Induced Seismicity Protocol for the First Enhanced Geothermal Systems Project in Pohang, Korea

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Introduction

Induced microseismicity has been regarded as a key component for the first EGS project initiated in Pohang, Korea which started in 2010. A regional case study of geothermal energy development in South Korea focusing on the comprehensive protocol addressing induced microseismicity is presented in this study. The protocol largely follows the seven steps suggested by the Department of Energy in United States with site specific adjustment and improvement as necessary. Site selection procedure, outreach program, establishment of local seismic network, and methodology in establishing traffic light system are introduced together with analysis of induced microseismicity from the first hydraulic stimulation campaign. The traffic light system was applied to the first hydraulic stimulation operation in January and February of 2016, and calibrated with induced microseismicity

Pohang EGS Project (Dec, 2010 ~)

- Location: Pohang, South Korea (Fig. 1)
- Boreholes: PX-1 (4.2 km), PX-2 (4.3 km) at EGS site
- Geothermal gradient: 41 °C/km (103.8 °C at 2,170 m depth of PX-1 borehole) (Yoon et al., 2015)
- 1st Hydraulic stimulation (PX-2, Jan ~ Feb, 2016) Total injected volume: 1,970 m³

Table 1. Seven steps suggested by U.S. DOE for addressing induced seismicity (Majer et al., 2012).

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Step 2: Outreach and communications program

The inauguration ceremony in August 2012 was a platform for communication with local governments and residents. As of September 2016, the total number of visitors was 740 from 173 organizations (Fig. 2).

Step 3: Review and selection of criteria for ground vibration

Regulations and standards for ground vibration in South Korea were reviewed, and a new standard covering the Pohang EGS project was suggested by considering domestic criteria and human response to ground vibration (MOCT, 2002).

Step 4: Establishment of local seismic monitoring network

DOE's suggestion (Majer et al., 2012)

- At least 8 three-component accelerometers.
- More than 5 sensors should be able to locate sufficient seismic events reliably.
- Events smaller than magnitude 1.0 should be able to be detected.

Fig. 3. Human response to vibration as frequency of vibration changes

Step 5: Quantification of hazards from natural and induced seismic events

- Cultural heritage
- Structures with masonry wall and wood ceiling
- Structures with underground foundations and concrete slabs
- Low storied structures with steel concrete frameworks and slabs
- High storied structures with steel concrete frameworks and slabs

Step 6: Characterization of the risk of induced seismic events

- An estimated equation for blasting vibration was converted to an equation relating peak ground velocity (PGV) to magnitude.

Fig. 4. A map showing the location of Pohang EGS site and seismic monitoring stations.

Step 7: Development of mitigation plan

PGV-M, equation + domestic criteria and human response to ground vibration

Step 8: Application and Calibration

Table 3. Data of induced seismic events detected by surface seismometers during the first hydraulic stimulation

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