Collins

Scheme of work

Geography: Key Stage 2 Years 3 and 4

Teachers Professional Development Programme

# Enquiry 1: Why do some earthquakes cause more damage than others?


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Connecting the curriculum through enquiry based learning

# **Key Question:** Why do some earthquakes cause more damage than others?

## Learning objectives

During the enquiry pupils will have opportunities through the application and analysis of a wide range of geographical skills and resources to:

- **Locate** and **describe** the effects of the Christchurch earthquake of 2011 from a range of sources;
- **Observe** and **record** the distribution of earthquakes in New Zealand over the past two hundred years;
- **Identify**, **describe** and **explain** the causes of earthquakes;
- **Describe** and **explain** why New Zealand experiences earthquakes when they don't occur at all in many other areas of the world;
- **Understand** through **explanation** and **reaching conclusions** why the most powerful earthquakes in the world do not necessarily cause the most deaths and destruction;
- **Identify**, **describe** and **explain** the causes of volcanoes;
- **Explain** why volcanoes often occur at the same location as earthquakes in places such as New Zealand;
- **Locate**, **describe** and **explain** why so many earthquakes and volcanoes occur around the Pacific Ring of Fire.

## Purpose of the enquiry

This enquiry introduces pupils to some key aspects of physical geography, in particular one of the major outcomes of tectonic activity in the world – earthquakes. Some work is also focused on volcanic activity, which is developed at greater depth at Upper Key Stage 2.

As they progress through the ancillary questions pupils come to understand why it is that earthquakes only tend to occur in particular areas of the world as a consequence of the pattern and movement of the tectonic plates of the Earth's crust. The pupils initially investigate the causes and impact of one specific recent earthquake in one particular location in the world, where earthquakes occur frequently, before looking more widely at global patterns. At all points the people–environment relationship, which is the subject paradigm of geography, is maintained through the enquiries as pupils seek to understand the interaction of people and earthquakes.

The pupils are supported to develop and apply high-order thinking to a consideration of why some earthquakes of the largest magnitudes do not always cause as much death and destruction as earthquakes of lesser magnitude. Here, the centrality of the human condition in terms of quality of life in particular and also technological development is an important area for the pupils to begin to understand.

## Context

The enquiry begins with the personal account of two people who experienced first-hand the Christchurch earthquake in New Zealand in 2011, together with a range of additional resources which captured the event. From the first two ancillary questions pupils are able to understand the impact of a single discrete earthquake event in one specific location before broadening their focus and being encouraged to think more conceptually – moving from the known to the unknown. Once the pupils have gained a solid awareness of why New Zealand is so regularly impacted by earthquakes, they are able to identify and explain global patterns of tectonic activity associated with the plates of the Earth's crust. It is at this point that volcanic activity is introduced and the similarity in distribution explored. In order to answer the main enquiry question the pupils recognise that the level of technological development and overall quality of life of people in different countries of the world has an important influence of how well they can prepare for and cope with the occurrence of earthquakes.

## National Curriculum coverage Geography

Pupils should be taught to:

### Locational knowledge

- Locate the world's countries, using maps to focus on Europe (including the location of Russia) and North and South America, concentrating on their environmental regions, key physical and human characteristics, countries and major cities.
- Identify the position and significance of latitude, longitude, Equator, Northern Hemisphere, Southern Hemisphere, the Tropics of Cancer and Capricorn, Arctic and Antarctic Circle, the Prime/Greenwich Meridian and time zones (including day and night).

### Human and physical geography

Describe and understand key aspects of:

- Physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle.
- Human geography, including: types of settlement and land use, economic activity including trade links, and the distribution of natural resources including energy, food, minerals and water.

### Geographical skills

- Use maps, atlases, globes and digital/computer mapping to locate countries and describe features studied.
- Use the eight points of a compass, four and six-figure grid references, symbols and key (including the use of Ordnance Survey maps) to build their knowledge of the United Kingdom and the wider world.

## Key Subject Vocabulary

Earthquake; Volcano; Continent; Ocean; Latitude; Longitude; Northern Hemisphere; Southern Hemisphere; Political map; Evacuation; Infrastructure; Transport; Business; River; Flood; Search and rescue; Epicentre; Magnitude; Richter scale; Distribution; Location; Pattern; Energy; Projection; Tsunami; Plate; Inner core; Outer core; Mantle; Crust; Fault; Alpine Fault; Design; Homeless; Refugees; Wealth; Eruption; Magma; Lava; Rock; Dormant; Extinct; Cone; Vent; Gas; Cloud; Chamber; Pacific Ring of Fire; Technology; Quality of life; Distribution; Wealth; Gross National Income.

