EARTHQUAKE SOURCE PARAMETERS OF MODERATELY EARTHQUAKE IN THE SOUTH EASTERN IRAN BASED ON TELESEISMIC AND REGIONAL DISTANCES

M. Mostafazadeh[1] and S.Ashkpour Motlagh[2]

[1] *Assistant Professor,Seismology Research Center of IIEES, I. R..Iran*
[2] *PhD student, Seismology Research Center of IIEES, I. R..Iran*
Email: mehrdad@iiees.ac.ir, s.ashkpoor@iiees.ac.ir

ABSTRACT :

Regional and teleseismic determination of body wave (S) spectra, interpreted in terms of the circular seismic source model, are used to estimate the parameters of March 13, 2005 earthquake that is occurred in south east of Iran. The results as follows: the seismic moment (Mo = 9.30 e +25 dyn-cm) , corner frequency (fo= 0.35hz), source dimension (R=3.9 km) and stress drop ($\Delta\sigma$= 0.26 $\times 10^4$ bar). Comparison between our results and Harvard CMT solution data show that it has some difference between common parameters. Especially the depth value reported by Harvard is 24 km greater than our result (CMT depth =56 km). Besides we can see some discrepancy between seismic moment parameters (Harvard data is Mo =1.17 e +25 dyn-cm). Scatter in the seismic moment values is caused by such factors as the site conditions and errors in the radiation pattern corrections.

KEYWORDS: Source parameter, spectra, southeast Iran

1. INTRODUCTION

Much of the mechanical deformation resulting from Arabia-Eurasia collision is accommodated in Iran plateau. On March 13, 2005, a large earthquake (M_W= 6.0) occurred in southeastern Iran (Fig. 1). Study of instrumentally earthquake records show that some of the large earthquakes with magnitude greater than 6 had occurred in south east of Iran during the past 30 years.

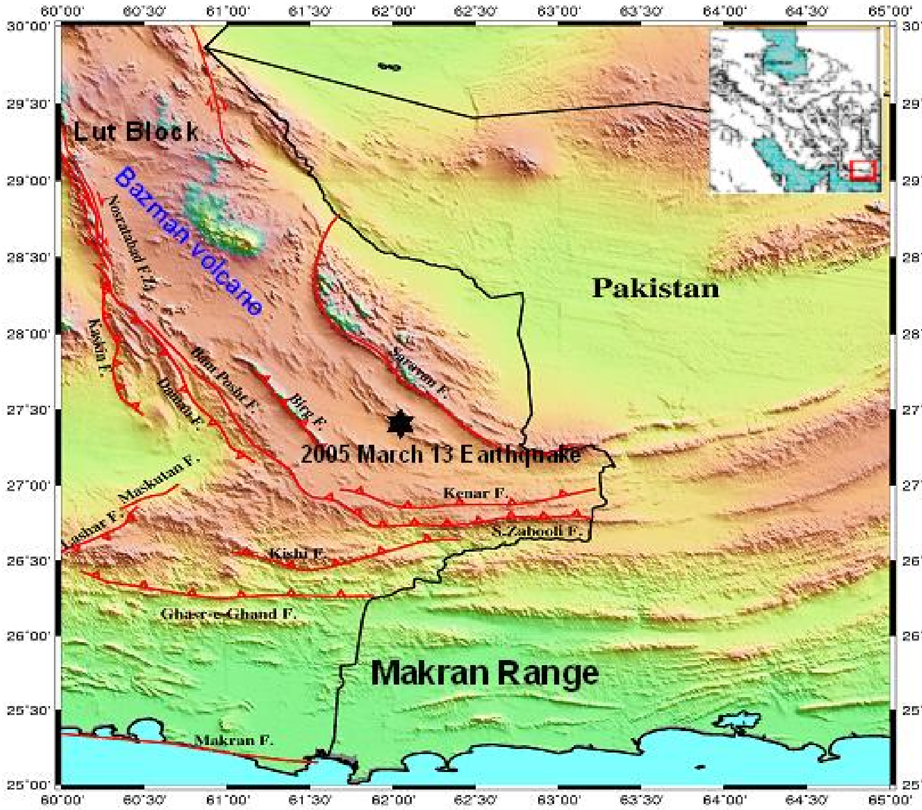

Figure 1 fault map and location of 2005 March 13 earthquakes.

