Natural Resources Canada's Overview Presentation and Technical Review Related to Seismic Hazards

Prepared for the Grassy Mountain Coal Project

Joint Review Panel Hearings

November 2020

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Presentation Outline

Background on Earthquakes:

- NRCan's role in relation to earthquakes
- What is an earthquake? Where do they occur? Why?
- Monitoring earthquakes in Canada
- Seismicity/Seismic Hazard in the Project area

NRCan's Review of Seismic Hazard Assessment for Grassy Mountain

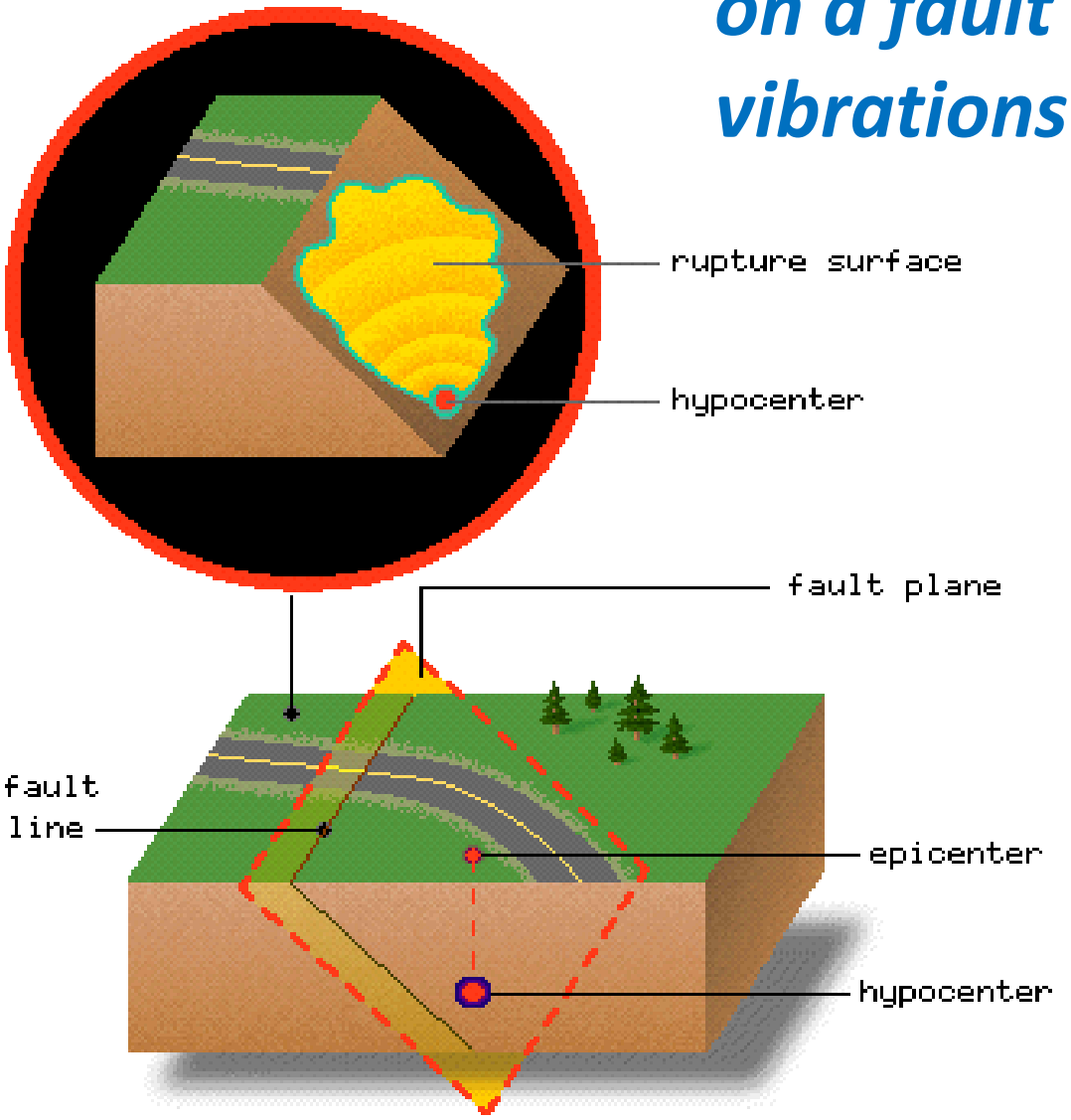
- Seismic Codes and Standards
- Local faulting and Vs information
- Potential Induced Seismicity

