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Investigation of deep and lateral changes of coda wave quality factor using short-time Fourier transform in northwest of Iran

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Extended Abstract

Summery

The present study attempts to explore the characteristics of seismic coda wave energy attenuation using single back scattering in northwestern Iranian plateau. For this purpose, the short-time Fourier transform is used to separate the frequency bands. To estimate quality factor, coda waves from more than 1600 small crustal events with magnitudes ranging from 2 to 5 Ml and epicenteral distances of less than 200 km have been used. In this study, coda wave quality factor has been calculated at 7 lapse times of 30 to 90 s. The results show that the best fitted line comes from lapse time of 40 s and the frequency relation is in the form of $Q = (103\pm1)f^{(0.88\pm0.04)}$. Relatively small values of Q0 indicate that there is high heterogeneity in the shallow layers of the region of northwestern Iran that can be due to the relatively high seismicity of the region. This is in line with our expectations of the crustal structure and the existence of Sahand and Sabalan volcanoes. The presence Sahand and Sabalan volcanoes in the region has created a warm crust in this area. On the other hand, the relationship between quality factor and temperature changes exponentially, and the quality factor decreases with increasing temperature. Moreover, the relationship between low values of the frequency with parameter n indicates high seismicity, active tectonics and the presence of large heterogeneities in the region. Existence of North Tabriz fault and many fractures in this region is one of the reasons for the high heterogeneity in this region.

Introduction

The amplitude of seismic waves is generally reduced while passing through the earth under the influence of the two main factors of geometrical spreading and apparent attenuation of seismic waves. Scattering attenuation, as an elastic phenomenon, redistributes seismic wave energy due to the collision of seismic waves (P, S and surface waves) with randomly distributed heterogeneities. The attenuation of coda wave, backscattered waves form heterogeneities, is one of the most important parameters in the estimation of seismic wave attenuation. In this study, the attenuation of seismic coda waves as scattered body waves has been estimated using single back-scattering model.

Methodology and Approaches

The most common method to estimate attenuation is single back-scattering model. Here, we use short-time Fourier transform (STFT) instead of bandpass filter. For each individual frequency, the envelopes of STFT coefficients of extracted waveforms for lapse times of 30, 40, 50, 60, 70, 80 and 90 seconds are measured as the BPF method. The obtained envelopes have been used in order to estimate attenuation at each individual frequency. Since the length of the window is constant in the STFT method, it is possible to determine fairly accurate frequency in a short window. However, to this purpose, each waveform is divided into 1 s windows (50 samples) overlapped by 90% (45 samples), and the STFT has been calculated for each window.

Results and Conclusions

In this study, attenuation parameter has been estimated in northwestern Iranian plateau using the STFT method. The results show good correlation between seismicity and tectonic of the study area for lapse times greater than twice the S-

wave travel time, especially for lapse time of 40 s. At lapse time of 40 s, the frequency-dependent relationship has been estimated as $Q = (103\pm1)f^{(0.88\pm0.04)}$ using the STFT method. It is concluded that the STFT model can be used as an appropriate time-frequency tool to study the energy attenuation of high-frequency coda waves due to the high correlation coefficients and low standard deviations of the relationship. Furthermore, the relatively low values of quality factor in frequency attenuation relation show that there is high heterogeneity among shallow layers of Iran northwestern region that is possibly due to the relatively high seismicity of the region.