



Seismicity of Egypt

Hazem Badreldin

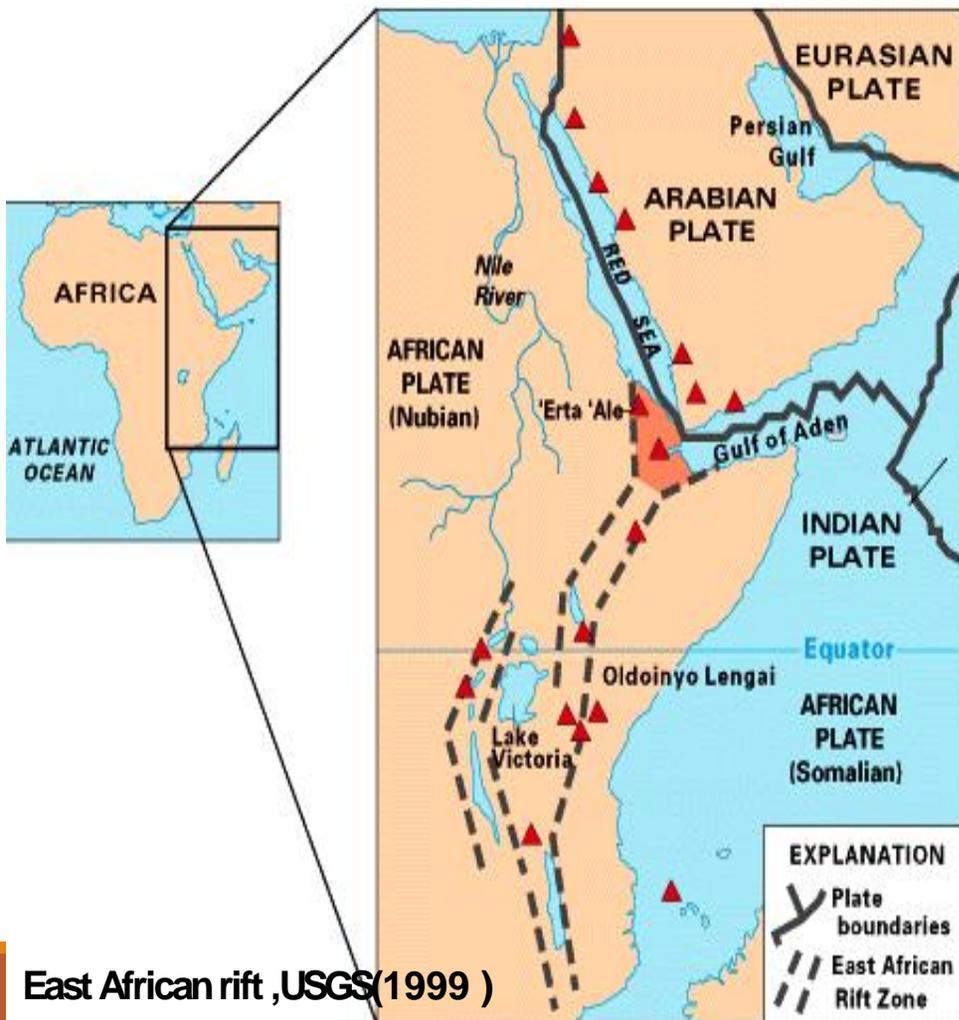
Research Assistant

National Research Institute of Astronomy and Geophysics (NRIAG), Cairo, Egypt
Geo.hazem@yahoo.com

Outline

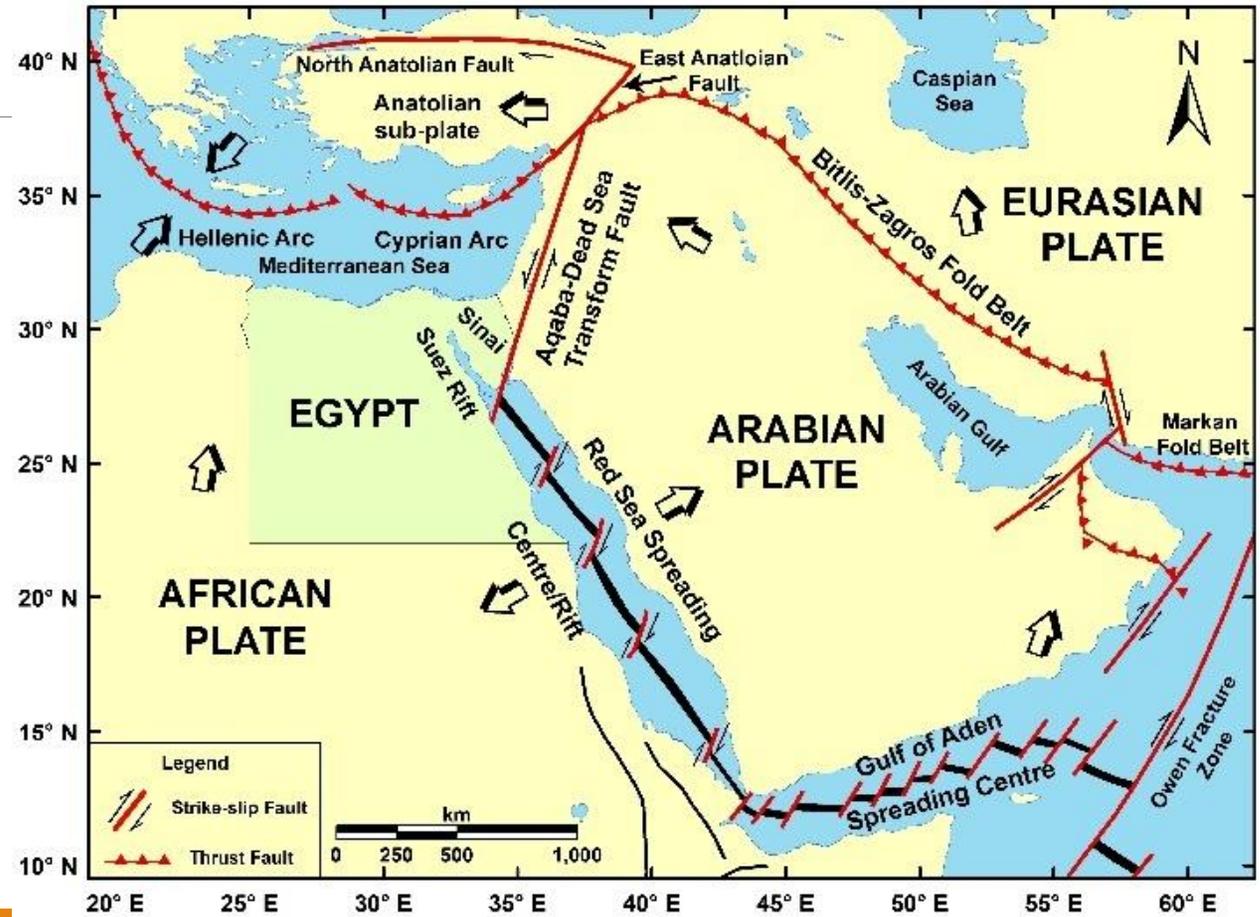
- Introduction
- Seimotectonic setting
- Seismicity of Egypt

Introduction



Location map of Egypt with in Africa

Seismotectonic setting of Egypt



redrawn after Ziegler [2001] and Pollastro [2003]

Seismicity of Egypt

A-Historical Seismicity

B-Instrumental Seismicity

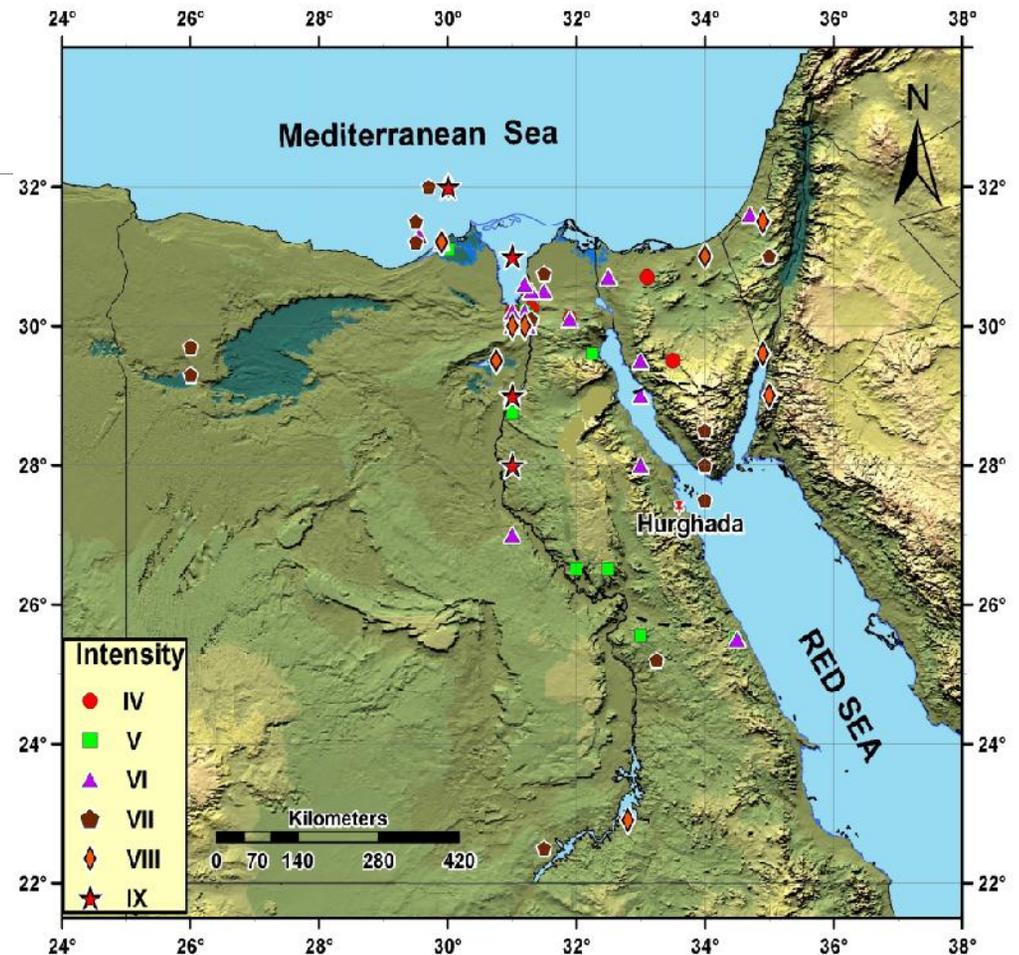
A-Historical seismicity

- ❖ Historical earthquakes which occurred before the advent of the seismograph, In the period from 2200 B.C. till A.D. 1899
- ❖ Forecasting seismic risk and mitigation of damage and human losses from future ones , Give valuable information on the recurrence interval of each region , construction of intensity maps and the rate of attenuation with distance.

Sources of historical earthquake data

- ❖ During the **Pharaonic** period the chief sources is the archaeological evidence provided by the temples and monuments themselves.
- ❖ In the classical period, **Greek** historiographers from about 500BC.
- ❖ and **Latin** ones from 200BC .
- ❖ During the **Byzantine** period (450AD-1453) more information becomes available mainly from ecclesiastical histories (Ambraseys et al. 1995).
- ❖ In the early seventh century, the formation of the **Islamic** Empire.

❖ Unfortunately a lot of remarks about some of historical earthquakes in Egypt were removal or it is became difficult to identify them because the distribution of population in a narrow zone along the Nile Valley and Delta.



Epicentral distribution of historical earthquakes in and around Egypt during the period from 2200 BC to 1899 AD (Toni, 2007 and 2012).

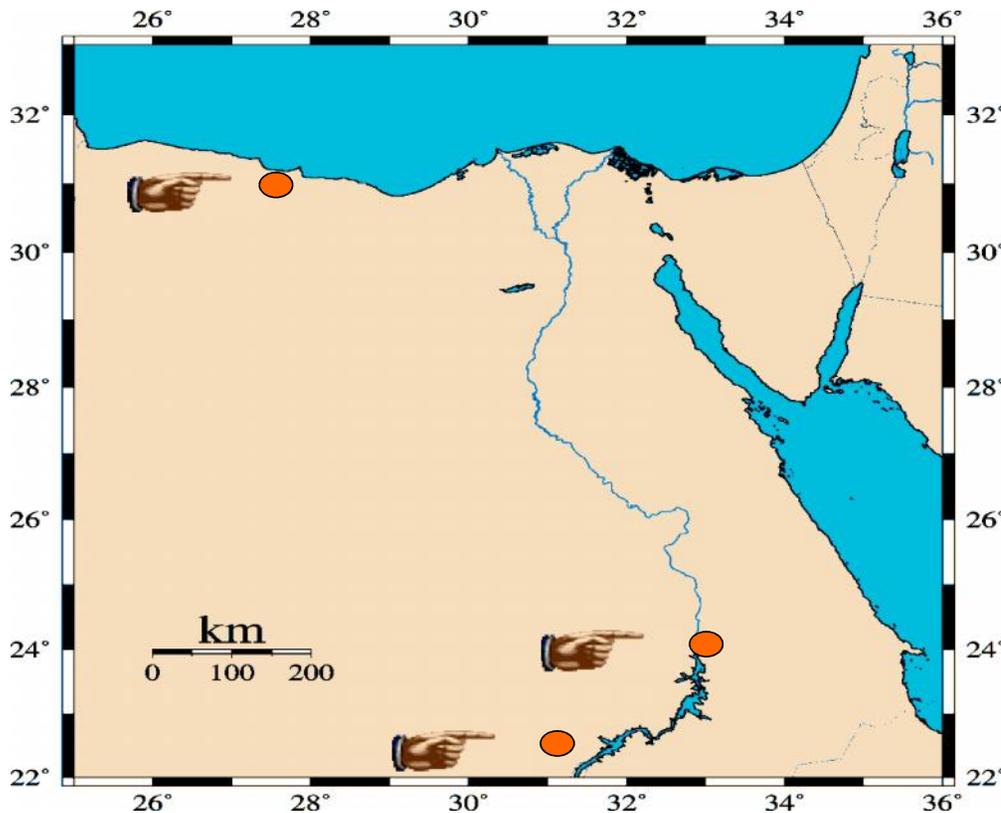
History of Upgrading the Seismic Stations

A single station at Helwan since 1898

- ❖ In 1899 is the beginning of the instrumental recording of earthquake
- ❖ the first seismic station at Helwan (about 25 km south of Cairo) .
- ❖ in 1964, Helwan station (HLW) has been selected as one of the American World Wide Standardized Seismograph Network (WWSSN).