Recommendations

Role of Natural Resources Canada

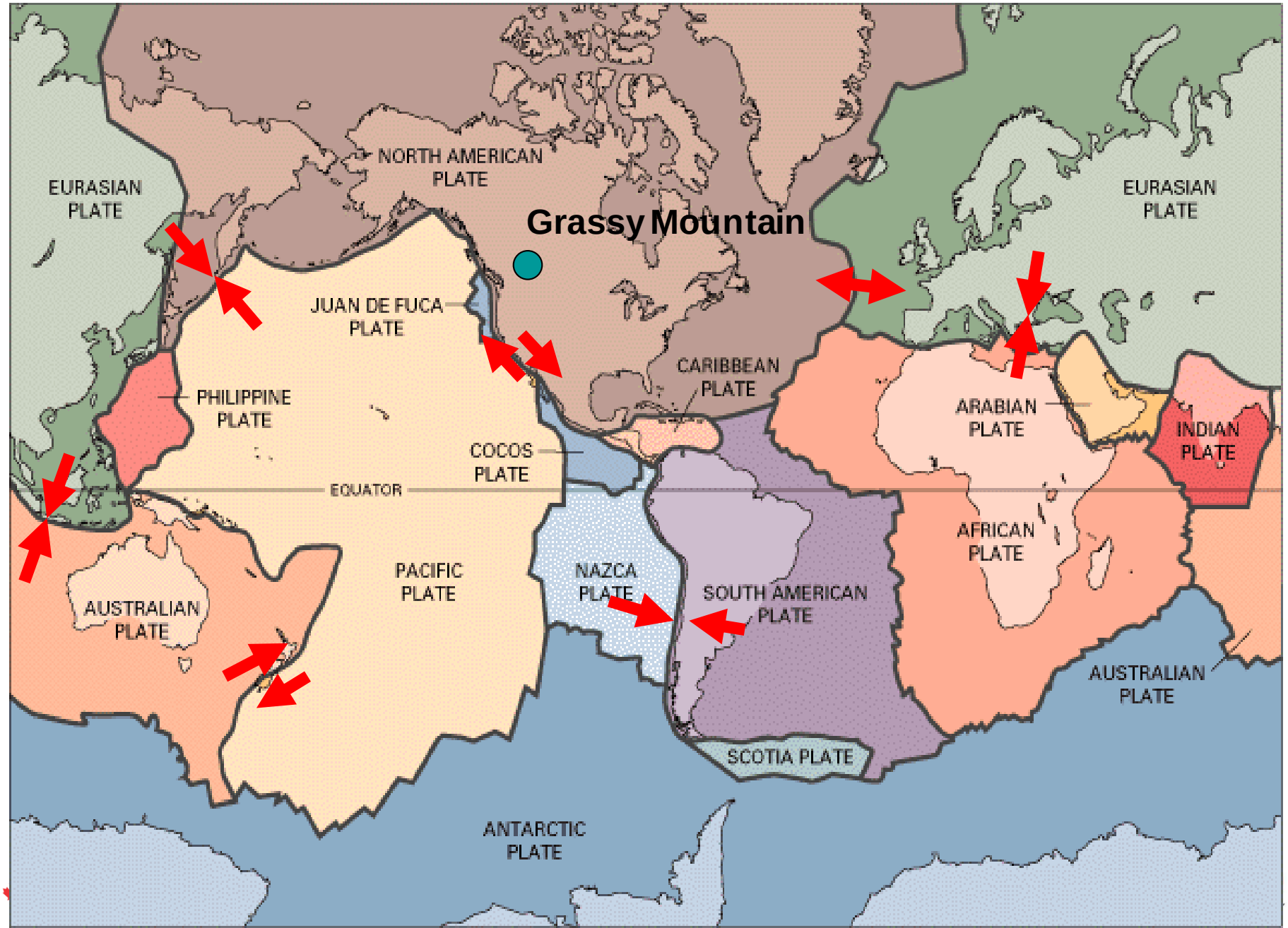
- NRCan is responsible for “the provision of information on the actual or probable occurrence and intensity of earthquakes”, which is accomplished by:
  - Recording and locating earthquakes in Canada and adjacent seas
  - Providing rapid information on significant earthquakes to the public, the media, emergency response, etc.
  - Maintaining the Canadian National Earthquake Catalogue
  - Providing national seismic hazard assessments
  - Conducting research into earthquake hazards to improve codes and standards

