At 4.35 am on September 4, 2010, the people of Christchurch and surrounding districts were awoken by violent shaking, accompanied for many by the sound of smashing crockery, breaking glass and the crash of bookshelves, ornaments and pictures. A magnitude 7.1 earthquake had occurred, and the shaking lasted for 30 seconds.

In that first tremor roads cracked, water and sewerage pipes ruptured, railway lines buckled, walls toppled and chimneys fell. The bells of Christchurch Cathedral were set ringing and historic buildings fractured. Despite all of the damage, nobody was killed.

The epicentre was 40 km west of Christchurch and the depth of the quake was at 10 km. It is the most damaging earthquake since the Hawkes Bay earthquake in 1931. For many people the earthquake came as a complete surprise, as there have been just 3 moderate earthquakes in the area in the past 40 years and any faultlines were not detected. In the three weeks following the earthquake there were over 1000 aftershocks, one of them with a magnitude of 5.1.

This made it difficult for building inspectors, who needed to return to look at buildings which they had already cleared. Many homes have been damaged, some so badly they will need to be demolished, and the Christchurch business community has been badly affected.

Experts say that the fault that caused the Canterbury earthquake had not moved for at least 16,000 years. The earthquake produced the strongest earthquake ground-shaking ever recorded in New Zealand.

The fault rupture itself occurred a previously unknown east-west faultline, visible at the surface for 24 kilometres from Greendale to near Rolleston.
Scientists believe not one but three earthquakes just seconds apart ripped a gash across the Canterbury Plains and unleashed energy equivalent to 67 nuclear bombs speeding into Christchurch. Scientists believe they have unearthed the trigger for the Canterbury earthquake. Their potential breakthrough involves a second previously unknown fault under the Canterbury Plains.

In the wake of the 7.1 magnitude quake, GNS Science geologists discovered a new fault trace running roughly west-east, shattering roads, water races and shunting shelterbelts and fences about three metres to the side.

A 7.1 magnitude earthquake releases energy equivalent of 670,000 tonnes of explosives, or 67 nuclear bombs of the size that devastated Hiroshima.

“A fault beneath the Canterbury Plains capable of generating an earthquake of that size is a major surprise,” said Canterbury University geologist Associate Professor Tim Davies.

The impact upon many communities and towns was devastating. Most of the damage was done in that first juddering tremor, creating damage estimated in the beginning at $2 billion and rising as estimates come in.

Until now, the recently revealed Greendale Fault has been blamed for unleashing the magnitude-7.1 quake on September 4.

GNS Science seismologists working fulltime on the data recorded since then think the second fault may be responsible and provide the missing piece of the puzzle.

They say evidence points to a blind thrust fault lying at depth somewhere in a broad northeast to southwest zone centred on the focus of the big quake close to Charing Cross.

They believe that when that fault ruptured it sent out shockwaves that kicked into action the slumbering Greendale Fault slightly further south.

The release of several pulses of energy from faults about 4.35am that day and a foreshock seconds before the main shake have complicated the picture.

GNS spokesman John Callan said the epicentre was the source of the first pulse of energy.

“There were two main pulses about 10 seconds apart, then a third less distinct pulse about 30 to 40 seconds later,” he said.

“The quake was a result of two faults rupturing within seconds of each other. The first fault to rupture was a blind thrust fault. It has no surface expression. It triggered the east-west Greendale Fault.

“Fortunately, there were seismometers at either end of the fault, at Greendale and Rolleston. This has helped with the completeness of the seismic record.

“This was a highly complex quake that was exceptionally well-recorded. The quake will contribute significantly to the understanding of earthquake physics and fault mechanics, and therefore it has global implications.”

Seismologist Bill Fry said there was still a lot that was unknown about the second hidden fault. “The Greendale Fault extends down through the upper and middle crust to about 10 to 12 kilometres. But the thrust fault – we’re still deciding on the exact location of that.”

The large quake changed the strain levels in rocks around the region, he said. “This has created an increase in stress fields in some areas and a decrease in others.”

Fry said the areas with the greatest strain were where the aftershocks were located.
Events of the first day

The Earth’s crust is divided into plates which are in constant motion and collision. The plates boundaries are called fault lines. Earthquakes are caused by sudden jolts between fault lines.

NORMAL FAULTS
Occurs when plates move away or extend

STRIKE-SLIP FAULTS
Occur when plates move alongside one another causing friction

REVERSE FAULTS
Occurs when plates come together/compress

Source: US Geological Survey, Graphic News / HERALD GRAPHIC

4.36 am Magnitude 7.1 quake hits the South Island. The epicentre is close to the town of Darfield. Reports of the quake being felt from as far away as Dunedin and Palmerston North.

4.38 am Initial reports of quake begin to filter through to Twitter website.

4.56 am First large aftershock strikes: magnitude 5.3 quake at a depth of 8 km, 30km west of Christchurch. Aftershocks continue through the day.

7.46 am First reports of looting in the central city

8.17 am Confirmation that two people have been seriously injured in the quake

9.35 am Civil Defence is warning of the risk of water shortages, advises people living on the flat in Christchurch to conserve water and boil all drinking water.

10 am Christchurch declares a state of local emergency

12 pm Prime Minister John Key says he is rushing to Canterbury to “show solidarity” with locals rocked by a major earthquake.

12.23 pm Christchurch Police confirm they have closed the city centre until tomorrow.

12.30 pm MetService issues a severe weather warning for the Canterbury region, warning of severe rain and gales. Temperatures expected to drop to 2°C overnight.

12.50 pm The cost of damage from the devastating quake could be as much as $2 billion, Earthquake Commission chief executive says. Ian Simpson

1.30 pm Christchurch Airport is operational after the airport runways and infrastructure were assessed for damage.

2.10 pm Waimakariri District Council is advising Kaiapoi residents to leave town if possible, as it may be a long time before water or sewerage services are restored.

2.20 pm Cellular networks in Canterbury are being restored to normal with both generator and mains power, but users are still being urged to stay off their cellphones unless they need to make essential calls.

4.30 pm A building in the CBD on the corner of Worcester and Manchester Streets burst into flames but was soon brought under control.

5 pm Power has been restored to 77% of Christchurch city. But rural areas are largely out of power as a result of downed poles or lines.

Sunday 5
3.00 pm Chief Medical Officer of Health advises all public buildings, including schools, are to remain closed until Wednesday for safety inspections.

Source: Sunday Star Times

What causes earthquakes

A moment in time: the clock tower in Victoria St stopped at the time of the earthquake
A week of the shakes

More than most disasters, an earthquake finds a city out. A severe shake tests infrastructures, examines emergency responses, exposes planning decisions and, most of all, it asks some searching questions of its people.

Canterbury, in its first week after the major tremor, which struck at 4.35am on September 4, has passed many of these tests with flying colours. It should give itself a collective pat on the back - but not too hard.

A week after one of the biggest jolts to strike, a modern, populated city anywhere in the world, Canterbury authorities have managed to restore most of the services usually taken for granted. By tomorrow, just about everybody still living in their own home in Canterbury should have water and power.

As expected, Canterbury people pitched in and did what they could for themselves and their neighbours and friends. The welfare centres set up on Saturday were still busy mid-week with about 280 people in occupation. But out of the city of 360,000 or so, that is not a large number.

People like bungy king A J Hackett went ahead with their weddings in the ruined city. Mike Bird didn’t have much choice. He had already tattooed September 4 on his arm.

By Wednesday, the chooks had started laying again and by Thursday, several schools had reopened. Not all the memories were bad. A few hours after the quake, writer Joe Bennett found everyone in good spirits. “Everyone, was talking in the sunshine. There was a lot of laughter. It didn’t seem to be the nervous laughter of survivors. It was cheerful, convivial. It felt like a holiday,” he wrote.

In the aftermath, Wayne Alexander, of Christchurch, said: “You’re never more in love with life and that’s what I like about it. Whenever you face loss, you realise on the other side of it what you’ve got.”

But first there was terror. For many, the noise was deafening as windows rattled fit to break, glass and crockery crashed to the floor and chimneys and tiles toppled. For many in the beach suburbs, the first panicked thought was for a possible tsunami. Those who had access to their vehicles caused a traffic jam as they headed away from the coast. Without power, many could not open their automatic garage doors.

Annette Preen, living on her own in her new house in Bexley, felt trapped as she tried to kick down her security door. “I thought I was going to die.” When she made it outside, she fell headfirst into the wet sand piled at her front door. “I felt flat on my face and the silt being so heavy, I couldn’t get out.”

For Chris Piper, 18, of St Martins, it was the scariest moment of his life. He was sleeping in a sleepout behind his family’s home and was woken painfully when a television fell on his feet.

“I threw my girlfriend on the lawn and then went to the house in bare feet and my underwear to see tiles and the chimney crashing down. I thought the whole house was going to collapse. I thought my whole family was going to die in front of me.”

