Updating the Egyptian Earthquake Source Parameters Database

Mona Abdelazim[(1)], Hesham Hussein[(1)], Mohamed ElGabry[(1)], Mohamed M. Gobashy[(2)] and Mohamed H. Khalil[(2)]
(1)National Research Institute of Astronomy and Geophysics, 11421 Helwan, Egypt
(2) Cairo University, Faculty of Science, Geophysics Department, Giza, Egypt

SnT 2019 CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

T1.2-P118

Abstract

Focal mechanism and source parameters are essential input for many seismological applications including source characterization, discrimination, and Seismic Hazard Assessment. In this study, we constructed new database of the updated Earthquakes Focal Mechanism and Source Parameters for Egypt. Data coverage for the catalogue extends from 2012 to 2018 including events with Magnitude ≥ 3.5. The catalogue compromise quality weighted Focal mechanism Solution and different source parameter including seismic moment, fault radius, corner frequency, stress drop, and moment magnitude. The database is regularly updated with the solution for events with magnitude using data from Egyptian National Seismological Network (ENSN), Egyptian Strong Motion Network, IMS,ORFEUS, ISC and IDC

Data sources

The digital waveform data were extracted from the database of the Egyptian National Seismological Network (ENSN). Additional information from the regional surrounding stations is also extracted as digital waveform from database of the Egyptian Strong Motion Network, International Data Center (IDC), International Seismological Center (ISC) and Incorporated Research Institutions for Seismology (IRIS). A catalogue is constructed from the different sources. The data in this catalogue are filtered to remove duplicate events from the catalogue. Unification of the magnitudes reported by the different agencies is performed in order to obtain a homogenous estimation for the size of earthquakes.

Methods

For fault plane solutions: There are several methods to calculate fault plane solutions we used :

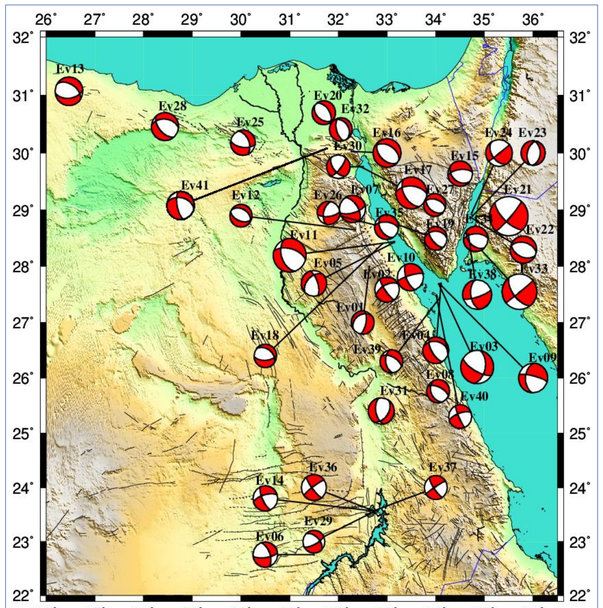
1) Polarity of first onset (**P**-wave) ***(Suetsugu, 1998)*** also polarities of S_H and S_V phase.
2) Spectral amplitude ratio of : S_V/P , S_H/P and S_V/S_H ***(Snoke et al., 1984)***

For reality of the solutions: a number of criteria are checked these criteria are quality control parameters such QP, AD, RPS, CS and CNP. ***(Salamon et al., 2003)***

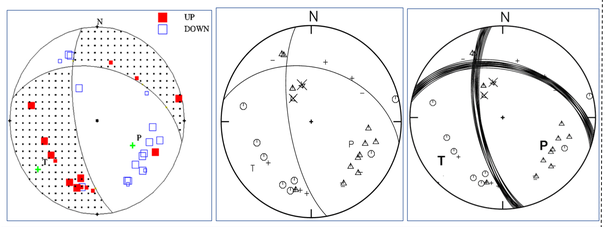
For source parameters : different source parameters are calculated such