The location map of the first seismic station in Egypt



➤ In 1975 short period (three component) Seismograph of Kimos type (Russian type):

- **Aswan**

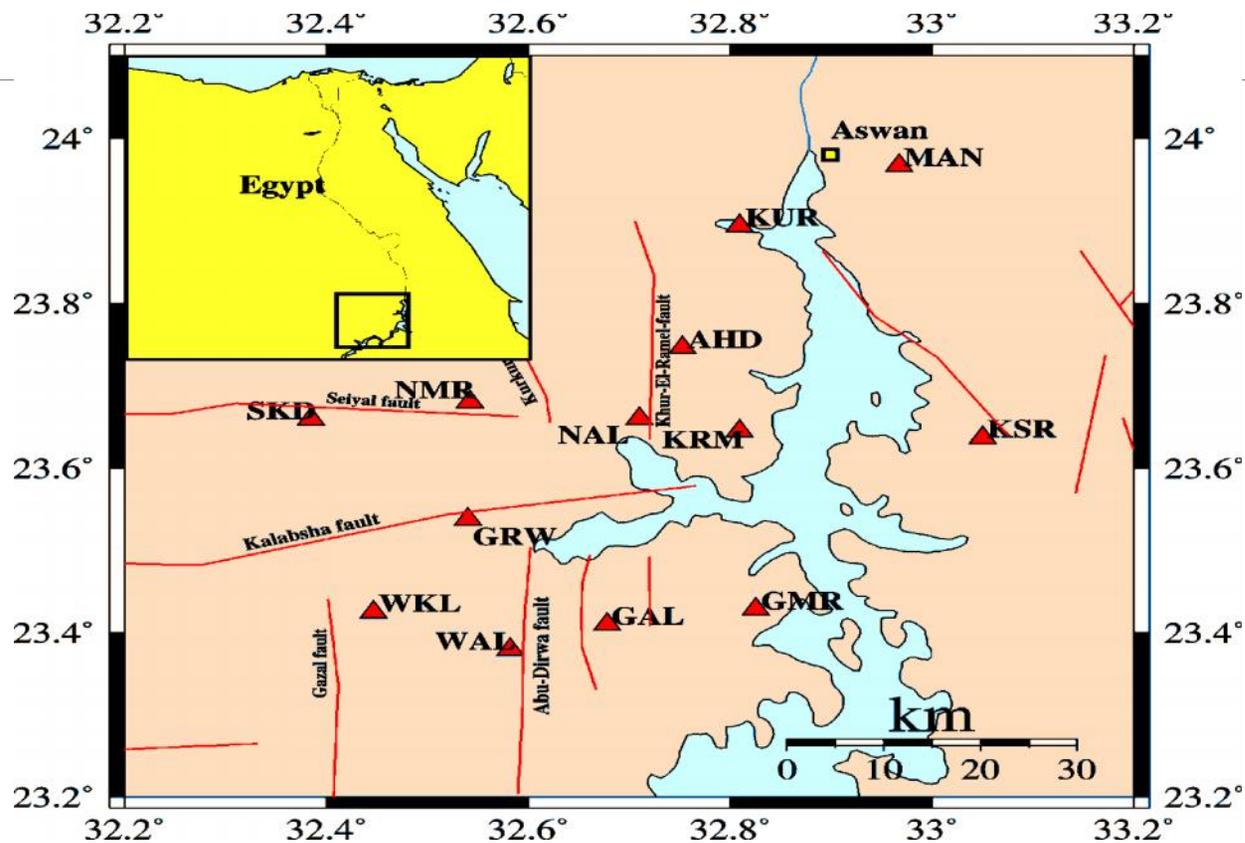
➤ In 1975, UNESCO denoted two stations Kimos type at:

- **Matrouh**

- **Abu-Simble**

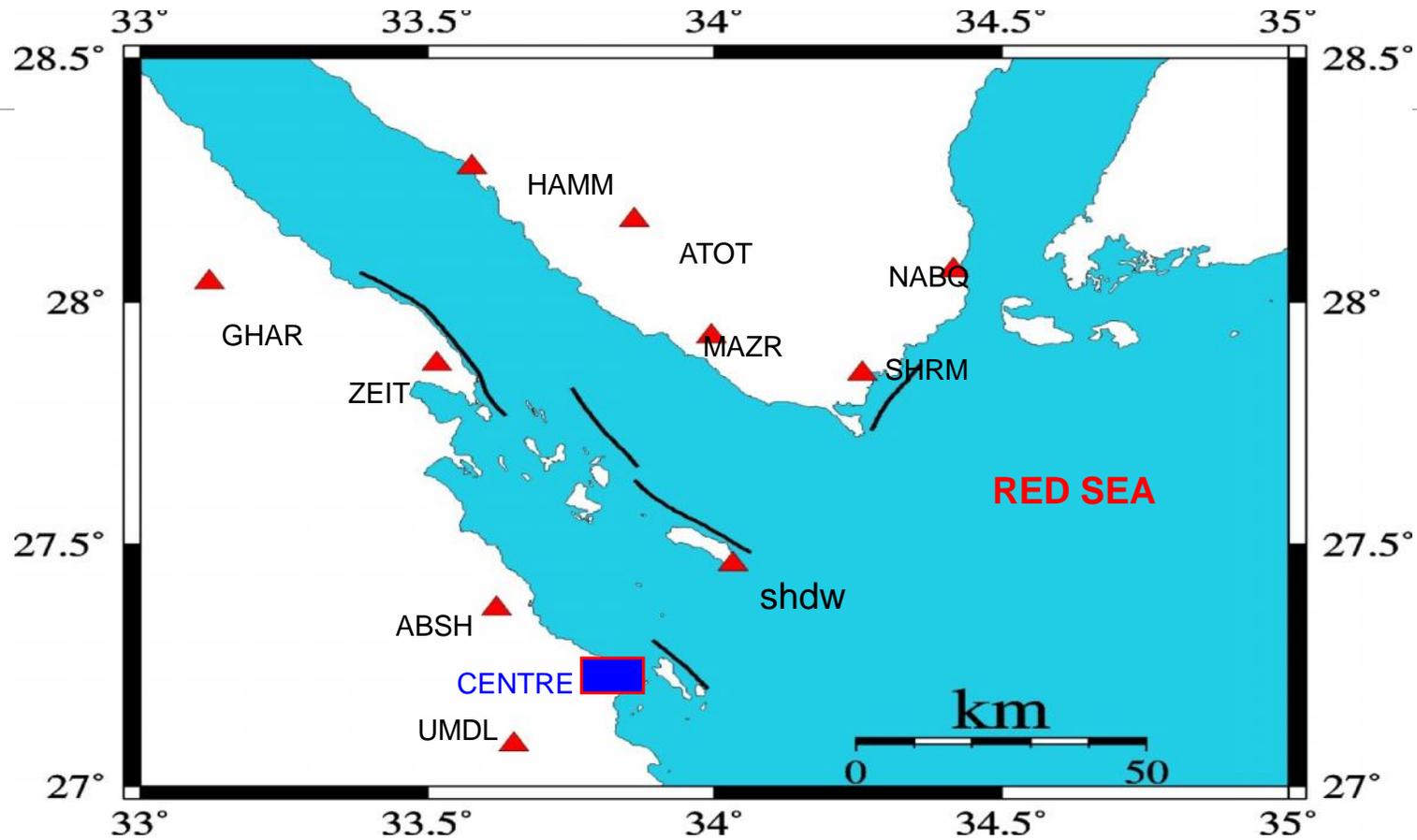
The locations map for the three seismic networks erected in Egypt

IN 1982 Aswan local Seismic network was established after Kalabsha earthquake (1981)



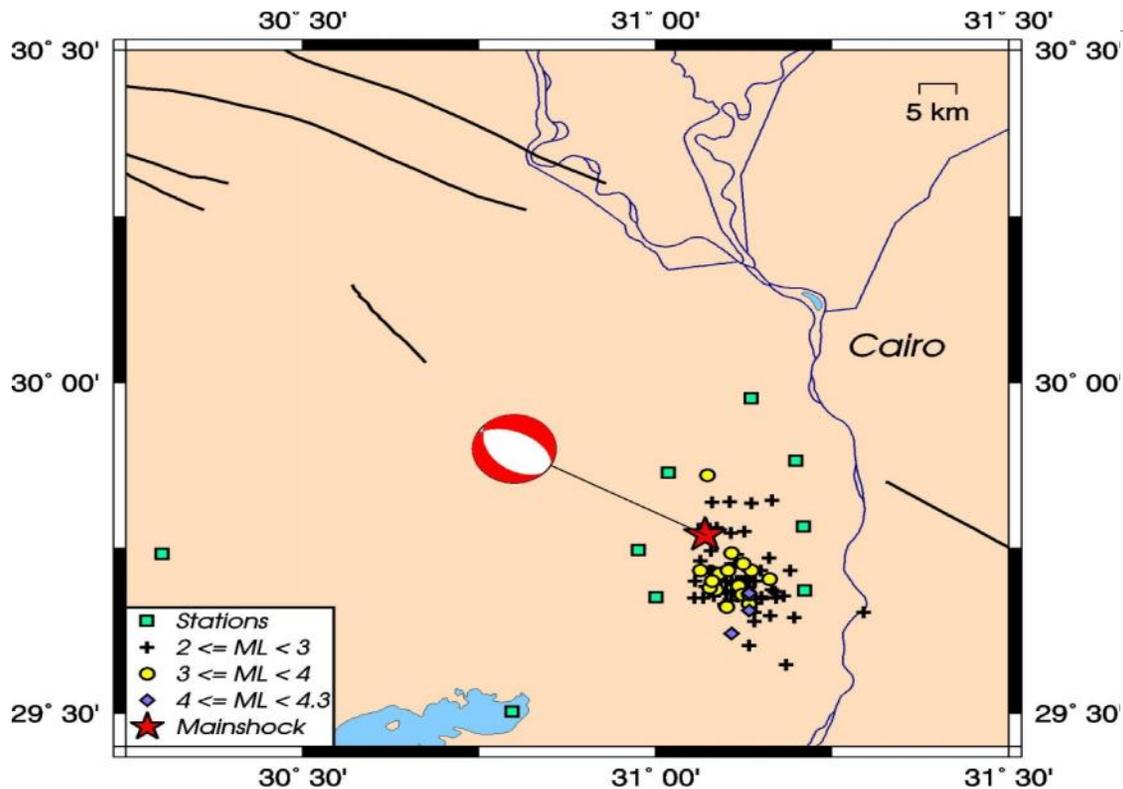
Main faults in Aswan area (after WCC, 1985)

In August 1994, a telemetry network of 10 stations installed at both sides at the southern part of the Gulf of Suez



After (NRIAG, 2010)

The October 12,1992 earthquake

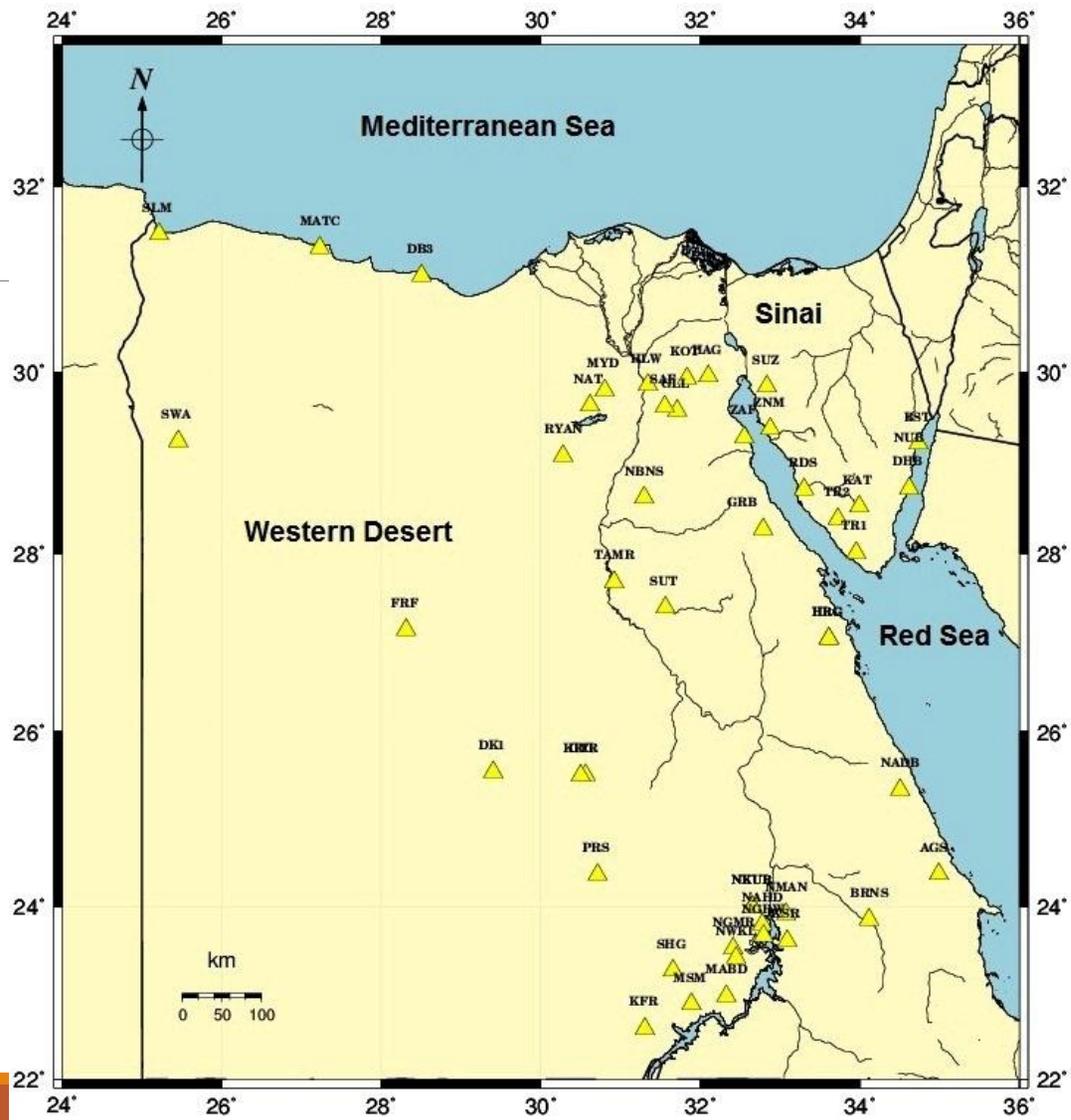


The 12 October 1992 earthquake caused 561 deaths, injured more than 9000 and left a damage of more than 35 million U\$.