## Connections to the subject content of other curriculum areas

### Language and literacy

Teachers should develop pupils' spoken language, reading, writing and vocabulary as integral aspects of the teaching of every subject. English is both a subject in its own right and the medium for teaching; for pupils, understanding the language provides access to the whole curriculum. Fluency in the English language is an essential foundation for success in all subjects.

#### Spoken language

Pupils should be taught to speak clearly and convey ideas confidently using Standard English. They should learn to justify ideas with reasons; ask questions to check understanding; develop vocabulary and build knowledge; negotiate; evaluate and build on the ideas of others; and select the appropriate register for effective communication. They should be taught to give well-structured descriptions and explanations and develop their understanding through speculating, hypothesising and exploring ideas. This will enable them to clarify their thinking as well as organise their ideas for writing.

#### Reading and writing

Teachers should develop pupils' reading and writing in all subjects to support their acquisition of knowledge. Pupils should be taught to read fluently, understand extended prose (both fiction and non-fiction) and be encouraged to read for pleasure. Schools should do everything to promote wider reading. They should provide library facilities and set ambitious expectations for reading at home.

Pupils should develop the stamina and skills to write at length, with accurate spelling and punctuation. They should be taught the correct use of grammar. They should build on what they have been taught to expand the range of their writing and the variety of the grammar they use. The writing they do should include narratives, explanations, descriptions, comparisons, summaries and evaluations: such writing supports them in rehearsing, understanding and consolidating what they have heard or read.

#### Vocabulary development

Pupils' acquisition and command of vocabulary are key to their learning and progress across the whole curriculum. Teachers should therefore develop vocabulary actively, building systematically on pupils' current knowledge. They should increase pupils' store of words in general; simultaneously, they should also make links between known and new vocabulary and discuss the shades of meaning in similar words. In this way, pupils expand the vocabulary choices that are available to them when they write.

In addition, it is vital for pupils' comprehension that they understand the meanings of words they meet in their reading across all subjects, and older pupils should be taught the meaning of instruction verbs that they may meet in examination questions. It is particularly important to induct pupils into the language that defines each subject in its own right, such as accurate mathematical and scientific language.

### Numeracy and Mathematics

Teachers should use every relevant subject to develop pupils' mathematical fluency. Confidence in numeracy and other mathematical skills is a precondition of success across the national curriculum.

Teachers should develop pupils' numeracy and mathematical reasoning in all subjects so that they understand and appreciate the importance of mathematics. Pupils should be taught to apply arithmetic fluently to problems, understand and use measures, make estimates and sense check their work.

Pupils should apply their geometric and algebraic understanding, and relate their understanding of probability to the notions of risk and uncertainty. They should also understand the cycle of collecting, presenting and analysing data. They should be taught to apply their mathematics to both routine and non-routine problems, including breaking down more complex problems into a series of simpler steps.

# **Key Question:** Why do some earthquakes cause more damage than others?

### Science

Pupils should be taught to:

- Compare and group together different kinds of rocks on the basis of their appearance and simple physical properties.
- Recognise that soils are made from rocks and organic matter.

### Computing

Pupils should be taught to:

- Understand computer networks including the internet; how they can provide multiple services, such as the World Wide Web; and the opportunities they offer for communication and collaboration.
- Use search technologies effectively; appreciate how results are selected and ranked; and be discerning in evaluating digital content.
- Use technology safely, respectfully and responsibly; recognise acceptable/unacceptable behaviour; identify a range of ways to report concerns about content and contact.

*NOTES*

## Ancillary Question 1: Why won't Paula and Richard forget 22 February 2011?

Without mentioning that they are going to be investigating earthquakes, read the letter in **Resource 1** to the pupils. Explain that Paula lives in the United Kingdom but was visiting friends and family in New Zealand in February 2011 during a two month, once-in-a-lifetime trip with her husband Richard. In the letter Paula describes what happened to her and Richard on the day. Give copies of the letter to the pupils and read it through with them several times.

The letter describes the devastation that occurred in the city of Christchurch, which is on South Island (Te Waiponamu) of New Zealand. Encourage discussion and reflection. What kind of things did Paula and Richard witness around them? How did they feel about what they saw? The letter does not say what the cause of this devastation was. What do the pupils think? It is likely that they will speculate that a war or conflict of some kind could be the cause and at some point it is probable that a pupil will mention an earthquake or volcano.

Now read the final paragraph of Paula's letter in **Resource 2** and in particular the phrase: *the ground beneath our feet shakes.* To what is Paula referring here? An earthquake. Before moving on, take time to ensure the pupils can locate New Zealand and the city of Christchurch by revisiting the world map of continents and oceans showing lines of latitude and longitude in **Resource 3**. Also look at the more detailed political map of Oceania in **Resource 4**.

Now project the photographs taken by Paula and Richard in **Resource 5** as they wandered around Christchurch on that day, feeling helpless. Encourage the pupils to make a note of all of the kinds of damage they can see in the photographs that the earthquake caused.

The film at www.youtube.com/watch?v=T32YvlEYS7I shows the actual moment of the earthquake recorded by CCTV cameras. There is also a short film of the immediate aftermath of the earthquake at www.youtube.com/watch?v=alC7JpUuDMI

Use extracts from these films with discretion given that it is difficult to avoid showing injury and trauma – perhaps use with the sound turned off?

## NOTES

### Ancillary Question 2: How has New Zealand been affected by earthquakes in the past?

Explain to the pupils that the earthquake that hit Christchurch in 2011 was not an unusual occurrence – they occur regularly through the country in both North Island (Te Ika-a-Māui) and South Island (Te Waiponamu).

Divide the pupils into pairs and give out the table of data in **Resource 6**. Spend some time familiarising the pupils with the information it contains and ensuring understanding of key vocabulary and geographical terms. What do they think the term *epicentre* means? The location or place on the Earth's surface directly above where an earthquake happens as the rocks move below. What do they think the word *magnitude* means? The size or power of an earthquake, which is measured on a scale of 1 to 10 known as the *Richter scale*. The higher an earthquake records on the Richter scale, the greater the amount of energy it releases when it occurs. From these data sets the pupils can work out the average number of years between serious earthquakes (over 6.0 on the Richter scale) occurring in New Zealand. On the basis of this average, they can make a projection of how long it will be before another serious earthquake occurs somewhere in the country (12.5 years from 2011).

Using a copy of the map of New Zealand in **Resource 7** and the outline map of New Zealand in **Resource 8**, the pupils can now compile their own map of the distribution of earthquakes in New Zealand.

The first thing they need to do is to select five colours for each of the five categories of magnitude in the key on the map.

Next on the outline map in **Resource 8**, the pupils should locate and label the names of the epicentres of each earthquake in the table in **Resource 6**.

Finally they should colour code the names of each of the epicentres on the map with the correct colour from their key according to its magnitude on the Richter scale. For example, if they have chosen red to signify all earthquakes with a magnitude of between 8.1 and 8.5, then they should shade over the Wellington label in red and so on for all of the epicentres.

The pupils can then be asked to consider the pattern or distribution (how something is spread out over an area) of the earthquakes in New Zealand since 1848 – are they mostly in North Island (Te Ika-a-Māui) or South Island (Te Waiponamu) or around the coast or inland etc.? After discussion and feedback the pupils can use bullet points to sum up three things that they have observed about the earthquake pattern.

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## Ancillary Question 3: Why does New Zealand have so many earthquakes?

Give the pupils copies of the maps in **Resources 9** and **10**. **Resource 10** shows the location of major earthquakes to hit the world since 1900 as green circles of different size and colour. The map projection will be different from what the pupils are familiar with as it is centred on the Pacific Ocean. Ask the pupils to locate New Zealand on both maps. Their immediate reaction will be that on the earthquakes map it is impossible to see the outline of New Zealand as it's completely covered with earthquake location symbols. What do the pupils observe about where earthquakes occur in the world? Do they occur everywhere? What about the United Kingdom? Clearly they happen in some places and not others – mostly within the earthquake zones shown in light green on the map. Do the pupils have any ideas about what causes earthquakes?

To progress their thinking give the pupils copies of the map of plate boundaries in **Resource 11**. Do they have any idea what a *plate* is? Using the diagram of the structure of the Earth in **Resource 12** explain that the very thin (on average only 40 km thick) outer layer of the Earth called the *crust* is broken up into huge blocks called plates – rather like the shell of a hard-boiled egg when it is tapped with a spoon (this can be demonstrated to the pupils!) What do the pupils notice about New Zealand in the map of plate boundaries in **Resource 11**? They should be able to see clearly that the country sits right on top of the crack between one plate and another – which two plates? Earthquakes tend to occur mostly along the cracks or boundaries all around the world where one plate meets another. Geographers call these cracks *faults*. The fault between the Indo-Australian Plate and Pacific Plate runs through New Zealand and is known as the *Alpine Fault*.

