# GPS measurements of current crustal movements along the Gulf of Suez, Egypt.


***Presented By***

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***At***

***National Research Institute of Astronomy and Geophysics (NRIAG), Helwan, Egypt.***

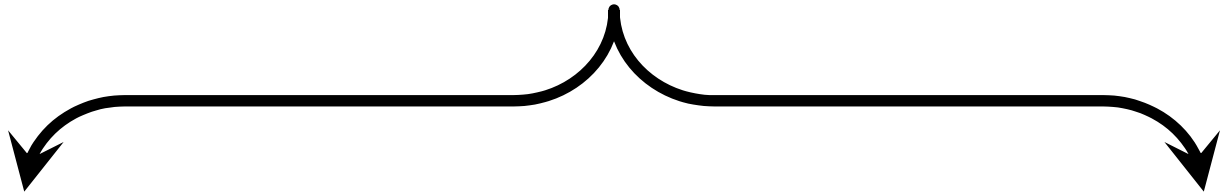

***United Nations/United Arab Emirates/United States of America Workshop on the Applications of Global Navigation Satellite Systems (GNSS)***

# Outline

1. Notes About NRIAG
2. Global Positioning System (GPS)
3. Case Study (Gulf of Suez)

# 1. Notes About NRIAG

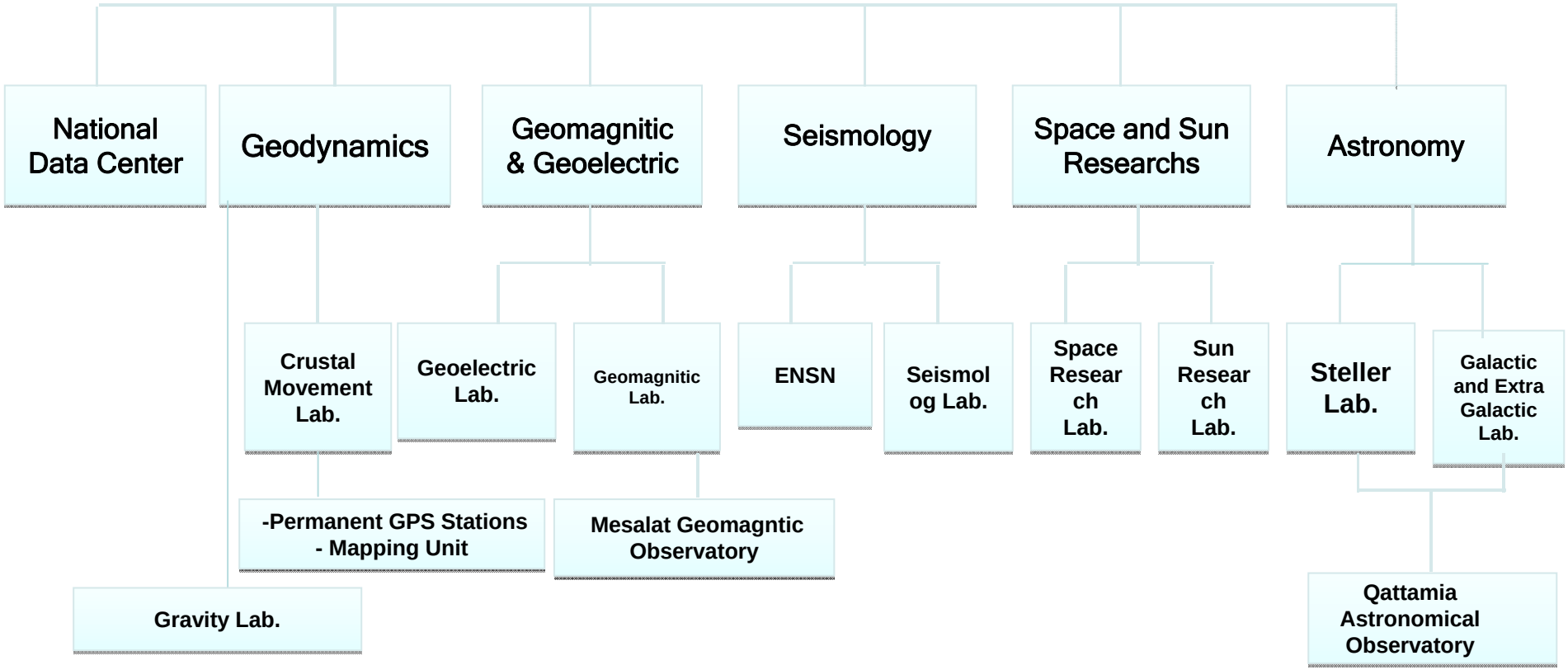
The National Research Institute of Astronomy and Geophysics (NRIAG) is the one of the oldest scientific institutions in Egypt (1903). The institute serves as a consultant agency in its field of specialization for the national plans of the permanent development of Egypt.



Astronomy
Studying of
Science of Space

Geophysics
Studying of
Science of Earth

# 1.1NRIAG Departments and Laboratories

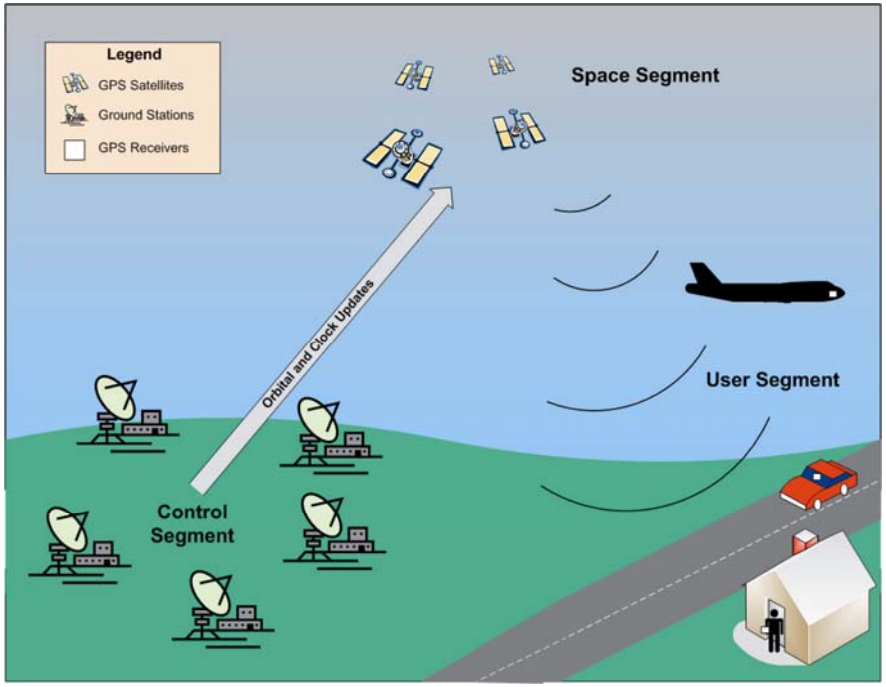


# 2. Global Positioning System (GPS)

- GPS structure
- How GPS Works
- GPS Errors
- GPS Application
- Applying GPS in Crustal Deformation

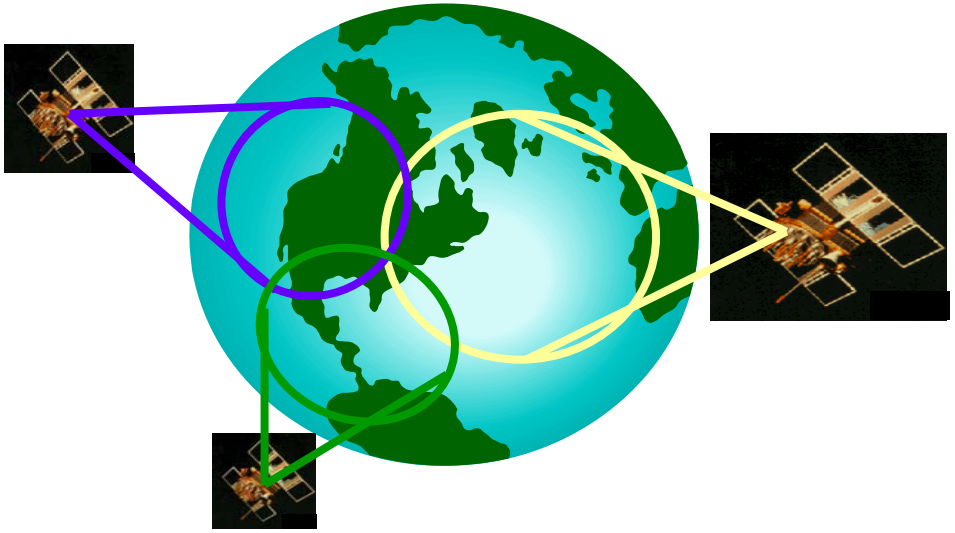
# 2.1 Structure of GPS

- GPS, which stands for Global Positioning System, is the only system today able to show you your exact position on the Earth anytime, in any weather, anywhere.



