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GEOELECTRICAL AND MAGNETIC INVESTIGATIONS TO DELINEATE THE GROUNDWATER OCCURRENCE AT ABU SOMA AREA, NORTH SAFAGA AREA EASTERN DESERT, EGYPT

Magdy, M. G.
Dept. of Geophysical Exploration, Desert Research Center, El-Matareya, Cairo, Egypt.

The geoelectrical resistivity sounding with the land magnetic survey measurements were integrated for groundwater exploration in the area of Abu Soma, 18 km to the north of Safaga, Red Sea Coast.

A total of fourty resistivity soundings and fourty two km magnetic profiling were measured in the study area. The deduced geoelectrical parameters were correlated with the data of two wells in order to assign the obtained resistivities to correspond lithologic formations. The depth to the basement rocks was estimated from the magnetic measurements.

The presented geoelectrical cross sections revealed the presence of some dislocations, which generally agree with those inferred from the magnetic results and surface geologic features.

Shallow and deep aquifers were detected in the investigated area. The shallow aquifer is represented by Pliocene sandstone and sandy shale of Gabir formations in the eastern side of the study area. Whereas at the western side, this aquifer is restricted to the Quaternary wadi deposits, sandstone and the fractured basement. The depth to this aquifer in both sides range from 30 m to 200 m. On the other hand, the deep aquifer is represented by the sandstone of Ranga member (Gabal El Rossas formation). The depth to this aquifer is deduced to be about 700 m. According to the electric resistivity of this aquifer proved to be more saline than the shallower one.

Keywords: geophysical exploration, groundwater, North Safaga, Egypt.

Its doubtful groundwater resource retorted to supply the tourists villages on the Red Sea coast. The present study was directed to reveal the potential of groundwater in Abu Soma area, 18 km north of Safaga City, Red Sea coast, between latitudes 26° 50' – 26° 55' N and longitudes 33° 45' – 33° 55' (Fig. 1).

The previous studies carried out in and around of Abu Soma area included the combined geological fieldwork (Akkad and Dardir, 1966; Philobbos *et. al*, 1982; El Bassyouny, 1982; Zaghloul, 1992 and Attalla, 1993) as well as the interpretation of the geophysical data obtained from Abu Soma – 1 well (EGPC, 1978) and the seismic interpretation for an area about 25 km NW of Gabal El – Zeit (Abu El Ata and Helal, 1992).

The present study covered an area of about 230 km^2. The geophysical methods carried out in the study area included electric resistivity and magnetic surveys. Electric resistivity was applied using Vertical Electric Sounding (VES) technique to study the geoelectric characteristics of the subsurface geological section. The magnetic survey was conducted to define the relief of the basement rocks and any possible subsurface geological structure that may affect the flow of groundwater if present.

Geomorphological Aspects

According to the data obtained from Hurghada meteorological station (far from study area about 40 km to the north), the maximum and minimum average temperatures were 27.5° c and 17.8°c respectively, total annual rainfall was 3.6mm., maximum rainfall / day was 24.7 mm., relative humidity was 49 % and evaporation / day was 13.9mm. (Egyptian Organization of Meteorology between 1975 and 1995).

Hydrographic regions

Abu Soma area is constructed mainly of one hydrographic basin with a specific drainage pattern and hydrogeological parameters. The down streams of this basin toward the Red Sea to the east (Fig.1) and encloses three geomorphic units.

Geomorphologic units

The studied area subdivide into the following main geomorphologic units:

i The mountainous area

It represents the upstream of the investigated area. It is composed of younger granites, which are characterized by high rugged relief and impermeable steep surface. The mountainous area is characterized by mature dendritic drainage system.

ii Hilly area

Occupy the eastern part of Abu Soma area and made up of faulted isolated hills of Miocene succession. The hilly area is represented by a low to moderate topographic forms, which having gently permeable slopes. The hilly area is characterized by parallel to sub parallel drainage system.

iii Coastal plain

The coastal plain is very low relief, wide catchment area and derived mainly of alluvial fans, wadi deposits and Pliocene marine sediments. The coastal plain is characterized by immature drainage pattern.

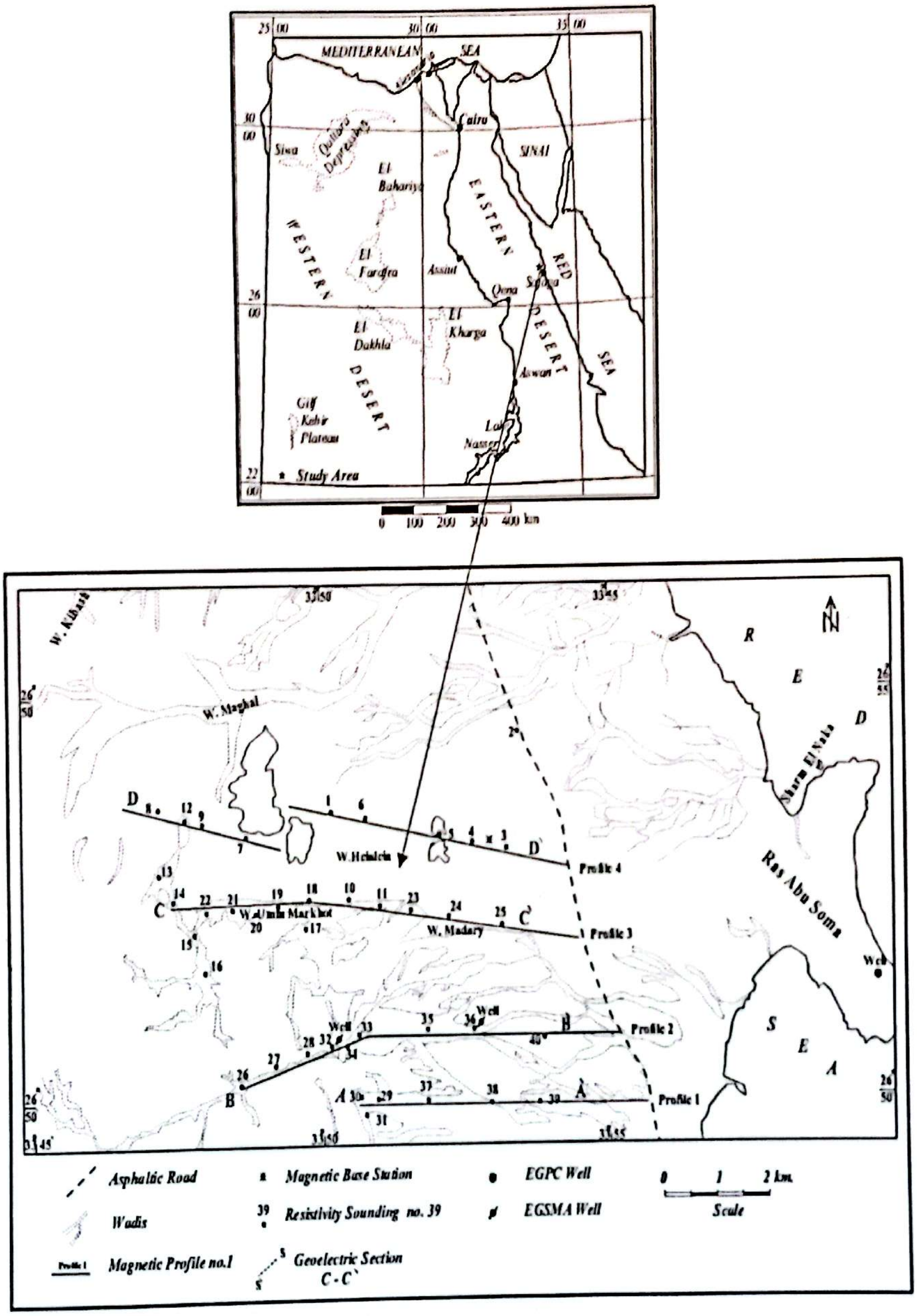

Fig. (1). Location map of the study area and the geophysical measurements

Geomorphologic parameters

Recharge and flooding events depend on some hydrological parameters, such as rainfall intensity, frequency and duration, potential evaporation and surface runoff intensity as well as on the lithological, structural and geomorphologic characteristics of the existing rocks. These parameters are determined from the available topographic map (scale 1:50000), aerial photographs (scale 1:40000) and field investigations.

