Geophysical Research Abstracts
Vol. 14, EGU2012-11436, 2012
EGU General Assembly 2012

Characterisation of the Seismotectonic State of Reservoir Locations Using the Magnitude Distribution of Earthquakes

C. Dinske (1), F. Wenzel (2), and S. A. Shapiro (3)

(1) FR Geophysik, Freie Universität Berlin, Germany (carsten@geophysik.fu-berlin.de), (2) Geophysical Institute, Karlsruhe Institute of Technology, Germany (friedemann.wenzel@kit.edu), (3) FR Geophysik, Freie Universität Berlin, Germany (shapiro@geophysik.fu-berlin.de)

Fluid injections in geothermal reservoirs usually induce small-magnitude earthquakes ($M < 2$). Sometimes, however, earthquakes with larger magnitudes ($M \sim 4$) occur. A key point for evaluating a potential seismic hazard due to a fluid injection is to identify the parameters which define the earthquake magnitude and its frequency. Recently, we have shown that under rather general conditions the probability of a seismic event having a magnitude larger than a given one increases proportionally to the injected fluid mass. The number of earthquakes larger than a given magnitude also depends on the seismotectonic state of the injection site. To characterise this state, we introduced the seismogenic index Σ. It combines four, generally unknown, site-specific seismotectonic quantities. Here we continue to comparatively analyse the seismotectonic state of several geothermal as well as non-geothermal reservoir locations using observations from fluid injection experiments. From our analysis it is obvious that the seismogenic index has a characteristic range of values for geothermal reservoirs on the one hand, [-4 $< \Sigma <$ 0.5], and hydrocarbon reservoirs on the other hand, [-10 $< \Sigma <$ -4] (the higher is the seismogenic index, the higher is the probability of an earthquake having a significant magnitude). We show that knowledge of the seismogenic index allows for estimating the level of seismic activity. It means that we can compute the expected number of induced earthquakes exceeding a given magnitude. Application of the seismogenic index in combination with the homogeneous Poisson model describing the earthquake occurrence permits to estimate the occurrence probability of a given magnitude earthquake. Furthermore, we analyse correlations between the seismogenic index and other injection-, reservoir- and seismicity-related parameters. We also address the question whether natural tectonic seismic activity within an area where a fluid injection is planned can be used to evaluate the seismotectonic state. For this purpose, we expand and reformulate the conceptual framework valid for fluid-induced seismicity to natural seismicity and derive an equivalent tectonic seismogenic index. We apply this model to reservoir locations with known seismogenic index determined from fluid-induced seismicity. We conclude from the obtained results that our formalism contributes to evaluate a possible seismic hazard by fluid injections.