Qatar Univ. Sci. Bull. (1989), 9: 213-226

INTERPRETATION OF THREE DIMENSIONAL SEISMIC DATA IN DELINEATING THE STRUCTURAL ELEMENTS AT RAS BUDRAN OIL FIELD, GULF OF SUEZ, EGYPT

By

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Key words : 3-D seismic data, Ras Budran, Gulf of Suez

ABSTRACT

Structural evaluation in Ras Budran oil field was achieved by using the state of art geophysical technology, represented by the 3-D seismic data. Integrated together with the borehole geological and geophysical data. The time contour maps of five reflectors starting with deeper top Kareem formation up to the shallowest top Zeit formation were constructed. These mappable horizons illustrate generally a half plunging NE - SW anticline which bisected by several fault systems at different levels. The fault pattern at deeper level consists of a coastal gravity NNW - SSE fault system, a strike gravity NE - SW fault system and a NW - SE trending gravity faults. At the top level it can be observed a growth faults of WNW - ESE trend as well as a new set of E - W faults.

INTRODUCTION

Structural interpretation of the area was achieved by integrating the available 3-D seismic data and both the geophysical-geological borehole data. The 3-D seismic data provides a new dimension for interpretation, it is the seiscrop or the horizontal seismic section (Bone et al, 1983 and Brown, 1983). These articles suggest formats for the display of the data, as well as techniques for deriving contour maps of horizons, strike directions, dip analysis, thickness of formations and fault blocks. These 3-D seismic studies were presented as a practical technique by Bone et al (1976). To day it is an established tool contributing to the solution of structural and stratigraphic evaluations (Brown, 1983). Accordingly several 3-D seismic studies have been presented as case history (Tagland, 1977; Bone, 1978; Hautefeuille and Cotton, 1979; Leflaive and Paturet, 1981; Black et al, 1982; Dahm and Graebner, 1982; Saeland and Simpson, 1982 and Sakr, 1985).

MATERIAL AND TECHNIQUE

To start the interpretation work in Ras Budran area (Fig. 1) a network of key-seismic lines was selected. These were used as a sort of "back bone" for the interpreted data. This network comprised every 5 th section in both the track and the CDP line directions. In addition, 100 selected seiscrops were used. The infilling sections were used to check specific problems and features (such as proper identification of fault cuts and fault extension), as well as to check changes in lateral reflecting variations of significant events. Interpretation proceeded in the following steps:

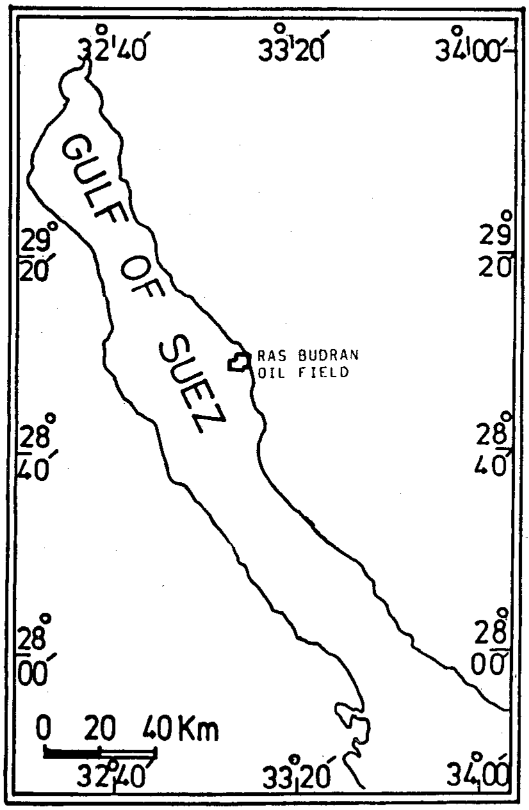

Fig. 1: Location map showing Ras Budran oil field, Gulf of Suez, Egypt.

1. Utilizing the borehole geological data on the migrated key-seismic sections. The genuine seismic signals were distinguished from the noise by the help of the synthetic seismograms (Fig. 2).

2. Picking of seismic markers, which correspond to the interface of Miocene formations viz top Zeit, Intra-Zeit, top South Gharib, top Belayim and top Kareem formations (Fig. 3).

3. Ties between the vertical seismic sections and the horizontal seiscrop slices (Fig. 4).

4. Interpretation and marking of the fault patterns as accurately as possible on the seismic sections using the seiscrop, which is a very sensitive tool to identify event dislocations (Fig. 5).

