New Zealand's Plates

What's happening with New Zealand's plates?

Introduce the world map and make sure students can locate and name the continents, the Pacific and Atlantic Oceans and New Zealand.

What do the dots and triangles on the world map represent? Large earthquakes and active volcanoes

If you draw lines linking up the darkest areas of dots what will that show? The edges of tectonic plates. Earthquakes and volcanoes happen mostly when plates collide.

Activity

• On individual world maps join all the dots around the Pacific Ocean by drawing a line through them. Label the Pacific Plate boundary (also known as the 'Ring of Fire')

• Join the dots above Australia and label the Australian Plate boundary.

Discuss

There are some lines of dots that are not so dark. What might they be? Sea floor spreading ridges where new crust is being made. The earthquakes here are less frequent and less violent. They could also be micro plate boundaries.

Activity

• Join the dots down the middle of the Atlantic Ocean and across the southern Pacific Ocean and label as sea floor spreading ridges.

Discuss

What happens in these sea floor spreading areas?

New plate material is made by magma welling up from the mantle and creating new crust.

What does the map show us about New Zealand?

We are on a plate boundary.

What happens to the Pacific Plate under the North Island and what is this process called?

It sinks under the Australian Plate and the process is called subduction.

Activity & Discussion

- Using the modelling materials from the previous lesson create a blue oceanic plate and a green continental plate.
- Lay these side by side (blue Pacific Plate to the right) and place the NZ map on top

• Mould the two plates so that the plate boundary on the map matches the bluegreen join underneath.

How could you show subduction with your model?

• Push the blue plate under the green plate. Adjust the plasticine to ensure the edges still match the plate boundary when you overlay the paper map of New Zealand.

What happens to the oceanic plate as it sinks down into the mantle?

The oceanic plate carries water and sediments with it as it descends. This lowers the melting point of the surrounding rock and parts of the descending plate may melt to form magma.

What will happen if the magma can find a way back to the Earth's surface? A volcano may form

- Use red playdough to cover part of the downward moving tip of the blue plate. The red playdough represents magma.
- Mould a small volcanic cone or caldera on the top surface of your model to represent the volcanoes formed by the subduction happening below.
- Make labels and photograph your model.
- Write an explanation of subduction to accompany your photograph.



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Learning Intentions

- Explain the connection between earthquakes, volcanoes and plate boundaries
- Identify the location of NZ's plate boundary
- Make a model of subduction

Success Criteria

Students can

- Correctly name the two plates involved in New Zealand's tectonic processes
- Show on a map the approximate location of the plate boundary running through New Zealand.
- Create a subduction model and explain it verbally and in writing

Resources

- Earthquake and Volcanic Eruptions World Map
- Modelling materials from previous lesson
- NZ Map with plate boundary and plate names.
- Camera

New Zealand's Plates What's happening with New Zealand's plates?

New Zealand's volcanoes and earthquakes happen because we are in the collision zone where the edges of two plates meet (converge). When major earthquakes and

zone where the edges of two plates meet (converge). When major earthquakes and volcanoes are plotted on a world map they reveal that New Zealand is part of a huge 'ring' of volcanic and earthquake activity. The plate boundaries around the Pacific Ocean are the most active in the world and this area is often referred to as the 'Ring of Fire'. Although the Pacific Plate is the world's largest tectonic plate, the South Island is the only significant area of land on the whole plate making it a truly oceanic plate.

The collision zone (plate boundary) can be seen on the poster set map as a dark line running from Tonga, down past East Cape, curving towards the South Island south of Wellington, running along the alpine spine of the South Island and back out to sea south of Milford Sound.

The edges of the Pacific and Australian Plates which meet under New Zealand are not straight lines so the collision zone does not behave the same way along its whole length. Also the convergence is not perpendicular to the plate boundary and there is rotation of the plates, so it is quite a complex boundary.

To the east of the North Island the heavy, oceanic Pacific Plate is sinking below the lighter, continental Australian Plate. This is called subduction. The oceanic plate sinks deeper and deeper into the mantle getting about 25°C hotter for every kilometre it sinks. Eventually parts of the down going edge of the oceanic plate melt and produce magma. The magma is hotter and lighter (more buoyant) than surrounding mantle rocks and may find its way back to the surface of the Earth through weaknesses in the overlying crust. When this happens volcanoes are formed.

Subduction can have a variety of results including earthquakes, volcanoes and geothermal systems. They are all a result of the friction and pressure created by the heavy plate sinking back into the hot mantle below.

Because the plates are relatively rigid, subduction is not a smooth process. Plates may be locked together by friction for thousands of years while the pressure builds up and the crustal rock slowly deforms. When the pressure exceeds the strength of the rocks, the friction is overcome and the crust will 'snap' suddenly, resulting in large subduction earthquakes.

