

Investigation on the temporal change in attenuation within ruptured fault zone of the 1999 Chi-Chi, Taiwan earthquake

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Attenuation, noted as $1/Q$, had been considered as a geophysical parameter related to the fluid content, temperature and fracture of the medium. The attenuation parameter related to S-wave named as Q_s has more significant indication to the factors indicated above. The damage zone of a large earthquake was often considered as a fracture zone, especially the hanging wall of a thrust faulting earthquake, which suggests a zone with possible high attenuation (decrease in Q). Earlier Q_p and Q_s tomography studies revealed the feature with high attenuation on the hanging wall of the ruptured Chelungpu fault of the 1999 Chi-Chi earthquake. To examine the attenuation character in the rupture fault, we further investigate the temporal variation of the attenuation, specifically in Q_s , within the hanging wall before, following and after the earthquake. We observed a decreasing in Q_s within the fault rupture zone two years following the 1999 Chi-Chi earthquake by Q_s tomography images and an analysis of single-path Q_s near the Chelungpu fault. The synthetic and sensitivity tests of the Q_s determination were carried out accordingly to justify the temporal variation. A Q_s value within the hanging wall above the hypocenter was determined to be 157 two years following the Chi-Chi earthquake, which is significantly lower than the values of 238 and 289 prior to and two years after the main shock, respectively, from the Q_s tomography. Similar values using a signal-path Q_s analysis, from events within the ruptured fault zone to stations along the fault were obtained. The corresponding Q_s values were 247 prior to the Chi-Chi earthquake. After the earthquake, we obtained the Q_s values of 158 and 318 for the time, two years following and two years after the earthquake, respectively. Considering the two independent methods in determination of Q_s , the reduction in Q_s of 89 two years following the Chi-Chi earthquake in both method is significant. Along with 1% V_s reduction revealed by the analysis of repeating earthquakes, our studies suggested possible reduction both in V_s and Q_s within the fault zone after the Chi-Chi earthquake. The observation of temporal changes in Q_s after the Chi-Chi earthquake implies variations of pore fluid saturation in the ruptured fault zone. The reduction in Q_s two years following the Chi-Chi earthquake might indicate high pore-fluid saturation within fractured fault zone rocks due to post-seismic redistribution of the fluid.

Keywords: attenuation, fault zone, temporal variation, earthquake rupture