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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 Qs 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 Qp and Qs 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 Qs, within the hanging wall before, following and after the earthquake. We observed a decreasing in Qs within the fault rupture zone two years following the 1999 Chi-Chi earthquake by Qs tomography images and an analysis of single-path Qs near the Chelungpu fault. The synthetic and sensitivity tests of the Qs determination were carried out accordingly to justify the temporal variation. A Qs 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 Qs tomography. Similar values using a signal-path Qs analysis, from events within the ruptured fault zone to stations along the fault were obtained. The corresponding Qs values were 247 prior to the Chi-Chi earthquake. After the earthquake, we obtained the Qs 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 Qs, the reduction in Qs of 89 two years following the Chi-Chi earthquake in both method is significant. Along with 1% Vs reduction revealed by the analysis of repeating earthquakes, our studies suggested possible reduction both in Vs and Qs within the fault zone after the Chi-Chi earthquake. The observation of temporal changes in Qs after the Chi-Chi earthquake implies variations of pore fluid saturation in the ruptured fault zone. The reduction in Qs two years following the Chi-Chi earthquake might indicates high pore-fluid saturation within fractured fault zone rocks due to post-seismic redistribution of the fluid.

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