The Abu Soma hydrographic basin is characterized by a low bifurcation ratio, and high stream order and frequency at the mountainous area to the west. While the hilly and coastal areas has high to moderate bifurcation ratio and low stream order and frequency.

El Shamy (1992) studied the quantitative integrated hydrologic interpretation of some geomorphometric parameters to evaluate 54 main basin in the Eastern Desert of Egypt. He classified them into three basin classes. Accordingly, Abu Soma basin belongs to the class III, which have moderate bifurcation ratio, high stream frequency and high drainage density values, i.e. moderate to low groundwater potentialities and moderate to high flooding.

Geological and Hydrogeological Setting

The geological study covers about 230 km^2 and is made up of Precambrian and sedimentary rocks of Middle Miocene age. The geological and structural map of the area, scale 1: 50000 (Fig.2) was constructed in the field based on aerial photographs, scale 1: 40000 (Attalla, 1993).

General Stratigraphy

The rock units encountered in the area belong to the following:

- Quaternary wadi deposit and alluvial fan.
- Plio – Pleistocene terraces.
- Miocene succession.
- Precambrian basement rocks.

According to previous geological studies the subsurface lithostratigraphic section of the Miocene sediments and its facies can be expected as follows:

Pliocene

- Plio-Recent 100 m. thick. sands, gravels and limestone.
- Shagra Formation 80 m. thick. reefal L. s and marl.
- Gabir Formation 40 m. thick. sandstone and sandy shale.

Upper Miocene

- Samh Formation 40 m. thick. marly shale, and carbonaceous sandstone.
- Umm Gheig Formation 180 m. thick. mainly limestone.

Middle Miocene

- Abu Dabab Formation 150 m. thick. gypsum, marl, sandstone.

Lower to Middle Miocene

- G. El Rossas Formation 180 m. thick. sandstone, gravel, limestone and marl.

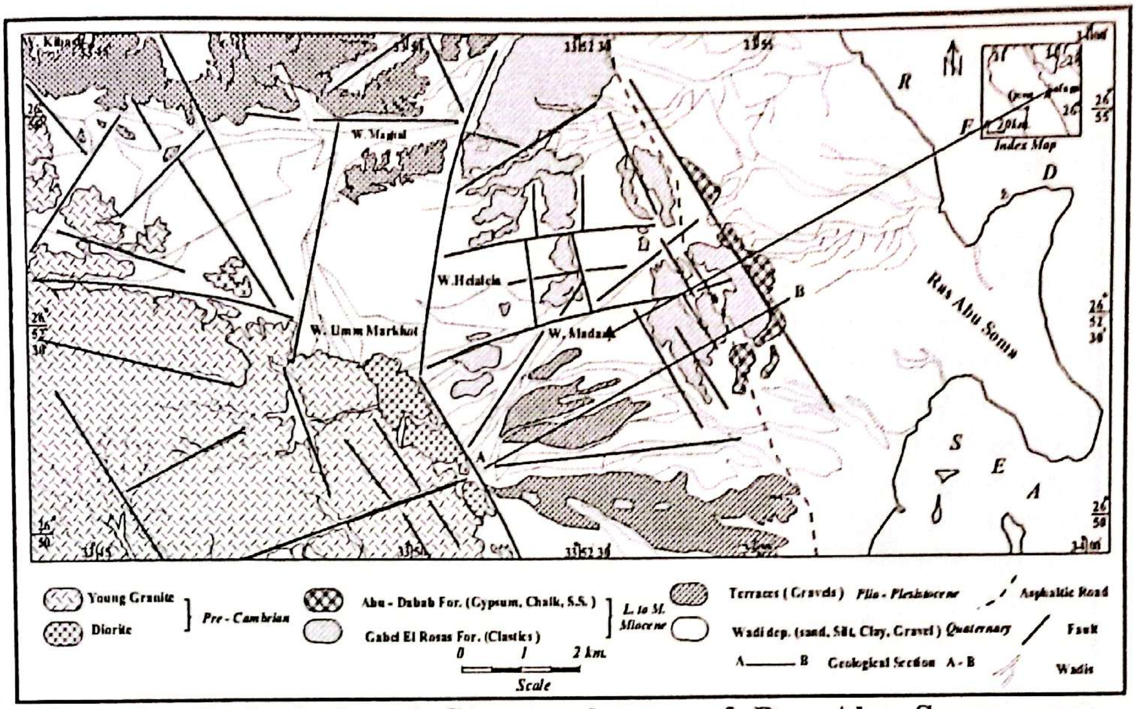

Fig. (2). Geological and Structural map of Ras Abu Soma area. (Attalla, 1993)

Moreover, further information was obtained from the only deep well drilled close to the study area (15 km. to the east of the study area, Fig. 1). Abu Soma – 1 well reached to the weathered (fractured) basement at depth of 1235 m. Its subsurface succession is as follows (EGPC, 1978):

Plio – Recent 120 m thick mainly sands, gravels and limestone.

M. Miocene
- Gharib, Zeit Formation 180 m thick Gypsum, anhydrite, S.S. and shale.
- Balayim Formation 120 m thick Gypsum, anhydrite, S.S., shale and limestone.

L. Miocene
- Kareem Formation 90 m thick Limestone, shale and marl.
- Nukhul Formation 90 m thick L.S., S.S., clay and anhydrite.

Cretaceous
- Turonian 180 m thick Limestone.
- Nubia 450 m thick Sandstone.

Unconformity

Weathered (fractured) basement

The proposed geological section A – B (Fig.2) shows a general uplift toward the east direction (Red Sea coast).

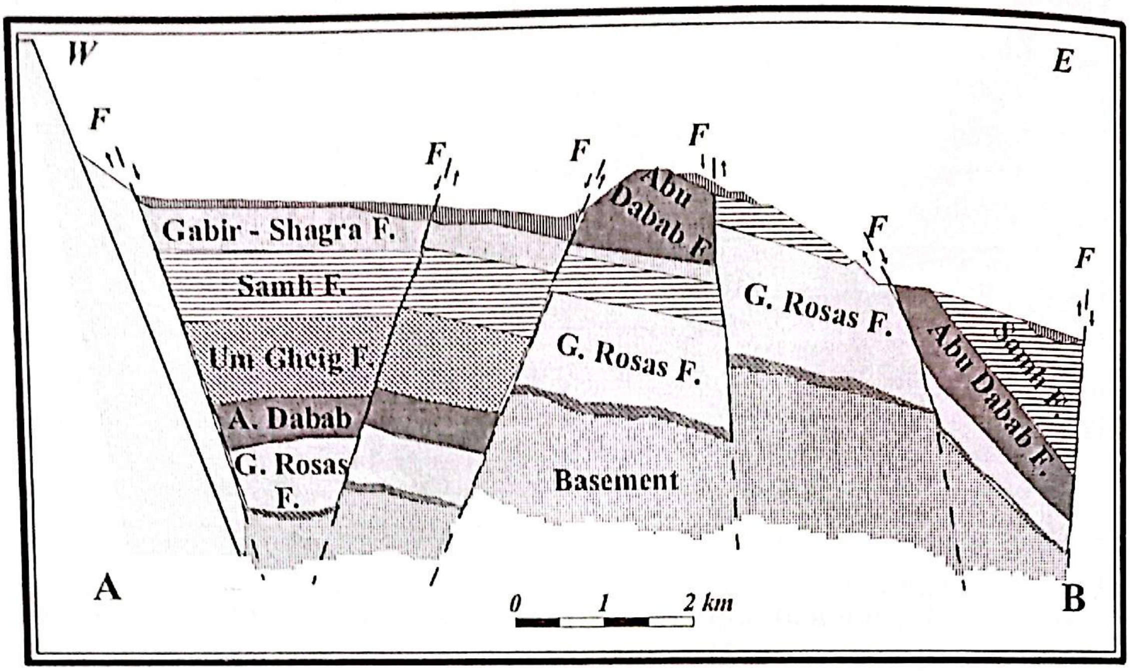

Fig. (3). Proposed geological section A – B Ras Abu Soma area (Attalla, 1993)

It is obviously clear from fig.(3) that a general uplift toward the east direction (Red Sea coast) in the faulted rock blocks. A basin like structure has resulted from this uplift having 6–8 km width. This basin is occupied mainly by the Pliocene and Miocene sediments. According to the aeromagnetic maps of the investigated area (sheets No. 49 and 50, Aero Service, 1985) and the depth to the basement rocks recorded from Abu Soma –1 well (EGPC, 1978) the depth to the basement rocks is 1230 m in the eastern side, where the well was located. While the depth to the basement is about 1880 m in the middle part of the southern side of the studied area, where the profile 1 was located.

