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THE DISTRIBUTION OF SEDIMENTARY BASINS IN NORTH EGYPT AND THEIR RELATION TO BASEMENT TECTONICS

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ABSTRACT

The study area is limited by 28°N Lat. and the mediterranean sea and meridians 25° and 31° 30 E. It includes the Northern part of the Western Desert, Nile Delta and Nile Valley: Fig.1.

An average density contrast equal to 0.24 mg/cm^3 was calculated in the study area between the basement complex and the sedimentary succession. The calculations were fulfilled on the measured gravity values together with the basement depths known from the drill hole data of wells spuded in the basement.

The Bouguer anomaly map of the area was used in calculating the residual component of the gravity field along profiles. The residual component was related mainly to structures on the basement surface. Consequently a corresponding basement relief map was constructed. The basement rocks lie at depths ranging between 0.4 km in some parts in the area to more than 12 km in some other parts.

The basement relief map showed the obvious control of the basement tectonics on the overlying sedimentary cover. Some of the structural highs and lows which are locally recongnized on the surface at different localities, were found to have a corresponding basement highs and lows.

Beside, several zones of major dislocations are present. They are illustrated on the basement relief map as zones of steep slopes separating the uplifted and downfaulted blocks.

The part of the Nile Valley lying in the present area was found to be tectonically controled by means of NE and NW fault systems, that run more or less parallel to the River Nile itself, having their origin as deep as the basement but with modified direction, number and areal extension.

INTRODUCTION

The area under study is characterized by almost a featureless plain cut by the occasional depressions of Qattara, Siwa, El Faiyum-Wadi El-Rayan. El-Bahariya and El Natrun as well as some of local folded and faulted complex as Abu Roash and El-Bahariya.

The Western portion of the area is generally characterized by apresistent limestone plateau known as El-Diffa (Mar marica) plateau. This plateau increases gradually in elevation from the coastal plain of the Mediterranean Sea to an elevation of approximately 200 m.a.s.L. The elevation then drop steadily towards the main belt of depressions passing through Qattara and Siwa. These depressions form a broad arcuate belt and are one of the salient geomorphic features of North Africa as they contain the lowest point on the African continent (the lowest point in the Qattara depression reaches about 134m below mean sea level). The age of the exposed limestone rocks of El-Diffa plateau is Middle Miocene [13].

The central portion of the area is generally blanketed by Miocene deposits. Along the Coastal areas; to the north; Limited Pliocene shales and sandstones are exposed. These pliocene sediments unconformably overlie the Miocene deposits. The southeastern portion of the area is covered mainly by the northerly gentle-dipping Tertiary strata; where the pliocene, Miocene and Oligocene sediments are the dominant surface outcrop in the north and northwestern portion, while in the east, south and southwest, the surface is covered mainly by the Eocene rocks.

Recent and Nile Aluvial deposits are resterictedto the Delta, Nile Valley and El-Faiyum Depression. Basaltic flows and sheets which are believed to be of Oligocene Miocene age are exposed in some localities such as in the Bahariya oasis, Gebel Qattrani, southwest of Cairo and west of the Nile Valley.

The study of the drill hole information together with the previous geological publications; such as those given by Shata [14,15], Farag [6], Sigaev [18], Amin [2] Said [13], Youssef [19] Bayoumi & El Gamili [4] Halsey [8], Riad et al. [11], Meshref et al. [9] El-Awady et al. [5], Meshref [10], Sharaf [16,17] ,,,,etc; refere to the fact that the northern part of the Western Desert which has a more or less monotonous surface is complicated in the subsurface by several structural elements, mainly in the form of folding, faulting, and unconformities. Such information will be definitly helpful in the interpretation of the geophysical anomalies observed in the area, particularly if these anomalies were associated with deep-seated sources controlled by the geologic activities and events working on the Earth's crust.

Using a simple analytical technique, it was possible to calculate the density contrast between the basement rocks and the overlying sedimentary rocks, and to separate from the total gravity field of the area the residual component resulting from the basement configuration. This technique takes in consideration the areal extent, form and amplitude of the anomalies as criteria for the depth of occurance of the anomalous masses.

