Key information on 2010/11 Canterbury earthquakes

This page answers some of the questions people have been asking about the earthquakes in Christchurch and Canterbury since September 2010.

If you have a question that is not answered here, you can email it to ecinfo@ecan.govt.nz. For more general information on earthquakes, check out our earthquake booklet.

Why are we getting so many earthquakes? Are these aftershocks normal?

Aftershocks occur as the Earth's crust readjusts after a big movement - in this case the September 2010 earthquake on the Greendale Fault. They are called aftershocks as they are part of the readjustment process, but this doesn't mean that some of them aren't significant earthquakes in their own right, with their own smaller aftershock sequences.

The sequence of aftershocks since September 2010 is within the normal range for an aftershock sequence after a big earthquake, however it is on the higher side of the average, both in the number and magnitude of larger earthquakes.

One of the main reasons for this is the nature of the Earth's crust under the Christchurch/mid Canterbury Plains area. In this area the rocks of the crust, below the gravels and the volcanic rocks of Banks Peninsula, are old, cold and relatively rigid. This means that much of the readjustment in the crust is happening in short, sharp bursts: earthquakes that we feel.

This is different to earthquakes that happen in the Southern Alps and Fiordland, closer to the boundary between the Australian and Pacific plates. Here, the rock in the crust is a little warmer and more 'bendy', and a lot of the readjustment after a big earthquake would happen as slow 'creep' that we wouldn't feel. There would still be aftershocks, but not quite as many.

The earthquakes will eventually die away to the same amount as we used to get before September 2010. Nobody can say for sure

how long this will take, but it might be a few years.

What do all the numbers, probabilities and statistics actually mean?

Seismologists use computer models to do their really complicated number-crunching for them. These models spit out numbers, like “there is a 50% chance of a magnitude 5.0 to 5.9 earthquake in the aftershock region within the next year”.

These sorts of numbers are useful for the likes of engineers and insurance companies. When probabilities are quantified like this they can be used by risk assessors at insurance companies to compare risks from different hazards (e.g. flooding, snowstorm and earthquakes). And the probabilities from the number-crunching models have already been incorporated into new building standards for rebuilding Christchurch, so that our buildings will be more resilient to earthquakes in the future.

But for normal people like us the numbers may not be very meaningful. A simple interpretation is this: The aftershocks will most likely die away over the next few years, and the chances of another significant aftershock get smaller over this time. But there is still the possibility of another significant earthquake before the aftershock sequence is over. Nobody can say for sure either way. So we need to figure out how to live around that possibility. Continue to quake-safe your home, have water stored at home, have a household emergency plan, and look out for and after each other. Know your neighbours and whether they might need help.

Do the scientists have any clue what they are doing?

In fact, clues are all that scientists have to go on. Much like detectives putting together evidence to solve a crime, scientists use evidence from their observations and models to understand the processes happening in the earth, and to give the most likely picture of what has happened in the past, and therefore what could happen in the future. Sometimes the evidence is pretty clear cut; sometimes there is a lot of uncertainty.

Scientists are not psychics. Do not expect them to be able to tell us exactly what is going to happen. Science cannot give us 100% certainty about what will happen in the future, but it can give us indications of what is likely, and not-so-likely based on past observations. We can use this information as individuals and communities to help us make decisions.

Earthquake forecasts are NOT the same as predictions. A forecast is a statistical likelihood of something happening over a certain period of time. A prediction gives a specific timing and location for something to happen. Noone can reliably predict earthquakes.

Did geologists know about earthquake faults under the Canterbury Plains before 2010?

Yes, geologists had identified faults under the Canterbury Plains, but they did not know about the particular ones that have caused the earthquakes since September 2010. Small to moderate earthquakes (less than magnitude 5 or so) that occasionally occurred under the Canterbury Plains indicated that small faults were present under the gravels.

Larger faults, such as the Hororata Fault, near Hororata, and the Springbank Fault, near Rangiora can be seen as broad warps in the ground that indicate faulting in the bedrock under the gravels. They can also be seen in seismic reflection profiles, that show a rough cross-section through the upper few kilometres of gravel and rock, done as part of oil exploration. There was no evidence at the ground surface prior to September of the Greendale Fault, which caused the September earthquake, and it had not been seen on any oil exploration seismic reflection profiles.

Seismic reflection profiles had not been carried out in or around Christchurch to look for faults under the gravel as they are extremely expensive to undertake, and it can be difficult to get good results from these investigations in urban areas because of all the other human noise around, such as traffic and construction.

