Egyptian Geophysical Society
EGS Journal, vol. 7, No. 1, 143-159 (2009)

INTEGRATED STUDY ON THE WATER RESOURCES OF WADI BARAGA BASIN, SOUTHERN SINAI, EGYPT, USING G.I.S, REMOTE SENSING AND GEOPHYSICAL EXPLORATION TECHNIQUES.

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دراسة تكاملية على مصادر المياه بحوض وادى براجة،جنوب سيناء،مصر باستخدام
تقنيات نظم المعلومات الجغرافية والاستشعار عن بعد والاستكشاف الجيوفيزيقى

الخلاصـة: يمثل هذا السهل التركيبى منطقة اهتمام كبيرة لسكان و محافظة جنوب سيناء حيث يستخدم فى اقامة رحلات السفارى للسائحين و كذلك فى انشاء بعض الفنادق فى ثلاثة مواقع رئيسية هى نويبع و دهب و شرم الشيخ و تأتى أهمية أخرى لهذا السهل حيث انة يعتبر تجميعاً لبعض الوديان مثل (الجيبى و الحدبة و زغرة)، و التى تحول الفيضانات التى تقطع الطرق التى تربط المدن المختلفة عبر خليج العقبة.

و تأتى أهمية هذه الدراسة فى ثلاث محاور، الأول دراسة سمات الإمداد بالمياه و المناطق التى تستقبل كميات كبيرة من السيول، و الثانى التحكم فى مياه الفيضانات ، و الثالث دراسة امكانيات تواجد المياة الجوفية لاختيار افضل مواقع لحفر أبار مياه إنتاجية.

و قد تم تطبيق أربعة أنواع من القياسات الجيوفيزيقية وهى المغناطيسية و السبر الكهربى العمودى و المقاومة ثنائية البعد و السيزمية الانكسارية.

و قد تم تحليل و تفسير هذه المعطيات حيث فسرت المعطيات المغناطيسية الوضع التركيبى للمنطقة و الدراسة الجيوكهربية لاختيار الوضع الجيوبيئى واقتراح مواقع للسدود لتخزين مياه الفيضانات، أما الطرق السيزمية فقد أعطت تصوراً لاختبارات التربة بمواقع السدود المقترحة.

ABSTRACT: *The basin of Wadi Baraga lies between latitudes 28 44 and 28 73 30 N and longitudes 24 22 30 and34 25 30E (Fig.1).This tectonic plain represent an interesting area, for south Sinai residence and government due to its use as desert camp for the tourists travailing and outdoor activity of the international hotels in three main important costal towns namely, Nweaba,Dahab and Sharm EL Shaikh. Anther major importance to this tectonic plain is as acting the upstream of some wadis (EL Gaybi,Hadaba, Kenkeshen and Zaghra)which transfer the floods down to strike the main highway which contacts the mentioned costal towns along the Gulf of Aqaba..*

This integrated study has three main targets; firstly study the recharging characteristics and its enhancement capabilities in the term of surface water harvesting , secondly control the flash flood which dropped from this tectonic plain to strike the very important highway which connects the touristic towns along the Gulf of Aqaba. ; Finally study the groundwater probabilities at Baraga tectonic plain to locate the best sites for drilling wells.

To achieve the previous targets, three phases of the work should be happen, firstly the pre field work; secondly the field work and post field work. The pre field work which takes place to clarifying the geological, topographical and structural characterization of the area. The surface processes (D.E.M, slope, and aspect and hill shade) were studied using geographic information systems to detect the surface water flow direction and accumulations and clarify the mechanism of surface water harvesting and/or flash flood control at the area. The groundwater indicators (natural vegetations, Quaternary deposits, sandstone out crops, surface lineaments and active wads) were studied using remote data.

Four kinds of geophysical measurements were applied in the field work (magnetic, vertical electrical soundings, two dimension resistivity and refraction seismic) with different targets .These measurements were processed, analyzed and interpreted on the post field work phase .Twenty two magnetic profile were measured in grid form to clarify the structural configuration of the area and detect the thickness of the sedimentary cover. Twenty vertical electrical soundings were measured for testing groundwater probabilities at the sites recommended from the pre field work and magnetic study to detect the best sites for drilling wells .Four tomography (two – dimension resistivity) profiles were measured for geo environmental testing of the proposed dame sites for flash flood control and/or surface water harvesting .Two seismic refraction profiles were measured for geotechnical testing of the bed rocks at the proposed dam sites.

Four out of seven recommended dam sites were suggested for flash flood controls (D4-7) whereas the seven are important for surface water harvesting. Four sites were recommended for drilling wells (W1-4). Final recommendations to perform Geo environmental and geotechnical studies at the outlet of Wadi EL Gaybi and Wadi Hadaba

1. INTRODUCTION

Wadi Baraga tectonic plain lies to the west of Aqaba Gulf in the south central Sinai at 28 44 and 28 73 30 N and longitudes 24 22 30 and34 25 30E (Fig.1). The study are lacks sufficient geological, hydrological and geophysical studies at this virgin tectonic plain and there is no any water point in the area except the hand dug wells in Wadi El Safra which represent different conditions. Baraga tectonic plain represent one of the best desert camps for desert traveling, camping and out door activities used by the international hotels in South Sinai. This plain represent the focal area which collect the surface water before it's flooding to strike the high way which runs between Nweaba and Sharm EL Shekh cities through Dahab along the Gulf of Aqaba.

Baraga tectonic plain is bounded by the basement rocks whereas its central portion is composed of sedimentary rocks (Fig. 2). Basement is mainly composed of metamorphic acidic volcanic rhyolite, quartz diorite rocks, alkaline granite of late "Dahab-Attar melange" and late proterozoic "Kathrine alkaline group". Sedimentary rocks are composed of Arabah Sandstone of Cambrian age and Galalah Fformation of Cenomenian age. Wadi floor contain Wadi deposits (after Geologic map 1994).

This tectonic plain (Fig. 3) bounded by Gebel Barga (1004m.),Gebel Neghami (885m.) ,Gebel Um Osman (848m.) ,Gebel Meryiekh (893m.) and EL Gaybi plateau (809m.) and recharged at basin through wadi Barga,Kraz and EL Safra (from Sant Katreen– Central Sinai)**.** It takes different flow direction

2. PRE-FIELD WORK

The remote sensing data such as, Aster image (2007), Tm Image (Landsate,2005) Spot image (Spot, 2003) and digital elevation model (D.E.M), were used to study the surface water harvesting , flash flood control, recharging characteristics and groundwater indicators of the study area using G.I S capabilities **.**

2.1. Surface water harvesting

The sterio pairs of Aster images (2007) were imported, stacked, merged subseted and processed to create the digital elevation model (D.E.M) of the study area with 15m resolution using Arcgis, 9.2and ENVI, 8.4. The D.E.M (Fig. 4) was used to detect the flow direction (slope), surface water accumulation points (hillshade) and the steepness degrees (aspect). The slope map (Fig. 5), aspect map (Fig. 6) and hill shade map (Fig. 7) were interpreted to clarify the flow directions and detect the best sites for dam constructions (divergent and storage)which are useful for both water harvesting and flash flood control . This besides the surface water accumulation points which recommended for geophysical testing.

2.2. Flash flood control

Four dam sites out of the recommended seven points were recommended for storage dames to control the floods which drops form the tectonic plain to strike the asphalt rood along the Gulf of Aqaba (Fig. 8) . Geo environmental testing (2D-Resistivity) was recommended at four sites (D1-D4) and geotechnical testing (seismic refraction) at two sites (S1&S2) to study the characterization of the bedrock for dams construction.

2.3. Groundwater indicators

Each of the Landsat image and spot image were subseted ,processed, analyzed and interpreted by the application of many filter techniques using Erdas imagine ,8.7,1997 to detect the groundwater indicators in the area. Five groundwater indicators were detected in the area (Fig.9) namely natural vegetation, Wadi deposits, Sandstone outcrops, active wadis and surface lineaments. Twenty points were recommended for geoelectrical testing in the form of vertical electrical soundings for groundwater explorations.

2.4. Recharging characteristics

The D.E.M., slope and aspect were used to study the surface water harvesting and flash flood control in the term of flow direction and surface water accumulations using G.I.S techniques .The Tm images(Landsate,2005) with resolution 30 m. and Spot image(Spot,2003)with 5m. resolution were used to clarify the groundwater indicators.

3. FIELD WORK

Four kind of geophysical measurement, were applied in Baraga tectonic plain (Fig. 10) for different targets; namely, ground magnetic, vertical electrical soudings, 2D resistivity (tomography) and seismic refraction measurements.

3.1. Ground Magnetic

The total magnetic intensity of the earth's magnetic field (ΔT) was measured along 22 profiles traversing the study area in three main directions, ENE-WSW and NNW-SSE and E-W. The total length of the surveyed lines is 112 km with station spacing of 50 m. The Proton Magnetometer, ENVIMAG, which has a resolution of one Gamma, was used. All magnetic stations were tied to one base station. The magnetic reading of each station was corrected for diurnal variation. The root mean quadratic error of the measurements did not exceed $\pm$ 0.5 Gamma.

Measurements along the various profiles were utilized to construct a magnetic contour map which has been used for detecting subsurface basement relief (thickness of sedimentary cover) and structure elements through the study area.

3.2. Vertical electrical soundings

A total of 20 Vertical Electrical Sounding (V.E.S) stations were carried out as pattern along three profiles trending NW-SE, W-E and S-N. The Schlumberger 4 electrodes array was applied in carrying out the field measurements of the V.E.S station where the current electrodes separation (AB) ranged from 1000 to 1400m. The topographic survey was carried out with the purpose of determining the location and ground elevation of the sounding stations.

A direct current resistivity meter (Terrameter model SAS 1000) was used for measuring the apparent resistance with high accuracy at different electrodes spacing. The calculated apparent resistivty is plotted against the corresponding AB/2 on bilogorithmic scale, each cycle 6.25 cm.