Along the Alpine Fault in the South Island the plate boundary behaves differently because the edges of the plates are meeting at a different angle and they both have landmasses on top. In this area the Pacific Plate and the Australian Plate are sliding past each other and the grinding of the edges is pushing up the Southern Alps. This type of movement is called a transform fault and it creates a distinct line in the landscape. The Alpine Fault when viewed from space is one of the longest and straightest lines on the surface of the Earth. About 10 million years ago bits of Nelson and bits of Otago were next to each other. If the plates continue to move at their current average speed of 35mm/year Christchurch and Milford Sound will be at the same latitude in another 10 million years. By then it may be possible for tourists to visit Haast and Mt Cook almost simultaneously.

At the south of the South Island subduction begins again but here it is the Australian Plate which is subducting under the Pacific Plate. In this area the Australian Plate has no land mass on top while the Pacific Plate is topped by the South Island. New Zealand's largest earthquake in 80 years (magnitude 7.8) on July 15 2009 was caused by movement along the interface of the two plates in this area.

If the Australian Plate is sinking back into the mantle why then are there no active volcanoes in this area? It is possible that this subduction zone is too young and volcanoes may occur as the plate sinks further.



Curriculum Links

Planet Earth and Beyond

Physical World

Science Concept	NOS
PE-Earth Systems L3/4 -develop an understanding of what makes up our planet PW-Physics Concepts L1/2-explore physical	Understanding about Science Investigating in Science
phenomena such as movement, forces and heat.	Communicating in Science

Alternative Modelling Material

If you used bread and butter in the previous lesson you can now add jam to represent magma forming on the descending plate. Once students have got the idea, press the slices together and you have a jam sandwich!

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Does subduction happen along the whole plate boundary in New Zealand?

No.

Subduction only happens north of Marlborough and south of Milford Sound. These two subduction areas are joined together by the Alpine Fault. In this area the two plates slide past each other rather than one sinking below the other.

What happens to the continental plate as the oceanic plate slides below it?

You may notice when you make the model that one or both plates are altered as you push one below the other. As pressure is applied, friction builds up and the plates may begin to 'buckle up' or even develop cracks. This illustrates the mountain building and earthquakes associated with subduction zones. Because of the friction involved both plates spend most of their time locked in position. When the pressure on the rocks becomes too great they jerk along suddenly causing earthquakes. Because the plates are constantly being moved along by the convection currents in the mantle pressure keeps building up until once again the crust cannot stand the strain and another earthquake occurs. In other words the pressure of the sliding action between the two plates deep underground is seen on the surface as cracks (faultlines) in the landscape.



Cross section of subduction identifying subduction earthquake zone.

What sort of earthquakes does subduction cause?

The biggest subduction earthquakes happen closest to the Earth's surface. Fortunately as the oceanic plate descends further and further into the hot mantle it becomes easier for one plate to slide across another without the locking and jerking that occurs closer to the surface. In addition to these subduction earthquakes which happen at the interface between the plates there are earthquakes which release the pressure within each plate. These are shown by bends or cracks in the surface of the continental plate in your model.

How are subduction trenches formed?

Something else your model may reveal is a trench (downward dip) at the point where the two plates touch. This illustrates the long deep undersea valleys that occur when one plate descends beneath the other. As the heavy plate sinks it depresses the Earth's surface creating a trench. The trenches are the plug holes down which material on the Earth's surface is drawn or sucked back into the Earth's interior. In New Zealand the Hikurangi Trough running up the East Coast of the North Island becomes the Tonga-Kermadec Trench and clearly reveals the plate boundary.

Depending on how much pressure you applied some of your continental plate may have been scraped off by the down going plate and dragged down on top of your blue plate. This happens to real plates and carries some continental crust material down into the mantle. These materials have a big influence on the type of volcanoes which may be formed above.

Or the reverse may have happened, some of the downgoing plate may have rubbed off onto your green plate. With real plates this would be seafloor sediments being scraped off the descending plate and added to the continental plate.

For more explanations of plate tectonics and types of plate boundaries see:

http://www.montereyinstitute.org/noaa/

(lessons 2 & 4 include excellent short videos and interactive activities that will extend able students)

http://www.sio.ucsd.edu/voyager/earth_puzzle/recycling_plates.html

http://pubs.usgs.gov/gip/dynamic/understanding.html

http://www.gns.cri.nz/what/earthact/crustal/index.html

http://www.sciencelearn.org.nz/contexts/earthquakes/ science_ideas_and_concepts/plate_tectonics

An excellent map can be found at http://mineralsciences. si.edu/tdpmap/

Which way are New Zealand's plates moving and how fast?

The Australian Plate is moving north and the Pacific Plate is moving west but of course the plates are moving on a sphere not a flat surface. So it is best to imagine the Pacific Plate as a huge cogged wheel rotating anti-clockwise into a relatively stationary Australian Plate. As the wheel turns different points have a different angle and speed of convergence, causing subduction in the north and south and a transform fault in the middle. The Pacific Plate moves on average 3-4cm/year (30-40mm/year).



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Activity sheet 6





Name: