Moment magnitude for weak earthquakes in the Mt. Etna volcano area

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Etna's seismicity is characterised by frequent weak events (local magnitude ML≤ 3) with shallow hypocentral depth (h≤ 5 km), mainly affecting the volcano's eastern flank, where there is morphological evidence of active faults. Although the ML of earthquakes rarely exceeds 4.0, the Etna area is among the areas with the highest seismic potential in Italy, and for the presence of the highly urbanised areas has relevant implications in terms of seismic risk [Azzaro et al. 2015].
Therefore, an accurate estimation of the energy released by weak seismicity is crucial to implement seismic event catalogues and to improve the accuracy of magnitude-return relationships required for an adequate seismic hazard assessment.
In this study, we calibrate a data-driven empirical equation for response spectra as a function of MW following the approach of Moratto et al., [2017], which is based on the method of Atkinson et al., [2014]. This method estimates MW values from response spectra in terms of Spectral Acceleration (SA), since such spectra smooth the irregularities observed in Fourier Amplitude Spectra due to the 5% damping applied in their calculation. The empirical equation is defined for SA computed at 1.0 and 0.3 s.
To fine-tune the relationship for the study, we applied a two-step procedure using ground motion simulations and MW estimates from independent approaches. In the first step, we estimated ground motions with a stochastic method for a Brune point source model using the parameters proposed by Langer et al. [2016], who calculated ground motion scenarios for Etna, distinguishing between two seismotectonic regimes: one with a focal depth of less than 5 km, mainly related to surface deformation processes, and the other related to the regional crustal deformation pattern for earthquakes with a focal depth of more than 5 km.
In the second step, we compiled a dataset of about 400 earthquakes with 1.0 ≤ ML ≤ 4.8 that occurred in the Etna region from 2005 to 2019, and calculated the MW from the long-period plateaus of earthquake source spectra properly corrected for path propagation.
Finally, we also provide an empirical relationship between ML and MW for the Etna region, which, together with relationship SA- MW can be easily implemented in real-time routine analyses and provide a fast method to calculate moment magnitudes.

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