5. Posting the fault locations on maps and infilling the time contours representing the mappable formations using a transparent base map and the interpreted seiscrops. Each seiscrop provides a time-defined contour line for each seismic marker. As a result, five time structural maps were obtained representing the mappable formations.

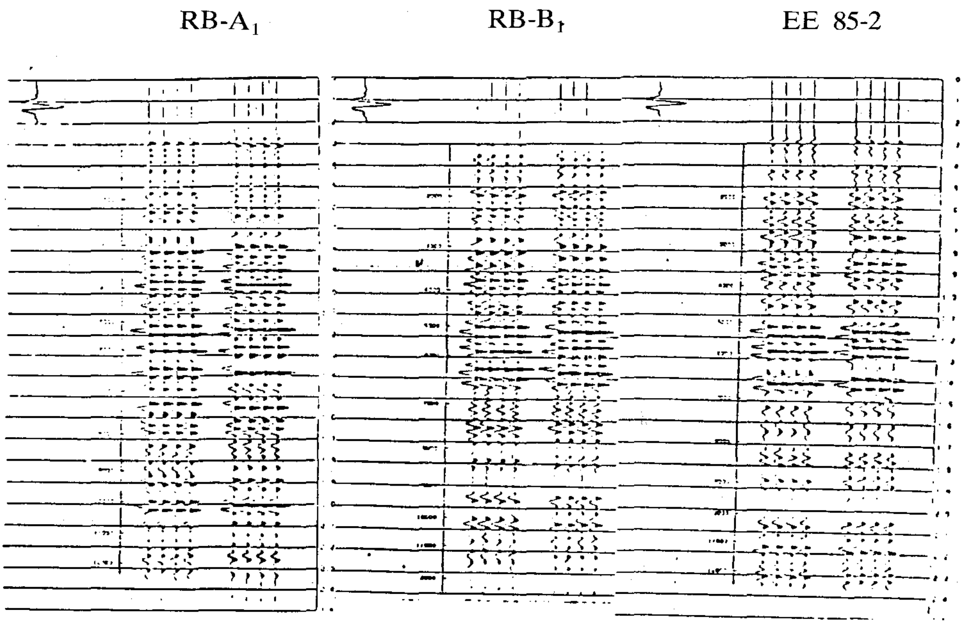

Fig. 2: Synthetic seismograms of wells RB-A_1, RB-B_1 and EE 85-2.

