at these sites. The results showed also that the basement relief and dykes as well as intersecting faults control the groundwater occurrences in the area. The investigated wadi suffers from lack of recharge and continued dryness period and over-pumping activities which appear to lower the depth to water in all water wells. It is concluded that the promising parts of the area as to groundwater occurrences are those covered by VES stations 2, 6, 6, 10, 11,13, 16, 24, 25 and 26, where groundwater is detected at a depth of 8–18m. From the previously mentioned discussions, the studied area of Wadi El Kharit is of low to moderate groundwater potentiality.

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