The plates of the Earth are not stationary but move very slowly in different directions. In New Zealand the Indo-Australian Plate and Pacific Plate are crashing into each other head on as shown in **Resource 13**. Beneath North Island (Te Ika-a-Māui) of New Zealand the rocks of the Pacific Plate are being squeezed underneath the rock of the Indo-Australian Plate. Beneath South Island (Te Waiponamu) the opposite is happening. See the film at www.youtube.com/watch?v=aQTfFCMYEI4

When one plate plunges below another in this way the rocks are forced to bend and grind against each other. When the rocks 'stick' together, huge stresses build up until they slip apart causing massive amounts of energy to be released as they do so. The surface of the Earth above is shaken or 'quakes', thus *earthquake.* The pupils can show that they are able to explain why New Zealand has so many earthquakes by making a short PowerPoint presentation using any of the photographs and maps that they have used or created so far in the first three ancillary questions.

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## Ancillary Question 4: Why don't the largest earthquakes always cause the most death and destruction?

Explain to the pupils that earthquakes are very common. Every day across the world there are on average about 250 earthquakes measuring 1–2 on the Richter scale (only noticeable by sensitive scientific recording instruments). Major earthquakes measuring 7–8 occur on average once a month and a large earthquake of 8 or more once a year. As we have seen at Christchurch the effect of earthquakes can be devastating but not all earthquakes have the same impact. Divide the pupils into pairs and ask them to think about what might affect the damage that an earthquake might do. The four things that you want them to consider are:

- The power or magnitude of the earthquake. On the Richter scale each step up is ten times more powerful than the one below. For example, the energy released by a magnitude 7 earthquake will be 10 times greater than an earthquake measuring 6.
- Where an earthquake happens e.g. below a city, in the middle of an ocean or somewhere remote where few people are living.
- The time of day or night that it happens.
- How rich or poor the country is, in which the earthquake happens.

Encourage feedback and discussion about each of these points.

Generally speaking the larger the earthquake on the Richter scale, the greater the damage is likely to be and so this is a good early indication. Where an earthquake happens is really important. A magnitude 7.5 earthquake occurring below a city will probably do more damage than a 7.5 earthquake occurring in the middle of an ocean or somewhere where there are few people living. The time that an earthquake happens can also have an influence. If it happens at night when everyone is at home then the result can be more serious than say, if it occurred during the middle of the day.

Rich countries tend to suffer less from similar-sized earthquakes than poorer ones. This is because they can afford to design and construct buildings that are stronger and can resist the shaking caused by earthquakes. Poorer countries may only be able to afford cheaper and weaker building materials.

The richer a country is, the more likely it is that emergency drills will be in place for people to follow when earthquakes hit and also have well-trained search and rescue services to hand. A very good example of this is the 7.0 earthquake that hit Haiti in 2010 (in terms of wealth Haiti ranks 176 out of 198 of the countries of the world – the 23rd poorest country). See the maps in **Resource 14** and **Resource 15** and the photographs in **Resource 16**. An estimated 220 000 people died, 188 000 homes were destroyed and 1.5 million people were made homeless. This was largely due to the poor design and construction of buildings. For example, cement with too much sand in it and multi-storey buildings too close together. In addition to this, the rescue and medical services were inadequate for the scale of the disaster – they were overwhelmed by the scale of the disaster.

Compare this with the 2010 earthquake close to the city of Concepción in Chile which had a magnitude of 8.8 (500 times stronger than the Haiti earthquake). It resulted in 525 deaths – see the map in **Resource 17** and the photographs in **Resource 18**. As a more prosperous country (the 51st wealthiest country in the world) Chile was able to design and build stronger buildings which, although damaged (as can be seen in the photographs), did not collapse. In addition the population knew what to do in the event of an earthquake and where the safe places to go to were. Rescue services were well trained and how to find people quickly who may have been buried.

As a summative piece to this line of enquiry the pupils can design and draw a poster called: *Why the Haiti earthquake caused so much more destruction than the earthquake in Chile.* The pupils can design this as they wish using maps, photographs, flags etc. but the poster must include enough written annotation in the way of labels to show they understand why the impact was so much greater in Haiti than in Chile.

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## Ancillary Question 5: Why do most volcanoes happen in the same places as earthquakes?

Show the pupils the map in **Resource 19**. This is a map of New Zealand showing ten volcanoes in North Island (Te Ika-a-Māui). So, as well as experiencing a lot of earthquakes, the country also has active volcanoes (volcanoes that have erupted within living memory). Some are shown in **Resource 20**.