Imagine the plight of paraplegic Renee Hayman, lying in her room at the Kate Sheppard Hospital in Avonside. “I felt quite helpless, really.”

At dawn, Christchurch turned on a pearler of a day. Residents could survey the damage in the light of warm bright sunshine. Another godsend, perhaps.

Supermarkets were some of the first businesses to re-open. By 10.40am, St Martins New World had cleaned up aisles smelling of vinegar and alcohol and had tills running on generator power. By midday, power was on again and business was as busy as a Christmas Eve, owner Russell McKenzie said.

Other supermarkets around town dealt with panic buying and were soon out of bottled water, milk, bread, batteries and candles. As it became clear starvation was going to be averted, the panic subsided. Frantic buying at the city’s service stations also abated as it became clear fuel supplies were not threatened.

Riccarton High School, like others in the region, was closed for a week to check the safety of buildings, water and sewerage

■ The Press, Saturday, 11 September 2010
The effects of the Quake

Christchurch remained off limits to an estimated 50,000 workers with police and army cordons in place around the central business district. A state of emergency was extended, and until buildings were cleared by structural engineers, staff needed to keep clear.

A series of aftershocks compounded the problem as they often further damaged buildings that had been cleared following the initial earthquake.

Damage occurred in many suburbs, with some residents moving away to stay with friends or relatives, or in temporary accommodation; yet other areas were relatively unscathed.

Apart from obvious structural damage (at least one Canterbury house in nine has chimney damage) there have been other effects. Liquefaction occurred in many suburbs, such as Avonside and Bexley Park, in East Christchurch.

When sandy soil is jolted hard by the earthquake, it changes its structure and falls apart. In this case water bubbled up through cracks in concrete like springs, bringing black silty soil with it that covered driveways with the consistency of heavy jelly.

Where the water and silt was trapped under concrete, paths and roads were pushed upward, tilting and breaking homes and creating mounds on roads and paths. The tarseal crust on many of these roads consequently broke into rubble.
The sea arch as it was in Sleepy Bay, top, and how it is now, after it collapsed, having been weakened and damaged by the September 4 earthquake.

Going, going, gone. A Canterbury landmark has been destroyed by the earthquake. The sea arch in Sleepy Bay on Banks Peninsula partially collapsed during the September 4 earthquake and the remainder fell into the sea more than a week ago.

The stone arch was a feature on peninsula walks and a fun challenge for kayakers. It was also the resting place for the ashes of members of the Narbey family who have farmed the area since 1850.

Brian Narbey was mustering sheep 9 days ago when he heard the remainder of the arch, known as the mirror or the spyglass, fall into the sea. “It was a big rumbling as it went down into the sea,” he said. “It’s a local landmark. There must be thousands of photographs taken of it. It has been there forever and now it has gone. It’s sad to see it go. It is a new era.”

Banks Peninsula resident and writer Fiona Farrell, who took these photographs, also said it was sad to see it go. “It is quite an absence. It feels quite strange,” she said.

The arch was also used as a location for Hollywood blockbuster Underworld: Rise of the Lycans. A miniature ship was filmed floating through the arch, with the footage used in the film’s closing moments.

Huge craters in Kaiapoi caused by the earthquake, large enough to walk in.

The movement of the land is shown by the shift of the shelter belt on a fault trace between Greendale and Burnham.

Sea arch tumbles into sea

The Press, 4 October 2010

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Liquefaction

L

arge tracts of silty, low-lying land in Canterbury were transformed from firm land to sludge. In what’s known as liquefaction, Christchurch’s sandy soil was shaken violently, causing water to rise through its pores. Scientists compared it to jumping on wet sand at the beach, it soon turns to a murky soup.

Professor Michael Pender from Auckland University’s geology department said the Canterbury quake was one of the most significant cases of liquefaction in New Zealand history, but the process could affect any town or city near a river, estuary or coastline.

Large sections of Christchurch were built on soft sediments which remained saturated after a wet winter. Roads, bridges and pipe infrastructure have been unsettled by the water squirting up through the soil during the 7.1 magnitude tremor.

As many as 9 out of 10 homes on the city’s flat have been damaged by the quicksand-like effect. Much of this damage was superficial rather than structural. But in Bexley, a 5-year-old subdivision, at least 100 new homes were left uninhabitable after silt, sewage and grey sludge cracked the road and squeezed through floorboards.

The worst-affected areas were coastal spots such as New Brighton, and suburbs that skirted the lower reaches of the Avon and Heathcote Rivers, in particular Dallington.

