

Seismic Hazard Abatement Program





Recommendations

- To take the first steps toward a seismic mitigation program for older existing buildings
- To improve our current regulatory system for implementation of current seismic codes and standards
- To create a new position as senior seismic specialist to act as a strong technical resource for the city and the community



Objectives

- To minimise loss of life and serious injury following a major earthquake
- To reduce property damage to buildings and contents
- To reduce the longer term effects on employment and business in the city
- To alleviate demands on our emergency response capability and social services



Report Summary

- Review seismic hazards in Vancouver
- Track the development of seismic codes
- Note progress in other jurisdictions
- Comment on the vulnerabilities of buildings
- Discuss the structural review program
- Outline a framework for further work
- Present recommendations for Council's consideration



Seismicity Of Vancouver

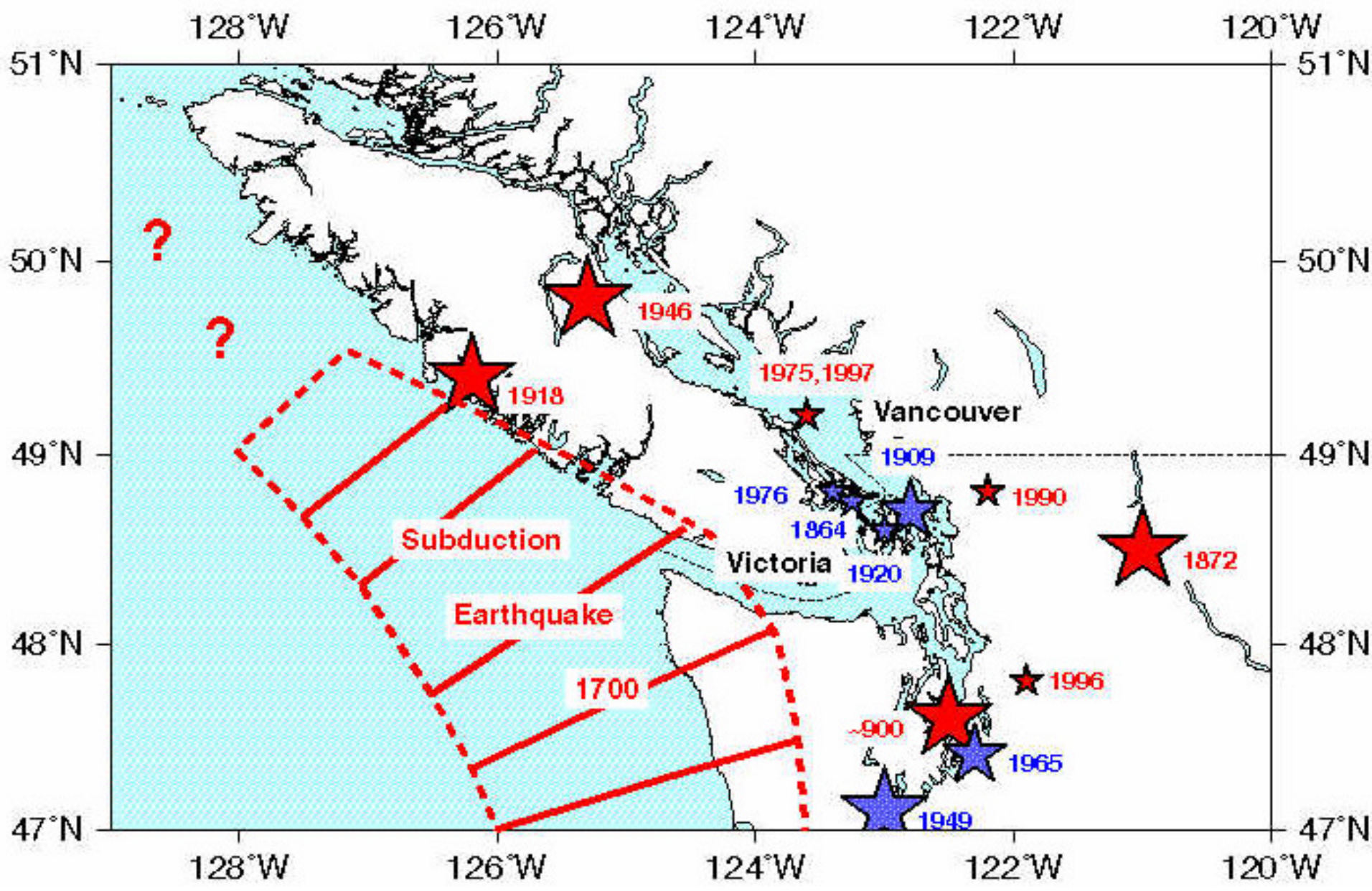
- Vulnerability of Vancouver to earthquakes recognised relatively late
- Two sources of earthquakes:-
 - Near field crustal earthquakes occurring in the crustal rock formations forming the North American plate
 - Subduction earthquakes occurring in the Cascadia subduction zone appx 125 km off the west coast of Vancouver Island



