Reverse Engineering Earthquakes using Lab-scale Replicas: Application to Mw5.5 2017 Pohang Earthquake

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An earthquake can happen due to many different phenomena such as sliding faults, fluid/gas injection into the subsurface or volcanic activities. Understanding the cause of earthquakes is one important step towards a better hazard assessment and better mitigation. In this study, we explore the physics behind different types of earthquakes by inducing similar mechanics in lab-scale experiments using an analogous model. Inside a transparent rectangular Hele-Shaw cell, we induce lab-scale microseismicity via pneumatic fracturing. An 80 x 40 cm transparent setup is prepared using a 1 mm thin layer of uncompacted granular medium having a fixed grain size is placed between two glass plates.

The seismic location results are compared with the image correlation results for displacement maps corresponding to the event times. Using air injection, this porous medium is compacted and fractured. This system is monitored using a camera recording 1000 images per second and accelerometers recording with 1 MHz sampling rate. Sources of earthquake-like vibrations are both located using acoustic recordings and image processing. We have observed that the deformation starts with compaction inside the medium; this compaction propagates toward the channel tips and causes the fingers to advance further inside the medium. We have observed (using optics and acoustics) that the movement starts inside the porous medium and progresses toward the channel tips, eventually causing channels to grow further. We also compared the characteristic patterns in these lab-scale events that are very similar to large scale correspondents, in particular with 2017 Mw 5.5 Pohang Earthquake. We reverse-engineered the signature of the recorded lab-scale signals to have a better understanding of this industrial hazard.