SECOND EUROPEAN CONFERENCE ON EARTHQUAKE ENGINEERING
AND SEISMOLOGY, ISTANBUL AUG. 25-29, 2014

M_W ESTIMATION FROM CRUSTAL CODA-WAVES RECORDED ON ANALOG SEISMOGRAMS IN FRANCE

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Accurate magnitude estimation is necessary to establish reliable seismicity catalogs in order to assess seismic hazard. Several studies have shown the interest of coda-waves for estimating seismic source properties (Rautian and Khalturin, 1978; Dewberry and Crosson, 1995). The coda amplitude stability from station to station offers a great advantage for estimating accurate magnitude from a limited set of stations (Mayeda et al., 2003), as it is the case for old records in most regions of the world. We develop a methodology based on coda-wave analog seismograms to determine the moment magnitude M_W in France. The method is applicable on recent digital seismograms as well as on old analog records. As no filtering is possible on paper records, we cannot use spectral analysis for determining the seismic moment and thus M_W. We first study the coda-waves properties directly in the time domain. For this analysis, we have used 109 earthquakes digitally recorded at 19 stations of the LDG French short-period velocimetric network between 1997 and 2013. We determine an empirical model which fits the observed coda envelopes of the rough time signal in which the propagation term is defined by $C_0(t)=t^{-\gamma}.\exp(-\beta(t))$ where $\beta(t)$ presents a quadratic variation in time $\beta(t)=\beta_1 t-\beta_2 t^2$. As the French territory presents different tectonic and geological units, the coda parameters β_1 and β_2 are estimated for four French regions. Inside each region, we notice that this model fits well the observed coda whatever the earthquake size is. In order to understand the significance of this quadratic empirical model, we have computed synthetic coda based on the single-scattering model (Aki and Chouet, 1975). In order to estimate the regional quality factors Q_c necessary for computing the synthetics we have performed a frequency analysis of coda-waves recorded on the recent LDG records. The synthetic coda explain well the quadratic terms fitting the rough coda records. In other words, the regional frequency dependence of Q_c within the [0.3Hz,7Hz] frequency-band of the instrument is the cause of the quadratic variation of $\beta(t)$ which is necessary to fit rough records. Another important factor to compute the amplitude of the source term is a site effect at the different stations. After correcting the coda envelopes for the propagation and the site terms, we obtain a stable coda magnitude M_{coda} which can be converted into M_w. In conclusion, the moment magnitude M_w can be determined directly from paper records using a linear M_{coda}-M_W relationship.

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