

Predicting Canada's Next Earthquake

A new field of seismic research anticipates where and when Canada's next major earthquake will strike



By Dr. Kristy F. Tiampo,
Industrial Research
Chair in Earthquake
Hazard Assessment,
Department of Earth
Sciences,
Faculty of Science,
University of Western
Ontario

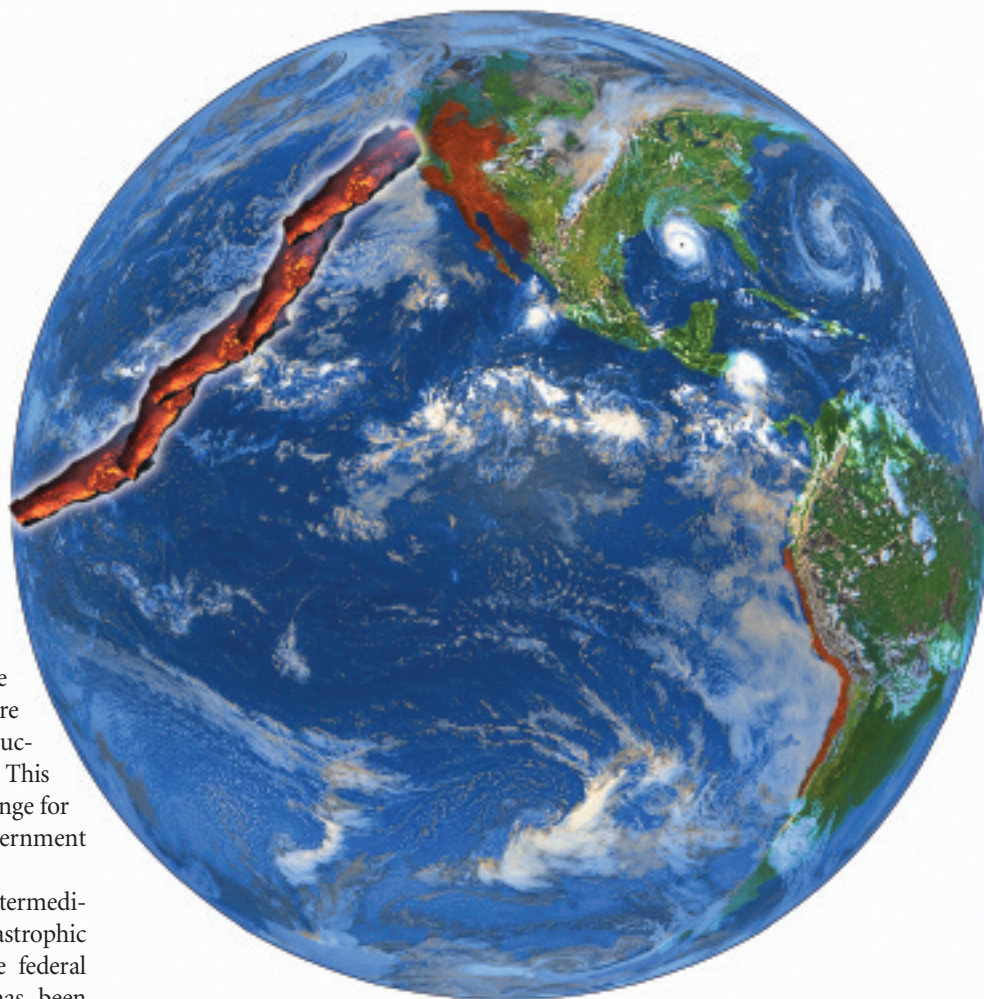
█ inevitably, a large earthquake will strike a major urban centre in Canada, causing great destruction and potentially a loss of life. This risk presents a tremendous challenge for the insurance community, government and the general population.

Sponsored by reinsurance intermediary Benfield, the Institute for Catastrophic Loss Reduction (ICLR) and the federal government, a new initiative has been launched in an exciting new field of seismic research that deals with anticipating when and where Canada's next major earthquake will strike.

EARTHQUAKE RISK IN CANADA

Earthquakes are the energy released when one block of rock moves suddenly past another block along a fault, a fracture or zone of fractures between two blocks of rock. When this movement occurs rapidly, it creates an earthquake (<http://pasadena.wr.usgs.gov/shake/>).

Today's magnitude scale, similar to the original Richter magnitude measurement



system, is really a measure of this energy release. Each unit is a jump of approximately 30 times the energy from the previous unit. In other words, a Magnitude 6 earthquake has approximately 30 times the energy of a Magnitude 5 event. Most faults produce repeated displacements over time, so regions of potential earthquake hazard are relatively well-known by scientists.

While earthquakes can occur almost anywhere in the world, the greatest percentage occurs on what is called the 'Ring of Fire,' a horseshoe-shaped feature that almost circles the Pacific Ocean.

