Induced Seismicity During Reinjection of Wastewater in Hellisheiði Geothermal Field, SW Iceland

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The Hellisheiði power plant is located at a triple junction.

- NNE-SSW trending normal faults and N-S striking strike-slip faults
- 550 L/s injection rate under hydrostatic pressure
Reinjection of waste water

- Injection started in September 2011
- Seismicity increased immediately
- Largest event 3.8 M_L
- Seismicity has since decreased
- Seismicity managed by steady injection rate

Bessason et al., 2012
Temporary network

- Stations from
  - Uppsala University
  - MIT
  - Reykjavík University
  - Iceland GeoSurvey
  - Regional IMO stations
  - 2009 – 2013

- Possibilities
  - Increase the level of detection, accuracy of locations, and focal mechanisms
Processing steps

1. MULTIPLET ANALYSIS
2. SEARCH
3. EVENT ASSOCIATION
4. ACCURATE TIME MEASUREMENTS
5. RELATIVE RELOCATION
Example of multiplets
Comparison of earthquake locations

Routine locations from the Icelandic Meteorological Office

Relative relocations
Example of changes in injection rate and an increase in seismicity
Example of no change in injection rate and an increase in seismicity
Focal mechanisms for master events
Focal mechanisms for master events

- Strike-slip events with N-S nodal plane:
  - N-S striking faults

- Normal faulting events with NE-SW nodal planes:
  - unclear strike

- Strike-slip events with NE-SW nodal plane:
  - NE-SW striking faults
Velocity changes with ambient noise*

*preliminary results
Thank you!
APPENDED SLIDES
Rate of injection
Most active day

All events Oct. 15, 2011

Injection on Oct. 14 and 15, 2011
Example of connection between change in injection and seismicity
Example of connection between change in injection and seismicity
Example of connection between change in injection and seismicity
Possible connection between change in injection and seismicity
Possible connection between change in injection and seismicity
No visible connection between change in injection and seismicity
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No visible connection between change in injection and seismicity
Change in temperature and seismicity

2011–09–10

2011–09–27

Temperature [°C]

Events

Hours