The basement depths in the various parts of the area

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show a good agreement with the drill hole information, also, a contradiction is noticed between the actual and calculated depths in other parts.

METHODS AND TECHNIQUE

The character of the observed gravity field and its relation to the subsurface structure was studied from the linear correlation between the gravity values at the 17 wells and their depths to the basement surface (Table 1) and (Fig.1) using the following relation:-

$$r = \frac{\sum_{i=1}^{n} (g_i - g')(H_i - h')}{\sqrt{\sum_{i=1}^{n} (g_i - g')^2 \sum_{i=1}^{n} (h_i - H')^2}}$$

where (r) is the correlation Coefficient, N is the number of well used, h_i are their depths to the basement, g_i are the gravity values at these wells and h',g' are the mean values of the depth and the gravity values respectively.

The correlation Coefficient (r=0.54) which was obtained from the above mentioned relation is small and has no significance which means that the correlation between the measured Bouguer anomaly values and the depths to the basement is weak. This conclusion indicates that the measured gravity field is not referred only to the effect at the basement complex. A different density contrast between the basement complex and the sedimentary succession were applied in order to get best fit with one of the residual fields. The best fit of the residual components were achieved by using density contrast equal to 0.24 gm /cm^3.

The residual component of the Bouguer anomaly map*, Fig. (2), of the area was determined, using the above calculated density contrast, by removing the regional component due to the change in the thickness of the earth's crust. The resulting component in this case is considered to be arising from the effect of the structures mainly on the basement surface. Calculations were carried out along fifty one profiles. Sixten of these profiles are the main profiles representing the basis of the computation of the regional-residual separation, and are chosen to pass by two wells at which the depth of the basement is known. Twinty seven other profiles run N-S and the other eight profiles are chosen to run E-W and crossing at least two of the main profiles. Values of the residual component were determined as the difference between the observed

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* This map was complied by the G.P.C. in 1984, with contour intervals equal to 1 mgal. Apart of the interpreted map in the scale 1:500,000 is shown in Fig.3 Because technical difficulties, this map was replotted in the scale 1:1 , 000,000 with contour intervals of 5 mgal Fig.2.

and regional components at points equally spaced along each profile. In this way a residual map ig.4 was constructed which is thought to be due to the basement relief. By using the above value of density contrast, the residual anomaly map of the area was transformed into basement depths, along the same profiles, in the form of contour map with a contour interval of 0.5 kms which is shown in Fig. 5.

RESULTS AND DISSCUSION

The density contrast between the basement rocks and the overlying sedimentary rocks was calculated and was found to have an average value of 0.24 gm/cm^3.

The examination of the basement relief map of the area indicates that:-

A) The thickness of the sedimentary section has different values at different localities, which ranges from less than 0.4 km, at the uplifted parts southeast and of El Nashfa well, east of Diyar well, near El Fashn-Benimazar and across the eastern side of the Nile, south of Sidi-Barani and N W of Qattara depression, to more than 6 km at the down faulted blocks south and S W of Qattara and more than 12 km at the northern part of the Nile Delta.

B) The basement surface is characterized by several archings and saggings in the form of ridges, uplifts and structural low as well as zones of dislocation having different areal extensions, relief and trend patterns. The most important of which are :-

1) **Qattara uplift** between a northern basin and Abu Gharadig basin, across the center of the area, ranges in depth from 0.4 km to 3.5 kms and seem to be constituted of three local uplifted structures.
2) **El-Bahariya-El Khatatba uplift** (Cairo- Bahariya uplift; Sigaef [18]) is another uplift of smaller lateral extent and its basement rocks are shallower than that of Qattara uplift. It has an average depth of about 1.5 km and consists of several local uplifts which extend mainly in NE-SW direction. They are El-Bahariya ridge, Diyur, east Diyur, W.Kadish, Kattaniya, Abu Roash, Rabat, Wadi-El Riayan uplifts.
3) **Nashfa uplift** is situated in the southeastern part of the area with a wide areal extension and its basement rocks are more shallower than El-Bahariya-El Khatatba uplift . It extends in the east direction across the Nile Valley, where the basement is reach at a depth of about 0.3 km.
4) **Northwestern uplift** at the extreem northwestern part of the area and is believed to extend westward to Libya parallel to the Mediterranean Coast.