Geological Structure

Faults and joints are the most prominent structures that affect the Precambrian basement and the Miocene rocks at Abu Soma area.

Three fault systems are recognized trending mainly NW – SE, ENE – WSW and NNE – SSW arranged in decreasing order of abundance. They are intersected at acute angles (commonly About 30°and 60°) suggesting development of conjugate shear faults related to the shearing stresses accompanying the development of the Gulf of Suez. The NW – SE faults system had been rejuvenation in post Middle Eocene. This system appears to have a profound influence on the area. These faults resulted in a re-arrangement of the existing ridges and basins.

It is worth to mention that the geological subsurface cross sections are highly complicated because of the intersection with huge fault and shear zones that caused laterally abrupt changes in facies or lithology through a narrow horizontal distance.

Joints and fractures are well developed and can be easily recognized on macroscopic scale. They have approximately the same trends of the fault systems (Attalla, 1993).

Hydrogeological Aspect

According to the previous studies, it is expected that there are two aquifers in the eastern side of investigated area. The shallow one enclosed in Shagara and Gabir Formations, which consist of reefal limestone and sandstone. The sandstone of Gabel El Rossas formation, Renga member (Nukhul), represents the deep aquifer. In the other hand, the western side of studied area the Quaternary wadi deposits, sandstone and fractured basement represent the aquifer.

Geophysical Field Measurement

Within the studied area, 40 Vertical Electrical Resistivity Soundings were measured using the Schlumberger arrangement. The locations of these resistivity sounding stations are shown on location map (Fig 1).
The maximum current electrode spacing (AB) ranges from 500 – 6000 m. The mean relative error of measurements was estimated to be ± 2 %. Resistivity soundings No. 32 and No. 36 were measured near water wells.

In the study area, four traverses (42 Km) were selected to be nearly perpendicular to the major structural trend. Traverse spacing was not equal depending on topography (Fig. 1). Stations were marked every 100 m on each traverse. Along the traverses the total intensity of the earth's magnetic field (ΔT) was measured every 25m to 50 m, depending on the expected depth to basement, using geometric proton magnetometer of one gamma sensitivity. All magnetic stations were tied to one base station (magnetic station no. 22 in profile 3 between VES 3 and 4, Fig. 1).

DATA INTERPRETATION AND RESULTS

Resistivity Sounding

All resistivity sounding curves were interpreted by using two layer curves and auxiliary graphs modified by Orellana and Mooney (1966). Results of interpretation were checked by RESIST software (Van der velpen, 1988) to make any required adjustment of the layer parameter (thickness and resistivity).

Within the western side of the investigated area, the characteristic resistivities of various rock units were determined from a parametric resistivity sounding No. 32 which is located near a drilled water well (EGSMA, 1995; Fig. 2).

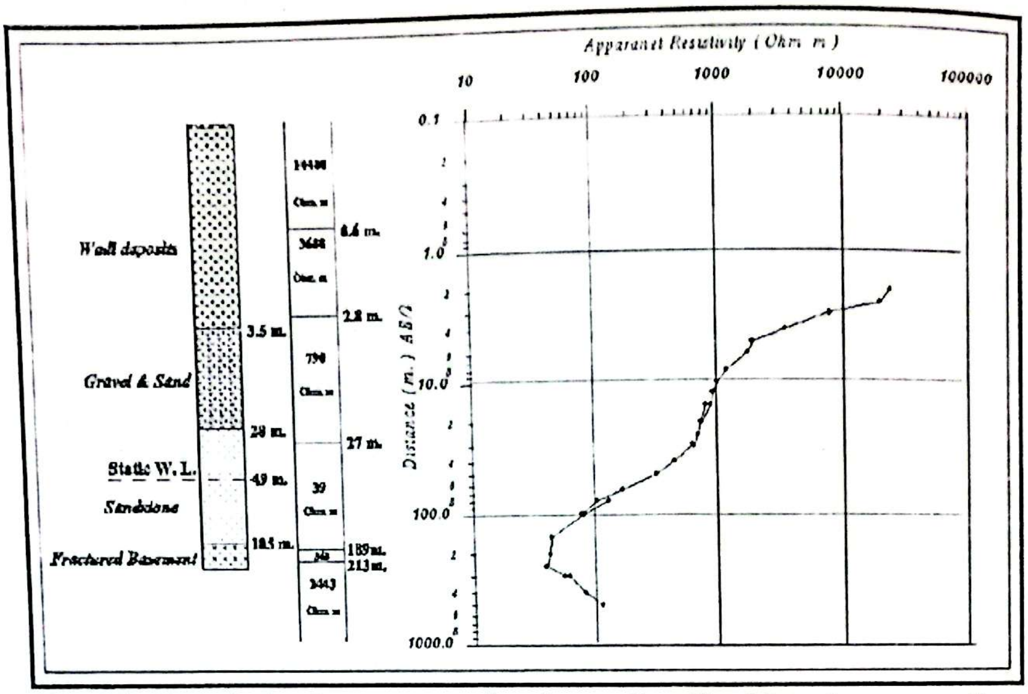

Fig. (4). Correlation between results of sounding No. 32 and water well.

Correlation between the interpretation results of resistivity sounding No.32 and lithostratigraphic section of a water well (Fig. 4), allow to establish the ranges of characteristic resistivities for the different rock units in the western side of the studied area. These are given in table (1).

TABLE (1). Resistivity ranges of various rock units in western side of the studied area

Type of Rock Units	Resistivity (ohm.m)
Surface layer	> 2000
Wadi deposits	500 - 600
Gravel & sand	140 - 250
Sandstone	30 - 120
Fractured and Fissured Basement	300 – 500
Solid Basement	> 1500

Data obtained from the well drilled by EGSMA (1995) and the geological and geophysical data from Ras Abu Soma -1 well drilled by EGPC (1978) help in the interpretation of the hydrogeologic conditions prevailing in the eastern side of the investigated area.

Within the eastern side of surveyed area, the parametric resistivity sounding No. 36 measured beside the drilled well (EGSMA, 1995; Fig. 2).

The correlation between resistivity sounding No. 36 and the data of the drilled well is shown in fig. (5).