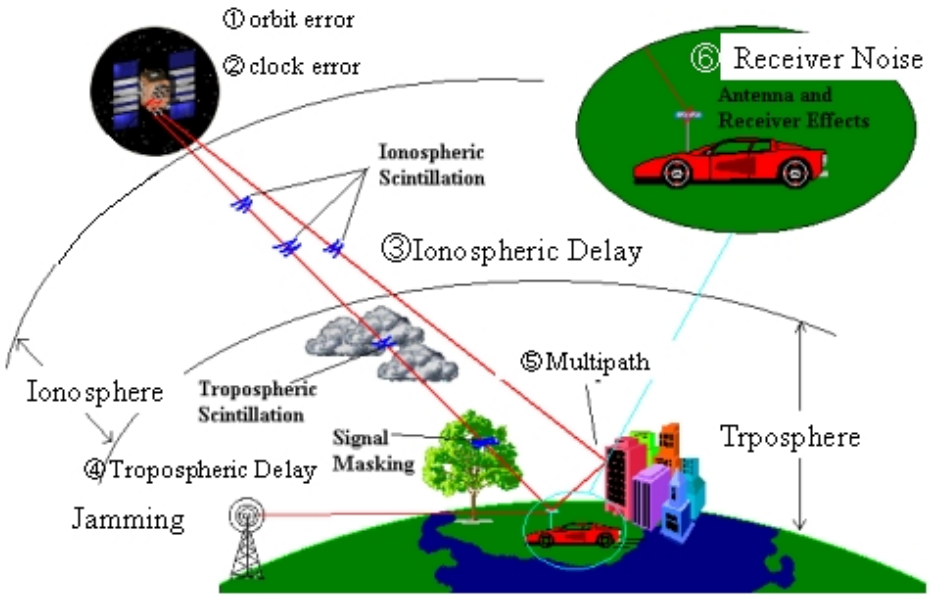

GPS consists of three segments: space segment satellites, control segment and user segment

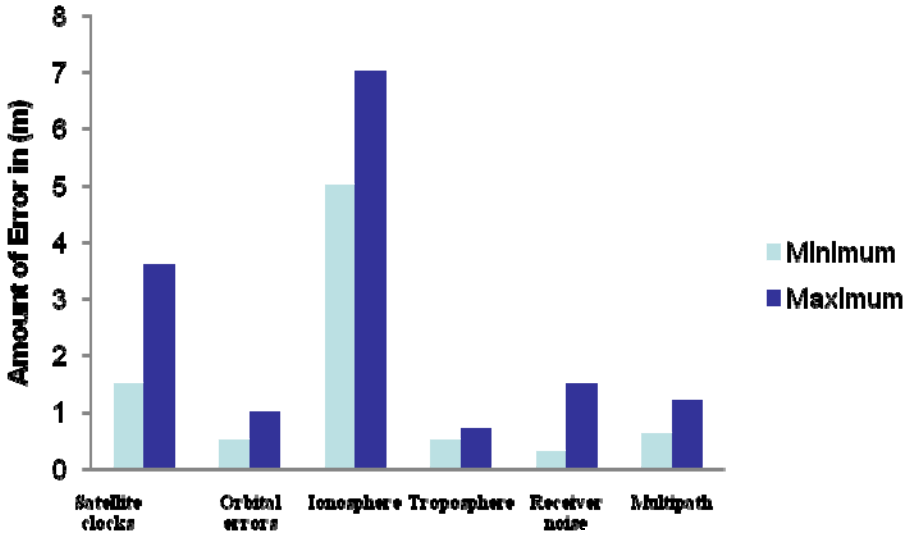
# 2.2 How GPS Work



- All satellites have clocks set to exactly the same time.
- All satellites know their exact position in space from data sent to them from the systems controllers.
- Each satellite transmits its position and a time signal.
- The signals travel to the receiver delayed only by distance traveled.
- The receiver calculates the distance to each satellite and trilaterates its own position.

# 2.3 GPS Errors



# 2.4 GPS Applications


GPS was primarily designed to be used by the military. However, many industries have found it to very useful. These days people are using GPS in ways that make their work more productive, safer, and sometimes even easier. There are five main uses of GPS today:

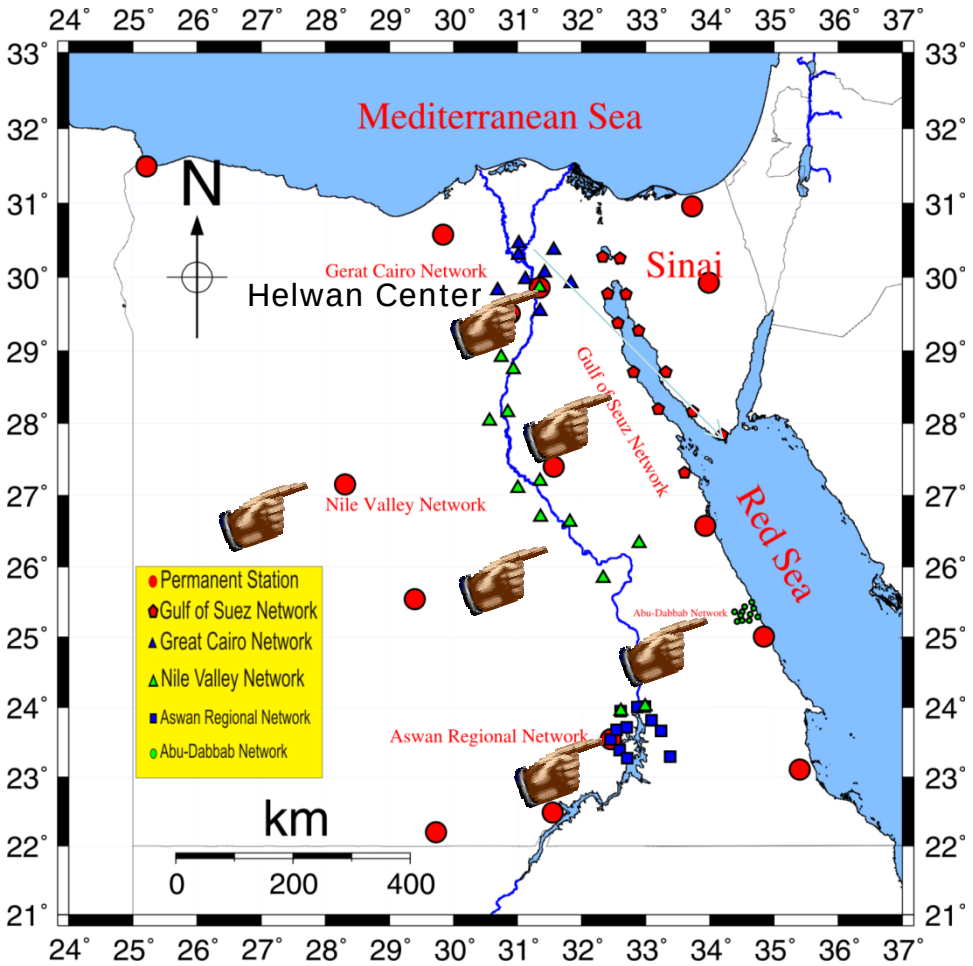
1. Location- determining a basic position.
2. Navigation - getting from one location to another.
3. Tracking - monitoring the movement of people and things.
4. Mapping- creating maps.
5.Timing - providing precise timing .

# 2.5 Applying GPS in Crustal Deformation

The following steps have to be followed for monitoring movements on the Earth's surface using GPS:

- Design and establishment of geodetic networks.
- Carrying out the repeated measurements (In NRIAG we have two ways of collecting GPS data, continuous and discontinuous techniques).
- Final analysis of repeated measurements using the scientific software (such as Berenes, GAMIT, GIPSY).

# 2.6 Distribution of GPS stations (geodetic networks) in Egypt



# 3. Case Study (Gulf of Suez)

This study aim to throw light upon the present state of recent crustal movements and its relationship to seismicity and tectonics along the Gulf of Suez, Egypt and try to solve many questions and problems connected with the geodynamics.

