Seismic Studies Program at the Alberta Geological Survey

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Landscapes and Geological Hazards

Ground Water Protection Council Forum, 2014
AGS Earthquake Studies Team

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Seismic monitoring approach

- Regional monitoring network
- Building earthquake catalogue
- Baseline analysis
- Forensic analysis
Seismic Monitoring
Network Magnitude Detection Threshold
Minimum magnitude detectable by 4 or more stations

2006

2009

2010
Seismic stations and networks used in our monitoring program

RAVEN telemetered
  Downloaded from IRIS
  8 stations

CNSN telemetered
  Downloaded from EC
  8 stations

ATSN telemetered
  Downloaded from EC
  Collaboration with U of C 6 stations

MRSN & US-REF telemetered
  Downloaded from IRIS
  5 stations

CRANE offline
  Canadian Rockies and Alberta Network 17 stations
  Collaboration with U of A

www.ags.gov.ab.ca
Earthquake catalogues

Earthquake Canada Data 1922-2006

AGS Earthquake Data 2006-2010

www.ags.gov.ab.ca
Seismic activity

- Seismicity in the WCSB is sparse and relatively quiescent.
- Long lasting clusters have been recognized.
- Two clusters account for the majority of Albertan seismicity.
- These clusters have been previously attributed to induced seismicity.

After Stern et al., 2013
Baseline Analysis
## Alberta earthquakes 2006 - 2010

<table>
<thead>
<tr>
<th>Year</th>
<th>National Parks (including BC)</th>
<th>Deformation Belt (outside of park)</th>
<th>Interior Craton</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mag. range</td>
<td>#</td>
<td>Mag. range</td>
</tr>
<tr>
<td>2006</td>
<td>2.2-3.7</td>
<td>4</td>
<td>0.4-2.9</td>
</tr>
<tr>
<td>2007</td>
<td>1.8-2.8</td>
<td>8</td>
<td>0.6-3.3</td>
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<tr>
<td>2008</td>
<td>1.3–3.6</td>
<td>14</td>
<td>0.5-3.6</td>
</tr>
<tr>
<td>2009</td>
<td>0.7-3.3</td>
<td>11</td>
<td>1.2-3.7</td>
</tr>
<tr>
<td>2010</td>
<td>1.5–3.1</td>
<td>11</td>
<td>1.4-2.9</td>
</tr>
<tr>
<td>Total</td>
<td>0.7-3.7</td>
<td>48</td>
<td>0.4-3.7</td>
</tr>
</tbody>
</table>

www.ags.gov.ab.ca
Seismic events and hydraulic fracturing

Criteria for correlation of seismic events and hydraulic fracturing

- 5 km and 10 km radius of search
- 1 week
Water disposal and injection wells

Criteria for correlation of seismic events and hydraulic fracturing

- 10-20 km radius search
- 10 years prior to this data set
Conclusions of the 2006-2010 data

No correlation between hydraulic fracturing and earthquakes

Three hydraulic fracturing events occurred within 10 km and 1 day of a seismic event

Possible but unlikely correlation between water injection and earthquakes

216 injection wells within 10 km of a seismic event

Possible correlation between water disposal and earthquakes

28 disposal wells were within 10 km of seismic events

Two wells which were located within 10 km of significant earthquake-event clusters

No correlation between acid gas injection and earthquakes

2 acid gas injection wells were within a 20 km radius of a seismic event
The Crooked Lake sequence

- New sequence of events near Crooked Lake.
- More than 60 located events.
- Dec 2013-Feb 2014
- 3.8 $M_L$ to 1.0 $M_L$
Questions
Thank you