Earthquake = Sudden movement on a fault plane causing seismic vibrations

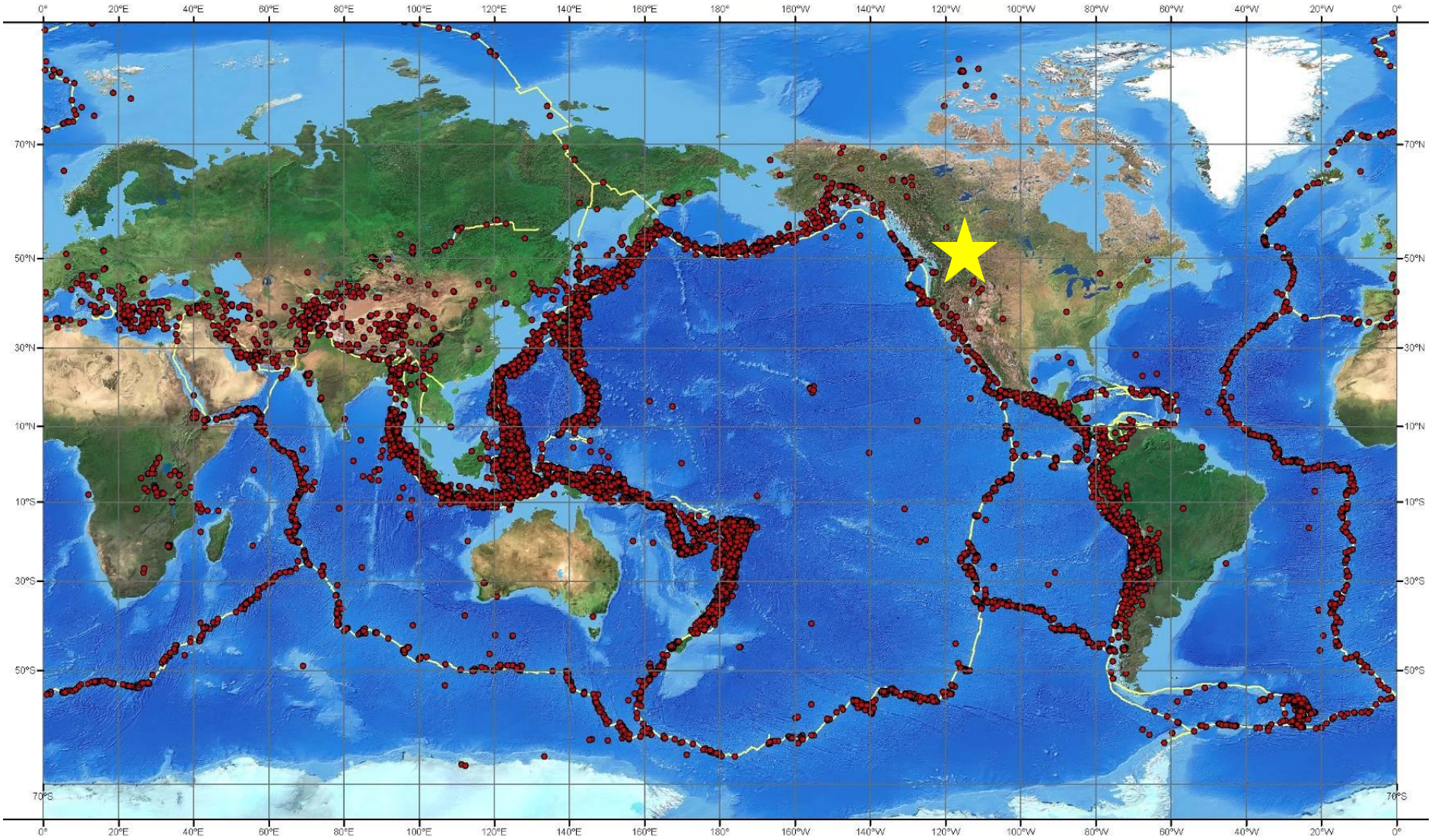


- The larger the area on which there is movement (rupture)
- The larger the magnitude of the earthquake