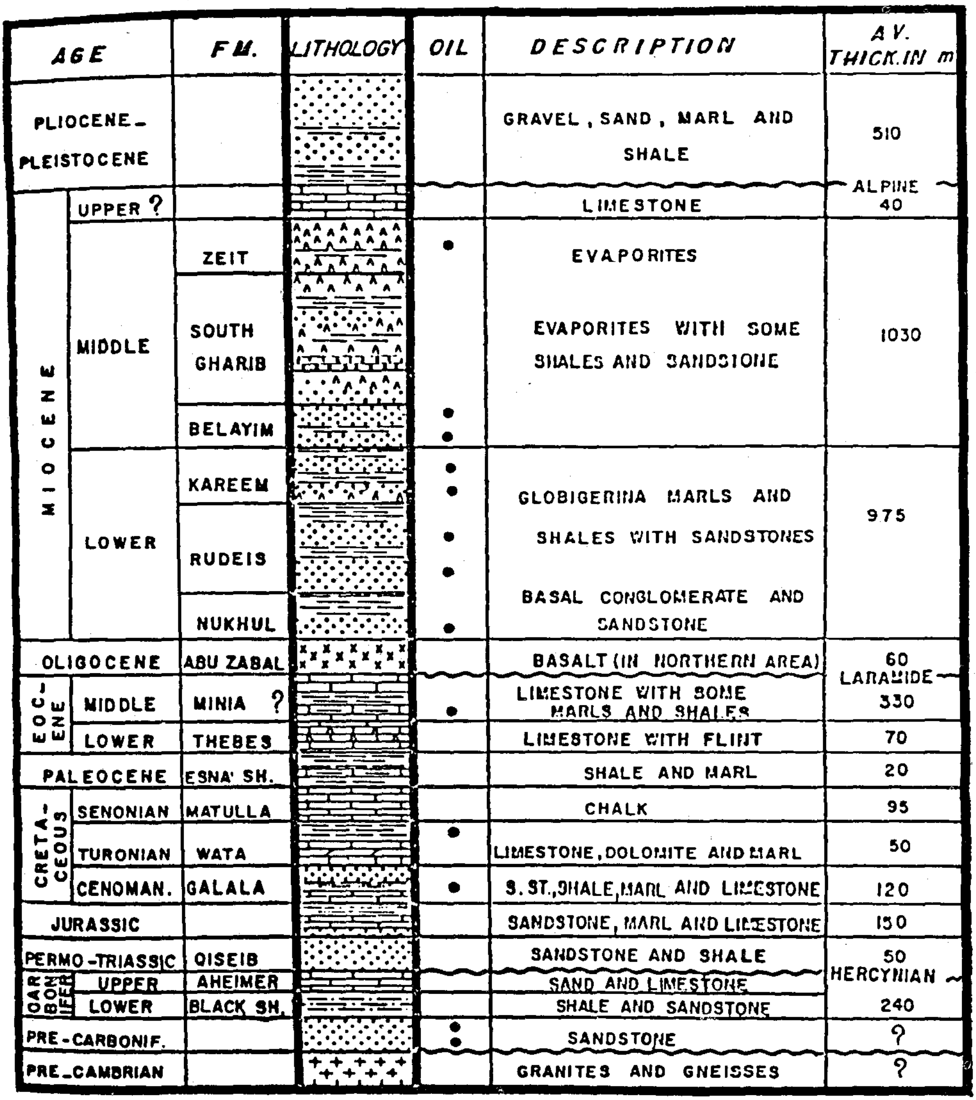

Fig. 3: Generalized geologic column of the Gulf of Suez. (After Barakat, 1982)