As a result, the Egyptian Government gave order to the National Research Institute of Astronomy and Geophysics to install the seismological network and strong motion network.

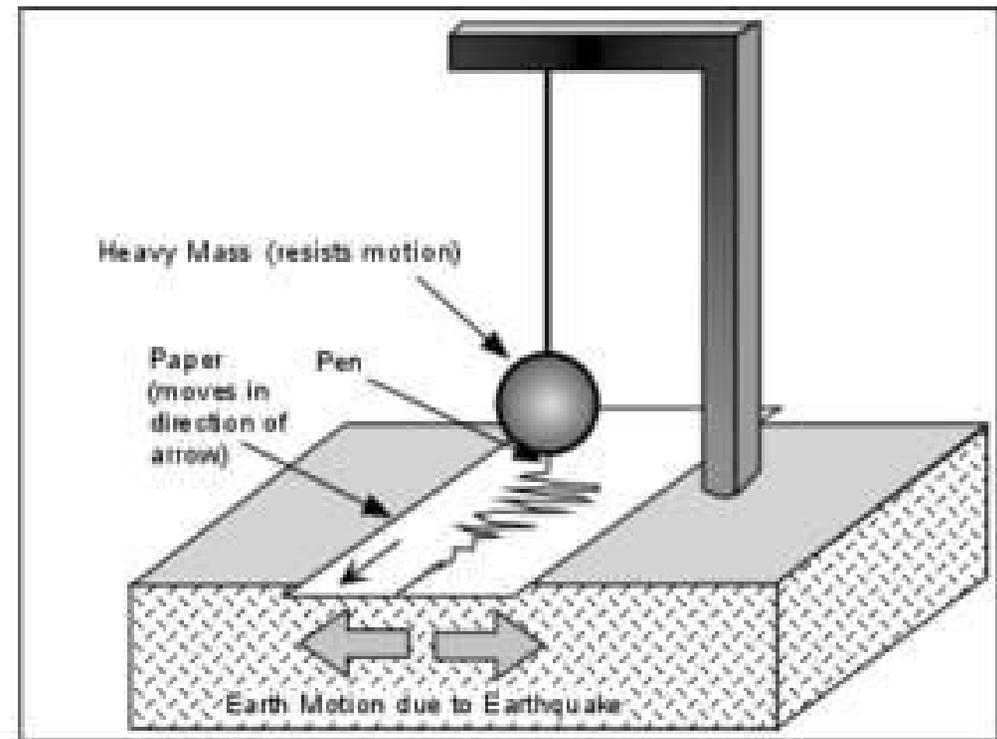
Modified after (Kamal Abou Elenean. et. al., 2000)

Distribution of ENSN



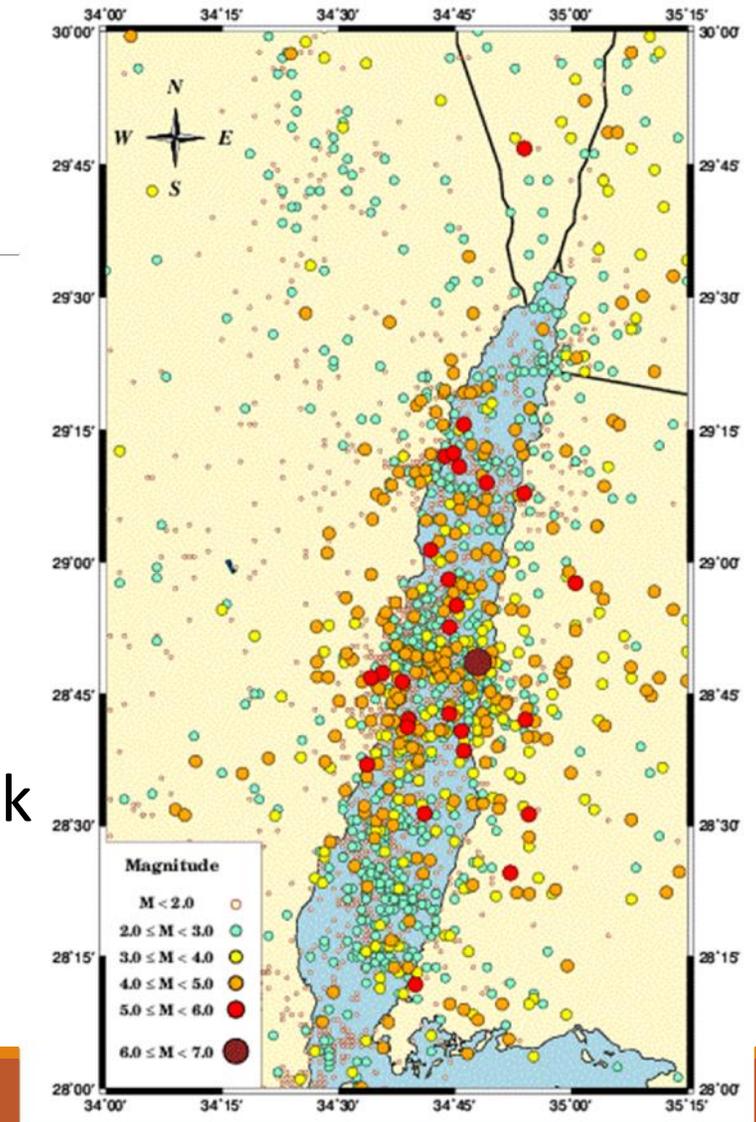
B-Instrumental Seismicity

Sieberg (1932a); Ismail (1960); Gergawi and El-Khashab (1968); Maamoun and Ibrahim (1978); Maamoun et al. (1980); Maamoun et al. (1984); Albert (1987); Kebeasy (1990); Abu Elenean (1997); Deif (1998); El-Hadidy (2012) ; Sawires et al. (2015); Abelazim et. al 2016 .



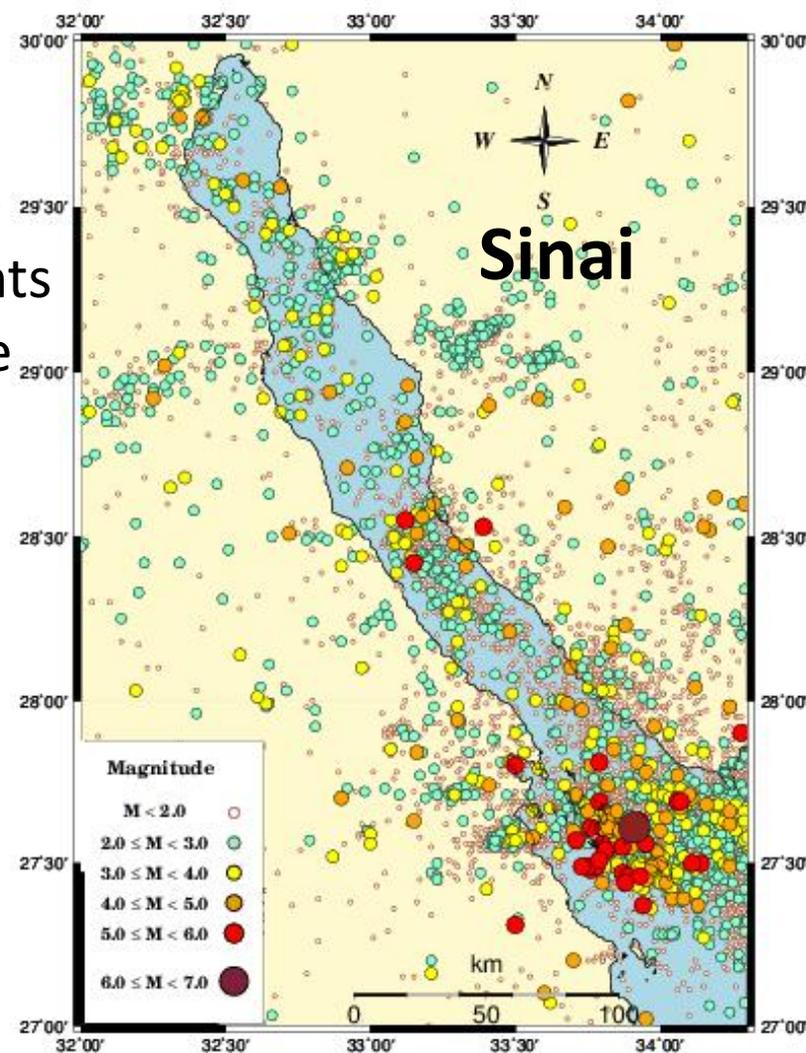
Gulf of Aqaba

- ❖ The Gulf of Aqaba has been affected by many destructive earthquakes.
- ❖ it is considered one of the most active seismic zones in Egypt
- ❖ The Gulf of Aqaba is characterized by foreshock-mainshock-aftershock, mainshock-aftershock and swarm type activity .



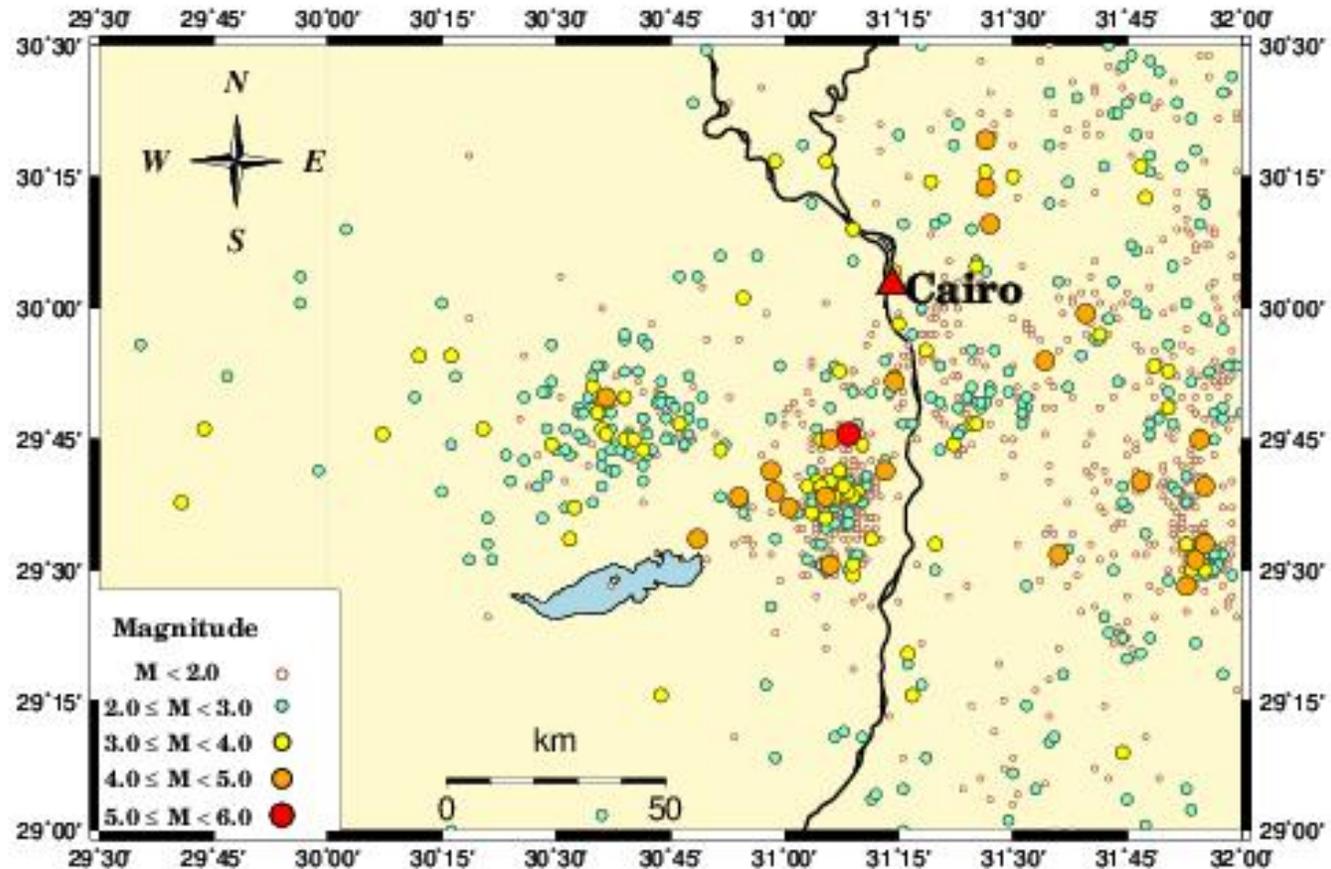
Gulf of Suez

- ❖ The seismic activity of the southern end of the Gulf of Suez is related to the crustal movements among the Arabian plate, African plate and the Sinai sub plate.
- ❖ The Gulf of Suez is characterized by foreshock-mainshock-aftershock, mainshock -aftershock and swarm type activity .



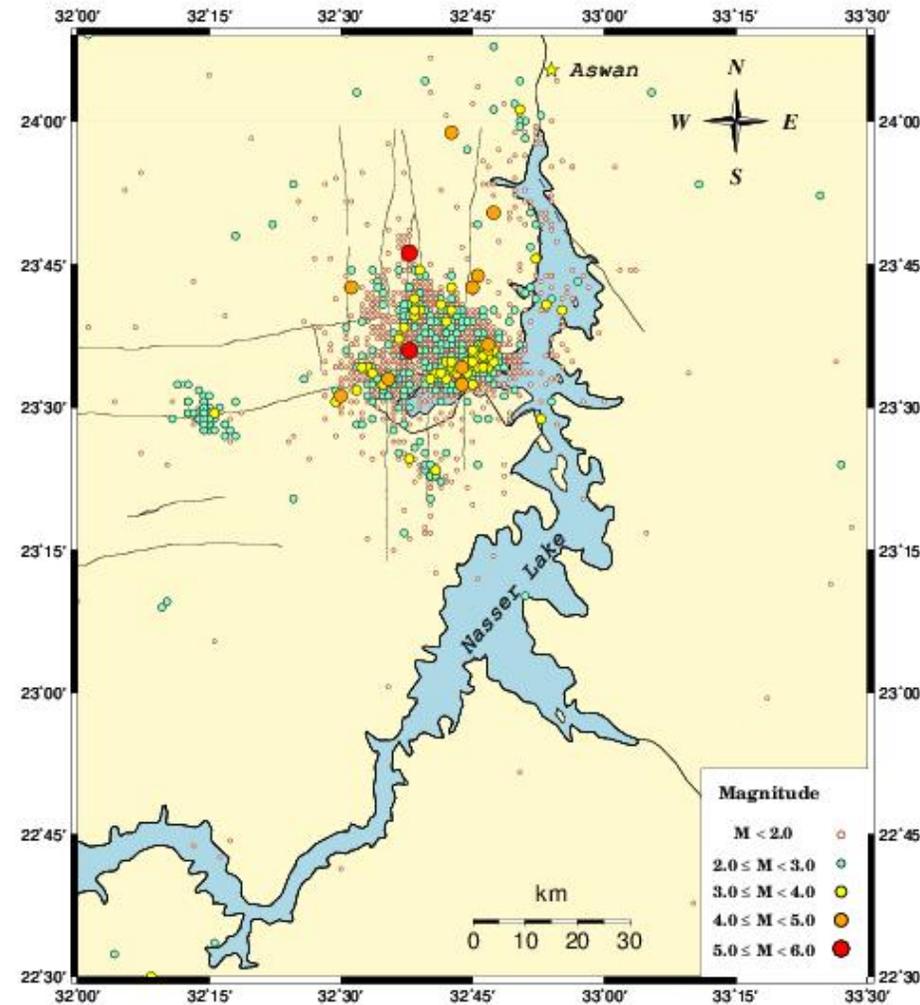
Dahshour zone

- ❖ This seismic zone is characterized by the occurrence of small to moderate magnitude earthquakes.
- ❖ There is a large number of historical events that has been reported in this Zone.
- ❖ The recent earthquake of 1992, October 12 (mb 5.8);



Aswan Zone

- ❖ Aswan is one of the most important areas in Egypt
- ❖ This seismic zone is the source of the November 14, 1981 earthquake (ML 5.5) which caused considerable damages to Aswan Area. This earthquake occurred at about 60 km SW of Aswan High Dam.
- ❖ Kalabsha, Kurkur and Khour El Ramla faults are the main reasons of the seismic activity in this zone

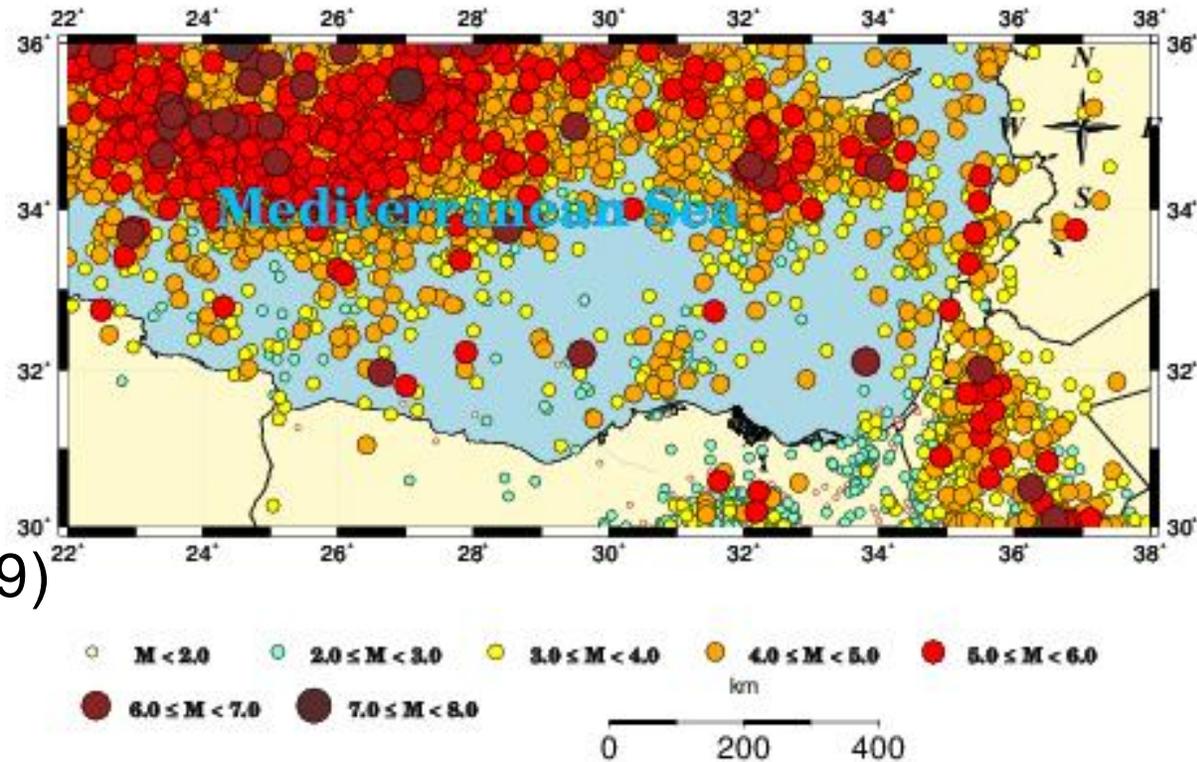


Passive continental margin

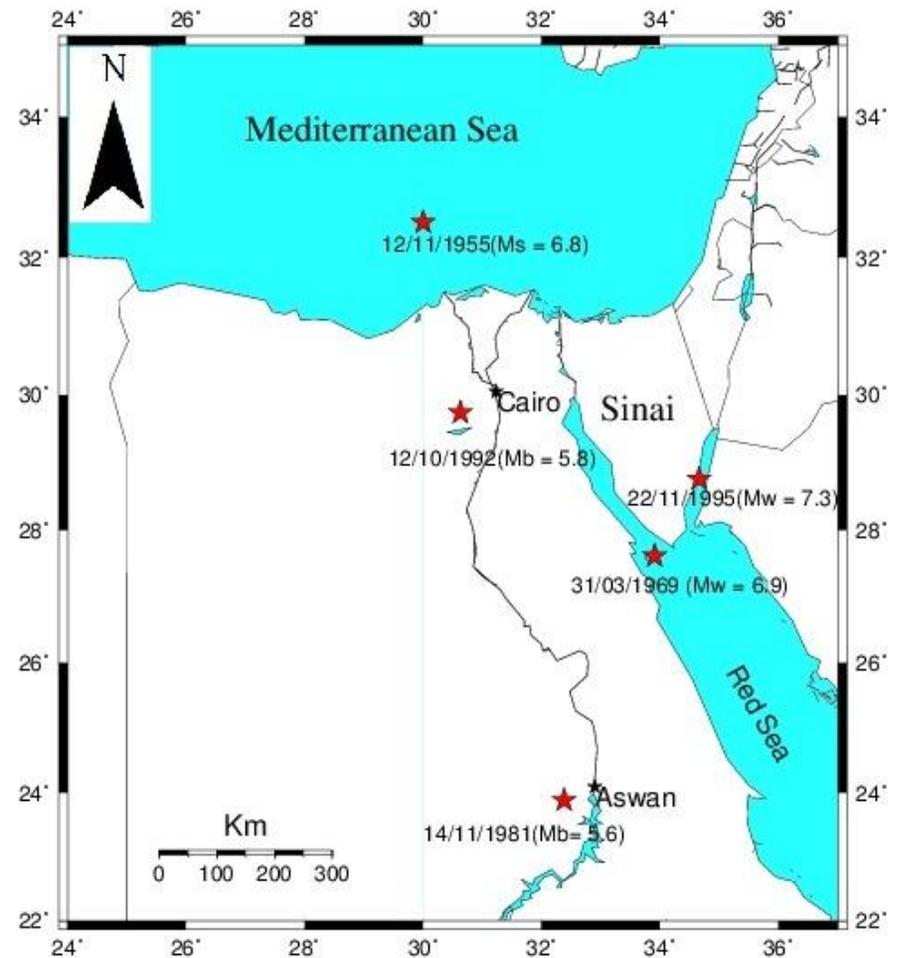
❖ The northern Egypt has been shocked by a number of moderate size earthquakes.

❖ The largest historical events in this area are those of 320 , 956 ,1303 and 1870 A.D.

❖ September, 12, 1955($M_s = 6.8$) and 10 October 2012 ($m_l = 5.29$)



- ❖ September 12, 1955 Alexandria earthquake ($M_s = 6.8$) .
- ❖ March 31, 1969 Shadwan Earthquake ($M_w = 6.9$)
- ❖ Nov. 14, 1981 Aswan (Kalabsha) earthquake ($M_b = 5.6$)
- ❖ October 12, 1992 Cairo (Dahshour) earthquake ($M_b = 5.8$)
- ❖ November 22, 1995 Gulf of Aqaba earthquake ($M_w = 7.3$)



The most recent severe damages earthquakes in Egypt.

THANKS FOR YOUR ATTENTION



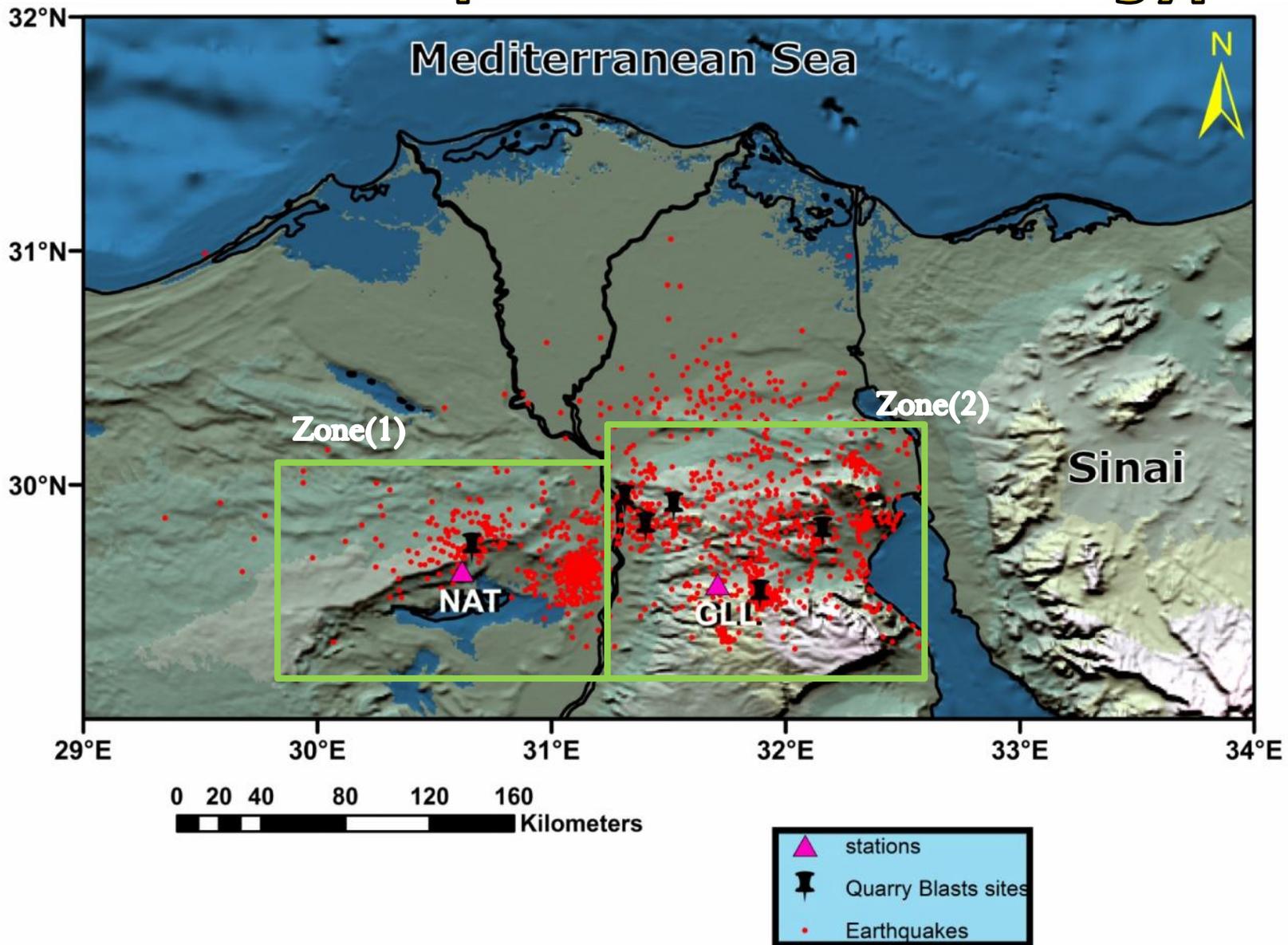
Decontamination of Microearthquake catalogue from quarry blasts in Northern Egypt