Where are earthquakes most likely to occur? Plate Boundaries



Where do most earthquakes occur?
90% occur on plate boundaries



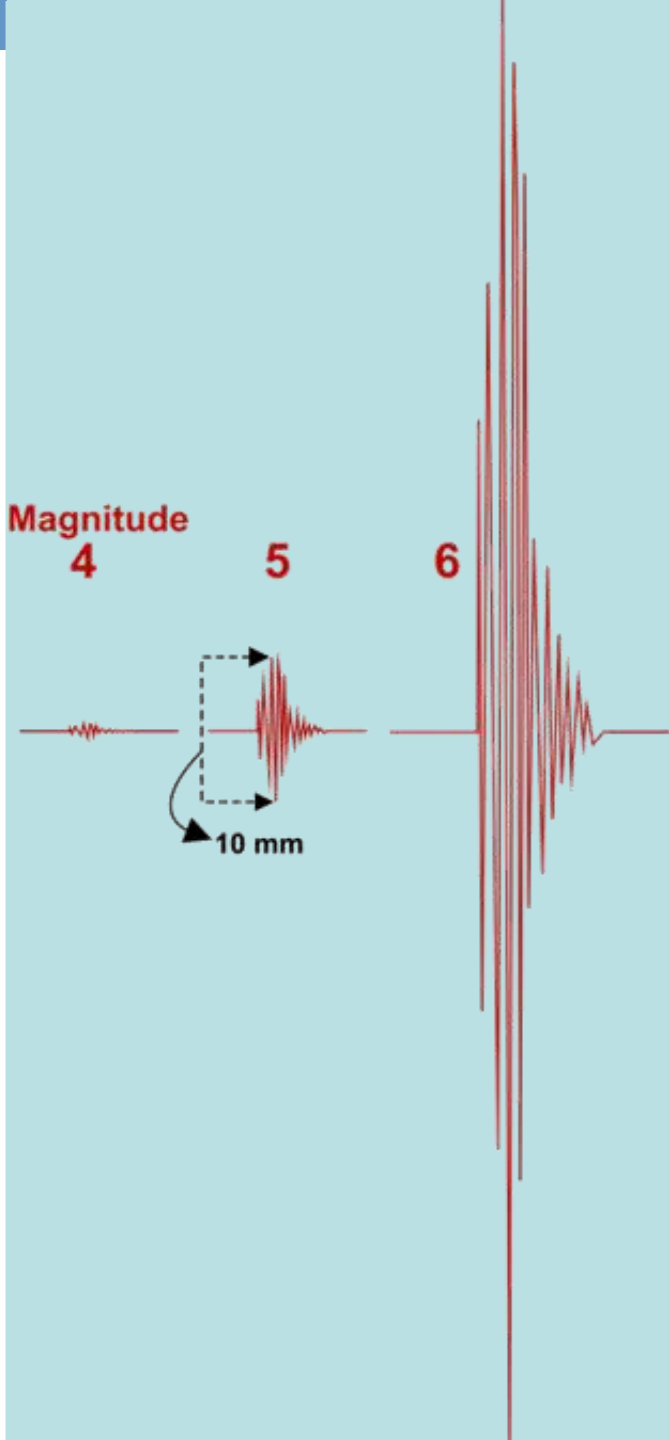
Size of an Earthquake

Magnitude (M) – as magnitude increases, the strength of ground shaking, duration, and area impacted increases very quickly. For an increase of 1 magnitude unit:

- *Ground shaking: Increases* by 10 times

- *Energy released:* Increases by 32 times

- M~3 – felt, no damage
- M~5 – possible minor damage near earthquake
- M~7 – damaging earthquake

