Relations between source parameters for large Persian earthquakes

Majid Nemati[1,*], Mohammad Tatar[2]

[1] *Shahid Bahonar University of Kerman, Department of Geology, Kerman, Iran*

[2] *International Institute of Earthquake Engineering and Seismology, Tehran, Iran*

Article history
Received September 18, 2014; accepted July 16, 2015.
Subject classification:
Relation, Earthquake, Magnitude, Rupture length, Displacement, Persia.

ABSTRACT

Empirical relationships for magnitude scales and fault parameters were produced using 436 Iranian intraplate earthquakes of recently regional databases since the continental events represent a large portion of total seismicity of Iran. The relations between different source parameters of the earthquakes were derived using input information which has usefully been provided from the databases after 1900. Suggested equations for magnitude scales relate the body-wave, surface-wave as well as local magnitude scales to scalar moment of the earthquakes. Also, dependence of source parameters as surface and subsurface rupture length and maximum surface displacement on the moment magnitude for some well documented earthquakes was investigated. For meeting this aim, ordinary linear regression procedures were employed for all relations. Our evaluations reveal a fair agreement between obtained relations and equations described in other worldwide and regional works in literature. The M_0-m_b *and* M_0-M_S *equations are correlated well to the worldwide relations. Also, both* M_0-M_S *and* M_0-M_L *relations have a good agreement with regional studies in Taiwan. The equations derived from this study mainly confirm the results of the global investigations about rupture length of historical and instrumental events. However, some relations like* M_W-M_N *and* M_N-M_L *which are remarkably unlike to available regional works (e.g., American and Canadian) were also found.*

1. Introduction

Relationships between source parameters of large earthquakes in the world have broadly been understood [e.g., Fuller 1987, Stromeyer et al. 2004, Bormann et al. 2007, Krystek and Anton 2007, Grünthal et al. 2009, Ristau 2009, Deniz and Yucemen 2010, Bethmann et al. 2011, Das et al. 2011, Baruah et al. 2012, Das et al. 2012, Gasperini et al. 2012, Grünthal and Wahlström 2012, Gasperini et al. 2013a, Gasperini et al. 2013b]. Magnitude is globally considered as the most efficient, measurable and a simple parameter for calculating the size of an earthquake. For the first time in the history of seismology Richter [1935] defined local magnitude scale for earthquakes. Many researchers [e.g., Sonley and Atkinson 2005, Chen et al. 2007, Yenier et al. 2008, Karimiparidari et al. 2013, Zare et al. 2014] have produced specific empirical relationships which convert various reported magnitude scales to M_W in some regions including Iranian territory. A significant reason for these conversions is that various seismological agencies report different magnitude scales for the earthquakes. Conversion of various magnitude scales to the main and authentic magnitude scale of M_W for most of the seismological catalogues is necessary (m_b, M_S, M_L as well as M_N ($=\mathrm{Log}_{10}(\mathit{Amplitude}/4\pi)+1.166\mathrm{Log}_{10}(\mathit{Epicentral\ Distance})-0.1$; Nuttli [1973]). Because the m_b, M_S, M_L and also M_N scales are independently calculated using maximum amplitude of body wave, surface wave, and shear wave of an earthquake in appropriate specific frequency ranges, respectively. Therefore, they cannot represent all source process energy of an earthquake; because the frequencies at which the above mentioned scales are calculated do not cover the whole rupture process. Also, a reliable earthquake catalogue, which usually contains homogeneous magnitude estimations for all events, is highly desirable. Homogeneous catalogues are applied in many seismic studies such as seismic hazard assessment, ground-motion prediction, long-term seismic strain rate assessment and also nuclear activity verification [Yenier et al. 2008].

Moreover, Shoja-Taheri et al. [2007] have used a large amount of strong-motion data recorded by National Strong Motion Network of Iran (BHRC) to develop relations for routine determination of M_L and M_W from digital horizontal components of the strong-motion records. Also, Shahvar et al. [2013] have presented a unified and homogeneous catalogue for the Iranian plateau ($M_W \geq 4.0$), created by merging data from two local catalogues and seven international agencies. Since, this operation requires the conversion of different magnitudes used by single agencies to a common type. In this attempt to convert different magnitude scales to M_W, regression relations that take into account errors on both variables are used.

Also, global empirical relationships between the basic source parameters (e.g., length, width and slip of a coseismic fault) and the moment magnitude [Hanks and Kanamori 1979, Kanamori 1979] of the corresponding earthquake have essentially been calculated [e.g., Kanamori and Anderson 1975, Bonilla et al. 1984, Wesnousky 1986, Wells and Coppersmith 1994, Papazachos and Papazachou 2003, Smith and Stock 2004]. Relations between earthquake parameters (e.g., scalar moment, fault length, faulted area, fault slip) and the magnitude of the corresponding earthquake are important issues for practical purposes. These relations can estimate the magnitude of an earthquake when such parameters are roughly known by either geological or seismological investigations. Ambraseys and Jackson [1998] summarized surface faulting cases in historical and recent earthquakes in the eastern Mediterranean region and in the Middle East (including Iran). They also derived relationships between magnitude, rupture length, surface displacements and mechanism, using the above mentioned dataset. Such empirical relations are also significant for theoretical reasons because they can physically test whether the models of the seismic rupture are valid [e.g., Utsu and Seki 1954, Tocher 1958, Nuttli 1983a, Nuttli 1983b, Ambraseys 1988, Wang and Ou 1998, Smith and Stock 2000, Papazachos et al. 2004, Karakaisis et al. 2010].

2. Data and error analysis

The database used in this study was gathered from various seismic catalogues. We used catalogues of the International Seismological Center (ISC as a main structure), the International Institute of Earthquake Engineering and Seismology of Iran (IIEES), the Institute of Geophysics of the University of Tehran (IGUT), the Engdahl relocated catalogue for 1900-2014 and many early to recent researches which have been carried out in Iran for the earthquakes after 1974. Appendix 1 shows the earthquake database used in this study. These earthquakes have occurred in response to the Arabian-Touran plates convergence (Figure 1a).

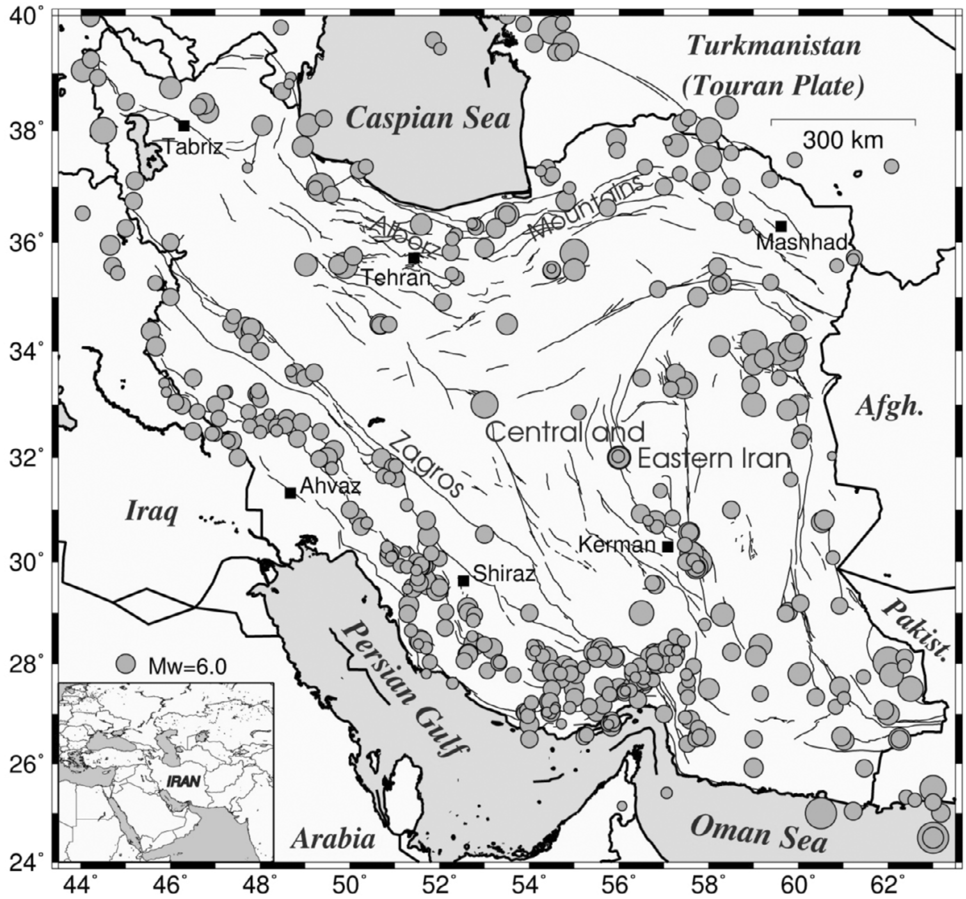
The parameters of M_0 and M_W are basically calculated by the Centroid Moment Tensor (CMT) solution of the Harvard University catalogue [2014]; the location, depth, m_b and M_S were adopted from the ISC catalogue [2014]; M_N was adopted from the IGUT catalogue [2014] and also M_L magnitudes of the events from the IIEES catalogue [2014]. *SRL*, *SSRL* and *MSD*, the surface rupture length, subsurface rupture length and maximum surface displacement for coseismic faults of the Persiaan earthquakes were adopted from well documented papers. This data was gathered from the sources introduced in the reference column in the table of Appendix 1, according to the fact that ISC reported depths are usually good for general classification as many of them are fixed depth mainly at 15 km. Several studies have shown that some of them could be wrong as much as several kilometers [e.g., Maggi et al. 2000].

Reported M_L and M_N for the earthquakes in Appendix 1 were adopted from IIEES and IGUT catalogues, respectively. Most of M_W, M_S and m_b as well as all of M_0 values were achieved from Harvard catalogue considering that the Global CMT catalogue adopts M_S and m_b values from the other reliable sources. *SRL*, *SSRL* and *MSD* for the earthquakes were adopted from geological surveys accomplished and published mainly by Geological Survey of Iran (GSI) (Appendix 1).

Separating the earthquake data with respect to their seismotectonic provinces, neither provides statistically different results nor improves statistical significance for the magnitude relations [e.g., Wells and Coppersmith 1994]. The Iranian earthquakes have mainly intra-plate behaviors and also Persian seismotectonic provinces are roughly associated with the same characteristics; although, Zafarani and Soghrat [2012] and Shoja-Taheri et al. [2007] have emphasized on the partial difference between Zagros and Alborz-Central Iran. Since, number of the events in each area (diagram) decreases, dividing the study area with respect to the seismotectonic provinces makes the results uncertain. This is the main reason of merging the data of all Iranian provinces except that of Makran and north of Alborz regions. According to these facts, we only excluded data of the plate-margin earthquakes from the database. This separation was necessary because of the significant differences between the plate-margin and the mid-plate earthquakes of a same seismic moment. A large plate-margin earthquake has bigger rupture length, rupture area, average fault displacement, smaller rupture width as well as smaller static stress drop in comparison to a mid-plate event. Plots of m_b versus M_S, m_b versus M_0, as well as M_S versus M_0, for plate-margin earthquakes show greater amounts of scatter in comparison to mid-plate earthquakes [Nuttli 1983a].

Karimiparidari et al. [2013] disregarded all aftershock and foreshocks in their newly compiled catalogue based on the procedure described by Gardner and Knopoff [1974]. Accordingly, the aftershocks and foreshocks are therefore excluded from our database based on their origin times, relative location to the mainshock and also over than 1 magnitude unit difference with the mainshock magnitude. Considering longer durations of aftershocks and foreshocks for larger earthquakes, no

(a)



(b)

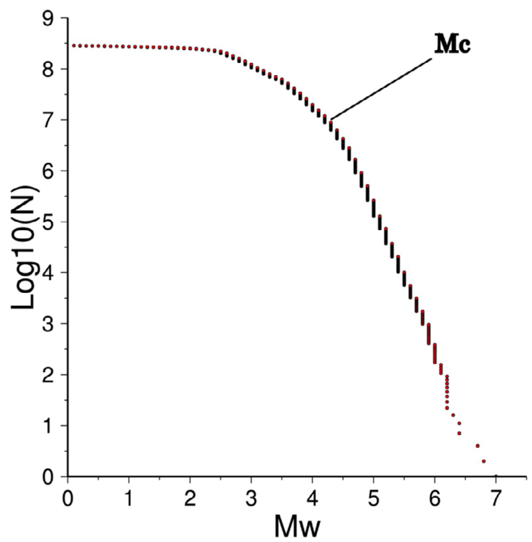


Figure 1. (a) Fault map of Iran with the epicentral distribution of 436 earthquakes investigated in this study. Faults were adopted from the active fault map of Iran [Hessami et al. 2003]. (b) M_C determination for our database.

constant durations were considered for the aftershocks and foreshocks. Nemati [2014] has introduced equations for both the ISC and IGUT databases for spatially separating the aftershocks from the background seismicity in Iran. We also took advantage from Nemati [2014] relations ($\text{Log}_{10}(A) = 0.45M_S + 0.23$) as a general guide for separating the aftershocks which situate in an equivalent circular area of $A(\text{km}^2)$ centered by the mainshock location.

The basic need for any earthquake catalogue is homogeneity in the magnitude and also data completeness. Concept of the completeness is that the data must include all earthquakes occur in a tectonical region during a specific time interval with magnitude larger than a certain value (magnitude of completeness (M_C)). Therefore assessment of M_C, usually estimated from bending of the Gutenberg-Richter diagram [Gutenberg and Richter 1956], is a significant issue. This is the smallest magnitude above which the catalogue is considered to be fully reported. In 1964-2014 period in ISC (after 1964), IIEES (after 2002) and IGUT (after 1996) catalogues (each reports seismic data with a global and regional seismological networks, respectively) this magnitude could optimistically be assumed to be 4.3 with a reliable and confident tolerance (Figure 1b, M_C for ISC catalogue after 1964).

m_b is obtained by using the waveform amplitude of the first 5 s of short period P waves recorded by short period sensors. M_S is generally calculated from surface wave amplitudes with 20s period. It can truly be used well for shallow earthquakes [Gutenberg and Richter 1956, Nuttli 1983a, Nuttli 1983b]. The original M_L is based on recordings of a typical Wood Anderson (W-A) seismograph. If such recordings are not available, then we produce them by converting digital recordings of well calibrated sensors to synthetic W-A ones. Then M_L is also determined from the peak amplitudes of the synthetic seismographs.

We examined the relationships between M_0 and m_b, M_S and M_L magnitude scales because M_W could directly be calculated from M_0 for most of the earthquakes. M_W could be easily obtained from the standard equation of $M_W = 2/3(\mathrm{Log}_{10}(M_0) - 16.1)$ [IASPEI 2005]. Therefore, we calculated dependence of the magnitude scales with M_0. For pre-instrumental earthquakes M_S was calculated from the maximum intensity (I_S) by the formula $M_S = 0.77I_0 - 0.07$ [Ambraseys and Melville 1982].

IGUT short period seismic stations are equipped with SS1 seismometers, medium-bands are equipped with Trillium-40s seismometers and broad-bands are equipped with CMG-3ESP-120s, CMG-3T-360s and also Trillium-240s seismometers. The IIEES seismometers are mainly broad-band of CMG-3T-360s type.

M_N scale is basically introduced by Nuttli [1973] which defines the size of an earthquake by using the formula $M_N = \mathrm{Log}_{10}(A/KT) + 1.166\mathrm{Log}_{10}(R) - 0.1$, where A, K, T and R are displacement amplitude (nm), amplification of the seismograph, natural period (s) of the seismograph and epicentral distance of the earthquake (km), respectively. The magnitude of an earthquake released by IGUT is in the corrected Nuttli [1973] magnitude scale; $M_N = \mathrm{Log}_{10}(\dot{A}) + 1.66\mathrm{Log}_{10}(R) - 0.1$ for R (epicentral distance)≤106 km and $M_N = \mathrm{Log}_{10}(\dot{A}) + 2.5\mathrm{Log}_{10}(R) - 1.8$ for 106 km<R ≤ 600 km and $\dot{A}$ (nm/s) is maximum velocity amplitude for Iranian earthquakes recorded with velocity meters [Rezapour 2005].

Figure 1a displays the epicentral distribution of 436 earthquakes of Appendix 1 on the fault map of Iran. A unified magnitude is necessary for depiction of the epicenters in the map (Figure 1a) regarding that the earthquakes symbols are displayed with respect to their magnitudes. For unifying the magnitude scale of the earthquakes, we applied widely used and available relationships based on very wide data sets ($M_W = 0.804m_b + 1.25$ and $M_W = 0.74M_S + 1.81$ for $3.5 < M_S < 6.1$ and $M_W = 0.83M_S + 1.25$ for $6.1 < M_S < 7.5$ [Scordilis 2006] for calculating M_W for some earthquakes (M_W(Cal.) column) in Appendix 1).

For evaluating the reliability of the equations, calculating a standard deviation as well as depicting a residual diagram for each equation is essential. Residual diagrams show how the difference between the calculated and observed dependent parameter versus the independent parameter, varies. If the fitted line to the residual plots closes to the horizontal state, the calculation is reliable [Yenier et al. 2008]. Deviation from horizontal slope for the fitted line dedicates uncertainties in the estimated parameter for an earthquake by our relation.

In this study, ordinary linear fit technique is used to compute the relationships between the magnitude scales and other source parameters. In the diagrams, symbols of some events may cover the others. All regressions for the diagrams were performed using the Origin software and map of Figure 1a and also all the diagrams were produced by GMT software [Wessel and Smith 1998].

3. Seismic relations

For the first time, Aki [1966, 1967] measured the value of seismic moment, M_0, for the 1964 Niigata Japanese earthquake and intelligently comprehended that the amplitude of a long period wave is proportional to M_0 of the corresponding earthquake.

The moment magnitude scale is roughly preferred by the majority of researchers for many applications, as it is more representative of the real size of an earthquake. We did not include scalar moments for pre-1976 events because only available M_0 with an independent method is appropriate for producing the relations. But, for post-1976 earthquakes the scalar moments of the Iranian earthquakes have appropriately been calculated with an independent method of Centriod Moment Tensor (CMT) solution by the Harvard University.

Large earthquakes (M>5.0, cut-off magnitude) are the only target of this study. In other words, we excluded small earthquakes from processing because the global and regional databases could not record and therefore report all small earthquakes. Also, the smaller events may be covered by larger events in waveforms recorded with the worldwide global and regional seismological networks. Hence, small cut-off magnitude make the global and regional catalogues incomplete.

Linear fit suggests the equations according to the model of $Y = (A \pm a)X \pm (B \pm b)$, where: Y and X are dependent and independent parameters, respectively; A and B are linear coefficients; and also a and b are tolerance errors for A and B, respectively (Table 1).

