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Past, present and future improvements of the efficiency of the local seismic network of the geothermal reservoir of Casaglia, Ferrara (North Italy)

Nasser Abu Zeid (1), Lorella Dall'olio (2), Samuel Bignardi (1), and Giovanni Santarato (1)

(1) University of Ferrara, Univeristy of Ferrara, Department of Physics and Earth Sciences, Ferrara, Italy (nsa@unife.it), (2) Municipality of Ferrara, remediation services

The microseismic network of Ferrara was established, in the beginning of 1990 and started its monitoring activity few months before the start of reservoir exploitation, for residential and industrial heating purposes, of the Casaglia geothermal site characterised by fluids of 100 °C: February 1990. The purpose was to monitor the natural seismicity so as to be able to discriminate it from possible induced ones due to exploitation activities which consists of a closed loop system composed of three boreholes: one for re-injection "Casaglia001" and two for pumping hot fluids. The microseismic network started, and still today, its monitoring activities with five vertical 2 Hz and one 3D seismometers model Mark products L4A/C distributed at reciprocal distances of about 5 to 7 km around the reservoir covering an area of 100 km^2. Since its beginning the monitoring activities proceeded almost continuously. However, due to technological limitations of the network HW, although sufficient to capture small magnitude earthquakes (near zero), the exponential increase of anthropogenic and electromagnetic noise degraded the monitoring capability of the network especially for small ones. To this end and as of 2007, the network control passed to the University of Ferrara, Department of Physics and Earth Sciences, the network HD for digitalisation and continuous data transmission was replaced with GURALP equipment's.. Since its establishment, few earthquakes occurred in the geothermal area with Ml < 1.5 and hypocentre depth > 5 km. However, following the Emilia sequence of 2012, and as an example we present and discuss the local earthquake (Ml 2.5) occurred in Casaglia (Ferrara, Italy) on September 3, 2015, in the vicinity of the borehole Casaglia1 used for fluid re-injection. In this case, both INGV national network and OGS NE-Italy regional networks provided similar information, with hypocenter at about 5-6 km North of the reservoir edge and about 16 km of depth. However, the same event, relocated by using also the microseismic data, felt within the reservoir area at 4-5 km depth, i.e. close to the geothermal reservoir. Still problems related to anthropogenic noise still present hence future improvements shall include the deepening of the existing boreholes to at least 100 m and the replacement of the seismometers with at least 1 Hz modern ones. Moreover, at least two or three stations shall be installed to fully be in line with recent Italian Guidelines that discipline the monitoring of industrial activities that exploits the subsurface.