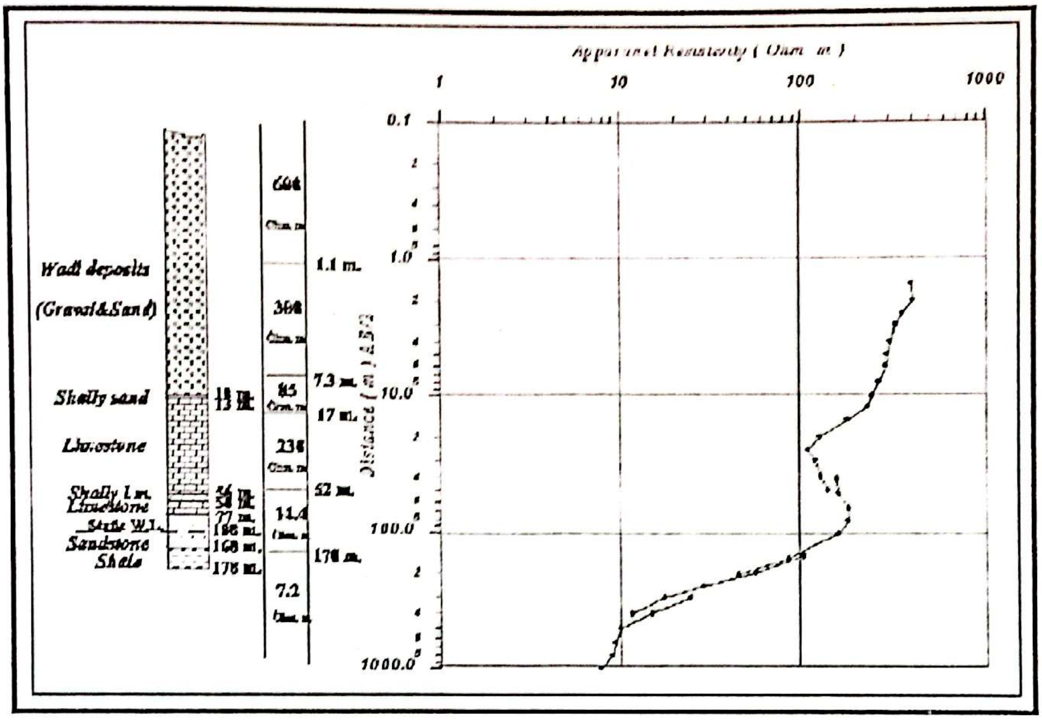

Fig. (5). Correlation between results of sounding No. 36 and drilled well.

Based on this correlation of the drilled well and the parametric resistivity sounding measured beside this well, the true resistivity ranges of different formations could be established as shown in table (2).

The interpreted geoelectrical parameters (resistivity and thickness) were used to illustrate the subsurface geologic setting in the surveyed area. Four cross-sections are chosen to illustrate subsurface picture to delineate groundwater aquifers in the study area.

Magnetic Survey

All magnetic stations were corrected for diurnal variation. The mean quadratic error of magnetic measurements obtained by the repeated measurement of about 10 % of all readings was found 0.8 gamma. Results of the geomagnetic survey are presented as magnetic profiles .The International Geomagnetic Reference Field (I. G. R. F.) in the study area was found 42425 gamma.

The total magnetic intensity measured along profiles was interpreted using Peter method (1949), Bean (1966) and El Hakim *et. al.* (1970) to estimate the depth to the basement rocks. Interpretation results obtained from these methods were checked by Magix Plus (1994) to make more adjustment of depth to the basement rocks.

TABLE (2). True resistivity ranges for the various formations in the eastern side of surveyed area

Formation Lithology			Resistivity Range (ohm.m)
Surface layer			> 2000
Sand & gravel	plio - Recent		100 – 300
Limestone			85 – 100
Reefal Limestone & marl	Shagara Form.	Pliocene	230 – 600
Sandy shale	Gabir Form.		10 – 30
Calcareous Sandstone	Samh Form.	Upper Miocene	40 – 50
Conglomerate	Samh Form.		200 – 300
Shale	Samh Form.		5 – 8
Marly Shale	Samh Form.		50 – 70
Marl	Samh Form.		100 – 110
Hard compact L.m.	Um Gheig Form.	M. Miocene	430 – 600
Sandy Clay or S.S.	G. El Rossas Form. (Ranga Member)	Lower to M. Miocene	10 - 14

The total intensity aeromagnetic contour map and total intensity aeromagnetic contour map reduced to the pole (sheet 49 and 50, Aero Service Report, 1985) assisted in this study to give idea about the basement structures and its relief, which may affect the overlying sedimentary section

Four geoelectric sections accompanied with the measured total magnetic intensity and the magnetic profiles reduced to the pole (R. T. P.) are constructed. The locations of these sections are shown in fig.(1). A description for these cross sections is given as follows:

Cross section A – A'

This section was located to southern side of studied area, starting from sounding station No. 30 near the basement rocks, Figs. (1 and 2). The quantitative interpretation of the total intensity magnetic along profile 1 is shown in table (3).

TABLE (3). Interpreted depth to the basement rocks along profile 1 using different methods

Distance (station)	Width (m.)	Depth (m.)				Average (m.)
		Peter (1949)	Bean (1960)	El-Hakim (1970)	Magix Plus (1994)	
1 - 14	1400	471	442	440	455	452
20 - 70	5000	1820	1835	1845	1852	1838

The shallower depth to the basement rocks is detected in the western side near the basement rocks at the beginning of this profile with a gradual increase towards the eastern side at the end of profile 1, as shown in table (3).

The total intensity of aeromagnetic map (sheet 50, Aero Service Division, 1985) shows that basement rocks are exposed in the west while Quaternary and Tertiary deposits outcrop along the coast and the north. Basement rocks appear deepen quite rapidly along a syncline at the south, where the interpreted depth to basement is deeper than 1500m for more than 70% of profile 1.

The geoelectric section A – A\ (Fig. 6) indicates that the fractured basement underlying the sandstone is detected at sounding No. 30 and 29. At these soundings, the thickness of sandstone is about 200m and 230m with electric resistivity 60 ohm.m and 70 ohm.m respectively. The electric resistivity of the fractured and fissured basement ranges between 257 ohm.m and 420 ohm.m. The decrease in the electric resistivity of the fractured basement may due to the presence of water.

Examination of the eastern side of the geoelectric section shows the presence of large thickness of Pliocene sandy shale (Gabir Formation) and Upper Miocene calcareous sandstone (Samh Formation) at sounding stations No. 37 and 38. The thickness of these two formations is about 250m and its electric resistivity ranges between 10 ohm.m and 40 ohm.m as shown in Fig. 6. The Upper Miocene Shale (Samh Formation) underlying the calcareous sandstone exhibits electric resistivity ranging from 5 – 8 ohm.m.

The low resistivity (14 ohm.m) is recorded at depth of about 700m at sounding station No.38. The decreasing of the electric resistivity can be interpreted as saline water in Lower Middle Miocene sandstone of Ranga member (Gabal El Rossas formation).

Cross section B – B

This section is located to the north of section A – A\ with the same direction (Fig. 1). The southwestern side of this section surrounded by Precambrian basement rocks (Fig. 2).

Geoelectric section accompanied with the measured total magnetic intensity (ΔT) and the magnetic profile reduced to the pole (R.T.P.) which are obtained from R.T.P. aeromagnetic contour map (Aero Service Division, 1985) are shown in fig. (7).

The geoelectric section B – B\ shows that the thickness of the sandstone and depth of basement increase towards eastern direction (at resistivity sounding No. 32). The thickness of sandstone is 162 m. (electric resistivity is about 39 ohm.m) and depth to basement is 220 m. The thickness of fractured basement rocks at this sounding is 24 m and its electric resistivity is about 360 ohm.m. The decreasing in electric resistivity of fractured basement is due to presence of water in its cracks and fissures.

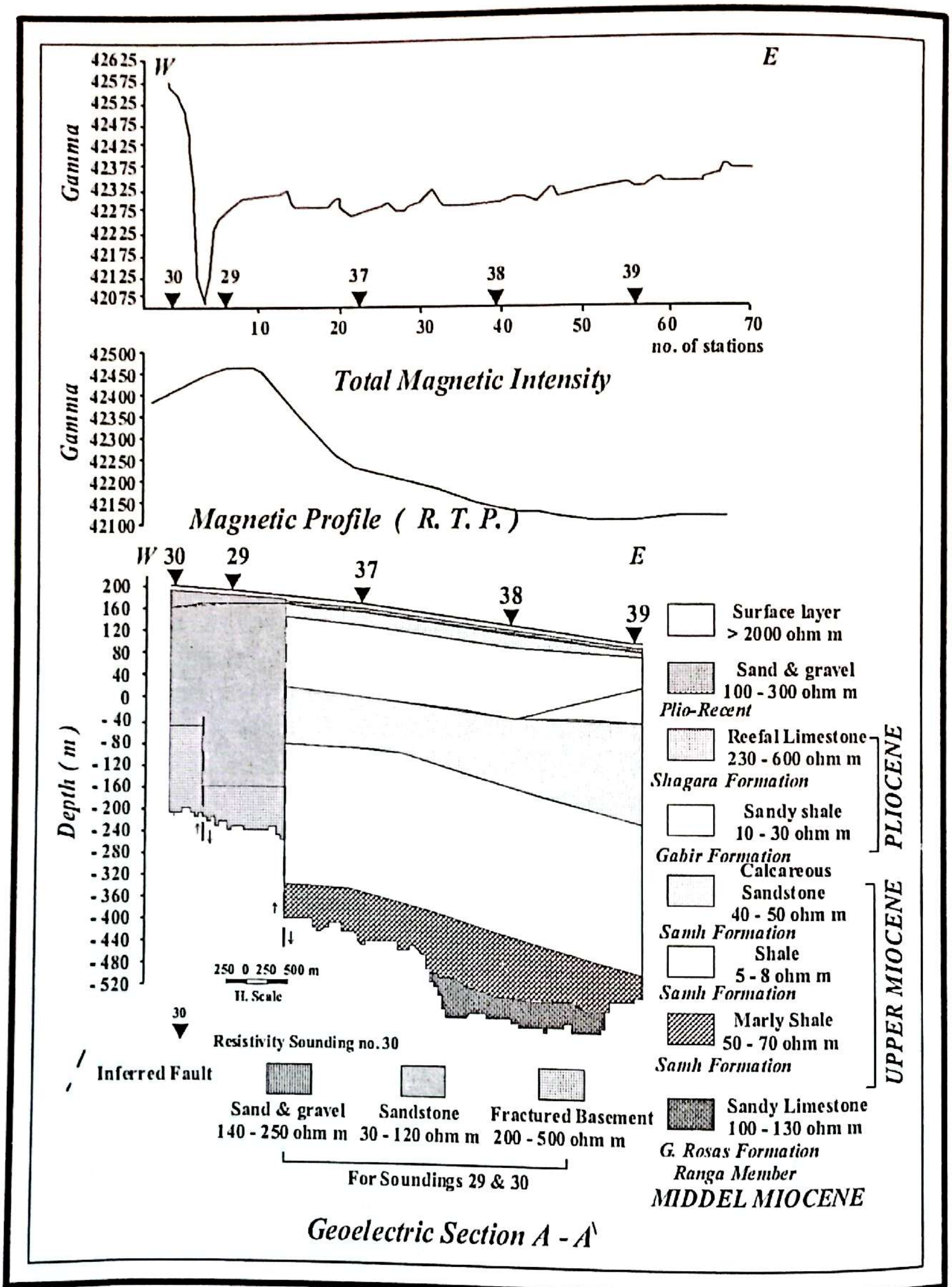

Fig. (6). Cross Section A – A' – Abu Soma Area

The estimated depths to the basement rocks using different methods of interpretation of the total magnetic intensity showed that the depth to the basement rocks increase gradually towards the eastern side of the investigated area (Table 4).

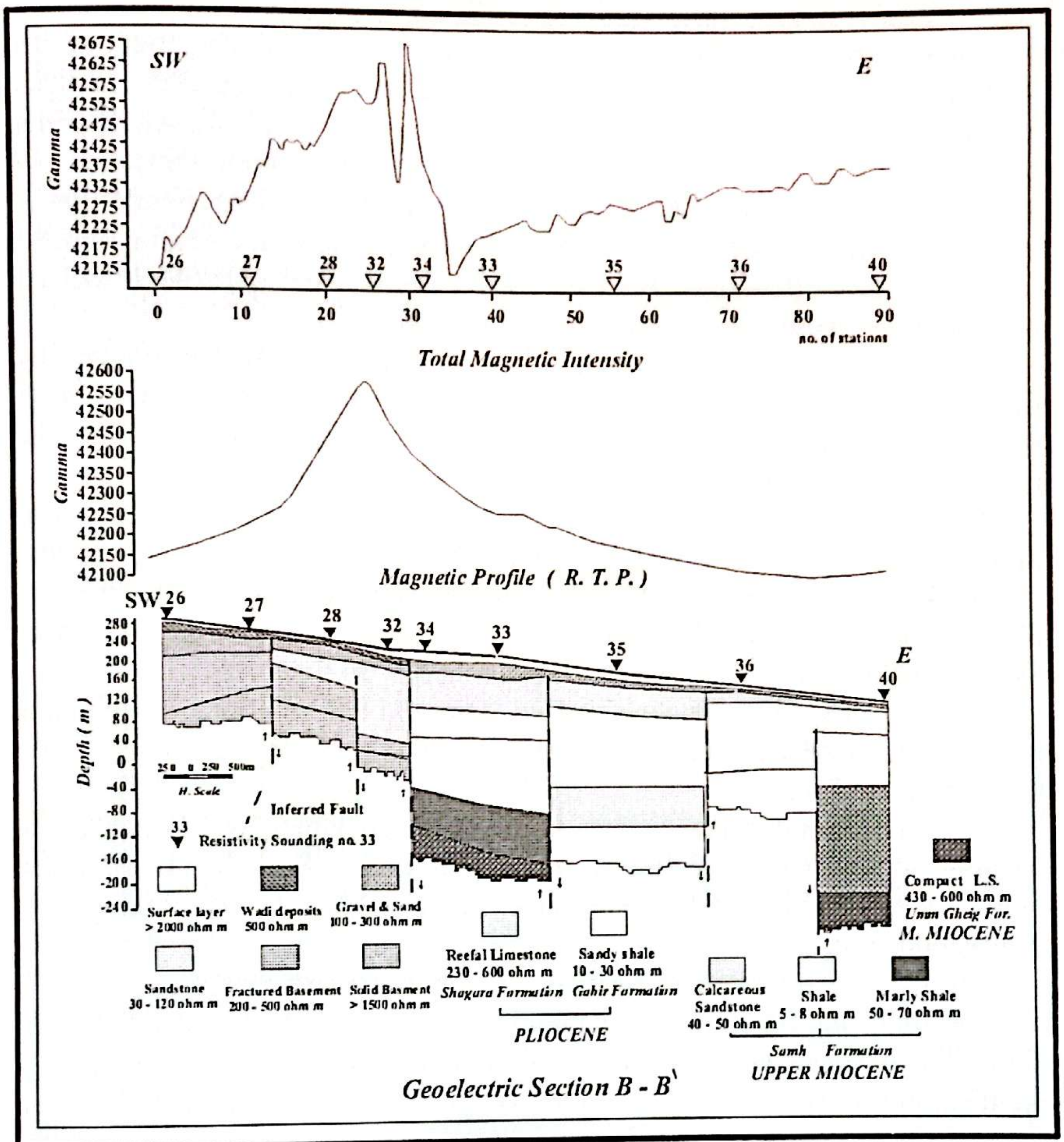

Fig. (7) Cross Section B – B' – Abu Soma Area

TABLE (4). Interpreted depth to the basement rocks along profile 2 using different methods

Distance (station)	Width (m.)	Depth (m.)				Average (m.)
		Peter (1949)	Bean (1960)	El-Hakim (1970)	Magix Plus (1994)	
1 - 6	500	73	73	71	70	71.75
7 - 17	1000	80	79	76	74	77.25
18 - 24	600	-	-	115	111	113
30 - 37	700	254	250	248	244	249
41 – 76	3500	1161	1152	1149	1150	1153
76 - 111	1300	-	1820	-	1790	1805

From the geological map (Fig. 2), it is clear that there is an eastward throwing major fault between sounding stations 32 and 34. The effect of this fault can be clearly noticed from the depth to the basement that has been estimated from the interpretation of the magnetic data (Table 4). At sounding No. 32, which is located at station No. 25, the depth to the basement is 249 m whereas at sounding 34 the depth increases to reach 1153m. In addition to this, a large thickness of sedimentary section is detected at sounding No. 33 and 34. At these soundings, the depth to Um Gheig Limestone (M. Miocene) is recorded at depth ranges between 320 and 360 m.