However, the possibility of a large earthquake up to magnitude 7 on an unknown fault near Christchurch had already been factored into the ground shaking modelling for Canterbury and New Zealand before September 2010. This modelling is used in determining earthquake loads for the Building Code.

Is there a fault under Barbadoes Street?

Geologists have found evidence for a fault under Barbadoes Street during investigations in the last few months. But let's not give Barbadoes Street a bad name – they found the fault there because Barbadoes Street is where they ran the seismic reflection line. The fault appears to run approximately east-west across the CBD and out to the east into Pegasus Bay, and runs under many streets. Geologists are still gathering information on faults underneath the gravels in and around Christchurch.

Are we going to get a magnitude 9 earthquake?

No. There are only a few places in the world where there are earthquake faults big enough to cause a magnitude 9 earthquake. These are big, long faults that mark the boundaries between tectonic plates. These sorts of faults occur around the edges of the Pacific Ocean, for example along the coast of South America. There is a possibility that there could be a magnitude 9 earthquake in the ocean to the north-east of New Zealand. However, in the South Island the largest earthquake fault we have is the Alpine Fault - this could cause an earthquake with a magnitude in the low 8s.

What about earthquakes in the rest of Canterbury?

In general, the chances of earthquakes in North and South Canterbury have not changed. Small to moderate sized earthquakes do happen fairly regularly in these areas, and will continue to happen. There are many known active faults in Canterbury, particularly in the Southern Alps and North Canterbury, which are capable of creating earthquakes. We still need to be prepared for earthquakes on these faults, and faults outside of Canterbury like the Alpine Fault, just as we did before September 2010. For more information on the earthquake hazard in Canterbury see our earthquake booklet.

Is the Banks Peninsula volcano going to erupt again?

No. The Banks Peninsula volcano became extinct about 5.8 million years ago. The conditions required for volcanic eruptions – one tectonic plate being forced under another and melting to create molten rock (magma) – no longer exist under Christchurch, so the volcano cannot spring back to life. These are the sort of conditions that currently exist under the North Island, creating the volcanos and geothermal areas around Taranaki, Taupo, Rotorua and Bay of Plenty.

Also, volcanic earthquakes caused by magma making its way to the ground surface look different on a seismograph than tectonic earthquakes caused by general stresses in the earth's crust. The earthquakes in Christchurch and Canterbury are not volcanic earthquakes.

Will we get a tsunami?

The earthquakes since September 2010 have not created tsunamis because they have not caused a big movement on the sea floor.

Just as before September 2010, the most likely tsunami to affect the Pegasus Bay coast is a distant-source tsunami. Distant-source tsunamis are generated more than three hours' travel time away from the coast, and for Pegasus Bay the most likely distant-source tsunami is one from South America. All four significant historic tsunamis to affect Pegasus Bay have come from South America (1868, 1877, 1960 and 2010). These tsunamis generally take 12-15 hours to reach us from South America, which is enough time to evacuate people from coastal communities.

Local-source tsunamis are tsunamis that take less than one hour to reach the coast. While scientists can't give a 100% guarantee, all the evidence about earthquake faults in Pegasus Bay collected so far suggests that they are unlikely to generate earthquakes big enough to cause a damaging tsunami. An earthquake has to be at least magnitude 6.5 to create enough displacement of the sea floor to create a tsunami, and even larger for that tsunami to be damaging on land.

Most of the movement on the recently discovered faults in Pegasus Bay is sideways movement, rather than vertical movement - it is the vertical movement that creates tsunamis. Modelling undertaken by GNS Science of a hypothetical equivalent to the Greendale Fault (the fault that caused the September 2010 earthquake) in Pegasus Bay showed that wave heights from a worst case tsunami would in most cases be less than 2 metres at the coast - most of which would be accommodated on the beach. The evidence so far shows that there is a very long time between movements (earthquakes) on the faults - in the order of thousands of years.

In summary:

The most likely tsunami scenario for Pegasus Bay is a tsunami from South America - this would take 12-15 hours to reach us which gives us time to issue warnings and evacuate people.

While we can't completely rule out a damaging local source tsunami generated in Pegasus Bay, all indications are that the likelihood of this is low.

What should you do if you feel a strong earthquake? In Christchurch and other areas along the Pegasus Bay coast, if you feel strong ground shaking it is most likely coming from an earthquake on land. Even if it is coming from an earthquake offshore it is very unlikely to have generated a tsunami. However, the consistent message across the whole of New Zealand that if you are near the coast (within 1-2 km) and feel strong ground shaking where it is hard to stand up, or moderate ground shaking that lasts for more than one minute, then you should move inland or to higher ground.