5) **Abu Gharadig basin is believed** to lie between the Qattara uplift and the Behariya uplift. It is of east-west direction and subdivided into several units separated by oblique ridges of varying importance. The basement rocks underlying the basin seem to lie at a depth ranging between 2.5 and 4.5 kms.

6) **The Northernbasin** is an elongated structural low which run parallel to the Mediterranean and is deeper than the Abu Gharadig basin. The basement surface underlying it has a depth more than 5 km; and includes Alamine basin, Matruh basin and extend to the south where Barakat, Louly-1, Nasr-1, Fadda and Yokout well. There is an elongated nose (ridge) situated in the central part of this basin and extends in an E-W direction separating the two major basins (Alamine and Matruh Basins).

7) **El-Gindi basin** is an structural low, north of Lake Qarun, between El-Bahariya-El Khatatba uplift and Nashfa uplift. It is considered to be the eastern extension of Abu Gharadig basin.

8) **The north easter basin** includes major down faulted blocks localized at the Nile Delta, Wadi El-Natrun and west and north of it. It is note that the average depth to the basement surface along this Zone ranges between 4 km to more than 12 km.

9) **Faghur basin** in the northwestern corner of the area having a wide areal extent and average depth more than 4 km.

10) <u>Southwestern basin</u> (Disoky basin) is situated in the southwestern portion of the map area and extends in the E-W direction down to the Qattara depression to El-Bahariya uplift and having basement depth varies from about 4 km to about 7 km.

C) Besides the above mentioned structural elements, several zones of major dislocations are present. They are illustrated on the basement relief map as zones of steep slopes separating the uplifted and downfaulted blocks.

D) The basement rocks in that portion of the area occupied on the surface by the Nile Valley is found to be affected by few NE and NW dislocation zones (Faults) trends of regional extension. Differential movement along these faults have probably resulted in a greater number secondary fractures within the sedimentary cover having modified NE and NW direction which techonically controlled the present course of the Nile River. Several portions of the river are seen to be parallel to or along such fractures.

E) The calculated basement depths showed a good a greement with the drill hole data. It is only in that portions of the areas including the the northern basin and the north and the north western of the Nile Delta that the calculated depths were found to be less than the actual depths. At the first portion the discribency may be due to the strong lithologic change in the basement rocks and a local down faulting across the major northern uplift; Fig.4. The second porotion was attributed to the presence of a considerable thickness of high density Tertiary at which may be responsible to the abnormal higher gravity at this portion of the area. These portions of the area were corrected as to the actual basement depth.

F) The basement surface which was encountered in some wells in the northeastern basin (Nile Delta), is estimated to be at a depth of more than 10 km in the onshore part. This is demonstrated by the presence of more than 4 km of sediments overlying the Middle Miocene in Kafr El-Sheikh and SW Bilqas-1 well. The estimated depth of basement was confirmed by AGIP [1], through the use of magnetic intensity profiles (Peters and Bruckshow methods). A similar depth of basement was estimated in the eastern extension of the Delta, in northern Sinai by Ginsburg and Gvirtzman [7], through their north-west southeast structural cross section based on reflection and refraction seismic shooting and well data. This can be clearly shown through the north-south geoseismic cross section illustrated in figure .

G) The existence of oil in a certain area depends on several factors including the presence of adequate source rocks, reservior rocks and oil traps. From the oil traps, only those which are associated with structural elements are discussed here. This is because, beside the fact that the majority of oil traps so far discovered in Egypt are of structural type [3], stratigraphic traps need, for their identification and evaluation another sort of data and a different way of study.

Accordingly from the structural features, which have been revealed to be characterizing the area, the following may be favourablr for oil accumulations:-

1) The portion of the sedimentary section lying above flanks or corner of the basement high localities. On some of such flanks, many of the exploratory producing wells, drilled by different oil companies are located such as WD 33-1& WD 33-2 WD 19-1, Qibli Abu Gharadig-1, umbarak, Dawabis-1, Gindi-1, Marzuk and others.