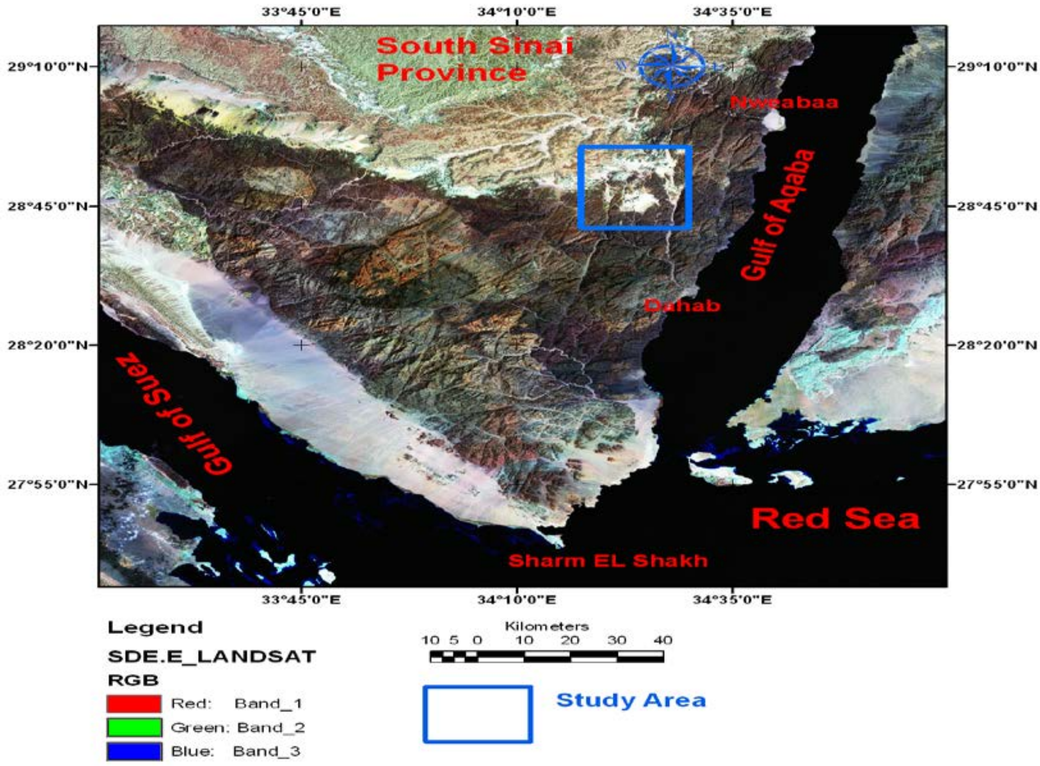

Fig. (1): Location map of Baraga tectonic plain, South Sinai, Egypt.

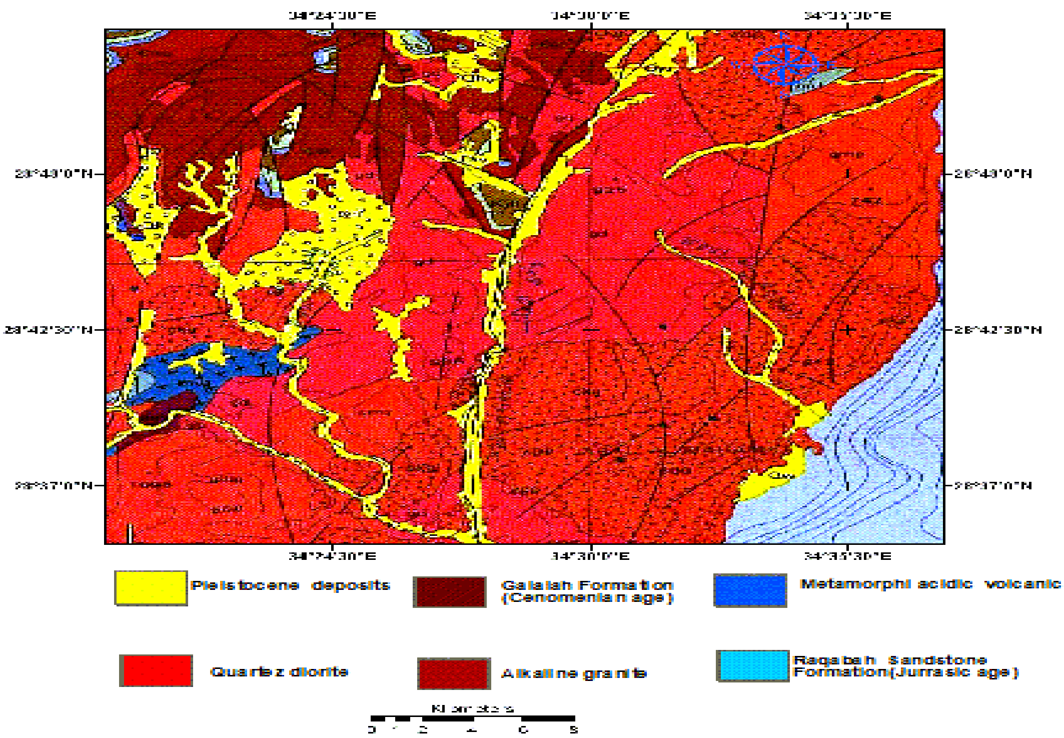

Fig. (2): Geological map of the study area (EGMSA, 1994).

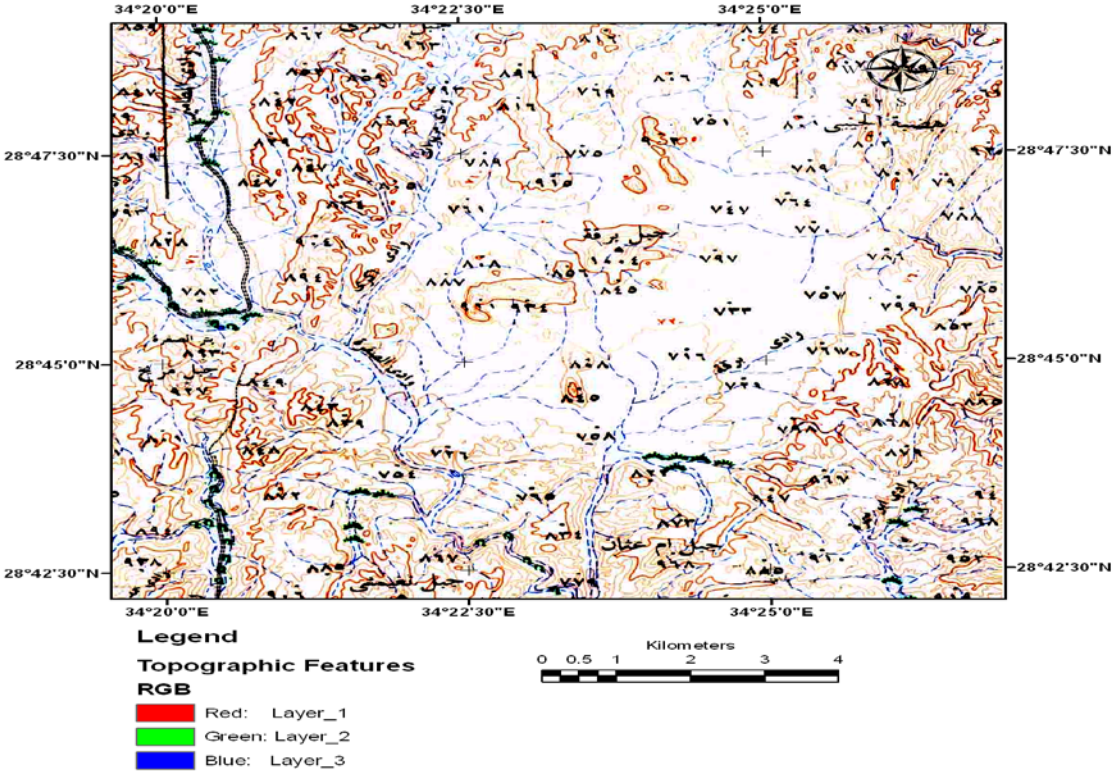

Fig. (3): Topographic map of the study area (E.M.S, 2006).

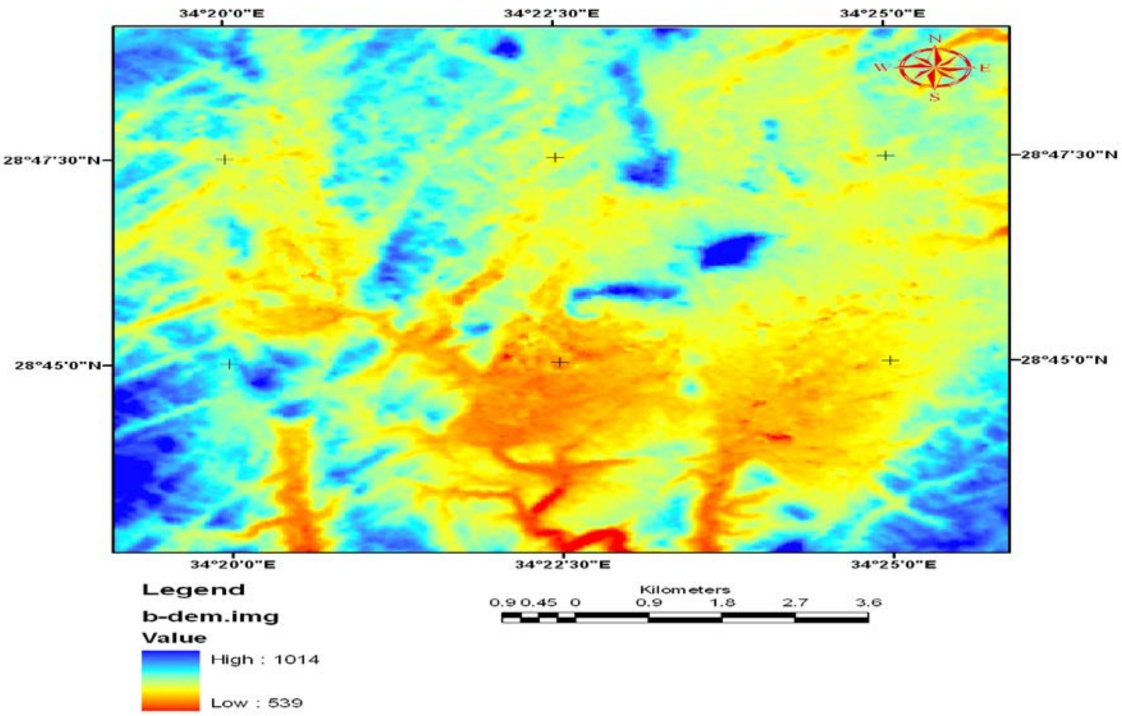

Fig. (4): Digital elevation model,15m resolution created from Aster images.