The error analysis was suggested evaluating the empirical relations obtained by the linear regression method and makes them satisfactory and reliable. A residual diagram presents the data scattering for each regression. Again, a linear trend was also fitted to each residual diagram determining whether the estimation is biased towards an independent parameter. Deviation from zero slope in this plot indicates biased estimation for the functional model. A dip less than 0.1 indicates a closer result to the average. In other words, a robust relation has a near zero slope for the fitted line to the corresponding residual diagram. Residuals for the dependent variables (e.g., M_0, M_W, M_N and SRL) which

Dependent parameter (Y)	Independent parameter (X)	Number of earth-quakes	Relation ($Y=(A\pm a)X\pm(B\pm b)$)	Standard deviation	Slop for the residual diagram	Resemblance
$Log_{10}(M_0)$	m_b	150	$Log_{10}(M_0)=(1.564\pm0.137)m_b+(16.128\pm0.759)$	0.540	1.374	Nuttli [1983b]
$Log_{10}(M_0)$	M_S	137	$Log_{10}(M_0)=(1.033\pm0.04)M_S+(19.044\pm0.254)$	0.327	0.081	Nuttli [1983b], Chen et al. [2007]
$Log_{10}(M_0)$	M_L	44	$Log_{10}(M_0)=(1.472\pm0.142)M_L+(16.195\pm0.803)$	0.356	-0.133	Chen et al. [2007]
M_W	M_N	45	$M_W=(0.863\pm0.110)M_N+(0.818\pm0.615)$	0.308	-0.030	-
M_N	M_L	48	$M_N=(0.915\pm0.074)M_L+(0.492\pm0.411)$	0.197	-0.005	Karimiparidari et al. [2013]
$Log_{10}(MSD)$	M_W	30	$Log_{10}(MSD)=(0.491\pm0.238)M_W-(1.458\pm1.442)$	0.717	5.943	-
$Log_{10}(MSD)$	M_W	22	$Log_{10}(MSD)=(0.525\pm0.164)M_W-(1.701\pm1.084)$	0.361	-3.388	Papazachos et al. [2004]
$Log_{10}(SRL)$	M_W	22	$Log_{10}(SRL)=(0.751\pm0.129)M_W-(3.586\pm0.841)$	0.296	-0.008	Wells and Coppersmith [1994]
$Log_{10}(SSRL)$	M_W	17	$Log_{10}(SSRL)=(0.587\pm0.096)M_W-(2.291\pm0.634)$	0.183	-0.012	Wells and Coppersmith [1994]
$SRL/SSRL$	M_W	11	$SRL/SSRL=(0.284\pm0.145)M_W-(1.166\pm0.960)$	0.241	-	Wells and Coppersmith [1994]
$Log_{10}(SRL)$	$Log_{10}(SSRL)$	11	$Log_{10}(SRL)=(0.1.299\pm0.185)Log_{10}(SSRL)-(0.657\pm0.294)$	0.191	-	-
$Log_{10}(MSD)$	$Log_{10}(SRL)$	26	$Log_{10}(MSD)=(0.413\pm0.232)Log_{10}(SRL)+(1.333\pm0.321)$	0.614	-0.003	-

Table 1. Relationships and number of earthquakes used for each empirical equation.

contains differences between the observed and calculated (produced by our relation) variables were drawn versus their independent variables.

We compared Iranian relations obtained in this study with that of the global and regional equations like Taiwan, America and also Canada. Regarding to lack of the earthquake data (11 events) for $Log_{10}(SRL)$-$Log_{10}(SSRL)$ and $SRL/SSRL$-M_W relations, the residual diagrams for both plots seems to be unnecessary.

3.1. Scalar moment and magnitude

For magnitude relations, some researchers separated the earthquakes with respect to their seismotectonic provinces (Karimiparidari et al. [2013] separated the data for M_S-m_b relation for a wide range of magnitude), magnitudes (Nuttli [1983a, 1983b] for a wide range of magnitude), depths (Nuttli [1983a] for plate margin earthquakes) and mechanisms [Karakaisis et al. 2010]. We did not separate the earthquakes with respect to their seismotectonic provinces because separating the data according to extensional and compressional tectonic environments, neither provides statistically different results nor improves the statistical significance of the regressions [Wells and Coppersmith 1994]. We did not also separate the earthquakes with respect to their magnitudes and depths because the events situate in a relatively narrow magnitude (5.0-7.4) and depth (continental events) ranges.

Regarding to the fact that M_W directly depends on M_0 and is calculated from M_0, calculating either M_0 or M_W values as the dependent parameter in the relations concludes the same results. The equations for magnitude scales were derived from specific magnitude ranges, considering that they meet the saturation values for each magnitude scale.

Chen et al. [2007] developed the seismic relations between four source parameters (M_0, M_S, m_b and M_L) using 201 Taiwan earthquakes during a 30 year period. They obtained results using the earthquakes with m_b between 4.8 and 6.6. Surprisingly, their relations do not depart from Nuttli's [1983a] worldwide result. It is noticeable that neither Nuttli [1983a] nor Chen et al. [2007] separated their data with respect to the tectonical regimes.

3.1.1. $Log_{10}(M_0)$-m_b

Chen et al. [2007] has produced relations using 201 shallow earthquakes in Taiwan ($Log_{10}(M_0)=1.73m_b+15.09$ and also $M_S=1.46m_b-2.52$ for $4.8<m_b<6.6$). For global mid-plate earthquakes, M_0-M_S, M_0-m_b and M_S-m_b relationships were inferred by Nuttli [1983a, 1983b] (e.g., $Log_{10}(M_0)=2.0m_b+13.75$; $4.5<m_b$). Scordilis [2006] also presented a global relation for M_0-m_b ($Log_{10}(M_0)=1.20m_b+17.90$). In this study, we derived a relation be-

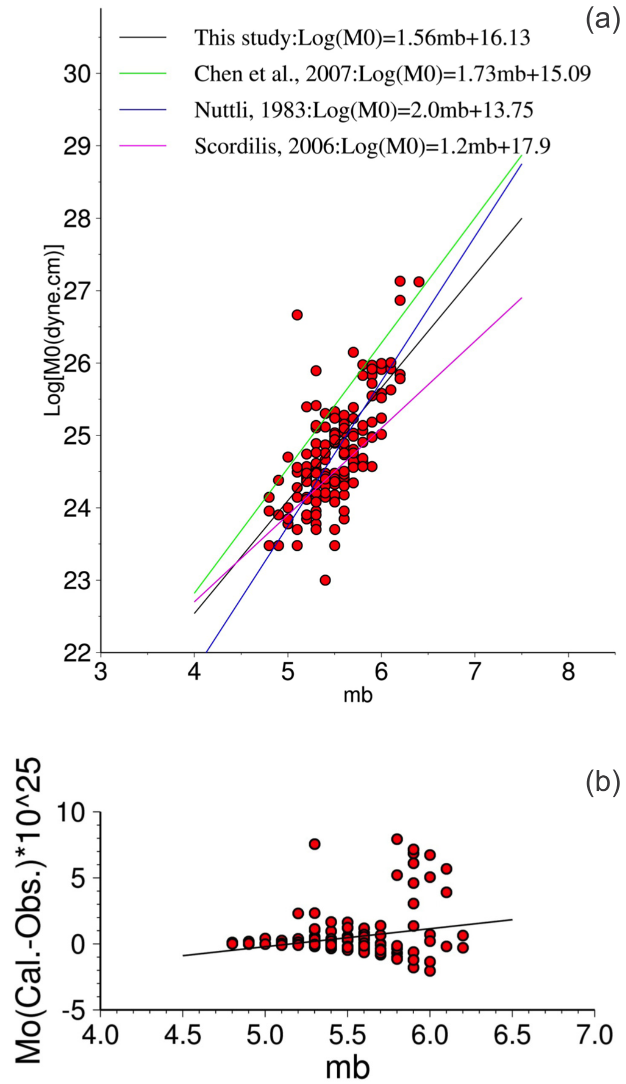


Figure 2. (a) $\text{Log}_{10}(M_0)$ versus m_b and related regression line. The black line is for this study. Green and blue lines given by Chen et al. [2007] and Nuttli [1983], respectively. (b) Residual diagram for Figure 2a.

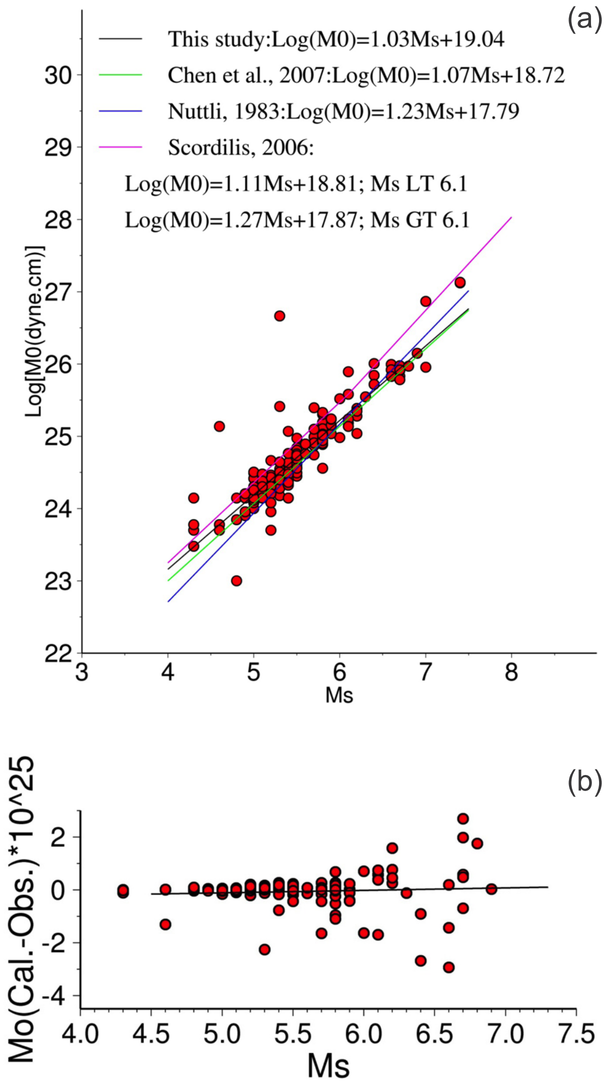


Figure 3. (a) $\text{Log}_{10}(M_0)$ versus M_S for the mid-plate Iranian earthquakes. Equations for Scordilis [2006] were drawn for M_S less than (LT) and greater than (GT) 6.1. The straight black line is for this study. (b) Residuals for scalar moment versus surface magnitude computed using ordinary linear regressions.

tween $\text{Log}_{10}(M_0)$ and m_b using 150 continental earthquakes in Persian Plateau with $4.8<m_b<6.4$ (Figure 2a). Figure 2b shows the $\text{Log}_{10}(M_0)$ residuals, which is the difference between the observed parameter from the Harvard catalogue and the calculated parameter in this study. This diagram dedicates to the deviation of the calculated $\text{Log}_{10}(M_0)$ from the observed values of the earthquakes with m_b greater than 5.8. Therefore, the produced relation could not reliably be used for the earthquakes with this range of m_b. According to Figure 2a it is obvious that our achieved result ($\text{Log}_{10}(M_0) = 1.6m_b + 16.1$) with a relatively high standard deviation (0.54) has more accordance with the Nuttli [1983a] worldwide equation than that of Chen et al. [2007] relation. Our results deviate from Scordilis [2006] in great magnitudes. The distribution deviates from linearity for big magnitude values in the residual diagram of Figure 2b which is, basically due to m_b saturation affects.

3.1.2. $\text{Log}_{10}(M_0)$-M_S

Chen et al. [2007] has also suggested a relation between M_0 and M_S using 201 Taiwan earthquakes ($\text{Log}_{10}(M_0) = 1.07M_S + 18.72$; $4.1<M_S<7.9$). For global mid-plate earthquakes, the M_0-M_S relationship has also been inferred by Nuttli [1983a, 1983b] ($\text{Log}_{10}(M_0) = 1.23M_S+17.79$) as well as Scordilis [2006] ($\text{Log}_{10}(M_0)= 1.20m_b + 17.90$). The source parameters for 137 Iranian earthquakes resulted a relation ($\text{Log}_{10}(M_0)$-M_S, Figure 3a) with a linear regression and a standard deviation of 0.32. The fitted line slope to the residuals (Figure 3b) for the $\text{Log}_{10}(M_0)$ is 0.081. Notwithstanding that it is near zero value and also it is a good confirmation for the introduced relationship, scattering is still seen at the diagram for few greater events which indicates the magnitude saturation effects. The equation of this study for M_0-M_S relation is correlated well to both Nuttli [1983a]

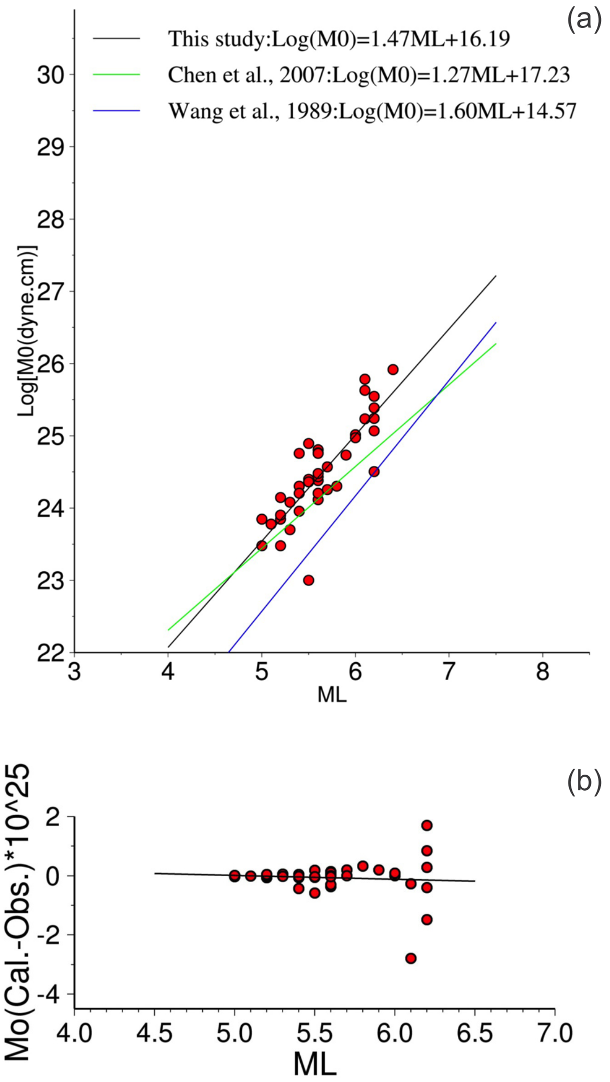


Figure 4. (a) Scatter plot of $\text{Log}_{10}(M_0)$ versus M_L. Lines are for comparisons of the conversion models with different studies in the literature. (b) Residual diagram for evaluating Figure 4a.

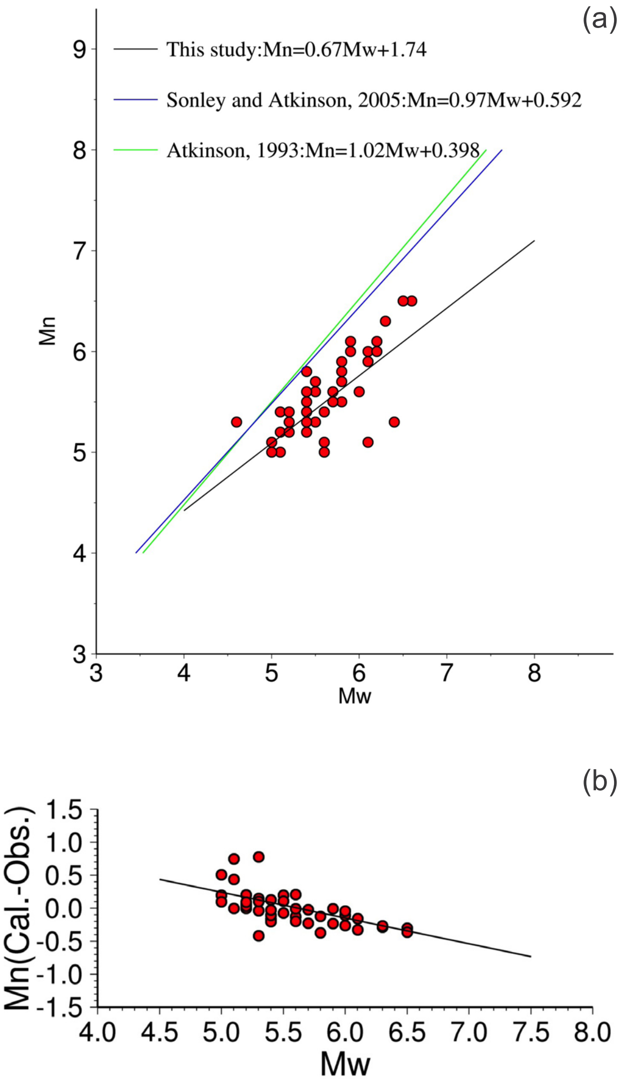


Figure 5. (a) Empirical relationship between M_W and M_N in Iran. Atkinson [1993] and Sonley and Atkinson [2005] equations correspond to the green and blue lines, respectively. Equation of the black line gives the regression result for this study. The two mentioned relationships (the American and Canadian) are very similar to each other. There is a vastly different magnitude range in the Iranian data. (b) Difference between the calculated and observed M_W versus M_N for the Iranian earthquakes.

and Scordilis [2006] worldwide equations and also with Chen et al. [2007] regional relationship (blue, green and pink fitted lines in Figure 3a, respectively).

3.1.3. $\text{Log}_{10}(M_0)$-M_L

From previous works in the literature for M_0-M_L relation we can point to both Chen et al. [2007] and Wang et al. [1989] works which have suggested relations for earthquakes in Taiwan. Using 44 Persian earthquakes with local magnitude, the plots of $\text{Log}_{10}(M_0)$ versus M_L, is depicted in Figure 4a. As Figure 4a shows a linear relationship with a standard deviation of 0.35 between the two parameters. This equation is reliably applicable to the earthquakes with M_L magnitude less than 6.1 (Figure 4b). This limitation is arisen from M_L saturation in big magnitude values. Although, there is correlation between the results of this study (black line in Figure 4a) for M_L with that of Chen et al. [2007] (green line) at least for smaller magnitude events; it departs from Wang et al. [1989] relationship (blue line).

3.2. Magnitude relations

3.2.1. M_N-M_W

M_N magnitude scale is the most common catalogue magnitude for the eastern North America, which has been introduced by Nuttli [1973]. M_N magnitude is calculated using either the amplitude of the shear wave or Lg phase which is a multiply reflected and refracted shear wave.

Magnitudes of 45 Iranian earthquakes in M_N and M_W scales resulted in an equation (with standard deviation of 0.2) which calculates magnitudes in Nuttli scale for events with moment magnitude between 4.5 and 6.7.

For the Canadian earthquakes, Atkinson [1993] and Sonley and Atkinson [2005] have suggested equations compared with the relation of this study (Figure 5a). The result of this study is not correlated well with both relations. Although, all regions (America, Canada and Iran) are characterized by continental behaviors, a possible explanation for this difference is smaller areas of Canadian and American studied regions in comparison to the broader Iranian area covered by the earthquakes. The difference between the calculated and observed M_N for the earthquakes applied in this section has been plotted as M_N residuals, which is characterized with the slope of −0.3 (Figure 5b).

3.2.2. M_N-M_L

We could not find a relation for M_N and M_L in Iran except Karimiparidari et al. [2013] equation. But there are many relationships between M_L and M_N and the other magnitude scales in the literature. Chen et al. [2007] have produced relations using 125 earthquakes in Taiwan between m_b and M_S scales with M_L ($M_S = 1.03M_L - 0.53$ and $m_b = 0.66M_L + 1.69$ both for $4.7<M_L<7.2$). Three relations between m_b and M_L which have also been determined are $m_b=0.85M_L+0.27$ [Shin 1986]; $M_L = 1.27m_b - 0.6$ [Wang et al. 1989], and $M_L = 0.75m_b + 1.94$ [Cheng and Yeh 1989].

