A DURATION–ENERGY PROCEDURE FOR RAPID ESTIMATE OF EARTHQUAKE MAGNITUDE USING EARLY PART OF P WAVEFORMS

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Abstract

Understanding the earthquake rupture process is the central-point in our understanding of fault systems and rapid magnitude determination. For example in an earthquake early warning system it is essential to be able quickly to determine the size and location of an earthquake. There are a number of procedures for rapid analysis of the magnitude of large earthquakes using seismic P wave portion of seismic waveforms at teleseismic distances. Because these procedures use only the P-wave portion of a seismogram thus the estimate of an event size is potentially available only a few minutes after the P waveform has been recorded at teleseismic distances, that is, in as little as 10–15 min after origin time (OT) at 30° great circle distance (GCD) and about 20 min after OT at 90° GCD.

We introduce a rapid and robust, energy-duration procedure, based on the Haskell, extended source model, to obtain an earthquake moment and a moment magnitude, M_{ED}. Using seismograms at teleseismic distances (30°–90°), this procedure combines radiated seismic energy measures on the P to S interval of broadband signals and source duration measures on high frequency, P-wave signals. The M_{ED} energy-duration magnitude is scaled to correspond to the Global Centroid-Moment Tensor (CMT) moment-magnitude, M_w^{CMT}, and can be calculated within about 20 min or less after origin time. In this study we present the application of the energy-duration methodology to a number of recent, large earthquakes (including 2007/09/12, Southern Sumatera earthquake, Mw^{CMT} 8.5 and 2004/12/2, Sumatra-Andaman mega-thrust earth- quake, Mw^{CMT} 9.0) using only SNSN (Swedish National Seismic Network) data.