

Predicting the big one

A huge earthquake devastated the West Coast 300 years ago, and another one is coming, but the question is, when? MARK HUME reports on a new field of research that might help to provide the answer

By MARK HUME

Globe and Mail, Saturday, November 27, 2004 - Page F9

VANCOUVER -- The earth shook for days. Entire villages were swept away by giant waves. Whales were found in the forest.

These stories, once thought to be nothing more than native legends, are now regarded by scientists as accurate oral accounts of a huge, magnitude 9 earthquake that struck the West Coast at 9 p.m. on Jan. 26, 1700.

Ten hours later, a tsunami, started by a convulsion of the ocean floor, hit Japan, its arrival recorded so precisely in historical journals that a few years ago scientists were able to trace the earthquake to its source, just off Vancouver Island, and to pinpoint its time.

One moment everything was calm. Then a cataclysmic event struck that echoed through generations of native storytellers with almost biblical overtones.

"The rivers became salt . . . the valleys were full of water . . . it became so cold that the children died," Sam Ulmer, a member of the Klallam tribe in Washington, told an anthropologist in 1925.

"I think a big wave smashed into the beach . . . everything was lost and gone," Louis Clamhouse said in a 1989 publication by the Canadian Museum of Civilization, in which she told the story of the Pachena people on Vancouver Island.

Scientists now know the event that shook the native world about 300 years ago was the second-largest earthquake to ever strike North America. Ever since then, people have been wondering: When will the next big one hit?

Generations of geological scientists have tried to answer that question, without success.

However, researchers at the Pacific Geoscience Centre have opened a field of study into deep-earth events that may help to identify the precursors of big earthquakes -- and make forecasts finally possible.

At the research centre near Victoria, the information that chatters in daily on seismic monitoring equipment is a constant reminder that the West Coast is an active earthquake area. Early this month, there was a flurry of more than 100 tremors off northern Vancouver Island.

Garry Rogers, a seismologist with the Geological Survey of Canada, says the seemingly solid earth on the West Coast is engaged in a

shoving match in which the offshore Juan de Fuca Plate is being forced beneath the North America Plate.

"If we bang a nail in the ground in Toronto, and put a GPS [global positioning system] station there, and bang a nail on Vancouver Island, and put a GPS station here, which we've done, we can see that Vancouver Island is slowly moving towards Toronto.

"This is building up the strain for the next huge . . . earthquake. When it will happen, we don't know. But that's what's happening out there. It's coiling up like a spring," he says.

When the spring releases, it will be 1700 all over again -- except that densely populated cities now stand where sparse villages once were.

"We are talking about the biggest earthquake that you can experience on Earth," said Mr. Rogers, who knows that if researchers could issue a warning of such an event, they could save countless lives.

In one native legend, a blind woman has a premonition and tells her two grandchildren to run up the mountain, allowing them to survive a tsunami that sweeps away the entire village.

Seismologists can only dream of that kind of prescience.

In China, researchers have looked at the strange behaviour of animals and insects before earthquakes, hoping to find some connection. In the United States, there has been work on trying to find patterns in the way rocks dilate under stress and Japanese scientists are using computer technology to analyze seismic activity.

The U.S. National Science Foundation recently committed \$100-million to set up a network of 800 GPS stations and 200 strain meters to better monitor changes in the Earth's crust.

But despite all this work and money, a method for predicting the next earthquake remains elusive.

In 1993, the U.S. Geological Survey thought it was onto something, warning there was a 37-per-cent chance of an earthquake in the Parkfield area, within days. It never arrived.

In 1995, Russian scientist Vladimir Keilis-Borok seemed to have a breakthrough when he predicted the earthquake that hit Kobe, Japan, that year. He was right again in predicting the Paso Robles, Calif., earthquake in December, 2003.

But his subsequent prediction of a major earthquake in Southern California between last January and Sept. 5 did not occur, bringing into doubt his theory that patterns of small earthquakes are precursors to large ones.

Mr. Rogers and his colleagues at the Pacific Geoscience Centre are involved in a new line of investigation that is having some promising results. Twice in a row -- in July of this year and March of last year -- they correctly predicted a tectonic event known as episodic tremor and slip.

An ETS event is not an earthquake. It occurs at a deep level on a fault where the rocks are hot and elastic. Instead of the offshore tectonic plates slipping steadily under North America, as had been assumed, the scientists discovered that there are periodic jumps that pass stress up to a shallower, locked section of the fault, where earthquakes occur.

ETS events aren't fully understood, but it's felt that they may "evolve into a trigger mechanism for a great subduction thrust earthquake," according to the Geological Survey of Canada.

Herb Dragert, a crustal-deformation expert with the Geological Survey of Canada, first detected ETS in 1999 while studying background noise from GPS stations.

Mr. Dragert's surprising data, first published in 2001, showed that seven GPS sites, strung from mid-Vancouver Island to Seattle, Wash., had briefly reversed their eastward drift.

It has long been known that the western margin of North America is slowly being compressed eastward as the Juan de Fuca Plate moves under North America, dragging the continent with it. Mr. Dragert's discovery was that during ETS, the North America Plate moved in the other direction, west, for up to six millimetres over 10 days.

"At first, the reaction in the scientific community was pure skepticism because people really didn't believe that GPS sites would march towards the continent, then turn around and go back," Mr. Rogers said. "They said, 'You've got something wrong on your analysis' . . . but once it was out and published with all the evidence, it was hailed as fantastic."

Mr. Rogers later supplemented the find by discovering tremors associated with the ETS event. "You can actually see these slips are happening, and when they start, it's some kind of weird non-earthquake signal -- it's not fracture and yet it's producing shearing-type waves, so we don't quite understand it yet."

What scientists do understand is that it is the first verifiable, predictable event associated in some way with earthquakes. ETS, they have proved, happens every 14 months.

"We see stress is going up like a staircase," Mr. Rogers said. "We suspect when it goes up one of these stairs, you have the earthquake . . . but we have no idea where on the staircase we are right now. We know that when we get to the top, there will be a megathrust earthquake, but we don't know where the top is."

However, scientists have done studies calculating, on the past record, the likelihood of lesser earthquakes on the West Coast.

And the data are sobering. One report estimates that there is a 22-per-cent chance that an earthquake big enough to damage buildings will hit Vancouver in the next 100 years. There is a 37-per-cent chance Victoria will be struck.

Over the same period, the probability of a smaller earthquake, strong enough to do slight damage, is 60 per cent for Vancouver and 78 per cent for Victoria. And there is a 99-per-cent chance that both cities will experience earthquakes strong enough to break dishes.

Even modest earthquakes can be dangerous in urban areas. One recent study identifies the Fraser River Delta as "the most seismically vulnerable area," because the top 10 to 20 metres of sediment is susceptible to seismic liquefaction. That area is now densely covered with housing.

Recent studies have also found that when tremors hit Victoria, the ground motion is twice as strong in some areas. People in homes built on bedrock barely felt the earthquake, while those on soft clay "saw pictures knocked out of place and furniture move."

In Port Alice, the closest community to the recent earthquake swarm, the biggest tremor shook houses and caused some concrete foundations to crack.

Mike Scott, who runs the Misty Rock Bed and Breakfast, demonstrated the casual attitude of many West Coasters when he shrugged off the event. "It was the usual, just a little shake," he said.

But Mr. Scott would be happy if scientists could figure out a way to predict earthquakes. "We all know there's going to be a big one sooner or later," he said.

Mark Hume is a member of The Globe and Mail's B.C. bureau