The principal purpose of this paper is to determine the dynamic characteristics of this earthquake through a joint analysis of teleseismic and regional data. Long period P and SH waveform stations of the Global Digital seismograph Network (GDSN) are used for the far field analysis. Our regional data are taken from digitally recording stations of the Iran National Broad- Band Seismic Network (INSN). Several investigators have studied the earthquake source by using far-field and near-field data. For example, Choy et.al (Choy, G. L., et. all., 1983), (Choy, G. L., et. all, 1988) used both types of data for the study of earthquake sources in the Northwest Territories, Canada.

There are two commonly encountered descriptions of point sources. The first is in terms of an angular description of the nodal planes in the P radiation from a purely slip motion on a fault. The second, of increasing importance, is the description of the source by the six independent components of the moment tensor, which are assumed to have common dependence on time (Kennet, B. L. N., 1988). The slip on the fault that generates the earthquake is determined by the direction of relative plate motion. The normal to the auxiliary plane then determines the direction of the slip vector. The magnitude of the slip can, in principal is determined from the scalar moment, M_O, of the earthquake, which can be obtained directly from the seismogram (Jackson, J., 1988). Body waveform modeling has become one of the most important tools available to seismologist for obtaining the strike, dip, and rake and centroid depth. In addition we can provide more information about fault-rupturing process. Teleseismic waveform modeling of earthquakes over the past ~30 years gives seismic moment precise to ~20 percent (Taymaz, T, et. all, 1991), (Taymaz, T, at. all., 1991). The seismic moment, M_O, is measure of the spectral amplitude of regional data (Bullen, K. E., & Bolt, B.A., 1985). It is related to two of the fundamental source parameters, average fault displacement, D, and fault rupture area, A, and rigidity module, μ, (Aki, K. 1966).

2. DATA ANALYSIS

In such procedures, values for earthquake moments must first be estimated by spectral analysis or integration of displacement records. In addition, methods based on coda wave analysis have been applied for moderate sized earthquakes (Aki, K., 1969), (Aki, K. and B. Chouet., 1975). The purpose of such methods is to allow the evaluation of the seismic moment using one of them, thereby reducing the need for spectral analysis. It would be preferable, of course, to base the estimation of M_O on records from broadband seismographs (Bolt, B. A. and Herraiz, M. 1983). The theoretical foundation for the proposed method comes from the well-known analytical expression derived by keilis-Borok (Keilis-Borok, V. I., 1960), and already applied to a number of earthquakes,

$$M_O = 4\pi\mu\rho\beta\Delta\Omega_0 / 2R\theta\o$$

Where μ (3.1×10^{11} dyne-cm) is rigidity, ρ (2.9 gr/cm^3) is the density β (3.7 km/sec) the shear wave velocity, $R\theta\o$ depends on the source radiation pattern (assumed 1.6, (Riznichenko, Yu. V., 1992)., Δ is the hypocentral distance from the source. The physical meaning of Ω_o is the product of pulse width and amplitude, and it is closely related to the mean value of seismic energy arriving in the time window considered (Bolt, B. A. and Herraiz, M. 1983). The corner frequency f_o was selected as the intersection of the low frequencies level (Ω_o) and a straight line that fit the spectral roll of, the slope of the lower of the two frequency bands was used.

