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A three-step inversion approach to solve for site effects and Q

°Cesar Moya and Kojiro Irikura (DPRI, Kyoto Univ.)

The spectral ratio of two earthquakes, for which the seismic moments are known, was inverted together with the spectral ratios of site effects and Q factor in order to obtain individual solutions for each one of the sites and the Q factor. The earthquakes were selected in such a way that their seismic moments were at least one order of magnitude different and the epicenters were preferably located far from each other.

In the first step, the spectral ratios of the events and the sites were written as logarithmic summations in matrix form and using no constrains. As it would be expected, the result yielded incorrect amplitude estimates for individual solutions for the sites and sources. However, considering that the propagation path effect was removed at this point (i.e. Q is not affected whether we invert spectral ratios or logarithmic summations), the spectral ratios of the sites and sources were to be reliable. The second step therefore consisted of retrieving the corner frequencies from the spectral ratio of the two events using a non-linear least squares fitting algorithm. Together with the seismic moments for the two earthquakes, the corner frequencies were used to make two omega-square source models. The third and last step corresponded to inverting once again the matrix containing the logarithmic summations but this time using the two source models as a constrain.

In previous work, the corner frequencies were read after taking spectral ratios of pairs of earthquakes (twins) which needed to be located very close to each other so that, the propagation path was similar for both of them. Here instead, that condition is no longer necessary. We tested this methodology first using synthetic data and then using the 2000 Tottori earthquake data. We compared the results to the ones obtained using twin earthquakes and observed that there were differences in the amplitude between the two methods; however, those differences remained within the standard deviation.