Rapid Temporal Changes of Fault Zone Site Response Associated With Strong Ground Motion

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Abstract

We systematically analyze temporal changes in fault zone (FZ) site response along the Karadere-Düzce branch of the North Anatolian fault that ruptured during the 1999 İzmit and Düzce earthquake sequences. The study involves primarily comparisons of strong motion seismic data recorded by station VO inside the Karadere fault and station FP ~300 m away from the fault starting 8 days before and ending 72 days after the Düzce mainshock. The spectral ratio between stations VO and FP is computed from the averaged spectra for the two horizontal components, and is used as a measure for FZ site response. The peak spectral ratio increases 80-150% and the peak frequency drops 20-40% at the time of the Düzce mainshock, and is followed by near-complete recovery with time scale of ~1 day. The observed temporal changes of FZ site response can be explained as reduction of seismic velocities by opening of pre-existing cracks inside the FZ due to strong ground motion, followed by logarithmic recovery. Our observations suggest nonlinear behavior of the fault zone material under strong ground motion of nearby major earthquakes. We also apply this method to the weak motion records generated by the 36 repeating earthquake clusters identified by Peng and Ben-Zion (2006) during the same period, but no clear temporal changes of peak spectral ratio or peak frequency is observed. This is likely because the first post-Düzce events in the repeating clusters occurred at least a few hours after the Düzce mainshock, when most of the rapid coseismic changes have been recovered.