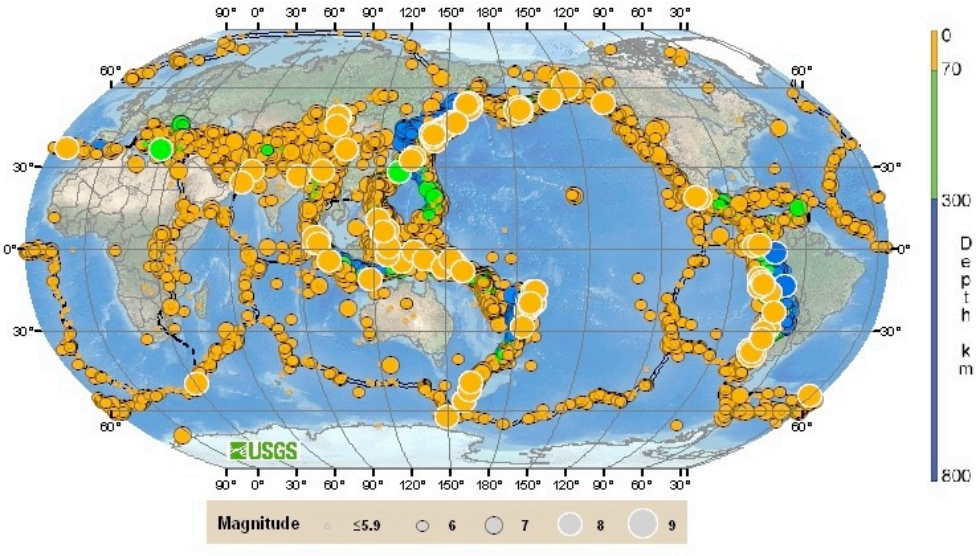
Earthquakes in a Nutshell
A guide for journalists prepared by the Science Media Centre of Canada

This is part of the Science in a Nutshell series produced by the SMCC. It offers a simple explanation of the science of earthquakes.

Of all Nature's calamities, few are more frightening or more potentially destructive than large earthquakes. Throughout the ages people of every culture have blamed quakes on angry gods thrashing around in the netherworld. Hollywood loves earthquakes that open gaping cracks in the ground, but in truth, really big earthquakes are extremely rare with only five in the last three centuries.

What is an earthquake?

Earthquakes are caused by plate tectonics, the continuous movement of massive rigid plates that make up the Earth's surface and driven by heat from deep inside the planet. This patchwork of plates drifts atop a soft mantle. The zone where two plates press against each other is called a fault. Several million earthquakes occur in the world every year, but most take place in remote areas or are too small to be detected.



The plates move past one another slowly—for example, at about five centimetres per year along the notorious San Andreas Fault that runs north-south through California. That fault marks the boundary between the Pacific plate and the North American plate. It is also a subduction zone where the oceanic plate slips under the less dense continental plate. Friction can stop two plates from slipping smoothly past one another, causing energy to build up until the friction can hold them no more. For a really large earthquake, that can take decades to centuries. The slip happens almost instantaneously, releasing huge amounts of energy. The greater the slippage or the longer the slip lasts, the more energy is released and the more drastic the shaking. As the waves travel away from the epicenter, the energy is spread over a larger area and it dissipates, much like the ripples produced from a rock thrown into a pool.

The "quakes" come from different kinds of shock waves that travel through the Earth's crust and also along the surface. They're set in motion by slippage along a fault line, and the point where they start is called the focus or hypocenter. The more common term epicenter refers to the point directly above that focus on the earth's surface.

Oil and gas exploration can create man-made earthquakes when fluids are pumped deep into the crust, raising underground pressure enough to trigger a small tremor. Concentrating a lot of weight on one part of the crust, such as filling a reservoir behind a dam, will push the crust down and may also trigger a small slip.

Earthquakes are not occurring more often than they did a generation ago as some people believe, but an expanded global network of seismograph stations and much faster communication means that more are

being located. According to the U.S. Geological Service, an average of 15 magnitude-7 or greater earthquakes have occurred worldwide annually since 1900 — a little more than one major earthquake per month. But there is also plenty of variability: 1989 had only six, but 1943 had 32.

How do you measure an earthquake?

An earthquake is measured by the amount of energy released by the slip. A magnitude-1 quake is not noticeable except with sensitive instruments. A magnitude-7 is the cutoff between a moderate and severe earthquake. A magnitude-9 is a really big one and they're extremely rare. As a rule, the larger the magnitude, the rarer the event.

Seismologists currently use the Moment Magnitude Scale to measure earthquakes, because the original Richter Scale did not give reliable results for earthquakes with a magnitude larger than 7 or when recorded more than 600 kilometres from the epicenter.

An earthquake's size and strength are related but are measured on different scales. For example, the earthquakes that struck Haiti and Chili in 2010 measured magnitudes 8.8 and 7.0, respectively. The Haiti earthquake was 63 times bigger than the Chilean one, but 500 times stronger. To calculate the differences between two earthquakes visit: http://earthquake.usgs.gov/learn/topics/how_much_bigger.php.

What factors influence the outcome of a quake?

Engineers, city planners and government officials worry about earthquakes greater than magnitude 6. The magnitude of the tremor, the length of time the ground shakes and the quality of the structural engineering determine what impact the earthquake has on buildings, bridges and roads. Buildings in really unstable zones are sometimes built with sophisticated "shock absorbers" in the frames. This makes them better able to withstand shaking without damage but it also makes them very expensive to construct. The world's largest "earthquake-safe" building is Istanbul's international airport terminal, which covers more than 180 square kilometres and perches atop 300 "seismic isolators" which act like giant ball bearings.

In Canada, British Columbia is especially susceptible to tremors, particularly along the Queen Charlotte Fault. The St. Lawrence Valley and parts of Ontario also experience tremors although the geology is more stable. Very old fault systems underlay the region, and the occasional snap can take place. They're usually minor, but a magnitude-6 earthquake stuck Cornwall, Ontario in the 1930s.

Can we forecast them?

Although scientists can't predict exactly when an earthquake will happen or how strong it will be, they can identify where they're most likely to happen and also forecast how often on average. Parts of the San Andreas Fault are monitored for land distortion with satellite sensing, giving researchers highly detailed pictures of surface strains that may indicate energy buildup.

A series of ocean floor seismographs off the coast of British Columbia are collecting earthquake data on the activity of the Juan de Fuca plate, which is sliding under the much larger North American plate. The NEPTUNE Canada Seismograph Network sends real-time information along a fibre optic cable to the Geological Survey of Canada's station in Sydney, B.C. Monitoring previously undetectable earthquake activity could teach the scientists more about the locations and magnitudes of future quakes. It will also help city planners update building codes in key areas.

For more information:

John Clauge, Canada Research Chair in Natural Hazard Research, Simon Fraser University.

Gail Atkinson, Canada Research Chair in Earthquake Hazards and Ground Motions, University of Western Ontario.

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Garry Rogers, Earthquake hazards, Natural Resources Canada. PI on the NEPTUNE project.

Earthquakes Canada: http://earthquakescanada.nrcan.gc.ca/index-eng.php

USGS Earthquakes Hazards Program: http://earthquake.usgs.gov

Written by Gord Leathers for the Science Media Centre of Canada

Image courtesy of the United States Geological Society

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