For more tsunami information for Christchurch, Pegasus Bay and Banks Peninsula, or for all of Canterbury, go to our tsunami pages. For general information on the tsunami hazard in Canterbury you can also read our tsunami booklet.

Was the magnitude 7.6 earthquake in the Kermadec Trench related to the Canterbury earthquakes?

No. The Kermadec Trench is the continuation of the plate boundary between the Australian and Pacific tectonic plates to the north of the North Island. Large earthquakes are not unusual in this area.

Once these earthquakes in Christchurch settle down, will everything go quiet again in Canterbury for another 10,000 years?

Unfortunately not. Once this sequence of earthquakes stops, the faults that they occurred on are not likely to move again for thousands of years. However, there are still many other known earthquake faults in Canterbury, particularly closer to the plate boundary in North Canterbury and the Southern Alps. While the ground shaking from an earthquake on one of these faults might not be so strong in Christchurch as the ground shaking we have recently experienced, we still need to be prepared for future earthquakes and their wider effects.

It is worth remembering that we live in a shaky region. In the first few decades of European settlement there was a decent shake every 10 or so years somewhere in Canterbury - see the historic earthquakes pages of our earthquake booklet. We just had it lucky between 1929 and 2010 with no big earthquakes near populated areas.

Is the crack in my back yard a faultline?

No. Unless you live on the Greendale Fault, in the Selwyn countryside.

The ground is cracked in many places in Christchurch and Kaiapoi, often because of lateral spreading of the ground near rivers, from landslide movement on slopes, or from warping or buckling of concrete or asphalt. These cracks generally only go down 1 or 2 metres into the ground, several metres at most.

Earthquake faults, on the other hand, start many kilometres down in the rocks of the Earth's crust. If an earthquake is big enough, the movement on the fault is so large that it comes right up to the ground surface - this produces a "fault line" on the ground (geologists call this a fault trace). Only the September 2010 earthquake was big enough in magnitude for the movement

on the fault - since named the Greendale Fault - to make it all the way up to the ground surface. The February, June and December 2011 earthquakes were too small in magnitude for the movement on the fault to make it up to the ground surface, so there is no "fault line" that can be mapped on the ground from these earthquakes, like there is for the September 2010 earthquake. The movement on the fault that moved in the February 2011 earthquake probably came up to within 1 or 2 km of the ground surface.

What is liquefaction?

Liquefaction is the process whereby, during earthquake shaking, sand and silt grains in wet soil try to compact and as a result they compact the spaces between them that are filled with water. The water pushes back and pressure builds up in the water until the silt and sand grains "float" in the water. The soil particles are then not able to support the weight of things on top, like buildings and roads, and they can tilt or sink. The pressurised water is forced up to the ground surface through the easiest path it can find - often through cracks and crevisses in the ground or concrete. The water takes silt and sand with it, forming sand boils or sand volcanos, or when there is lots of it, filling up entire streets and properties with sand and silt.

Liquefaction only happens in loose sandy or silty soils that are below the water table. It doesn't happen in clay soils, which tend to stick together, and it is very unusual in gravelly soils. Some Christchurch, Kaiapoi and Selwyn soils are very susceptible to liquefaction and it doesn't take much shaking to for them to liquefy. Others are less susceptible, and the shaking needs to be very strong, or go on for a long time, for them to liquefy. This explains why different areas liquefy in different earthquakes.

Note: don't make the mistake of using the wrong liquefaction terms: "liquefaction" is the process, the resulting product on the ground surface is "silt" or "liquefaction silt".

You can find out more about liquefaction from our liquefaction poster.

Has liquefaction left big holes under the ground that I can't see?

Generally no. When water and sand and silt is forced to the ground surface, what was above it subsides to fill in the space. However, there are a few instances where liquefaction has occurred under concrete or asphalt and it hasn't been able to subside to fill in the resulting space. There may also be a few places near rivers or streams where lateral spreading has happened under lawn or concrete and can't be easily seen.

Related Pages

Tsunami information for Christchurch, Pegasus Bay and Banks Peninsula
GeoNet
GNS Science Canterbury earthquake page
Natural Hazards Research Platform
IPENZ (Engineers New Zealand) earthquake fact sheets
Royal Society earthquake information paper
Dr Mark Quigley's page
Christchurch City Council earthquake information
Canterbury Earthquake Recovery Authority (CERA)