3. ATTENUATION

The attenuation is required set of information for estimating the spectral in the regional distance. Various authors, such as Gupta and Nuttli (Gupta, I. N.and O. W. Nuttli 1976) have developed attenuation relations for specific regions and have emphasized the need for developing independent relations for other parts of the world. To determine the attenuation parameters, Q, in Iranian plateau (Nuttli, Otto. W., 1980) study about crustal phases of Iranian earthquake recorded by stations in Iran and he found 125 value for P_g, 200 for L_g, and 150 for S_n phases respectively.

The data set for computing the seismic moment comes from broad band recorded by an INSN and GDSN regional and teleseismic networks respectively. The portion of the record encompassing the body phase was windowed tapered with cosine bells in the first and last 10 per cent of the window, and then entered into a fast Fourier transform. The S wave spectrum was taken from the horizontal component which appeared to have the largest pulse-like signal, the largest moment, or the component that best fits the Brune model (Brune, J. N. 1970). The spectra were corrected for the effects of filter, and instrument response and attenuation parameter (fig.2 and fig.3). Average estimates for the multiple stations events were obtained using methods described by Archuleta (Archuleta et al., 1981). The spectral parameters as well as the letter identification of event are given in Table 1, 2.

Figure 2 Amplitude spectra that are prepared by using S wave records in regional stations.

