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Modeling of Strong Ground Motion in "The Geysers" Geothermal Area

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The Geysers is a vapor-dominated geothermal field located about 120 km north of San Francisco, California. The field is actively exploited since the 1960s, and it is now perhaps the most important and most productive geothermal field in the USA. The continuous injection of fluids and the stress perturbations of this area has resulted in induced seismicity which is clearly felt in the surrounding villages. Thus, based on these considerations, in the present work Ground Motion Prediction Equations (GMPEs) are derived, as they play key role in seismic hazard analysis control and for monitoring the effects of the seismicity rate levels. The GMPEs are derived through the mixed non-linear regression technique for both Peak Ground Velocity (PGV) and Peak Ground Acceleration (PGA). This technique includes both fixed effects and random effects and allows to account for both inter-event and intra-event dependencies in the data. In order to account for site/station effects, a two steps approach has been used. In the first step, regression analysis is performed without station corrections and thus providing a reference model. In the second step, based on the residual distribution at each station and the results of a Z-test, station correction coefficients are introduced to get final correct model.
The data from earthquakes recorded at 29 stations for the period September 2007 through November 2010 have been used. The magnitude range is ($1.0 < Mw < 3.5$) while the hypocentral distances range between 0.5 km and 20 km. The final models are compared with standard models obtained using data collected in different tectonic environments and magnitude ranges to understand the compatibility of the model obtained from data collected in geothermal fields with respect to those obtained from natural seismic events. The residual analysis is performed at individual stations to check the reliability of the station corrections and for evaluating the fitting reliability of the retrieved model. The best model has been chosen on the basis of inter-event standard error and R-square test. After the introduction of the site/station correction factor, an improvement in the fit is observed, which resulted in total standard error reduction and increased R-square values.