Structural deformation of the Sufr El Dara accommodation zone, Western side of the Gulf of Suez Rift

Thesis submitted in partial Fulfillment of the requirement for
The degree of Master of philosophy In Science (Geology)

By

Mohamed Mohamed El-Said Mohamed Abdallah

B.Sc. (Geology)

Supervisors

Prof. Dr. Adel Ramadan Moustafa
Professor of structural Geology
Head of Geology department
Faculty of Science
Ain Shams University

Prof. Dr. Mohamed Hamed Abdel Aal
Professor of Geophysics and
Vice deen of post graduated
studies and research
Faculty of Education
Ain Shams University

Dr. Ali Mohamed Ali Abd-Allah
Assistant Professor of Structure Geology
Ain Shams University

Geology Department
Faculty of Science
Ain Shams University
Cairo2009

NOTE

In addition to the research work materialized in this thesis, the candidate has attended postgraduate courses for one academic year in the Faculty of Science, Ain Shams University in the following topics:-

Advanced Structural Geology

Geotectonics

Field Geology and Mapping

Photogeology and Remote Sensing

Geomorphology

Biostratigraphy

Advanced Lithostratigraphy

Sedimentary petrology

Sedimentation

Geostatistics and Basic Language programing

English Language

He has successfully passed the final examination in the courses.

Professor Dr. Adel Ramadan Moustafa

Head of Geology Department

ACKNOWLEDGEMENTS

I am indebted to Professor Dr. Adel Ramadan Moustafa, Professor of Structural Geology, Department of Geology, Faculty of Science , Ain Shams University, Professor Dr. Mohamed Hamed Abdel Aal, Professor of Geophysics, Department of Geology and Biological Sciences, Faculty of Education, Ain Shams University and Dr. Ali Mohamed Ali Abd-Allah, Assistant professor of Structural Geology, Department of Geology, Faculty of Science , Ain Shams University for supervising this work and for constructive criticism during the progress of the work covered by the present thesis.

I am also grateful to the Geological and Geophysical Data Center of the Egyptian General Petroleum Corporation (E.G.P.C.) for providing the seismic data and well logs used in this study.

Abstract

The study area represents the southwestern part of the Sufr El Dara accommodation zone in the south part of the Suez rift. This zone separates the southern (southwest dipping) half graben form the central (northeast dipping) half graben. This study was carried out to delineate the subsurface geological structures affecting the area. The present study is mainly based upon regional and residual magnetic map derived from a total intensity magnetic map, detailed examination of seismic reflection profiles and data obtained from 15 wells drilled in the study area. Structure contour, isochron and composite dip maps were constructed for the Miocene formations (Zeit Formation, South Gharib Formation, Belayim Formation and Kareem Formation). In addition, regional and residual magnetic maps for each 500 m downward depth interval were constructed.

The structural style in the study area is mainly controlled by faults and their related tilted blocks. The transfer zone in the north is controlled by NNE to NE oriented faults, whereas the southwest-tilted Gebel El Zeit block is governed by the Clysmic faults. The former faults extend from the Red Sea Mountains in the west to affect the zone area, where they were reactivated during the Late Cretaceous deformation and then during the Suez rifting phases. These faults have left-lateral normal-slip movement as indicating from the left-lateral offset of the magnetic anomalies. This left-lateral movement resulted in several reverse faults and folds that obliquely oriented to these faults. Some of these reverse faults form positive flower structures on the top surface of the transfer zone. The faults affecting the study area started their development during the

Oligo-Miocene rifting phase and continued through the Miocene age, where the Miocene basin was formed on the trough of Esh El Mellaha block as the transfer zone received a relatively thin Miocene section. The fault displacements were estimated on the planes of three faults which show that:

Both of the northeast oriented faults bounding the southeastern limit of the zone and inside the zone had high displacement rates during the deposition of the Miocene rocks except during the deposition of the Belayim sediments. During the deposition of these sediments, Esh El Mellaha clysmic fault has the highest displacement rate.

1- The two faults of the accommodation zone had the maximum displacement (more than 370 meters per million years) in the study area during the deposition of the Upper Miocene evaporites of South Gharib and Belayim Formations. On the other hand, Esh El Mellaha clysmic fault had the minimum displacement rate (less than 50 meters per million years) during the deposition of the Rudies Formation.
2- During the Miocene time, the displacement rates of the northeast oriented fault inside the accommodation zone were higher than the rate values of the fault bounding the zone except during the deposition of the Rudies Formation.
3- The rate of the displacement on the plane of Esh El Mellaha clysmic fault increased upward through the Miocene time, where it was constant during the deposition of the Kareem and Belayim Formations. On the contrary, the rate of the displacements of the two faults of the accommodation zone show random patterns, in the single fault and in relation to each

other. These patterns attributed that, the large number of faults that dissect the accommodation zone fragmented the zone into several blocks that were differently activated by the same tectonic movement, the blocks displaced in different rates. Also, the displacement on the planes of the two faults reached their maximum values during the deposition of the Miocene evaporites.

4 The Miocene formations were deposited during active tectonic movements where the northeast oriented faults which control the accommodation zone were more active than the Clysmic faults which form the half graben, except during the deposition of the Belayim Formation. These structures affect most of the rock units ranging in age from Precambrian to Recent. The faults exist in three main sets, which are NNW set (Clysmic trend), N-S set and NNE set. The Clysmic faults are the longest and have the largest displacement and were formed by a northeast oriented extension during the Oligo-Miocene initial stage of Suez rifting. The rotation on the listric planes of some Clysmic faults formed several southwest- tilted blocks. The transfer zone has different directions of tilting inside the Miocene beds.

List of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

INTRODUCTION

The study area represents the southern part of the Dara accommodation zone in the Suez rift. This zone separates the southern (southwest dipping) half graben form the central (northeast dipping) half graben.

A- location of the Study Area

The study area (Figure 1.1) is located between Latitudes 27° 45̀ and 28 05̀ N and Longitudes 33° 10̀ and 33° 35̀ E on the south western coast of the Gulf of Suez. The area is geographically surrounded to the north by Gebel Gharamoul, to the east by Gebel El-Zeit crest, to the west by Esh El-Mellaha range (NW-SE trend) and to the south by Zeit Bay. The central area is a gravel plain. Miocene rocks are well exposed at Gebel Gharamul, Gebel El Zeit and Gebel Abu Gerfan.

B- Objectives of the Study

The Objectives of the study are:

1- To map the subsurface syn-rift formations.
2- To delineate the subsurface geologic structures affecting the study area by using seismic data.
3- To study the basement topography.
4- To study the bedding attitude in and around the southern part of the Dara accommodation zone.
5- To determine the different tectonic events that affected the study area.
6- To propose a structural model for the study area with respect to the regional structural setting of the Suez rift.