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Effective sensitivity estimate of the microseismic monitoring network deployed in Bruchsal geothermal field

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First half of 2010, a permanent seismic network was deployed to monitor the exploitation of the Bruchsal deep geothermal field. This hydrothermal pilot project is based on a well doublet drilled, with an offset of about 1.3 km, to 2000 m and 2500 m depth in the Buntsandstein, Rotliegend and Zechstein formations; a Kalina cycle is used as heat converter or exchanger. The seismic array is composed of four three-component 4.5 Hz geophones cemented at 100 m depth in the surrounding of the injection and the production wells. The continuous monitoring should help to anticipate on any possible major damage on surface and may help to image the geothermal reservoir.
No stimulation or circulation was performed during the first 16 months of monitoring. This provides us the opportunity to build-up our knowledge on the existing background seismicity. Using the results of the network background noise analysis and the records of natural earthquakes, the raw data screening procedure has been tuned. Despite the good working order of the network, no local seismicity has been identified in the continuous records but numerous regional earthquakes were detected. Therefore, the question of the effective sensitivity of the seismic network at the field scale and especially at the level of the geothermal reservoir arises.
To try to answer this question, the network sensitivity is first estimated by comparing the detected regional seismicity with that compiled from the catalogues of the German seismological central observatory (SZGRF-BGR), the Rhineland-Palatinate seismological center (LGB-RLP) and the European-Mediterranean Seismological Centre (EMSC). So far, in our database, more than 40 earthquakes between ML=1.3 and 4.8 were detected by the network at distances from about 33 km up to 500 km. Other earthquakes from the compiled catalogue were not detected but could be a posteriori identified on the seismograms and many more not identifiable at all. The magnitude-distance distributions of these three types of records allowed us to estimate the effective sensitivity of the network one may expect at distances closer than 33 km including the reservoir zone, only a couple of kilometers from the monitoring stations.
A second sensitivity estimate is proposed without the use of recorded seismicity and follows an approach typically used in a network design phase. It aims at modeling the smallest magnitude an event should have to be detected by the seismic network according to the detection procedure. Hence, the data filtering, the background noise level observed (or assumed) on every geophone components, the number of stations required to detect and a simple model of seismic amplitude attenuation are involved in such modeling. At last, these two approaches are compared to check if the modeled detected sensitivity is in accordance with the observed effective sensitivity.