2) The highly fraclimed zone of the Nile Valley especially on the corners of tilted blocks. This is because deep erosion of the high corners of these blocks and redeposition of eroded sediments offers good reservoirs. Also, during phases of block movements which coinside with periods of deposition contemporaneous structures might have been formed which are considered as good structural traps.

3) Along the unconformity surface of the upper Cretaceous. This due to the presence of both source and reservoir rocks in the upper Cretaceous Sediments. It is possible that along such unconformity surface, especially on anticlinal and monoclinal surface, that favourable structures such as "baldheaded structures" and "hogback ridges" are developed. They possibly provided in those parts of the sedimentary section overlying the uplifted basement regions, when permeability variations favourable.

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REFERENCES

1- AGIP, 1966: Nile Delta conseccion reflection land survey report for LEOC: LEOC/explo. Rep. Geoph., 15 pp

2- Amin, M.S., 1961: Subsurface Features and oil prospects of the Western Desert of Egypt. 3rd Arab Petrol. Cong., secrest, General, Leage of Arab states, Cairo, Egypt.

3- Babae, A.G. 1968: Geology of the U.A.R.; Gelogic History, Tectonics, oil prospects and Recommendations. Report submitted to the Gen-Petrol. Co. by V./D Technoexport, Cairo vol. 1, Book 2.

4- Bayoumi, A.I. & El Gamili, M.M., 1969: An attempt for the Estimation of the Basement depths in the Northwestern Desert of Egypt. Sc. and Techn. Bull., Assiut Univ., Vol. 12, Part II

5- El-Awady, M., Zein El-din, M.Y. and Marzouk, M, 1980: Tectonic and Geologic History of the Nile Delta, Egypt, Delta Jur. of Scie., 5, pp. 234-278.

6- Farag, I.A.M., 1959: Stratigraphy of Egypt part I, second ed. Lecture Notes for the B.Sc students Faculty of Science, Cairo University.

7- Ginsburg, A. and Gvirtzman, G. 1979: Changes in the Crust and the Sedimentary cover across the transition from the Arbian platform to the Mediterranean Basin: Sed. Geol.,v. 23,pp. 19-39.

8- Haslsey,J.H. and Gardner, W.C., 1975: Tectonic Analysis of Egypt using the Earts-1 sattellite data A. lecture delivered at the Gen. Petrol. Comp. of Egypt.

9- Meshref, W.M., Refai, E.M., Sadek, H.S., Abdel-Bakii S.H., El-Sirage, A.M.H, El Kattan, E.M.I, El Meliegy, M.A.M. and Late El Sheikh M.M. (1980): Structural Geophysical interpretation of Basement rocks of the Northwestern Desert of Egypt, Annals of the Geol. Survey of Egypt Vol.X,pp (923-937).

10- Meshref, W.M., 1984: Regional structural setting of North Egypt, Sixth Expl. Sim. Egyptian Gen. Pet. Corp., pp(I7-32).

11- Riad,S., Shaaban,M. and Tea leb,A., 1979: Tectonic trends and basement relief in the area of Minya (Egypt) Bull.No 209 Hel. Inst. of Ast and Geoph.

12- Riad, S., El-Etr, H.A. and Abdel Mokhles, 1984: Basement tectonics of Northern Egypt as Interpreted from Gravity Data. proceedings of the 4th Inter. Conferr. On basement Tectonics. Vol.4.

13- Said,R., 1962: The geology of Egypt. El-Sevier publishing Co., Amesterdam and New York.

14- Shata, A.A., 1953 a : New light on the structural development of the Western Desert of Egypt. Bull. Inst. Desert, Egypt, Vol.3.