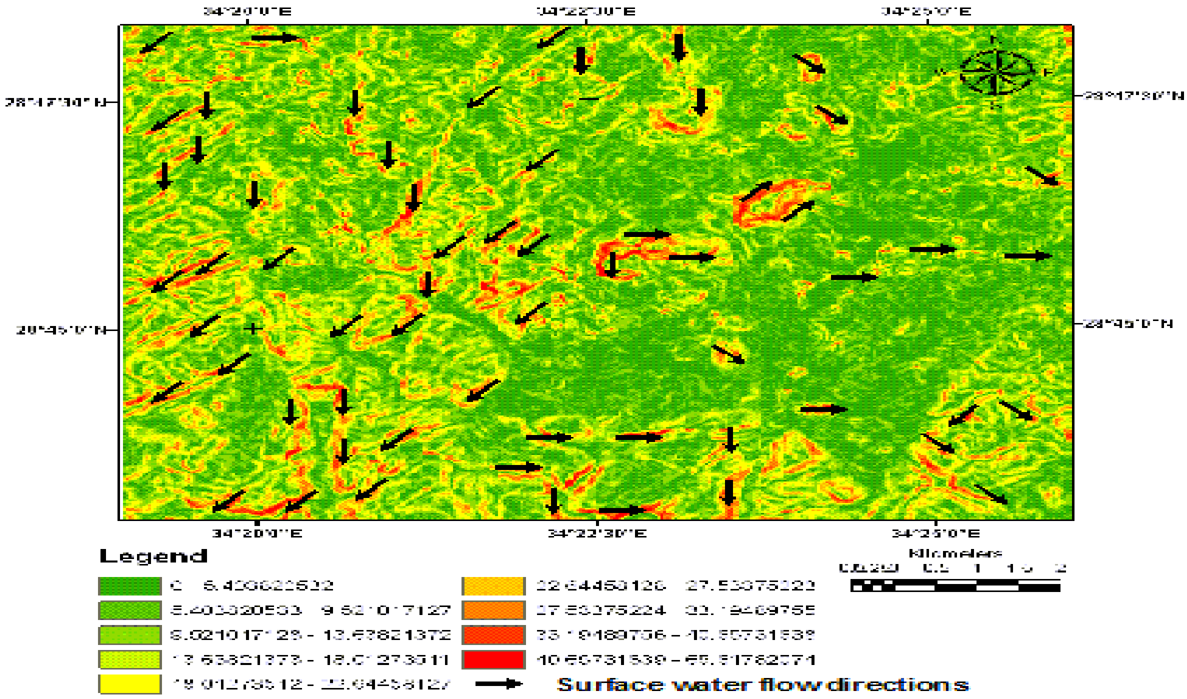

Fig. (5): Slope map showing the surface water flow directions.

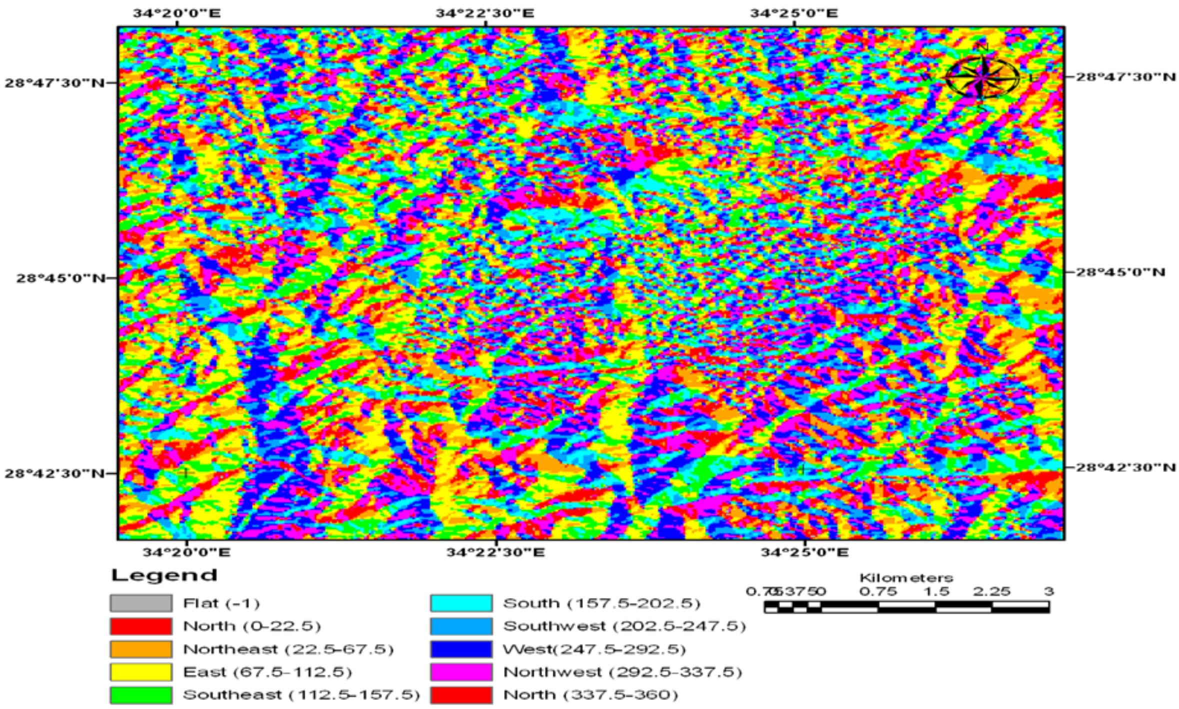

Fig. (6): Aspect map showing the flow intensity.

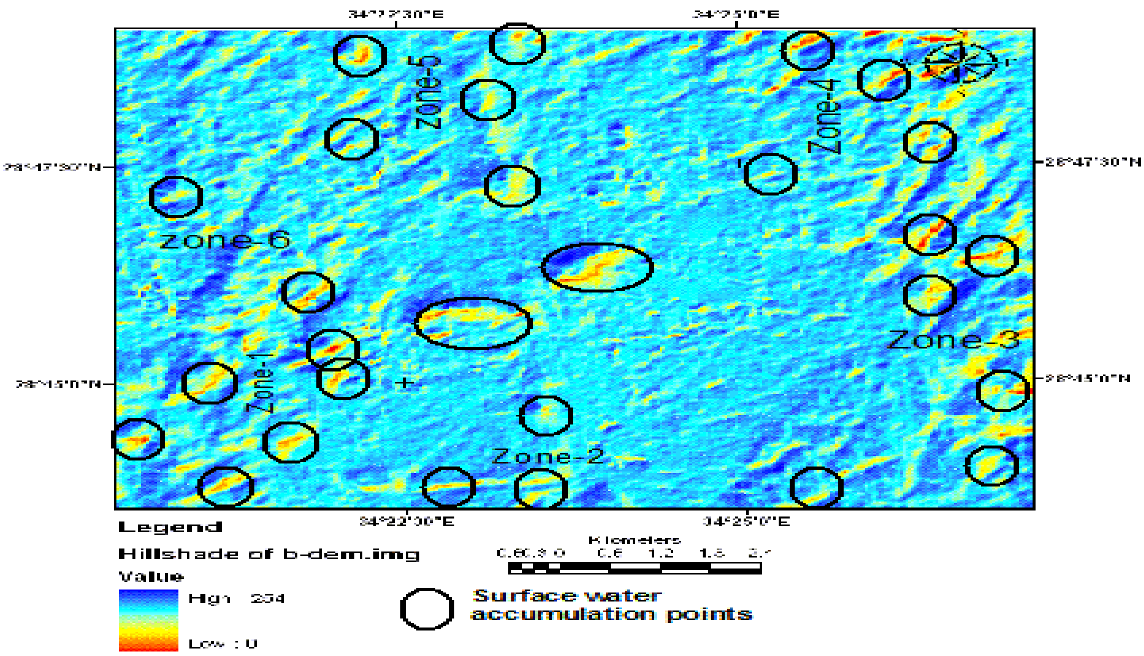

Fig. (7): Hill shade map showing the surface water accumulations.

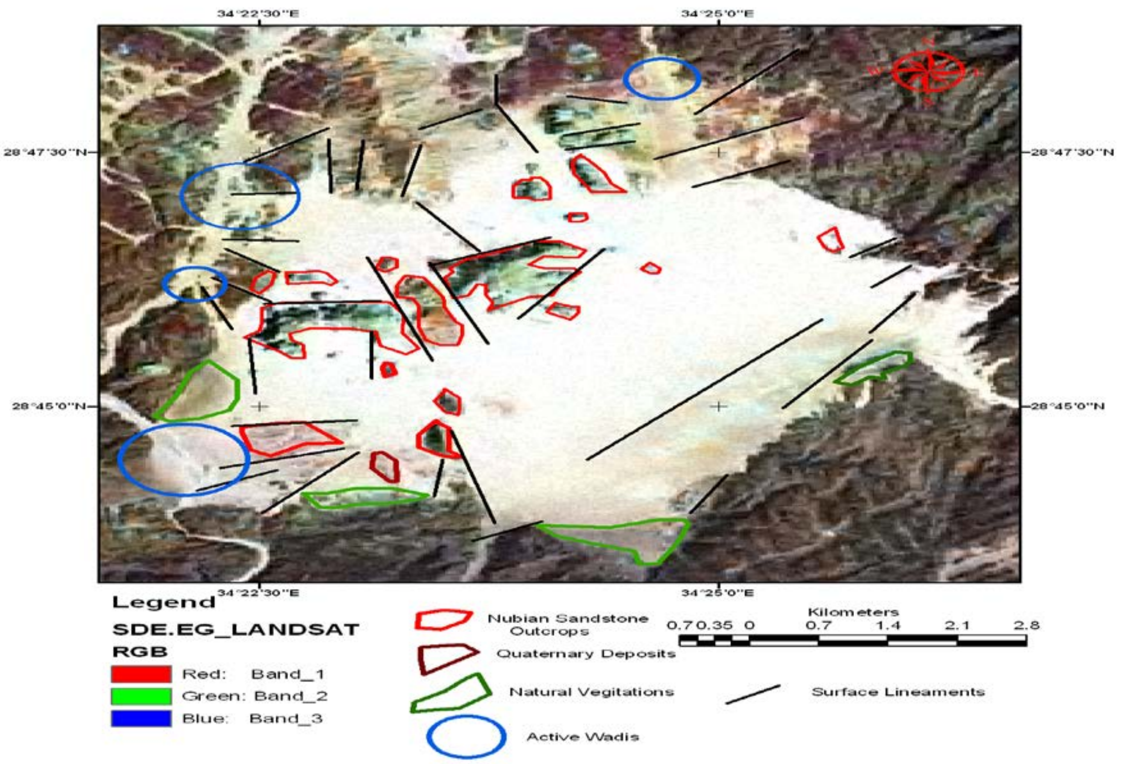

Fig. (8): Landsat image showing the interpreted groundwater indicators.

