AN ASPECT OF ENVELOPE CURVE OF INITIAL P-WAVES FOR EARTHQUAKE EARLY WARNING SYSTEM

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One of the vital tasks in the earthquake early warning (EEW) system is rapid and precise estimation of earthquake magnitude and distance. The Japanese EEW called the Urgent Earthquake Detection and Alarm System (UrEDAS), is used by railways in order to stop high-speed trains (Nakamura, 1988). In the UrEDAS, the event magnitude is determined by applying well-known method namely predominant period (T_P^{max}) on the initial seconds of arriving P-waves, which was introduced by Allen and Kanamori (2003). Then, the epicentral distance is indirectly estimated using an attenuation relationship as a function of magnitude (here, estimated magnitude) and the peak ground amplitude of P-wave. Another approach for estimation of distance is introduced by Odaka *et al.* (2003), which directly estimates the epicentral distance using growth curve of initial P-wave at single station. Odaka *et al.* (2003) fitted a simple function as Equation 1 to the few seconds of early part of P-wave and calculated A (1/sec) and B parameters using the least-squares method.

$$Y(t) = Bt.\exp(-At) \qquad (1)$$

The origin of time t is considered since P-phase arrival time. Odaka *et al.* (2003) showed an inverse relationship between log(B) and log(Δ), where Δ denotes epicentral distance in km. According to Odaka *et al.* (2003) while the amplitude of large earthquake arias exponentially with time t, A values would be less than zero and vice versa for small to moderate earthquakes. The decreasing rate of B parameter with distance is mostly due to two key environmental mechanisms including (1) intrinsic attenuation and (2) geometrical spreading. Therefore, B measurements seemed to be independent of magnitude and can be used in order to quick estimation of distance. However, for the waveforms recorded at same distances, different values of B parameter are determined. It can be due to the sensitivity of P-wave envelope to some factors such as local heterogeneities in the subsurface, source duration, radiation pattern, etc. (Odaka *et al.*, 2003). In this study, more than 500 acceleration waveforms of 21 earthquakes with magnitude range between 3 and 6 and epicentral distances less than 160 km occurred in Japan (see Figure 1), are used in order to study effects of intrinsic attenuation and geometrical spreading on the initial envelope of P-wave.

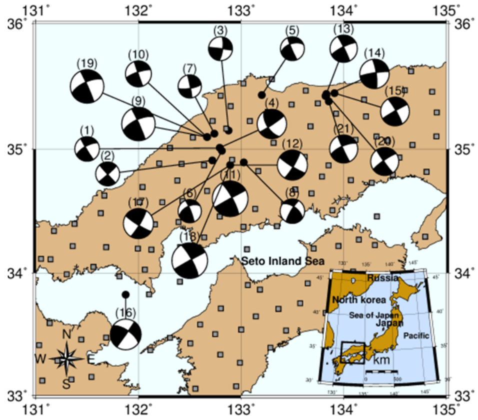

Figure 1. Map of accelerometer locations (squares), epicenters of the considered earthquakes (black circles) and their focal mechanisms.

According to the method proposed by Odaka *et al.* (2003), B-Δ approach is implemented in order to extract two parameters, A and B, from waveforms. The function form in Equation 1 is fitted to two initial seconds of acceleration signals. For this purpose, the logarithm of this function is used as ln(y)= ln(Bt)-At. In this way, parameters A and B are calculated using the least-squares method.

After extracting parameters A and B, values for the logarithm of epicentral distance are plotted against the logarithm of B (Figure 2). As a result, at larger distances (greater than 100 km), the intrinsic attenuation is dominant factor in reducing the amplitude of waves. Therefore, this study proposes the B- Δ approach at distances less than 100 km, in order to rapid estimation of epicentral distances.

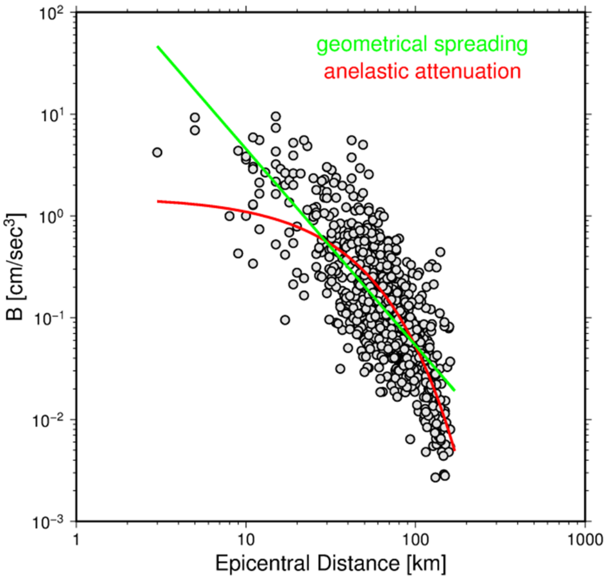

Figure 2. Relation between B values and epicentral distance of the studied earthquakes.

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