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Seismicity of the northern Upper Rhine Graben – Constraints on the present-day stress field from focal mechanisms

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The seismicity of the northern Upper-Rhine Graben and its seismic hazard have recently attracted new attention due to the potential of this region for geothermal power generation. The natural seismicity can be used to determine active fault zones and stress conditions within the crust. It also provides important background information for the estimation of seismic hazard and possible induced seismicity. The natural seismicity of this area is also interesting because of swarm earthquakes which occurred in the 19th century. The characterization of the natural seismicity in this region is one of the main goals of the project SiMoN (Seismic Monitoring of the Northern Upper-Rhine Graben), which is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). We present new results for the microseismic activity in an area of approximately 50 x 50 km by analyzing seismogram recordings from a temporary network of up to 13 broad-band stations in combination with data from permanent stations. The network will soon be expanded by several borehole stations to accommodate for the relatively high noise levels in the densely populated Rhine-Main region. Since November 2010 a number of 64 local earthquakes have been recorded within the immediate vicinity of the network with magnitudes in the range between ML = 0.5 and ML = 3.2. The detection threshold is a local magnitude of approximately 1.0, the magnitude of completeness is Mc = 1.3. The observed seismicity extends to a depth of 24 km with a pronounced maximum in the depth distribution between 9 to 18 km. In addition to the data recorded by the SiMoN stations we used recordings provided by the regional seismological services to determine focal mechanisms and to derive the current stress field. The associated fault-plane solutions show predominantly strike-slip mechanisms, whereas normal and reverse faulting mechanisms rarely occur. An inversion of the focal mechanisms leads to an orientation of the maximum horizontal stress in N135°E. In the center of the study area a shift in the orientation of the maximum horizontal stress by almost 90° can be observed. We apply 3-dimensional geomechanical modeling to explain this observation.