By
Walid Farid Ahmed

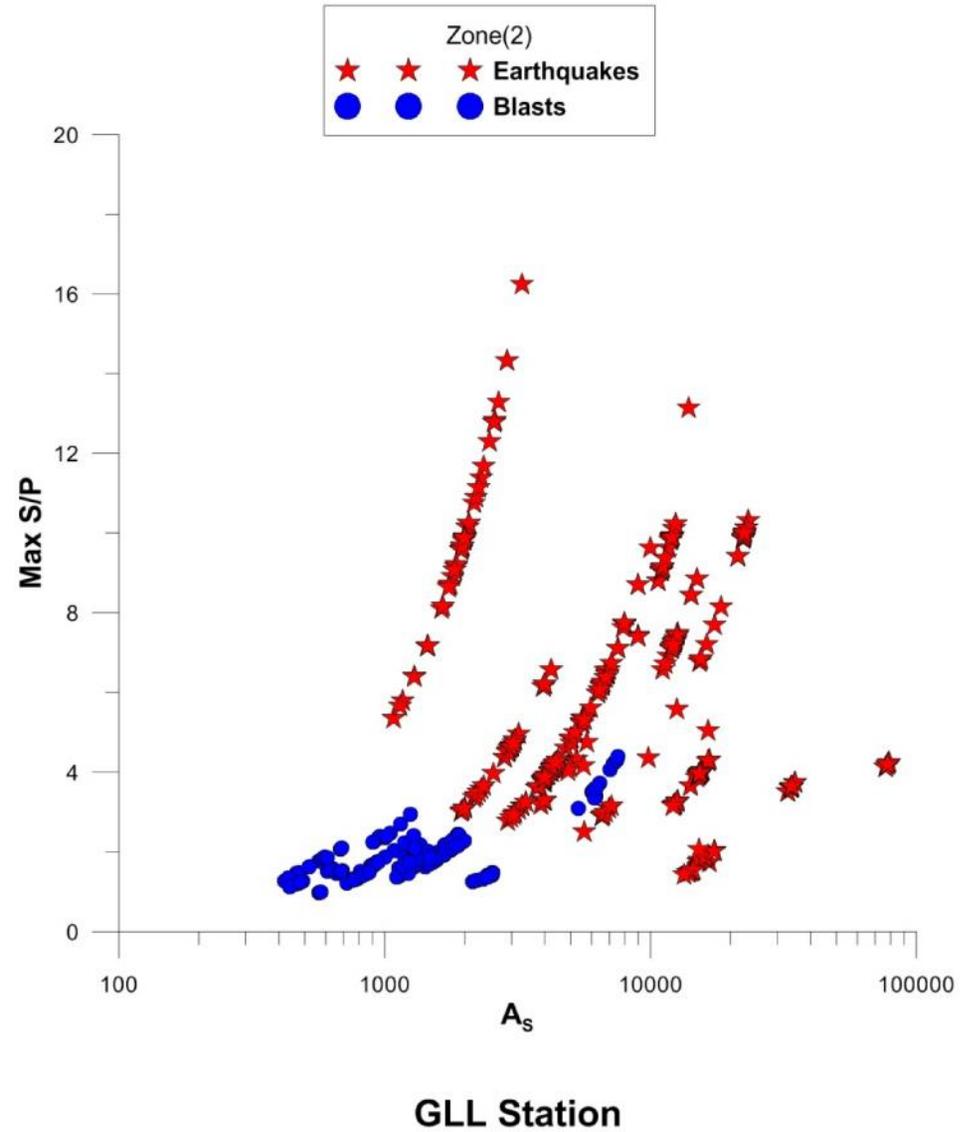
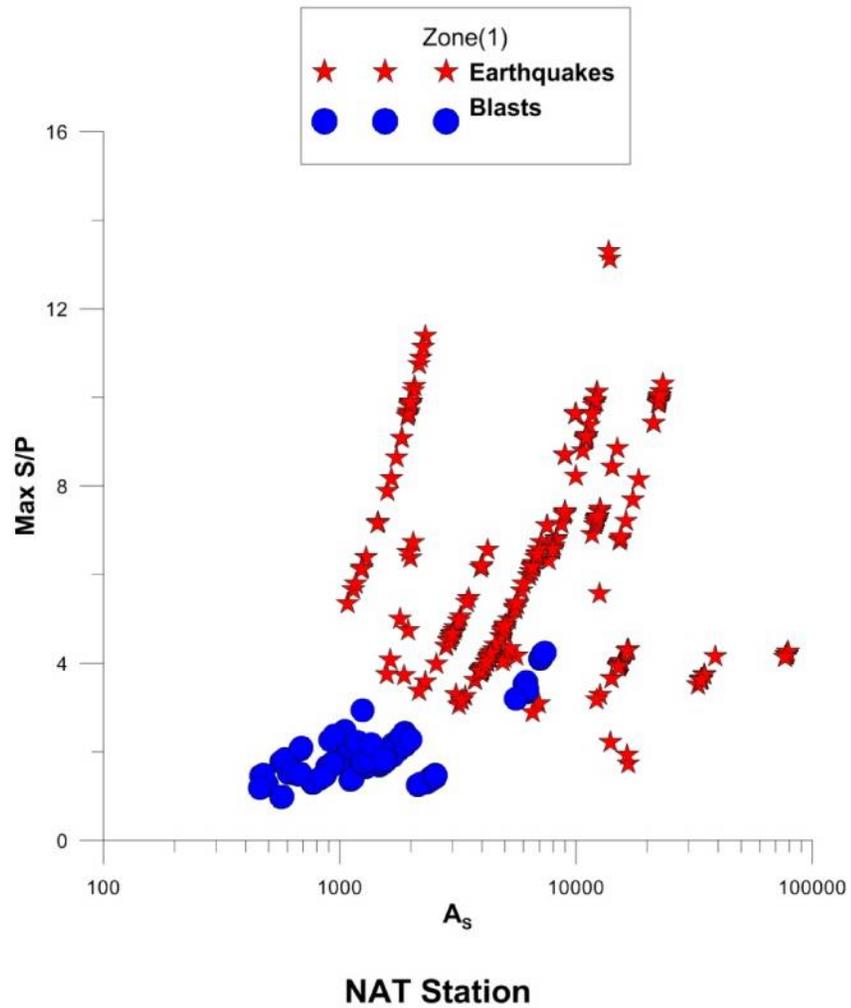
Assistant Researcher
Egyptian National Seismological Network (ENSN)
National Research Institute of Astronomy and Geophysics (NRIAG)
Egypt

E-mail: walid_farid2003@yahoo.com

Microearthquakes of Northern Egypt



S/P wave amplitude peak ratio

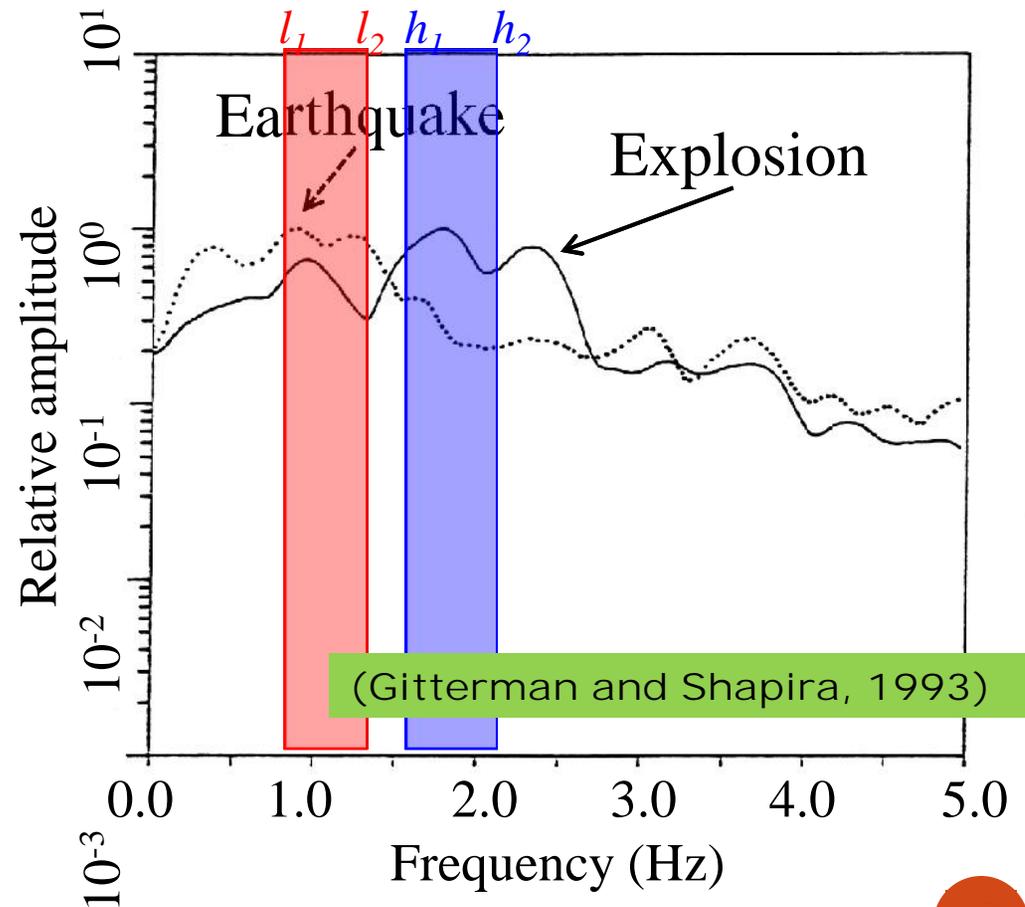
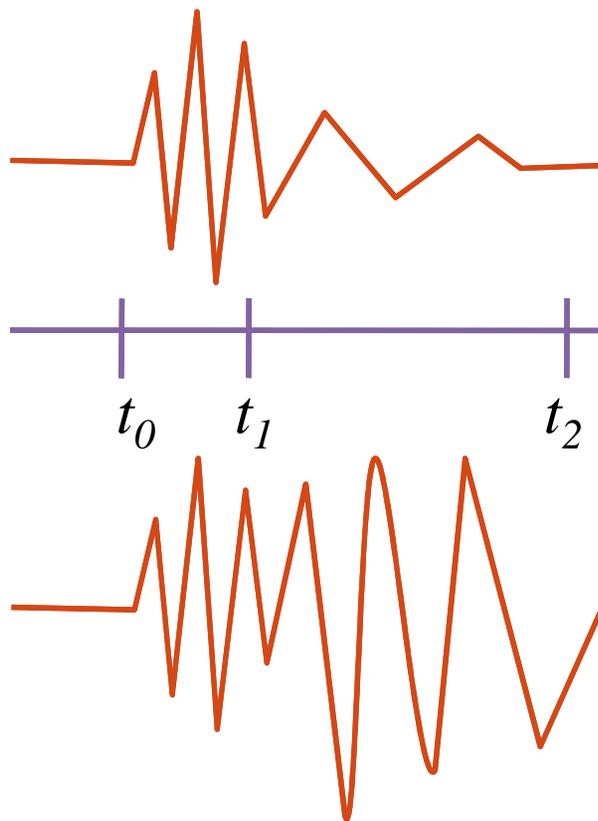


Complexity and Spectral amplitude ratio analysis

$$C = \frac{\int_{t_1}^{t_2} s^2(t) dt}{\int_{t_0}^{t_1} s^2(t) dt}$$

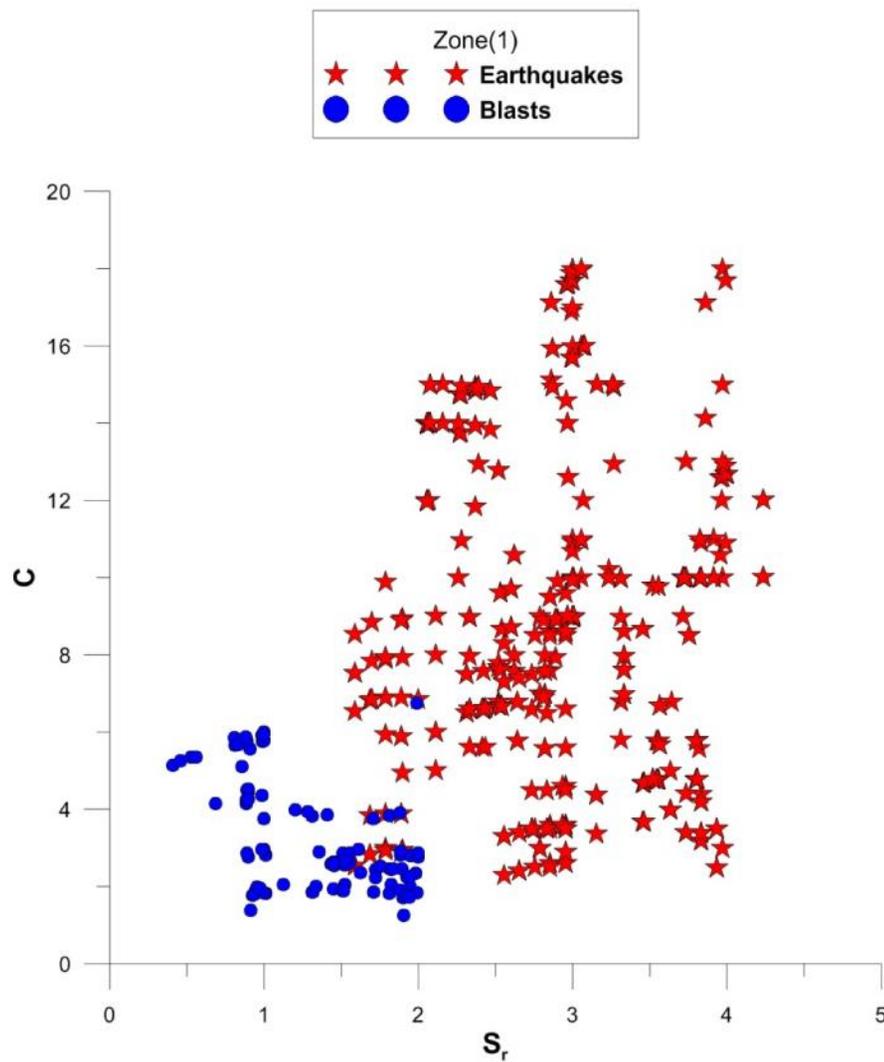
$$SR = \frac{\int_{h_1}^{h_2} A(f) df}{\int_{l_1}^{l_2} A(f) df}$$

(Arai and Yosida, 2004)

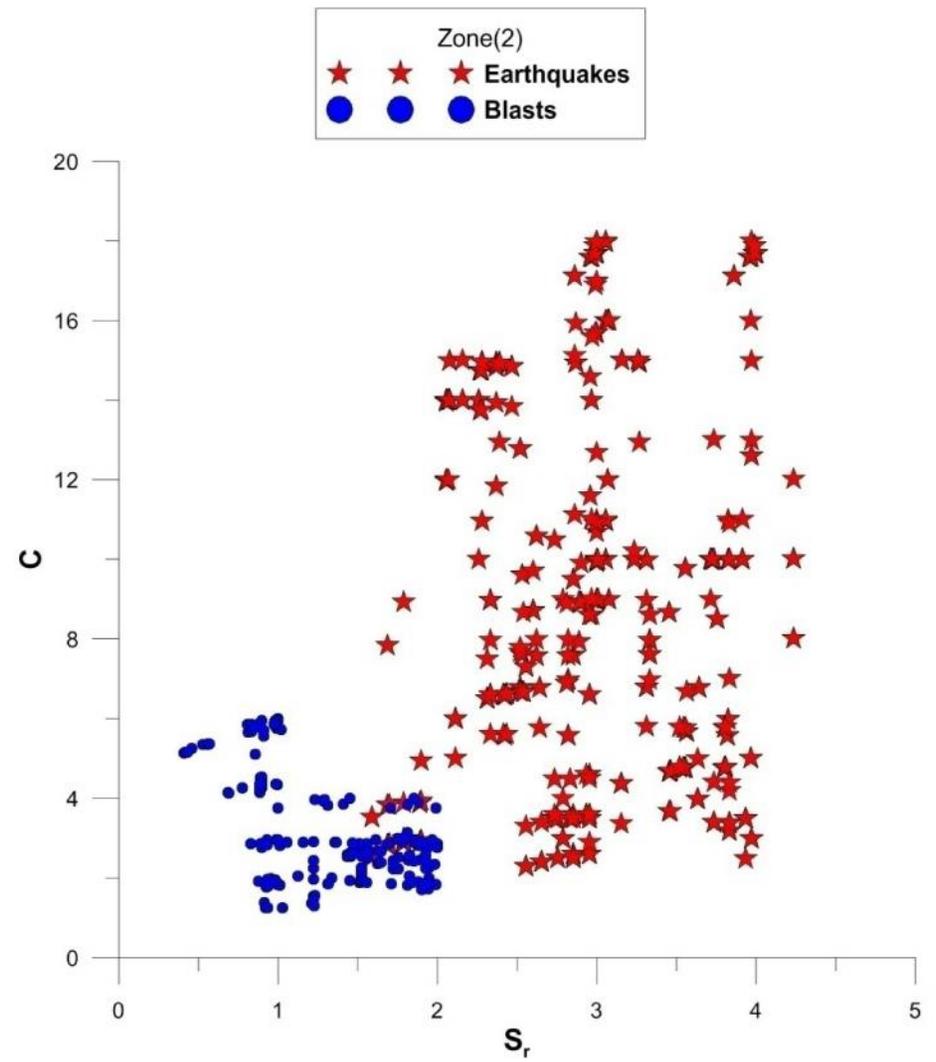


(Gitterman and Shapira, 1993)

Complexity and Spectral amplitude ratio analysis



NAT Station

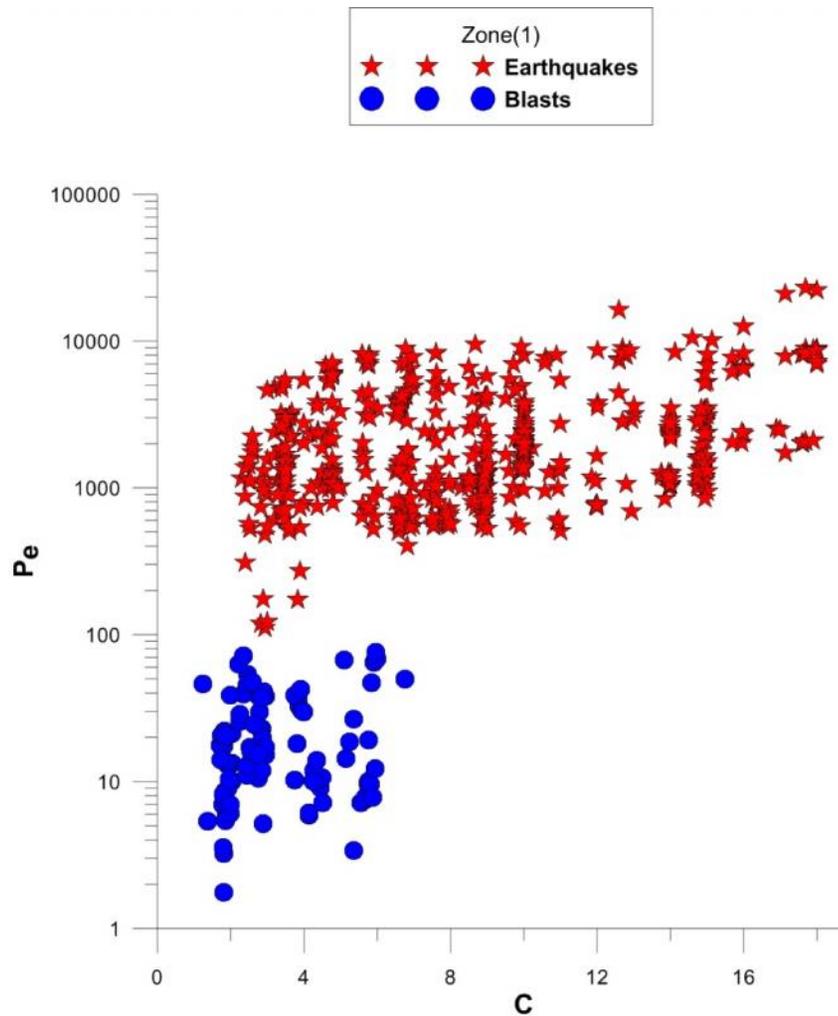


GLL Station

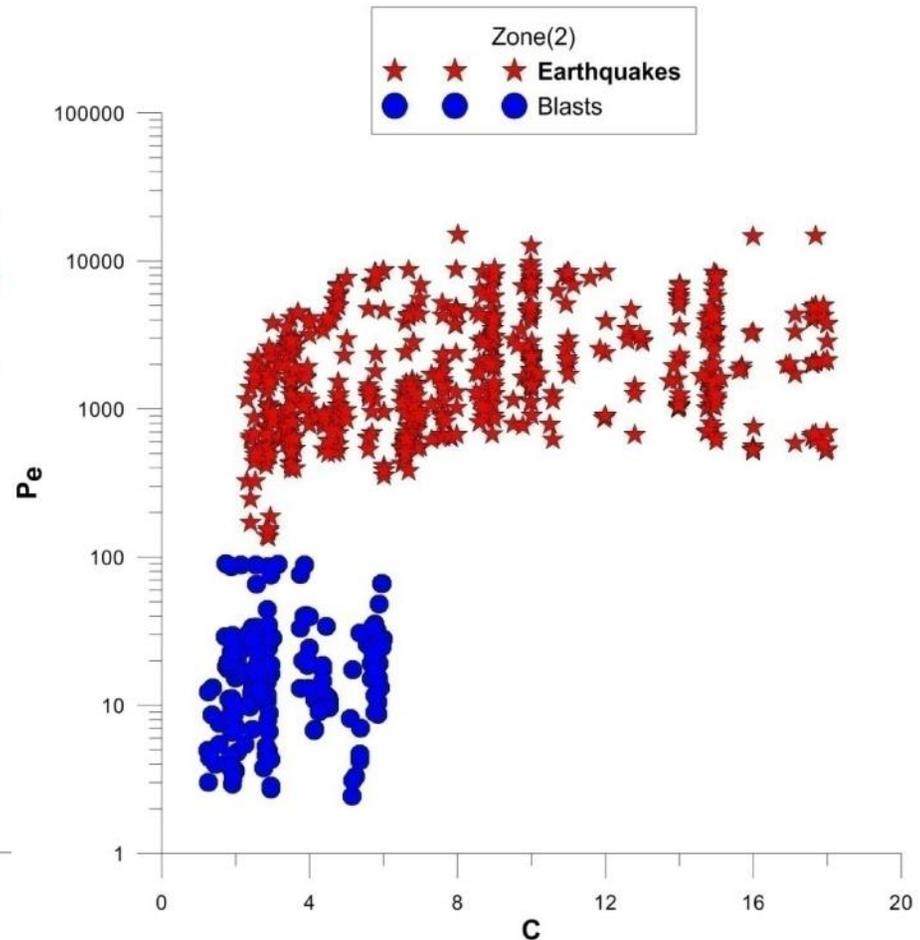
Multi- parameter discrimination; Pe (Power of event) analysis

$$Pe = (R_{S/P})^2 \times C \times (Sr)^2$$

(Kekovali et al., 2012)