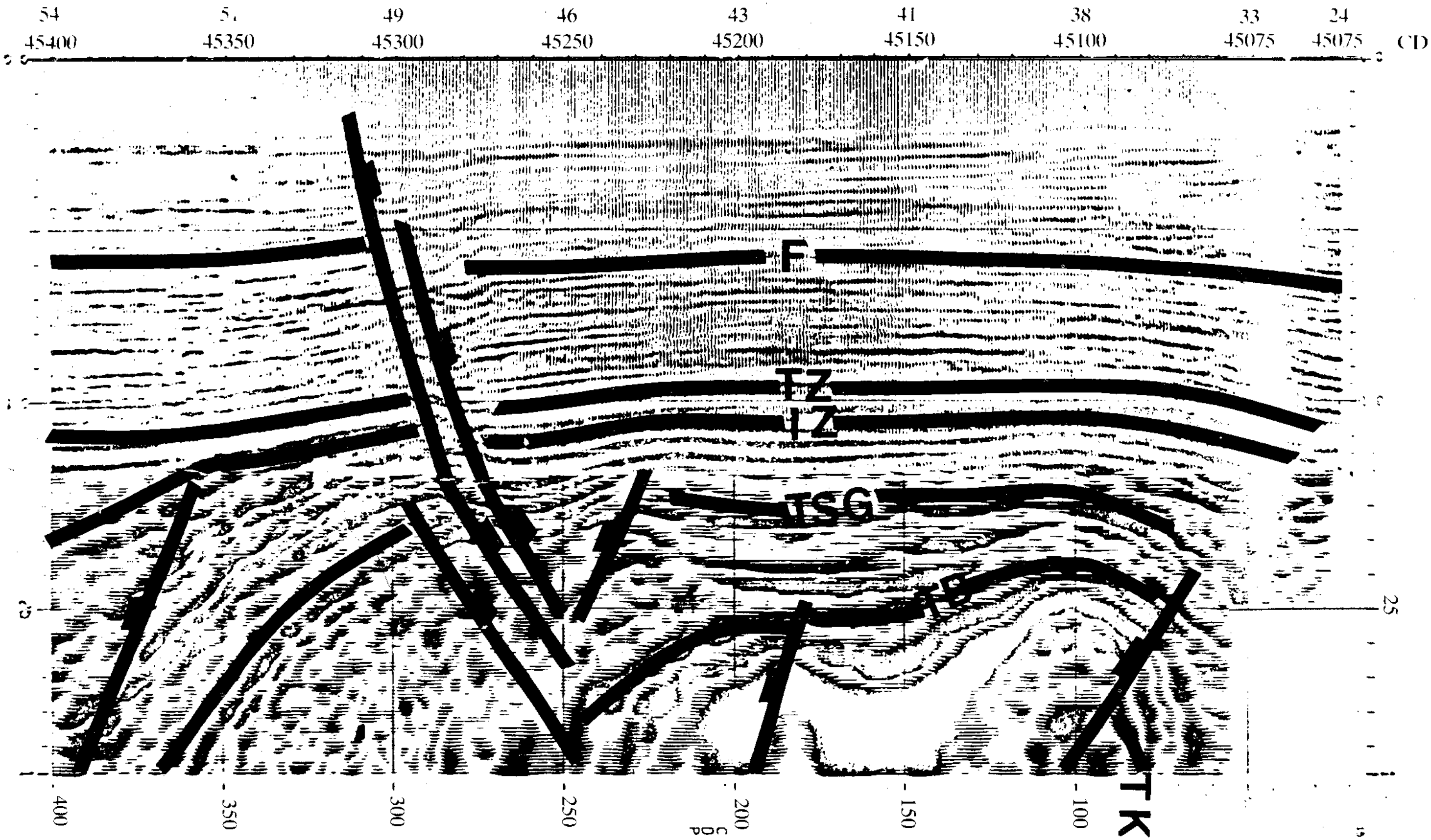

Fig. 4: Sample of interpreted track seismic line/seiscrop at time level 1200 m. sec.

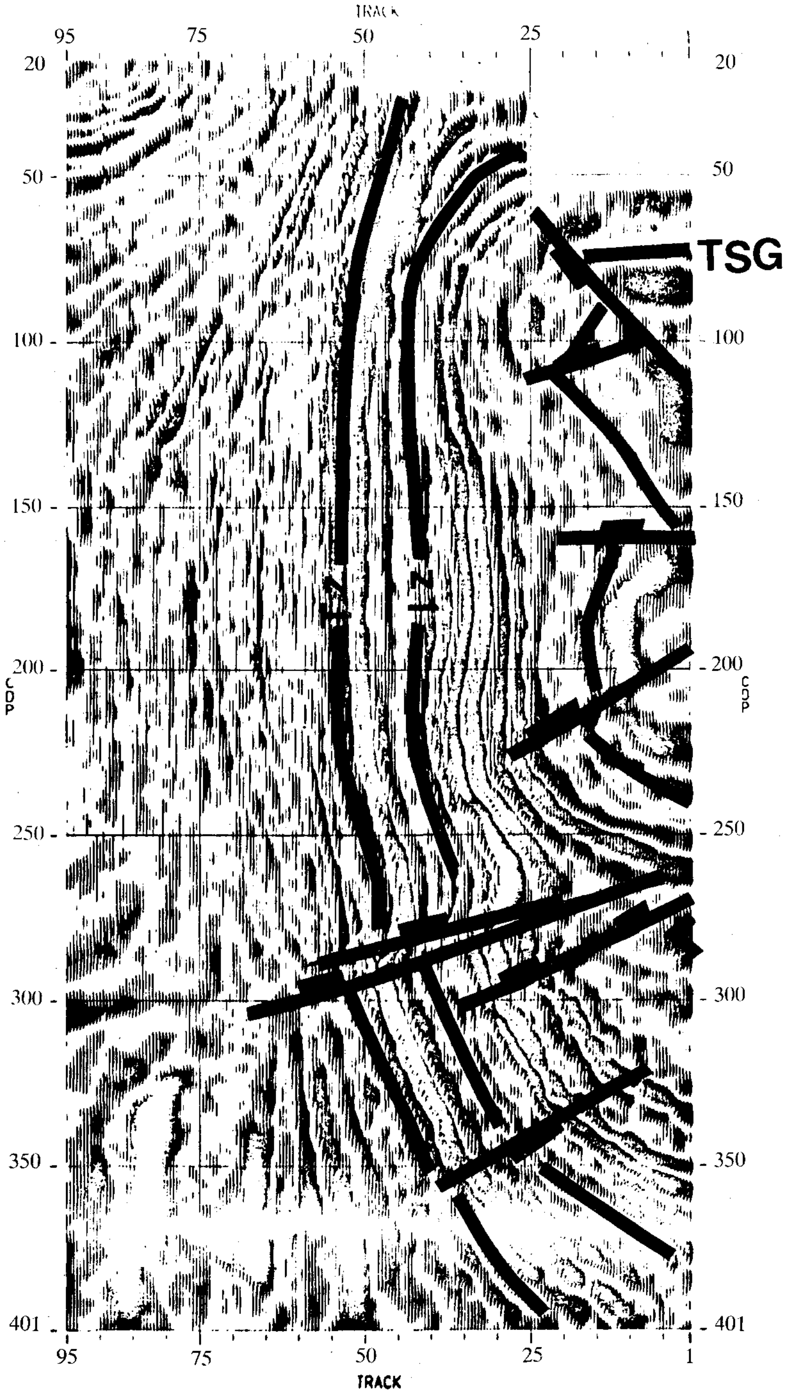

Fig. 5: Sample of interpreted seiscrop at time level 1018 m. sec.