Homes in Kaiapoi, near the Waimakariri River, were also reported to have sunk into the soil.

Geologists said when rising water was concentrated into small cracks it could create sand volcanoes — mounds of sand that pushed up to the surface, as seen on the streets of Avonside and Linwood.

Professor Pender was surprised that some new developments suffered major damage from underground water.

“You’d expect the engineers doing the site investigation to realise that there is this loose sand present and do some remedial work before they built foundations.”

New Zealand Herald, 7 September 2010
Impact on structures

Some of the older buildings built before earthquake building codes were in place have been affected badly. Many are heritage buildings and add history to the city, but they may have to be demolished as the cost of replacing them may be too expensive.

The fact that many modern buildings were largely unaffected shows that New Zealand’s building codes are strong.

Seismic lessons

The Press, 16 October 2010

“Modern buildings are designed to bend like a piece of wire rather than breaking like a stick,” the director of the city’s largest structural and civil engineering firm, Holmes Consulting Group, says.

While attention has focused on the damage to the city’s older buildings and private homes, the effect on the city’s modern commercial buildings was less dramatic but nevertheless holds important lessons for the future.

“Essentially, earthquake design in New Zealand began in 1965. In 1976, it was brought into the modern era with research at the University of Canterbury with an approach which concentrated on saving lives. Buildings would fail but in a very controlled way,” Hare says.

“There was an acceptance and growing realisation that you couldn’t make building indefinitely stronger because there would always be a stronger earthquake. It would be impractical to simply build extremely strong buildings - they must also have the ability to yield, flex and move in an earthquake. Many, but not all, of Christchurch’s taller buildings have been designed in this way and most handled the earthquake well.”

The 1929 Murchison and the 1931 Hawke’s Bay earthquakes profoundly shaped New Zealand’s perception of the hazards of living in a seismically active environment.

Attention was focused on weaknesses in building construction, especially poor building standards and the lack of any provision for earthquake-resistant design.

This led to a draft by-law in 1931, which was incorporated into a building code in 1935. Building codes in 1965, 1976, 1984 and 1992 have added requirements to accommodate changes in building materials and design. Rather than prescribing specific materials, designs or construction methods, the 1992 New Zealand code outlines how a building must perform to withstand the forces expected during an earthquake.

This allows builders to use innovative design and construction methods to create earthquake-resistant buildings. For a moderate earthquake, the main aim is to protect a building from structural damage. For a major earthquake, however, the goal is to protect life by ensuring a building will not collapse and people can escape from it, even if the building itself is badly damaged.
Economic impact

The Treasury estimates that the Canterbury earthquake will cost about $4 billion. This is made up of many items, most of which are shown in the panels below. Over the next few years, the region will get a boost economically as people begin to replace items they have lost (eg. houses, furniture, TVs) and both local and central governments rebuild their facilities such as roads, drainage, schools and so on. This increased economic activity will give a boost to the local region compared to other areas.

Costs of the Quake

**HOUSEHOLDS: HOUSING**
- Over 93,000 claims made to EQC
- about 5000 houses have damage costing more than $100,000
- 17,000 claims for chimney damage, almost half of which where the chimney is the only

**BUSINESSES : ASSETS**
- Some 50 buildings were declared unsafe
- cost of repairing wharves at the Port of Lyttelton
- large-scale loss of goods, such as warehousing of foodstuffs

**HOUSEHOLDS : INCOMES**
- damage to buildings/premises so some employees had access to their place of employment.
- Government’s Earthquake Support Subsidy, for businesses with fewer than 20 staff, paid the wages of staff while firms got operational again

**BUSINESSES: INCOME**
- loss of production and sales through damaged buildings

**LOCAL GOVERNMENTS**
- damage to public infrastructure: roading, sewerage and drainage

**CENTRAL GOVERNMENT**
- damage to schools and hospitals
- Loss of taxation
- Payment of benefits

Loss of business and home

*The Press, 11 September 2010*

An Indian dairy owner whose family lived above his business is without a home and income after his quake damaged building was condemned.

Ferry Rd Mini Market owner Hemant Shah was just one example given to Ethnic Affairs Minister Pansy Wong of the plight of Christchurch’s ethnic communities yesterday.

Shah’s dairy suffered only minor damage, but the flat he shared with his wife and two children above the shop has been given a red “no-go” sticker.