Crustal Earthquakes

- Earthquakes due to slippage on fault lines located in underlying bedrock strata
- Can occur at relatively shallow depths with magnitudes typically less than M8
- Can be very damaging if epicentre is located close to an urban area
- Pacific Northwest has a history of crustal earthquakes occurring every 20 to 40 years on average

Some Significant Felt Earthquakes in the Victoria/Vancouver Areas

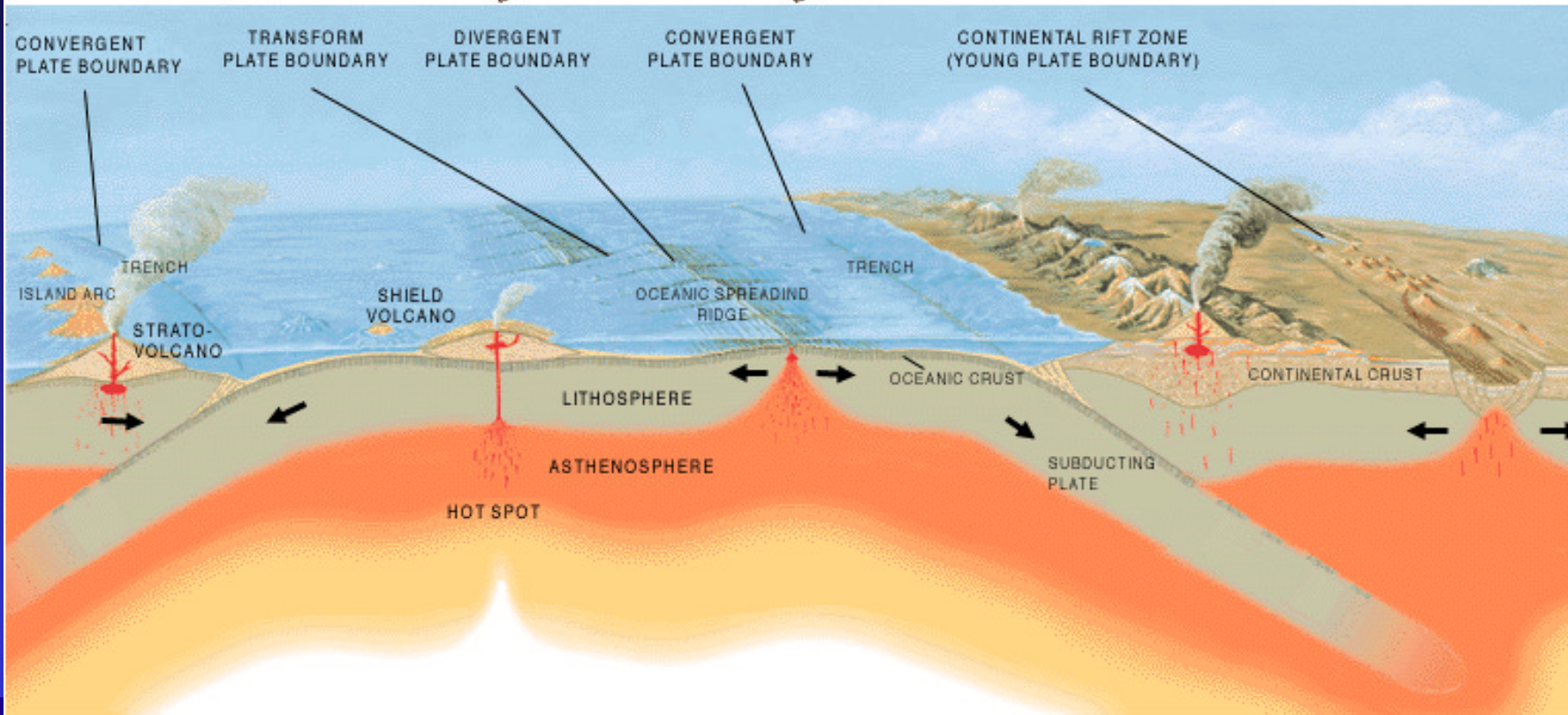
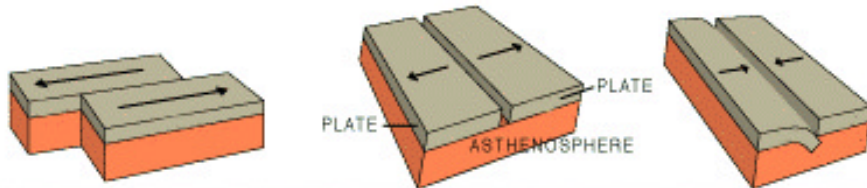