Seismic moment *(M$_o$)* $M_o = \frac{4\pi\rho v^3 R \Omega_o}{FR_{\theta\phi}}$	**Source radius *(r)*** $r = \frac{2.34v}{2\pi f_c}$
Stress drop *(Δσ)* $\Delta\sigma = \frac{7}{16} \cdot \frac{M_o}{r^3}$	**Average displacement across the fault *(d^o)*** $d_o = \frac{M_o}{\pi\rho V_S^2 r_o^2}$
Moment Magnitude *(M$_w$)* $M_w = 2/3 \log_{10}(M_o) - 10.73$	
Mean value $\langle x \rangle = \text{anti log}\left(\frac{1}{N_s}\sum_{i=1}^{N_s} \log x_i\right)$	**Multiplicative error factor** $E_x = \text{anti log } (SD[\log \langle x \rangle])$
Standard deviation $SD\ [\log\langle x \rangle] = \left[\frac{1}{N_s - 1}\sum_{i=1}^{N_s} (\log x_i - \log\langle x \rangle)^2\right]^{\frac{1}{2}}$	

Focal mechanism solutions



Map shows distribution and fault plane solutions for earthquakes in Egypt in the period from 2012 to 2018



Example for focal mechanism solution for one event : Left drawing represent mechanism by first polarity, middle one represent polarities with amplitude ratios and the right one represent the accepted solutions which enter in the evaluation of solution

Table 1: The list for criteria of quality control (**Salamon et al., 2003**)

Quality parameter		weight		
		1, good	2, fair	3, poor
QP	Range of solution	20° >	20° ≤ QP ≤40°	40° <
AD	Azimuthal distribution	180° <	180°>AD > 90°	90° >
RPS	Reversed polarity stations	10 percent >	10 % ≤ RPS ≤ 30 %	30 % <
CS	Critical stations	0	1 ≤ CS ≤ 4	4 <
CNP	Constraint on nodal planes	CNP=2	CNP=1	CNP=0

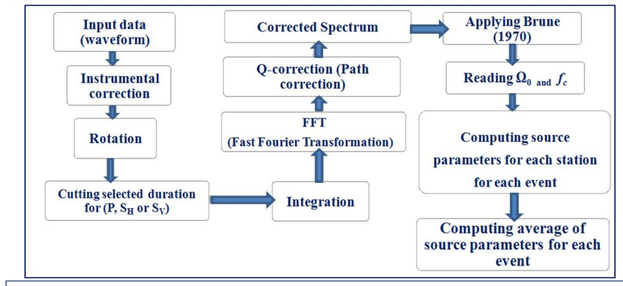
Table 2: Examples for some earthquakes which evaluated and checked by applying quality control parameters

Quality parameters (1 = good, 2 = fair, 3 = poor)									
Event no	QP			AD	Data		CS	CNP	Total
	Strike	Dip	Rake		NPU	RPS			
1	6.3	0.6	1.4	221	26	5	0	1	6
	1			1	1		1	2	
2	2.4	6.2	1.8	209	20	0	0	2	5
	1			1	1		1	1	
3	1.2	2.9	0.4	292	22	1	0	2	5
	1			1	1		1	1	
4	3.2	1.0	5.9	229	38	1	0	2	5
	1			1	1		1	1	
5	2.6	0.9	1.3	283	27	0	0	2	5
	1			1	1		1	1	

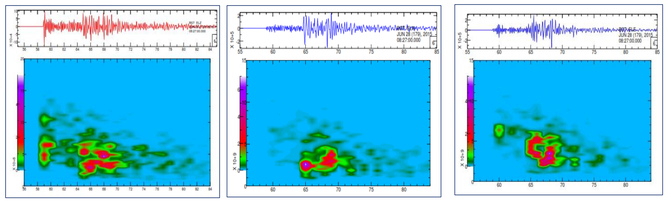
NPU: number of polarities used in the focal mechanism solutions.

RPS: reversed polarity stations = number of inconsistent polarities.