RESULTS AND DISCUSSION

Structural elements as recognised within the Miocene section in Ras Budran area, at five mappable levels, are illustrated in figures 6, 7, 8, 9 and 10. The structural analysis will be handled starting with the deeper mappable top Kareem formation up to the shallowest mappable top Zeit formation, as the older tectonics generally control the younger elements.

Top Kareem formation structural map (Fig. 6) represents the interface between the high velocity Belayim anhydrite and the lower velocity Kareem clastics. The general structure at this level shows a half plunging anticlinal structure with a northeast-southwest axis. The structure plunges towards the southwest direction and is bounded to its northeast edge by the coastal major gravity fault system

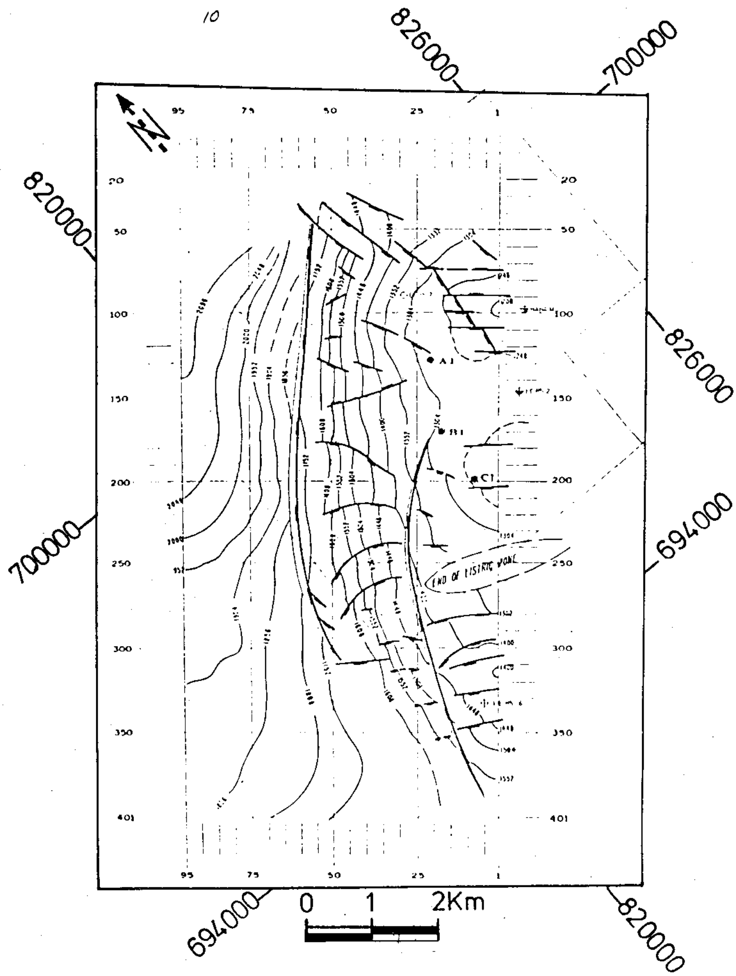

Fig. 6: Two way time contour structural map on top Kareem formation.

trending in a north northwest-south southeast direction. This anticline could be one of the flexural folds generated by the compressional stress components of the Gulf regional couple mechanism. This coastal fault system which starts to appear at this level, at the eastern edge of the surveyed area, had interacted with another cross elements. A strike gravity fault system of a northeast-southwest trend which could be related to the pre-Miocene rejuvenated fault systems of a rough displacement about 100 μ sec., appeared at this level. A structural saddle observed around well EE 85-2, may suggest a deeper structural element of northwest-southeast trend. A number of northwest-southeast trending gravity faults are present which are slightly curved in shape and step down in a southwest direction. Such structural complexities observed at this level show the expected interaction between the different tectonic trends prevalent in the Gulf of Suez area.

