AIN SHAMS UNIVERSITY
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STRESS FIELD VARIATIONS AND SEISMOTECTONICS OF EGYPT

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ABSTRACT

The present study attempts to delineate the seismotectonics situation of Egypt from earthquakes distribution and source mechanism estimation. To reach these goals, we relocated the entire events recorded by ENSN seismic Network during the period from(1997-2007) by using SEISAN program to get a comprehensive view of seismicity. Moreover, we have determined the mechanisms of 87 events using both polarity and amplitude ratio of SV/P. The Egyptian Territory has been classified into 9 geographic zones based on different kind of mechanisms. For each zone we have determined the stress regime by inversion of earthquake source mechanisms.

The results indicate that normal faulting movements with strike slip component characterize the majority of the earthquake focal mechanisms. The obtained results are highly consistent with the previous work. The analysis of earthquake mechanisms suggests that the present day stress field in Northern Egypt is dominated by normal faulting with strike- slip component. Southern Egypt is dominated by pure strike- slip stress regime. Gulf of Aqaba is dominated by normal faulting with strike- slip regime. North Gulf of Suez is characterized by normal faulting with strike- slip regime

while South Gulf of Suez is dominated by normal faulting regime due to the opening of rift towards the south. Eastern Desert is revealed by strike slip with normal component However Western Desert reveal pure normal faulting regime with minor strike-slip component. The orientation of P-axes reflects that the maximum horizontal stress (σ_H) in Southern Egypt is aligned to nearly E-W direction while in Northern Egypt it is aligned with mix of NW-SE and nearly E-W compression.

Key words: Stress regime, Focal mechanism, Egypt.

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CHAPTER 1

INTRODUCTION

The present-day stress field in Egypt is a key element for understanding its seismotectonic situation. Seismotectonics of Egypt is dominated by the opening of the Red Sea, Gulf of Suez and Gulf of Aqaba. Moreover Sinai Subplate plays an essential role in this complex situation. The convergence of the African and Eurasian plates in the Eastern Mediterranean represents the older tectonic framework.

Local variations in stress orientations and relative magnitudes exist at a variety of scales and may be due to several forces acting on the lithosphere **(Forsyth and Uyeda, 1976; Richardson et al., 1979; Zoback, 1992; Badawy, 1996; Badawy and Horvath, 1999a)**. The status of stress in the lithosphere is controlled by local forces (stress concentration due to structure heterogeneity, crustal loading and asthenosphere thermal anomalies) and regional more uniform forces directly related to the plate motion and interaction (ridge- push, viscous shear force at the asthenosphere-lithosphere boundary, continental collision).

The information on relative stress magnitudes or stress regime could be inferred from earthquake focal mechanisms and in- situ stress measurements.

The stress tensor is defined using standard notation with compressive stress when $\sigma_1 > \sigma_2 > \sigma_3$.

Anderson (1951) defined three stress regimes on the basis of relative stress magnitudes:

1) Extensional stress regime ($\sigma_v = \sigma_1$) corresponding to normal dip slip fault.

2) Strike- Slip regime ($\sigma_v = \sigma_2$) corresponding to faulting with horizontal slip.

3) Thrust faulting regime ($\sigma_v = \sigma_3$) corresponding to reverse dip slip faulting.

The stress field can be transitional between the above regimes if two of the stresses are approximately equal in magnitude. A stress field of the form $\sigma_v = \sigma_1 > \sigma_3$ can produce a combination of both normal and strike-slip faulting whereas a stress field of the form $\sigma_1 > \sigma_v = \sigma_3$ produce a combination of strike slip and thrust faulting.

The World Stress Map (WSM) project provided unique database on the orientation and relative magnitudes of the stress field in the Earth's lithosphere **(Zoback, 1992).** This project has provided a large amount of crustal stress data for many regions all-over the world. Therefore the purpose of this study aims to reconstruct the recent stress field in Egypt to understand the stress acting within the plate and to compare the shallow and deep crustal stress orientations

on the basis of new analysis of borehole breakouts and earthquake focal mechanisms.

The present study attempts to delineate the seismotectonic situation of Egypt from distributions and source mechanism estimation of some recent earthquakes. To reach this goals, we relocated the entire events from (1997-2007), establishing the mechanisms and deriving stress regimes.

This thesis consists of the following chapters:

1) Reviewing the geology, structure and tectonics of Egypt (Chapter two).
2) Studying the historical seismicity, instrumental seismicity and relocating the earthquakes during the period from 1997 to 2007. Inaddition, we have determined the mechanisms of these events depending on the polarity of the first P- wave arrivals and the amplitude ratio SV/P by using Seisan program (Chapter three).
3) Estimating the stress parameters of these events during the period from 1997 to 2007 by using triangle program (Chapter four).
4) The discussion and conclusions of the study are presented in (Chapter five).