3.1 Tectonic setting

3.2 Seismicity

3.3 Collecting and Analysis of GPS data

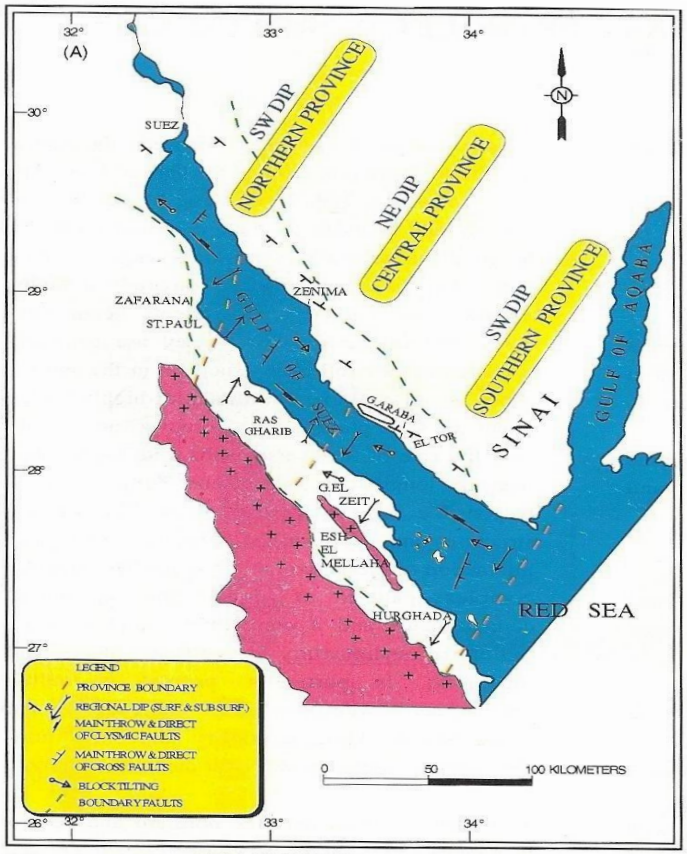
3.4 Results and Discussion

## Borders of the Gulf of Suez from Satellites

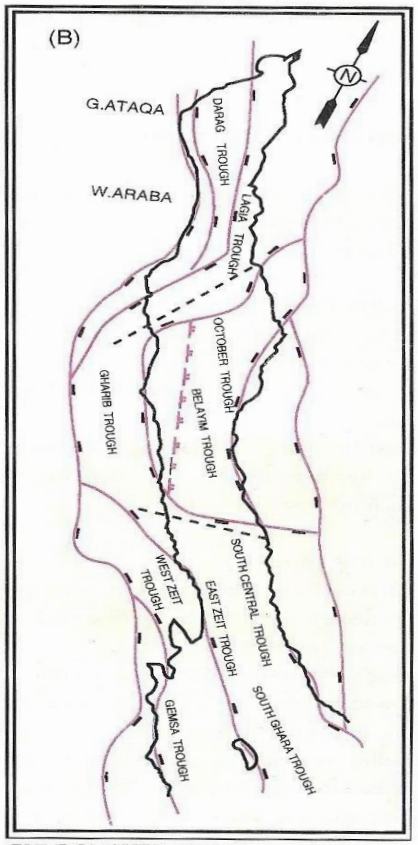

## Locations of oil fields in the Gulf of Suez


The Gulf of Suez, an important shipping route for oil and other products, lies along the edges of the African country of Egypt and the Sinai Peninsula. The Gulf of Suez is approximately 195 miles (314 km) in length. The width runs from 12 to 27 miles (19 to 43km).

# 3.1 The Current Situation of the Gulf of Suez

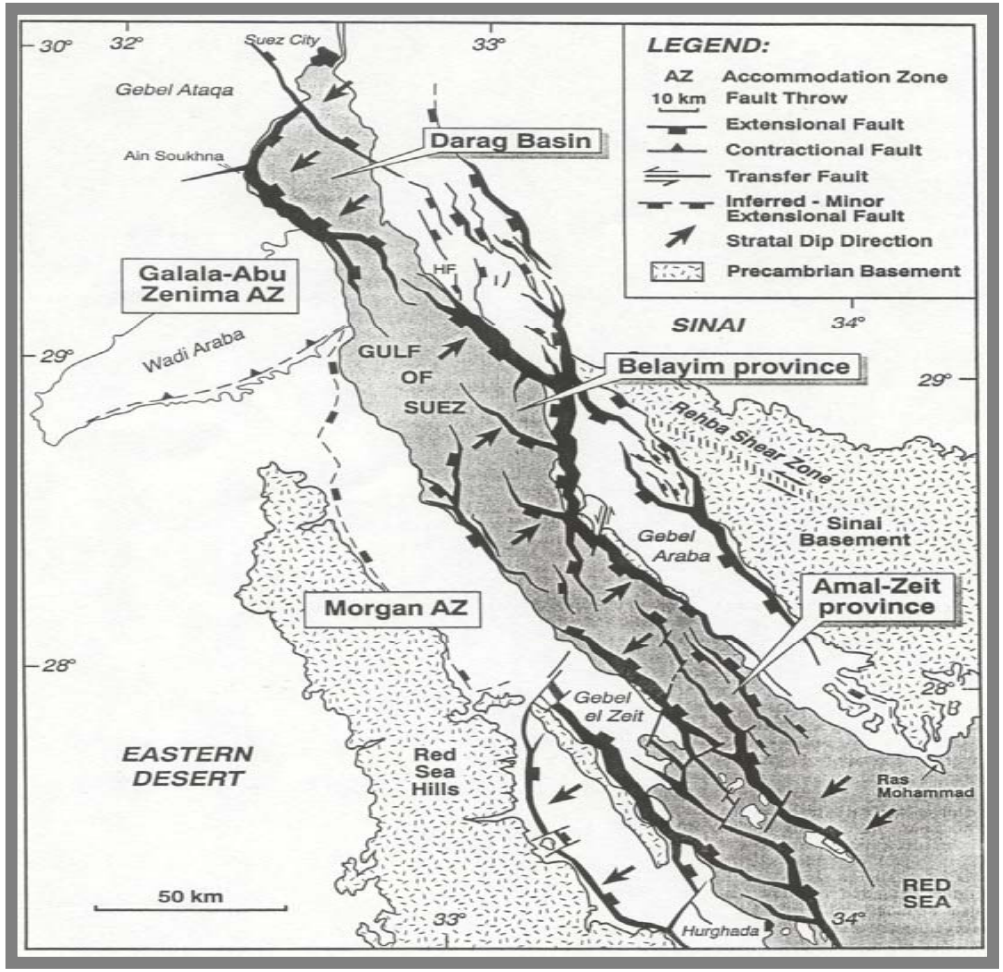



GULF OF SUEZ RIFT STRUCTURAL PROVINCES (MODIFIED AFTER MOSTAFA, 1976 & RASHID, 1990).

