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Seismic source parameters of the induced seismicity at The Geysers geothermal area, California, by a generalized inversion approach

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The accurate determination of stress drop, seismic efficiency and how source parameters scale with earthquake size is an important for seismic hazard assessment of induced seismicity. We propose an improved non-parametric, data-driven strategy suitable for monitoring induced seismicity, which combines the generalized inversion technique together with genetic algorithms. In the first step of the analysis the generalized inversion technique allows for an effective correction of waveforms for the attenuation and site contributions. Then, the retrieved source spectra are inverted by a non-linear sensitivity-driven inversion scheme that allows accurate estimation of source parameters. We therefore investigate the earthquake source characteristics of 633 induced earthquakes (ML 2-4.5) recorded at The Geysers geothermal field (California) by a dense seismic network (i.e. 32 stations of the Lawrence Berkeley National Laboratory Geysers/Calpine surface seismic network, more than 17.000 velocity records). We find for most of the events a non-selfsimilar behavior, empirical source spectra that requires $\omega\gamma$ source model with $\gamma > 2$ to be well fitted and small radiation efficiency ηSW. All these findings suggest different dynamic rupture processes for smaller and larger earthquakes, and that the proportion of high frequency energy radiation and the amount of energy required to overcome the friction or for the creation of new fractures surface changes with the earthquake size. Furthermore, we observe also two distinct families of events with peculiar source parameters that, in one case suggests the reactivation of deep structures linked to the regional tectonics, while in the other supports the idea of an important role of steeply dipping fault in the fluid pressure diffusion.