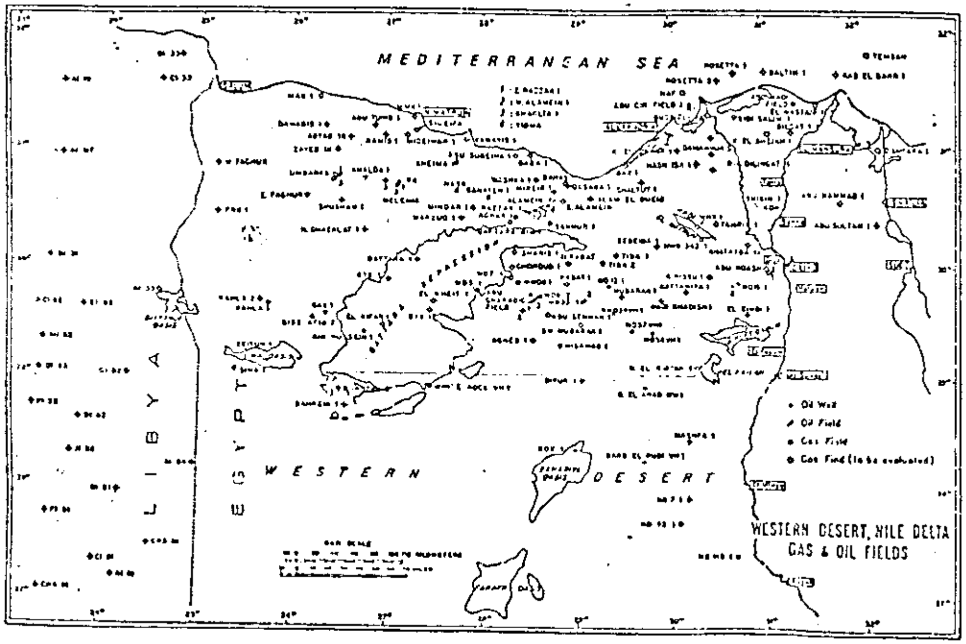
15- Shata, A.A., 1955: An Introductory Note on the Geology of the Northern portion of the Western Desert. Bull. Inst. Desert, Egypt, Vol.4.

16- Sharaf, M., 1980: Structural Interpretation of Geophysical Anomalies in the Area Lies North of Siwa Oasis, Northern Western Desert, Egypt, M.Sc. Thesis, Assiut Unv.

17- Sharaf, M., 1984: Interpretation of Bouguer Anomalies of El-Faiyum Area in Terms of Subsurface Geological structures, Ph.D. Thesis, Assiut Univ.

18- Sigaev, N.A., 1959: The Main Tectonic Features of Egypt: Geological Survery, Cairo

19- Youssef, M.I., 1968: Structural Pattern of Egypt and its interpretation Am. Assoc. Petr. Geol. Bull., Vol. 52, No.4.