Using 48 large events in Iran we have calculated a reasonable equation between M_N and M_L with a standard deviation less than 0.2 (Figure 6a). 48 M_L values [IIEES 2013] (independent variable) have not been converted from the other scales rather calculated based on simulated records. IIEES seismological network records the waveforms with Broad-Band instruments. A credibility test performed for this relation to see if the conversion is near reality. Likely to the other relations, a test plot depicted for the residuals for M_N scale with a fitted line to the events with a slope of −0.005. Near zero slope for the fitted line to the residuals shows a reliable transformation for the magnitudes in the range of $4.9<M_L<6.2$ (Figure 6b). Our result for M_N-M_L relation gives slightly greater values to M_N in comparison to the Karimiparidari et al. [2013] equation for Iranian earthquakes.

3.3. Coseismic rupture parameters and magnitude

Karakaisis et al. [2010] calibrated relations globally between the magnitude of earthquakes and surface rupture length, surface displacement and rupture width for the earthquakes occurred in 464 BC to 1911 and 1911 to 2008 separately with the magnitude of completeness of 6.5 and 5.2, respectively. Murotani et al.

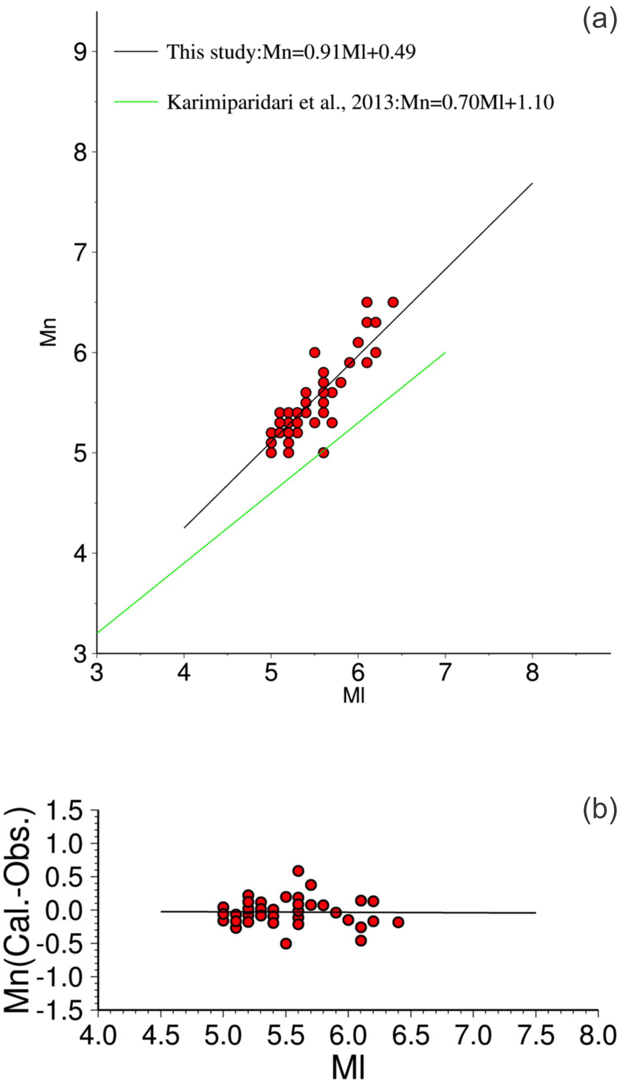


Figure 6. (a) M_N-M_L relation for 48 Persian earthquakes (red dots); (b) credibility test for this diagram.

[2013] also derived relations between M_W, average slip and rupture area for great plate margin earthquakes around the world. Papazachos et al. [2004] have also related fault parameters to M_W using 149 intraplate and plate-margin earthquakes.

Papazachos et al. [2004] have used a considerable number of published global earthquake data, which is homogeneous and fairly accurate to relate the fault length (L, km) and the fault width (W, km) as well as the average slip of a fault (u, cm), with M_W for three kinds of faults (dip-slip and strike slip faults in continental regime and dip-slip faults in subduction regions). Papazachos et al. [2004] also obtained a relation between M_W and average displacement (D). They calculated average displacement from $M_0=\mu AD$ formula. Parameters A and μ are ruptured area and the rigidity, respectively, and M_0 is calculated from $\text{Log}_{10}(M_0)=1.5M_W+16.1$. Also, they obtained dependence between A and M_W from empirical diagrams. Here, we compared our results with Papazachos et al. [2004] relation for conti-

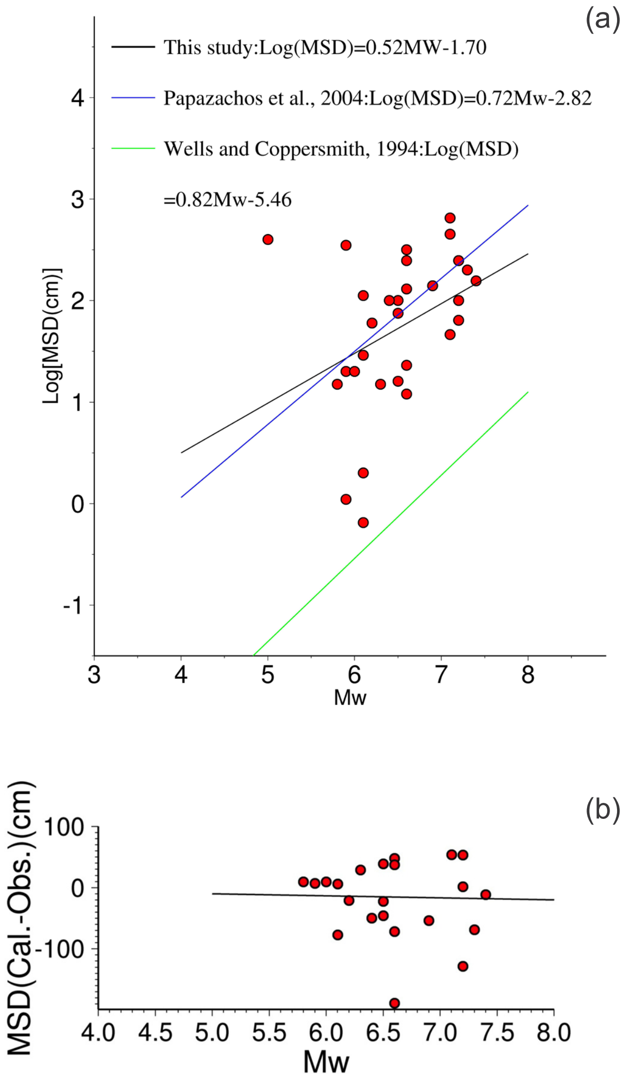


Figure 7. (a) Relation between coseismic fault displacement and M_W for 30 mid-plate earthquakes in Iran; (b) reliability test for this diagram using 22 events.

nental faults. Papazachos et al. [2004] attended to global relations between seismic fault parameters and moment magnitudes for 193 continental earthquakes (M>6.0).

SRL, *SSRL* and *MSD* for Persian earthquakes in the next sections have been adopted from the field measurements, mainly performed by the Geological Survey of Iran (see Appendix 1 for the references).

3.3.1. $\text{Log}_{10}(MSD)$-M_W

We consider the resultant of maximum horizontal and vertical displacements of the earthquakes as maximum surface displacement (*MSD*). Using 30 Persian earthquakes with M_W between 5.0 and 7.4, an equation was derived with a high value of standard deviation (0.7). The earthquakes with unusual surface ruptures, like 1972 Mishan-Zagros (m_b 5.4 and 400 cm displacement; Berberian [1976a]), 1976 Chalderan-Azarbaijan (m_b 6.1 and 350 cm displacement; Berberian [1976a]), 1989 Golbaf (m_b 5.5 and 1.1 cm displacement; Berberian and Qorashi [1994]) and also 1998 Fandogha (m_b 5.9 and 316 cm displacement; Berberian et al. [2001]) earthquakes, make the diagram much scattered (Figure 7a). Residual diagram estimates 5.94 for the slope of the fitted line to the data, which is extremely high. Excluding the data with unusual surface displacements from the diagram of Figure 7a permits us to estimate better regression and also a residual diagram with 22 events (Figure 7b). Slope of the fitted line to the residual data and standard deviation for the second estimation are −3.38 and 0.36, respectively which are remarkably better than the first diagram. But still scattering is seen in the residual diagram. Notwithstanding we gathered all the data related to *MSD* in Iran, the diagram of Figure 7a is not linear. Even after excluding 8 big outliers and desultory data from 30 ones, still scattering is seen in the diagram. Our results as well as those of Papazachos et al. [2004] depart from Wells and Coppersmith [1994] relation for global earthquakes. It is important that both Papazachos et al. [2004] and Wells and Coppersmith [1994] have estimated their equations using global databases and both correspond to the maximum real (not surface) displacement. One of the possible reasons for this difference is that the magnitude range for Papazachos et al. [2004] ($5.0<M_W<9.6$) database is slightly greater than that of Wells and Coppersmith [1994] ($4.5<M_S<8.1$).

Regarding the fact that for a certain magnitude, fault slip is about the same for strike-slip faults and dip-slip faults in continental regions [Papazachos et al. 2004] and also lack of surface slip data in Iran we did not separate the data with respect to the strike-slip and dip-slip mechanisms.

3.3.2. $\text{Log}_{10}(SRL)$-M_W

Iranian researchers have derived relation between M_L and M_S and maximum surface rupture length (L) using 14 Iranian earthquakes (e.g., Mohajer-Ashjaei and Nowroozi [1978], $M_L = \text{Log}_{10}(L) + 5.4$; Berberian et al. [1996, 2000], $M_S = 1.24\text{Log}_{10}(L) + 4.99$ for M>6.0; Nowroozi [1985] and Berberian et al. [1996], $M_S = 1.11\text{Log}_{10}(L) + 5.19$). Considering that M_W and M_S are nearly identical in the practical range of magnitudes for fault rupture studies in the Iranian plateau (M_S~6.0-8.0; e.g., Scordilis [2006]), the moment magnitude does not play the basic role in the Iranian relations. Also, generation of a seismic relation by converted M_W scale is neither informative nor reliable and we could not compare our estimated equations with them. Unlike the $\text{Log}_{10}(MSD)$-M_W relation, the equation estimated here (with 22 events, $5.6<M_W<7.4$ and standard deviation of 0.29) correlates well to that of Wells and Coppersmith [1994] (the *SRL* value is max-

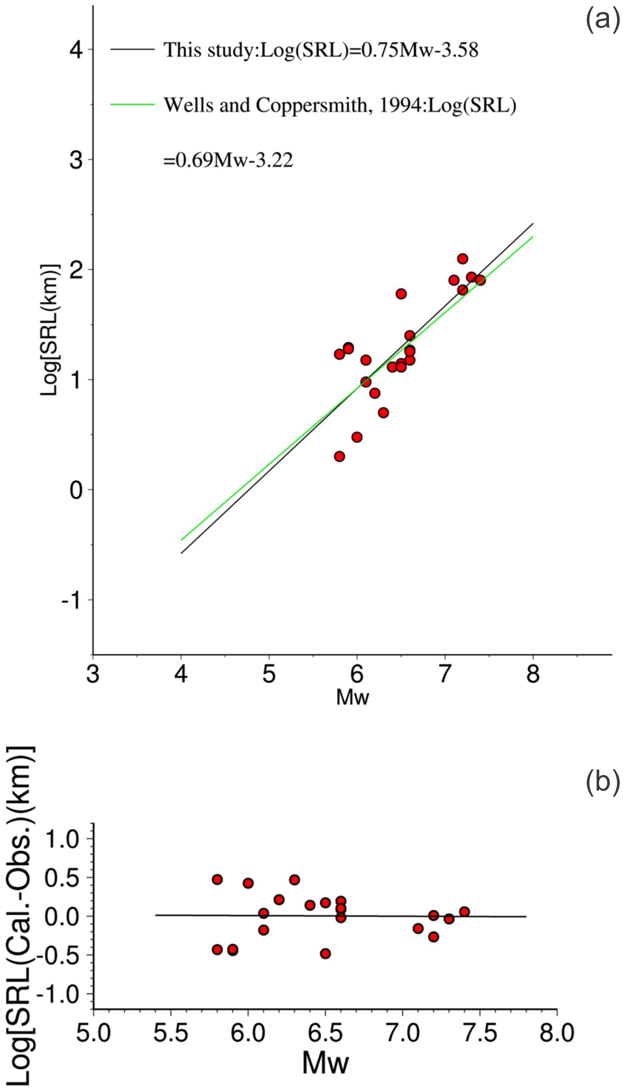


Figure 8. (a) Relation between *SRL* and M_W using 22 Iranian interplate earthquakes; (b) reliability test for this diagram.

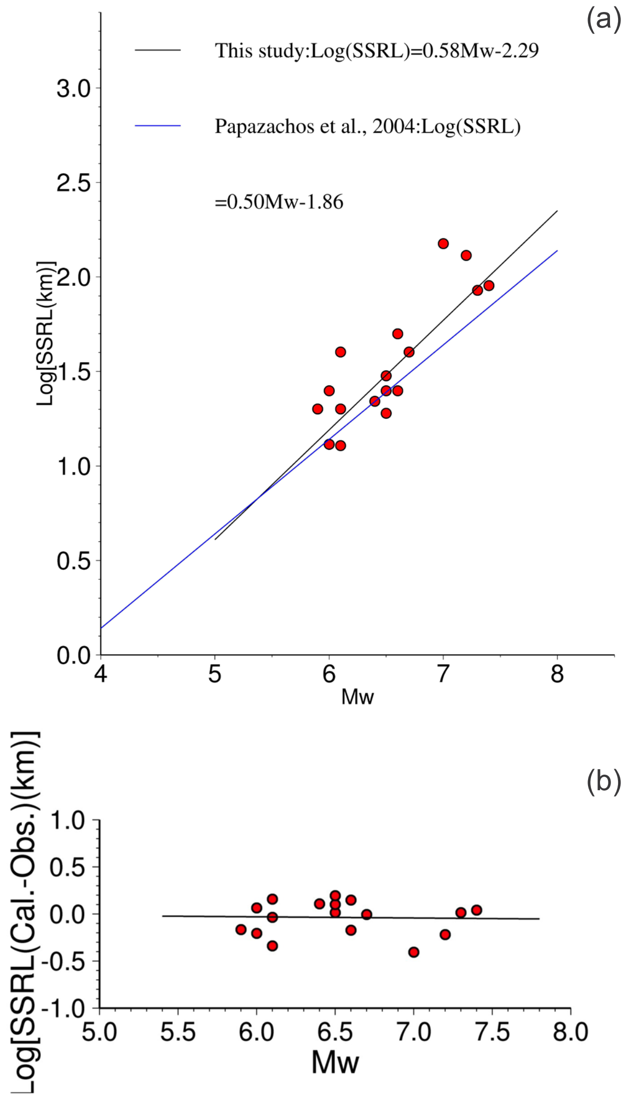


Figure 9. (a) Variation of the logarithm of the subsurface coseismic fault length, *SSRL* (in km), as a function of M_W for earthquakes in continental regions of Iran. (b) Residual test for the equation of Figure 9a. Straight lines are linear fits to the data in both diagrams.

imum real (not surface) rupture length) (Figure 8a). Slope for the fitted line to the events in residual plot is -0.008 (Figure 8b). It confirms a reasonable estimation between $\mathrm{Log}_{10}(SRL)$ and M_W relation for Iranian earthquakes.

3.3.3. $\mathrm{Log}_{10}(SSRL)$-M_W

Wells and Coppersmith [1994] generally assumed *SRL* to be about 75% of *SSRL* for global earthquakes. For the first time in Iran we have suggested an equation between *SSRL* and M_W using 17 continental earthquakes ($\mathrm{Log}_{10}(SSRL) = 0.59M_W - 2.29$) with a standard deviation of about 0.18. The slope of the fitted line to the earthquakes symbols applied for residual diagram is -0.012. Here, we compare our equation with that of Papazachos et al. [2004]. We estimate more *SSRL* value than that of Papazachos et al. [2004]. The subsurface rupture lengths for Persian earthquakes were adopted from the aftershock surveying each have been performed by a dense local network (see Appendix 1). According to the fact that the local networks data are rare not only in Iran, but also in the world, this equation is highly informative and will contain valuable information about subsurface extension for future earthquakes in Iran (Figure 9a,b).

3.3.4. $SRL/SSRL$-M_W

We produced an equation for *SSRL* and M_W for the first time in Iran using 17 continental earthquakes ($\mathrm{Log}_{10}(SSRL) = 0.59M_W - 2.29$) and also an equation for *SRL* and M_W ($\mathrm{Log}_{10}(SRL) = 0.75M_W - 3.59$) in previous sections. Using 11 earthquakes in Iran, we want to see how $SRL/SSRL$ ratio varies when M_W of an event changes. Figure 10 does not show good linearity for the ratio of $SRL/SSRL$ versus M_W. The standard deviation for this regression is about 0.24.

In seismology, *SRL* is generally assumed to be

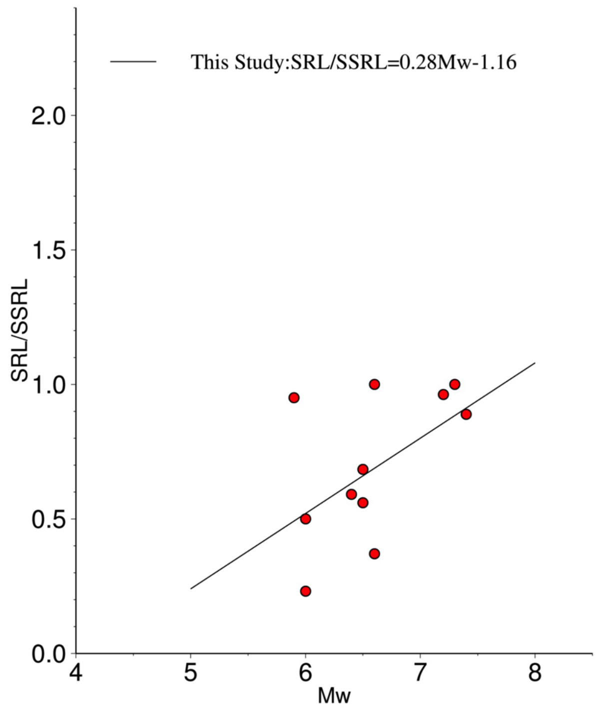


Figure 10. Ratio of *SRL*/*SSRL* versus M_W for 11 Iranian earthquakes.

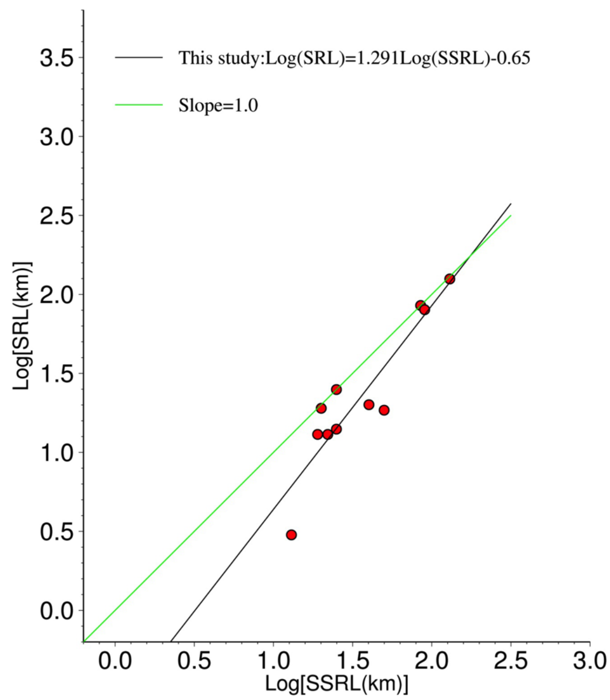


Figure 11. Diagram of *SRL* versus *SSRL* estimated from the distribution of source parameters for 11 continental earthquakes in Persia.

about 75% of *SSRL*, Wells and Coppersmith [1994]. They have also depicted plot of *SRL* to *SSRL* ratio against M_W of 53 events out of 421 worldwide earthquakes. They concluded that *SRL* is a more reliable estimator for *SSRL* when the magnitude increases. Because of fewer number of earthquakes associated with both *SRL* and *SSRL* in Iran and scattering of the data in Figure 10, we do not depict residual diagram for this equation ($SRL/SSRL = 0.28M_W - 1.16$). The calculated *SRL*/*SSRL* for the moderate continental earthquakes using this relation is slightly underestimated. Average of available data about rupture length for earthquakes concludes that we could generally assume *SRL* to be about 70% of *SSRL* in Iran.