The family has been barred not only from their home, but also from their business. Shah’s wife and children were living, separated, with various friends and a miscommunication at Work and Income meant he was initially told he was entitled to only a $113 benefit.

Shah had contents insurance, but no income protection.

Community leader Natu Rama called on the Government to provide guarantees to small business owners, particularly around insurance.

Hardeep Singh, a friend of Rama and a restaurant owner, had just taken the lease on a number of premises in the Ferrymead area, but had been unable to open because he had been given a 21-day standdown by his insurance company, Rama said.

The Government needed to act “to alleviate the pain in the short term”. He suggested an interim guarantee would allow business owners to get back on their feet.

Wong said she would consider the insurance issue.

Language difficulties had become an issue because “in a stress situation the mother tongue sets in”.

Many small businesses could not open because of the damages
Impact on people

The physical effects of an earthquake are dramatic and frightening. Also traumatic is the impact upon the lives of ordinary people — families, children, the sick and the elderly. Some of the effects will linger for months; maybe even years. Study the situations listed in each box and explain the complications.
A helping hand

Immediately following a earthquake assistance is first sought from families and neighbours, followed by emergency services. After that it is the turn of central government, local governments and relief agencies. The following is a list of some organisations that helped.

Disruption was complex. Good communication, flow of information and division of responsibilities needed to be established and coordinated.

For each of the following, research and describe where they fitted into the massive task of returning Christchurch’s people and city infrastructure to normal - both short term and long term.

Police Civil Defence
New Zealand Red Cross Canterbury Earthquake Commission
Work And Income Housing New Zealand
Victim Support City Housing Age Concern Home visits*
Earthquake Commission
Air New Zealand Earthquake Relief Flights
Central Government Local Government*
Recovery Assistance Centres Housing Emergency Lease Programme

Mayor’s Welfare Fund

Insurance Council Discretionary Response Fund
*Christchurch City Council

Natural disasters can sometimes bring out the best in people. It is a healthy neighbourhood where members experience a major disaster, yet manage to look after each other throughout. It is also a healthy society that picks itself up, dusts itself off and plans to make improvements in case sometime like it happens again.
What are earthquakes?

THEORY OF PLATE TECTONICS
The surface of the Earth is divided into seven major plates and several minor ones. They move a few centimetres a year riding on semi-molten layers of rock underneath the crust. As the plates move they pull apart or collide, unleashing the powerful movements known as earthquakes.

TYPES OF PLATE BOUNDARY
1. Rift valley
Continental plates pull apart allowing crust to sink.

2. Mountain building
Continental plates collide forcing rock layers to fold and pile up into mountain ranges.

3. Volcanic islands
Spreading ocean floor is much thinner than continental plates but can break the sea surface forming volcanic islands.

4. Sea floor spreading
Basaltic magma rises to form new ocean floor along a fault. An undersea ridge is formed which gradually spreads as new material pushes it along its way accompanied by almost constant earthquake activity.

Mantle currents
Movement of tectonic plates is thought to be driven by sluggish heat currents within the mantle.

5. Subduction
Ocean floor is forced under continental crust and into the magma where it is consumed and recycled. The subduction process is accompanied by the world’s strongest quakes, measuring up to 8.9 on the Richter Scale, which can heave the ocean floor by many metres.

6. Strike-slip faults
Form where two plates shear past each other. The resulting earthquakes are less powerful than those in the subduction zones but can be more destructive to people because of their focus nearer the surface.

Subduction zone
Spreading zone
Thrust fault
Strike-slip fault
Uncertain/diffuse boundary

The crust of the Earth is made of several plates, large areas of solidified rock which float on a layer, called the mantle, above the Earth’s core. The mantle begins about 10 km below the oceanic crust and about 30 km below the continental crust and makes up nearly 80% of the Earth’s total volume.

As these plates are free to slowly move, they can either drift towards each other, away from each other or slide past each other. Many of the earthquakes which we feel are located in the areas where plates collide or try to slide past each other.

Because the earth is very hot inside, a current of heat flows from the core to the crust. This is called convection current and it also takes place in the mantle. This current cools down as it comes closer to the surface of the Earth.

As a result, the rising of the current decreases and goes into a horizontal direction along the bottom of the crust. When the current cools down more, the convection current descends again and goes to the inner Earth. There the temperature increases and the current rises again. This goes on and on.

When the current comes to a weaker part of the crust, such as at a volcano, magma comes above the Earth’s surface. The convection current along the bottom of the crust causes the tectonic plates to move. This is called plate tectonics.

