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Estimation of shear wave quality factor (Qs) of seismic data of Firoozabad-Kojour earthquake

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Keywords

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Extended Abstract

Summary

The attenuation of seismic waves with respect to distance is one of the most important parameters in seismological and earthquake engineering studies. The purpose of this study is to estimate quality factor of shear waves (Q_S) of seismic data of the earthquake occurred in the Central Alborz at 34º to 37º north latitude and 50º to 56º east longitude, using the spectral drop. For this purpose, the data from earthquake of May 28, 2004 Firouzabad-Kojur and its aftershocks, recorded by seismic networks of Sari and Semnan, affiliated with the Institute of Geophysics of Tehran University have been used; and the quality factor of direct S wave (Q_S) at the seven central frequencies of 1.5, 3.0, 4.5, 6.0, 9.0, 12.0 and 18.0 Hz has been estimated. The estimated frequency-dependent relationship of Q_S on N-S and E-W components are $Q_S=76.61f^{0.8}$ and $Q_S=70.35f^{0.85}$, respectively. The mean values of Q_S for the two components indicate a relation with frequency that is $Q_S=73.54f^{0.83}$. The results show an increase in Q_S with increasing frequency, and Q_0 value for this area corresponds with the seismotectonic study of the region.

Introduction

When seismic waves pass through the earth they interact with inhomogeneous, anisotropic and non-elastic environments. Obviously, by knowing the effect of these factors on seismograms, we can obtain a considerable amount of information from within the earth. The energy of waves from a seismic source decreases with increasing distance from the source, and consequently, the seismic wave amplitude will decrease. It is mainly due to the geometry of propagation of seismic waves and partly due to the anelastic properties of the material through which they travel. The energy loss of seismic waves due to non-elastic effects is named intrinsic absorption. The inverse of attenuation represents quality factor. By calculating the quality factor in each region, we can understand the rate of seismic activity in that region. Moreover, this quantity has many applications in seismological and earthquake engineering studies. The study region is located at longitude 50°-56° E and latitude 34°-38° N in north of Iran, and in terms of seismotectonic provinces of Iran, it is located in Central Alborz (Mirzaei et al., 1998). The Alborz Mountain of northern Iran form a belt of active crustal deformation along the southern side of the Caspian Sea within the broad Arabian-Eurasia continental collision zone. In this study, the quality factors of shear waves (Q_S) have been estimated in the Central Alborz.

Methodology and Approaches

There are many different methods for estimating the quality factor. In this study, the spectral decay method (Anderson and Quas, 1988) have been used for estimation the quality factor of shear waves (Q_S) at the seven central frequencies of 1.5, 3.0, 4.5, 6.0, 9.0, 12.0 and 18.0 Hz. For this estimation, shear waves on horizontal components (E-W and N-S) have been analyzed (Yoshimoto et al., 1993; Chung et al., 2001; Kim et al., 2004; Rahimi et al., 2010a). The bandwidth of each frequency band is 2/3 of its central frequency. To determine the shear wave window on the seismogram, the start of the S wave is determined by observation, and then, the end of the window is determined using the Kinoshita (1994) algorithm. Furthermore, the shear wave velocity in the study region can be considered as an average of 3.58 km/s (Afsari et al. 2015). With the first-order fit (with slope b) in the least squares, Q_S is obtained in each frequency band for the horizontal components E-W and N-S, according to the $Q_S = -(\pi f/\beta b)$.

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Results and Conclusions

In this study, we have analyzed the attenuation of the S waves using the data recorded of the 2004 Firouzabad-Kojur earthquake and its aftershocks. The mean Q_S values for the seven central frequencies have been determined. The estimated frequency-dependent relations for E-W and N-S components are expressed as $Q_S=70.35f^{0.85}$ and $Q_S=76.61f^{0.8}$, respectively. Finally, the mean Q_S-frequency relationship of the two horizontal components of the studied range is expressed as $Q_S=73.54f^{0.83}$. In the Central Alborz region, the values of Q at 1.0 Hz are less than 200 for the frequency-dependent relationships of Q_S. This implies high attenuation of the wave S at the studied frequencies and distances. A strong correlation between n and the level of tectonic activity of the region has been observed by several investigators (Aki, 1980; Gupta and Ashwani, 1988). The value of n in the estimated QS relation for the study region indicates that the area is active. Morover, the results obtained in this study are consistent with previous studies carried out in the active seismotectonic zones in Iran and elsewhere in the world.

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