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From induced seismicity to direct time-dependent seismic hazard

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The growing installation of industrial facilities for subsurface explorations worldwide, particularly in proximity of urbanized areas, requires refinements in understanding both the mechanisms for triggering the induced seismicity and their effects in terms of hazard. In fact, particularly in proximity of densely populated areas, induced low-to-moderate, high-frequency seismicity can be clearly felt by population and, in some cases, can produce damages to non-structural elements of buildings or even structural damages when rural buildings are involved. As a consequence, it is nowadays definitely important to be able to estimate time-dependent seismic hazard for providing a guide during the field operations and for monitoring their direct effects in the surrounding areas.

In the present work a time-dependent probabilistic seismic hazard analysis is presented. The technique is aimed at integrating the models of earthquakes occurrence which best correlate with field operations and ground-motion prediction techniques in a Bayesian framework to estimate in a time-evolving approach the probability of exceedance of selected ground motion parameters, that are of engineering interest.

Using data from different geothermal areas, e.g. The Geysers in Northern California, seismic hazard analysis is performed through: 1. Identification of the earthquake occurrence model which, on the basis of statistical tests, best correlates with the observed seismicity; 2. Time and space analysis of the recurrence relationship, mainly the *b*-value of the Gutenberg-Richter relationship; 3. Estimation of the maximum expected magnitude earthquake; 4. Selection of the best ground-motion parameters and predictive equation; 5. The selection of the most appropriate exposure times that cannot be classic ones for example 475 years.

Finally, the availability of high-quality catalogues covering long periods offers a unique opportunity for testing the proposed technique. In this respect, using different portions of the available catalogues a first setting of the technique is performed, and the prediction capability is evaluated through a statistical analysis.