3.3.5. $\mathrm{Log}_{10}(SRL)$-$\mathrm{Log}_{10}(SSRL)$

Generally, in seismology the length of rupture at the surface is assumed to be smaller than SSRL [e.g., Wells and Coppersmith 1994]. They used the source parameters of 421 global intra-plate and inter-plate earthquakes (after 1900; M>5.0) and revealed that the ratio of *SRL* to *SSRL* of a fault increases when the magnitude of the corresponding earthquake increases. A little number of events within 53 global earthquakes investigated by Wells and Coppersmith [1995] has *SRL* greater than its *SSRL*. Here, we generally examine this idea for the Iranian earthquake faults.

The symbols of Figure 11 as well as the fitted line to the symbols (the black line corresponding to the equation of $\mathrm{Log}_{10}(SRL) = 1.29\mathrm{Log}_{10}(SSRL) - 0.65$) and green line (slope = 1.0) manifestly reveal that our study is slightly different from Wells and Coppersmith [1994]. Figure 11 shows that all the earthquakes applied for plotting the diagram have *SSRL* greater than their surface ruptures (see the line with slope 1).

3.3.6. $\mathrm{Log}_{10}(MSD)$-$\mathrm{Log}_{10}(SRL)$

There is a remarkable difference between *MSD*-*SRL* relation, estimated for the Iranian earthquakes (Figure 12a) and the global equation of Wells and Coppersmith [1994]. Figure 12a was depicted using 26 Persian earthquakes with a relatively high standard deviation (0.65) and a considerable amount of scattering. Notwithstanding near zero slope (−0.003) of the residual diagram, the relation could prudently be used for estimation of rupture characteristics for the earthquakes in Iran (Figure 12b).

4. Discussion and conclusion

Relationships between source parameters for large earthquakes in Iran have rarely been investigated. The present work has computed seismic relations using a relatively complete catalogue gathered from Persian earthquakes. Using a large amounts of seismological (magnitude and *SSRL*) and geological data (*SRL* and *MSD*), source behaviors for 436 earthquakes with $M \geq 5.0$ were investigated. Empirical relationships between M_0 and other classical magnitude scales (m_b, M_S and M_L) were derived using seismic databases of ISC, IIEES and IGUT. The empirical relationships in this study demon-

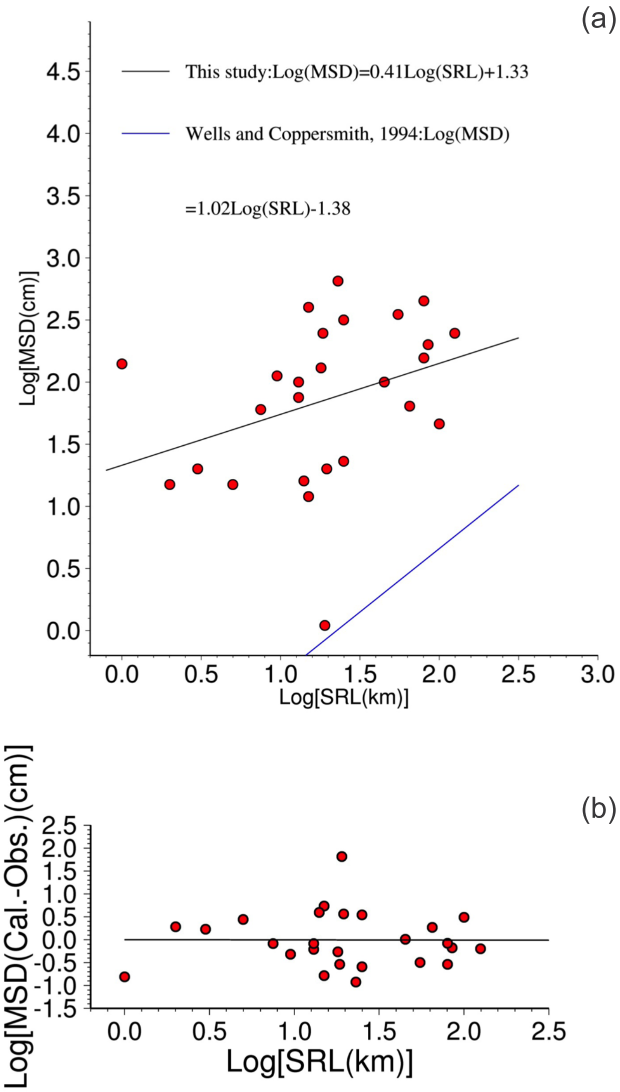


Figure 12. (a) Regression for relation between $Log_{10}(MSD)$ and $Log_{10}(SRL)$ using 26 Iranian earthquakes from 1900 to 2013 (the black and blue lines indicate to this study and Wells and Coppersmith [1994], respectively); (b) residual diagram for equation of Figure 12a.

strate a relatively robust correlation between the magnitude and various rupture parameters, which helps to confidently use these relationships for estimate either magnitudes or rupture parameters. The comparisons indicate that our models correlate fairly to the estimations of some regional and worldwide studies. Analysis of data of various magnitudes shows that regressions containing many number of the data points, are more reliable in comparison to the diagrams with less number of the events. The equations for *SSRL* is appropriate where it is difficult to estimate the deep behaviors of coseismic faults, such as buried or blind faults for example in the Zagros area in Iran.

SRL-M_W relation indicates that the Iranian earthquakes of large magnitude do not necessarily have large rupture lengths (e.g., ≈56 km rupture length calculated for *M* 7.1 event unlike 1997 Zirkuh-e Qaen earthquake (*M* 7.1) with >100km rupture). A possible explanation for this underestimation is that for a certain magnitude in continental regions, fault length is slightly greater for strike-slip events than dip-slip earthquakes [Papazachos et al. 2004]. Separating the data for strike-slip and dip-slip events decreases the uncertainty in magnitude estimations from *SRL* of the earthquakes.

We compared our derived empirical equations with that of the other studies in the literature. M_0-m_b, M_0-M_S, M_N-M_L and MSD-M_W equations have a well correlation with the worldwide and also regional relations calculated by Nuttli [1983a], Karimiparidari et al. [2013] and Papazachos et al. [2004], respectively. Also, M_0-M_S and M_0-M_L relations show good resemblance with a regional work in Taiwan [Chen et al. 2007]. According to the similarity between the results of this study and Taiwanese, it could be concluded that Iranian seismotectonic properties are not so different from Taiwan area, which is belonging to a region of Southeast Asia. We mainly confirm the results of Wells and Coppersmith [1994] for rupture length of the global historical and instrumental earthquakes. Also, we explored that the ratio of $SRL/SSRL$ slightly increases when the magnitude of corresponding earthquake increases.

However, some relations like M_W-M_N and M_N-M_L, which remarkably depart from scarce regional works (Atkinson [1993] for America, and Sonley and Atkinson [2005] for Canada) were found. This might imply that the tectonic conditions, accumulation of seismic stress energy, and crustal properties of the Iranian territory do not behave exactly like the North American region.

If we consider standard deviation under 0.35 [Wells and Coppersmith 1994], M_0-M_S, M_W-M_N, M_N-M_L, SRL-M_W, $SSRL$-M_W, $SRL/SSRL$-M_W and $SRL/SSRL$ relations were especially well calculated. The calculations for *MSD* relations are mainly associated with high standard deviations. One possible explanation for this problem is extraordinary surface displacements measured for moderate earthquakes in Persia like 1998 Fandogha (≈320 cm maximum slip for M_W 6.6; Berberian et al. [2001]) earthquake.

Acknowledgements. Thanks to the Institute of Geophysics, the University of Tehran and International Earthquake Engineering and Seismology of Iran for their online earthquake databases.

References

Aki, K. (1966). Generation and propagation of LG waves from the Niigata earthquake of June 16, 1964. 2. Estimation of earthquake movement, released energy, and stress-strain drop from G-wave spectrum, B. Earthq Res. I. Tokyo, 44, 23-88.

Aki, K. (1967). Scaling law of seismic spectrum, J. Geophys. Res., 72, 1217-1231.

Ambraseys, N.N. (1988). Magnitude - fault length relationships for earthquakes in the Middle East, In: W.H. Lee, H. Meyers and K. Shimazaki (eds.), Historical Seismograms and Earthquakes of the World, Acad. Press Inc., 309-310.

Ambraseys, N., and C. Melville (1982). A History of Persian Earthquakes, Cambridge University Press.

Ambraseys, N., and J. Jackson (1998). Faulting associated with historical and recent earthquakes in the eastern Mediterranean region, Geophys. J. Int., 133, 390-406.

Atefi, S., and M.R. Gheitanchi (2010). Investigation of source characteristics of the 1997 Ardabil Earthqualce, 14th Iranian Conference of Geophysics, 1220-1223 (in Persian).

Atkinson, G.M. (1993). Earthquake source spectra in eastern North America, B. Seismol. Soc. Am., 94, 1079-1095.

Baruah, S., P.K. Bora, R. Duarah, A. Kalita, R. Biswas, N. Gogoi and J.R. Kayal (2012). Moment magnitude - local magnitude relationship for the earthquakes of the Shillong-Mikir plateau, or the eastern India Region: a new perspective, Geomatics Natural Hazards and Risk, 3 (4), 365-375; doi:10.1080/19475705.2011.596577.

Berberian, M. (1976a). Documented earthquake faults of Iran, Geol. Surv. Iran, 39, 143-186.

Berberian, M. (1976b). The 1962 earthquakes and earlier deformation along the Ipak earthquake fault, Geol. Surv. Iran, 39, 419-427.

Berberian, M., and J.S. Tchalenko (1976a). Field study and documentation of the 1930 Salmas (Shahpour-Salmas) earthquake, Geol. Surv. Iran, 39, 271-342.

Berberian, M., and J.S. Tchalenko (1976b). Earthquakes of southern Zagros (Iran): Bushehr region, Geol. Surv. Iran, 39, 343-369.

Berberian, M., and I. Navai (1978). Naghan (Chahar Mahal-e Bakhtiari-High Zagros, Iran) earthquake of 6 April 1977. A preliminary field report and a seismotectonic discussion, Annali di Geofisica, 31 (1), 5-27.

Berberian, M., and D. Papastamatiou (1978). Khorgu (North Bandar-e Abbas, Iran) earthquake of March 21, 1977: A preliminary field report and a seismotectonic discussion, B. Seismol. Soc. Am., 68 (2), 411-428.

Berberian, M. (1979). Tabas-e Golshan (Iran) catastrophic earthquake of 16 Sep. 1978; a preliminary field report, Disasters, 2 (4), 207-219.

Berberian, M., I. Asudeh and S. Arshadi (1979). Surface rupture and mechanism of the Bob-Tangol (Southeastern Iran) earthquake of 19 Dec. 1977, Earth Planet. Sc. Lett., 42, 456-462.

Berberian, M. (1982). Aftershock tectonics of the 1978 Tabas- e-Golshan (Iran) earthquake sequence: a documented active thin- and thick-skinned tectonic' case, Geophys. J. R. astr. Soc., 68, 499-530.

Berberian, M., J.A. Jackson, M. Ghorashi and M.H. Kadjar (1984). Field and teleseismic observation of the 1981 Golbaf-Sirch earthquakes in SE Iran, Geophys. J. Int., 77 (3), 809-838.

Berberian, M., M. Qorashi, J.A. Jackson, K. Priestley and T. Wallace (1992). The Rudbar-Tarom earthquake of June 20, 1990 in NW Persia: Preliminary field and seismological observations, and its tectonic significance, B. Seismol. Soc. Am., 82, 1726-1755.

Berberian, M., and M. Qorashi (1994). Coseismic fault-related folding during the south Golbaf earthquake of November 20, 1989, in southeast Iran, Geology, 22, 531-534.

Berberian, M. (1995). Master blind thrust faults hidden under the Zagros folds: active basement tectonics and surface morphotectonic, Tectonophysics, 241, 193-224.

Berberian, M., M. Ghorashi, M. Talebian and J. Shoja-Taheri (1996). Seismotectonic and earthquake-fault hazard investigations in the Semnan region (Contribution to the Seismotectonics of Iran, Part VII), Geol. Surv. Iran, 63, 266 pp. (in Persian).

Berberian, M. (1997). Seismic source of the transcaucasian historical earthquakes. Historical and prehistorical earthquakes in Caucasus, Academic Publishers, Netherlands, 233-311.

Berberian, M., M. Qurashi, J. Shoja-Taheri and M. Talebian (2000). Seismotectonics and earthquake-fault hazard investigations in the Mashhad-Neyshabour region (Contribution to the seismotectonics of Iran, Part VIII), Geol. Surv. Iran, 72, 233 pp. (in Persian).

Berberian, M., M. Qorashi, J.A. Jackson, E. Fielding, B.E. Parsons, K. Priestley, M. Talebian, R. Walker, T.J. Wright and E. Baker (2001). The 1998 March 14 Fandoqa earthquake M=6.6 in Kerman, southeast Iran: Re-rupture of the 1981 Sirch earthquake fault, triggering of slip on adjacent thrusts, and the active tectonics of the Gowk fault zone, Geophys. J. Int., 146 (2), 371-398.

Berberian, M., and R. Walker (2010). The Rudbar-Tarom 7.3 earthquake of 1990 June 20; seismotectonics, coseismic and geomorphic displacements, and historic earthquakes of the western 'High-Alborz', Iran, Geophys. J. Int.; doi:10.1111/j.1365-246X.2010.04705.

Bethmann F., N. Deichmann and P.M. Mai (2011). Scaling relations of local magnitude versus moment magnitude for sequences of similar earthquakes in Switzerland, B. Seismol. Soc. Am., 101, 515-534; doi:0.1785/0120100179.

Bonilla, M., R. Mark and J. Lienkaemper (1984). Statis-

tical relations among earthquake magnitude, surface length and surface fault displacements, B. Seismol. Soc. Am., 74, 2379-2411.
Bormann, P., R. Liu, X. Ren, R. Gutdeutsch, D. Kaiser and S. Castellaro (2007). Chinese National Network Magnitudes, Their Relation to NEIC Magnitudes, and Recommendations for New IASPEI Magnitude Standards, B. Seismol. Soc. Am., 97 (1B), 114-127; doi:10.1785/0120060078.
Chen, K., W.G. Huang and J.H. Wang (2007). Relationships Among Magnitudes and Seismic Moment of Earthquakes in the Taiwan Region, Terr. Atmos. Ocean. Sci., 18 (5), 951-973.
Cheng, S.N., and Y.T. Yeh (1989). Catalog of earthquakes in Taiwan from 1604 to 1988, Open File Rept., Inst. Earth Sci., Acad. Sin., 255 pp. (in Chinese).
Das, R., H.R. Wason and M.L. Sharma (2011). Global regression relations forcon version of surface wave and body wave magnitudes to moment magnitude, Nat. Hazards, 59, 801-810; doi:10.1007/s11069-011-9796-6.
Das, R., H.R. Wason and M.L. Sharma (2012). Homogenization of Earthquake Catalog for Northeast India and Adjoining Region, Pure Appl. Geophys., 169, 725-731; doi:10.1007/s00024-011-0339-6.
Deniz, A., and M.S. Yucemen (2010). Magnitude conversion problem for the Turkish earthquake data, Natural Hazards, 55, 333-352; doi:10.1007/s11069-010-9531-8.
Faridi, M., and A. Sartipi (2012). The 2012 Ahar-Varzaghan earthquakes report, Geol. Surv. Iran, internal report (in Persian).
Fatemi, J., B. Akashehand and G. Hamidi (1998). The 1989/11/20 Golbaf Earthquake and its aftershocks, J. Earth and Space Physics, University of Tehran, Iran, 24 (1/2), 11-15 (in Persian).
Fuller, W.A. (1987). Measurement Error Models, Wiley, New York, 440 pp.
Gardner, J.K., and L. Knopoff (1974). Is the sequence of earthquakes in Southern California, with aftershocks removed, Poissonian?, B. Seismol. Soc. Am., 64 (5), 1363-1367.
Gasperini, P., B. Lolli, G. Vannucci and E. Boschi (2012). Calibration ofmoment magnitude estimates for the European-Mediterranean and Italian regions, Geophys. J. Int., 190, 1733-1745; doi:10.1111/j.1365-246X.2012.05575.x.
Gasperini, P., B. Lolli and G. Vannucci (2013a). Empirical Calibration of Local Magnitude DataSets Versus Moment Magnitude in Italy, B. Seismol. Soc. Am., 103 (4), 2227-2246; doi:10.1785/0120120356.
Gasperini, P., B. Lolli and G. Vannucci (2013b). Body wave magnitude m_b is a good proxy of moment magnitude Mw for small earthquakes (m_b<4.5-5.0), Seismol. Res. Lett., 84 (6), 932-937; doi: 10.1785/0220130105.
Gheitanchi, M.R., A. Fatehi and A.Sadidkhoy (1998a). Investigations of the February 4th 1997 Bojnourd, North-East Iran, earthquake sequence, J. Earth and Space Physics, University of Tehran, Iran, 24 (1/2), 29-35.
Gheitanchi, M.R., D. Shafiei and E. Bayramnajad (1998b). The February 28, 1997, Ardabil, Northwest Iran, Earthquake and its Aftershocks, J. Earth and Space Physics, University of Tehran, Iran, 24 (1/2), 1-9.
Gheitanchi, M.R. (2004). The June 22 2002 Changoureh-Avaj earthquake in Qazvin province, north central Iran, J. Earth and Space Physics, University of Tehran, Iran, 30 (1), 23-30.
Gheitanchi, M.R., and M. Raeesi (2004). Analysis of the 1997 Zirkuh (Ghean-Birjand) aftershock sequence in east-central Iran, Acta Seismologica Sinica, 17 (1) 38-46; doi:1000-9116(2004)01-0038-09.
Grünthal, G., D. Stromeyer and R. Wahlström (2009). Harmonization check of M_w within the central, northern, and north-western European earthquake catalog (CENEC), J. Seismol., 13, 613-632; doi:10.1007/s10950-009-9154-2.
Grünthal, G., and R. Wahlström (2012). The European-Mediterranean Earthquake Catalog (EMEC) for the last millennium, J. Seismol., 16, 535-570; doi:10.1007/s10950-012-9302-y.
Gutenberg, B., and C.F. Richter (1956). Earthquake magnitude, intensity, energy and acceleration (second paper), B. Seismol. Soc. Am., 46, 105-145.
Hanks, T.C., and H. Kanamori (1979). A moment magnitude scale, J. Geophys. Res., 84, 2348-2350.
Hessami, K., F. Jamali and H. Tabassi (2003). Map of Major Active Faults of Iran, Tech. rep., International Institute of Earthquake Engineering and Seismology, Iran; http://www.iiees.ir.
Hollingsworth, J., J. Jackson, R. Walker, M. Gheitanchi and M. Bolourchi (2006). Strike-slip faulting, rotation, and along-strike elongation in the Kopeh Dagh mountains, NE Iran, Geophys. J. Int., 166, 1161-1177.
Jackson, J.A., and T.J. Fitch (1979). Seismotectonic implications of relocated aftershock sequences in Iran and Turkey, Geophys. J. R. Astr. Soc., 57, 209-229.
Jackson, J.A., and T.J. Fitch (1981). Basement faulting and focal depth of the larger earthquakes in the Zagros mountains (Iran), Geophys. J. R. Astr. Soc., 64, 561-586.
Jackson, J., et al. (2006). Seismotectonic, rupture process, and earthquake hazard aspects of the 2003 December 2 6 Bam, Iran, earthquake, Geophys. J. Int., 166, 1270-1292.