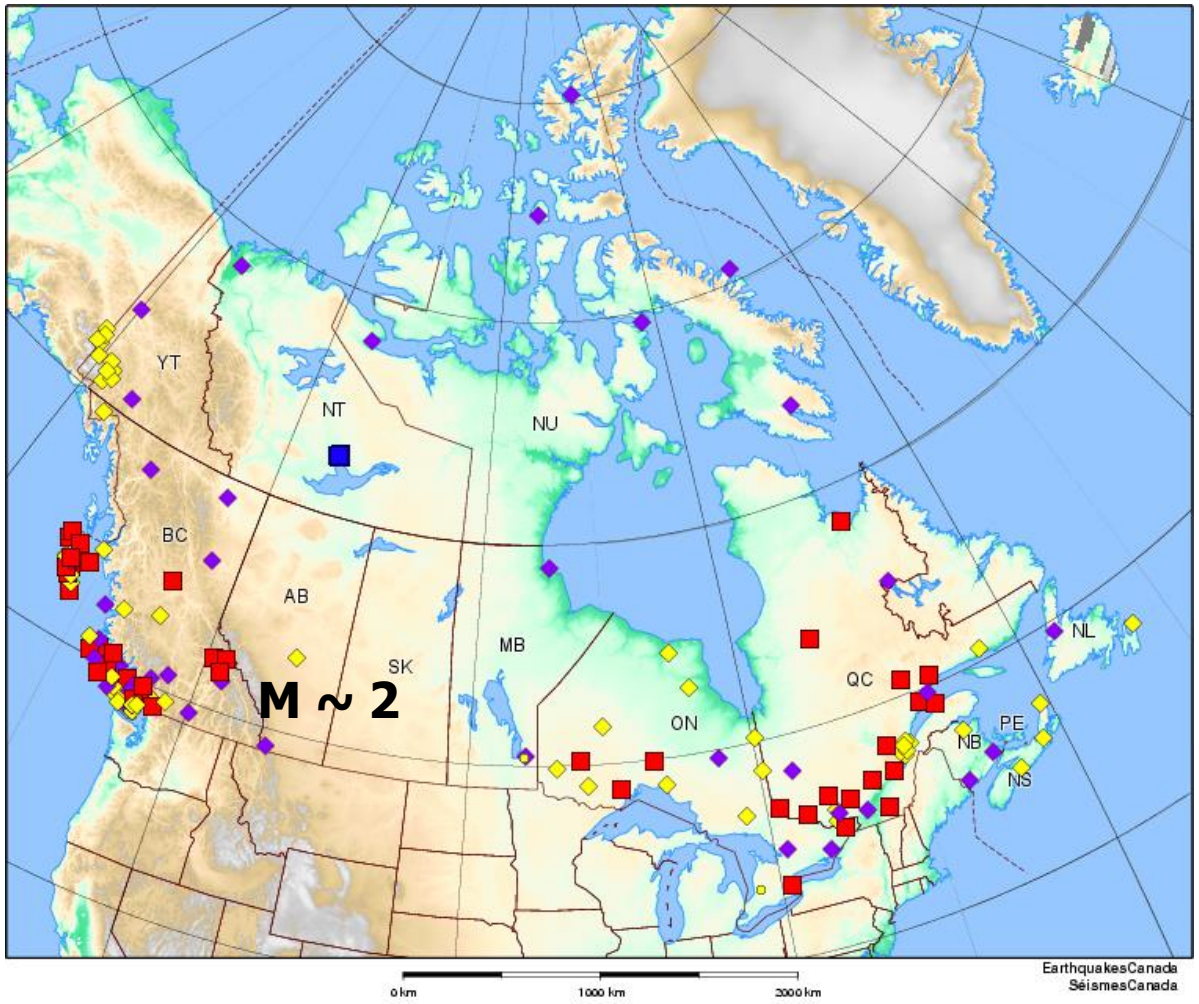


Earthquake Effects

- Earthquakes smaller than M2½ generally not felt
- M4+, shaking can be felt over distances of 100-200 km
- Near the epicentre, M~5 is where you may see minor damage (e.g., to masonry, items falling).

