Abstract

Fluid injection into the rock formations represents a valuable analog to study the role of high-pressurized fluids in the seismogenic process. It is carried out in depths up to first thousands of meters in order to increase the permeability of rock formation for better exploitation of hydrocarbons and geothermal energy. The increased fluid pressure results in decrease of the strength of fractures and faults which causes their brittle failure that is observed in the form of microearthquakes and enables imaging of the stimulated rock volume. Besides this positive role, seismicity sometimes increases to the level that can be felt by the population, which can cause concerns about the seismic risk of these industrial operations. Thus, one of the main interests focused by recent studies deals with the maximum earthquake that can be triggered by hydraulic stimulations. I introduce the ratio between the hydraulic energy and released seismic energy, the seismic efficiency of injection, to assess the effect of fluid injection to the seismicity. This parameter is applied to data from two geothermal reservoirs (Gross Schönebeck and Soultz-sous-Forets) and one gas reservoirs (East Texas). We find that for different data sets, the seismic efficiency encompasses a broad range of magnitudes; from about 10^{-6} to 10^{-4} in two formations up to 1 in third formation. Comparison with the statistical analysis indicates that higher seismic efficiency of injection is accompanied by lower b-values and vice-versa. Stimulations with smaller seismic efficiency of injection are also typical by the high correlation between the growth of the stimulated rock volume and the total seismic moment, whereas the larger seismic efficiency of injection is also accompanied by anti-correlation of these parameters.