Kanamori, H., and D.C. Anderson (1975). Theoretical basis of some empirical relations in seismology, B. Seismol. Soc. Am., 65, 1073-1096.

Kanamori, H. (1979). Seismological aspects of intracontinental earthquakes, Proc. Inter. Research Conf. on Intra-Continental Earthquakes, September 17-21, Ohrid, Yugoslavia, 117-127.

Karakaisis, G.F., C.B. Papazachos and E.M. Scordilis (2010). Seismic Sources and Main Seismic Faults in the Aegean and Surrounding Area (Proceedings of the 12 International Congress, Patras, May 2010), Bull. Geol. Soc. Greece.

Karimiparidari, S., M. Zaré, H. Memarian and A. Kijko (2013). Iranian earthquakes, a uniform catalog with moment magnitudes, J. Seismol., 17 (3), 897-911.

Krystek, M., and M. Anton (2007). A weighted total least-squares algorithm for fitting a straight line, Meas. Sci. Tech., 22, 3438-3442.

Maggi, A., J.A. Jackson, K. Priestley and C. Baker (2000). A re-assessment of focal depth distributions in southern Iran, the Tien Shan and northern India: do earthquakes really occur in the continental mantle?, Geology, 28 (6), 495-498.

Mohajer-Ashjaei, A., and A.A. Nowroozi (1978). Observed and probable intensity zoning of Iran, Tectonophysics, 49, 149-160.

Murotani, S., K. Satake and Y. Fujii, (2013). Scaling relations of seismic moment, rupture area, average slip, and asperity size for M~9 subduction-zone earthquakes, Geophys. Res. Lett., 40, 5070-5074; doi:10.1002/grl.50976, 2013.

Nemati, M., and M. Gheitanchi (2011). Analysis of 2005 Dahuieh (Zarand) aftershocks sequence in Kerman province, J. Earth and Space Physics, University of Tehran, Iran, 37, 1-9.

Nemati, M., B. Oveisi, M. Foroutan and M.J. Bolourchi (2012). Geomorphology and seismology of Mw 5.8 Koodian, Southeast Zagros, Geol. Surv. Iran, 85, 81-88 (in Persian).

Nemati, M. (2013). Some aspects about seismology of 2012 August 11 Ahar-Varzaghan (Azarbayjan, NW Persia) earthquakes sequences, Journal of Sciences, Islamic Republic of Iran, 24 (3), 229-241; ISSN:1016-1104.

Nemati, M. (2014) An appraisal of aftershocks behavior for large earthquakes in Persia, J. Asian Earth Sci., 79, Part A, 432-440; doi:10.1016/j.jseaes, 2013.10.015.

Nissen, E., M. Ghorashi, J. Jackson, P. Parsons and M. Talebian (2007). The 2005 Qeshm Island ea rthquake (Iran) a link between buried reverse faulting and surface folding in the Zagros Simply Folded Belt?, Geophys. J. Int., 171, 326-338.

Nissen, E., F. Yamini-Fard, M. Tatar, A. Gholamzadeh, E. Bergman, J.R. Elliott, J.A. Jackson and B. Parsons (2010). The vertical separation of mainshock rupture and microseismicity at Qeshm Island in the Zagros Simply Folded Belt, Iran, Earth Planet. Sc. Lett., 296, 181-194.

Nowroozi, A.A., A.M. Mohajer-Ashjai, M.R. Rad and A.A. Izadpanah (1977). The mainshock and aftershocks of the March 21, 1977 earthquake in the Khurgu region, Atomic Energy Authority of Iran, internal report.

Nowroozi, A.A. (1985). Empirical relationships between magnitudes and fault parameters for earthquakes in Iran, B. Seismol. Soc. Am., 75 (5), 1327-1338.

Nuttli, O.W. (1973). Seismic wave attenuation and magnitude relations for eastern North America, J. Geophys. Res., 78, 876-885.

Nuttli, O.W. (1983a). Empirical magnitude and spectral scaling relations for mid-plate and plate-margin earthquakes, Tectonophysics, 93, 207-223.

Nuttli, O.W. (1983b). Average source-parameter relations for mid-plate earthquakes, B. Seismol. Soc. Am., 13, 519-535.

Papazachos, B.C., and C.B. Papazachou (2003). The earthquakes of Greece, Ziti Publications, Thessaloniki, 273 pp.

Papazachos, B.C., E.M. Scordilis, D.G. Panagiotopoulos, C.B. Papazachos and G.F. Karakaisis (2004). Global relations between seismic fault parameters and moment magnitude of earthquakes (Proceedings of the 10th International Congress, Thessaloniki, April 2004), Bull. Geol. Soc. Greece, 36.

Rezapour, M. (1991). Study of mechanism and aftershocks of 1990 Roudbar-Manjil earthquake, Geophysics Institute, University of Tehran, Iran, M.Sc. thesis (in Persian).

Rezapour, M. (2005). Magnitude scale in the Tabriz seismic network, J. Earth Space Phys., 31 (1), 13-21.

Rezapour, M. (2009). Analysis of the causative fault during Silakhor earthquake, March 31, 2006 in Lorestan province, Iran. J. Geophysics, 3 (1), 75-89 (in Persian).

Richter, C.F. (1935). An instrumental earthquake magnitude scale, B. Seismol. Soc. Am., 25, 1-32.

Ristau, J. (2009). Comparison of Magnitude Estimates for New Zealand Earthquakes: Moment Magnitude, Local Magnitude, and Teleseismic Body-Wave Magnitude, B. Seismol. Soc. Am., 99 (3), 1841-1852; doi:10.1785/0120080237.

Scordilis, E.M. (2006). Empirical global relations converting M_S and m_b to moment magnitude, J. Seismol., 10, 225-236.

Shahrabi, T., and G.h. Dolouei (2009). Seismicity properties of the Silakhour-Boroujerd plane based on locally recorded data, Eng. Geol. J., 3 (2), 697-716.

Shahvar, M.P., M. Zare and S. Castellaro (2013). A Unified Seismic Catalog for the Iranian Plateau (1900-2011), Seismol. Res. Lett., 84 (2), 233-249.

Shin, T.C. (1986). Duration-magnitude correction for Taiwan Telemetered Seismographic Network, Bull. Inst. Earth Sci., Acad. Sin., 6, 109-120.

Shoja-Taheri, J., S. Naserieh and H. Ghofrani (2007). M_L and M_W Scales in the Iranian Plateau Based on the Strong-Motion Records, B. Seismol. Soc. Am., 97 (2), 661-669.

Smith, G.C., and C.h. Stock (2000). Evidence for different scaling of earthquake source parameters for large earth-quakes depending on faulting mechanism, Geophys. J. Int., 143, 157-169.

Sonley, E., and G. Atkinson (2005). Emperical relationship between moment magnitude and Nuttli magnitude for small-magnitude earthquakes in Southeastern Canada, Seismol. Res. Lett., 26 (6), 726-755.

Stromeyer, D., G. Grünthal and R. Wahlström (2004). Chi-square regression for seismic strength parameter relations, and their uncertainties, with applications to an M_w based earthquake catalog for central, northern and north-western Europe, J. Seismol., 8 (1), 143-153.

Talebian, M., E. Fielding, G. Funning, M. Qorashi, J. Jackson, H. Nazari, B. Parsons, K. Priestley, P.A. Rosen, R. Walker and T.J. Wright (2004). The 2003 Bam (Iran) earthquake: rupture of a blind strike-slip fault, Geophys. Res. Lett., 31, L11611.

Talebian, M., J. Biggs, M. Bolourchi, A. Copley, A. Ghassemi, M. Ghorashi, J. Hollingsworth, J. Jackson, E. Nissen, B. Oveisi, B. Parsons K. Priestley and A. Saiidi (2006). The Dahuiyeh (Zarand) earthquake of 2005 February, 22 in central Iran, Geophys. J. Int., 164, 137-148.

Tatar, M., D. Hatzfeld, A.S. Moradi and A. Paul (2005). The 2003 December 26 Bam earthquake (Iran), M 6.6, aftershock sequence, Geophys. J. Int., 163, 90-105.

Tatar, M., J. Jackson, D. Hatzfeld and E. Bergman (2007). The 2004 May 28 Baladeh earthquake (M_w 6.2) in the Alborz, Iran: overthrusting the South Caspian Basin margin, partitioning of oblique convergence and the seismic hazard of Tehran, Geophys. J. Int., 170, 249-261.

Tchalenko, J.S. (1975). Seismicity and structure of the Kopeh Dagh (Iran, USSR), Phil Trans. Roy. Soc., London, 278, 1-25.

Tocher, D. (1958). Earthquake energy and ground breakage, B. Seismol. Soc. Am., 48, 147-153.

Utsu, T., and A. Seki (1954). A relation between the area of aftershock region and the energy of mainshock, J. Seismol. Soc. Japan, 24, 233-240.

Walker, R.T., K. Priestley, M.J. Andalibi, M.R. Gheitanchi, J.A. Jackson and S. Karegar (2005a). Seismological and field observations from the 1990 November 6 Furg (Hormozgan) earthquake: a rare case of surface rupture in the Zagros mountains of Iran, Geophys. J. Int., 163, 567-579.

Walker, R.T., E. Bergman, J. Jackson, M. Ghorashi and M. Talebian (2005b). The 2002 June 22 Changureh (Avaj) earthquake in Qazvin province, northwest Iran: epicentral relocation, source parameters, surface deformation and geomorphology, Geophys. J. Int., 160, 707-720.

Walker, R.T., E.A. Bergman, W. Szeliga and E.J. Fielding (2011). Insights into the 1968-1997 Dasht-e-Bayaz and Zirkuh earthquake sequences , eastern Iran, from calibrated relocations, InSAR and high-resolution satellite imagery, Geophys. J. Int.; doi:10.1111/j.1365-246X.2011.05213.x.

Walker, R.T., E.A. Bergman, J.R. Elliott, E.J. Fielding, A.R. Ghods, M. Qorashi, J. Jackson, H. Nazari, M. Nemati, B. Oveisi, M. Talebian and R.J. Walters (2013). The 2010-2011 South Rigan (Baluchestan) earthquake sequence and its implications for distributed deformation and earthquake hazard in southeast Iran, Geophys. J. Int., 1-26; doi:10.1093/gji/ggs109.

Wang, J.H., C.C. Liu and Y.B. Tsai (1989). Local magnitude determined from a simulated Wood-Anderson seismograph, Tectonophysics, 166, 15-26.

Wang, J.H., and S.S. Ou (1998). On scaling of earthquake faults, B. Seismol. Soc. Am., 88, 758-766.

Wells, D.L., and K.J. Coppersmith (1994). New empirical relationships among magnitude, rupture length, rupture width, rupture area and surface displacement, B. Seismol. Soc. Am., 84, 974-1002.

Wesnousky, S.G. (1986). Earthquake, quaternary faults and seismic hazard in California, J. Geophys. Res., 91, 12587-12631.

Wessel, P., and W.H.F. Smith (1998). New improved version of Generic Mapping Tools released, EOS, Trans. AGU, 79 (47), 579; www.soest.hawaii.edu/gmt.

Yenier, E., O. Erdoğan and S. Akkar (2008). Empirical relationships for magnitude and source-to-site distance convergence using recently compiled Turkish strong-ground motion database, The 14th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China.

Zafarani, H., and M.Soghrat (2012). Simulation of Ground Motion in the Zagros Region of Iran Using the Specific Barrier Model and the Stochastic Method, B. Seismol. Soc. Am., 102, 2031-2045.

Zare, M., et al. (2014). Recent developments of the Middle East catalog, J. Seismol.; doi:10.1007/s10950-014-9444-1.

Web references

Harvard University, Department of Geological Sciences, Centroid Moment Tensor catalogue: http://wwwglobalcmt.org/CMTsearch.html.

International Seismological Center, ISC catalogue: http://www.isc.ac.uk.

International Seismological Center, Engdahl catalogue: http://www.isc.ac.uk.

Institute of Geophysics University of Tehran, IGUT catalogue: http://irsc.ut.ac.ir.

International Institute of Earthquake Engineering and Seismology of Iran, IIEES catalogue: http://iiees.ac.ir.

International Association of Seismology and Physics of the Earth's Interior (IASPEI): http://www.iaspei.org.

Origin Software: http://www.microcal.com.

Corresponding author: Majid Nemati,
Shahid Bahonar University of Kerman, Department of Geology,
Kerman, Iran; email: nematimajid_1974@uk.ac.ir.

Appendix 1

Large earthquakes occurred after 1900 in Iran. The earthquakes attributed to asterisks and are mainly associated with the earthquake name are interplate events and were excluded from processing. The sources are: 1- Tchalenko [1975]; 2- Berberian and Tchalenko [1976a]; 3- Berberian and Tchalenko [1976b]; 4- Berberian [1976a]; 5- Berberian [1976b]; 6- Nowroozi et al. [1977]; 7- Berberian and Navai [1978]; 8- Berberian and Papastamatiou [1978]; 9- Berberian et al. [1979]; 10- Berberian [1979]; 11- Jackson and Fitch [1979]; 12- Jackson and Fitch [1981]; 13- Ambraseys and Melville [1982]; 14- Berberian [1982]; 15- Berberian et al. [1984]; 16- Rezapour [1991]; 17- Berberian et al. [1992]; 18- Berberian and Qorashi [1994]; 19- Berberian [1995]; 20- Berberian [1997]; 21- Fatemi et al. [1998]; 22- Gheitanchi et al. [1998a]; 23- Gheitanchi et al. [1998b]; 24- Berberian et al. [2000]; 25- Berberian et al. [2001]; 26- Gheitanchi [2004]; 27- Gheitanchi and Raeesi [2004]; 28- Talebian et al. [2004]; 29- Tatar et al. [2005]; 30- Walker et al. [2005a]; 31- Walker et al. [2005b]; 32- Hollingsworth et al. [2006]; 33- Jackson et al. [2006]; 34- Talebian et al. [2006]; 35- Nissen et al. [2007]; 36- Tatar et al. [2007]; 37- Rezapour [2009]; 38- Shahrabi and Dolouei [2009]; 39- Atefi and Gheitanchi [2010]; 40- Berberian and Walker [2010]; 41- Nissen et al. [2010]; 42- Nemati and Gheitanchi [2011]; 43- Walker et al. [2011]; 44- Faridi and Sartipi [2012]; 45- Nemati et al. [2012]; 46-Nemati [2013]; 47- Walker et al. [2013]; 48- Engdahl catalogue [2014]; 49- Harvard CMT catalogue [2014]; 50- IGUT catalogue [2014]; 51- IIEES catalogue [2014] and 52- ISC catalogue [2014].

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
1	23/01/1909	2:48:18	53.000	33.000	35	-	-	-	-	7.4		7.22	45	-	100	Silakhur-Doroud	4, 13, 52
2	18/04/1911	18:14:36	56.000	32.000	50	-	-	-	-	6.7	-	6.65	-	-	-	-	52
3	17/09/1923	7:09:14	55.000	35.500	35	-	-	-	-	6.5	-	6.49	-	-	-	-	52
4	22/09/1923	20:47:38	56.500	29.000	35	-	-	-	-	6.9	-	6.81	-	-	-	-	52
5	19/05/1926	21:13:55	59.000	26.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
6	9/05/1927	10:31:47	56.000	27.500	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
7	7/07/1927	20:06:30	62.000	27.000	100	-	-	-	-	6.5	-	6.49	-	-	-	-	52
8	22/07/1927	3:55:10	53.500	34.500	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
9	12/11/1927	14:45:50	46.500	32.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
10	6/11/1928	13:42:35	53.500	40.000	35	-	-	-	-	5.6	-	5.75	-	-	-	Apsheron*	52
11	1/05/1929	15:37:30	58.000	38.000	35	-	-	-	-	7.1		6.98	-	50+	-	Baghan-Garmab	1, 4, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
12	15/07/1929	7:44:14	49.500	32.000	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
13	3/09/1929	12:07:39	62.250	26.500	110	-	-	-	-	6.5	-	6.49	-	-	-	-	52
14	29/10/1929	5:53:39	54.500	27.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
15	15/04/1930	9:56:27	54.000	29.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
16	6/05/1930	22:34:23	44.500	38.000	35	-	-	-	-	7.2	-	7.06	23	-	650	Salmas-Azarbaijan	2, 4, 20, 52
17	11/05/1930	22:35:46	55.000	27.500	35	-	-	-	-	6.0	-	6.08	-	-	-	-	52
18	2/09/1930	18:58:48	51.500	30.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
19	27/04/1931	16:50:38	46.000	38.750	35	-	-	-	-	6.5	-	6.49	-	-	-	-	52
20	5/05/1931	6:42:15	54.000	26.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
21	28/07/1931	17:36:25	52.000	29.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
22	8/08/1931	8:54:16	58.500	37.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
23	22/01/1932	0:48:56	47.000	33.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
24	4/02/1932	21:18:09	62.250	26.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
25	15/03/1932	10:18:06	48.000	34.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
26	18/04/1932	11:23:21	64.000	25.000	35	-	-	-	-	6.0	-	6.08	-	-	-	Makran*	52
27	7/05/1932	14:54:09	45.000	36.250	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
28	20/05/1932	19:16:11	53.500	36.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
29	8/09/1932	7:25:32	58.500	31.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
30	21/02/1933	19:02:59	57.500	27.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
31	5/10/1933	13:29:45	57.750	35.000	35	-	-	-	-	6.0	-	6.08	-	-	-	-	52
32	28/11/1933	11:09:18	56.000	32.000	35	-	-	-	-	6.2	-	6.24	25	-	-	Behabad-e Kuhbanan	4, 20, 52
33	2/01/1934	20:55:38	57.500	30.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
34	4/02/1934	13:27:14	51.750	30.500	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
35	22/02/1934	8:07:13	45.000	38.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
36	13/06/1934	22:10:28	62.500	27.500	80	-	-	-	-	7.0	-	6.90	-	-	-	Makran*	52
37	5/03/1935	10:26:35	53.250	36.250	35	-	-	-	-	6.0	-	6.08	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
38	11/04/1935	23:14:43	53.500	36.500	35	-	-	-	-	6.8	-	6.73	-	-	-	-	52
39	30/06/1936	19:26:06	60.000	33.000	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
40	25/01/1939	11:02:22	50.000	31.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
41	6/04/1939	4:08:00	54.500	35.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
42	10/06/1939	8:36:41	56.500	33.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
43	4/11/1939	10:15:24	49.500	32.000	35	-	-	-	-	6.0	-	6.08	-	-	-	-	52
44	4/05/1940	21:01:54	58.250	35.250	35	-	-	-	-	6.5	-	6.49	-	-	-	-	52
45	6/07/1940	17:45:12	46.500	33.500	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
46	16/02/1941	16:39:03	59.000	33.750	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
47	10/06/1941	20:38:43	47.500	32.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
48	10/01/1943	2:35:58	59.750	32.900	-	-	-	-	-	6.2	-	6.24	30	-	-	Nozad	4, 52
49	6/02/1943	2:35:58	63.000	24.500	35	-	-	-	-	6.2	-	6.24	-	-	-	Apsheron*	4, 52
50	27/10/1945	21:57:00	60.500	25.000	-	-	-	-	-	8.2	-	7.88	-	-	-	Makran*	52
51	27/11/1945	21:56:50	63.000	24.500	35	-	-	-	-	8.2	-	7.88	-	-	-	Makran*	52
52	27/07/1946	16:25:43	46.000	36.000	35	-	-	-	-	5.5	-	5.67	-	-	-	-	52
53	17/08/1946	9:48:06	46.000	35.000	35	-	-	-	-	5.6	-	5.75	-	-	-	-	52
54	4/11/1946	21:47:47	54.500	39.750	35	-	-	-	-	7.5	-	7.30	-	-	-	Apsheron*	52
55	5/08/1947	14:24:10	63.000	25.500	35	-	-	-	-	7.3	-	7.14	-	-	-	Makran*	52
56	23/09/1947	12:28:09	59.000	33.000	35	-	-	-	-	6.8		6.73	10	-	-	-	43, 52
57	3/10/1947	6:13:51	58.000	27.500	35	-	-	-	-	6.2	-	6.24	-	-	-	-	52
58	5/10/1948	20:12:05	58.000	37.500	35	-	-	-	-	7.3	-	7.14	-	-	-	-	52
59	9/05/1950	11:16:56	58.400	38.400	-	-	-	-	6.1	-	-	6.54	-	-	-	-	5, 13
60	16/08/1951	23:52:10	57.000	28.000	-	-	-	-	-	5.5	-	5.67	-	-	-	-	5, 51
61	12/02/1953	8:15:31	55.000	35.800	-	-	-	-	6.9	-	-	7.42	1+?	-	140	Toroud	4, 51, 52
62	1/11/1954	21:09:58	57.000	37.000	-	-	-	-	-	5.5	-	5.67	-	-	-	-	51
63	17/12/1955	8:06:42	49.000	33.500	-	-	-	-	-	5.5	-	5.67	-	-	-	-	51