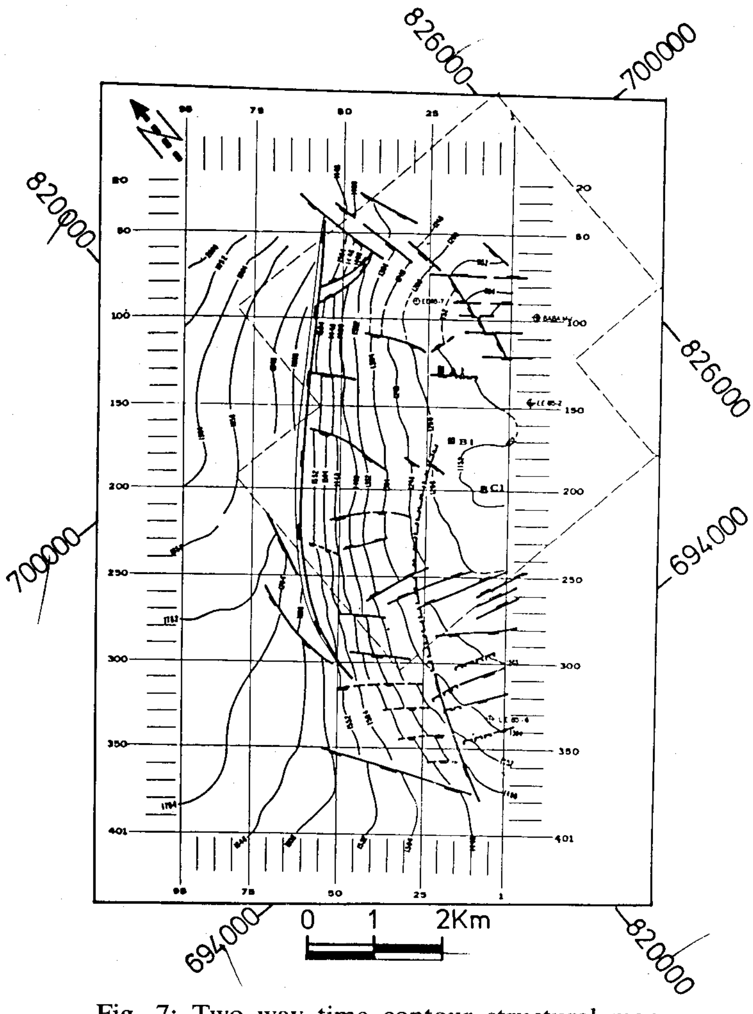

Fig. 7: Two way time contour structural map on top Belayim formation.

Following the structure in the shallower Belayim formation (Fig. 7), generally the same structural picture still exists but with less magnitude. The pre-Miocene strike faults (NE-SW trend) have less displacement (about 70 μ sec.). There are a new set of gravity growth faults start to appear, which are of west northwest-east southeast trend, and down throw to the north-northeast direction. The structural saddle around well EE 85-2 still presists at this level and also at the shallower levels, but with less magnitude. This suggests that the predicted deeper cross element had occured after the deposition of the Miocene formations.