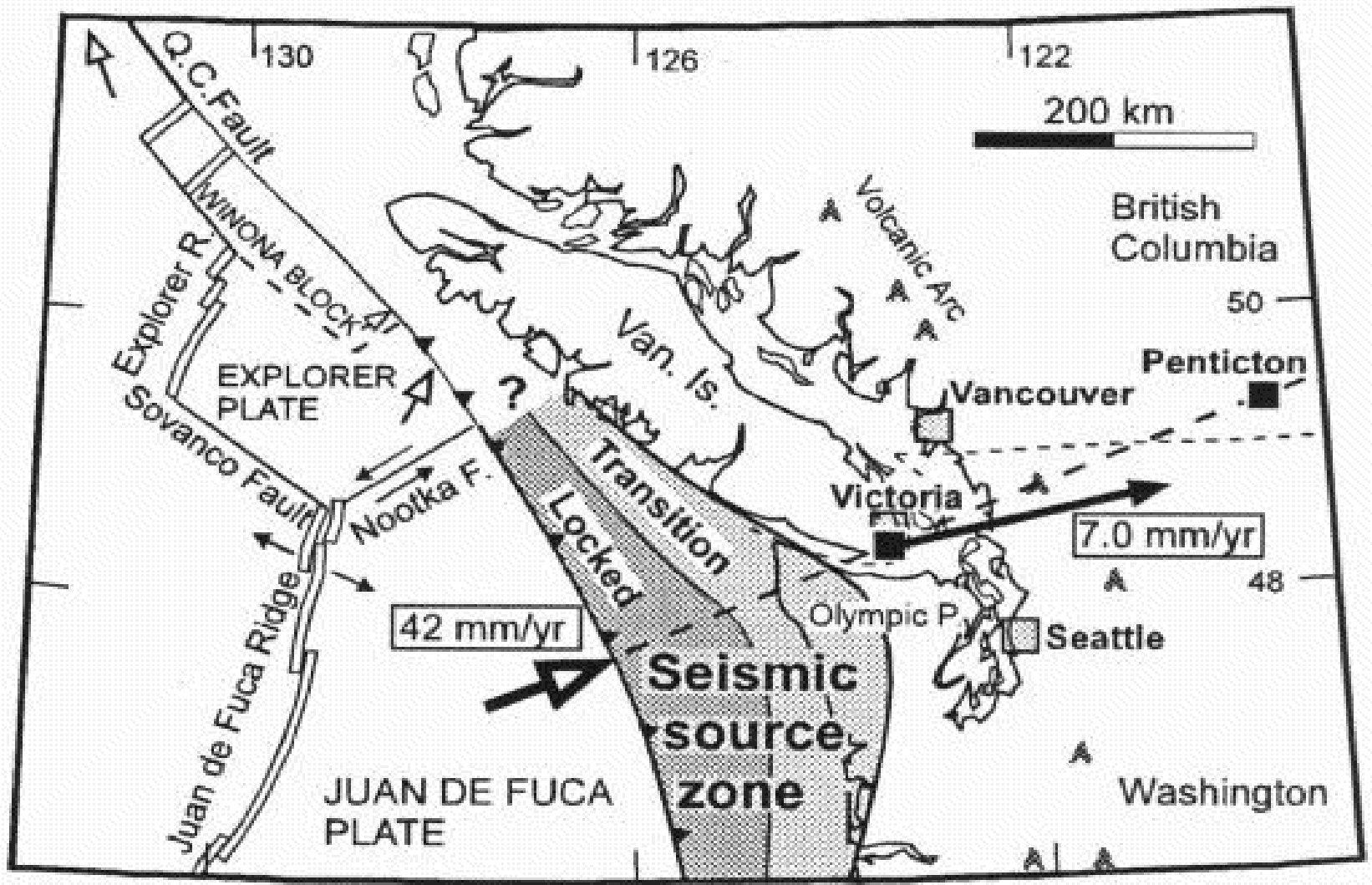
Subduction Earthquakes

- Frequency of occurrence every 600 years
- Last subduction quake Jan 26th 1700
- Typical magnitude Richter M8 - M9+
- Fault length up to 1000 km
- Epicentre appx 200 km from Vancouver
- Shaking duration up to 4 min
- Notable EQ's Alaska 1964 (M9.2) and Chile 1960 (M9.5) - Two largest subduction EQ's

Subduction Earthquakes



Subduction Earthquakes





Development Of Seismic Building Regulations

- 1906 San Francisco earthquake
- 1933 Long Beach EQ & Field Act
- 1941 first edition of NBC
- 1953 NBC included seismic design
- 1967 Vancouver adopted 1960 NBC
- 1970 - 1985 continued improvement
- 1990 major update with emphasis on ductility and good detailing



Vulnerability of Buildings in the City to effects of Earthquakes

- Earthquake resistance of buildings is highly dependent upon the age and type of building
- Earthquake codes and our technical knowledge have improved greatly over last 30 years, largely as a result of experience
- Buildings constructed prior to 1960's are at increased risk
- Greatest risk is associated with unreinforced masonry buildings (URM's)



Vulnerability of Buildings in the City to Effects of Earthquakes

- Estimate appx 8,000 buildings of 3 storeys or more are vulnerable to earthquakes
- Seismic upgrading of URM's can take various levels of upgrading
- “Bolts Plus” is an effective and relatively inexpensive upgrade procedure for URM's which results in a good benefit/cost ratio.



Vancouver's Masonry Heritage





Vancouver's Masonry Heritage





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Vancouver's Masonry Heritage





Programs In Other Jurisdictions

- United States
 - Most advanced of the Pacific Rim countries
 - State of California requires municipalities to develop seismic mitigation plans
 - NEHRP goals of achieving seismic resilience in two stages
 - Many Californian municipalities have implemented seismic retrofit ordinances
 - Northridge EQ has provided impetus for further mitigation work



Programs In Other Jurisdictions

- New Zealand
 - Hawkes Bay earthquake of 1931
 - Seismic upgrading commenced 1964 for buildings undergoing major renovations