The results of the two seismic lines carried out in Abu Soma area by Canadian Superior Oil LTD-Egypt (EGPC, 1978) show the horst-like uplift structure in the Red Sea coast where Abu Soma-1 well is located, while the middle part of Abu Soma area forms a basin-like structure.

The geoelectric section B – B\ (Fig. 7) shows a large thickness of sandy shale of Pliocene (Gabir Formation) at sounding stations No. 35 and 36. Its thickness is about 130 m with electric resistivity ranges between 17 ohm.m and 20 ohm.m. This Pliocene sandy shale is underlain by Upper Miocene shale (Samh Formation) at sounding No. 36.

The variation in thickness of Pliocene and Upper Miocene sediments is due to the presence of faults as shown in geological map (Fig.2).

Cross section C – C

This section passes along Wadi Markhat, which is located to the western side of the studied area surrounded by Precambrian basement rocks, while the eastern side of this section passes along Wadi Madary taking W – E direction (Fig. 1).

The interpretation of the magnetic measurements along profile No. 3 and the total intensity of aeromagnetic contour map (R. T. P) indicate, as shown in fig. (8), that the depth to the basement rocks increases gradually from station 85 (near sounding station No. 18) toward the eastern side. The depth to the basement rocks is listed in table (5).

TABLE (5). Interpreted depth to the basement rocks along profile 3 using different methods

Distance (station)	Width (m.)	Depth (m.)			Average (m.)
		Bean (1960)	El-Hakim (1970)	Magix Plus (1994)	
32 – 64	3200	1213	1170	1190	1191
64 - 70	600	700	660	690	683
85 - 90	500	130	118	127	125
95 - 115	2000	57	66	63	62
115 – 125	1000	92	122	110	108

From table (5), it is evident that the depth to the basement rocks increases toward the eastern side of this profile. The depth is about 1191 m at the eastern side, while in the middle side (between stations No.64 and 70) the depth is 683 m. West of the major fault, where sounding station No. 19 is located (between stations No. 85 – 90) the depth to the basement is about 125 m (Fig. 8).

The geoelectric section accompanied with the total magnetic intensity measured along profile 3 and magnetic profile (R. T. P.) (Fig. 8) shows that the depth to the basement rocks is relatively shallower (about 60 m) in the middle part at resistivity soundings No. 22 and No. 21, while at resistivity soundings No. 14 and 19 respectively the depth to the fractured basement rocks is about 100 m and 145 m and its electric resistivity is about 480 ohm.m and 500 ohm.m. The thickness of sandstone that overlies the fractured basement rocks is about 82 and 60 m at soundings No. 14 and 19 respectively and its electric resistivity is about 74 ohm.m.

Due to the major fault located between resistivity soundings No.19 and 18 (Fig. 2) the thickness of the sedimentary section becomes large starting from sounding No.18 to the south east side as shown in geoelectric section (Fig. 8).

The Umm Gheig compact limestone is detected at relatively shallow depth at sounding No. 18 (about 360 m). The depth of this limestone increases gradually toward southeast direction (about 470m at sounding No. 11) due to Abu Soma basins as mentioned before. The variation in thickness of calcareous sandstone and shale of Upper Miocene (Samh Formation) is obvious in this geoelectric section. This variation in thickness is due to the character of the Red Sea Miocene deposits (Said, 1962 and Zaghloul, 1992).

Cross section D – D^1 :

This section runs along the extreme northern side of the study area in NW – SE direction (Fig. 1).

The interpretation of the magnetic measurements along profile No. 4 and the total intensity of aeromagnetic contour map (R. T. P.) indicate, as shown in fig. (9), that the depth to the basement rocks increases gradually toward the eastern side. The depth to the basement rocks is listed in table (6).

TABLE (6). Interpreted depth to the basement rocks along profile 4 using different methods

Distance (station)	Width (m.)	Depth (m.)				Average (m.)
		Peter (1949)	Bean (1960)	El-Hakim (1970)	Magix Plus (1994)	
32 -64	3200	1223	1171	1180	1190	1191
64 - 70	600	-	690	660	700	683
86 - 92	600	156	148	149	147	150
92 – 101	900	176	168	174	170	172
109 - 114	500	-	-	224	216	220
114 - 119	500	-	-	246	234	240

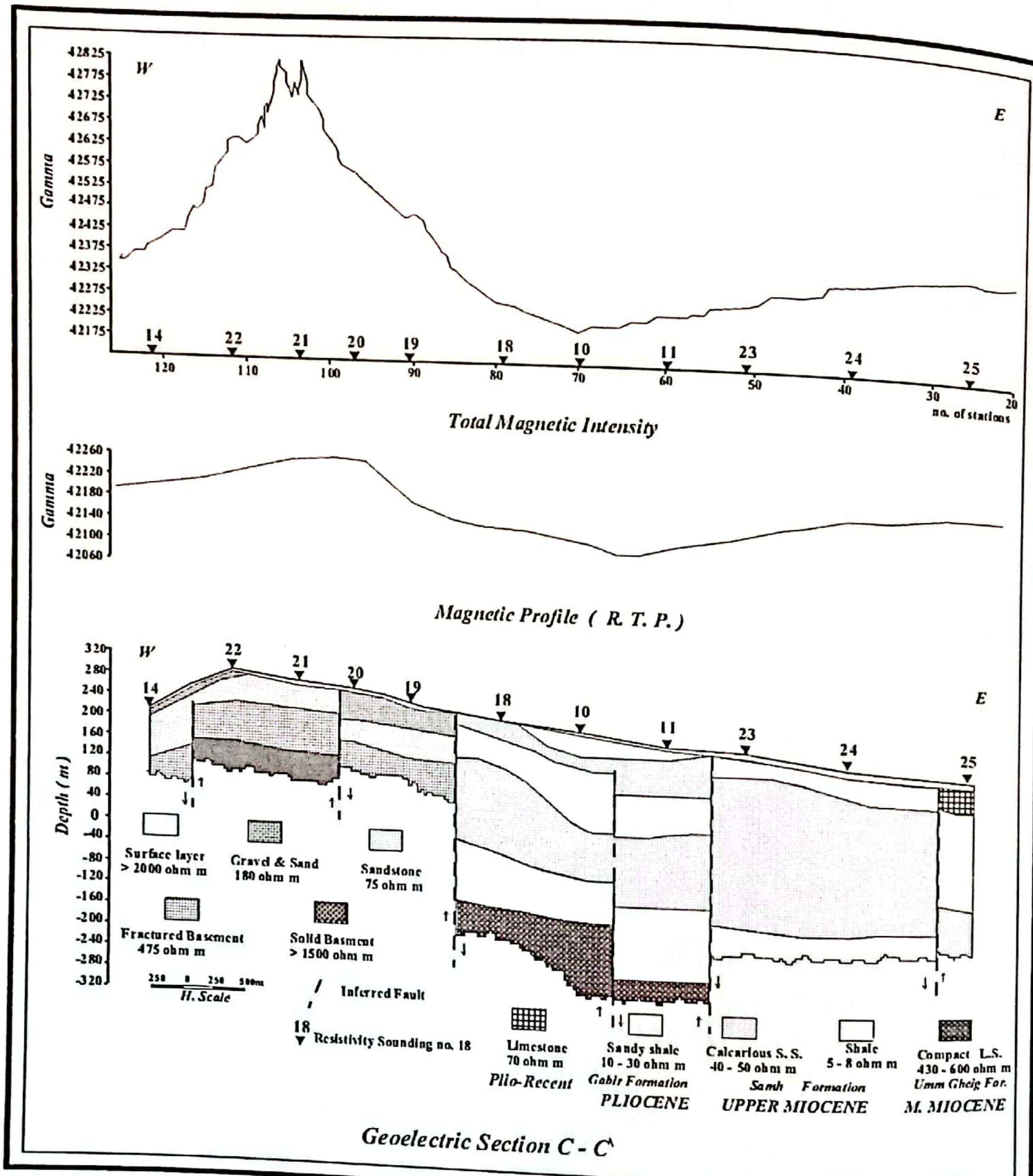

Fig. (8). Cross Section C – C\ – Abu Soma Area

Sounding station No. 1 (station 72) was located in sedimentary part of the study area near the granite rocks (Fig. 2). Therefore, the estimated depth to the basement rocks from the magnetic measurements and aeromagnetic map (R. T. P.) is about 510 m and the depth gradually increases towards the east direction.