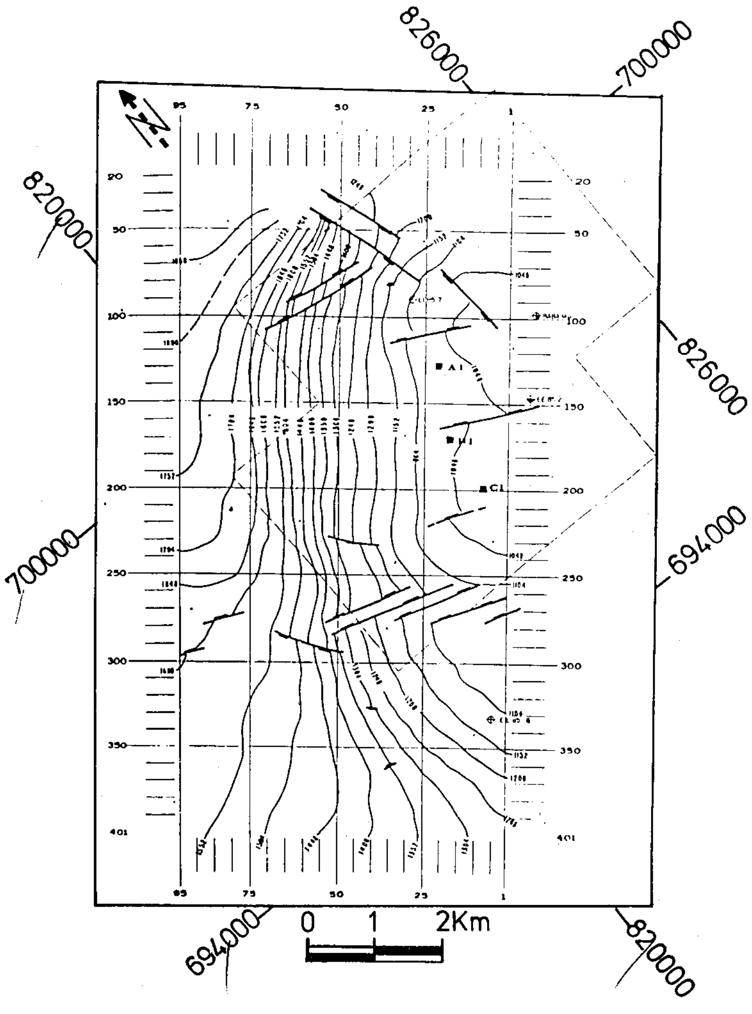

Fig. 8: Two way time contour structural map on top South Gharib formation.

The structural elements at the shallower level, representing top South Gharib formation (Fig. 8), can be traced as more or less the general deeper picture continues but without the pre-Miocene structural elements. On the other hand, the growth faults which appears at top Belayim level are well developed at this level. Moreover, the coastal fault system traced at the deeper levels are offset here and slightly affect this level. Intra-Zeit reflection time structural map (Fig. 9) marks a salt shale interface and is located between the unstable upper Zeit and the relatively stable lower Zeit. This map is a simplified structural picture observed at the deeper South Gharib level except that growth fault system observed at the deeper level is well developed at this level.

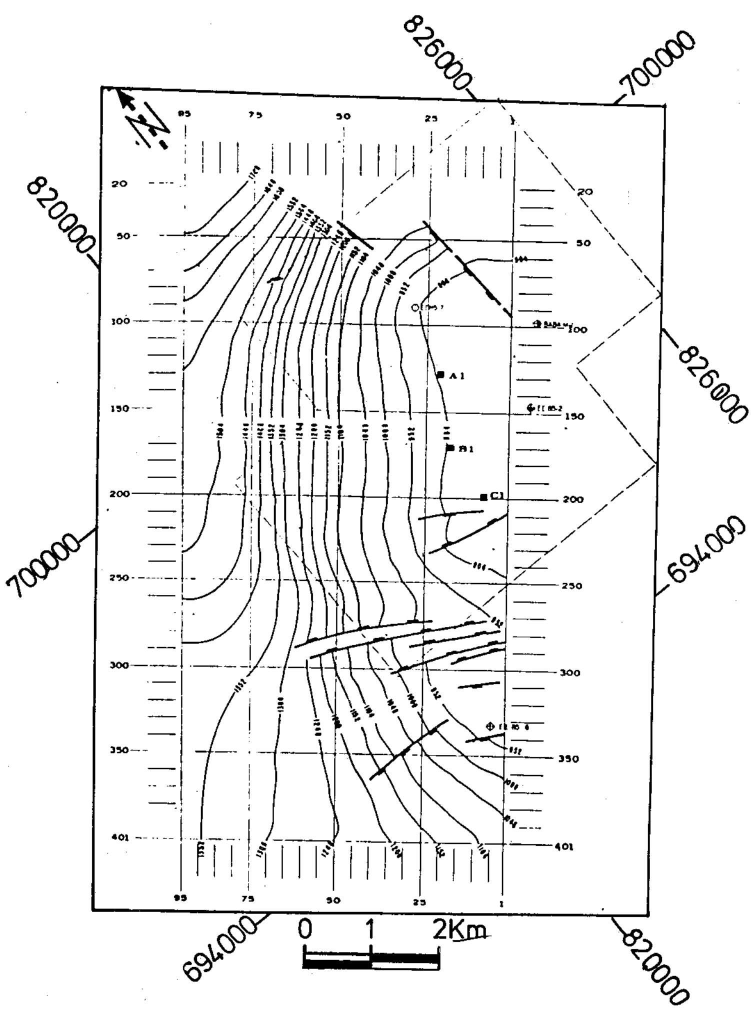

Fig. 9: Two way time contour structural map on Intra Zeit marker.

At the top Zeit level (Fig. 10), the mapped reflector represents the interface between the post-Zeit clastics and Zeit evaporite-shale series. The observed structure shows a relatively well developed growth faults of west northwest-east southeast trend, as well as a new set of simple gravity faults of nearly east-west trend. The coastal fault system is not observed at this level and is probably offset outside the studied area.