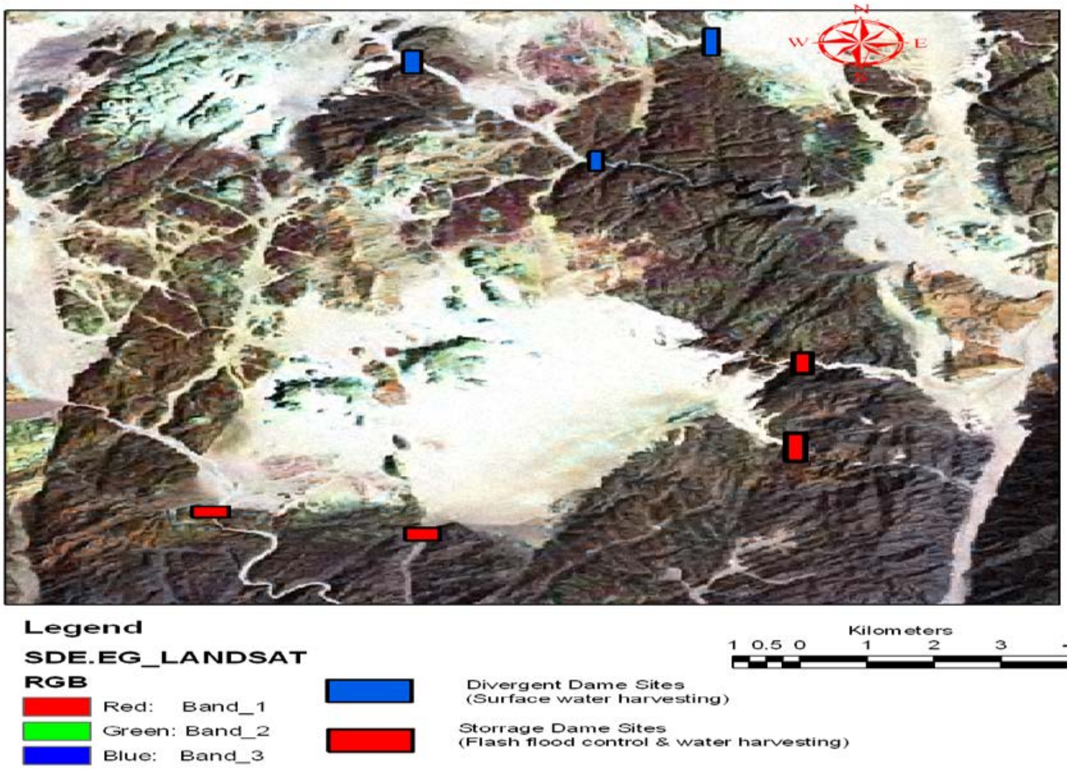

Fig. (9): Recommended dame sites for flash flood control and surface water harvesting

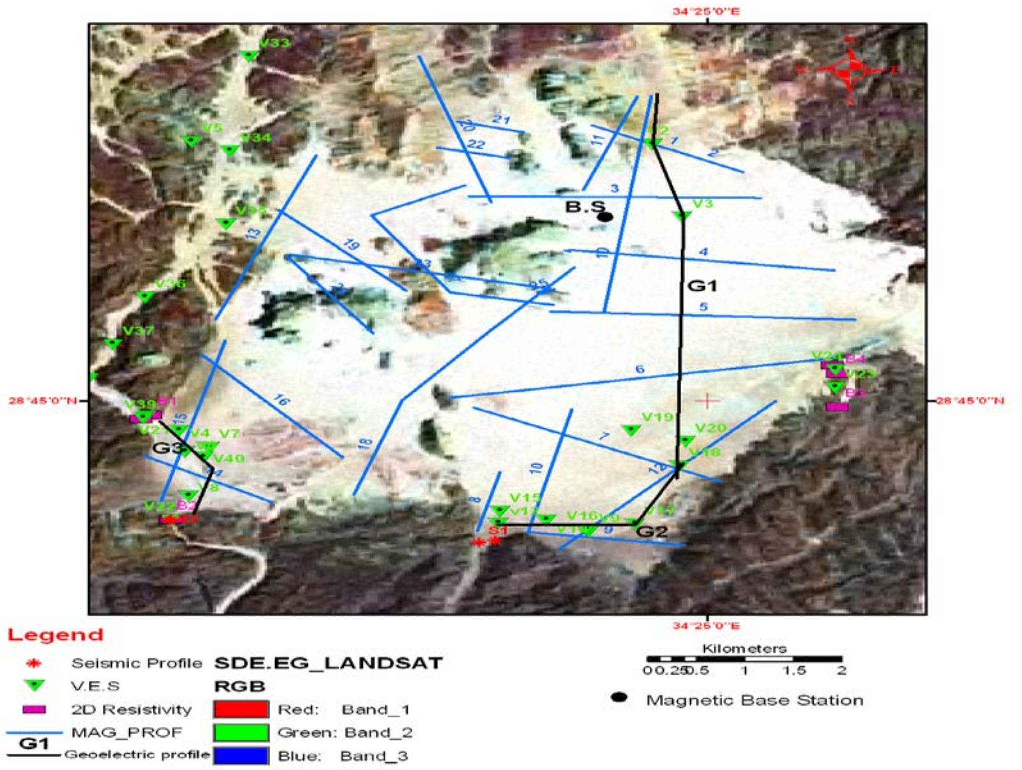

Fig. (10): Location map showing the different geophysical measurements.

3.3. The electrical tomography

The two-dimensional electrical resistivity imaging or electrical tomography was applied which is a technique developed for the investigation of areas of complex geology particularly for groundwater and engineering investigations. This method produces continuous image for the distribution of the electrical properties in the subsurface (Griffiths and Barker, 1993). The survey technique involves measuring a series of constant separation traverses with the electrode separation being increased with each successive traverse. The Wenner electrode array was used for acquiring the measurements which started, at the first traverse with unit electrode separation "*a*" (5 m) and increased at each traverse by one unit i.e. *2a, 3a, 4a ....,na*; where n is a multiplier. The length of the profile, depth of penetration and the required resolution determine the applied unit electrode separation. The imaging profiles were measured directly crossing Baraga tectonic plain at 4-sites with a total length varying from 130 to 190 m according to the width of the recommended dam site.

3.4. Shallow refraction seismic

Seismic survey is conducted through 4 layouts along 2 tested dam sites. The maximum distance between the shotpoint and the last geophone, is 120 m, with spacing from 5 to 10 m between geophones. The arrival times have been recorded by a twelve channel signal enhancement seismograph model EG&G 1225 Geometrics with a sledge hammer as a source of energy.

4. POST-FIELD WORK (PROCESSING, ANALYZING AND INTERPRETATIONS)

4.1 Ground magnetic

A total magnetic field intensity survey was conducted on the same grid pattern. Some tie lines were used normal to the profiles to control for consistency and reliability of the data. The drift correction of the reading for each station was carried out. These corrected data are stored in the computer to carry out the girding and contouring by Geosoft Program. 1994, (Geosoft mapping and processing system) to produce total intensity magnetic map (Fig. 11) and reduced to pole magnetic map. The filtering separation techniques (low pass and high pass) were applied to estimate the regional and local structural elements which play important role in the groundwater recharging in the area and also in the flash flood control. The spectral analysis technique was applied to estimate the depth to basement and the thickness of sedimentary cover

4.1.1. Reduced to pole

In the present study, the total intensity magnetic map has been reduced to the pole (Fig. 12) using Geosoft Program, 1994 (Mag map Fourier domain processing system) where some parameters as inclination (42.2°), declination (2.75°), magnetic field strength (42911.5gamma), and height of the instrument sensor from the ground surface (1.6 m) are defined for the program. The linear anomalies which show minor presence in the north western part reflect the presence of faulted basement block or displacement in the basement surface. Concentric, closed, anomalies detected allover the area especially in the west, southwest indicate block structures and /or nonhomogenities in petrographic composition of the basement or lithological change in sedimentary cover. The asymmetrical anomalies are probably due to block structures.

4.1.2. Filtering technique

A computer program has been used to produce residual grid from the total grid by applying high pass filter and the regional component can be determined by applying low pass filter.

In the present study, the anomaly separation filtering technique (Geosoft program. 1994), is applied on the reduced to the pole magnetic map (RTP), where regional and residual separation was carried out Therefore, the separation was carried out at different wave numbers, maximum, and shallow depths respectively (Figs. 13&14). The structural elements interpreted from magnetic using Afleck, 1963 techniques at Baraga tectonic plain (Fig. 15) show that the area is highly structurally controlled .The twenty five fault lines which recorded in the area divide Baraga tectonic plain to six subtectonic plains. (PT1-6) and controlled the thickness of sedimentary cover and reflect the block movements. Three major tectonic trends are recorded in the area, NW-SE.NE-SW and W-E respectively.

4.1.3. Depth Estimation using Spectral Analysis Technique

The authors estimated the depth to basement at 20 profiles across the study area using Baranov (1957) and Spector and Grant (1970**)** estimation techniques. These profiles cover the different anomalies in the total magnetic intensity map (Fig.16). Figure (17) given as examples - represent the amplitudes spectrum diagram along profiles no. 10 and 15, respectively as estimated using spectral analysis technique.

The depth to basement rocks at the different profiles was calculated, tabulated and contoured using ARC gis 9.2 to estimate the thickness of sedimentary cover in the area (Fig. 17). The depth to basement rocks map show four subbasins in the area (suggested to be good recharging conditions)with a maximum depth 155 m and a minimum depth 30 m.Two major sub basins are recorded at the northern and southern west areas. The sedimentary cover thickness was decreased towards the centre (Sandstone mountainous area) and the borders (basement rocks outcrops).

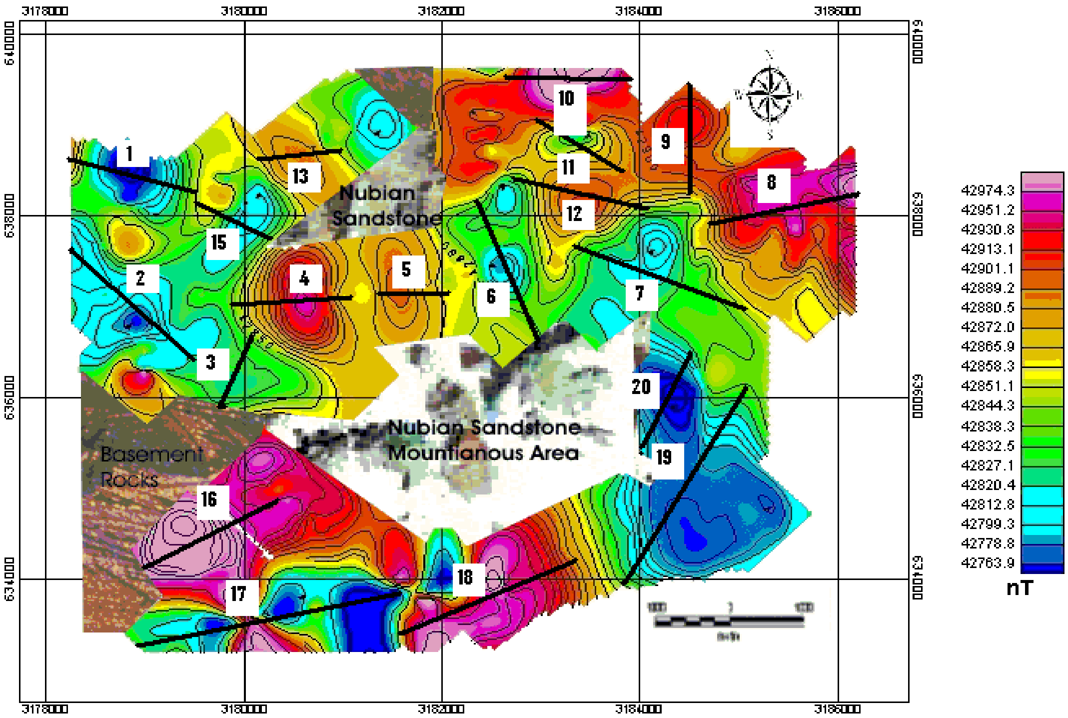

Fig. (11): Total magnetic intensity map showing locations of the spectral analysis profiles.