The geoelectric section (Fig. 9) shows that the depth to the basement rocks is about 190m and 220m at sounding station No. 7 and 12. The thickness of sandstone is variable in this section. The maximum thickness of sandstone is recorded in sounding stations No. 7 and 12 (150 – 190). The electric resistivity ranges from 70 ohm.m to 100 ohm.m at sounding stations No. 12 and 7, respectively.

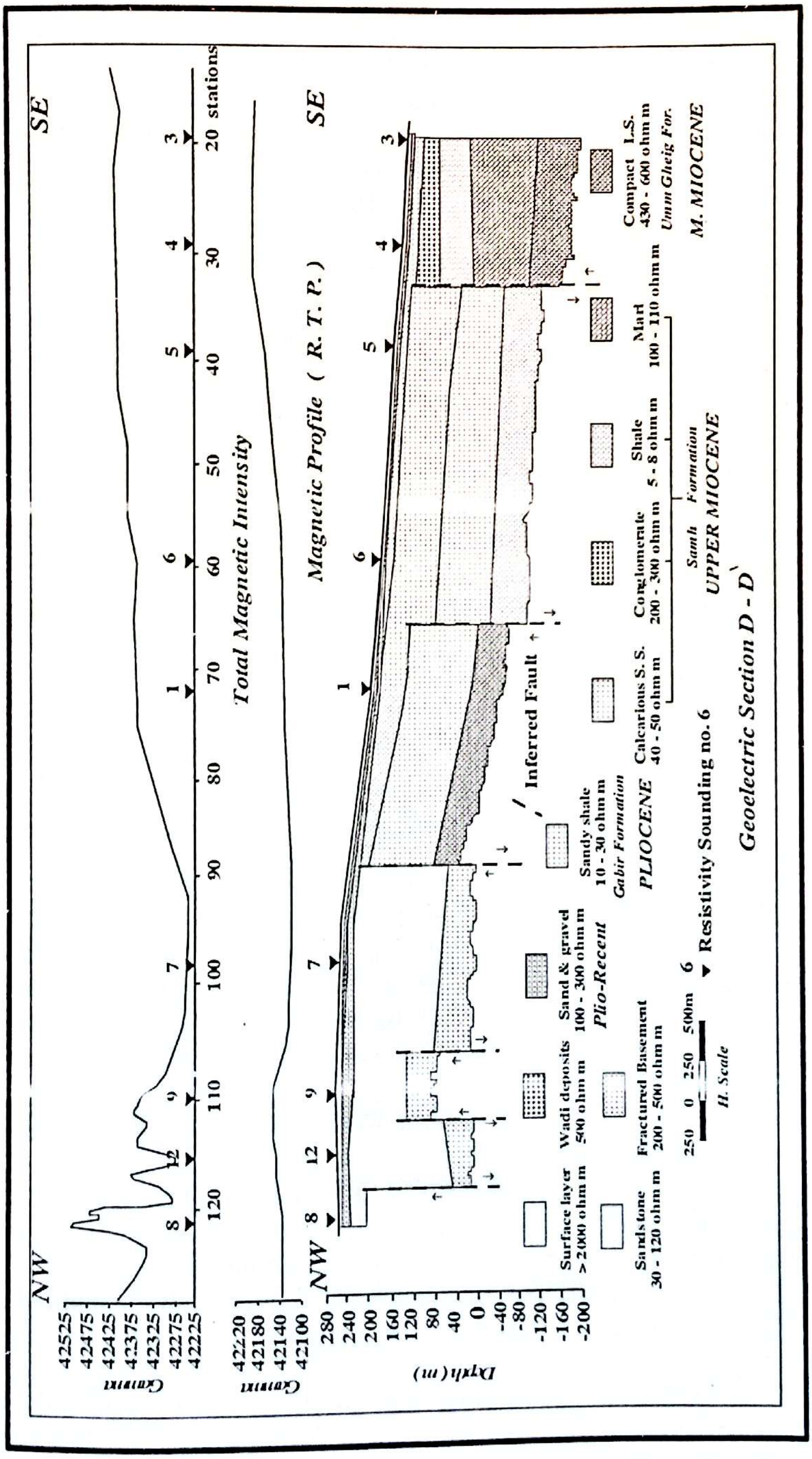

Fig. (9). Cross Section D– D' – Abu Soma Area

The depth to the compact limestone of Middle Miocene (Umm Gheig Formation) is detected at 200 m, 340 m and 300 m in sounding stations No. 1, 4 and 3 respectively as shown in fig. (9). The electric resistivity of this limestone is more than 400 ohm.m i.e. not contains water. The shale, marl, conglomerate and calcareous sandstone of the Samh Formation (Upper Miocene) are overlaying the limestone with variable thickness and wide ranges of resistivities (Table 2).

CONCLUSION

The present study was directed to delineate the groundwater occurrence in Ras Abu Soma area that lies 18 km to the north of Safaga on the Red Sea Coast. The selected area covers about 230 km^{2}.

The geophysical methods carried out in the study area included electric resistivity sounding and magnetic surveys. Within the studied area 40 Vertical Electrical Resistivity Soundings were measured using the Schlumberger arrangement. The maximum current electrode spacing (AB) ranges from 500 – 6000 m. Two parametric resistivity soundings No. 32 and No. 36 were measured near two water wells to make correlation between the interpretation results of these soundings and lithostratigraphic section of the wells. The correlation allows establishing the ranges of characteristic resistivities for the different rock units in the studied area. Along four traverses (42 Km) the total intensity of the earth's magnetic field (ΔT) was measured every 25m to 50 m. The total magnetic intensity measured along profiles was interpreted using different methods to estimate the depth to the basement rocks. The total intensity aeromagnetic contour map and total intensity aeromagnetic contour map reduced to the pole assisted in this study to give idea about the basement structures and its relief, which may affect the overlying sedimentary section.

Based on the correlation of the two drilled wells and the parametric resistivity soundings measured beside these wells led to detection of two types of formations separated by a major fault. The rock units in the western side belong to Quaternary wadi deposits, sandstone and Precambrian basement rocks. In the eastern side of the study area the formations are related to Pliocene and Miocene succession.

According to the total magnetic intensity measurements and aeromagnetic contour map as well as the geological structures map of the area, an eastward throwing major fault and sets of minor faults are detected.

Moreover, the interpretation results of the resistivity soundings and the four geoelectric sections provided two aquifers, shallow and deep in the investigated area.

The shallow aquifer is represented by Pliocene sandstone and sandy shale of Gabir formations in the eastern side of the study area. Whereas at the western side, this aquifer is restricted to the Quaternary wadi deposits, sandstone and the fractured basement. The depth to this aquifer in both sides range from 30 m to 200 m.

A large thickness of sandy shale or sandstone of Gabir Formation is deduced from the interpretation results of resistivity soundings. Its thickness ranges between 120 m and 200 m and its electric resistivity varies from 15 ohm.m to 20 ohm.m. So, it is expected that the water is relatively saline. According to the data of recently drilled water well the salinity of water was found 3360 ppm.

