Geophysical Research Abstracts
Vol. 13, EGU2011-10821, 2011
EGU General Assembly 2011

Induced seismicity at Berlín geothermal field, El Salvador: Spatiotemporal characteristics of microearthquakes down to $M_W - 0.5$

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As presented by a number of field observations in geothermal sites, larger magnitude events (LMEs hereafter) might be triggered by the shut-in of the wells. It is strongly believed that fluid injection decreases effective normal stress within the pre-existing fractures resulting in LMEs depending on injection rate. The GEISER (Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoirs) project has been developed to investigate the induced seismicity in various geothermal sites focusing on generation process of the LMEs. In this context, we investigate microseismic activity monitored at Berlín geothermal field, El Salvador, during a hydraulic stimulation. We used data from a local seismic network deployed in direct vicinity of simulated area. The network consists of 12 3-component geophones located in 6 boreholes. Here we analyze approx. 600 seismic events ranging from $M_W - 0.5$ to $M_W 3.8$. Daily rate of the seismicity indicates remarkable rise in the number of seismic events for particular time spots compared to the background seismicity and correlates to injection rate. The largest event considered to be LME ($M_W 3.8$) occurred after the shut-in of injection well. We investigate physical process behind temporal clustering of the earthquakes using refined hypocenter catalogue. We improve the hypocenter distribution using Double-Difference relocation technique based on cross-correlation-derived differential travel times. This provides insight into 3-D view of fault-network and spatiotemporal behavior of the seismicity, and therefore allows better understanding the interaction of neighboring sources along the target area. Our preliminary analysis shows that temporal clusters are characterized by co-located earthquakes representing progressive failure of adjacent sources within several hours. The source parameters of co-located events are precisely calculated using spectral ratio technique that eliminates unknown path effects commonly introduced to the seismic data. The applied methodology allows characterizing the spatiotemporal distribution of various source parameters, such as static stress drop and apparent stress, in a well-resolved scale.