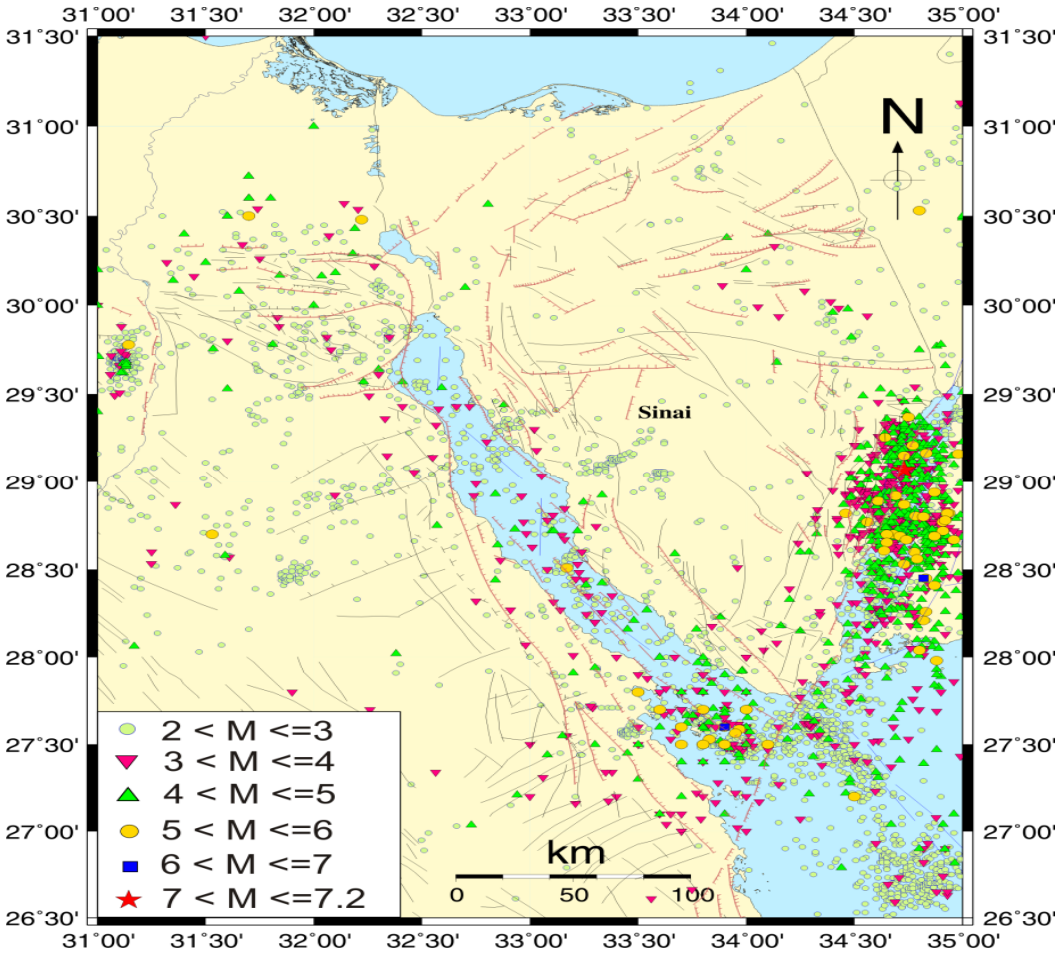



GULF OF SUEZ MAJOR TECTONIC FEATURES AND TROUGHS (MESHREF 1990)

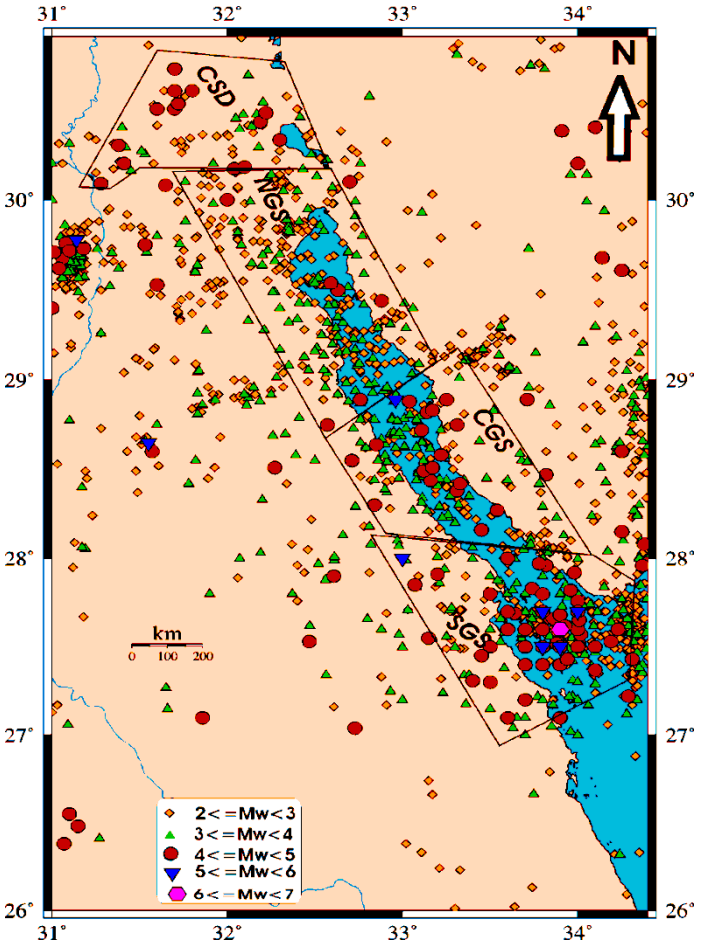
# Tectonic and accommodation zones in the Gulf of Suez (After S.Khalil, 1998).