Natural Earthquakes – global average:
M 5-6: 1319 / year
M 2-3: 150 / hour

Canadian National Seismograph Network



Seismic Monitoring History

M ~7 : 1898
M ~5 : 1940
M ~4 : 1970
M ~2 : 1990's

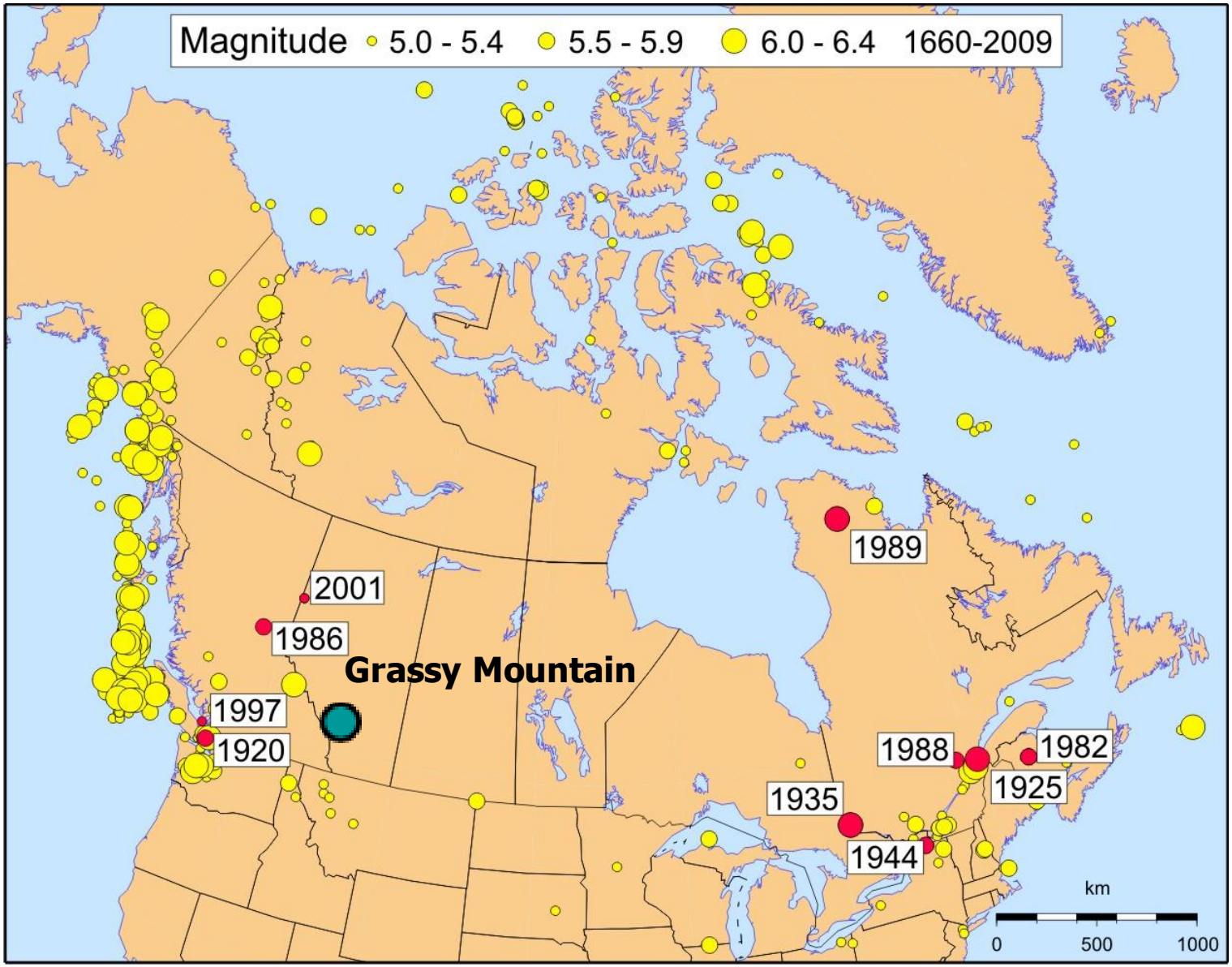
AER Seismic Network
BELVA: 11 km away

Tectonics of the Region

- The proposed Project site is more than 800 km from the active plate boundary along the west coast.

- The Project site is in the “Fold and Thrust Belt” of the Canadian Cordillera – a region of “collision” that formed the Rocky Mountains ~65 MY ago.

M 5 - 6.4 Earthquakes in Canada



Cassidy et al., 2010

Seismicity of the Region

The proposed Project site is in a region of low seismicity.

During the past 40 years, there have been:

- 11 earthquakes (largest M3.2) within 50 km
- 49 earthquakes (largest M4.3) within 100 km
- 719 mining blasts within 50 km
- 1759 mining blasts within 100 km