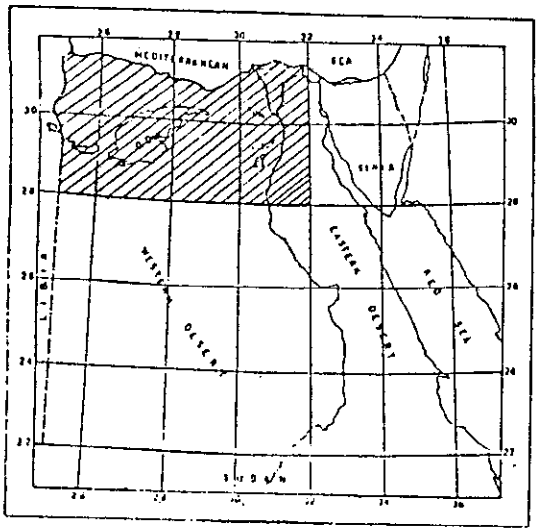


Fig 1 Location Map of the study Area

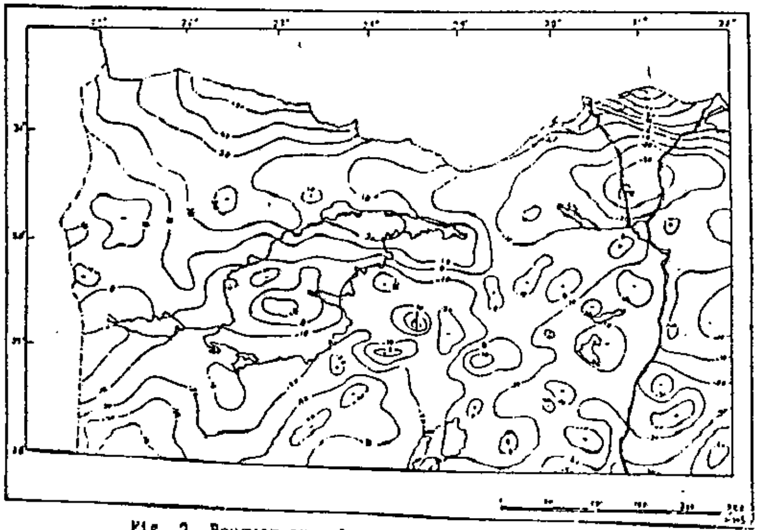


Fig 2 Bouguer anomaly map of the Norther Western Desert, Egypt (After G.P.C. 1985)

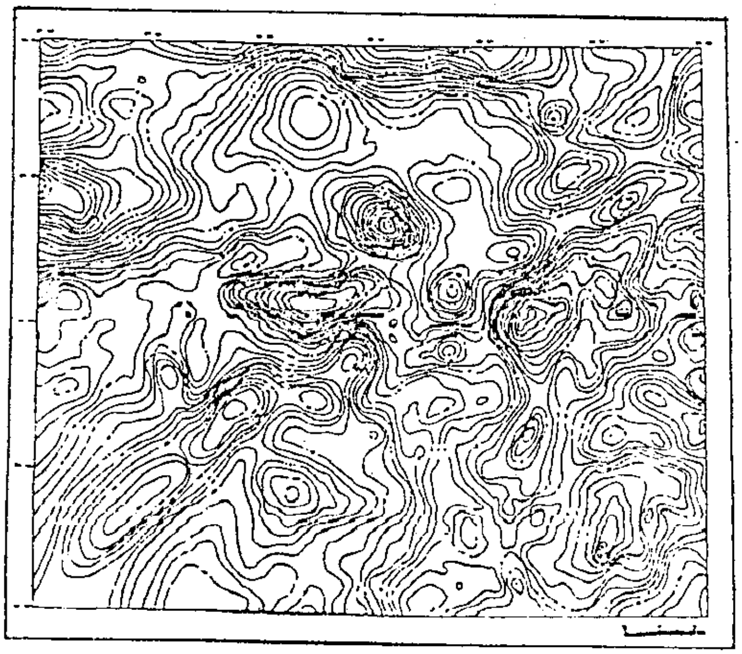


Fig 3 Portion of the Bouguer anomaly map of the Northern Western Desert, Egypt(Seal 1:500,000) (After C.P.C. 1985)

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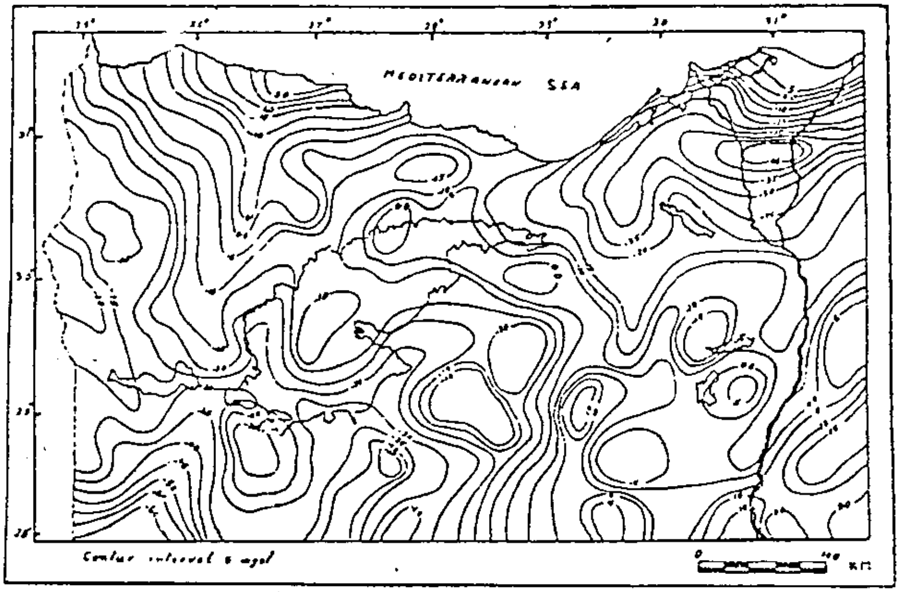

Fig (4) Residual Component Map of the Bouguer Anomaly Field.