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
64	12/04/1956	22:34:46	50.200	37.300	-	-	-	-	-	5.5	-	5.67	-	-	-	-	51
65	31/10/1956	14:03:43	54.430	27.250	-	-	-	-	5.5	-	-	5.88	-	-	-	-	51
66	13/12/1957	1:45:05	47.670	34.410	42	-	-	-	-	6.7	-	6.65	20	-	-	-	4, 13, 52
67	5/05/1958	5:21:30	44.710	35.570	-	-	-	-	-	5.5	-	5.67	-	-	-	-	51
68	14/08/1958	11:26:59	47.740	34.150	-	-	-	-	5.5	-	-	5.88	-	-	-	-	51
69	16/08/1958	19:13:44	47.830	34.380	-	-	-	-	-	6.6	-	6.57	-	-	-	-	13
70	1/08/1960	2:20:50	54.380	28.120	62	-	-	-	6.0	-	-	6.43	-	-	-	-	48, 52
71	6/04/1961	18:12:39	56.780	28.200	29	-	-	-	5.7	-	-	6.10	-	-	-	-	13
72	11/06/1961	5:10:23	54.510	27.930	0	-	-	-	-	6.5	-	6.49	-	-	-	-	13
73	11/06/1961	5:30:15	54.900	27.920	68	-	-	-	-	5.6	-	5.75	-	-	-	-	48, 52
74	11/06/1961	12:31:26	54.490	27.890	12	-	-	-	-	5.7	-	5.83	-	-	-	-	48, 52
75	23/06/1961	16:36:34	55.030	27.780	121	-	-	-	-	5.6	-	5.75	-	-	-	-	48, 52
76	1/04/1962	0:45:09	58.930	33.370	0	-	-	-	-	5.5	-	5.67	-	-	-	-	52
77	29/06/1962	22:35:46	48.830	32.360	60	-	-	-	-	5.6	-	5.75	-	-	-	-	5, 48, 52
78	1/09/1962	19:20:40	49.880	35.580	29	-	-	-	-	7.2	-	7.06	100	-	46.1	Buyin Zahra	4, 5, 13, 52
79	4/09/1962	13:30:14	49.740	35.590	43	-	-	-	5.6	-	-	5.99	-	-	-	-	48, 52
80	4/09/1962	22:59:17	44.210	39.970	5	-	-	-	-	5.8	-	5.91	-	-	-	-	48, 52
81	29/09/1962	6:53:46	57.000	27.000	-	-	-	-	-	5.5	-	5.67	-	-	-	-	52
82	1/10/1962	12:14:01	54.780	27.950	40	-	-	-	-	-	6.3	6.30	-	-	-	-	48, 52
83	13/10/1962	10:23:38	50.070	35.750	35	-	-	-	5.5	-	-	5.88	-	-	-	-	48, 52
84	6/11/1962	0:09:49	55.510	28.120	36	-	-	-	5.6	-	-	5.99	-	-	-	-	13
85	24/03/1963	12:44:05	47.800	34.440	40	-	-	-	-	5.8	-	5.91	-	-	-	-	13
86	2/05/1963	1:58:21	54.700	27.700	40	-	-	-	-	5.8	-	5.91	-	-	-	-	52
87	3/05/1963	10:44:31	51.700	30.800	-	-	-	-	-	5.8	-	5.91	-	-	-	-	52
88	30/06/1963	7:41:10	49.200	33.600	-	-	-	-	-	5.5	-	5.67	-	-	-	-	52
89	19/01/1964	9:13:54	54.000	26.790	38	-	-	-	5.6	-	-	5.99	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	SRL (km)	$SSRL$ (km)	MSD (cm)		
90	20/03/1964	3:15:47	55.210	27.930	64	-	-	-	4.7	-	-	4.99	-	-	-	-	52
91	19/08/1964	9:33:09	52.650	28.210	37	-	-	-	5.5	-	-	5.88	-	-	-	-	52
92	19/08/1964	15:20:14	52.640	28.190	47	-	-	-	5.5	-	-	5.88	-	-	-	-	52
93	20/08/1964	5:39:46	52.620	28.180	33	-	-	-	5.6	-	-	5.99	-	-	-	-	52
94	22/12/1964	4:36:36	56.910	28.200	43	-	-	-	5.7	-	-	6.10	-	-	-	-	52
95	21/06/1965	0:21:14	55.890	28.120	26	-	-	-	5.8	-	-	6.21	-	-	-	-	52
96	18/09/1966	20:43:56	54.300	27.870	39	-	-	-	5.9	-	-	6.32	-	-	-	-	52
97	11/01/1967	11:20:46	45.670	34.090	39	-	-	-	5.6	-	-	5.99	-	-	-	-	52
98	29/01/1967	7:56:40	55.210	26.540	34	-	-	-	5.1	-	-	5.44	-	-	-	-	52
99	1/02/1967	1:07:20	55.270	26.580	22	-	-	-	5.0	-	-	5.33	-	-	-	-	52
100	29/04/1968	17:01:56	44.230	39.240	17	-	-	-	5.3	-	-	5.66	-	-	-	-	52
101	2/08/1968	13:30:23	60.920	27.540	65	-	-	-	5.7	-	-	6.10	-	-	-	-	52
102	30/08/1968	10:47:41	59.010	34.150	25	-	-	-	5.9	-	7.1	7.10	80	-	450	Dasht-e Bayaz	43, 52
103	1/09/1968	7:27:31	58.240	34.090	14	-	-	-	5.9	-	6.3	6.30	-	-	-	Ferdows	43, 52
104	14/09/1968	13:48:26	53.170	28.300	3	-	-	-	5.8	-	-	6.21	-	-	-	-	52
105	15/11/1968	6:25:39	58.500	37.600	22	-	-	-	5.1	-	-	5.44	-	-	-	-	52
106	3/01/1969	3:16:37	57.830	37.100	4	-	-	-	5.4	-	-	5.77	-	-	-	-	52
107	29/04/1969	4:37:39	51.540	29.590	21	-	-	-	5.5	-	-	5.88	-	-	-	-	52
108	7/11/1969	18:34:04	60.020	27.800	74	-	-	-	6.1	-	-	6.54	-	-	-	-	52
109	23/02/1970	11:22:29	54.520	27.830	36	-	-	-	5.4	-	-	5.77	-	-	-	-	52
110	28/02/1970	19:58:49	56.330	27.810	41	-	-	-	5.5	-	-	5.88	-	-	-	-	52
111	30/07/1970	0:52:20	55.940	37.850	22	-	-	-	5.7	-	-	6.10	-	-	-	-	52
112	25/10/1970	11:22:21	45.170	36.740	44	-	-	-	5.3	-	-	5.66	-	-	-	-	52
113	9/11/1970	17:41:43	56.810	29.550	114	-	-	-	5.4	-	-	5.77	-	-	-	-	52
114	14/02/1971	16:27:32	55.738	36.621	3.6	-	-	-	5.3	-	-	5.66	-	-	-	-	52
115	12/04/1971	19:03:25	55.607	28.297	37.3	-	-	-	6.0	-	-	6.43	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
116	26/05/1971	2:41:46	58.195	35.554	24.5	-	-	-	5.4	-	-	5.77	-	-	-	-	52
117	9/08/1971	2:54:35	52.809	36.271	11.6	-	-	-	5.2	-	-	5.55	-	-	-	-	52
118	8/09/1971	12:53:37	60.040	29.186	34.1	-	-	-	5.3	-	-	5.66	-	-	-	-	52
119	8/11/1971	3:06:34	54.471	27.037	11.2	-	-	-	5.6	-	-	5.99	-	-	-	-	52
120	9/12/1971	1:42:32	56.417	27.280	24.5	-	-	-	5.3	-	-	5.66	-	-	-	-	52
121	3/04/1972	8:06:09	52.725	28.545	56.6	-	-	-	4.5	-	-	4.77	-	-	-	-	52
122	10/04/1972	2:06:50	52.785	28.395	10.6	-	-	-	6.0	-	-	6.43	20	40	-	Qir-Karzin	4, 11, 19, 52
123	11/04/1972	6:00:03	62.070	37.361	20.1	-	-	-	4.9	-	-	5.22	-	-	-	-	52
124	12/06/1972	13:34:00	46.252	32.984	33.7	-	-	-	5.3	-	-	5.66	-	-	-	-	52
125	14/06/1972	4:34:30	46.116	33.048	46.6	-	-	-	5.2	-	-	5.55	-	-	-	-	52
126	2/07/1972	12:56:06	50.870	30.087	27.3	-	-	-	5.4	-	-	5.77	15	-	400	Mishan-Zagros	3, 4, 19, 52
127	6/08/1972	1:12:51	61.220	25.040	36.2	-	-	-	5.4	-	-	5.77	-	-	-	Makran*	52
128	17/11/1972	9:09:02	59.144	27.404	79.4	-	-	-	5.2	-	-	5.55	-	-	-	-	52
129	26/04/1973	14:30:05	60.830	27.143	42	-	-	-	5.0	-	-	5.33	-	-	-	-	52
130	2/08/1973	19:56:26	56.575	37.353	35.2	-	-	-	5.1	-	-	5.44	-	-	-	-	52
131	25/08/1973	14:58:11	56.794	28.171	56.7	-	-	-	5.3	-	-	5.66	-	-	-	-	52
132	11/11/1973	7:14:52	53.002	30.531	19.4	-	-	-	5.4	-	-	5.77	-	-	-	-	52
133	7/01/1974	15:24:40	47.950	33.262	51.7	-	-	-	5.0	-	-	5.33	-	-	-	-	52
134	7/03/1974	11:36:02	55.952	37.648	21.3	-	-	-	5.2	-	-	5.55	-	-	-	-	52
135	17/11/1974	15:05:47	55.103	32.854	38.6	-	-	-	5.0	-	-	5.33	-	-	-	-	52
136	27/11/1974	16:52:51	45.658	35.255	57.2	-	-	-	5.0	-	-	5.33	-	-	-	-	52
137	2/12/1974	9:05:47	55.892	28.140	59.2	-	-	-	5.4	-	-	5.77	-	-	-	-	52
138	14/01/1975	22:07:54	44.823	35.436	68.1	-	-	-	4.9	-	-	5.22	-	-	-	-	52
139	7/03/1975	7:04:43	56.245	27.472	30.7	-	-	-	5.8	-	-	6.21	-	-	-	-	52
140	21/09/1975	14:16:38	51.045	31.591	28.3	-	-	-	5.2	-	-	5.55	-	-	-	-	52
141	8/10/1975	8:15:52	55.661	28.218	62.4	-	-	-	5.1	-	-	5.44	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
142	24/12/1975	11:48:57	55.500	27.037	35.6	-	-	-	5.5	-	-	5.88	-	-	-	-	52
143	10/03/1976	4:39:20	57.439	28.455	83.2	-	-	-	4.7	-	-	4.99	-	-	-	-	52
144	16/03/1976	7:28:58	55.004	27.331	35.8	-	-	-	5.4	-	-	5.77	-	-	-	-	52
145	22/04/1976	17:03:07	52.122	28.706	18.6	0.37	-	-	5.9	5.5	5.6	5.60	-	-	-	-	49, 52
146	15/10/1976	23:03:25	51.994	30.059	3.2	-	-	-	5.1	-	-	5.44	-	-	-	-	52
147	7/11/1976	4:00:50	59.233	33.864	5.6	1.09	-	-	5.6	6.2	6.0	6.00	-	-	-	-	49, 52
148	7/11/1976	11:07:58	47.936	33.198	63.3	-	-	-	5.5	-	-	5.88	-	-	-	-	52
149	15/11/1976	8:03:23	47.945	33.191	53.1	-	-	-	5.2	-	-	5.55	-	-	-	-	52
150	24/11/1976	12:22:16	44.037	39.051	9.7	-	-	-	6.1	-	-	6.54	55	-	350	Chalderan-Azarbaijan	2, 4, 49, 52
151	5/01/1977	5:44:41	56.251	27.469	34.9	0.05	-	-	5.5	5.2	5.1	5.10	-	-	-	-	49, 52
152	18/01/1977	8:48:54	48.003	33.105	49.2	-	-	-	5.2	-	-	5.55	-	-	-	-	52
153	21/03/1977	22:42:07	56.493	27.624	37	14	-	-	5.7	6.9	6.7	6.70	-	40	-	Khurgu-Bandar-e Abbas	6, 8, 12, 41, 49, 52
154	23/03/1977	23:51:16	56.583	27.632	35.1	0.22	-	-	5.7	5.4	5.5	5.50	-	-	-	-	49, 52
155	24/03/1977	4:42:25	56.617	27.651	40	-	-	-	5.2	-	-	5.55	-	-	-	-	52
156	29/03/1977	22:29:17	56.395	27.613	36.1	-	-	-	5.1	-	-	5.44	-	-	-	-	52
157	1/04/1977	13:36:24	56.304	27.566	22.6	0.96	-	-	5.9	6.0	5.9	5.90	-	-	-	-	49, 52
158	6/04/1977	13:36:38	50.697	31.992	42.5	1.3	-	-	5.4	5.9	6.0	6.00	-	25	-	Naghan-Zagros	7, 19, 49, 52
159	26/04/1977	16:25:29	48.922	32.662	51.6	-	-	-	5.4	-	-	5.77	-	-	-	-	52
160	19/05/1977	22:58:32	55.333	27.152	33.6	-	-	-	5.2	-	-	5.55	-	-	-	-	52
161	25/05/1977	11:01:47	52.064	34.907	38.9	-	-	-	5.3	-	-	5.66	-	-	-	-	52
162	26/05/1977	1:35:14	44.377	38.925	37.9	0.37	-	-	5.2	5.4	5.6	5.60	-	-	-	-	49, 52
163	5/06/1977	4:45:08	48.076	32.637	44.8	1.56	-	-	5.6	5.8	6.1	6.10	-	-	-	-	49, 52
164	19/10/1977	6:35:12	54.918	27.801	39.4	0.21	-	-	5.5	5.2	5.5	5.50	-	-	-	-	49, 52
165	10/12/1977	5:46:23	56.633	27.680	43.8	0.31	-	-	5.1	5.0	5.6	5.60	-	-	-	-	49, 52
166	19/12/1977	23:34:33	56.483	30.928	26.1	0.77	-	-	5.3	5.8	5.9	5.90	19.5	-	20	Gisk	8, 9, 52
167	10/02/1978	20:50:48	62.401	25.326	31.3	-	-	-	5.1	5.0	-	5.26	-	-	-	Makran*	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
168	11/02/1978	21:40:13	55.430	28.196	51.8	-	-	-	5.2	4.9	-	5.18	-	-	-	-	52
169	16/09/1978	15:35:57	57.437	33.369	34.1	132	-	-	6.4	7.4	7.3	7.30	85	85	200	Tabas-e Golshan	9, 10, 14, 49, 52
170	4/11/1978	15:22:20	48.947	37.713	36.8	3.8	-	-	6.0	6.1	6.3	6.30	-	-	-	-	49, 52
171	6/12/1978	17:18:13	57.153	33.292	18.6	-	-	-	5.3	5.2	-	5.42	-	-	-	-	52
172	14/12/1978	7:05:22	49.639	32.140	40.4	1.9	-	-	5.6	6.2	6.1	6.10	-	-	-	-	49, 52
173	10/01/1979	1:26:04	60.953	26.551	3.8	1.08	-	-	5.5	5.9	6.0	6.00	-	-	-	-	49, 52
174	10/01/1979	15:05:43	61.023	26.475	3.3	1.72	-	-	5.5	6.1	6.1	6.10	-	-	-	-	49, 52
175	16/01/1979	9:50:07	59.531	33.956	9.7	6.75	-	-	5.9	6.7	6.5	6.50	-	-	-	-	49, 52
176	13/02/1979	10:36:15	57.435	33.349	22.9	-	-	-	5.4	5.5	-	5.67	-	-	-	-	52
177	14/11/1979	2:21:18	59.806	34.029	3	8.15	-	-	6.0	6.7	6.5	6.50	60	-	-	-	43, 49, 52
178	27/11/1979	7:12:34	59.900	34.093	3	46.1	-	-	5.1	5.3	7.0	7.00	-	150	-	Kuli-Boniabad	43, 49, 52
179	7/12/1979	9:23:56	59.918	34.139	0	1.53	-	-	5.9	6.1	6.1	6.10	15	-	-	-	43, 49, 52
180	9/12/1979	9:12:04	56.867	35.142	22.9	0.28	-	-	5.2	5.5	5.6	5.60	-	-	-	-	52, 49
181	1/01/1980	2:45:55	60.387	27.336	40	-	-	-	5.3	-	-	5.66	-	-	-	-	52
182	12/01/1980	15:31:40	57.257	33.583	13.6	1.27	-	-	5.3	5.8	6.0	6.00	-	-	-	-	49, 52
183	4/05/1980	18:35:20	49.065	38.091	35.8	7.8	-	-	5.3	6.1	6.5	6.50	-	-	-	-	49, 52
184	22/07/1980	5:17:08	50.350	37.358	36.8	-	-	-	5.3	5.1		5.34	-	-	-	-	52
185	19/10/1980	17:24:11	48.592	32.737	47.7	0.55	-	-	5.2	5.7	5.8	5.80	-	-	-	-	49, 52
186	17/11/1980	18:26:32	56.109	27.437	44.8	-	-	-	5.1	4.7	-	5.02	-	-	-	-	52
187	28/11/1980	21:15:31	56.562	27.659	42.8	0.14	-	-	5.5	5.1	5.4	5.40	-	-	-	-	49, 52
188	18/12/1980	12:34:20	44.653	35.944	74.2	2	-	-	5.4	5.8	6.1	6.10	-	-	-	-	49, 52
189	19/12/1980	1:16:56	50.673	34.501	29.2	2.13	-	-	5.5	5.8	6.2	6.20	-	-	-	-	49, 52
190	22/12/1980	12:51:21	50.672	34.485	39.5	0.46	-	-	5.4	5.2	5.7	5.70	-	-	-	-	49, 52
191	1/04/1981	10:17:00	51.483	29.835	41	-	-	-	5.5	4.4	-	4.77	-	-	-	-	52
192	16/04/1981	10:27:19	56.370	27.732	52.6	-	-	-	5.3	4.3	-	4.69	-	-	-	-	52
193	11/06/1981	7:24:25	57.718	29.895	30.9	9.82	-	-	6.0	6.6	6.6	6.60	15	-	12	Golbaf	18, 49, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
194	23/07/1981	0:05:33	45.206	37.106	50.9	0.69	-	-	5.6	5.5	5.8	5.80	-	-	-	-	49, 52
195	28/07/1981	17:22:23	57.770	29.988	11.1	9.01	-	-	5.9	7.0	7.2	7.20	65	-	64	Sirch	15, 25, 49, 52
196	4/08/1981	18:35:43	49.412	38.206	39.8	0.29	-	-	5.4	5.2	5.6	5.60	-	-	-	-	49, 52
197	14/10/1981	9:12:40	57.759	29.900	43.4	-	-	-	5.2	4.6	-	4.93	-	-	-	-	52
198	11/07/1982	13:19:51	56.275	27.880	45.2	-	-	-	5.3	4.8	-	5.10	-	-	-	-	52
199	19/12/1982	19:40:52	57.558	30.565	33.1	-	-	-	5.1	6.2	-	6.24	-	-	-	-	52
200	7/02/1983	15:06:27	57.589	26.887	24.5	0.98	-	-	5.5	5.7	5.9	5.90	-	-	-	-	49, 52
201	5/03/1983	14:22:37	49.342	32.497	39.4	0.35	-	-	5.3	5.3	5.6	5.60	-	-	-	-	49, 52
202	14/03/1983	12:12:48	54.601	39.367	33	-	-	-	5.2	5.6	-	5.75	-	-	-	Apsheron*	52
203	25/03/1983	11:57:47	52.362	36.132	10	-	-	-	5.1	4.9	-	5.18	-	-	-	-	52
204	26/03/1983	4:07:20	52.279	36.057	33	-	-	-	5.4	4.9	-	5.18	-	-	-	-	52
205	18/04/1983	10:58:49	62.070	27.782	44.5	0.14	-	-	6.4	6.3	6.7	6.70	-	-	-	Makran*	49, 52
206	28/05/1983	11:35:55	48.562	32.606	42.9	0.26	-	-	5.6	5.0	5.5	5.50	-	-	-	-	49, 52
207	12/07/1983	11:34:20	56.422	27.612	42	1.07	-	-	5.7	5.8	6.0	6.00	-	-	-	-	49, 52
208	22/07/1983	2:41:01	49.226	36.978	43	-	-	-	5.6	5.0	-	5.26	-	-	-	-	52
209	22/02/1984	5:44:37	54.109	39.522	0	0.54	-	-	5.1	5.8	5.8	5.80	-	-	-	Apsheron*	49, 52
210	6/07/1984	4:08:03	58.336	36.560	10	-	-	-	4.8	5.8	-	5.91	-	-	-	-	52
211	6/08/1984	11:14:36	57.191	30.847	22.1	0.15	-	-	5.6	5.3	5.4	5.40	-	-	-	-	49, 52
212	2/02/1985	20:52:35	52.990	28.383	44.1	0.19	-	-	5.1	5.3	5.4	5.40	-	-	-	-	49, 52
213	7/08/1985	15:43:26	53.059	27.864	39.7	0.26	-	-	5.4	5.4	5.5	5.50	-	-	-	-	49, 52
214	16/08/1985	10:46:48	59.364	37.133	10	0.27	-	-	5.4	5.2	5.6	5.60	-	-	-	-	49, 52
215	29/10/1985	13:13:40	54.811	36.745	12.6	1.61	-	-	6.0	6.0	6.1	6.10	-	-	-	Ali Abad-e Gorgan*	49, 52
216	27/01/1986	16:35:51	48.679	38.932	55.7	-	-	-	5.3	4.3	-	4.69	-	-	-	-	52
217	2/05/1986	3:18:37	53.322	28.022	26.8	0.23	-	-	5.5	5.1	5.5	5.50	-	-	-	-	49, 52
218	3/05/1986	10:37:42	53.343	28.027	31.1	-	-	-	5.4	4.7	-	5.02	-	-	-	-	52
219	12/07/1986	7:54:25	51.580	29.911	1.2	0.41	-	-	5.7	5.5	5.7	5.70	-	-	-	-	49, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
220	20/12/1986	23:47:10	51.595	29.948	32.1	0.16	-	-	5.4	4.9	5.4	5.40	-	-	-	-	49, 52
221	29/04/1987	1:45:25	56.127	27.427	27.5	0.43	-	-	5.8	5.4	5.7	5.70	-	-	-	-	49, 52
222	10/08/1987	10:52:21	63.887	29.851	175.6	-	-	-	5.5	-	-	5.88	-	-	-	-	52
223	7/09/1987	11:32:28	54.758	39.368	38.6	0.41	-	-	5.5	5.5	5.7	5.70	-	-	-	Apsheron*	49, 52
224	18/12/1987	16:24:06	56.672	28.153	44.5	-	-	-	5.7	5.5	-	5.67	-	-	-	-	52
225	26/01/1988	9:34:50	47.080	32.740	40.1	0.26	-	-	5.2	5.4	5.5	5.50	-	-	-	-	49, 52
226	30/03/1988	2:12:43	50.182	30.854	35.5	0.74	-	-	5.4	5.7	5.8	5.80	-	-	-	-	49, 52
227	22/04/1988	1:54:08	50.371	30.748	26	-	-	-	5.1	4.5	-	4.85	-	-	-	-	52
228	11/08/1988	16:00:06	51.588	29.961	17.9	0.57	-	-	5.4	5.6	5.8	5.80	-	-	-	-	49, 52
229	11/08/1988	16:04:46	51.693	29.947	36.3	1.42	-	-	5.6	5.9	6.0	6.00	-	-	-	-	49, 52
230	22/08/1988	21:23:36	52.378	35.348	18.4	-	-	-	5.0	5.0	-	5.26	-	-	-	-	52
231	23/08/1988	5:30:51	52.275	35.420	34.7	-	-	-	5.0	4.8	-	5.10	-	-	-	-	52
232	6/12/1988	13:20:42	51.638	29.921	16.9	0.78	-	-	5.5	5.6	5.9	5.90	-	-	-	-	52
233	2/04/1989	6:42:03	57.288	28.166	33.1	0.14	-	-	5.2	4.8	5.4	5.40	-	-	-	-	52
234	2/04/1989	21:24:37	47.766	32.600	33	-	-	-	5.5	5.0	-	5.26	-	-	-	-	52
235	27/05/1989	20:08:38	50.882	30.130	33.4	1.25	-	-	5.6	5.7	6.0	6.03	-	-	-	-	49, 52
236	29/05/1989	5:46:42	50.926	30.092	38.3	-	-	-	4.7	4.5	-	4.85	-	-	-	-	52
237	13/09/1989	7:01:32	54.254	37.281	38.3	-	-	-	5.1	4.4	-	4.77	-	-	-	-	52
238	4/11/1989	20:47:19	57.574	30.573	16.4	-	-	-	5.0	5.6	-	5.75	-	-	-	-	52
239	20/11/1989	4:19:05	57.722	29.881	18	0.81	-	-	5.5	5.7	5.9	5.91	19	20	1.1	Golbaf	18, 21, 52
240	7/12/1989	12:59:33	59.000	25.923	11.3	0.97	-	-	5.7	5.8	6.0	5.96	-	-	-	-	49, 52
241	20/01/1990	1:27:10	52.999	35.892	25	1.02	-	-	5.5	5.8	6.0	5.97	-	-	-	Firuzkuh	49, 52
242	20/06/1990	21:00:11	49.346	36.989	18.5	135	-	-	6.2	7.4	7.4	7.39	80	90	156	Rudbar-Tarom	16, 17, 40, 49, 52
243	26/09/1990	15:32:40	60.912	29.139	33.8	0.3	-	-	5.4	5.4	5.6	5.62	-	-	-	-	49, 52
244	11/10/1990	13:57:06	48.200	32.816	50.3	-	-	-	5.3	4.4	-	4.77	-	-	-	-	52
245	6/11/1990	18:45:53	55.470	28.230	15.7	8.32	-	-	6.1	6.6	6.6	6.58	18.5	50	247	Darab-e Hormozgan	30, 49, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	SRL (km)	$SSRL$ (km)	MSD (cm)		
246	16/12/1990	22:18:50	51.290	28.984	16.3	0.41	-	-	5.3	5.5	5.7	5.71	-	-	-	-	49, 52
247	1/01/1991	19:18:58	48.457	39.796	72.6	-	-	-	5.0	-	-	5.33	-	-	-	-	52
248	14/02/1991	8:25:58	50.830	30.280	47.3	-	-	-	5.3	4.6	-	4.93	-	-	-	-	52
249	22/05/1991	16:29:02	55.788	27.395	24.6	-	-	-	5.7	5.1	-	5.34	-	-	-	-	52
250	24/07/1991	9:45:44	44.039	36.523	46.2	-	-	-	5.4	5.1	-	5.34	-	-	-	-	52
251	11/10/1991	3:14:42	50.748	31.647	41.2	-	-	-	5.1	5.1	-	5.34	-	-	-	-	52
252	4/11/1991	1:50:32	50.249	30.680	37.1	0.31	-	-	5.3	5.5	-	5.67	-	-	-	-	52