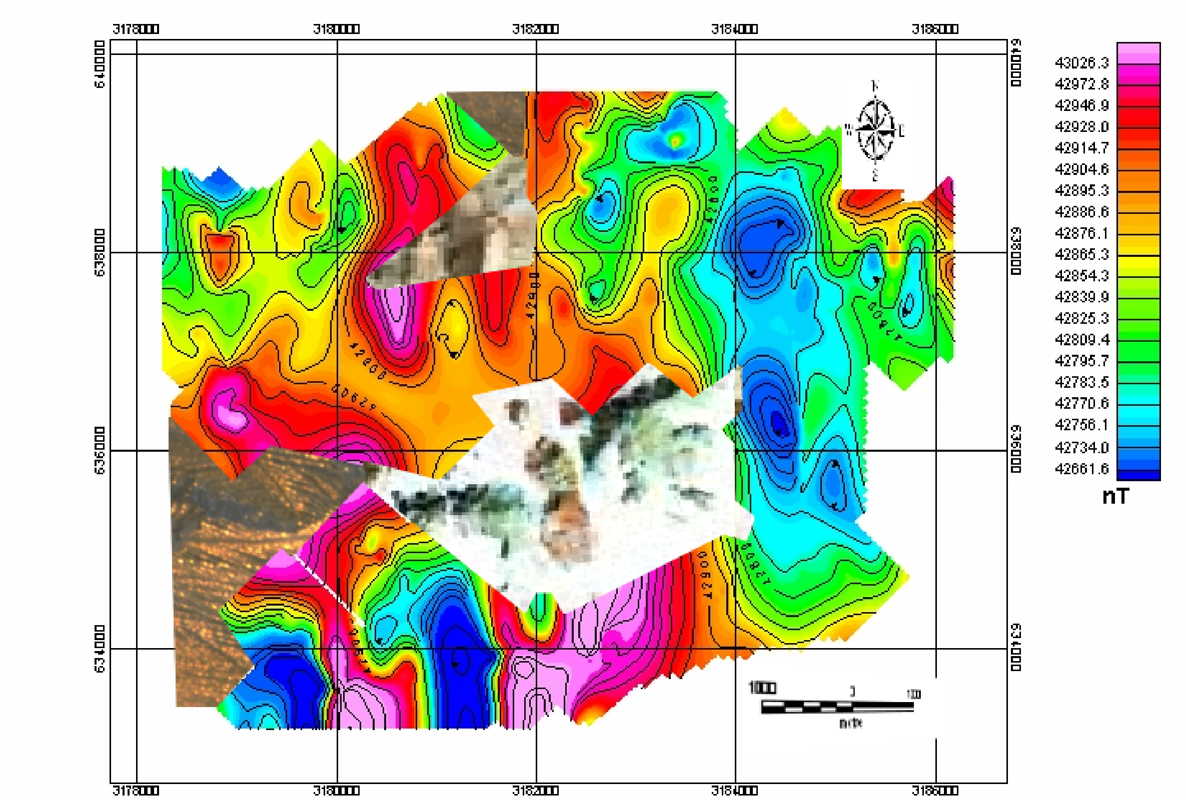

Fig. (12): Reduced to pole magnetic intensity map (R.T.P.).

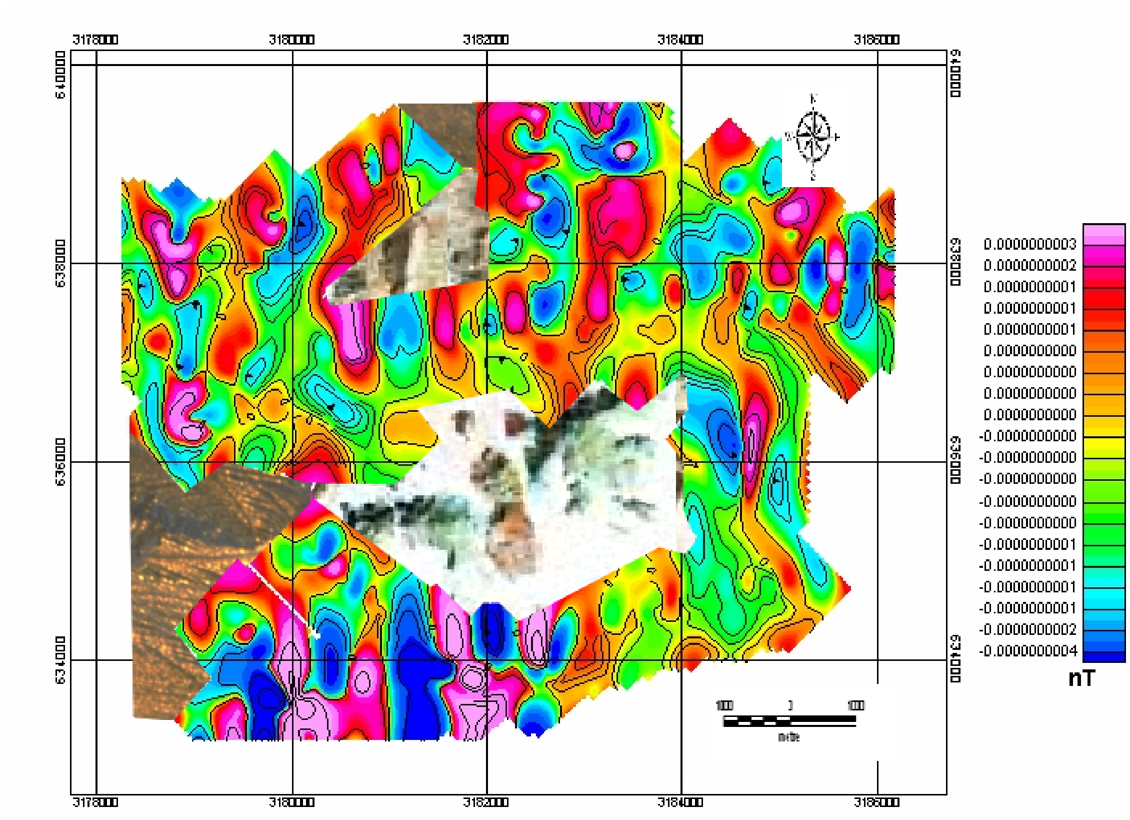

Fig. (13): Low pass frequency magnetic anomaly map.

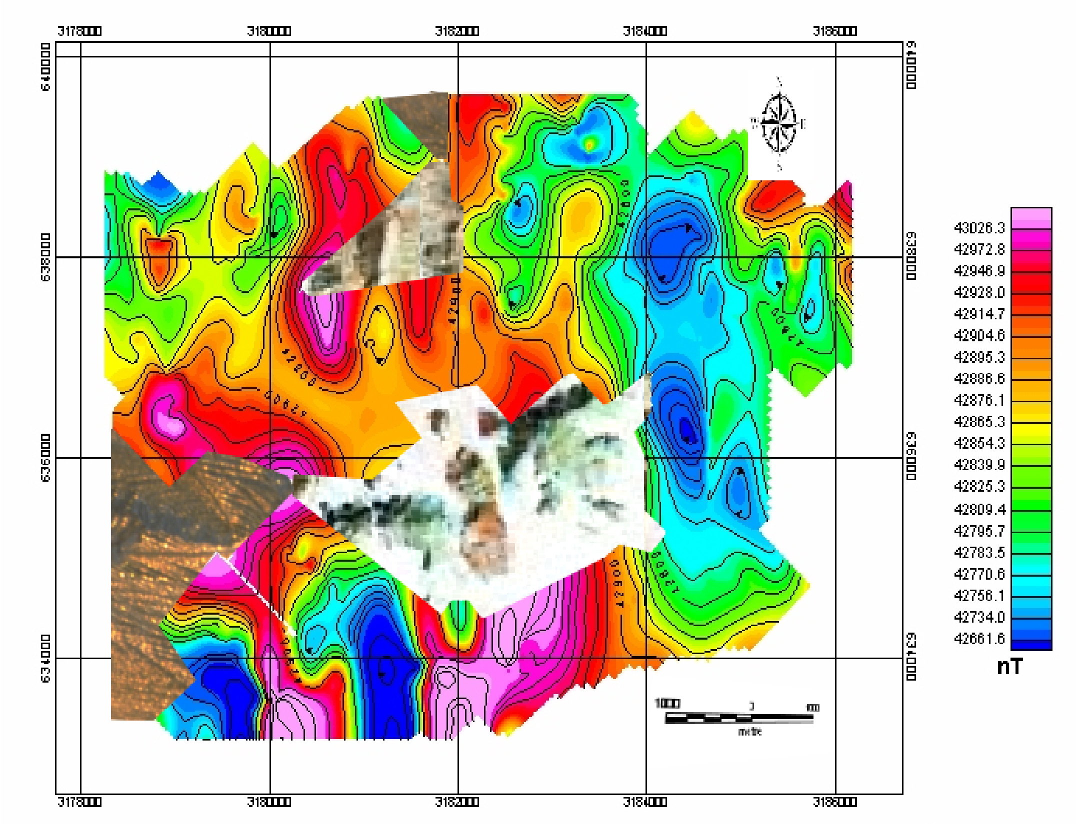

Fig. (14): High pass frequency magnetic anomaly map.