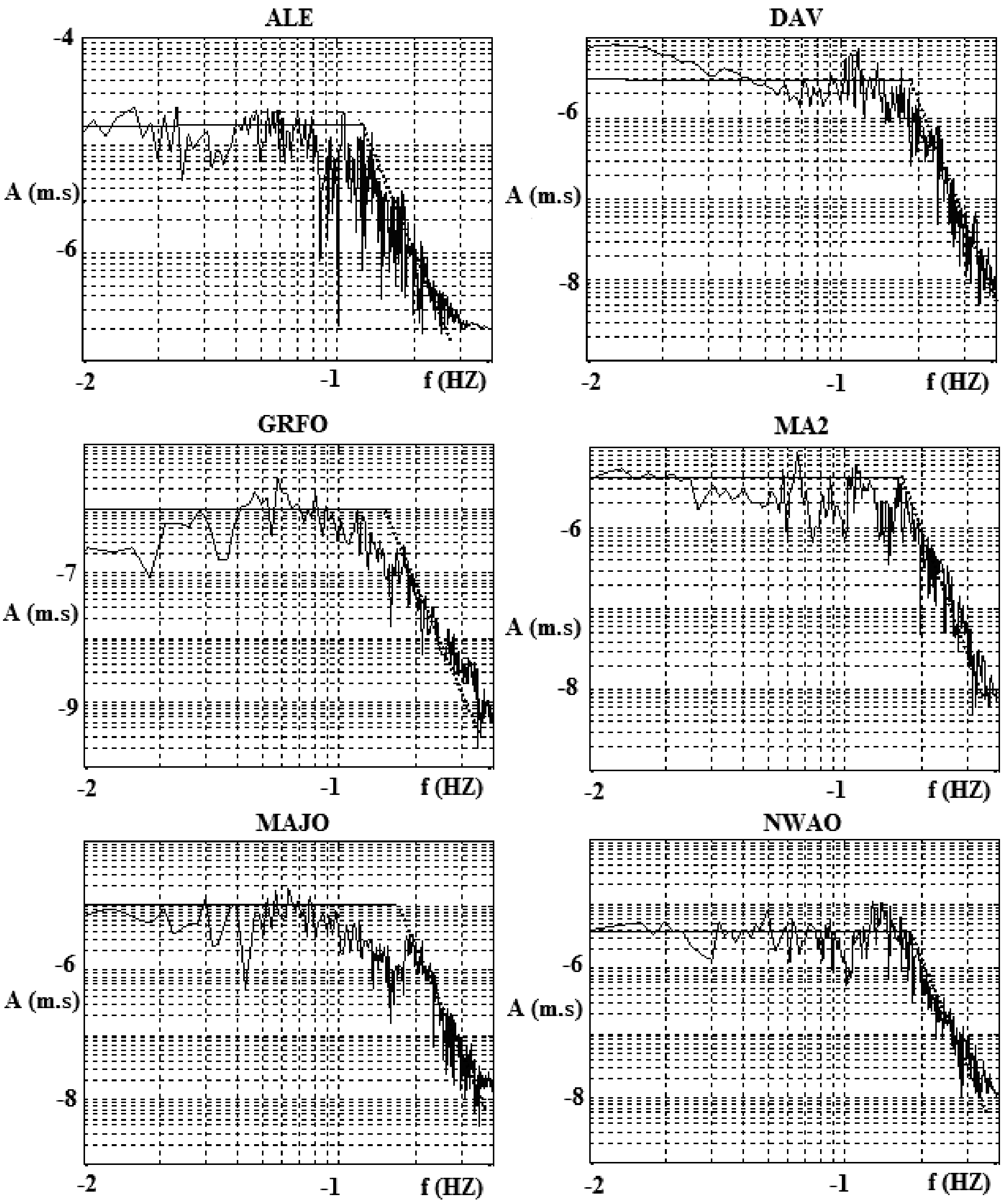

Figure 3 Amplitude spectra that are prepared by using S wave records in teleseismic stations.

4. SOURCE RADIOUS AND STRESS DROP

Source radius was calculated with Brune model (Brune, J. N. 1970) from the spectral corner frequency (Source radius $r_0 = 2.34\ \beta / 2\ \pi f_0$). Final estimates of each source radius were obtained using a linear average of the individual estimates available for that event. Stress drop was obtained by dividing the mean of the moment (M_O) estimates by the cube of the mean of the source radius (Fletcher, J. B. 1980). Estimates of Stress drop ($\Delta\sigma = 7M_O/16r^3$) and source radius and are given in Table 3.

station	Δ (×10^5 cm)	$\Omega_0 \times 10^{-1}$ (cm-sec)	M_O (10^{25}dyn-cm)	f_0 (Hz)
NASN	1390	4.24	7.698	0.30
MAKU	2430	4.40	13.966	0.24
ZHSF	265.56	0.13	0.0449	0.70
GHIR	1040	5.89	8.001	1.02
DAMV	1760	5.68	13.058	0.25
BNDS	739	7.07	9.235	0.93
ASAO	1700	6.11	13.567	0.22
SNGE	1920	3.41	8.552	0.70
SHGR	1610	4.56	9.589	0.71

Table 1: Source parameters and regional station data of the 13 March 2005 earthquake.

S-Code	**Dis(km)**	**Az(°)**	Ω_o (m.s)	**F_e(HZ)**
ALE	7310	353	1.4E-5	0.13
BILL	7723	23	9.0E-6	0.15
DAV	7512	96	3.0E-6	0.18
DGAR	3974	162	1.0E-5	0.14
GRFO	4510	314	1.0E-6	0.16
GUMO	8760	75	1.7E-5	0.16
KBS	5955	350	4.0E-6	0.14
KMBO	4305	224	8.0E-6	0.14
LVZ	4520	346	7.0E-5	0.15
MAJO	7420	61	6.0E-6	0.14
MA2	7410	34	3.03-6	0.16
MSEY	3750	192	7.0E-5	0.10
OBN	3480	334	2.8E-5	0.15
TATO	6128	78	1.6E-5	0.19
TIXI	6300	20	1.0E-5	0.15
YAK	6240	32	1.0E-5	0.17
CHTO	3896	96	1.3E-5	0.10
COLA	9490	12	7.0E-6	0.16
KONO	5350	327	6.0E-6	0.16
LSZ	5916	222	3.8E-6	0.16
MAJO	7115	60	8.0E-6	0.18
NWAO	8836	135	4.0E-6	0.18
TLY	4418	40	7.2E-5	0.10

Table 2: Source parameters and teleseismic station data of the 13 March 2005 earthquake.