253	28/11/1991	17:20:00	49.582	36.862	50.4	0.32	-	-	5.6	5.0	5.6	5.64	-	-	-	-	49, 52
254	7/12/1991	14:22:33	62.997	25.225	29.9	0.29	-	-	5.2	5.1	5.6	5.61	-	-	-	Makran*	49, 52
255	19/12/1991	18:55:21	57.261	28.072	54.8	-	-	-	5.3	4.8	-	5.10	-	-	-	-	52
256	30/01/1992	5:22:02	63.172	25.009	29.1	0.67	-	-	5.4	5.6	5.9	5.85	-	-	-	Makran*	49, 52
257	19/05/1992	12:25:00	55.601	28.281	54.8	0.29	-	-	5.6	5.1	5.6	5.61	-	-	-	-	49, 52
258	11/09/1992	12:06:04	51.119	29.921	47	-	-	-	5.1	5.0	-	5.26	-	-	-	-	52
259	11/09/1992	18:24:16	60.768	30.078	43.7	-	-	-	5.2	4.8	-	5.10	-	-	-	-	52
260	22/09/1992	14:05:56	52.719	36.339	43.5	-	-	-	5.1	4.3	-	4.69	-	-	-	-	52
261	27/11/1992	21:09:17	59.911	37.481	24.4	0.1	-	-	5.0	5.0	5.3	5.30	-	-	-	-	49, 52
262	17/12/1992	10:39:29	61.468	25.909	30.9	0.44	-	-	5.7	5.3	5.7	5.73	-	-	-	-	49, 52
263	6/01/1993	22:51:45	52.142	29.026	23.6	0.14	-	-	5.4	5.4	5.4	5.40	-	-	-	-	49, 52
264	12/04/1993	14:00:41	57.134	28.268	33.3	-	-	-	5.2	4.4	-	4.77	-	-	-	-	52
265	22/06/1993	16:32:45	50.831	30.197	43	-	-	-	5.4	4.9	-	5.18	-	-	-	-	52
266	21/10/1993	21:52:24	51.236	30.193	37.3	-	-	-	5.1	4.3	-	4.69	-	-	-	-	52
267	19/12/1993	11:45:31	62.593	25.270	24.4	-	-	-	5.1	4.9	-	5.18	-	-	-	-	52
268	23/02/1994	8:02:05	60.570	30.806	6	1.72	-	-	6.0	6.1	6.1	6.12	9.5	-	112	Sefidabeh	24, 49, 52
269	24/02/1994	0:11:13	60.517	30.768	13.4	3.3	-	-	6.0	6.0	6.3	6.31	-	-	-	-	49, 52
270	1/03/1994	3:49:00	52.624	29.100	9.3	-	-	-	5.8	6.1	-	6.16	-	-	-	-	52
271	29/03/1994	7:56:51	51.314	29.154	12.9	1.37	-	-	5.3	4.6	6.1	6.06	-	-	-	-	49, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
272	30/03/1994	19:55:42	52.777	28.961	16.5	0.16	-	-	5.3	5.2	5.4	5.44	-	-	-	-	49, 52
273	3/04/1994	6:51:58	52.747	28.856	20.9	-	-	-	5.0	4.9	-	5.18	-	-	-	-	52
274	20/06/1994	9:09:03	52.641	29.014	8.6	0.8	-	-	5.8	5.8	5.9	5.90	-	-	-	-	49, 52
275	31/07/1994	5:15:40	48.366	32.578	46.9	0.25	-	-	5.2	5.3	5.6	5.57	-	-	-	-	49, 52
276	6/08/1994	21:02:17	54.395	27.037	30.8	-	-	-	5.2	4.2	-	4.61	-	-	-	-	52
277	11/08/1994	6:46:33	54.480	27.019	24.7	-	-	-	5.1	4.4	-	4.77	-	-	-	-	52
278	1/10/1994	8:25:16	57.533	27.333	50.1	-	-	-	5.0	-	-	5.33	-	-	-	-	52
279	29/10/1995	6:27:21	51.860	39.577	39.8	-	-	-	5.3	4.9	5.5	5.50	-	-	-	-	49, 52
280	6/11/1995	3:53:23	57.498	27.788	33	-	-	-	5.0	4.5	-	4.85	-	-	-	-	52
281	26/02/1996	8:08:23	57.051	28.306	66.2	0.23	-	-	5.2	-	5.5	5.54	-	-	-	-	49, 52
282	18/10/1996	9:26:05	57.549	27.663	49.7	-	-	-	5.2	4.8	-	5.10	-	-	-	-	52
283	18/11/1996	11:52:14	51.574	29.904	26	0.08	-	-	5.3	4.9	5.9	5.90	-	-	-	-	49, 52
284	4/02/1997	10:37:51	57.289	37.739	35.7	6.7	-	-	5.8	6.6	6.5	6.52	-	30	100	Garmkhan-e Bojnurd	23, 32, 49
285	28/02/1997	12:57:23	48.041	38.088	39.2	1.73	-	-	5.5	6.1	6.1	6.13	-	20	29	Ardebil	22, 39, 49
286	19/04/1997	5:53:18	56.861	28.019	58.9	2.58	-	-	5.3	5.3	6.2	6.24	-	-	-	-	49, 52
287	10/05/1997	7:57:30	59.823	33.878	6.7	73.5	-	-	6.2	7.0	7.2	7.21	125	130	247	Zirkuh-e Ghaen	25, 27, 43, 49, 52
288	20/06/1997	12:57:36	60.024	32.327	34.8	0.24	-	-	4.9	5.4	5.6	5.55	-	-	-	-	49, 52
289	3/10/1997	11:28:42	54.693	27.801	47.5	-	-	-	5.1	4.8	-	5.10	-	-	-	-	52
290	20/10/1997	6:09:11	57.262	28.535	93	0.15	-	-	5.5	-	5.4	5.42	-	-	-	-	49, 52
291	14/03/1998	19:40:32	57.612	30.161	43.5	9.43	-	-	5.8	6.7	6.6	6.62	25	-	316	Fandogha	25, 49, 52
292	10/04/1998	15:00:53	60.086	32.454	33	-	-	-	5.2	5.7	-	5.83	-	-	-	-	52
293	10/06/1998	8:30:16	58.508	28.228	113.1	0.5	-	-	5.0	-	5.8	5.77	-	-	-	-	49, 52
294	9/07/1998	14:19:22	48.484	38.687	55.4	-	-	-	5.8	5.5	-	5.67	-	-	-	-	52
295	1/08/1998	23:38:33	56.542	27.723	34.7	-	-	-	5.0	4.8	-	5.10	-	-	-	-	52
296	4/08/1998	11:41:58	57.352	37.231	33	-	-	-	4.9	5.1	-	5.34	-	-	-	-	52
297	21/09/1998	21:35:29	51.267	31.093	46.5	-	-	-	5.1	4.6	-	4.93	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
298	4/10/1998	0:42:50	47.196	33.231	24.9	-	-	-	5.2	4.8	-	5.10	-	-	-	-	52
299	5/10/1998	2:20:32	47.236	33.235	18.1	-	-	-	5.2	4.9	-	5.18	-	-	-	-	52
300	13/11/1998	13:01:08	53.641	27.779	15.3	0.16	-	-	5.3	5.1	5.4	5.44	-	-	-	-	49, 52
301	4/03/1999	5:38:27	57.203	28.277	36.9	10.1	-	-	6.1	6.4	6.6	6.64	-	-	-	Hormozgan	49, 52
302	6/05/1999	23:00:51	51.917	29.534	17.2	-	-	-	5.7	6.3	-	6.32	-	-	-	-	52
303	6/05/1999	23:00:56	51.726	29.566	73.9	-	-	-	5.9	-	-	6.32	-	-	-	-	5
304	6/05/1999	23:13:26	51.938	29.446	46.7	2.47	-	-	5.2	5.7	6.2	6.23	-	-	-	-	49, 52
305	24/09/1999	19:17:14	51.358	28.654	30.8	-	-	-	5.2	4.7	-	5.02	-	-	-	-	52
306	8/11/1999	21:37:21	61.246	35.715	10	0.2	-	-	5.4	5.2	5.5	5.50	-	-	-	-	49, 52
307	19/11/1999	4:40:25	54.405	37.344	34.8	0.14	-	-	5.2	5.1	5.4	5.40	-	-	-	-	49, 52
308	26/11/1999	4:27:22	54.891	36.976	10	-	-	-	5.0	4.6	-	4.93	-	-	-	-	52
309	5/12/1999	13:12:31	61.220	35.681	13.4	-	-	-	5.0	4.5	-	4.85	-	-	-	-	52
310	2/02/2000	22:58:02	58.239	35.243	35.2	0.09	-	-	4.8	5.2	5.3	5.27	-	-	-	-	49, 52
311	5/03/2000	9:40:07	56.453	27.957	40.9	0.16	-	-	5.4	5.2	5.4	5.44	-	-	-	-	49, 52
312	22/08/2000	16:55:15	57.389	38.131	15	0.36	-	-	5.1	5.8	5.7	5.67	-	-	-	-	52, 49
313	13/09/2000	3:55:12	51.702	27.804	43	-	-	-	4.4	4.2	-	4.61	-	-	-	-	52
314	23/10/2000	6:54:50	59.830	31.580	33	0.09	-	-	5.3	4.9	5.3	5.27	-	-	-	-	49, 52
315	6/12/2000	17:11:07	54.811	39.493	33	39	-	-	6.7	7.4	7.0	7.03	-	-	-	Apsheron*	49, 52
316	23/03/2001	5:24:12	46.597	32.875	34.5	0.14	-	-	5.1	4.9	5.4	5.40	-	-	-	-	49, 52
317	28/03/2001	16:34:21	51.269	29.898	15	-	-	-	5.1	4.7	-	5.02	-	-	-	-	49, 52
318	3/04/2001	17:36:34	47.999	32.481	27.1	-	-	-	5.0	4.7	-	5.02	-	-	-	-	52
319	10/06/2001	1:52:08	53.876	39.850	33.2	0.14	-	-	5.4	5.2	5.4	5.40	-	-	-	Apsheron	49, 52
320	2/11/2001	22:05:31	54.584	27.137	32.9	-	-	-	5.2	4.1	-	4.53	-	-	-	-	52
321	17/02/2002	13:03:50	51.782	28.036	15	0.12	-	-	5.5	5.0	5.4	5.35	-	-	-	-	49, 52
322	11/03/2002	20:06:37	56.068	25.148	10	-	-	-	5.1	4.1	-	4.53	-	-	-	-	52
323	5/04/2002	18:40:18	55.981	32.026	19.9	-	-	-	5.0	4.6	-	4.93	-	-	-	-	52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
324	17/04/2002	8:47:23	56.757	27.671	33	-	-	-	5.3	4.9	-	5.18	-	-	-	-	52
325	24/04/2002	19:48:04	47.404	34.641	10	-	-	-	5.3	5.1	-	5.34	-	-	-	-	52
326	24/04/2002	20:10:00	47.341	34.492	26.9	0.14	-	-	4.8	4.3	5.4	5.40	-	-	-	-	49, 52
327	18/06/2002	3:19:24	45.906	33.237	36.3	-	-	-	5.0	4.2	-	4.61	-	-	-	-	52
328	22/06/2002	2:58:21	49.022	35.589	10	6.97	-	-	6.2	6.4	6.5	6.53	14	~25	16	Changureh-e Avaj	26, 31, 49, 52
329	25/09/2002	22:28:12	49.310	31.975	10	0.3	-	-	5.5	5.1	5.6	5.62	-	-	-	-	49, 52
330	10/10/2002	12:13:41	52.249	35.824	14.9	-	-	-	4.5	5.6	-	5.75	-	-	-	-	52
331	11/01/2003	17:45:28	51.513	29.674	13.4	0.07	-	-	5.2	4.8	5.2	5.20	-	-	-	-	49, 52
332	14/01/2003	14:13:55	62.358	27.950	39.7	-	-	-	5.4	4.8	-	5.10	-	-	-	-	52
333	14/02/2003	10:29:00	56.797	28.035	45.4	0.3	-	-	5.2	5.3	5.6	5.62	-	-	-	-	49, 52
334	27/05/2003	10:30:49	51.278	29.468	14	-	-	-	4.9	4.2	-	4.61	-	-	-	-	52
335	24/06/2003	6:52:49	61.012	27.316	40.7	-	-	-	5.4	4.7	-	5.02	-	-	-	-	52
336	3/07/2003	14:59:27	60.850	35.575	2.1	-	-	-	5.3	4.9	-	5.18	-	-	-	-	52
337	10/07/2003	17:06:39	54.153	28.303	19.7	0.48	-	-	5.8	5.5	5.8	5.75	-	-	-	-	49, 52
338	10/07/2003	17:40:16	54.115	28.227	14.3	0.36	-	-	5.7	5.5	5.7	5.67	-	-	-	-	49, 52
339	4/08/2003	3:28:16	59.710	28.991	9	0.3	-	-	5.3	5.3	5.6	5.62	-	-	-	-	49, 52
340	21/08/2003	4:02:10	59.768	29.026	25.9	0.87	-	-	5.5	5.8	5.9	5.93	-	-	-	-	49, 52
341	29/08/2003	6:55:51	51.529	28.389	27	-	-	-	5.0	4.2	-	4.61	-	-	-	-	52
342	5/11/2003	7:58:50	56.138	27.461	24.1	-	-	-	5.2	4.2	-	4.61	-	-	-	-	52
343	15/12/2003	22:57:23	54.125	28.255	15	-	-	-	5.0	4.3	-	4.69	-	-	-	-	52
344	26/12/2003	1:56:53	58.304	28.965	15	9.31	-	-	5.9	6.8	6.6	6.61	25	25	23	Bam	28, 29, 33, 49, 52
345	14/01/2004	16:58:46	52.287	27.615	12.6	-	-	-	5.4	4.5	-	4.85	-	-	-	-	52
346	28/01/2004	9:06:47	57.473	26.929	20.4	-	-	-	5.2	4.8	-	5.10	-	-	-	-	52
347	28/05/2004	12:38:43	51.588	36.321	17	3.65	-	-	6.2	6.3	6.3	6.34	-	40	-	Baladeh-e Kojour*	36, 49, 52
348	6/10/2004	11:14:28	57.904	28.773	32.5	-	5.2	-	5.0	4.6	-	4.93	-	-	-	-	51, 52
349	7/10/2004	12:54:58	57.287	28.267	41	-	5.0	-	5.2	4.2	-	4.61	-	-	-	-	51, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
350	7/10/2004	21:46:19	54.432	37.168	32.7	0.32	6.2	-	5.6	5.3	5.6	5.64	-	-	-	-	49, 51, 52
351	16/10/2004	10:04:36	45.863	33.406	38.8	-	5.1	-	5.3	4.3	-	4.69	-	-	-	-	51, 52
352	10/01/2005	18:47:29	54.514	37.213	31.8	0.13	5.6	-	5.2	5.0	5.4	5.38	-	-	-	-	51
353	22/02/2005	2:25:21	56.807	30.770	13	5.2	-	-	5.9	6.4	6.4	6.44	13	22	100	Dahuieh-e Zarand	34, 42, 49, 52
354	13/03/2005	3:31:21	61.904	27.084	51.8	1.17	6.2	-	5.8	5.4	6.0	6.01	-	-	-	-	51
355	23/04/2005	14:39:37	60.747	32.029	7.8	-	-	-	4.7	4.0	-	4.44	-	-	-	-	52
356	14/05/2005	18:04:56	56.848	30.674	28.9	-	5.2	-	5.4	4.8	-	5.10	-	-	-	-	51
357	24/09/2005	19:28:05	52.005	39.430	59.4	-	-	-	5.1	4.6	-	4.93	-	-	-	-	52
358	26/09/2005	18:57:03	47.712	37.333	10	-	-	-	5.0	4.2	-	4.61	-	-	-	-	52
359	27/11/2005	10:22:17	55.827	26.748	10	1.03	6.0	-	6.0	5.8	6.0	5.98	3	13	20	Qeshm	35, 41, 49, 51, 52
360	27/11/2005	16:30:36	55.770	26.807	10.7	-	5.8	-	5.3	5.3	-	5.51	-	-	-	-	51, 52
361	28/02/2006	7:31:04	56.830	28.105	31.1	1.37	-	5.1	5.8	6.1	6.1	6.06	-	-	-	-	49, 50, 52
362	25/03/2006	7:28:57	55.662	27.552	10	0.78	5.5	6.0	5.6	5.6	5.9	5.89	-	-	-	-	51, 52, 50, 49
363	31/03/2006	1:17:03	48.795	33.582	15.4	1.71	6.1	5.9	5.7	5.9	6.1	6.12	-	40	2	Darb-Astaneh-e Borujerd	37, 38, 49, 50, 51, 52
364	31/03/2006	11:54:03	48.678	33.631	15.8	-	5.2	5.3	4.8	4.4	-	4.77	-	-	-	-	50, 51
365	7/05/2006	6:20:55	56.650	30.794	10	-	-	-	4.7	4.3	-	4.69	-	-	-	-	50, 52
366	3/06/2006	7:15:36	55.884	26.784	13.4	0.06	5.1	5.4	5.3	4.6	5.2	5.15	-	-	-	-	50, 51
367	28/06/2006	21:02:11	55.824	26.864	16	0.64	5.6	5.5	5.7	5.5	5.8	5.84	17	-	-	-	50, 51
368	12/10/2006	17:08:21	54.747	39.868	45	0.1	-	-	5.4	4.8	5.3	5.30	-	-	-	Apsheron*	49, 50, 52
369	18/06/2007	14:29:50	50.867	34.496	11	0.24	5.6	5.0	5.3	5.1	5.6	5.55	-	-	-	-	49, 50, 51, 52
370	11/07/2007	6:51:15	48.639	38.818	28.6	-	5.0	5.1	4.9	4.2	-	4.61	-	-	-	-	5, 50, 51
371	22/11/2007	3:44:51	54.710	26.805	15.1	-	-	-	5.2	4.2	-	4.61	-	-	-	-	50, 52
372	5/05/2008	21:57:55	54.082	28.361	40.2	-	5.1	5.3	5.3	4.5	-	4.85	-	-	-	-	50, 51
373	27/08/2008	21:52:39	47.381	32.322	17.6	0.58	5.6	5.7	5.3	5.4	5.8	5.81	-	-	-	-	50, 51
374	3/09/2008	22:43:13	47.287	32.318	10	0.05	-	5.0	5.1	4.3	5.1	5.10	-	-	-	-	49, 50, 52
375	10/09/2008	11:00:34	55.833	26.772	12	1.74	6.2	6.0	6.0	5.9	6.1	6.13	-	12.8	0.65?	Qeshm	41, 49, 50, 51, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
376	11/09/2008	2:16:10	55.798	26.819	10	-	-	-	5.1	5.0	-	5.26	-	-	-	-	5, 50
377	8/12/2008	14:41:48	55.859	26.851	32.8	0.05	5.3	5.2	5.3	4.6	5.1	5.10	-	-	-	-	49, 50, 51, 52
378	30/04/2009	10:04:27	61.445	27.738	73	0.07	5.0	5.2	5.6	-	5.2	5.20	-	-	-	-	49, 50, 51, 52
379	7/05/2009	22:44:03	57.058	25.414	28.6	-	-	-	5.3	4.4	-	4.77	-	-	-	-	50, 52
380	22/07/2009	3:53:04	55.766	26.791	18.7	0.01	5.5	5.3	5.4	4.8	4.6	4.63	-	-	-	-	51, 52, 50, 49
381	4/10/2009	21:50:50	49.595	31.798	14.9	-	5.1	-	5.0	4.7	-	5.02	-	-	-	-	51, 50, 52
382	25/10/2009	17:47:50	63.932	29.559	126.5	-	-	-	5.5	-	-	5.88	-	-	-	-	50, 52
383	16/01/2010	20:23:36	48.368	32.512	10	-	-	-	5.0	4.5	-	4.85	-	-	-	-	50, 52
384	27/04/2010	22:58:01	54.902	27.123	16.5	0.03	5.0	5.0	4.9	4.3	5.0	4.95	-	-	-	-	49, 50, 51, 52
385	20/07/2010	19:38:10	53.898	27.036	14.4	0.57	5.6	5.8	5.7	5.5	5.8	5.80	2	-	15	Koodian-South Za-gros	45, 49, 50, 51, 52
386	20/07/2010	19:50:12	53.894	27.015	15.1	-	5.1	5.2	5.0	5.2	-	5.42	-	-	-	-	5, 50, 51
387	30/07/2010	13:50:13	59.383	35.268	19.4	0.2	5.8	5.7	5.4	5.0	5.5	5.50	-	-	-	-	49, 50, 51, 52
388	31/07/2010	6:52:57	56.748	29.582	14.9	0.16	5.6	5.8	5.4	4.9	5.4	5.44	-	-	-	-	49, 50, 51, 52
389	11/08/2010	17:26:22	57.082	37.812	18.8	-	5.0	5.0	4.9	4.0	-	4.44	-	-	-	-	50, 51, 52
390	27/08/2010	19:23:49	54.497	35.486	12.5	0.54	5.9	5.9	5.6	5.5	5.8	5.79	-	-	-	-	49, 50, 51, 52
391	28/08/2010	0:29:06	54.495	35.518	14.2	-	5.2	5.0	4.8	4.0	-	4.44	-	-	-	-	50, 51, 52
392	7/09/2010	2:11:07	54.567	27.097	26.9	-	-	5.1	5.2	4.1	-	4.53	-	-	-	-	50, 52
393	27/09/2010	11:22:45	51.695	29.654	21.3	0.94	6.0	6.1	5.9	5.5	5.9	5.95	-	-	-	-	49, 50, 51, 52
394	11/11/2010	13:37:33	57.127	27.909	18.5	-	-	-	4.7	4.0	-	4.44	-	-	-	-	50, 52
395	26/11/2010	12:33:44	52.546	28.060	17.2	0.2	5.4	5.6	5.6	5.1	5.5	5.50	-	-	-	-	49, 50, 51, 52
396	20/12/2010	18:42:00	59.150	28.368	14.5	8.26	6.4	6.5	5.9	6.7	6.6	6.58	~18	-	~130	Rigan-e Baluchestan	47, 49, 50, 51, 52
397	5/01/2011	5:55:48	51.815	30.159	9.6	0.14	5.2	5.2	5.3	5.0	5.4	5.40	-	-	-	-	49, 50, 51, 52
398	18/01/2011	20:23:26	63.995	28.683	79.9	88	7.0	-	6.8	-	7.3	7.26	-	-	-	-	49, 50, 51, 52
399	27/01/2011	8:38:30	59.052	28.151	18.5	2.42	6.2	6.0	5.7	6.2	6.2	6.22	~7.5		~60	Rigan-e Baluchestan	47, 49, 50, 51, 52
400	15/06/2011	1:05:29	57.657	27.950	33.3	0.18	5.7	5.3	5.3	5.0	5.5	5.47	-	-	-	-	49, 50, 51, 52
401	26/06/2011	19:46:59	57.653	30.035	24.8	0.06	5.1	5.2	5.0	4.3	5.2	5.15	-	-	-	-	49, 50, 51, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
402	19/10/2011	2:52:44	54.300	28.150	-	0.07	5.2	5.3	-	-	5.2	5.20	-	-	-	-	49, 50, 51, 52
403	9/01/2012	19:53:37	55.640	27.180	-	-	5.0	5.1	5.4	-	-	5.77	-	-	-	-	50, 51, 52
404	11/01/2012	17:08:01	52.775	36.328	15.8	0.03	5.2	5.0	5.1	-	5.0	4.95	-	-	-	-	49, 50, 51, 52
405	19/01/2012	12:35:51	58.835	36.288	8.3	0.09	5.4	5.4	5.6	-	5.1	5.10	-	-	-	-	49, 50, 51, 52
406	27/02/2012	18:48:56	56.920	31.370	10	0.08	5.2	5.4	5.2	-	5.2	5.24	-	-	-	-	49, 50, 51, 52
407	29/02/2012	5:10:43	46.930	32.457	5	0.08	-	-	4.9	-	5.2	5.24	-	-	-	-	52, 50, 49
408	20/04/2012	3:05:42	46.990	32.453	10	-	5.0	-	5.0	-	-	5.33	-	-	-	-	49, 50, 51, 52
409	3/05/2012	10:09:38	47.740	32.860	10	0.16	5.4	5.5	5.3	-	5.4	5.44	-	-	-	-	49, 50, 51, 52
410	13/05/2012	18:21:15	53.950	27.060	-	-	-	-	4.9	-	5.4	5.40	-	-	-	-	50, 52
411	1/07/2012	2:49:46	51.020	31.841	6.6	0.07	-	-	5.0	-	5.2	5.20	-	-	-	-	52, 50, 49
412	1/07/2012	22:01:29	60.000	34.520	-	-	5.3	5.3	5.3	-	5.4	5.40	-	-	-	-	51, 50, 52
413	24/07/2012	6:50:09	50.880	31.620	10	0.03	-	5.0	4.8	-	5.0	4.95	-	-	-	-	52, 50, 49
414	11/08/2012	12:23:18	46.826	38.329	11	6.04	6.1	6.5	6.2	6.7	6.5	6.49	13	19	75	Ahar-Varzaghan	44, 46, 49, 50, 51, 52
415	11/08/2012	12:34:36	46.750	38.470	-	4.24	6.1	6.3	6.1	-	6.3	6.30	-	-	-	Ahar-Varzaghan	44, 46, 49, 50, 51, 52
416	6/09/2012	1:57:15	54.050	27.230	-	0.08	5.2	5.2	5.3	-	5.2	5.24	-	-	-	-	49, 50, 51, 52
417	6/09/2012	3:43:40	53.970	26.960	16	-	-	-	5.0	-	-	5.33	-	-	-	-	50, 52
418	7/11/2012	6:26:33	46.620	38.418	10	0.27	5.6	5.4	5.4	5.4	5.6	5.59	-	-	-	-	49, 50, 51, 52
419	5/12/2012	17:08:14	59.571	33.506	14.4	0.57	5.4	5.6	5.6	5.6	5.4	5.40	-	-	-	-	49, 50, 51, 52
420	12/01/2013	3:25:04	50.954	31.828	4.1	-	-	5.1	5.4	-	5.6	5.60	-	-	-	-	50, 52
421	21/01/2013	19:48:59	57.467	30.330	10	0.12	5.3	5.4	5.3	5.2	5.4	5.35	-	-	-	-	49, 50, 51, 52
422	28/02/2013	11:06:05	57.547	38.220	33	-	-	-	4.7	-	5.5	5.50	-	-	-	-	50, 52
423	9/04/2013	11:52:50	51.593	28.428	12	3.5	6.2	6.3	5.9	6.3	6.3	6.33	5	-	15	Kaki-e Bushehr	49, 50, 51, 52
424	9/04/2013	12:05:41	51.560	28.460	11	-	5.1	5.3	5.4	-	6.4	6.40	-	-	-	-	50, 51, 52
425	16/04/2013	10:44:20	61.996	28.033	80	509	-	7.5	7.0	-	7.7	7.70	-	-	-	Saravan*	50, 51, 52
426	17/04/2013	3:15:53	62.370	28.120	67	0.37	5.7	5.6	5.8	-	5.7	5.68	-	-	-	-	49, 50, 51, 52
427	1/05/2013	18:31:05	51.700	28.310	-	0.03	5.2	5.1	5.5	-	5.0	4.95	-	-	-	-	49, 50, 51, 52

