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The Next Megaquake

A huge megathrust earthquake and tsunami, just like the one that occurred on Boxing Day, will one day hit America.

Megaquake Q&A
Programme transcript

On Boxing Day 2004 the world was shocked by one of the worst natural disasters of all time. The cause of so much devastation was the most powerful kind of earthquake on the planet - a megathrust. Megathrust earthquake only occur on a particular kind of fault. Scientists have now discovered that just such a fault could cause a huge megathrust earthquake and tsunami right off the coast of North America.

The subduction zones

The surface of the earth is divided into giant plates of rock - and most earthquakes occur at faults where two of the plates meet. Where the plates are colliding one of the plates usually gets pushed down under the other - this is subduction.

Not surprisingly, the process of subduction can be very violent. The two plates can get stuck together and the result is that the area where subduction is occurring (the subduction zone) gets compressed. Eventually the strain on the fault becomes too much. The plates suddenly slip past each other. The result is a megathrust earthquake.

Subduction zones are mainly found in South East Asia (like the subduction zone that caused the Indian Ocean Tsunami) and around the Pacific Rim. It has long been known that a subduction zone runs along the Pacific northwest coast, from northern California all the way to Vancouver Island in Canada. It's called the Cascadia Subduction Zone, and is linked to the Cascade Range of volcanoes that includes Mt St Helens.

Quiet in Cascadia

No one, however, thought that this area was at significant risk from earthquakes, largely because there was no historical record of large earthquakes there. The first suggestion of a problem came when plans were drawn up to build a number of nuclear power stations near the coast of Washington state.

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Tom Heaton, a geophysicist and engineer from the California Institute of Technology, was brought in to examine the proposal from a geohazards perspective. Heaton pointed out the possibility that the Cascadia Subduction Zone might be capable of producing a megathrust earthquake.

The lack of historical record might be explained if the last such earthquake had occurred before Europeans arrived in the region during the 18th century. Heaton pointed to the existence of Native American legends that might be describing a megathrust earthquake that had happened before written records began. In the end, the nuclear power station project ran out of money and the reactors were never completed. Heaton's concerns were still just theoretical - there was no scientific evidence that such earthquakes had actually occurred.

When Brian Atwater, a specialist in marshes and estuaries, heard about Heaton's theory he decided to take a look himself. He started investigating in the very areas where the Native legends had been recorded. He found evidence that some time in the past there had been a sudden change in land level. The coast had dropped down, drowning forests under layers of mud. Other geologists soon found similar evidence all along the Pacific northwest coast. The simplest explanation was that there had been a huge megathrust earthquake in the past. This evidence, however, still wasn't enough to convince.

The orphan tsunami

The most intriguing piece of evidence came from Japan. As the Indonesian earthquake has shown, megathrust earthquakes can create tsunamis capable of crossing entire oceans. If there had been a giant earthquake in Cascadia it should have sent a tsunami across to Japan. So Japanese geologist Kenji Satake looked in old Japanese texts for any record of such a tsunami.

What he was looking for was an orphan tsunami, a wave the comes out of nowhere, with no local earthquake recorded. Satake and his colleagues found several such records from January 1700. The final proof came when scientists in America were able to date the land level change there by looking at the tree rings of drowned red cedar trees. They found that entire forests had been killed in the winter of 1699/1700, matching the Japanese records perfectly.

This evidence enabled scientists to put together a picture of the last Cascadia megathrust earthquake. It occurred around 9pm on 26 January 1700, and would have had a devastating effect on over 600 miles of coast. It's little wonder that the Native people of the region passed on legends of that event that survive to this day.

A deadly warning

Before the 1700 event was discovered, the people of the Pacific north-west would have had little awareness of the threat of earthquakes and even less of tsunamis. Now that is starting to change. Tsunami evacuation signs are being installed along the coast. The region's building codes are now some of the strictest in the world. All new buildings are designed to withstand a powerful earthquake.

However, building to survive a megathrust earthquake is a major challenge. These earthquakes tend to last several minutes - much longer than other quakes - and there is little knowledge about how

King Solomon's Stone

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modern buildings will react to such shaking.

As the events of Boxing Day 2004 showed, the tsunami unleashed by the sudden movement of the sea floor can be even more devastating than the earthquake. Unlike the Indian Ocean, the Pacific has a warning system that should give the other nations of the Pacific Rim many hours of warning.

On the Pacific northwest coast, however, a tsunami from Cascadia will arrive in some places in under half an hour. In such regions the key to saving lives is education. People there have to know that if they feel an earthquake they should move inland and to high ground. This knowledge could save many lives.

The terrible events of 26 December are a warning to the world that we should be better prepared for these huge geological catastrophes. This message has particular significance for the people of the Pacific northwest. One day that region will be hit by a megathrust that will probably be very similar to the Indonesian earthquake. At least, thanks to the work of many scientists, they have been forewarned.

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