Seismicity of the Region

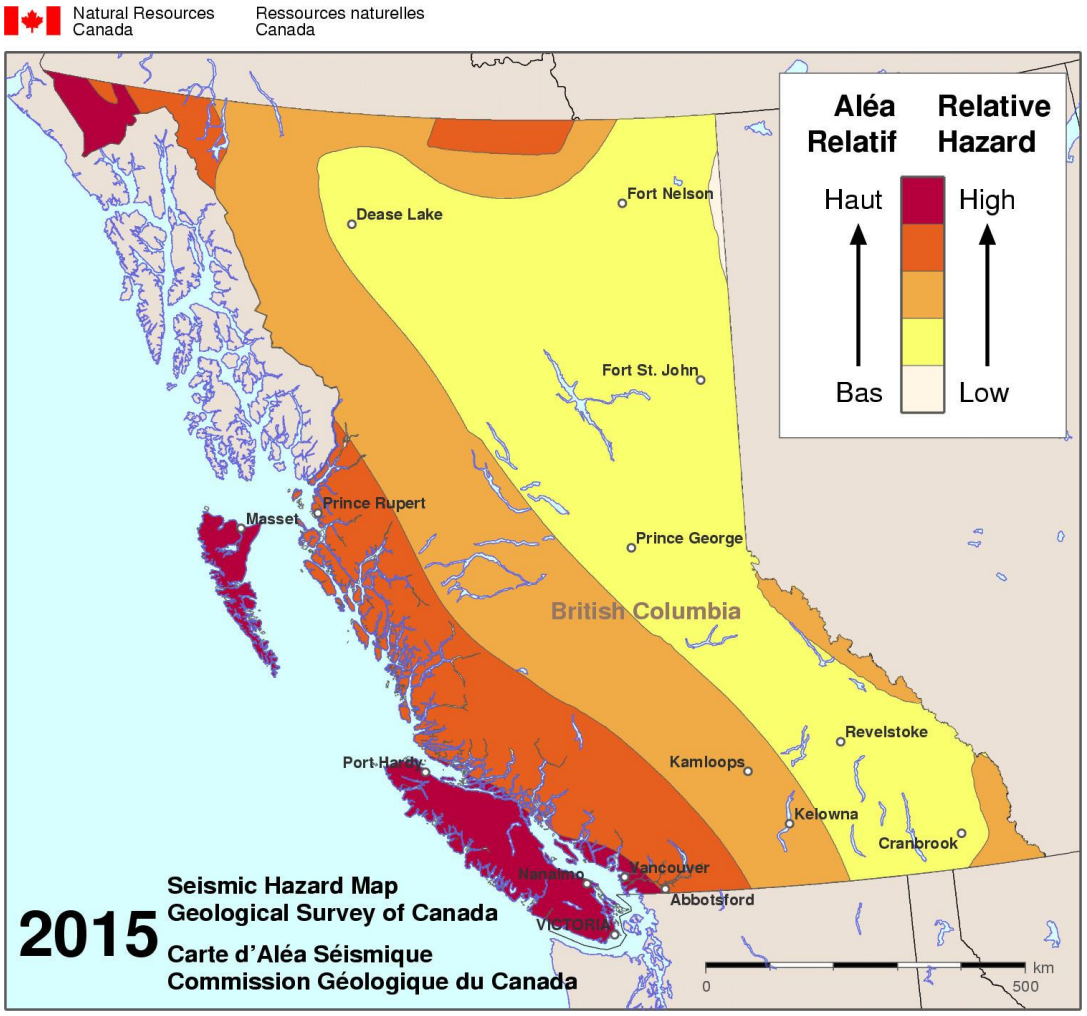
Larger earthquakes (M5-6) have occurred with in the “Fold and Thrust Belt” at much larger distances from the Proposed Project site.

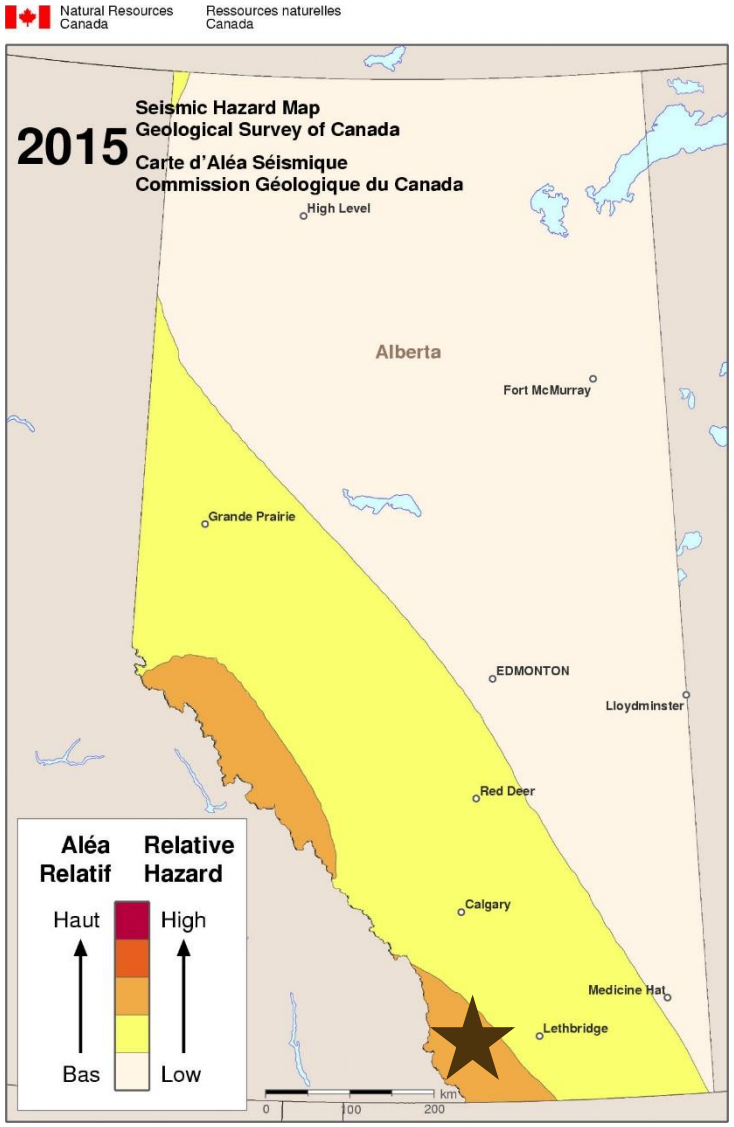
For example, the largest historic earthquakes are:

