**ACTIVITY: Earthquake intensity**

**Activity idea**

In this activity, students study damage descriptions from earthquakes and allocate a Modified Mercalli Intensity (MMI) number.

By the end of this activity, students should be able to:

* understand the Modified Mercalli Intensity (MMI) scale
* look at damage descriptions of historic New Zealand earthquakes and allocate Modified Mercalli Intensity scale numbers to them
* understand the difference between magnitude and intensity of earthquakes.

This activity was developed for the Earthquake Commission (EQC) and has been kindly provided for use on the Science Learning Hub.



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**Introduction/background**

Earthquakes are often described by their magnitude using the Richter scale, which is a measure of the amount of energy released. However, how this energy is experienced at the surface depends on many things, such as the depth of the earthquake and the type of landscape affected.

Another way of describing earthquakes is by the effect on people and the environment at the surface. This is indicated by the Mercalli Intensity scale. A New Zealand version of this scale takes account of such things as ground conditions and building construction standards. This is called the Modified Mercalli Intensity (MMI) scale and has steps numbered 1–12, with 1 being the least effect and 12 the most. This grades the impact an earthquake has on people and property, so it will be different at the epicentre to places further away.

The effect of an earthquake, and therefore the MMI number, normally gets less as you move away from the epicentre. The MMI number quoted for an earthquake is normally that observed near the epicentre.

The MMI scale provided is an official simplified version that concentrates on the effects of earthquakes on people and structures. The full scale, describing effects on people, fittings, structures and the environment can be found at <http://info.geonet.org.nz/display/quake/New+Zealand+Modified+Mercalli+Intensity+Scale>.

**What you need**

* Simplified New Zealand Modified Mercalli Intensity scale
* Information about 6 New Zealand earthquakes

**What to do**

1. Give out copies of [simplified New Zealand Modified Mercalli Intensity scale](#MMI) and read through and discuss with the class.
2. Give out copies of [information about 6 New Zealand earthquakes](#info) and ask students to look at the damage descriptions of a few historic New Zealand earthquakes and allocate Modified Mercalli Intensity scale numbers to them. They should be close to those given below, which are the MMI numbers given by GeoNet, the source of the other data presented to students.

|  |  |  |  |
| --- | --- | --- | --- |
| **Location** | **Mag** | **Depth** | **MMI** |
| Gisborne | 6.8 | 40km | 8 |
| George Sound | 6.7 | 24km | 7 |
| Lake Rotama | 5.4 | 5km | 8 |
| Fiordland | 7.2 | 24km | 7 |
| Edgecumbe | 6.5 | 6km | 9 |
| Buller | 7.8 | 12km | 10 |

1. If your students have completed the [Earthquake location](http://www.sciencelearn.org.nz/contexts/earthquakes/teaching_and_learning_approaches/earthquake_location) activity, have them allocate an MMI number to the area near the epicentre that they plotted in the North Island. (This will be based on their prediction of what might happen. In reality, intensity is only allocated after actual damage has been recorded. It is still a useful exercise, as students should get a good idea of some of the factors that affect intensity.)

**Discussion questions**

* Does the highest magnitude earthquake have the highest MMI?
* Does the lowest magnitude earthquake have the lowest MMI?
* What factors might result in lower magnitude earthquakes having higher effects at the surface? For example, why do you think the Edgecumbe earthquake, which had nearly the lowest magnitude of the 6 in this activity, had the second highest MMI?
* You could encourage a discussion about the merits of using magnitude and intensity when describing earthquakes. Magnitude is a quantitative measure – it is a single value that indicates the amount of energy released at the source of the earthquake. Intensity is a qualitative measure – it indicates the violence of earth movement at a particular location, and intensity value varies according to such things as ground structure and distance from epicentre.