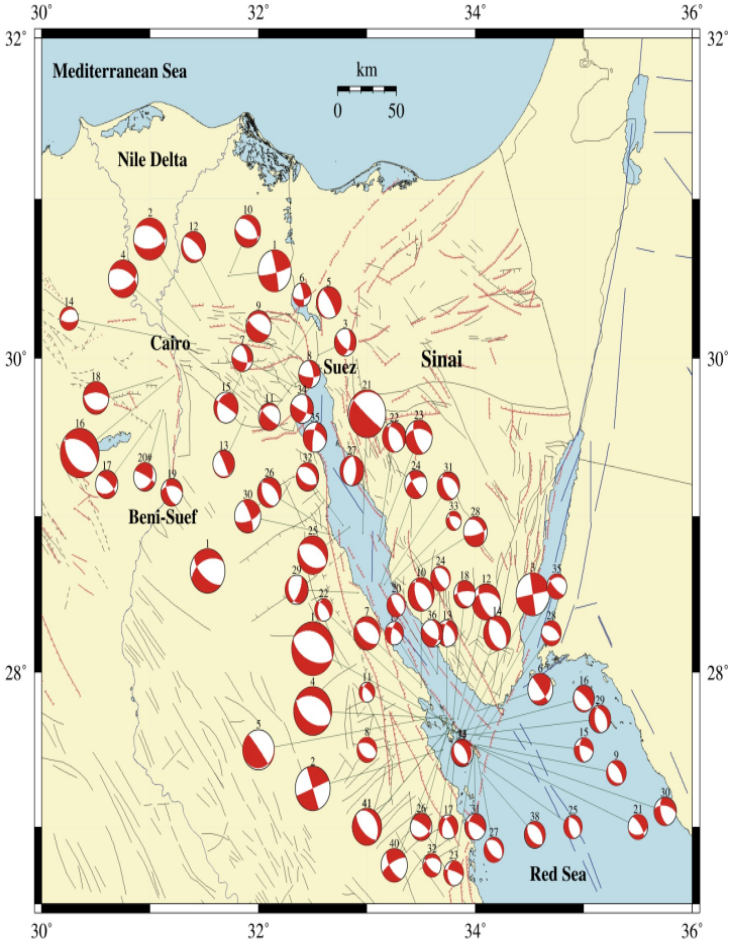


# 3.2 Seismicity of the Gulf of Suez 1900-2010 (the seismological data obtained from ENSN)

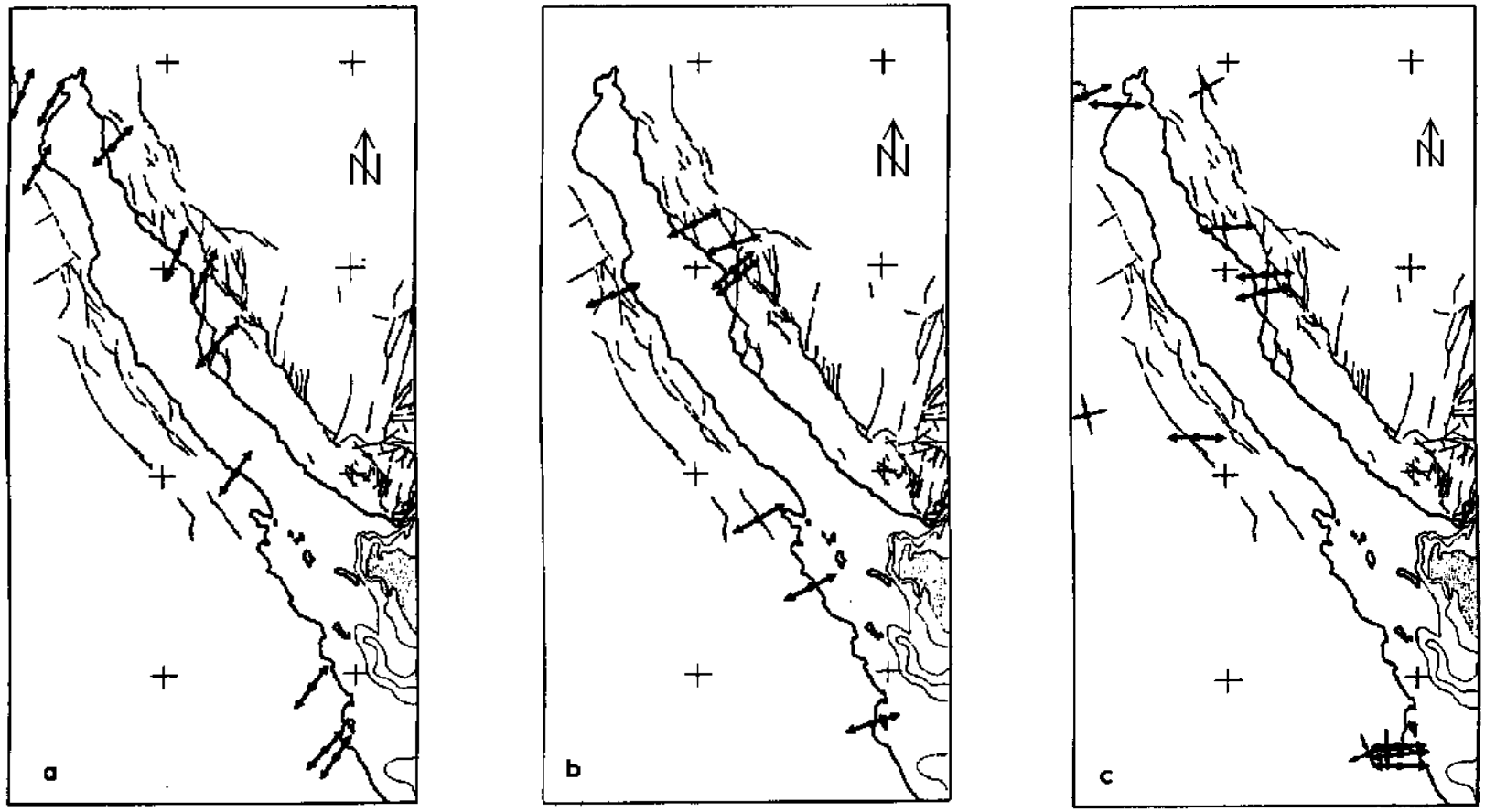


# Seismicity and focal mechanism of the Gulf of Suez associated with the seismotectonic zones. After ( Enayat,A.A., 2005).



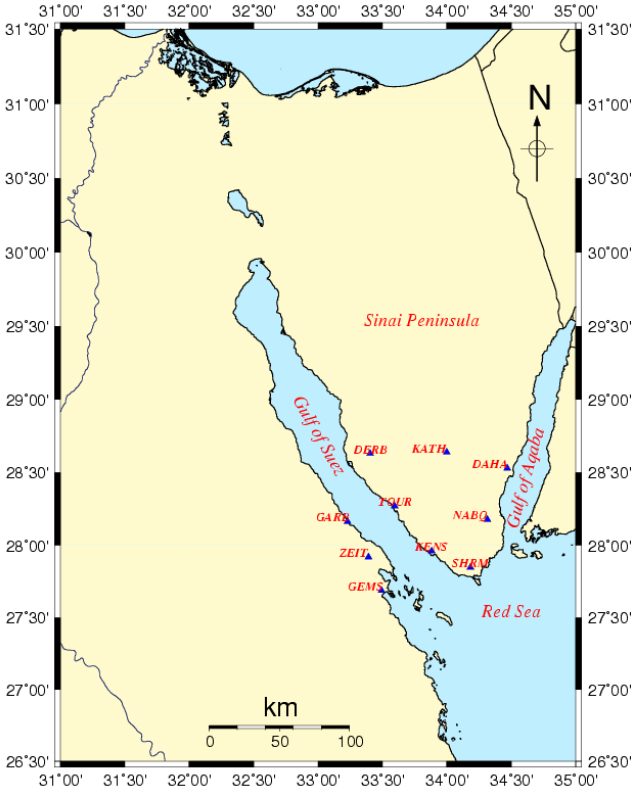
# The paleostress directions in the Gulf of Suez. (after Lyberis, 1988; and Steckler et al., 1988)



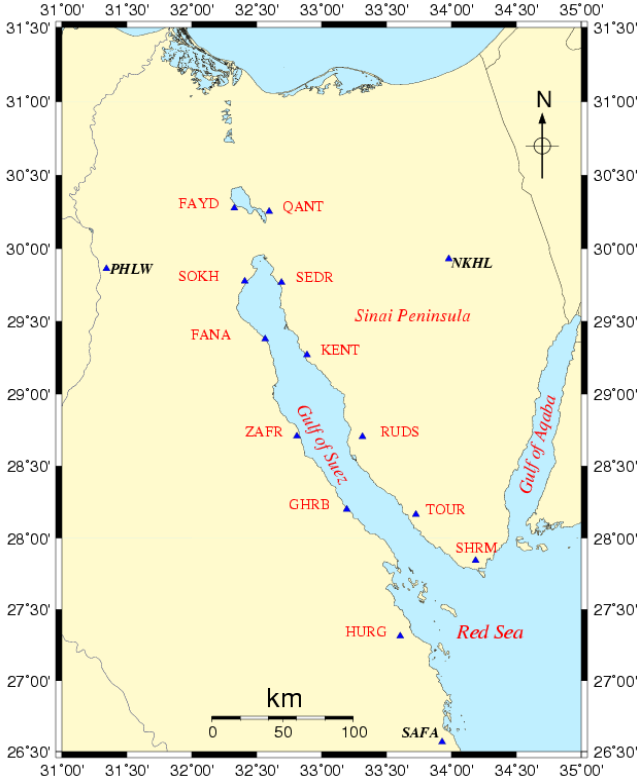

a- Early Miocene b- Middle to late Miocene. c- Plio-Quaternary.