- Feb. 4, 1918 M6 near McNaughton Lake (420 km away)
- May 14, 1978 M4.8 near McNaughton Lake (453 km)
- Mar. 21, 1986 M5.4 near Prince George (720 km away)
- 1959 M7.2 near Hebgen Lake, Montana (~600 km)

No damage near southern AB at these distances.

2015 Earthquake Hazard Map for BC/AB





NRCan's Review of Seismic Hazards

- Seismic hazards in the area and the codes/standards that will be utilized;
- Local and regional seismicity
- Potential for induced seismicity
- Evidence for active faulting
- Vs30 for design

NRCan's Review of Seismic Hazards

Codes and Standards

- In the October 2016 submission (CIAR #49 Page 7), NRCan requested that the Proponent remove reference to the 1985 National Building Code of Canada (NBCC) in its EIA documentation, and confirm that the 2015 NBCC values would be considered for the dam design.
- The Proponent responded in its 4th Addendum to the EIA (CIAR #55) stating that, "As the detailed design progresses, the current codes and standards will be referenced".
- In its final submission to the Joint Review Panel (CIAR #542), NRCan noted "that the Canadian Dam Association Guidelines 2013 would be an important document for reference."

NRCan's Review of Seismic Hazards

Potentially Active Faults / Vs30

- In NRCan's October 2016 Submission (CIAR #49 Page 7), the proponent was asked to "confirm that these (shaking values) would be modified, as required, based on actual shear-wave velocities at the project site."
- The Proponent responded in the 4th Addendum to the EIA – Attachment 2 (CIAR #55 Page 31) that their "…analysis will be modified, as required, based on actual shear-wave velocities at the Project site."
- In NRCan's July 2018 Submission (CIAR #73 Page 2) "confirmation from the Proponent that no postglacial faulting was observed at the site of the proposed Grassy Mountain Coal Project" was requested.
- The Proponent responded in the 8th Addendum to the EIA (CIAR #89 Page 155) by noting that based off observations "of the available exposed areas, no visible fault is observed to have reached post-glacial stratigraphic levels".

NRCan's Review of Seismic Hazards

Potential for Induced Seismicity

- In the October 2016 submission (CIAR #49 Page 7), NRCan requested that the Proponent "discuss the potential for induced seismicity that could possibly result from fracking in the project's vicinity."
- The Proponent responded in its 4th Addendum to the EIA – Attachment 2 (CIAR #55 Page 31), stating that "there is currently no hydraulic fracturing operations occurring in the vicinity of the Project" and "the potential for induced seismicity from fracking in the vicinity of the Project is considered to be low."

NRCan's Review of Seismic Hazard

In the Government of Canada's final submission (CIAR #542) to the Joint Review Panel, NRCan notes the following:

- "NRCan is satisfied with the Proponent's characterization of seismicity and potential induced seismicity from fracking in the project area."

- "NRCan recommends that the Proponent adhere to their commitment to use the most current NBCC and Canadian Dam Association Guidelines during the construction phase of the Project."

Thank You