A New Method of Estimating Epicentral Distance and Magnitude for Early Earthquake Detection (3) Measures against Multiple Shock

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In the previous report we introduced a simple function of the form of Btexp(-At) to represent an envelope waveform of an initial part of P wave arrival and showed that the epicentral distance could be estimated from the parameter B in a quite short time (e.g., 3 seconds) after the P-wave arrival. The combination of two parameters A and B may give a good indication of the size of an earthquake because the above function expresses the wave behavior well. We present a new method of estimating the magnitude from A and B with a formula M= a A + b log B + c. We expect the method may cope well with multiple shocks by repeating the magnitude estimation with some adequate time interval.

1. Introduction

The 2000 Western Tottori earthquake M 7.3 is known to be a multiple shock and after Umeda et al. (2001), the duration time of the preliminary fracture is 3 seconds and its magnitude is estimated as 6. From the viewpoint of early earthquake alarm, the estimation of magnitude of multiple shocks is a serious and quite difficult problem.

2. Method

From the observation of seismic waveforms we understand that the envelop waveform of small earthquakes decays soon after the initial rise while that of large earthquakes grows up for some time. We introduced a simple function of the form of Btexp(-At) to express a difference in waveform quantitatively and showed that the parameter B could be used for the estimation of epicentral distance [Odaka et al.(2001), Tsukada et al(2001)]. The combination of two parameters A and B may give a good indication of the size of an earthquake because the above function expresses the wave behavior well. Hence, we try to estimate the earthquake magnitude by using the following formula

$$M = a A + b \log B + c , \quad (1)$$

where a, b and c are the parameters to be determined by the least squares method.

We compared JMA magnitudes with those estimated by the above formula in which the coefficients a, b and c were determined for 10 earthquakes including Western Tottori earthquake M7.3, Geiyo earthquake M6.7 and its largest aftershock M5.0 so that the estimated magnitudes might agree with JMA magnitudes. We used the Kyoshin (strong-motion) Net (K-NET) data that was opened to the public by the National Research Institute for Earth Science and Disaster Prevention.

3. Results and Discussion

Analysis was made for the first 3, 6 and 8 seconds of data after the P arrival. The estimated magnitudes for the Western Tottori earthquake varied from around M6.2 (mean value) to around M7 (mean value) with the change of the analysis interval from 3 to 6 and 8 seconds and those for other earthquakes did not change so much.

The above result is consistent with the description of Umeda et al. (2001) and it also suggests that our method may cope well with multiple shocks by repeating the magnitude estimation with some adequate time interval.

References

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