# 3.3 Gulf of Suez Network

**Sinai Network**
**From 1997 to 2003**

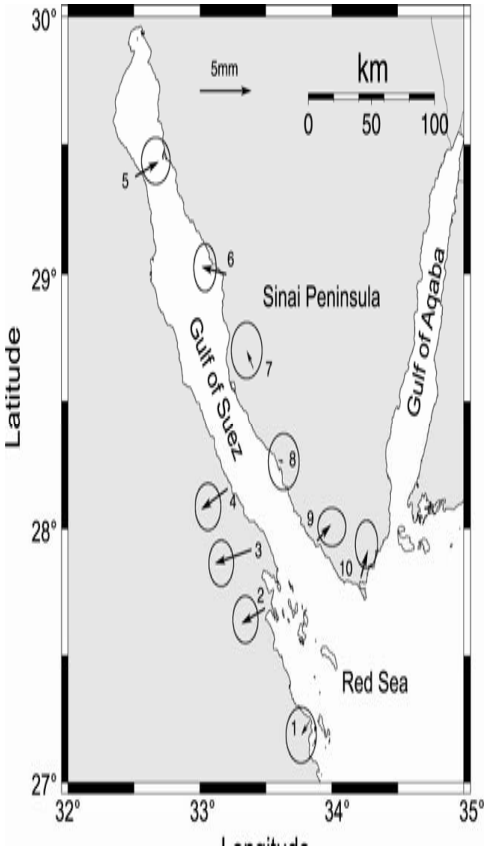



**Gulf of Suez Network**
**From 2007 until now**

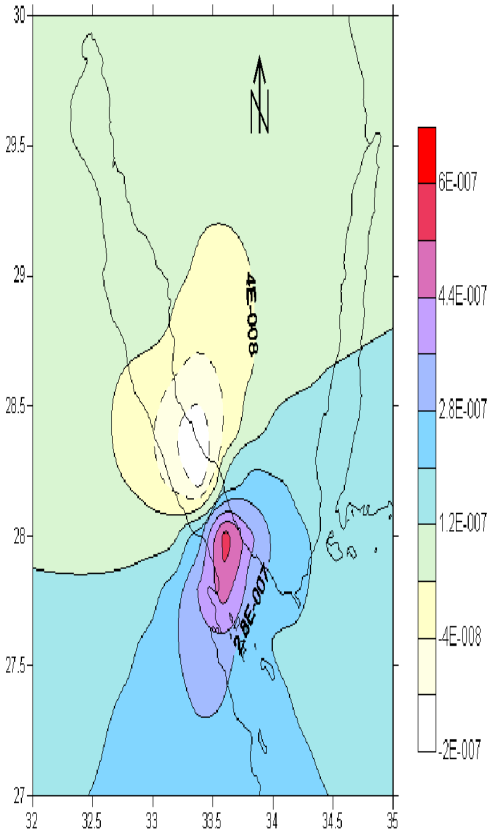


# Deformation Parameters along the Gulf of Suez from 1997 to 2003

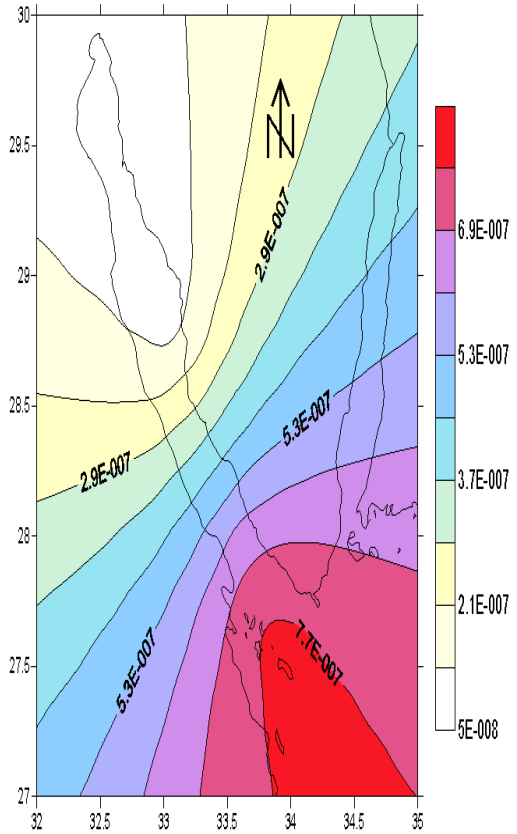
**Rate of Horizontal displacement vectors**




**Distribution of the dilatation strain rates**



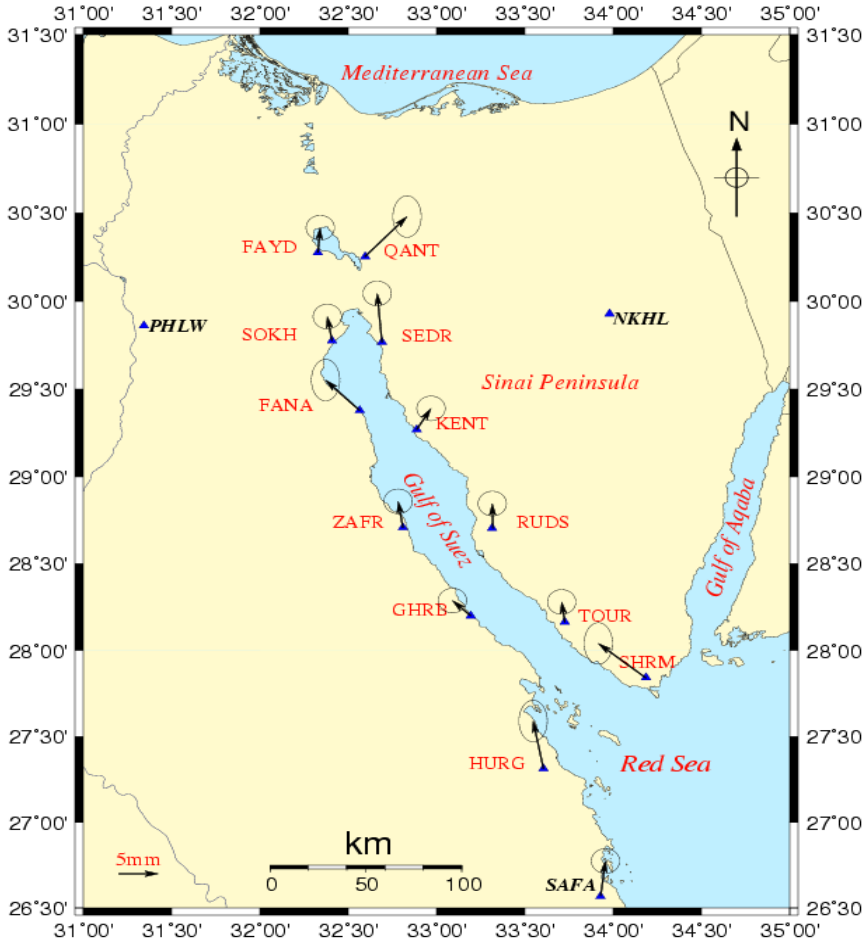

**Distribution of the maximum shear strain rates**



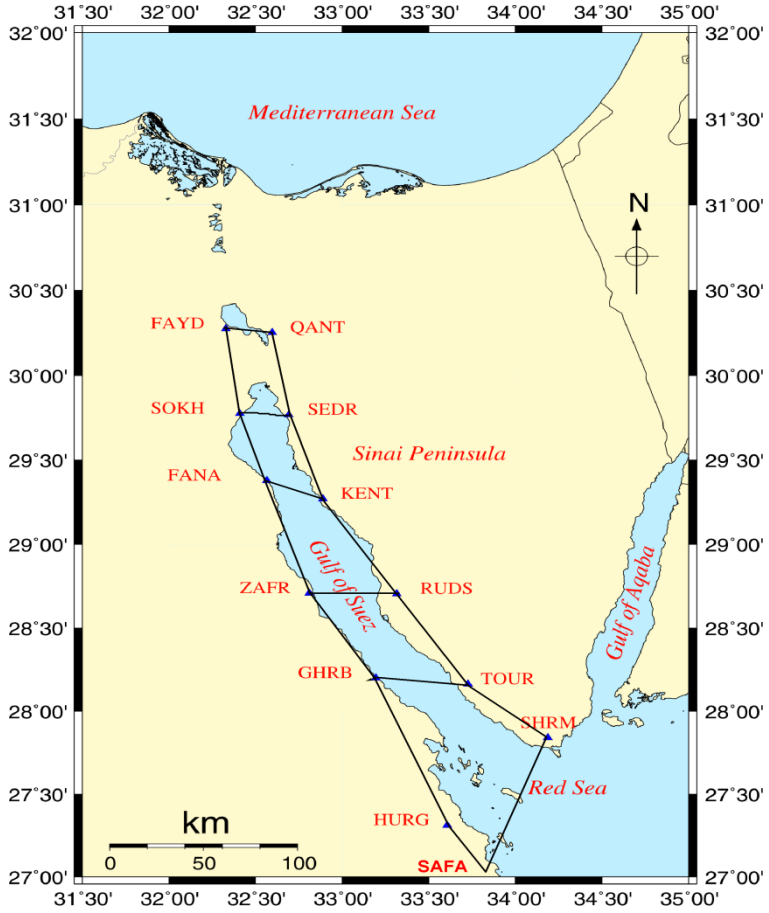
# 3.4 Gulf of Suez Results
# 3.4.1 Velocity Results