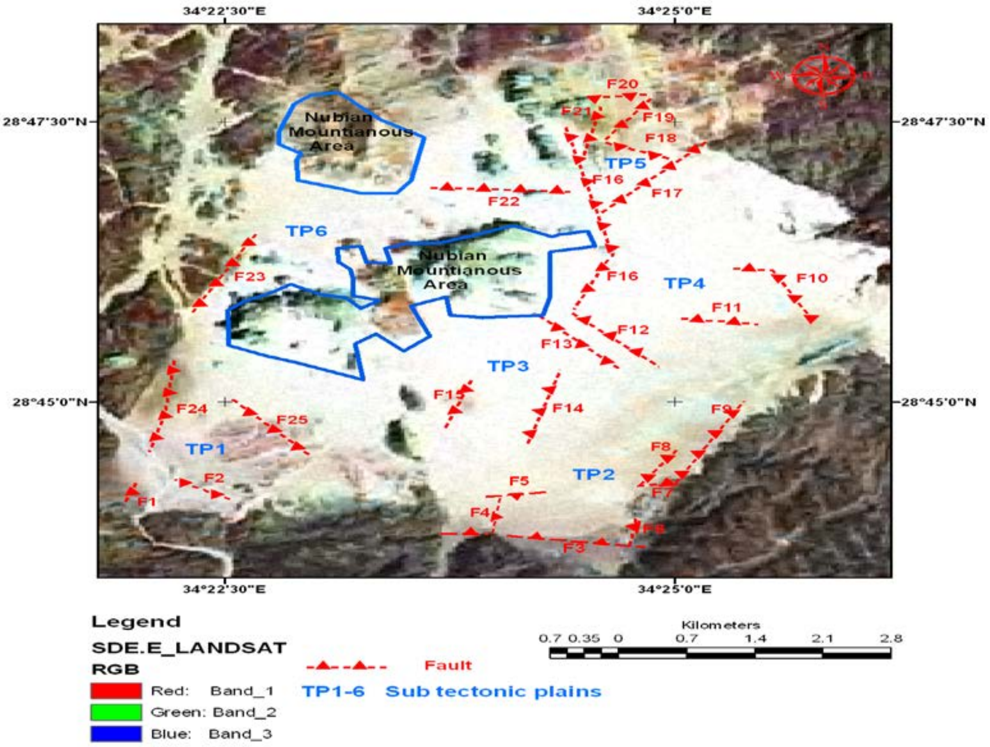

Fig. (15): Structural tectonic trends interpreted from filtering of the magnetic data.

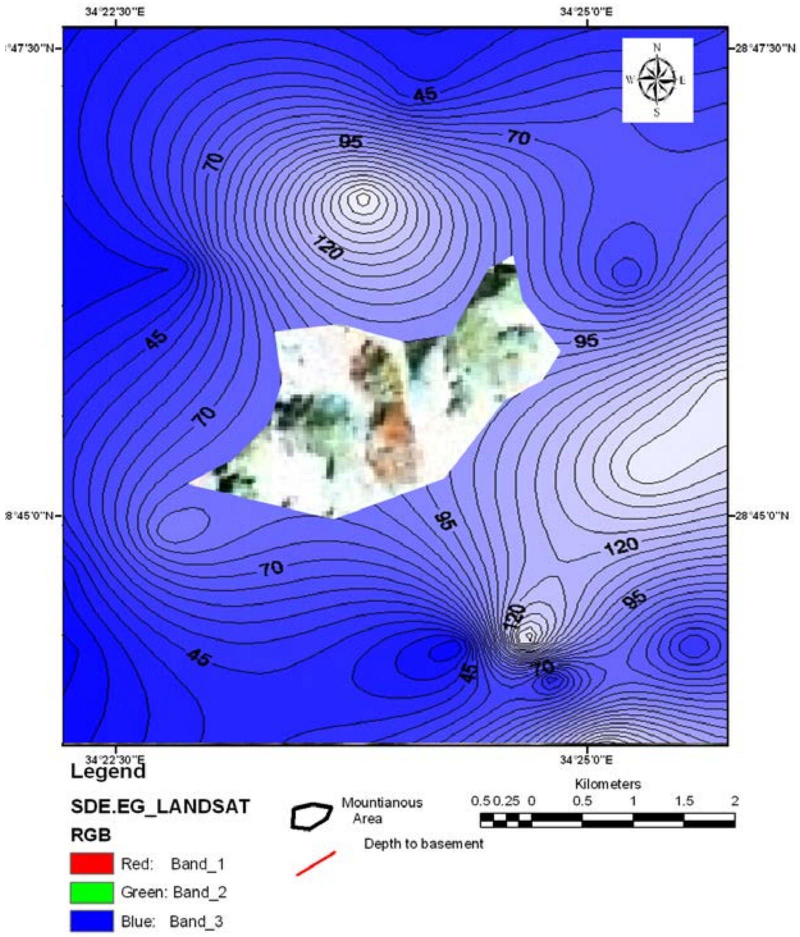

Fig. (16): Thickness of sedimentary cover as interpreted from magnetic data.

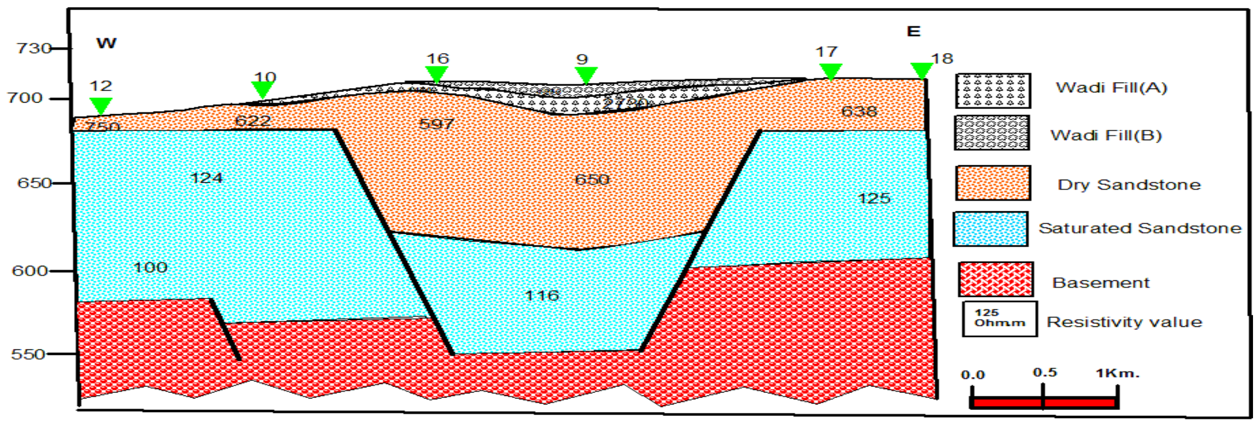

Fig. (17): Geoelectrical cross-section NO.1.

4.2. Vertical electrical soundings

The computer software RESIST", version 1.0was used for the quantitative inversion of the geoelectrical sounding (VES) curves.

Six geoelectrical layers are recorded at the cross-sections (Figs. 18-20) at Baraga tectonic plain. These layers were interpreted as six rock units representing two formations; namely Wadi fill (A & B), Araba Sandstone Formation (dry, thermal effected and saturated units, respectively) and basement complex.

4.2.1 Geoelectric cross-section No.1

This cross-section which (Fig. 18) is trending W-E direction and passing through six vertical electrical soundings delineate two formations and basement complex .Wadi fill shows resistivities between 640 and 2700 ohm.m and thickness between 2 and 20m. Araba Sandstone Formation has been classified into two main rock units, the upper one show a high resistivity range (from 590 to 750 ohm.m) and 20m as maximum thickness and interpreted as dry sandstone. The lower unit (100-125 ohm.m) represents the water bearing formation with a thickness between 65 and 100 m. The best sites for drilling wells recommended around the veses No.10, 12, 17 and 18 due to depth considerations. The basement rocks recorded at different depths with high resistivity values ranged between 1220 and 6730 ohm.m

4.2.2 Geoelectric cross-section No. 2

This cross-section (Fig. 19) trending SE-NW direction shows two formations and basement complex .Wadi fill (1000 and 2570 ohm.m) has thickness ranged between 10 and 25 m. Araba Sandstone Formation is classified into three main rock units, the upper one show high resistivity (from 350 to 560 ohm.m) and a thickness between 10 and 45m and interpreted as dry sandstone. The lower unit (32-130 ohm.m) represents the water bearing formation with a thickness between 15 and 100 m. The best sites for drilling wells are recommended around the veses No.4, 6 and 11 due to thickness considerations. The basement rocks are recorded at different depths with high resistivity values between 1220 and 6730 ohm.m.

4.2.3 Geoelectric cross-section No. 3

This cross-section (Fig. 20) trending SE-NW direction, delineates two formations and basement complex .Wadi fill (1000 and 2570 ohm.m) has a thickness between 10 and 25 m. The Araba Sandstone Formation is classified into three main rock units, the upper one show a high resistivity (from 350 to 560 ohm.m) and a thickness between 10 and 45 m and interpreted as dry sandstone. The lower unit (32-130 ohm.m) represents the water bearing formation with a thickness between 15 and 100 m.

The best sites for drilling wells are recommended around the veses No.10, 12, 17 and 18 due to depth and thickness considerations. The basement rocks are recorded at with high resistivity values between 1220 and 6730 ohm.m.

4.3. Two-Dimensional Electrical Imaging

For the interpretation of the imaging data, RES2DINV, ver 3.4 computer program, written by Loke (1998) was used. It is a Windows-based computer program that automatically determines a two-dimensional (2-D) subsurface resistivity model for data obtained from electrical imaging surveys (Griffiths and Barker 1993). The program enables removing bad datum points before inverting the data so that they do not influence the resulting model.

4.3.1. Profile No. 1

The true resistivity plot of the two-dimensional imaging profile passing across the first recommended dam site for Baraga tectonic plain (Fig. 20), obtained after 3 iterations of the inversion program indicates that this plot consists of three zones. The upper zone represents the dry conditions and has a wide range of resistivity values between 35.3 and more than 63.9 ohm.m.

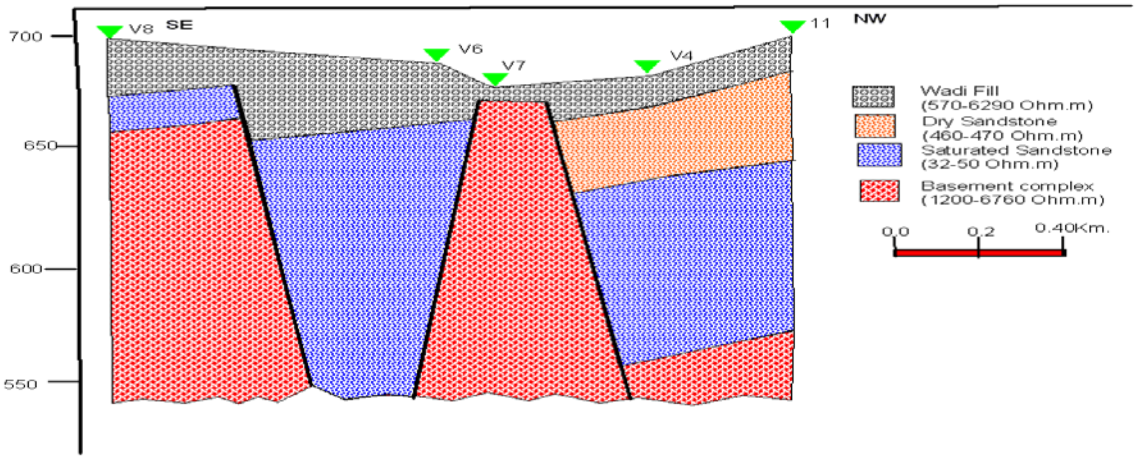

Fig. (18): Geoelectrical cross-section NO.2.