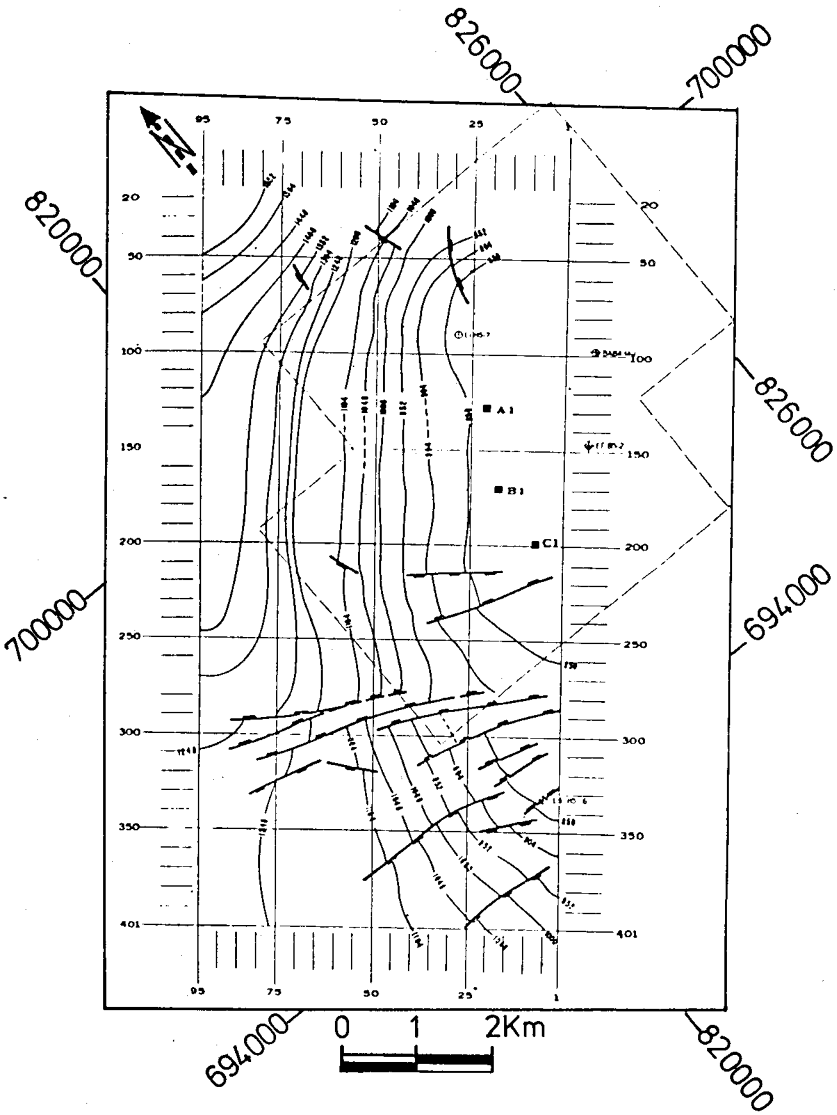

Fig. 10: Two way time contour structural map on top Zeit formation.

CONCLUSIONS

The structural elements of Ras Budran oil field have been delineated through the interpretation of 3 - D seismic data with the helpful of geophysical and geological information from the drilled wells. The time contour maps of five reflectors starting with deeper top Kareem formation up to the shallowest top Zeit formation were constructed. These maps illustrate generally a half plunging NE - SW anticline which bisected by several fault systems at different levels. The fault pattern at deeper levels consists of a coastal gravity NNW - SSE fault system, a strike gravity NE - SW fault system and a NW - SE trending gravity faults. This explain the structural complexities observed at these levels by the expected interaction between these different tectonic trends prevalent in the Gulf of Suez area. On the other hand, at the shallower levels growth faults of WNW - ESE trend as well as a set of E - W faults are reported.

Generally, it can be concluded that the structural pattern of various stratigraphic intervals reflect the tectonical history of the area during Miocene and post-Miocene ages. To a certain extent, they indicate structural highs and lows as well as major fault zones in the pre-Miocene.

ACKNOWLEDGEMENT

The authors would like to express their deep gratitude to the members of exploration department of Suez Oil Company, Egypt, for facilitating the collection of necessary data.

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تفسير البيانات السيزمية ذات الأبعاد الثلاثة في استنتاج العناصر التركيبية بمنطقة حقل راس بدران - خليج السويس - مصر

محمـــد محمـــد عزت صقـــر - محمـــود عبد المنعم الحفنـــاوي

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