So, how does a volcano form? Show the pupils the two films at www.youtube.com/watch?v=Be7o6BYVOzA and www.youtube.com/watch?v=WgktM2luLok

Now give the pupils a copy of the map of the distribution of volcanoes in **Resource 21** and ask them to compare it with the map of earthquakes in **Resource 10**. What do they notice about the pattern of volcanoes compared with earthquakes? They are very similar. Most earthquakes tend to occur where earthquakes are frequent. Why is this? What did the two films tell us about how volcanoes form? Red-hot liquid rock called magma rises up through cracks in the rocks of the Earth's crust and erupts out onto the surface as lava. The biggest cracks are where one block or plate of the Earth's crust meets another, such as between the Pacific Plate and Indo-Australian Plate through the centre of New Zealand.

Based on the films and the knowledge they have gained from studying New Zealand, support the pupils to describe and explain six stages in the formation of a volcano using the storyboard template in **Resource 22**.

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## Assessment

This enquiry presents several opportunities to evaluate at different stages how the pupils are progressing in geography through the mastery of key geographical skills and outcomes. It is not necessarily intended that all of the following learning activities should be assessed. Rather the list can be used as a general guide for selecting perhaps one or two assessment opportunities relevant to individual pupils rather than on a whole group basis.

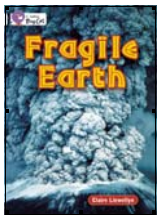
| Ancillary Question | Learning Activity | Possible source of evidence of achievement |
|---|---|---|
| 1 | **Locate** and **describe** the effects of the Christchurch earthquake of 2011 from a range of sources | Labelled map<br>Oral<br>Bullet point list |
| 2 | **Observe** and **record** the distribution of earthquakes in New Zealand over the past two hundred years | Map with colour key |
| 3 | **Identify**, **describe** and **explain** the causes of earthquakes | Annotated cross-sectional diagram |
| 3 | **Describe** and **explain** why New Zealand experiences earthquakes when they don't occur at all in many other areas of the world | Short PowerPoint presentation |
| 4 | **Understand** through **explanation** and **reaching conclusions** why the most powerful earthquakes in the world do not necessarily cause the most deaths and destruction | Poster |
| 5 | **Identify**, **describe** and **explain** the causes of volcanoes | Storyboard |
| 5 | **Explain** why volcanoes often occur at the same location as earthquakes in places such as New Zealand | Piece of explanatory writing |
| Homework | **Locate**, **describe** and **explain** why so many earthquakes and volcanoes occur around the Pacific Ring of Fire | Short report |

## Homework possibilities

To run in conjunction with the enquiries that the pupils are carrying out at school, a possible area of research could be the *Pacific Ring of Fire*. This encompasses the coastal areas of the land masses adjoining the Pacific Ocean along which 90 per cent of all earthquakes and 75 per cent of all active volcanoes occur. The pupils could produce a short report that locates the area with appropriate maps and identifies why so many volcanoes and earthquakes occur here. The pupils can draw upon their knowledge and understanding (particularly of where tectonic plates meet) emanating from the class-based enquiries to support this task.

## Further reading

Collins *Big Cat* has books for every child in the classroom with a wide variety of genres, top authors, relevant topics and a range of engaging formats and illustrative styles. Listed below is a selection of from the Big Cat list to support the enquiry topics in Connected Geography for KS1. Find out more at Collins *Big Cat* – www.collins.co.uk

| | | | |
|---|---|---|---|
| ISBN: 978-0-00-723110-2 | *Fragile Earth* | Claire Llewellyn |   |

Collins *Primary Geography* provides a progressive, skills based scheme for primary school pupils.

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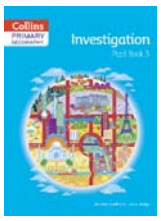
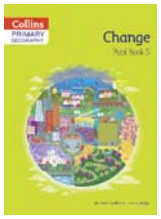
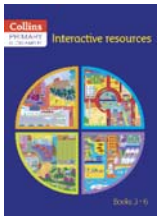
|---|---|---|---|
| ISBN: 978-0-00-756359-3 | *Primary Geography Pupil Book 3 Investigation* | Stephen Scoffham and Colin Bridge |   |
| ISBN: 978-0-00-756360-9 | *Primary Geography Pupil Book 4 Movement* | Stephen Scoffham and Colin Bridge |   |
| ISBN: 978-0-00-756361-6 | *Primary Geography Pupil Book 5 Change* | Stephen Scoffham and Colin Bridge |   |
| ISBN: 978-0-00-756362-3 | *Primary Geography Pupil Book 6 Issues* | Stephen Scoffham and Colin Bridge |   |
| ISBN: 978-0-00-756369-2 | *Primary Geography Interactive resources 3-6* | |   |