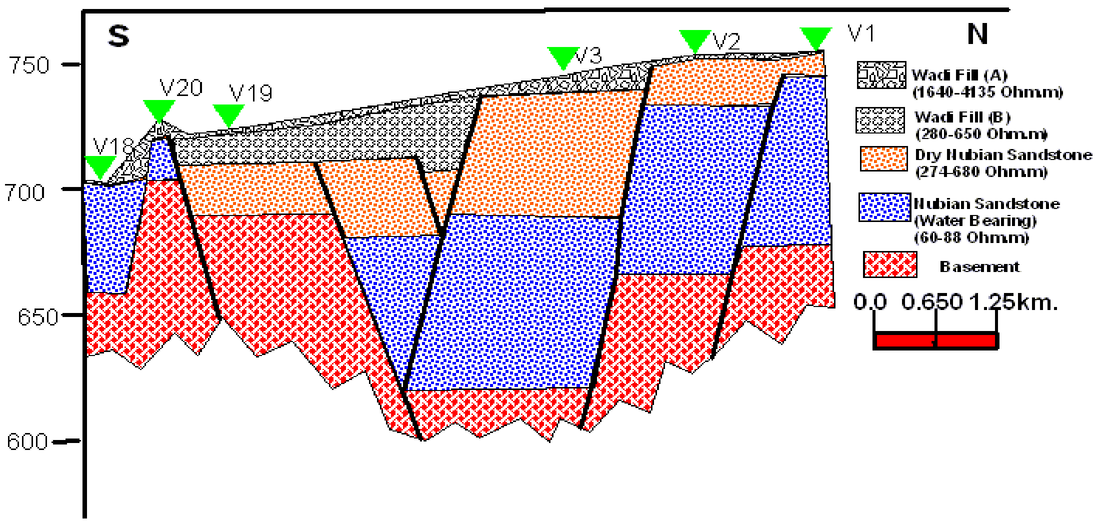

Fig. (19): Geoelectrical cross-section NO.3.

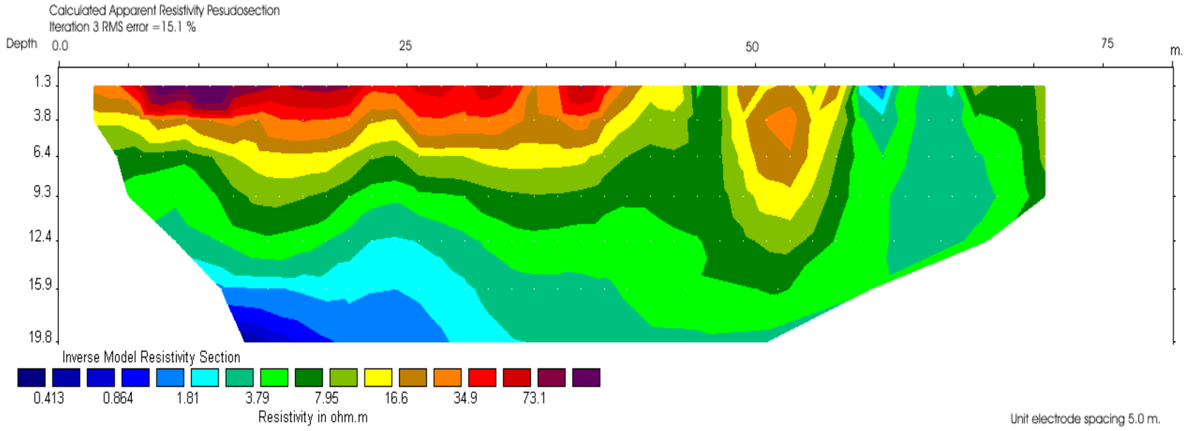

Fig. (20): 2D-resistivity profile across site NO.1.