No.	Date (dd/mm/yyyy)	Time	Coordinate		Depth (km)	M_0(10^25dyne.cm)	Source parameter (Geology)									Earthquake name	Reference
			Long. (°E)	Lat. (°N)			M_L	M_N	m_b	M_S	M_W	M_W (Cal.)	*SRL* (km)	*SSRL* (km)	*MSD* (cm)		
428	11/05/2013	2:08:08	57.770	26.560	15	2.22	-	6.1	5.9	6.2	6.2	6.20	-	-	-	Hormozgan	50, 51, 52
429	11/05/2013	3:09:47	57.926	26.548	8.9	0.21	-	-	5.3	5.4	6.1	6.10	-	-	-	-	50, 51, 52
430	12/05/2013	0:07:00	57.522	26.404	17.6	0.3	5.6	-	5.5	5.4	5.6	5.62	-	-	-	-	49, 50, 51, 52
431	12/05/2013	10:54:49	57.765	26.716	14	0.25	5.5	-	5.4	5.3	5.5	5.50	-	-	-	-	49, 50, 51, 52
432	18/05/2013	10:03:19	57.800	26.540	10	0.25	5.5	-	5.5	-	5.5	5.50	-	-	-	-	49, 50, 51, 52
433	18/05/2013	10:57:47	57.712	26.502	15	0.23	5.5	-	5.5	5.4	5.5	5.54	-	-	-	-	49, 50, 51, 52
434	22/11/2013	6:51:26	45.560	34.370	-	-	5.4	5.6	5.1	-	6.0	6.00	-	-	-	-	49, 50, 51, 52
435	28/11/2013	13:51:37	51.410	29.490	-	-	5.6	5.6	5.6	-		5.99	-	-	-	-	50, 51, 52
436	2/01/2014	3:13:57	54.460	27.250	-	-	5.6	5.5	5.4	-	5.7	5.70	-	-	-	-	50, 51, 52