 - 1968 - Municipal councils empowered to require seismic upgrading of URM's
 - 2000 - Legislation currently before Minister to extend mandatory upgrading to other hazardous classes of buildings



Programs In Other Jurisdictions

- Japan
 - Adopted stringent codes in 1971 & 1980
 - Existing buildings exempted from seismic provisions of 1980 building law
 - Kobe earthquake revealed high vulnerability of older building stock to earthquakes
 - Intensive efforts underway to address the risks of older non-conforming buildings using voluntary and government approaches



Structural Review Program

- Program to audit the quality of structural designs for new and upgraded buildings
- Commenced in 1996, appx 60 reviews carried out to date
- Results warrant continuation of some form of seismic peer review program
- Intent is to model the program along the lines of the building envelope specialist program



Seismic Mitigation Study

- Objectives and target areas
- Levels and methods of upgrading
- Costs of upgrading
- Socio-economic impacts
- Community involvement
- Incentives and voluntary upgrading
- Time frames



Seismic Reviews For New Buildings

- Adopt a facilitative system to achieve a conciliatory regulatory environment
- Provide for in-house screening of designs
- Work co-operatively with APEGBC to enhance existing concept review system
- Model approach on Building Envelope Program
- Continue modest program of structural audits
- Allow for cost recovery from designers who repeatedly fail to meet acceptable code standards



Seismic Specialist

- Roles & responsibilities
 - Act as a strong technical resource to staff and the construction community
 - Develop a public information program
 - Co-ordinate development of seismic mitigation policy for the city
 - Facilitate an improved regulatory system
 - Administer structural review program
 - Assist with further development of emergency response plans



Conclusions

- To develop a comprehensive seismic hazard abatement program
- To reduce seismic hazards with respect to existing and new buildings
- To substantially reduce the life-safety, economic and recovery impacts of a major earthquake
- To be funded from currently allocated building permit revenues