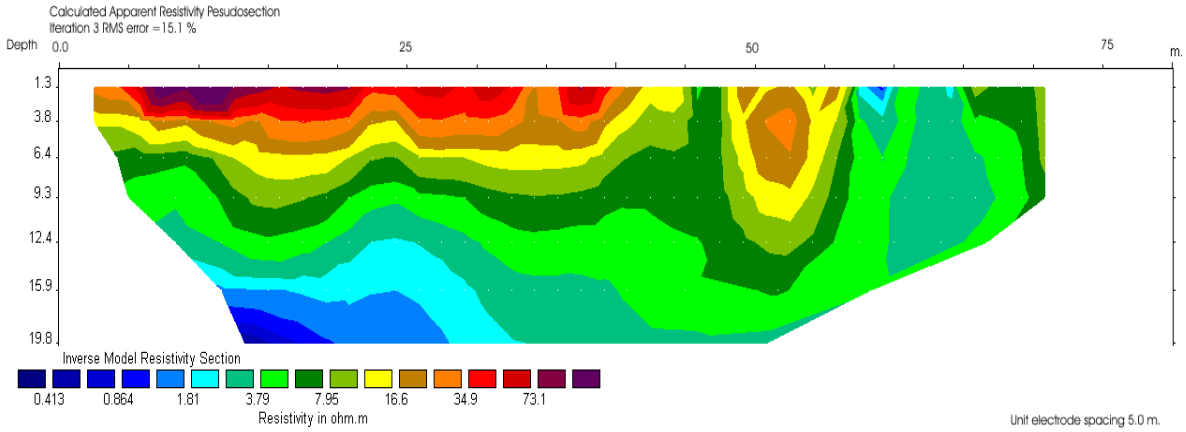

Fig. (21): 2D-resistivity profile across site NO.2

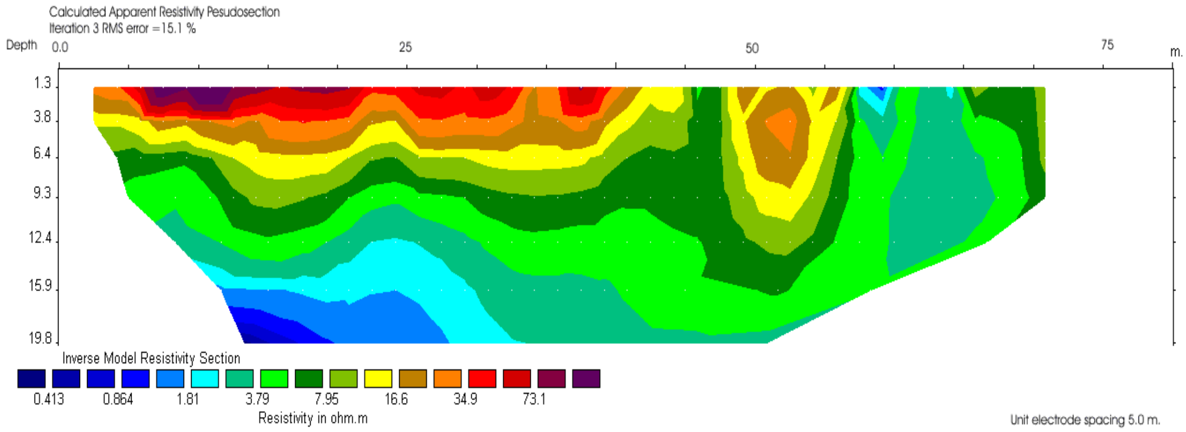

Fig. (22): 2D-resistivity profile across site NO.3

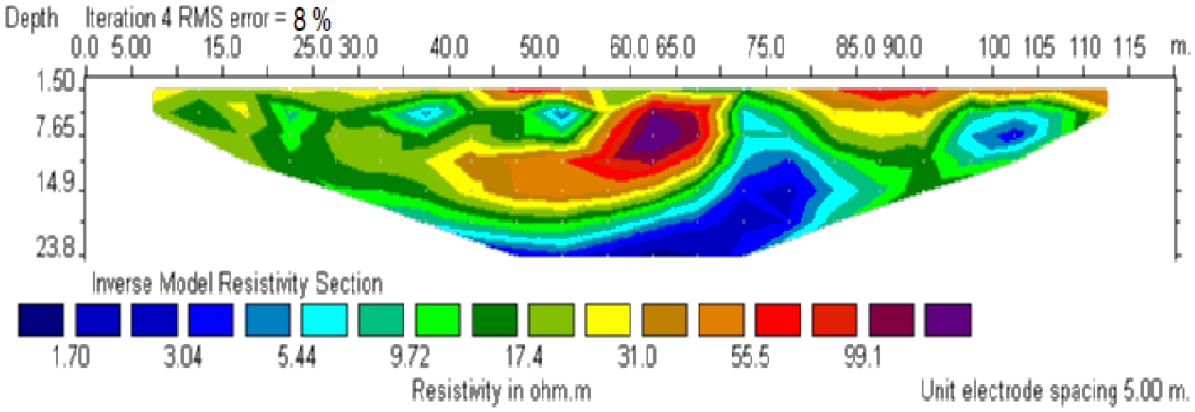

Fig. (23): 2D-resistivity profile across site NO.4

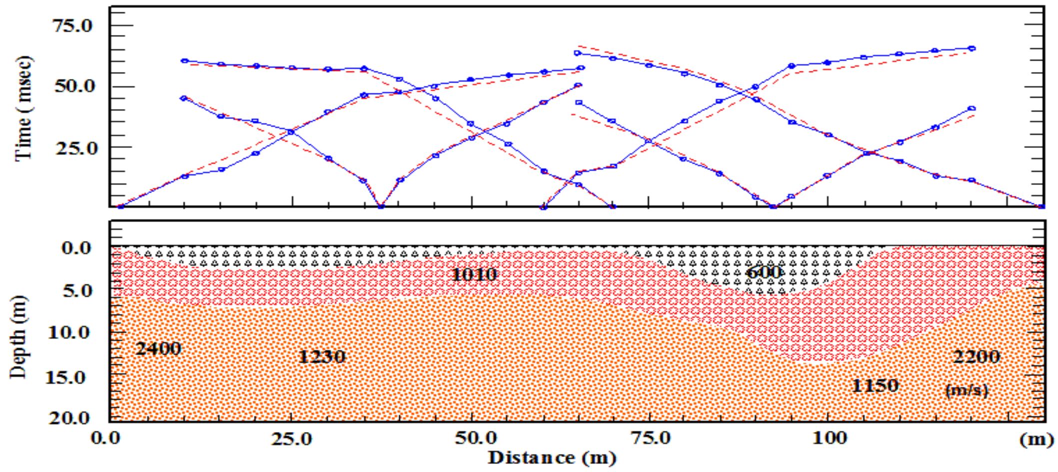

Fig. (24): 2D-seismic refraction cross-section across site NO2

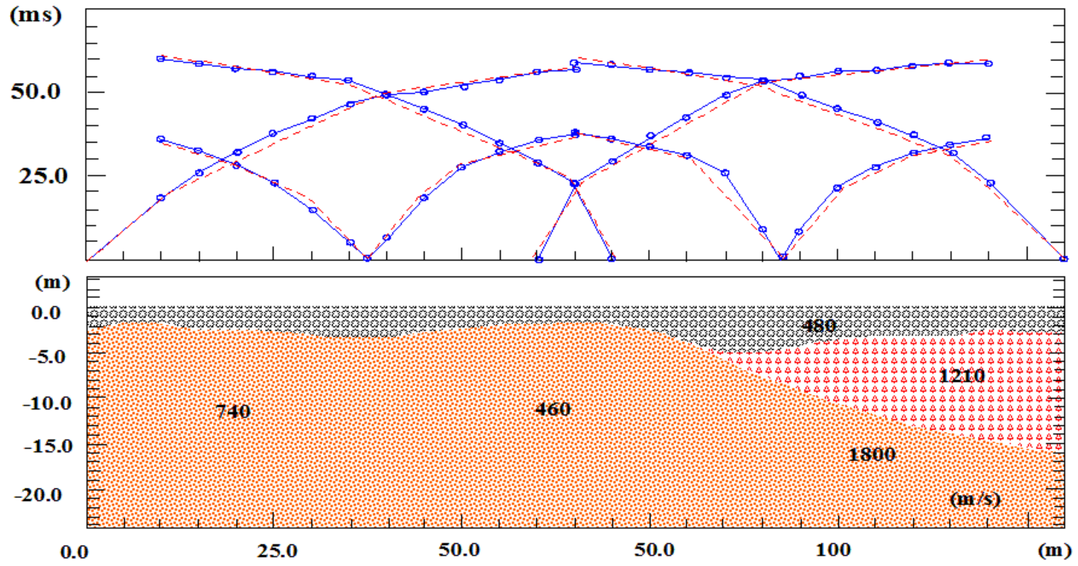

Fig. (25): 2D-seismic refraction cross-section across site NO.3.

The thickness of this zone reaches about 6.5m. Along this zone wedge a decrease of resistivity values (63.9-19.5 ohm.m) are recorded from west to east. The high values are attributed to the presence of basement fragments within the coarse alluvial deposits at these locations. The second zone (5.95-19.5 ohm.m) is recorded with 6m in thickness. This zone represents the fresh groundwater with a resistivity ranging from about 1 to 5.95 ohm-m. It extends to a depth ranging from 12.4 to 19.8 m. A geoenvironmentally surface stone dam is recommended in this site for flash flood control but for surface water harvesting the bed rock must be at depth more than 20 m.

4.3.2. Profile No. 2

The true resistivity plot passing across the second recommended dam site for Baraga tectonic plain (Fig. 22) shows three zones. The upper zone has a wide range of resistivity values (from16.6 to more than 73.1 ohm.m.)and 4m in thickness. Along this zone wedge a decrease of resistivity values is recorded from west to east. The high values are attributed to the presence of basement fragments within the coarse alluvial deposits at these locations. The second zone (3.97- 16.6 ohm.m) is recorded with 8 m thick. The third zone represents the water bearing part. This zone represents the brackish groundwater with a resistivity ranging from about 0.413 to 3.97 Ohm-m. It extends to a depth ranging from 12.4 to 19.8 m. A geo-environmentally, surface stone dam is recommended in this site for flash flood control but for surface water harvesting the bed rock must be at depth more than 20 m.

4.3.3. Profile No. 3

The true resistivity plot passing across the third recommended dam site (Fig. 23), consists of three zones. The upper zone has resistivity values ranging between 9 and more than 28.2 ohm.m. The thickness of this zone reaches to about 7.5 m. along this zone wedge a decrease of resistivity values is recorded from west to east. The high values are attributed to the presence of basement fragments within the coarse alluvial deposits at these locations. The second zone (3.32- 9 ohm.m) are recorded with 4 m thick .The third zone represents the water bearing part. This zone represents the brackish groundwater with a resistivity ranging from about 0.413 to 3.97 ohm-m. It extends to a depth ranging from 12.4 to 19.8 m. A geo environmentally surface stone dam recommended in this site for flash flood control but for surface water harvesting the bed rock must be at depth more than 25m.

4.3.4. Profile No. 4

The true resistivity plot passing across the fourth recommended dam site (Fig. 24) consists of three zones. The upper zone represents the dry conditions and has a wide range of resistivity (from 35.3 to more than 63.9 ohm.m.)and about 6.5m thick. Along this zone wedge a decrease of resistivity values (63.9-19.5 ohm.m) is recorded from west to east. The high values are attributed to the presence of basement fragments within the coarse alluvial deposits at these locations. The second zone (5.95- 19.5 ohm.m) is recorded with 6m in thickness .The third zone represents the water bearing part. This zone represents the fresh groundwater with a resistivity ranging from about 1 to 5.95 ohm-m. It extends to a depth ranging from 12.4 to 19.8 m. A geo environmentally surface stone dam is recommended in this site for flash flood control but for surface water harvesting the bed rock must be at depth more than 20 m.

4.4. Seismic refractions

The shallow refraction seismic data has been interpreted using the computer program SeisREFA-version 1.30-copyright Oyo Corporation 1990, 1991. It is a software package designed to assist in the interpretation of seismic refraction data in terms of a laterally varying earth structure. It enables interpreting seismic refraction data with the Generalized Reciprocal Method (GRM) or the Delay Time Method. It provides a user friendly means of entering, editing, interpreting and producing annotated hard copy results of seismic refraction first arrival data (Palmer, 1980).

The interpretation of the shallow seismic data was used to construct two cross sections (S_1&S2along the study sites (Fig. 24&25). These cross sections show that, the succession consists of three geo-seismic layers according to their velocities. The uppermost layer has a velocity ranged from of 480-600 m/sec and thickness range 1-4 m at S2 and S3 respectively. This layer consists of sand and wadi fill. The second layer has a velocity of 1010-1200 m/sec and a thickness of 5-9 m. The third layer has a variable velocity ranging between 640 and 2400 m/sec. It should be noticed that the velocity of this layer is increasing toward both margins where it is equivalent to the Nubian sandstone.

5. SUMMARY AND CONCLUSION

The surface process study using G.I.S techniques show the presence of many surface water flow directions and accumulation points and define six surface zones depending on the slope at the area. Five groundwater indicators (natural vegetations, wadi deposits, sandstone outcrops, active wadis and surface lineaments) are recorded at the area using the remote sensing techniques.

Seven dam sites are recommended using G.I.S and remote sensing for surface water harvesting and flash flood control. Three major tectonic trends are defined at the area namely, the Aqaba trend (NE-SW),Clysmic(NW-SE)and Syrian arc(W-E) .The six subtectonic plains detected at Baraga tectonic plain using magnetic data show that the surface water flow directions and accumulation points have structural roots.Good thickness of the sedimentary cover are recorded using the spectral analysis technique of the magnetic data. This considerable thickness reflects good groundwater probabilities at the area. Four locations are recommended for drilling water wells for touristic uses at the locations of Veses No. 10, 12, 17 and 18.

The geo environmental study using the 2D-Resistivity shows that the four defined dam sites are good for storage dams constructions (surface water harvesting purpose).The geotechnical study using the seismic refractions at the two sites are recommended for flash flood control and show the suitability of the two sites for barrier constructions . Finally, the recommended dam sites at Baraga tectonic plain may control the flash flood completely at W.Hadaba and partially at W. EL Gaybi. Geo environmental and geotechnical studies are strongly recommended at W. EL Gaybi which drained directly to Dahab-Nweabea asphalt road as recharged from each of Baraga tectonic plain and EL Gaybi plateau.

Surface and ground water modelling and rainfall – run off studies are recommended to calculate the water budget at this tectonic plain.

6. REFERENCES

Affleck, L., 1963. Magnetic anomaly trend and spacing patterns. Geophysics, Vol. 28, (3), 379-395.

Baranov, V., 1975. Potential fields and their Transformation in applied geophysics. Geoexploration Monographs, Series L, No. 6, Gebruder Borntrager, Berlin, Stuttgart, Germany, pp. 359-380.

Geological Survey of Egypt, 1994. Geological map of Sinai, Arab Republic of Egypt, sheet No.1, Scale 1: 250,000

ESRI Inc., 1997. Erdas Imagine Field Guide, 3rd ed., California,USA.

ENVI, 2000. The environment visualizing images. ver. 3.4, Research Systems, Inc. USA.

Geosoft programs, 1994. Specialized geophysical processing and interpretation programs and mapping system Geosoft Incorporated, 204 Richmond St. W. Toronto, Ontario, Canada.

Griffiths, D.H. and Barker, R.D., 1993. Two-Dimensional resistivity imaging and modeling in areas of complex geology. Jour. of Applied Geoph., 29, 211-226.

Loke, M.H., and Barker, R. D., 1996a. Practical techniques for resistivity surveys and data inversion. Geophysical Prospecting, 44, 499-523.

Loke, J., 1998. RES2DINV. V. 3.4, Rapid 2-D resistivity inversion using the least-square method. ABEM Instrument AB, Bromma, Sweden.

Military Survey of Egypt, 2006. Topographical map of Sinai, Arab Republic of Egypt, sheet No.25, Scale 1: 50,000

Palmer, D., 1980. The generalized reciprocal method of Seismic refraction interpretation, K., B. S., Ed., Soc. Explore. Geophs. P.101.

Spector, A. and Grant, F. S., 1970. Statistical model for interpreting aeomagnetic data, Geophysics, Vol. 35, No. 2, 293-302.

Seisrefa, 1992. Seismic refraction interpretation Software,Version 2.00 PRev.E,USA, Copyright oyo corporation

Van Der Velpen, B.P.A., 1988. “RESIST”, version 1.0, a package for the processing of the resistivity sounding data: M.Sc. Research Project, ITC, Delft, The Netherlands.

Zohdy, A.A.R., Eaton, G.P. and Mabey, D.R., 1984. Application of surface Geophysics to groundwater investigations, U.S. Geol. Survey. Book 2 (3rd printing), Section D, Chapter 1. 107-115.

Zohdy, A.A.R., 1989. A new method for the automatic interpretation of Schlumberger and Wenner sounding curves, Geophysics, Vol. 54, (47), pt. 2, 23p.