The Spatial Distribution of Site Response from the Yokohama High-Density Strong Motion Network

Kenichi Tsuda[1]; Ralph Archuleta[2]; Kazuki Koketsu[3]

[1] Department of Geological Sciences,UCSB; [2] Department of Geological Sciences, UCSB; [3] Earthq. Res. Inst., Univ. Tokyo

The objective of this study is to estimate the spatial variation of site response over very short distances. Using accelerograms from the Yokohama high-density accelerometer array (150 surface and 9 borehole accelerometers located in a 20x20 km2 area) we have determined the horizontal, frequency-dependent, site response for all stations. We have tried to correlate the site response with geophysical, geotechnical and geological parameters. The data set comes from 21 earthquakes; 13 recorded at all borehole stations. Using the data recorded at the boreholes we have determined: source parameters (seismic moment and corner frequency) for each event; Q(f) for the path; and the frequency-dependent site factors for the boreholes Sb(f). We use Boatwright's (1978) representation of the omega-squared spectrum for the source. We assumed that the quality factor is constant for frequencies less than 1.0 Hz while having a power law relation for frequencies greater than 1.0 Hz. The borehole data are inverted, using a heat bath algorithm, to find source and path parameters. The difference between the observed and predicted spectrum is taken to be Sb(f). We iterate on the inversion until Sb(f) and Q(f) stabilize. Once stable values of Sb(f) and Q(f) are obtained, we invert the borehole data only for the source parameters (Mo and fc) for all 17 deep events individually. The same procedure is applied to four shallow events. A merit of this inversion scheme is that it is independent of a reference station i.e. there is no a priori constraint about site response. For deep events Q(f) = 285f0.06; shallow events (depth less than 25 km) Q(f) = 74f0.28. We determine seismic moments that are generally within the factor of 2 of values determined by NIED. Seismic moments are roughly proportional to fc-3 with a constant stress drop of 100 bars for the deep events. Knowing Mo, fc, and Q(f), we determine the site amplification factors Si(f) for the 150 surface stations by averaging the ratio between predicted and observed amplitude spectra for all of the recorded events. The surface site responses for 0.1-1.0 Hz correlate with the averaged S-wave velocity in the upper 30m. We introduce a site correlation function to compare the site response between station pairs separated by less than 1.0 km to estimate the spatial variation of site response. Initial results indicate that for the Yokohama array the surface site response can be predicted within 20% up to distances of 1.0 km for frequencies less than 2 Hz.