CALCULATION OF Q_S IN NW IRAN

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In this study, we investigate attenuation of shear waves in NW Iran using local events recorded at the stations of IRSC. We used the method of spectral ratio in two different frequencies (Mukhopadhyay & Tyagi, 2006). For this purpose, waveforms recorded by eight short period stations of the Tabriz network (TBZ, BST, AZR, HRS, HSH, SHB, MRD, SRB) from 1996 to 2012 have been analysed. As the recording sampling rate was 50 sps, the maximum frequency used was 25 Hz. We used seventeen central frequencies of 0.5, 0.63, 0.79, 1, 1.25, 1.58, 1.99, 2.5, 3.16, 3.98, 5.01, 6.3, 7.94, 10, 12.58, 15.14, and 19.95 Hz. The analysis was performed on the transverse component. We calculated the signal wave as the 90% of the total energy of the shear wave window. To avoid Gibbs' phenomenon, we applied a 5% cosine-taper to the beginning and the end of the time series of the signal window and the spectrum was calculated using FFT. We calculated the logarithm of the spectral amplitude ratios at different frequencies (i.e., f_1=1 Hz and f_2=1.25, 1.99, 3.16, 5.01, 7.94, 12.58, 19.95). We assumed that the source of earthquakes were the same, thus, we chose earthquakes with magnitudes between 2 and 4. Figure 1 shows the results for station HRS. We also used an alternate formula $(((E - W)^2 + (N - S)^2/2)^{1/2})$ based on energy-conservation. The results were the same. Our results show that Ln (H/V) goes to zero that means our stations were located on hard rock. Following formula is what we consider for finding direct Quality factor, Q_d, (Mukhopadhyay & Tyagi, 2006):

$$\mathrm{Ln}[A_b(f_1)/A_b(f_2)] = \ln[A_0(f_1)/A(f_2)] + \ln[R(f_1)/R(f_2)] - \pi\,(f_1 - f_2)\,t\,/\,Q_d \quad (1)$$

$$\mathrm{Slop} = -\pi\,(f_1 - f_2)\,/\,Q_d \quad (2)$$

in which A_b is the amplitude of shear wave at different frequencies f_1 and f_2, t is the travel time of the shear wave, A_0 is the spectral amplitude of the source at different frequencies f_1 and f_2, $R(f)$ is the site effect which is calculated using H/V method (e.g. see Figure 1). By plotting the logarithm of the amplitude ratio in two frequencies (f_1, f_2) versus travel time of the shear wave, the slope of the line presents the direct quality factor. Figure 2(a) shows the logarithm of amplitude ratio versus travel time for a selected event.

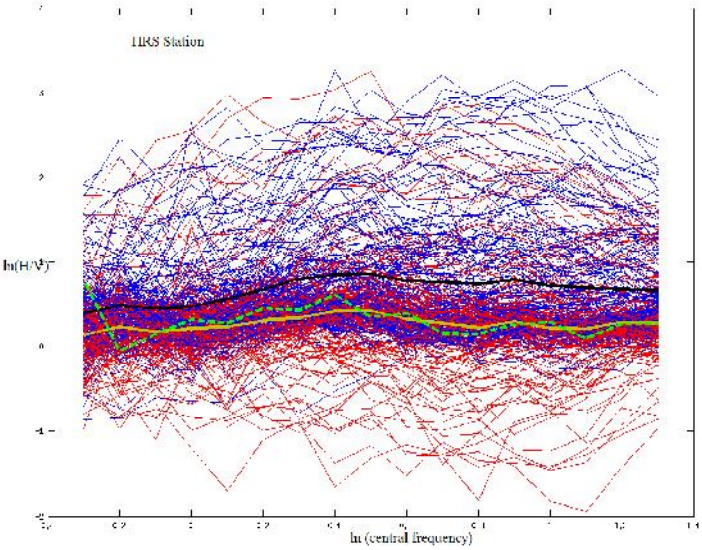
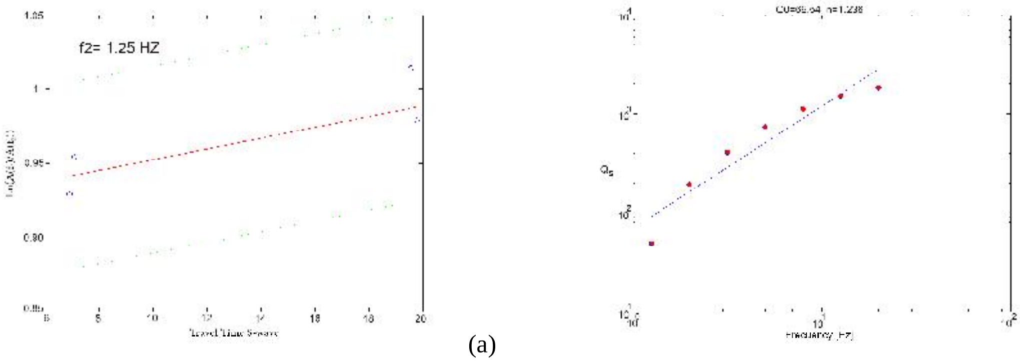


Figure 1. H/V ratio versus frequency in station HRS. The result of H/V for H as E-W component, N-S component and $([(E\text{-}W)^2+(N\text{-}S)^2]/2)^{1/2}$ are shown in blue, red and black, respectively

The observed shear wave quality factors are strongly dependent on frequency. Quality factor dramatically increases with increments in frequency. Considering 100 events recorded at least in 5 stations we found $Q_d = 69.54 f^{1.2}$. Obtained relationship is close to what was calculated before by Rahimi and Hamzelou (2009) for an area near Sabalan, west of our study area. Small coefficient (i.e. 69.54) is probably due to geothermal activities in NW Iran.



(a) (b)

Figure 2. (a) $Ln(A(f_1))/A(f_2))$ versus S wave travel time for one event recorded by five stations; (b) Q versus different frequencies

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