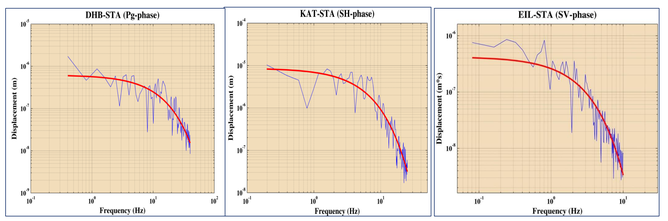
Earthquakes Source parameters



Flow chart show that steps processing to perform source parameters



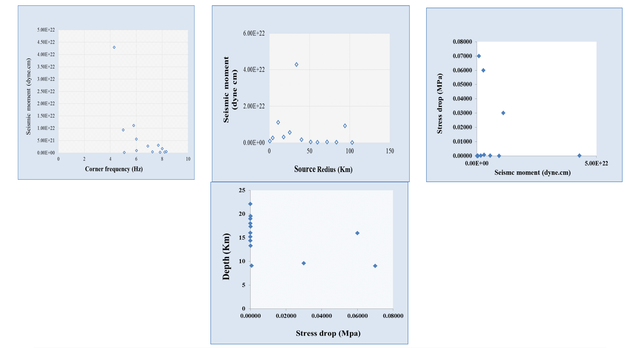
Spectrogram for different components of station to detect the best duration for different phases



Displacement spectra for different stations the blue line show the spectrum and red line show fitted omega-square source model curve

Table 3 : Different source parameters calculated for events in Egypt (EX: 2012-01-30_17-04-26.35 In Gulf Suez source region)

EV.NO	STA CODE	DIST(Km)	AZ°	f$_0$(Hz)	Ω$_0$(cm s)	M(dyne cm)	r$_o$(Km)	Δσ(Mpa)	d$_o$(m)	Mw
Ev01	TR1	36.5	343	6.5	1.68E-04	5.49E+21	9.86	0.0041	0.0078	3.8
	TR2	83.7	337	5.5	2.62E-04	1.96E+22	8.86	0.0056	0.0097	4.1
	HRG	84.2	213	6.5	1.40E-04	1.06E+22	10.86	0.0031	0.0065	4
	KAT	92.2	356	4.8	1.60E-04	1.32E+22	13.86	0.0015	0.0040	4
	MV			5.8		1.11E+22	10.7	0.03	0.007	4
	SD			± 0.06		± 0.23	± 0.08	± 0.24	± 0.16	± 0.01
	Er			1.16		1.7	1.21	1.76	1.46	1.03



Some scaling relations for calculated source parameters for events In Gulf Suez source region

Conclusions

- An updated focal mechanism and source parameters catalogue for Egypt since 2012 till 2018 is compiled.
- Most of earthquakes in Egypt have been dominated by extensional stress regime which give pure normal faults, normal faults with strike slip component (oblique) and strike slip faults. Where, Pure normal faults exist in Gulf of Suez and Nile Valley source regions. The combination between normal faults and strike slip components is observed when moving toward the west. Strike slip faulting mechanism exists only in Aswan source region.
- By applying quality control parameters on the previous solutions , the results show that these solutions are of good quality.
- Studying earthquakes source parameters and mechanisms for these earthquakes enabled us to extract important parameters which are essential for many studies such seismic hazard, source discrimination and source mechanics

References

- **Salamon, A., Hofstetter, A., Garfunkel, Z., Ron, H., (2003).** Seismotectonics of the Sinai subplate—the eastern Mediterranean region. Geophys. J. Int. 155, 149– 173.
- **Snoke JA, Munsay JW, Teague AG, Bollinger GA (1984).** A program for focal mechanism determination by combined use of polarity and S_V-P amplitude ratio data. Earth Notes 55(3):15.
- **Suetsugu, D., (1998).** Practice on source mechanism, IISEE Lecture Notes, 104 pp.

Disclaimer: The views expressed on this poster are those of the author and do not necessarily reflect the views of NRIAG nor the CTBTO