**The annual horizontal Velocity derived from GPS for the period from 2007 to 2010 in ITRF 2005**

# The Residual Horizontal Velocity along the Gulf of Suez



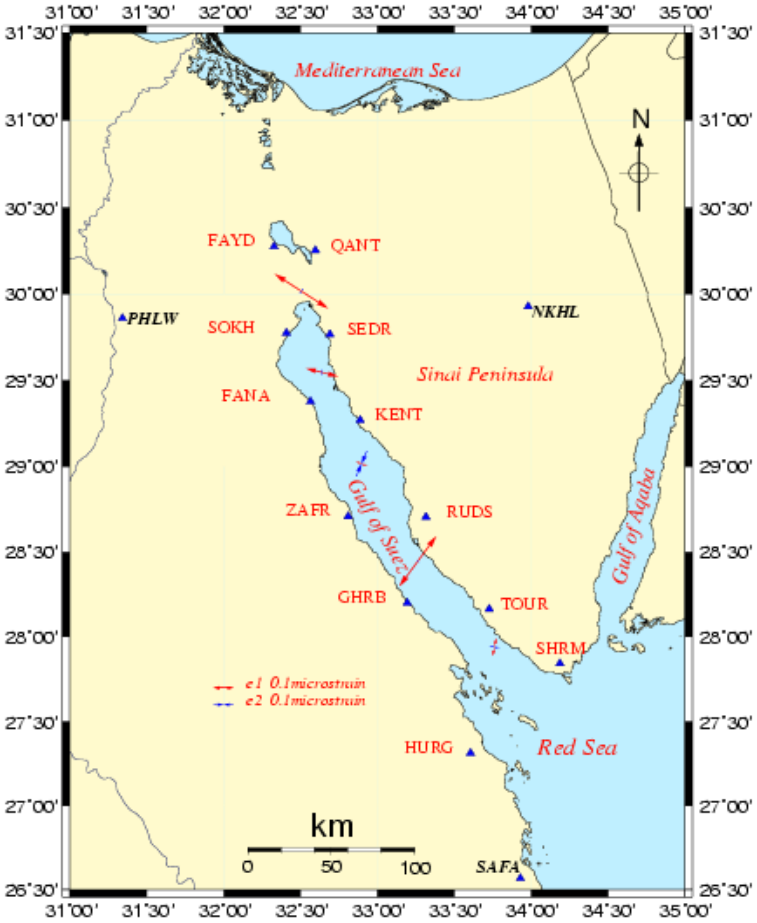
# 3.4.2 Strain Results

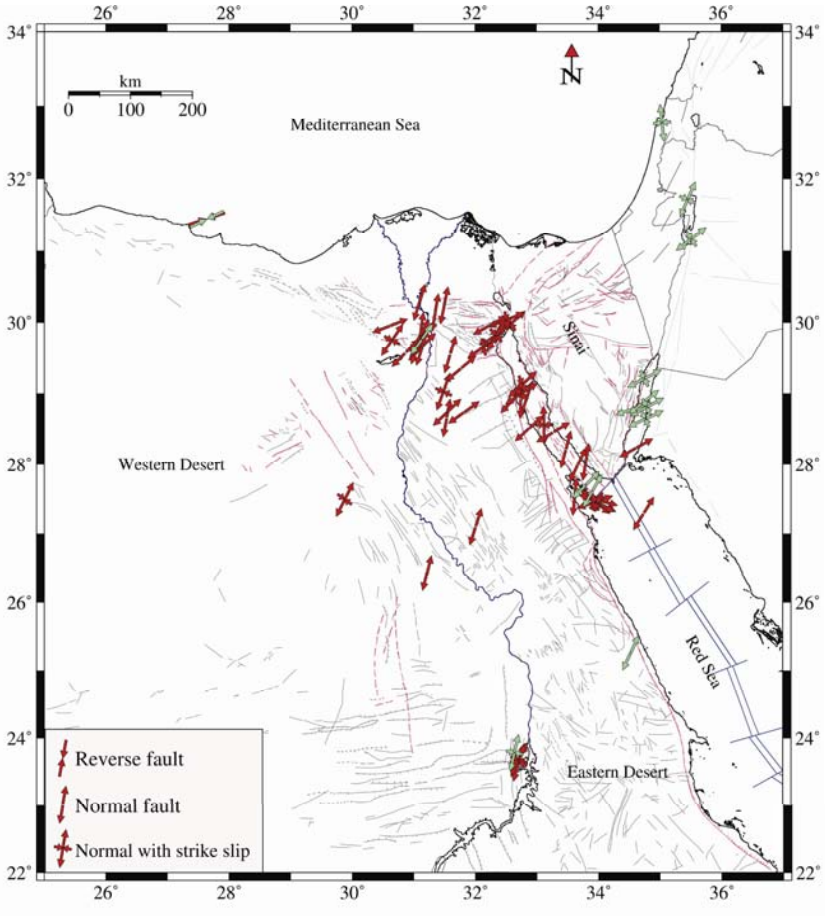



Gulf of Suez blocks

## The annual Principle Strain along the Gulf of

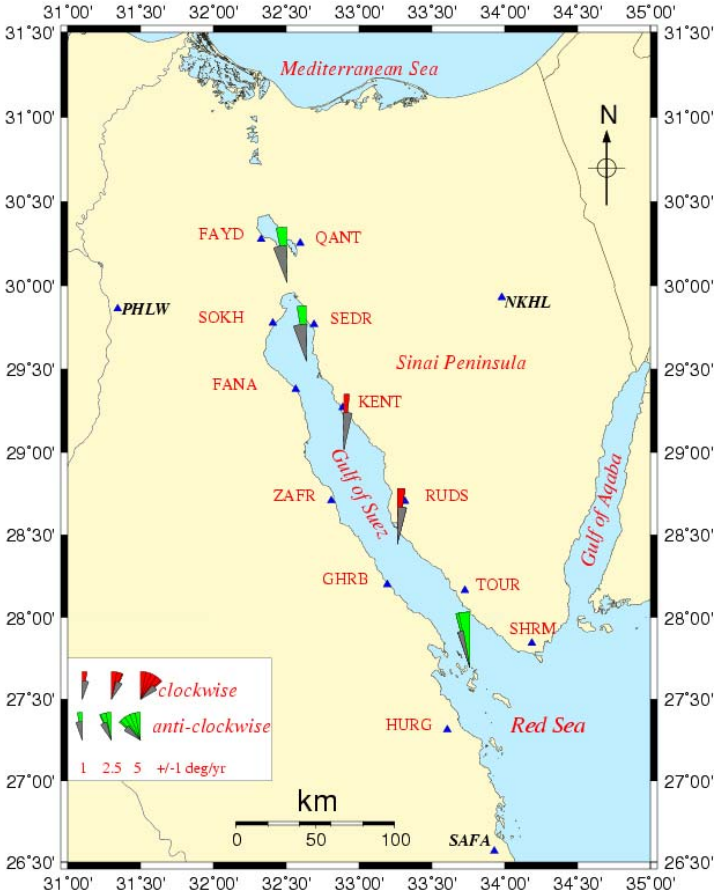
## Present-day stress field deduced from focal mechanisms (Abou Elenean, 2007)

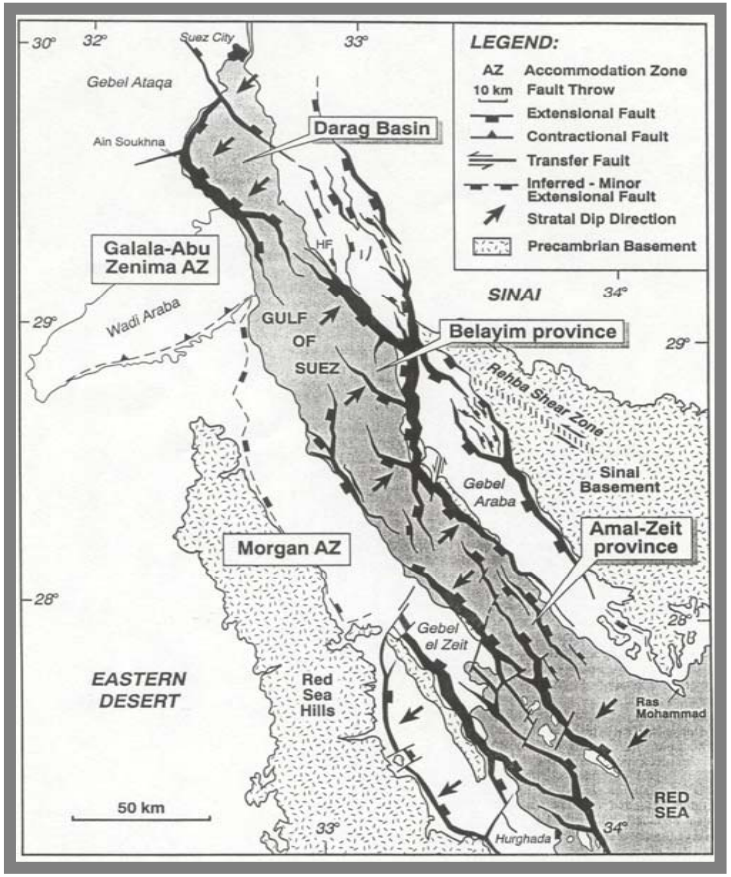


Annual rotation rates along the Gulf of Suez geodetic network blocks

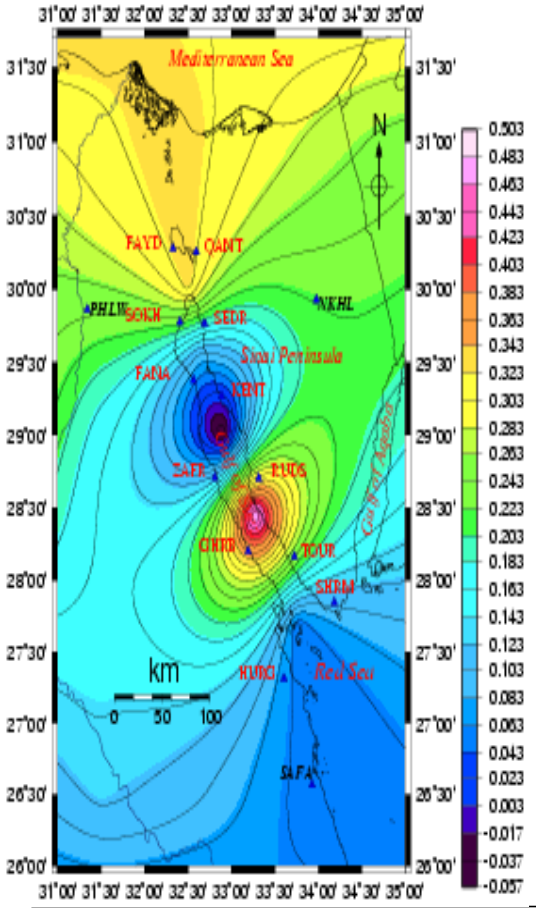
Tectonic and accommodation zones in the Gulf of Suez (After S. Khalil, 1998).