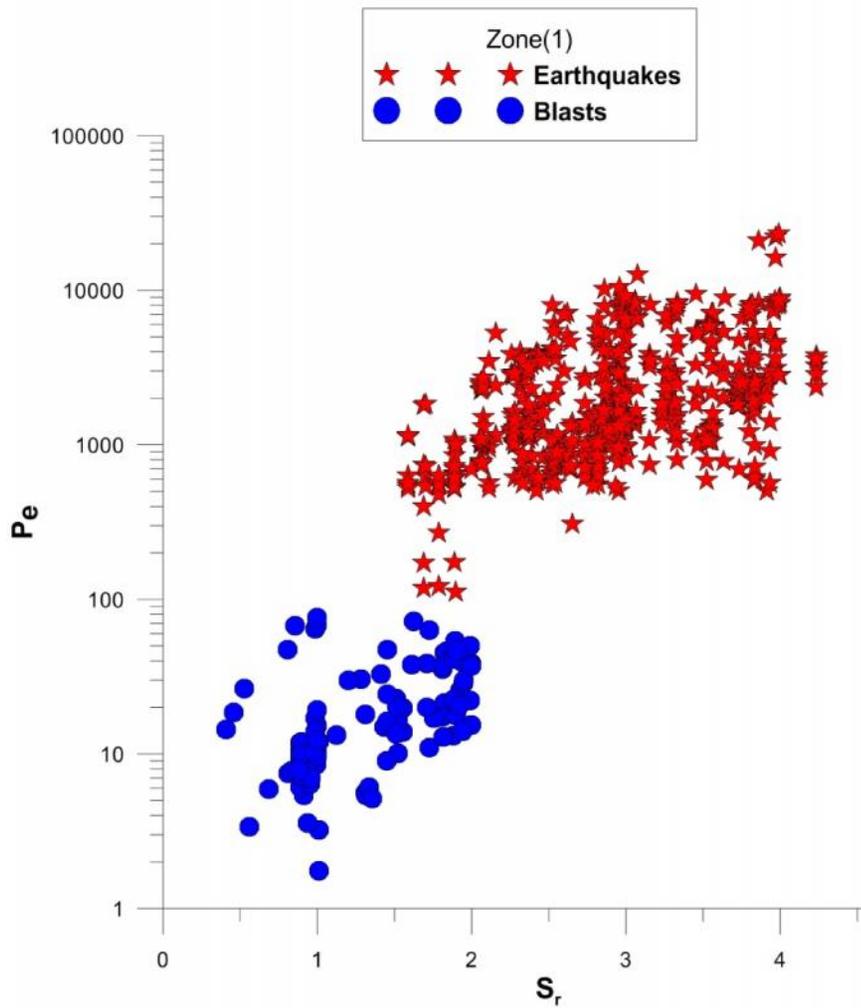


NAT Station

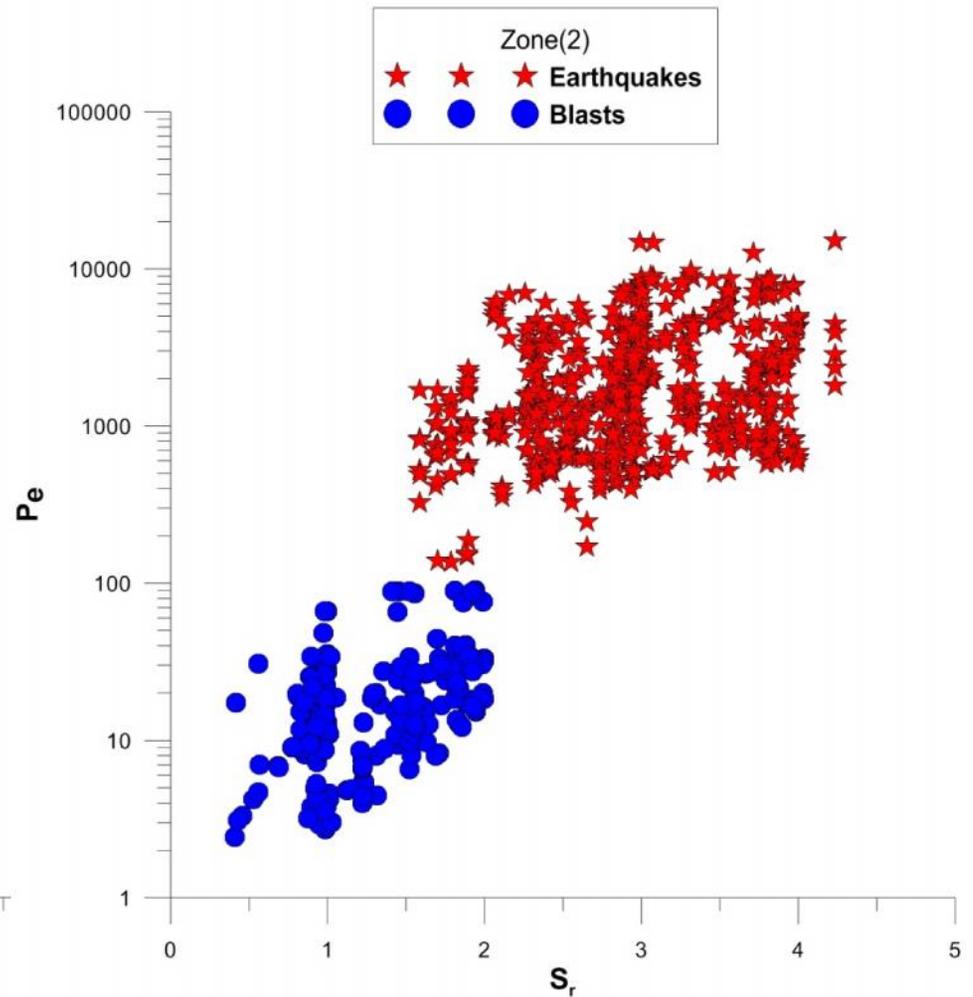


GLL Station

Multi-parameter discrimination; Pe (Power of event) analysis

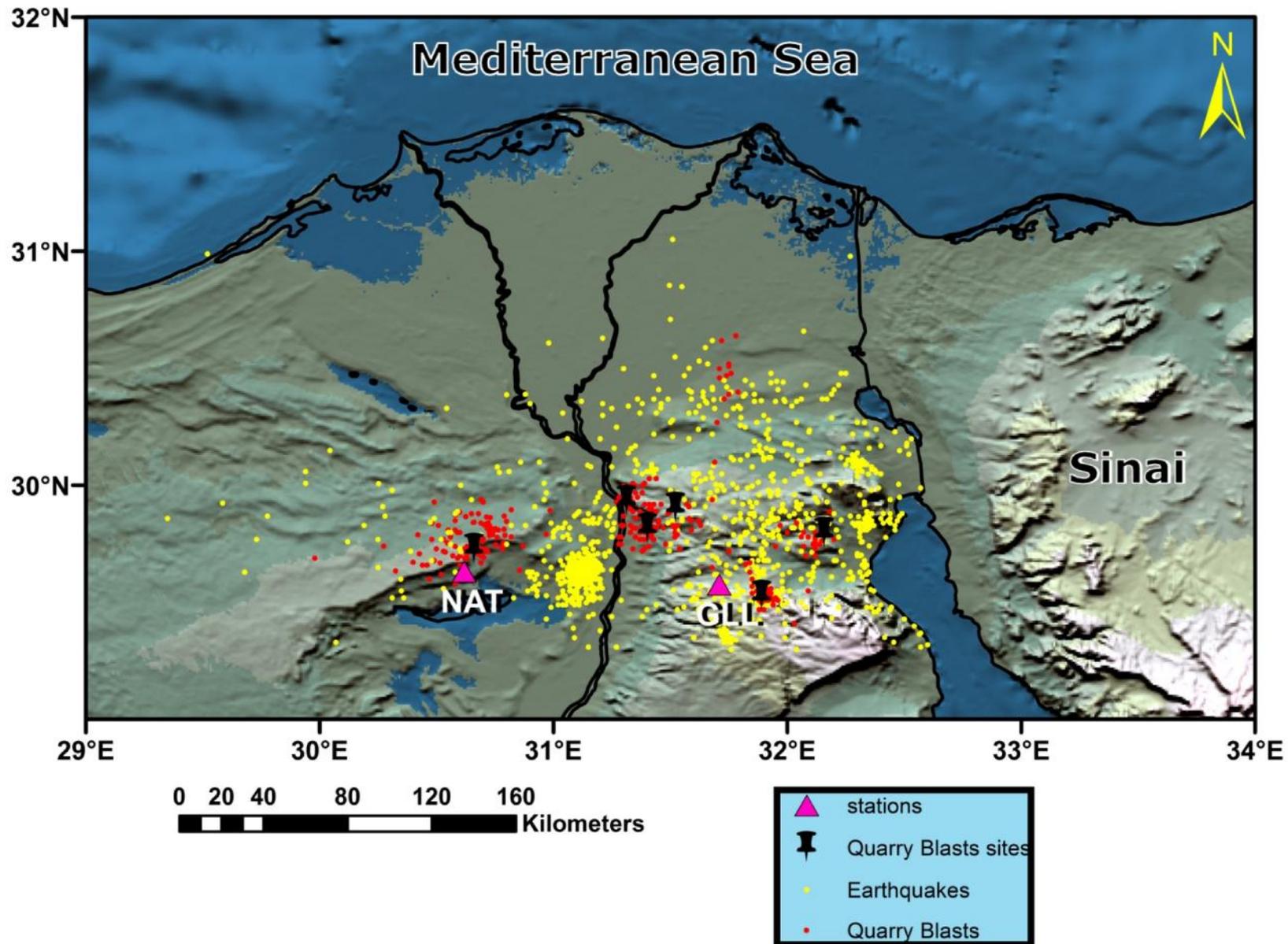


NAT Station



GLL Station

After Decontamination



Conclusion

| No. | Zone (1) | Zone (2) |
|----------------|----------|----------|
| Initial events | 605 | 876 |
| Earthquakes | 503 | 679 |
| Blasts | 102 | 197 |

Thanks For Your Attention



Focal mechanism solutions in Egypt

- The focal mechanisms of earthquakes in and around Egypt are calculated for the period 2012 -2016 with local magnitude ≥ 3.5 .
- Data source:

The digital waveform data were extracted from the database of :

- Egyptian National Seismological Network (ENSN)
- International Data Center (IDC)
- International seismological center (ISC)



- Methods:

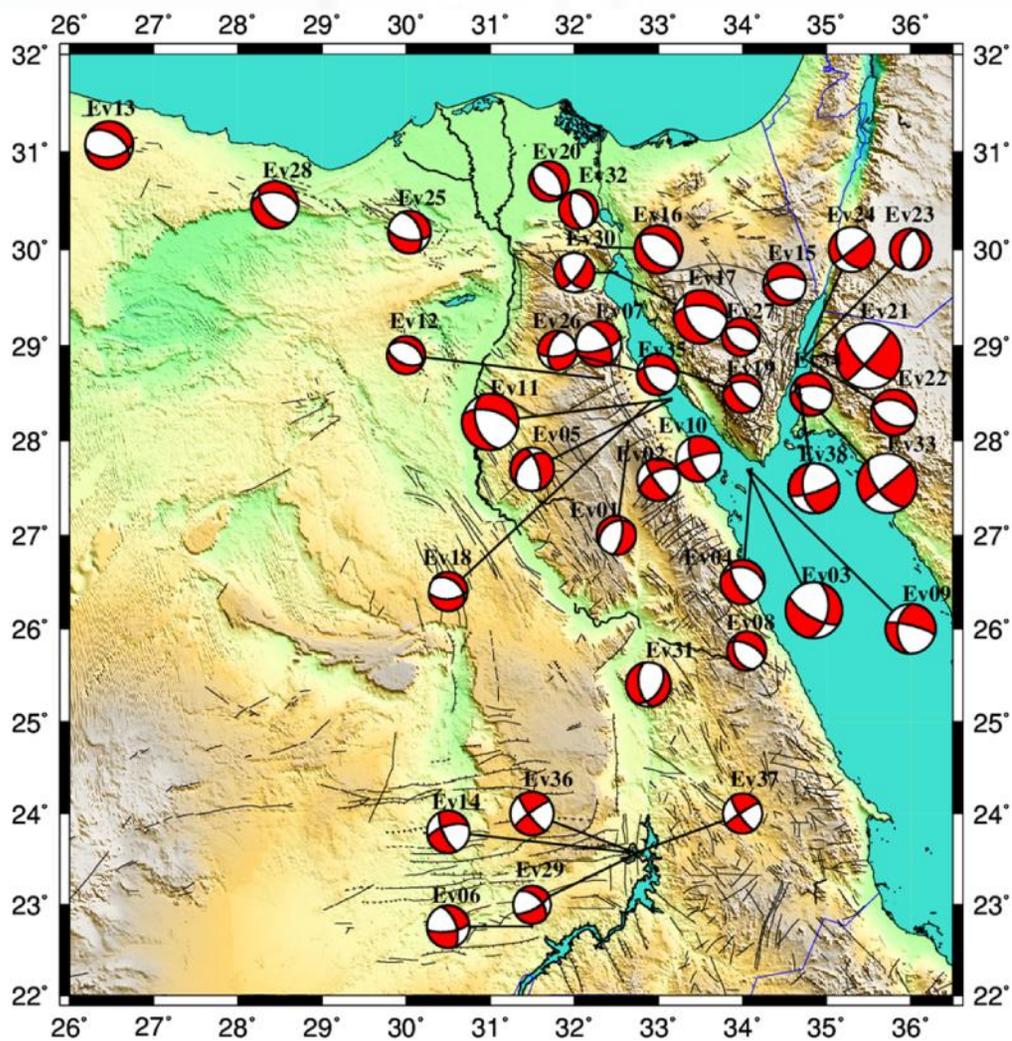
In this study we depend on two software:

- PMAN software
- FOCMEC software

PMAN software is used to obtain an initial focal mechanism solution. FOCMEC software is used to add more information to make the obtained solutions more reliable solutions such polarities of \mathbf{S}_V , \mathbf{S}_H , and spectral amplitude ratios of \mathbf{S}_V/\mathbf{P} , \mathbf{S}_H/\mathbf{P} and $\mathbf{S}_V/\mathbf{S}_H$.



- Quality control :
- An accepted solution was required to have:
- At least ten polarity readings.
- Azimuthal coverage of station readings on the focal sphere greater than 90° .
- A total sum of the values (points) of the reliability estimators of at least fair (9–11 points), where good solutions (5–8 points) were given less weight and poor solutions (12–15 points).

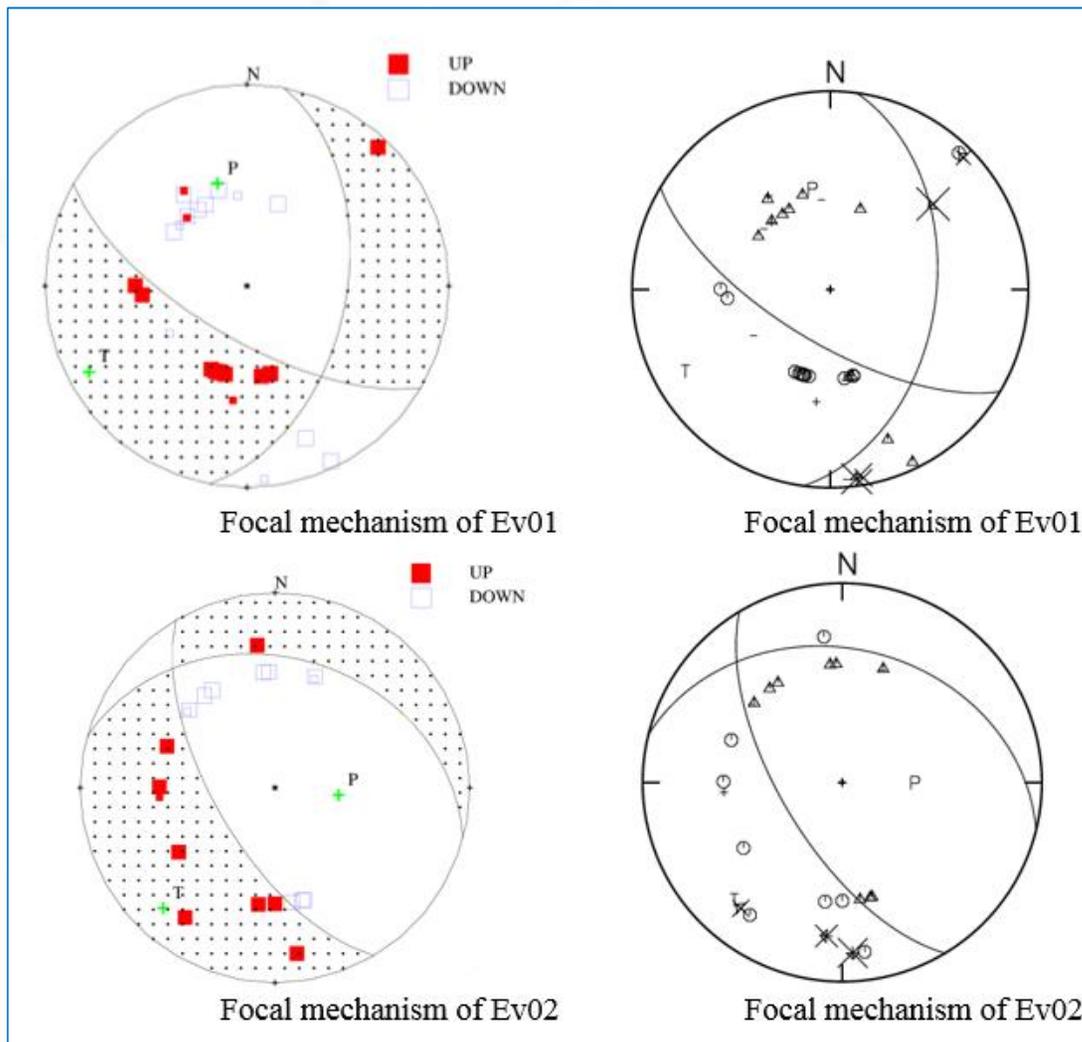


Focal mechanism solutions for earthquakes in Egypt during the period from 2012 to 2016