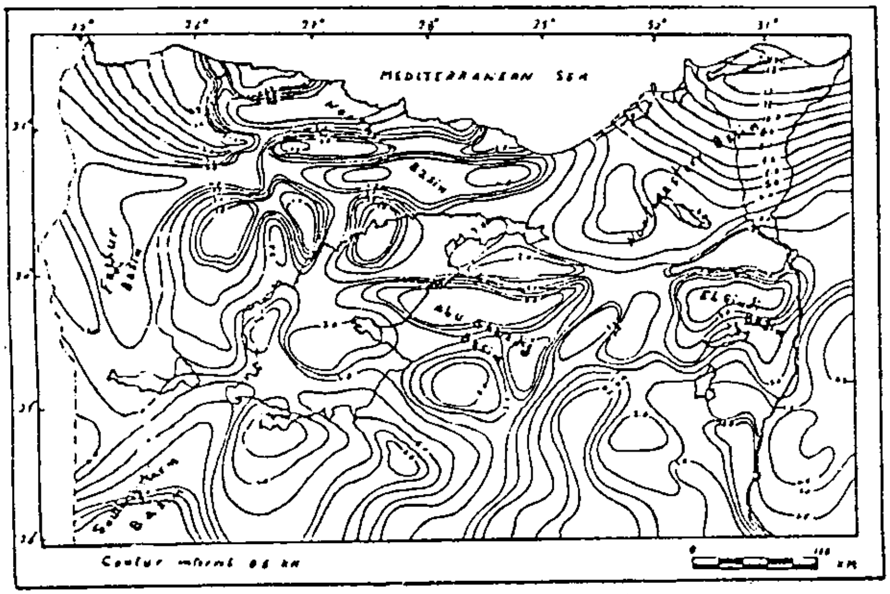

Fig (5) Basement Relief Map of the Northern Egypt.

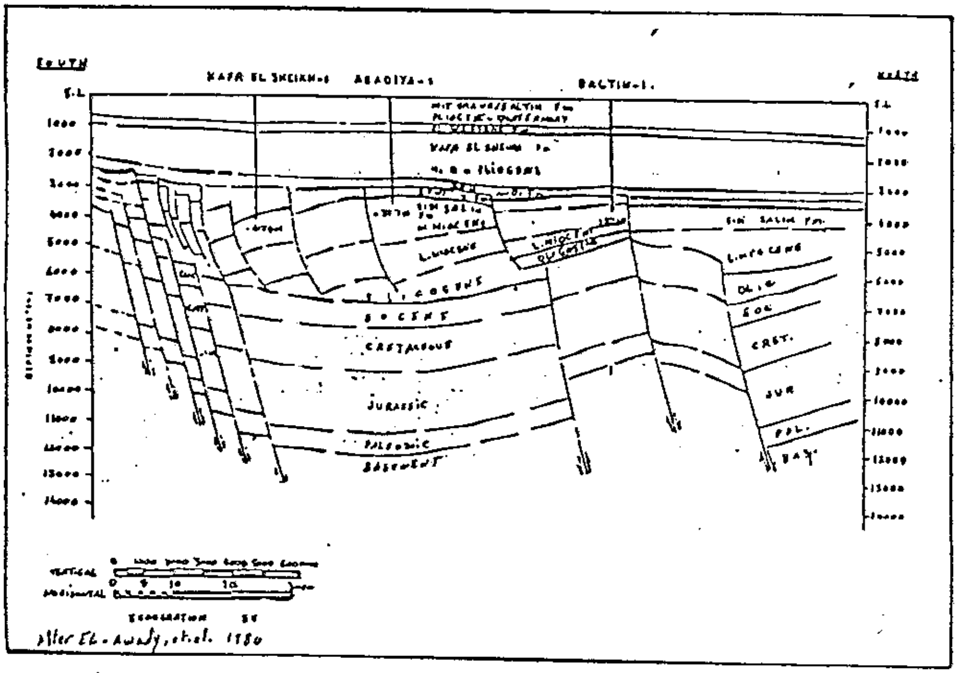

FIG 6 GEOSEISMIC CROSS SECTION THROUGH KAFR EL SHEIKH-1 ABADIYA-1 AND BALTIM-1 WELLS

Table I: Wells drilled down to the basement complex in area under study.

