Estimation of focal mechanisms of large number of induced seismicity to understand fracture system in the geothermal reservoir

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Induced microseismicity is a phenomenon often observed in hydrocarbon and geothermal reservoirs accompanying changes in pore pressure due to injection. Estimation of the focal mechanism of induced microseismicity is beneficial to characterize the distribution of the existing fractures in the reservoir. The focal mechanism of microseismicity is often constrained by the polarity information of first P-wave arrivals. However, it’ s difficult to obtain enough P-wave polarities from a limited number of stations due to cost consideration. The new method was proposed to better constrain the focal mechanism of injection induced microseismicity by introducing *in situ* stress magnitude/orientation information and the injection wellhead pressure (Mukuhira et al., 2018). The range of possible focal mechanism estimated by available polarization information was constrained by in situ stress data further.

We have applied this method to 47 microseismicity events with relatively larger magnitude during the hydraulic stimulation in Basel, Switzerland. In this study, we apply our method to more than 2,000 smaller magnitude events of which the orientations of fault are unknown. By estimating more fault orientation, we can understand the entire fracture system of the reservoir.

All the events are divided into 101 groups based on waveform similarity, and assume all group member occur from one single fracture. we choose one group (group 4) based on good linear shape, relatively larger magnitude of members, large number of events and occurrence time during the injection period. We estimate the fault orientation by principal component analysis (PCA) of hypocenter distribution of 54 events from group 4, and then regard this fault orientation as reference. Meanwhile, we also use the first P-wave arrivals polarities and *in situ* stress information to constrain the focal mechanism together. Then, we will compare the two estimates of fault orientation by PCA and our method, and discuss the validity of our method for smaller events. Then, we will apply our method and constrain the focal mechanisms of other groups. Consequently, we will estimate the focal mechanism of more than 2,000 events from Basel, Switzerland using this method. Our work will enhance the validity of our method further and also contribute to better understanding the fracture system in the reservoir in Basel, Switzerland.

Keywords: Induced seismicity, Fracture system, Basel, Switzerland, Focal mechanism