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Calculation of Source Parameters for January 27, 2011 Rigan Earthquake (Iran)

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SUMMARY

On January 27, 2011, an earthquake ($M_w=6$) occurred in Mohammad Abad Rigan, Kerman province of Iran and trembled the region. Many aftershocks recorded after this earthquake in the area, so it is important to recognize the source parameters of the earthquake. Rigan region is located in Kerman province and central-east Iran seismotectonic province, which is an intraplate environment surrounded by the foregoing convergent zones. In this study, recurrence period diagram for this area is depicted and according to the diagram, long recurrence period for major and great earthquakes in this region had appraised. After correction of recorded data, to access the main characteristics of source parameters, the corrected accelographs has been exploited. Through an averagion approach, the best possible amounts for corner frequency, seismic moment, moment magnitude are obtained.

Introduction

On January 27, 2011, an earthquake ($M_w=6$) occurred in Mohammad Abad Rigan, Kerman province of Iran and trembled the region. Many aftershocks recorded after this earthquake in the area, so it is important to recognize the source parameters of the earthquake. Rigan region is located in Kerman province and central-east Iran seismotectonic province, which is an intraplate environment surrounded by the foregoing convergent zones. The region referred in this study is enclosed between 57° and 61.5° east longitudes and 27° and 30° north latitudes. Seismicity in this region is mainly due to the continental shortening between the Eurasian and Arabian plates. Figure 1 illustrates region active faults, earthquakes and micro earthquakes and focal mechanism of large earthquakes in this region. Epicenter of January, 27, 2011 Rigan earthquake is showed on map. Historical and instrumental earthquake data along with recent earthquake data in the studied region indicate that return period for an earthquake with magnitude 6 (Rigan earthquake) is 12 years which is also showed in Figure 1.

Figure 1 Seismotectonic map and epicenters of Rigan earthquake (left) and recurrence period diagram (right)

Method

Main earthquake of Rigan recorded by 8 digital strong motion accelograph stations inside the region which are located in epicentral distance from 15 to 60 kilometers to the earthquake. For 4 stations which had convenient signal to noise ratio, we compute earthquake parameters such as corner frequency, maximum amplitude for Fourier spectra, seismic moment and moment magnitude. The data used for this study is 3 component earthquake records related to Rigan, Chah malek, Fahraj and Sarzeh stations. First we apply linear baseline correction then we apply convenient filtering which is 4 order butterworth band-pass filter. After that, we depicted acceleration Fourier spectra for each station. A sample of corrected Fourier spectra and time series for Sarzeh station is displayed in Figure 2.

Figure 2 Logarithmic Fourier spectra diagram (left) and time series for Sarzeh station (right)

After processing data, we compute f_c , and k then we compute Ω_0 using relation 1. Then, by using relation 2 we calculate M_0

$$k = \Omega_0 (2\pi f_c)^2 \quad (1)$$

$$M_0 = \frac{4\pi\rho\beta^2}{\Re_{\theta\phi} FVG(R)} \Omega_0 \quad (2)$$

In this region, all of the accelographs are located in a distance less than 100 kilometers to the earthquake therefore, we use relation 3 for this study. For computing moment magnitude we apply relation 4 which is Kanamori relation (Kanamori, 1977):

$$G(R) = \begin{cases} R^{-1} & , R < 100(Km) \\ (100 * R)^{-\frac{1}{2}} & , R \geq 100(Km) \end{cases} \quad (3) \quad M_w = \frac{2}{3} \log M_0 - 10.73 \quad (4)$$

Table1. Estimated parameters for Rigan earthquake

Station	code	Long	Lat	Distance	Fc	K	Ω_0	M0	Mw
Rigan	5173	59.012	28.654	47.78	0.15	0.1251	0.140836	3.5×10^{26}	6.77
Chah Malek	5176-3	59.157	28.554	34.98	0.18	0.1594	0.124619	2.3×10^{26}	6.64
Fahrai	5178	58.885	28.948	83.16	0.15	0.1145	0.128903	3.7×10^{26}	6.79
Sarzeh	51.79-4	59.021	28.334	15.97	0.17	0.2833	0.248307	2.1×10^{26}	6.62

Conclusion

Average values of corner frequency, k and moment magnitude for 27.01.2011 Rigan earthquake are: $f_c=0.16$, $k=0.17$ and $M_w=6.7$. All of the results in this study are in good agreement with former reported results from other responsible seismological centers inside and outside of our country. Corrected Fourier spectra diagram is depicted for every 4 stations. By studying Rigan earthquake, it is concluded that seismic activity in this region is mostly due to Bam and Kahurak faults and most of earthquakes taking place in upper crust. Seismotectonic of this region is mainly related to moderate earthquakes that occur every 12 years.

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