Underlying convection is responsible for movement of the crustal plates that compose the earth's surface. [For more information about this, go to: <http://pubs.usgs.gov/gip/dynamic/dynamic.html>]. Earthquakes and volcanoes occur where these plates meet, rubbing against each other and causing heat and friction. The stick-slip action associated with this motion results in earthquakes; the heat generated contributes to volcanism.

The Ring of Fire is simply where a series of these plates converge and become tectonically active. The largest of these

events is called a subduction earthquake, in which the subducting slab breaks over a very large region as it pushes below the overriding plate.

Canada has tectonic environments that are expected to produce significant earthquakes in both eastern and western urban centres. A large earthquake near a major city in Canada could produce damage in the multi-billion dollar range and result in thousands of deaths.

The most active seismic region – and the only volcanic region within Canada – lies on the west coast, again on the Ring of Fire, where the coastal region of south-western B.C. is subject to large crustal as well as great subduction thrust earthquakes. These events are rare, but they can be extremely devastating, as seen in Indonesia in December 2004.

On the other hand, with four earthquakes in the Magnitude 6 range since 1663, the Charlevoix seismic zone is the most seismically active region of eastern Canada. It is the best place to study intraplate seismicity in Canada, similar to those that occurred in the New Madrid, U.S. earthquakes of 1811-1812 and the Bhuj, India earthquake of 2001.

Finally, although large earthquakes in southern Ontario are infrequent, seismic risk is a significant social and economic issue due to the density of both population and critical facilities. Recent moderate earthquakes – such as the Magnitude-5.2 earthquake near North Bay, Ontario in January 2000, and the Magnitude-4.3 earthquake in Georgian Bay in October 2005 – serve as reminders of the seismic potential in Ontario.

Much of the concern associated with the earthquake hazard stems from uncertainties in the occurrence rates and spatial distribution of earthquakes. However, the potential for better quantifying the location and timing of upcoming events can significantly aid in hazard assessment and response planning, alleviating the loss and tragedy associated with these extreme events, and will reduce the exposure of Canadian citizens and infrastructure to seismic risk.

Earthquake damage is a direct result of both the level of shaking the event induces and the type and quality of the structures that it shakes. The shaking an earthquake produces is physical, a function of its magnitude and geometry, and the local government building codes govern the type of structure.

EARTHQUAKE RESEARCH

Earthquake losses are greatly reduced through a better understanding of earthquake risk. Many scientists today are working at developing techniques for creating time-dependent, intermediate and short-term occurrence probabilities for earthquake hazard.

One of the programs for this express purpose is located at the University of Western Ontario's Department of Earth Sciences. This research is aimed at studying the patterns in the small seismicity, and trying to understand what they tell us about the dynamics of the fault system and the nature and progression of the largest earthquakes. This will in turn help us to better understand the location and timing of these large events.

To date, important research in hazard mapping has been done for many seismically active regions. Until recently, however, there has been no coherent, multi-disciplinary program in earthquake forecasting in Canada.

Reinsurance intermediary Benfield and the ICLR, in conjunction with the federal government (Natural Sciences and Engineering and Research Council), have agreed to support such a research program through the funding of an Industrial Research Chair in Earthquake Hazard Assessment at the University of Western Ontario. This program was subjected to a rigorous peer review process in order to secure the needed financial support.

Specific goals of this research include:

- to apply specific, intermediate-term, time-dependent occurrence probabilities to various tectonic regimes in Canada, in order to better assess their capabilities and limitations;
- to examine, integrate and develop additional methodologies and techniques in the fields of seismic and geodetic analysis and physics of complex systems for the purpose of establishing a full set of tools for quantification of both the location and time of future earthquake events;
- to develop a series of models and techniques for the study of earthquake physics in order to ensure the continuing success of this program. Such methods would be extended to the development of

short-term, time-dependent probabilities of earthquakes in Canada and other significant hazard zones; and

- to raise awareness in both the scientific and emergency hazard preparedness communities of these methodologies and their efficacy. In addition, the program seeks ways to facilitate knowledge transfer between the insurance industry, local and regional government agencies responsible for hazard management, and scientists in the field of earthquake hazard assessment.

Researchers have acquired the seismicity catalogs for both the eastern Charlevoix region and the western Cascadian subduction zone in Canada and initiated a study of the unique statistics and characteristics of the data. Researchers expect that in several years, they will better understand the capability of this data to provide insight into time-dependent seismic behavior, how defects in that data affect its accuracy, and where data collection capacity can be improved.

Researchers are also participating in emerging international efforts to assess earthquake risk in California, Europe, Japan, and the Caribbean, as well as a long-term initiative to develop testing and validation methodologies for earthquake risk assessment.

A significant advancement in earthquake hazard analysis - which can be used to assist a wide range of emergency responders and preparedness organizations from a variety of locations in Canada and around the world - remains the long-term goal of this research program. 