In the western side, a large thickness of sandstone is recorded (from 80 to 180 m). The electric resistivity range between 39 ohm.m and 70 ohm.m. A basin-like structure has been detected at the northwestern side of the study area. The electric resistivity of fractured basement varies from 360 ohm.m to 480 ohm.m. The electric resistivity of the solid basement rocks is more than to 2000 ohm.m. The decrease of the electric resistivity of the basement rocks means that it contains relatively low saline water. According to this study, a water well was drilled at that part of the area. The static water level was found at depth 49 m in sandstone with salinity 960 ppm.

The deep aquifer in Abu Soma area is represented by Lower Middle Miocene sandstone of Ranga member (Gabal El Rossas Formation). The depth to this aquifer is recorded at depth of about 700m at the middle part of the southern side of the studied area (Abu Soma basin). The electric resistivity of this layer is 14 ohm.m. The decrease of the electric resistivity can be interpreted as saline water in Gabal El Rossas Formation.

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دراسة جيوكهربية ومغناطيسية لتحديد تواجد المياه الجوفية في منطقة أبو سومه – شمال سفاجا – الصحراء الشرقية – مصر

مجدى مينا جرجس
قسم الاستكشاف الجيوفيزيائى – مركز بحوث الصحراء – المطرية – القاهرة

الدراسة الحالية أجريت لتحديد تواجد المياه الجوفية في منطقة ابوسومة التى تقع شمال مدينة سفاجا بحوالي ١٨ كم بالصحراء الشرقية . المنطقة المختارة للدراسة مساحتها حوالي ٢٣٠ كم٢ وتقع بين خطى طول٤٥/ ٣٣° – ٥٥/ ٣٣° وخطى عرض ٥٠/ ٢٦° – ٥٥/ ٢٦° .

الطرق الجيوفيزيائية التي أجريت في منطقه الدراسة تضمنت الجس الكهربي العمودي لقياس المقاومة الكهربية والمسح المغناطيسي . تم قياس ٤٠ جسه كهربية عمودية باستخدام توزيع شلمبرجير وتراوحت أقصى مسافة بين قطبي توصيل التيار (ا ب) بين ٥٠٠ – ٦٠٠٠ متر ، تم قياس جستين كهربيتين رقمي ٣٢ و ٣٦ بجوار بئران للمياه الجوفية حفرا بمنطقة الدراسة. تم إجراء مضاهاة بين قيم المقاومة الكهربية المستنتجة من الجستين الكهربيتين وبين التتابع الصخري للطبقات داخل هذان البئران. قد ساهمت هذه المضاهاة في تحديد مدى قيم المقاومة الكهربية الحقيقية للوحدات الصخرية المختلفة.

تم قياس المركبة الكلية لشدة المغناطيسية الأرضية على طول أربعه خطوط أو بروفيلات إجمالي أطوالها ٤٢ كم ، وقد تم القياس بمسافات تراوحت من ٢٥ – ٥٠ متر على هذه الخطوط . تم إجراء تفسير نتائج هذه القياسات لتقدير عمق صخور القاعدة باستخدام طرق مختلفة للتفسير للوصول لأدق عمق لصخور القاعدة . وتم الاستعانة أيضا بخرائط كنتورية للمركبة الكلية لشدة المغناطيسية أجريت على الصحراء الشرقية بواسطة القياسات المغناطيسية الجوية وكذلك لنفس الخرائط الكنتورية بعد تصحيحها بالنسبة للقطب الشمالي ، وهذه الخرائط ساعدت في إعطاء تصور للتراكيب التحت سطحية لصخور القاعدة وتضاريسها والتي قد تؤثر على القطاع الرسوبي الذي يعلوها .

اعتمادا على المضاهاة التي أجريت بين نتائج تفسير الجسات الكهربية والمعلومات الجيولوجية المتاحة أمكن تميز نوعان من التتابعات الصخرية بمنطقة الدراسة :

- الجزء الغربي ويشمل الرواسب الوديانية الحديثة وصخر رملي ثم صخور القاعدة المتشققة والمصمتة .
- الجزء الشرقي وبه قطاع رسوبي ذات سمك كبير وتمثله صخور البليوسين وتتابعات الميوسين.

ويفصل الجزء الغربي عن الجزء الشرقي فالق (صدع) أساسي ومجموعة من الفوالق الفرعية ذات رميات جهة الشرق تم الاستدلال عليها من القياسات والخرائط المغناطيسية وكذلك من الجيولوجية التركيبية لمنطقة الدراسة.

بالإضافة إلى ذلك تم تحديد خزانان جوفيان بمنطقة الدراسة ، الأول سطحي نسبيا والأخر عميق . الخزان السطحي تمثله صخور الحجر الرملي والرملي الطفلى لعصر البليوسين (تكوين جابر) وذلك في الجزء الشرقي من منطقة الدراسة . أما في الجزء الغربي فتمثله الرواسب الوديانية والحجر الرملي وصخور القاعدة المتشققة ويتراوح عمق هذا الخزان من ٣٠ – ٢٠٠ متر في جزئي المنطقة.

وقد تم تحديد أكبر سمك من الحجر الرملي والرملي الطفلى (تكوين جابر) في مواقـع الجسات الكهربيـــة رقمي ٣٧ ؛ ٣٨ (قطاع أ ـ أ/) ورقمي ٣٥ ، ٢٦ (قطاع ب - ب/) ويتراوح السمك بين ١٢٠ - ٢٠٠ متر ، ومقاومة كهربيه لهذه الطبقة تراوحت بين ١٥ - ٢٠ أوم · متر ومنها يمكن التوقع أن المياه ذات ملوحة عالية نسبيا· وقد تم الحفر في موقع الجسه الكهربية رقم ٣٦ ووجدت ملوحة المياه ٣٣٦٠ جزء في المليون·

في الجانب الغربى من منطقة الدراسة تم تحديد أكبر سمك للحجر الرملي في مواقع الجسات الكهربية أرقام ٢٩ (سمك حوالي ٢٣٠ متر) ، جسه كهربيه رقم ٣٢ (سمك حوالي ١٦٢ متر) ، جسه كهربيه رقم ١٤ (سمك حوالي ٨٠ متر) ، جسه كهربيه رقم ١٩ (سمك حوالي ٦٠ متر) ، جسه رقم ١٢ (سمك حوالي ١٨٠ متر) وجسه كهربيه رقم ٧ (سمك حوالي ٥٥ متر) وقد وجد أن الجسات الكهربية أرقام ١٢ ، ١٤ ، ٢٩ ، ٣٢ تقع في تركيب جيولوجي هابط مما يساعد على تجميع المياه الجوفية في مواقع هذه الجسات·

وقد وجد أن المقاومة الكهربية لصخور القاعدة المتشققة تتراوح من ٣٦٠ - ٤٨٠ أوم · متر بينما المقاومة الكهربية لصخور القاعدة عادة ما تكون أكبر من ٢٠٠٠ أوم · متر وقد يعزى انخفاض المقاومة الكهربية لصخور القاعدة المتشققة لاحتوائها على مياه ذات ملوحة منخفضة نسبيا· وقد تم الحفر في موقع الجسه الكهربية رقم ٣٢ بناء على هذه الدر اسه ووجدت المياه على عمق ٤٩ متر في الحجر الرملي وملوحتها حوالي ٩٦٠ جزء في المليون·

الخزان العميق بمنطقة الدر اسه فيوجد في صخور الحجر الرملي التابع للميوسين الأوسط والسفلي في تكوين جبل الرصاص على عمق حوالي ٧٠٠ متر في موقع الجسه رقم ٣٨ والتي تقع في الجزء الجنوبي الأوسط من منطقـــة الدراسة (حوض أبو سومه) · والمقاومة الكهربية لهذا التكوين حوالي ١٤ أوم · متر ، وهذا الانخفاض في قيمة المقاومة الكهربية يعزى أن مياه هذا الخزان قد تكون مالحة·