

Lesson 6: Earthquakes

Lesson Plan

Use the *Earthquake* PowerPoint presentation in conjunction with the Lesson Plan. The PowerPoint presentation contains photographs and images and follows the sequence of the lesson. The *factsheet for teachers* to accompany this lesson also explains some of the key points in more detail. It is expected that the places mentioned in the Lesson Plan will be located on Google Earth, or by using an atlas.

Key questions and ideas

- What is an earthquake?
- Where do earthquakes happen?
- What is the role of plate tectonics in the formation of earthquakes?
- To understand that earthquakes have different magnitudes and these impact differently.
- Where are California and the San Andreas Fault?
- To understand the significance of the San Andreas Fault on the landscape and people of California.
- What are the potential dangers of the San Andreas Fault in the future?

Subject content area

- Locational knowledge: Using maps to focus on North and South America, concentrating on key physical and human characteristics.
- Place knowledge: Understand geographical similarities and differences through the study of a region within North and South America.
- Physical geography: Describe and understand key aspects of physical geography, including earthquakes.
- Geographical skills and fieldwork: Use maps and digital/computer mapping to locate countries and describe features studied.

Downloads

- Earthquakes (PPT)
- Factsheet for teachers PDF | MSWORD
- Japan Earthquake Case Study PDF | MSWORD
- Examples of children's work 1 (PDF)
- Examples of children's work 2 (PDF)
- Examples of children's work 3 (PDF)
- Examples of children's work 4 (PDF)
- Examples of children's work 5 (PDF)
- Examples of children's work 6 (PDF)

Additional links:

An animated guide on why earthquakes occur, how they are measured and why tsunamis can result can be found on the Guardian website:

<http://www.theguardian.com/world/interactive/2008/jan/23/earthquakes?intcmp=239>

Starter

Show a picture of the after effects of the earthquake in Folkestone, Kent, on 28th April 2007. The earthquake had a magnitude of 4.3 on the Richter scale. Do not contextual the information. Pupils should identify enquiry questions: who, what where, why? What is the evidence? The *factsheet for teachers* contains background information on this earthquake.

Pupils may assume that the damage on the photograph is a product of stormy weather, the collapse of a badly built structure or vandalism.

Discuss that earthquakes in the UK are infrequent, but can happen. In fact, between 200 and 300 earthquakes are detected in the UK, by the British Geological Survey every year. The risk from these earthquakes is not insignificant.

To find out the last earthquake occurrence in the UK visit the British Geological Survey site: http://www.earthquakes.bgs.ac.uk/earthquakes/recent_uk_events.html You will be surprised how many earthquakes there are.

Main Teaching

What is an earthquake? An earthquake is simply a vibration of the Earth's crust. Every thirty seconds there is an earthquake somewhere in the world. Some earthquakes are barely detected while others cause immense damage and loss of life.

Where do earthquakes occur? Like volcanoes, earthquakes mostly occur along plate boundaries. As we know the plates are not motionless but move across the mantle.

Ask pupils if they can remember the types of plate boundaries discussed in the last lesson. Remind them if necessary that at constructive plate boundaries two plates move apart from each other, and as they do so molten rock bubbles up between the plates and then hardens to form new crust. Iceland was an earlier example of volcanic activity at a constructive plate boundary. At destructive plate boundaries two plates move towards each other, or converge. The heavier plate is forced below the lighter plate. Mount Etna in Sicily was an earlier example of a volcano formed at a destructive plate boundary. (Japan's 2011 earthquake, as detailed in the accompanying case study, also occurred at a destructive plate boundary).

You may like to show pupils, once again, the interactive map of the world detailing the major tectonic plates, volcanoes and earthquakes. Go to the Geological Society website: <http://www.geolsoc.org.uk/Plate-Tectonics>

Transform plate boundaries: Show pupils the diagram of a transform plate boundary and explain that earthquakes are also very common at transform plate boundaries. Here, rather than moving apart or towards each other, the two plates move **past** each other. Friction may cause them to stick, but when they eventually become unstuck, often with a violent jolt, it can cause an earthquake.

The Focus and Epicentre: (Show pupils the image of the structure of an earthquake). The focus of an earthquake is the point deep underground where the earthquake begins. The epicentre is the point on the Earth's surface that is immediately above the focus. When the earthquake is triggered by the jolting of tectonic plates, shock waves (called seismic waves) immediately spread out in all directions from the focus. They spread for many kilometres, but their intensity reduces with distance; the closer to the epicentre, the greater the impact of the seismic waves.