Average corner frequency (f_0)	0.35 hz
Source radius (km)	3.9 km
Average seismic moment (dyne-cm)	9.30 e +25 (this study) 1.17 e +25 (CMT)
Stress drop (bar), (1bar =10^6 dyn/cm^2)	0.26×10^4

Table 3: source parameters of 13 March 2005 earthquake.

5. DISCUSSION AND CONCLUSION

We can see clearly some discrepancy between Harvard parameters and source parameters that are calculate in this study. Because for shallow earthquakes the routine Harvard CMT solutions, which low pass filter the data at 45 s period, do not accurately resolve the centroid depth. Moreover, because the CMT solution is not constrained to be a double-couple source, it often has an intermediate eigenvalue to the moment tensor that is significantly different from the zero value it would have if it were truly double-couple.

6. REFRENCES

Aki, K. (1969). Analysis of the seismic coda of local earthquake as scattered waves, J. Geophys.. Res. 74, 615-631.

Aki, K. and B. Chouet (1975). Origin of coda waves: source, attenuation and scattering effects, J. Geophys. Res. 80, 3322-3342.

Aki, K. (1966). Generation and propagation of G waves from the Niigatu earthquake of June 16, 1964, 2: estimation of earthquake moment, released energy energy, and stress strain drop from G wave's spectrum, Bull. Earthquake. Res.. Ins., Tokyo Univ. 44, 73-78.

Archuleta, R., Cranswick, E., Muller, C, and Spudich, P., (1982). Source parameters of the 1980 Mammoth Lake, Califoria Earthquake Sequence, J. Geophys. Res., 87, 4595-4607.

Bolt, B. A. and Herraiz, M. (1983). Simplified estimation of seismic moment from seismograms, Bull. Seism. Soc. Am, Vol.73, No.3, 735-748.

Brune, J. N. (1970). Tectonic stress and spectra of seismic shear waves from earthquakes. J. Geophys. Res. 75, 4997-5009.

Bullen, K. E., & Bolt, B.A., (1985). An introduction to the theory of seismology, Cambridge university press.

Choy, G. L., Boatwright, J. W. Dewey, and S. A. Sipkin (1983). A teleseismic analysis of the New Brunswick earthquake of January 9, 1982, J. Geophys. Res. 88, 2199-2212.

Choy, G. and Boatwright, J. W. (1988) teleseismic and near field analysis of the Nahani earthquake in the Northwest Territories, Canada, Bull. Seism. Soc. Am. 78, 1627-1652.

Fletcher, J. B. (1980). Spectra for high dynamic range digital recordings of Oroville, California aftershocks and their source parameters. Bull. Seism. Soc. Am. Vol. 70, No 3, 735-755.

Futterman, W. I., 1962. Dispersive body waves, J. geophys. Res., 67, 5279-5291.

Gupta, I. N.and O. W. Nuttli (1976). Spatial attenuation of intensities for central U.S. earthquakes, Bull. Seism. Soc.Am. 66, 473-751.

Jackson, J., and D. P. Mckenzie, (1988). The relationship between plate motion and seismic moment tensor, and rates of active deformation in the Mediterranean and Middle east, Geophys. J., 93, 45-73.

Kennet, B. L. N.(1988). Seismological algorithms, pp. 427-440, academic press, 24/28 oval Road London NWI.

Keilis-Borok, V. I. (1960). Investigation of the mechanism of earthquakes (English translation), Soc. Res.Geophys. 4,29.

Nuttli, Otto. W., (1980). The excitation and attenuation of seismic crustal phases in Iran. Bull. Seism. Soc. Am. Vol. 70, No 2, 469-485.

Riznichenko, Yu. V., (1992). Problems of seismology, 3-27.

Taymaz, T., Jackson, J. & Mckenzie. D., 1991. Active tectonics of the north and central Agean Sea Geophys. J. Int., 106, 433-490.

Taymaz, T., Eyidogan, H., & Jackson, J., 1991. Source parameters of large earthquake in the east Anatolian fault zone (Turkey). Geophys. J. Int. 106, 537-550.