ESC2016-306, 2016
35th General Assembly of the European Seismological Commission

35th General Assembly of the European Seismological Commission
4–10 September 2016 Trieste

Induced seismicity caused by hydraulic fracturing in deep geothermal wells in Germany and adjacent areas

Thomas Plenefisch (1), Lisa Brückner (1), Lars Ceranna (1), Nicolai Gestermann (1), Georg Houben (1), Torsten Tischner (1), Ulrich Wegler (1), Matthias Wellbrink (1), Christian Bönnemann (1), Andreas Bertram (2), and Bernd Kirschbaum (2)

(1) Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany (thomas.plenefisch@bgr.de), (2) Umweltbundesamt (UBA), Dessau-Roßlau, Germany (Andreas.Bertram@uba.de)

Recently, the BGR has worked out a study on the potential environmental impact caused by hydraulic fracturing or chemical stimulations in deep geothermal reservoirs in Germany and adjacent areas. The investigations and analyses are based on existing studies and information provided by operators. The two environmental impacts being essentially considered in the report are induced seismicity and possible contamination of the groundwater reservoirs which serve for drinking water supply. Altogether, in this study, information on 30 hydraulic frac operations and 26 chemical stimulations including information from neighboring countries were compiled and analyzed. Out of the hydraulic stimulations two thirds were carried out as waterfracs and one third as fracturing with proppants.

Parameters used in the study to characterize the induced seismicity are maximum magnitude, number of seismic events, size of the seismically active volume, and the relation of this volume to fault zones and the cap rock, as well as, finally, the impacts at the Earth's surface. The response of the subsurface to hydraulic fracturing is variable: There are some activities, which cause perceptible seismic events, others, where no perceptible but instrumentally detected events occurred, and moreover activities without even any instrumentally detected events. A classification of seismic hazard with respect to tectonic region, geology, or depth of the layer is still difficult, since the number of hydraulic fracturing measures in deep geothermal wells is small making a statistically sound analysis impossible. However, there are some indications, that hydraulic fracturing in granite in tectonically active regions like the Upper Rhine Graben results in comparatively stronger, perceptible seismicity compared to hydraulic fracturing in the sedimentary rocks of the North German basin.

The maximum magnitudes of induced earthquakes caused by hydraulic fracturing of deep geothermal wells in Germany are significantly smaller than those in other areas of mining activity in Germany. The vertical distance between the earthquakes and the cap rocks was at least 1,000 m. Therefore a hazard for the groundwater reservoirs serving for drinking water supply, which are located above the cap rock layers, is unlikely.

Based on the analysis of the study we conclude in summary, that in compliance with existing rules, the installation of monitoring equipment as well as following the state-of-the-art scientific and technological expertise a detraction of the groundwater as a result of hydraulic fracturing in deep geothermal reservoirs can be ruled out. Moreover, the probability of perceptible seismic events can be minimized by an appropriate monitoring system in combination with an immediate response system and reaction plan.