How is the power of an earthquake measured? The 'power' or strength of an earthquake is called its **magnitude**. The **Richter scale** is a measurement of the magnitude of an earthquake. Earthquakes with the highest magnitude have a measurement on the Richter scale of 9. Not all earthquakes can be felt by people on the ground, earthquakes with a magnitude of less than 3 are so faint that they can only be detected by seismographs (a type of measuring and recording instrument). Earthquakes with

magnitudes of 5 cause cracks to appear in walls and bricks to fall. With a magnitude of 9, an earthquake is a severe, often catastrophic event. An earthquake of this scale will cause widespread destruction and leave many people injured or dead.

Can earthquakes be predicted? Although it is known that most earthquakes occur at the plate boundaries, there is no reliable method of predicting the exact time, place or magnitude of an earthquake. This means it is hard to evacuate an area prior to an earthquake and instead a lot of effort has been put into ensuring that new buildings are constructed to withstand an earthquake; that people know what to do in the event of an earthquake and that warning systems are in place.

The San Andreas Fault

The San Andreas Fault marks the boundary between two tectonic plates: The Pacific plate and the North American plate. This is a transform plate boundary; the Pacific plate (on the west) moves in a north westerly direction, relative to the North American plate (on the east). This causes earthquakes along the fault. The entire San Andreas Fault is 1287 km long (800 miles) and reaches to depths of 16 km (10 miles). In places the Fault is 1.5 km wide (1 mile).

The San Andreas Fault extends from northern California (on the west coast of USA) southwards to Cajon Pass near San Bernardino. From Cajon Pass the main San Andreas Fault branches into smaller fault lines.

Show pupils the map of the location of the San Andreas Fault, or use Google Earth. Also show pupils the photographs of the Fault.

The plates move, on average, 6 cm each year. If a person stood on one side of the Fault and looked across it, features on the opposite side would appear to have moved to the right. Show pupils the photograph of the displaced fence to illustrate the effect of this movement on the small scale.

Geologists believe that the total displacement (movement) along the Fault is at least 563 km (350 miles) since the San Andreas fault came into being about 15-20 million years ago.

The 1906 San Francisco earthquake: Thousands of small earthquakes occur in California each year. Large, highly destructive earthquakes, however, occur on average once every 100-150 years along the Fault. The San Francisco earthquake of April 18, 1906 was the most recent of these. It is estimated to have had a magnitude of 8.3 on the Richter scale and lasted for one minute. It resulted from a displacement, or movement, of the Fault by 6 metres. Damage was caused by both the earthquake and by the fire that swept through the city afterwards. Nearly eight square kilometres and 28 000 buildings were destroyed resulting in millions of dollars in damage. Seven-hundred people were killed and thousands were left homeless. Show pupils the photographs of the aftermath of the earthquake.

The 1989 Loma Prieta earthquake: A segment of the San Andreas Fault ruptured under the Loma Prieta peak in the Santa Cruz Mountains, northern California. The earthquake, with a magnitude of 6.9 on the Richter scale lifted the mountains themselves and then sent seismic waves 16km away from the epicentre, towards the city of Santa Cruz. When the seismic waves reached San Francisco, the upper deck of a section of Oakland's Interstate 880 collapsed. More than 40 slabs of concrete, each weighing 500 tonnes, fell onto the cars below. In San Francisco's Marina district mud and sand was shaken to form viscous liquid that acted like quicksand and caused buildings to become unstable and collapse. In total 28 000 homes and businesses were destroyed, 3 800 people were injured and 63 people died. Show pupils photographs of the aftermath of the earthquake.

The Big One: This is a hypothetical earthquake with a magnitude of 8 or greater that is expected to happen along the San Andreas Fault. See the Factsheet for more information.

For an up to the hour map of earthquakes on the west coast of USA visit the USGS website:
<http://earthquake.usgs.gov/earthquakes/map/>

Main Activity

Pupils will design a board game. This might be in the style of Monopoly, Snakes & Ladders or one of their own devising. To progress in the game players will need to correctly answer questions on earthquakes. Incorrect answers will result in being 'sent back' several places etc.

The board games should be colourful and eye-catching, but decorated with topic-specific pictures, diagrams and maps.

High ability pupils will be expected to devise harder questions for their game; they may also write additional questions in chance/community chest-style cards. The geographical detail of the decorations will also be more thorough.

The board game could also cover other aspects of the module as the class teacher decides.

Plenary

'Let's be Seismologists!'

The class teacher defines the effects of an earthquake. From the evidence, pupils have to deduce its measurement on the Richter scale. Use the information on the Richter scale in the *factsheet for teachers* to help you.