Well Name	basement depth in meter	Bouguer Anomaly in mg
Abu Roash -1	1916	-5.5
Alamx -1	4105	16.0
Gre-6-1	2268	-14.0
Khatatba -1	1906	-8.0
Nashfa -1	732	-10.5
Sharib -1	2472	26
Umbaraka -1	4030	28.5
Umbaraka -2	3743	27
WD -57-1	2989	-8.0
Zeitun-1	3527	-1.0
Bahariya-	1841	-8.5
Diyur	1624	-1.0
Rabat -1	2200	-2.0
Siwa -1	3420	4.5
W Natrun-1	4079	-8.5
El-Rayan	1289	-7.5
Kattaniya	4069	3.8

توزيع أحواض الترسيب فى شمال مصر وعلاقته بتكتونية الركيزه المعقدة

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تقع منطقه البحث فى الجزء الشمالى من الصحراء الغربيه ووادى النيل والدلتا شمال خط عرض ٢٨ شمالا ، حيث امكن ايجاد قيمه التغيير فى الكثافه بين صخور الركيزه المعقده والصخور الرسوبيه من قيم شذوذ البوجير وعمق صخور الركيزه المقابله ووجد ان قيمه التغيير فى الكثافه يساوى ٠,٢٤ جم/سم٢ . ومن خلال التحليل الكمى لشذوذ البوجير امكن فصل مجال الجاذبيه الى مركبتين على بروفيلات طوليه واخرى عرضيه ، احدهما تعزى الى التراكيب التحت سطحيه العميقه ذات الامتداد الاقليمى (المركبه الاقليميه) والاخرى تعزى الى سطح صخور الركيزه المعقده والتراكيب الرسوبيه التى تقع عليها (المركبه المحليه) ومن المركبه المحليه امكن حساب عمق الركيزه المعقده وذلك باستخدام الابار التى تصل اعماقها الى الصخور الركيزه كنقط تحكم وتم اعداد خريطه توضيحيه متكامله للتضاريس السطحيه للصخور الناريه المعقده لهذه المنطقه ووجد ان عمقها يتراوح من (اقل من ٢,كم) الى (اكثر من ١٣ كم) وان هذا السطح معقد نظرا لوجود عديد من المرتفعات والاحواض . ويمكن القول ان المنطقه تعرضت اساسا لقوى ضغطيه فى الاتجاه شمال جنوب وان هذه اثرت على المنطقه فى ازمنه متعدده .

كذلك هناك شواهد على تعرض المنطقه لقوة ضغط مرتبطه بتكون قشره ارضيه محيطه فى البحر الاحمر وان اتجاه هذه القوى هو شمال ٥٥ شرق . وبالاضافه الى ذلك وجد ان الجزء العلوى من القشره الارضيه والذى يمتد فوق وادى النيل قد تأثر بفوالق عميقه ذات اتجاهين شمال شرق وشمال غرب مما اثر على الغطاء الرسوبى واتجاه مجرى النيل فى الجزء الواقع منه بمنطقه البحث كذلك امكن التعرف من وجهه النظر التركيبيه على المناطق التى يحتمل ان يتواجد بها البترول والتى تتمثل فى قمم التحدبات التى تقابل الاجزاء العاليه من صخور القاعده وبعض المناطق التى تكثر بها الفوالق ويزداد فيها سمك الرسوبيات ، حيث

يوصى الباحث باجراء دراسات جيولوجيه وجيوفيزيائيه مكثفه على هذه المناطق كذلك فقد امكن تعيين توزيع احواض الترسيب فى المنطقه وهى مناطق ذات اهميه خاصه فى البحث والتنقيب عن البترول والغاز وخصوصا اذا كانت تحتوى على تراكيب ثانويه تعيد التجمع الطبيعى لها ٠