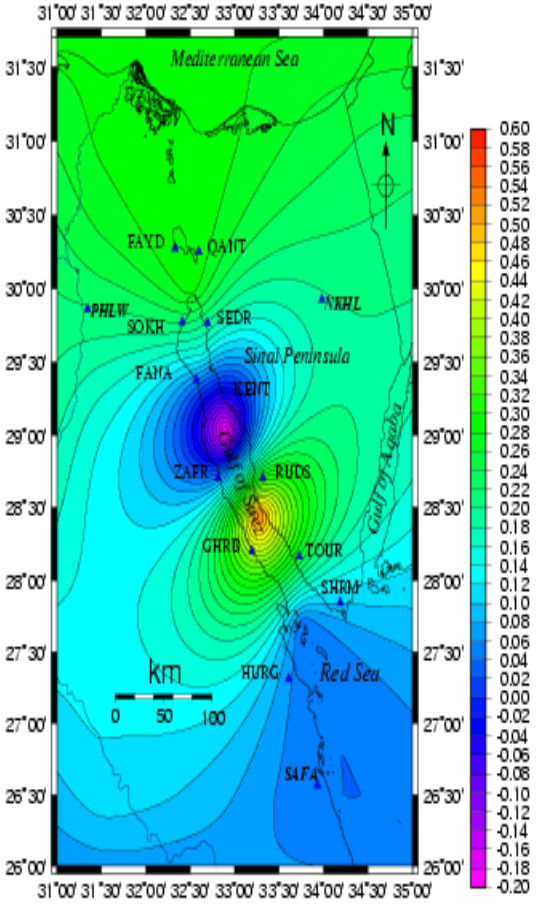



# Annual Deformation Parameters along the Gulf of Suez

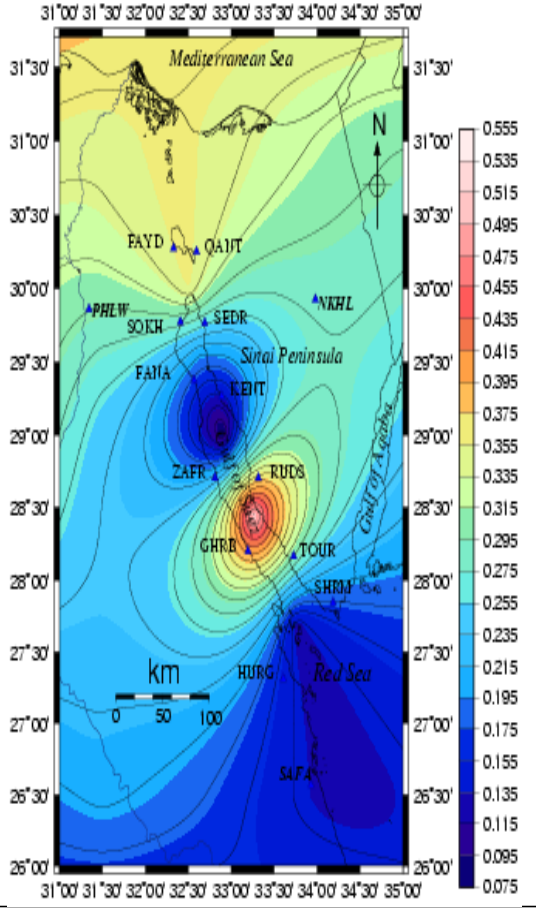
## Horizontal strain



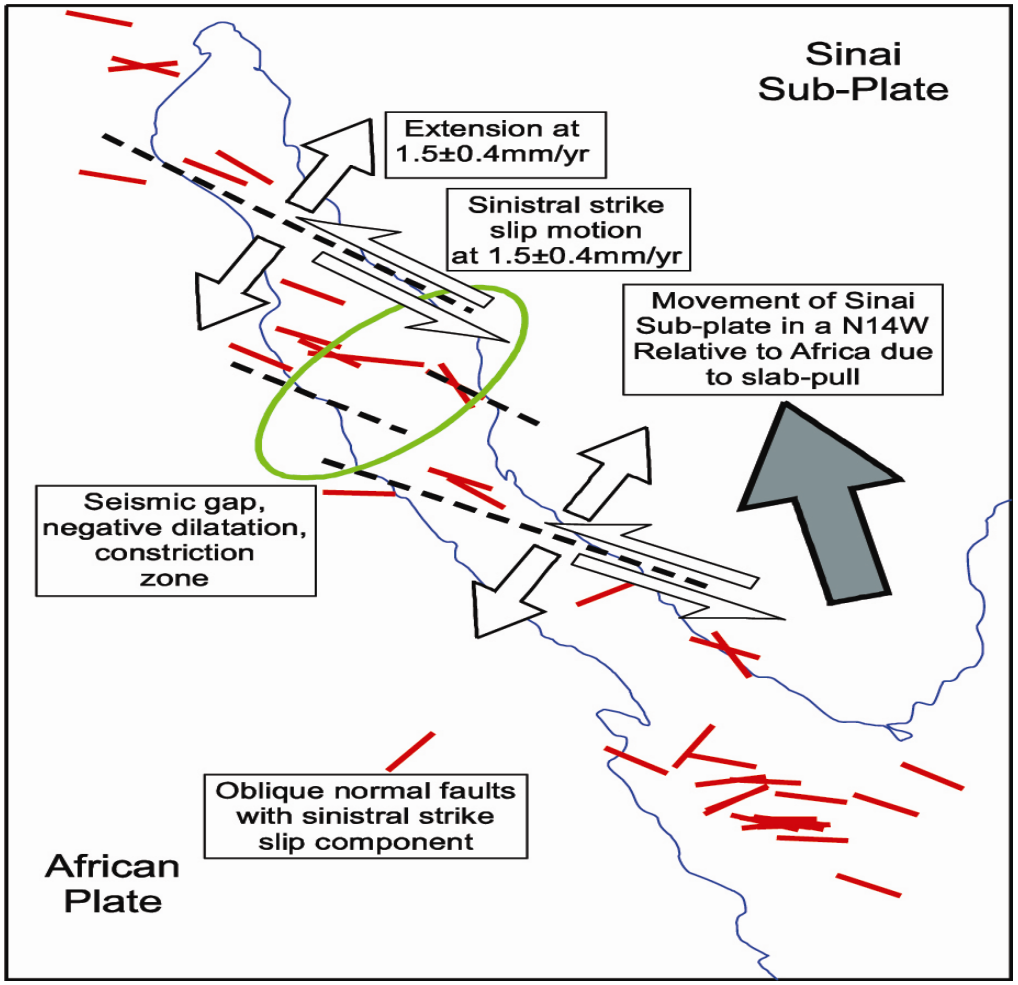

## Dilatation strain




## Shear strain



# Kinematics model of the Suez rift based on the new finding of seismological and GPS surveying.



# CONCLUSION

- The horizontal velocity of the Gulf of Suez network (including the velocity of the African plate) coincides with the plats kinematic model.

- From the obtained residual horizontal velocity, the Gulf of Suez area can be divided into two main parts, eastern and western. The average rate of velocity on the eastern side is about 5mm ± 1.17mm per year in the north to northeast direction, while for the western side is about 4.5mm ± 1.15mm per year in north to northwest direction, which can be regarded to the opening of the Gulf.

- Principle axes of the strain rates across the blocks of the network indicate that the Gulf of Suez is suffered from extensional forces acting in the NNE-SSW to NNW-SSE direction.

- Annual rotation rates along the Gulf of Suez geodetic network blocks show that the southern and northern parts of the gulf rotate in anti-clock wise direction, while the middle part of the gulf rotates in clock wise direction, which consistent with the tectonic setting of the area.

- Deformation parameters of strain indicate that the area divided to three provinces in addition to Cairo-Suez-district zone which similar to seismotectonic zones.

# THANKS