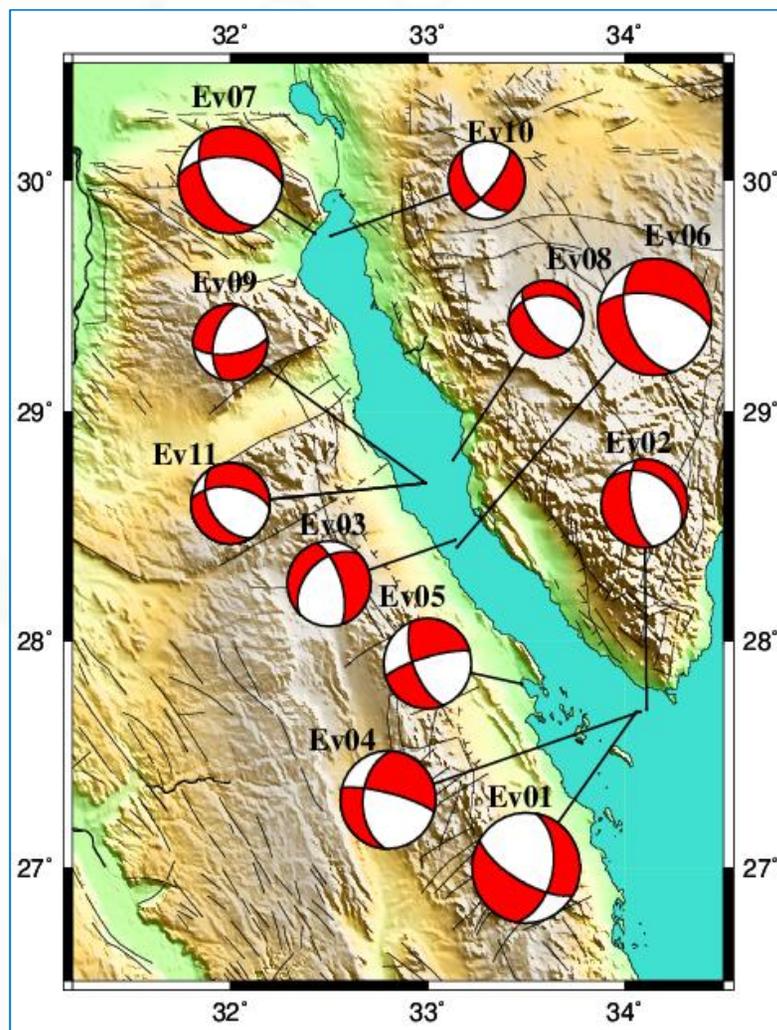


Focal mechanism in Gulf of Suez region

| Ev.no | Date | | | Time | | | Location | | H(Km) | ML | Mechanism | | | | | | P-axis | | T-axis | |
|-------------|------|-------|-----|------|---------|---------|----------|-------|-------|------|-----------|------|-------|---------|------|-------|--------|------|--------|------|
| | Year | Month | Day | Hour | Minutes | Seconds | Lat | Long | | | Strike1 | Dip1 | Rake1 | Strike2 | Dip2 | Rake2 | az | pl | az | pl |
| Ev01 | 2012 | 1 | 30 | 17 | 4 | 26.35 | 27.69 | 34.06 | 9.59 | 5.18 | 120 | 69 | -135 | 11 | 49 | -29 | 343.9 | 46.1 | 241 | 12.3 |
| Ev02 | 2012 | 6 | 2 | 8 | 13 | 56.68 | 27.70 | 34.11 | 9.08 | 4.14 | 169 | 65 | -67 | 285 | 33 | -129 | 96.1 | 62.7 | 222 | 16.9 |
| Ev03 | 2013 | 1 | 22 | 0 | 35 | 52.42 | 28.44 | 33.14 | 15.95 | 3.99 | 225 | 44 | -36 | 343 | 66 | -127 | 206.4 | 52.9 | 99.1 | 12.7 |
| Ev04 | 2013 | 4 | 7 | 15 | 58 | 1.86 | 27.69 | 34.08 | 17.35 | 4.57 | 183 | 46 | -16 | 284 | 79 | -135 | 154.2 | 39.2 | 46.5 | 20.6 |
| Ev05 | 2013 | 4 | 11 | 3 | 56 | 9 | 27.81 | 33.48 | 19.53 | 4.22 | 158 | 64 | -13 | 253 | 78 | -153 | 118.6 | 26.9 | 23.7 | 9.61 |
| Ev06 | 2013 | 6 | 1 | 11 | 49 | 28.87 | 28.42 | 33.15 | 13.31 | 5.45 | 160 | 50 | -43 | 282 | 58 | -131 | 136.0 | 56 | 39 | 5 |
| Ev07 | 2014 | 7 | 22 | 3 | 3 | 44.99 | 29.77 | 32.43 | 22.13 | 4.99 | 149 | 51 | -49 | 274 | 54 | -130 | 124 | 59 | 31 | 1 |
| Ev08 | 2015 | 6 | 10 | 6 | 48 | 23.71 | 28.79 | 33.13 | 16 | 3.6 | 141 | 63 | -62 | 272 | 39 | -132 | 96 | 61 | 149 | 13 |
| Ev09 | 2015 | 8 | 6 | 6 | 16 | 52 | 28.69 | 32.99 | 15.2 | 3.57 | 83 | 65 | -41 | 193 | 53 | -148 | 43 | 46 | 140 | 7 |
| Ev10 | 2015 | 12 | 1 | 0 | 59 | 53.85 | 29.76 | 32.51 | 19 | 3.65 | 142 | 54 | -158 | 39 | 72 | -38 | 355 | 39 | 11 | 94 |
| Ev11 | 2016 | 9 | 8 | 0 | 26 | 50.78 | 28.69 | 32.99 | 18 | 3.78 | 148 | 47 | -49 | 277 | 56 | -125 | 131 | 61 | 31 | 5 |



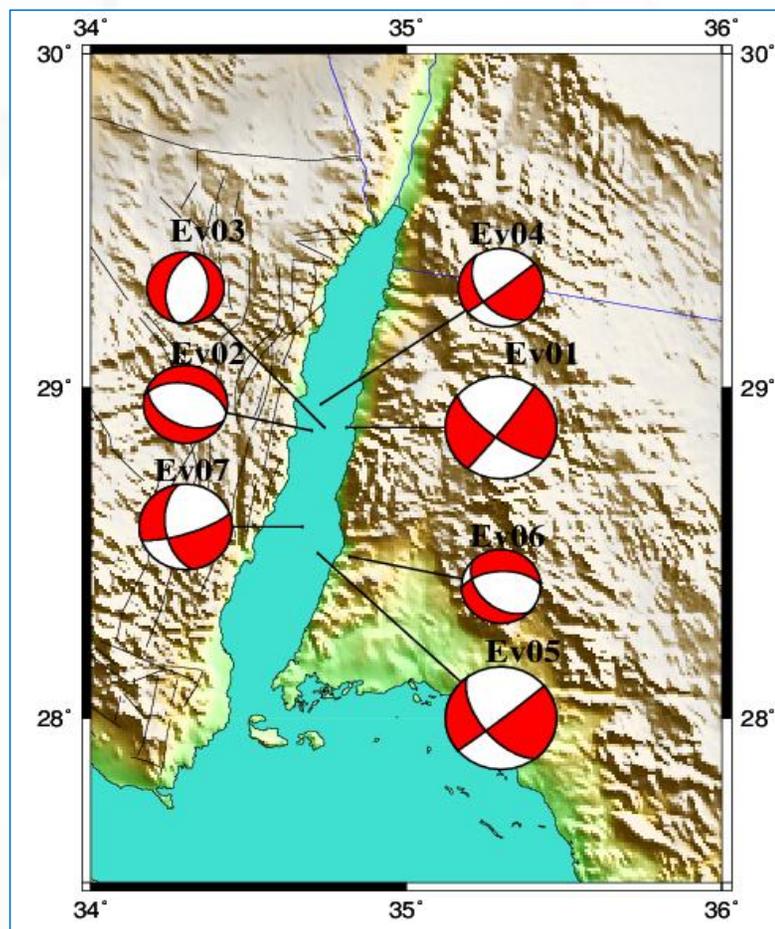
Fault plane solutions for earthquakes in the Gulf of Suez region



Fault plane solutions for earthquakes
in the Gulf of Suez region.

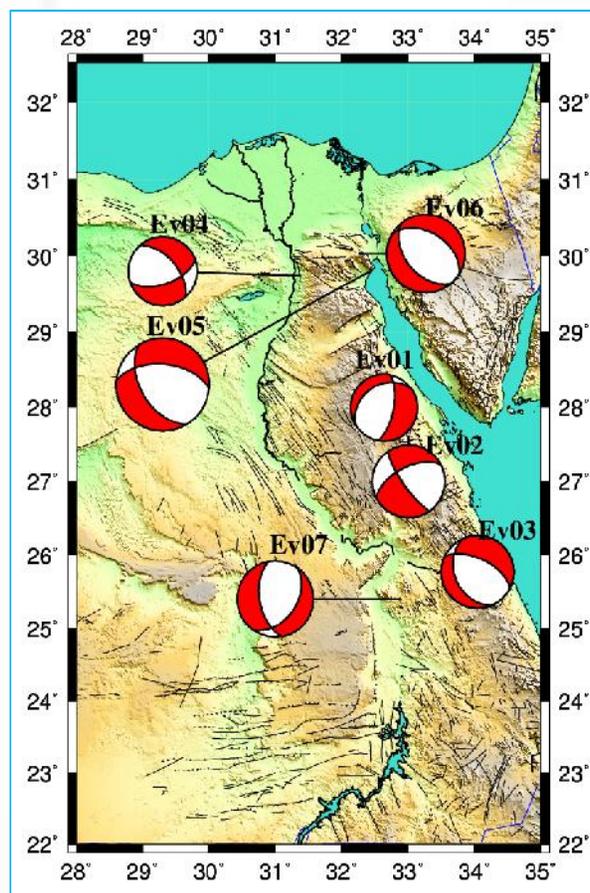


Focal mechanism in Gulf of Aqaba region



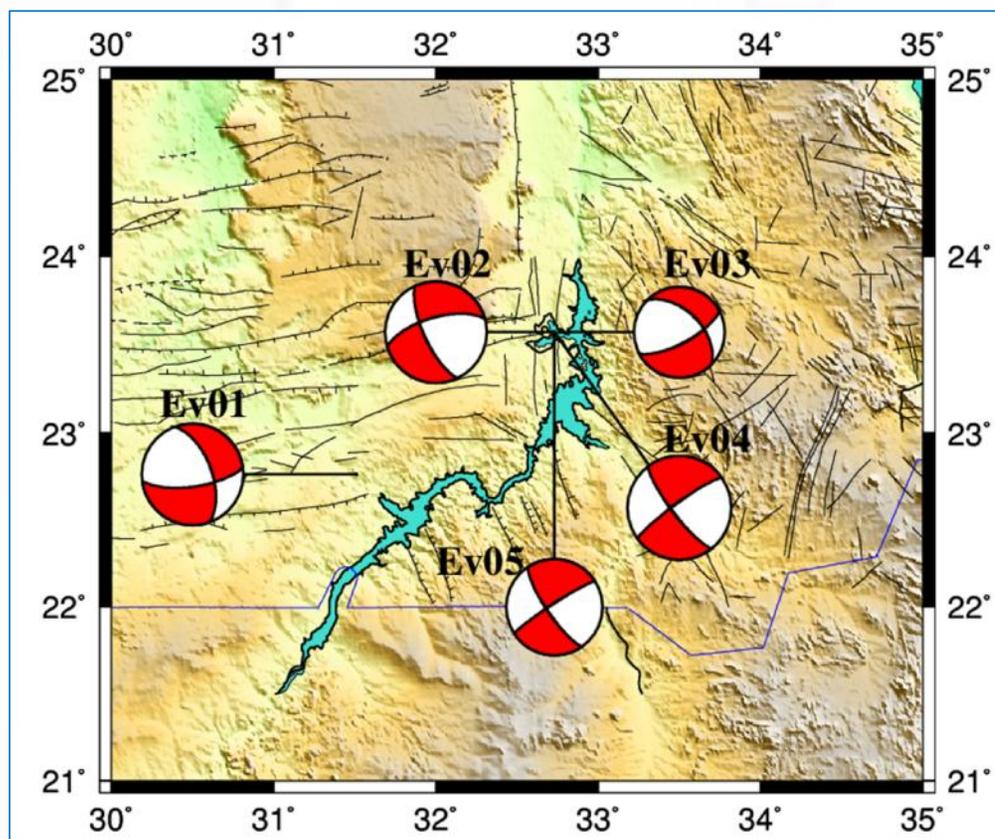


Focal mechanism in Eastern desert



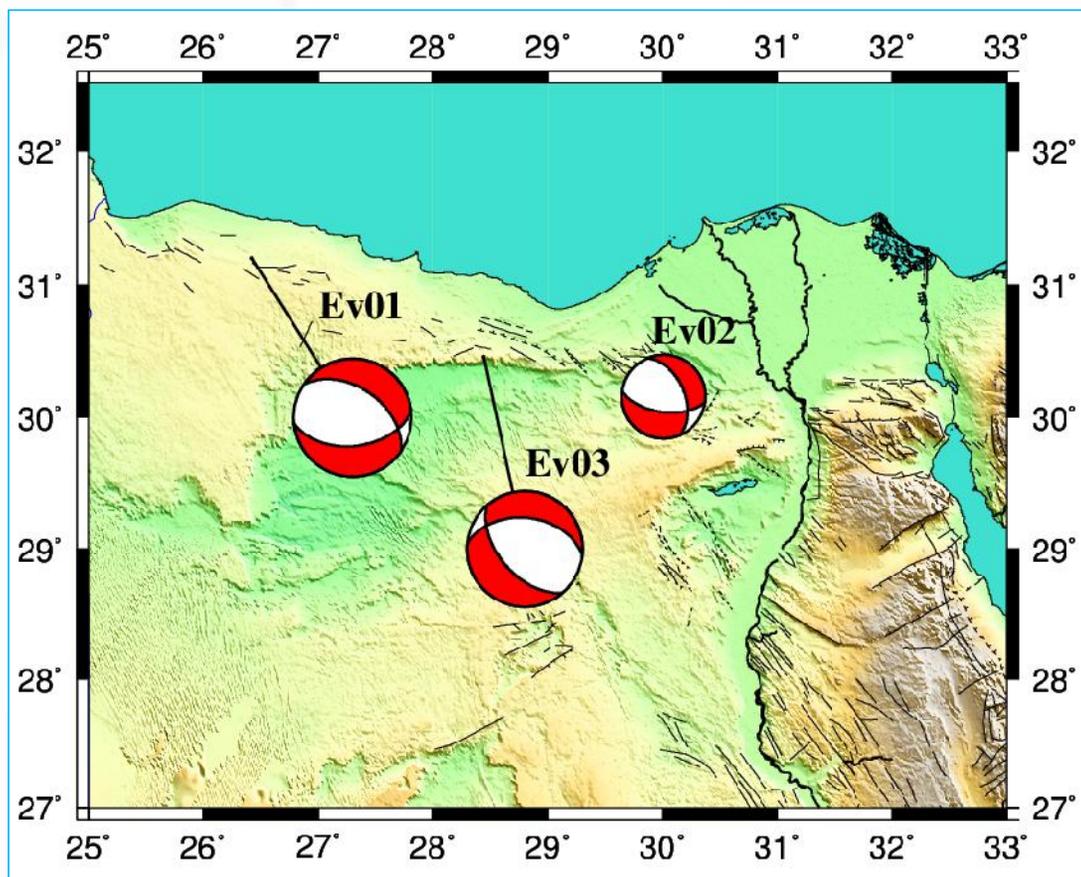


Focal mechanism solutions at Aswan region





Focal mechanism in Western desert





Focal mechanism in Sinai region