**Simplified New Zealand Modified Mercalli Intensity scale**

|  |  |
| --- | --- |
| **MM 1: Imperceptible** | Barely sensed only by a very few people. |
| **MM 2: Scarcely felt** | Felt only by a few people at rest in houses or on upper floors. |
| **MM 3: Weak** | Felt indoors as a light vibration. Hanging objects may swing slightly. |
| **MM 4: Largely observed** | Generally noticed indoors, but not outside, as a moderate vibration or jolt. Light sleepers may be awakened. Walls may creak and glassware, crockery, doors or windows may rattle. |
| **MM 5: Strong** | Generally felt outside and by almost everyone indoors. Most sleepers are awakened and a few people alarmed. Small objects are shifted or overturned, and pictures knock against the wall. Some glassware and crockery may break, and loosely secured doors may swing open and shut. |
| **MM 6: Slightly damaging** | Felt by all. People and animals are alarmed, and many run outside. Walking steadily is difficult. Furniture and appliances may move on smooth surfaces, and objects fall from walls and shelves. Glassware and crockery break. Slight non-structural damage to buildings may occur. |
| **MM 7: Damaging** | General alarm. People experience difficulty standing. Furniture and appliances are shifted. Substantial damage to fragile or unsecured objects. A few weak buildings are damaged. |
| **MM 8: Heavily damaging** | Alarm may approach panic. A few buildings are damaged and some weak buildings are destroyed. |
| **MM 9: Destructive** | Some buildings are damaged and many weak buildings are destroyed. |
| **MM 10: Very destructive** | Many buildings are damaged and most weak buildings are destroyed. |
| **MM 11: Devastating** | Most buildings are damaged and many buildings are destroyed. |
| **MM 12: Completely devastating** | All buildings are damaged and most buildings are destroyed. |

**Information about 6 New Zealand earthquakes**

| **Location** | **Magnitude** | **Depth** | **Damage description** | **MMI** |
| --- | --- | --- | --- | --- |
| Gisborne | 6.8 | 40km | This earthquake struck just before 9pm on 20 December 2007 and was felt from Auckland to Dunedin. Several buildings in the Gisborne central business district collapsed, and others were structurally damaged. It was fortunate that no-one was killed by falling rubble. Lesser damage was reported from other parts of the Gisborne region, Hawke's Bay, Bay of Plenty, Manawatu and Wellington. |  |
| George Sound, Fiordland | 6.7 | 24km | On Tuesday 16 October 2007, the lower South Island felt a large earthquake off the coast of Fiordland, in the vicinity of George Sound. The quake struck at 1:29am, and was felt widely from Stewart Island to Wellington. The shaking caused landslides in the steep slopes of Milford Sound, while in the nearby Hollyford Valley, objects were thrown to the floor, including a heavy VHF radio that fell from its position atop a television set. The earthquake also caused minor contents damage in the town of Te Anau, where shop stock fell from shelves. |  |
| Lake Rotama,  Bay of Plenty | 5.4 | 5km | This earthquake was the largest of a swarm that affected the Lake Rotoehu area in July 2004. It caused severe damage to buildings and services in the Lake Rotoehu and Lake Rotoma areas and widespread minor damage throughout the Bay of Plenty. It triggered numerous landslides and was felt from Waikato to the Bay of Plenty. |  |
| Fiordland | 7.2 | 24km | This earthquake struck the south-west corner of the South Island on 22 August 2003. The epicentre was not near any heavily populated areas, so personal injuries and damage to property were quite minor. It was felt from Auckland to Stewart Island, and even as far away as Sydney, Australia, but it was experienced most strongly in the small South Island town of Te Anau. Here, buildings shook, and objects and small appliances were thrown from shelves.  Closer to the epicentre, in the steep slopes of Fiordland, over 200 landslides were triggered, some of which generated small local tsunami when they hit the water. Further offshore, the earthquake raised the seafloor significantly, causing another small-scale tsunami that was recorded up the coast at Jackson Bay and also at Port Kembla in Australia, 1,650km away. |  |
| Edgecumbe, Bay of Plenty | 6.5 | 6km | The earthquake struck Edgecumbe at 1:42pm on 2 March 1987 and was felt over most of the North Island. Hardest hit were the towns of Edgecumbe, Te Teko, Kawerau, Matata and Thornton, where chimneys toppled and poorly constructed houses suffered serious damage. In Edgecumbe, the shaking cracked asphalt in roads and footpaths, damaged river embankments, toppled a locomotive and tore large power transformers, weighing up to 20 tonnes each, from their mountings. Railway lines were extensively damaged, bending and buckling under the huge force of the quake.  Some foreshocks just before the main event meant that a number of weak and poorly constructed buildings were evacuated and so were empty when they collapsed in the main earthquake. There were no deaths, but 25 people were injured. |  |
| Buller | 7.8 | 12km | The earthquake that struck Murchison, north-west South Island, on 17 June 1929 was felt all over New Zealand. Fortunately, the most intense shaking occurred in a mountainous area that was sparsely populated. The shaking triggered extensive landslides over thousands of square kilometres. Most of the 15 casualties were caught in landslides.  Across an area of 26,000km2, many roads, buildings, bridges and other structures were severely damaged. Thirty-eight new lakes formed after the earthquake when massive slips blocked rivers and waterways in the region. |  |