The movement of these plates is very slow. The bumping of two tectonic plates causes an earthquake.

There are many fault-lines in the Earth’s crust. The typical rate of movement is around a millimetre a year. Rocks tend to stick so that over a period of centuries they reach a critical level and everything gives at once.
New Zealand has often been called the “Shaky Isles”. The term has been derived from New Zealand’s frequent seismic activity. The islands lie on the margin of two colliding tectonic plates, the Pacific and Indo-Australian Plates.

Earthquakes are common, particularly in the southwest of the South Island and in the central North Island, and the North Island’s scenery is marked by several active and dormant volcanic cones. The recent Canterbury earthquake occurred along faults not previously detected; however the region is prone to seismic events because of its proximity to established faultlines.

With seismologists recording up to 15,000 earthquakes a year, New Zealand deserves its reputation as the “Shaky Isles,” but most are too small to be felt by the country’s 4.3 million people.

Up to 150, however, are large enough to register, and every schoolchild is drilled on how to react to an earthquake - get under your desk or in a doorway when you feel a tremor and taught the need to prepare for the “Big One.”

Being centred in an area seismologists had not identified as quake-prone, the Canterbury shake showed that nowhere in the country was safe from a devastating tremor.

The epicentre of Canterbury’s quake was some distance from the Alpine Fault, which runs about 600 kilometres up the spine of the South Island and is the boundary of two massive geological plates that are constantly grinding against each other.

Seismologists said it has ruptured four times in the past 900 years, each time producing an earthquake of about magnitude 8, lifting the Southern Alps in the process and producing some of New Zealand’s most spectacular scenery.

Scientists predicted a “high probability” that it would produce one of the biggest earthquakes since Europeans settled in New Zealand.

Wellington, which has five major fault lines, has long been regarded as the most likely to experience the Big One.

Seismologists said the so-called Wellington fault, which last produced a quake of about magnitude 7.6 300 to 500 years ago, would spawn another inside the next 200 years.

As 20 aftershocks ranging from 3.9 to 5.2 on the Richter scale were recorded in about 15 hours after the early morning shock in Canterbury, it was impossible to predict whether another Big One would hit Christchurch.

But records showed that Napier was struck by a massive aftershock measuring 7.3 10 days after the city was levelled 89 years ago.

It is all a bit unpredictable, and shocking when it occurs in a place where it was not expected.
Power of earthquakes

Left side of the chart shows the magnitude of the earthquake and right side represents the amount of high explosive required to produce the energy released by the earthquake. The middle of the chart shows the relative frequencies.

Notable earthquakes

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Event</th>
<th>Energy Release (equivalent of explosive underground)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>February 27, 2010 8.8 Chile</td>
<td>475 megatonnes</td>
</tr>
<tr>
<td>8</td>
<td>March 27, 1964 9.2 Alaska</td>
<td>475 megatonnes</td>
</tr>
<tr>
<td>8</td>
<td>June 17, 1929 7.8 Murchison</td>
<td>15 megatonnes</td>
</tr>
<tr>
<td>7</td>
<td>February 3, 1931 7.8 Napier</td>
<td>475 kilotonnes</td>
</tr>
<tr>
<td>7</td>
<td>September 4, 2010 7.1 Christchurch</td>
<td>475 kilotonnes</td>
</tr>
<tr>
<td>6</td>
<td>May 24, 1968 7.1 Inangahua</td>
<td>15 kilotonnes</td>
</tr>
<tr>
<td>5</td>
<td>Average tornado</td>
<td>475 tonnes</td>
</tr>
<tr>
<td>4</td>
<td>Large lightning bolt</td>
<td>15 tonnes</td>
</tr>
<tr>
<td>3</td>
<td>Moderate lightning bolt</td>
<td>475 kg</td>
</tr>
<tr>
<td>2</td>
<td>Everyone feels the quake</td>
<td>15 kg</td>
</tr>
</tbody>
</table>

How to read the Richter Scale, the best known scale for measuring the magnitude of earthquakes

Earthquake's force

- A magnitude 7 quake is roughly equivalent to the explosion of a 475 kilotonne bomb underground

Possible effects

- Conspicuous cracks in ground
- Masonry and wood structures seriously damaged
- Danger of large landslides
- People have difficulty standing, steering vehicles
- Chimneys, stucco and masonry walls crack
- Pipes break, danger of fire
- Masonry and wood structures seriously damaged
- Everyone feels the quake
- Houses shake, glass breaks, furniture slides, objects fall

Source: US Geological Survey, World Bank