
Cracked Plates

Audience: Year 11 Geography, Science. Year 12 Earth Science

Time Required: 15 minutes

- Activity:** In this activity, students investigate dynamics in the earth's crust that explain multiple Earth Science phenomena.
- Standards:** NZ Curriculum standards for which this inquiry may provide background Geography AS 91007
- natural processes that operate to produce the extreme natural event(s)
- Level 1 Science AS90952
- formation of volcanoes or mountains due to collisions between the Pacific plate and Australian plates
 - lateral movement along tectonic plate boundaries
- Earth Sciences
- 91189 describing the plate tectonic and rock cycle processes that have formed the types of rocks in the locality
 - 91191 Demonstrate understanding of the causes of extreme Earth events in New Zealand
- Learning Outcomes:** Students will
- explain the pattern of earthquakes globally to gain insight about the driving forces that cause them.
 - explore ways that large plates of the crust interact when they meet.
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Map URL: <http://arcg.is/14qiye>

Engage

Can earthquakes occur anywhere on the earth?

- Click the map URL link above to launch the map.
- ? Where have students heard of earthquakes occurring?
- ? Is there a pattern to the quakes that students have heard about? *[Many will think of "The Ring of Fire."]*
- With the Details pane visible, click the button, Show Contents of Map.
- Turn on the layer, Global Quakes Of Large Magnitude 5.8 Or Greater.
- ? What patterns are visible where quakes occurs? *[A common misconception is that quakes occur just around continents or oceans. Help students recognize that quakes define plates around both sections of continents and oceans together. There are exceptions, of course (for example, the Pacific.) There are also some earthquakes in the middle of tectonic plates.]*
- ? What is happening to the area within a ring of earthquakes? *[This area moves as one piece, so no collisions are happening inside a single piece of crust called a plate.]*

Explore

How many different ways can you be in motion?

- Turn on the layer, Relative Motion At Plate Boundaries.
- Note that you will not see anything until you perform the next step.
- Press the button, Bookmarks.
- Select each bookmark and describe the plate movement at the bookmark. *[South America and the Kermadec Trench north east of NZ would have a direct collision, California and south of NZ would have a side swipe, and Mid Atlantic would be torn apart.]*

Explain

What are these types of plates called?

- Earthquakes occur where large pieces of the earth's crust run into, pull away from, or slide against other pieces of independent crust.
- Turn on the layer, Plate Boundaries.
- Click the Plate Boundaries layer name so you can see its legend.
- Choose each bookmark in turn (South America, California, New Zealand and Mid Atlantic Ridge).
- ? What are plates that collide head-on called? *[Convergent.]*
- ? What are boundaries called where plates are stretched apart? *[Divergent.]*
- ? What are boundaries called where plates are in a side-swipe collision? *[Transform.]*
- Turn off the layer, Global Quakes Of Large Magnitude 5.8 Or Greater.

Elaborate

How are earthquakes distributed differently at each plate boundary type?

- Turn on the layer, New Zealand Quakes by depth 1930-2017.
- ? Do these earthquakes occur only at the boundary between plates? [No, they spread out - on one direction.]
- ? In what direction do the earthquakes become deeper? Comment on the pattern you see. *[Earthquakes in North Island are orientated NE-SW and are deeper as you move to the West]*
- ? Suggest a hypothesis for what is happening to these colliding earthquakes. *[Because quakes happen where plates touch and only on the continent side, The North Island must be on top of the Pacific crust. The Pacific plate must be going under the Australian plate]*
- ? Ask students to fill in the three row table with where earthquakes occur compared to plate boundary types.
- You will need to turn on the plate boundary theme and turn off the New Zealand Quakes by depth 1930-2017

(Repeat the steps above for divergent and transform boundaries.)

<i>Convergent</i>	<i>Quakes compared to boundary</i>	<i>Pattern of depths of quake</i>
	<i>Only one side</i>	<i>Gets deeper under continent</i>
<i>Divergent</i>	<i>Close boundary</i>	<i>More shallow but random</i>
<i>Transform</i>	<i>Both sides of boundary</i>	<i>Mixed depths but random</i>

Evaluate

Which type of boundary occurs along the South Alps?

- Turn on the layer, New Zealand Quakes by depth 1930-2017? Determine which type of plate boundary occurs here based on your table. *[This is a transform boundary.]*
- Turn on the layer, New Zealand Quakes by magnitude 1930-2017.
- ? What do you notice about the pattern of earthquakes in relation to the South Alps region? What might this suggest? *[No recent earthquakes have occurred on this transform boundary. Seismic pressure may be building]*
- Read about the Alpine Fault <http://bit.ly/2nilkU9>
- ? How seriously would you evaluate the risk of a major earthquake on this fault to be?

Key Skills

Measure

- Click the button, Measure.
- Click the Distance button. Choose unit of measurement.
- Click once on the map to start measurement. Click again to change direction. Double click to stop.

Bookmark

- Click the button, Bookmarks.
- Choose a bookmark.
- The map move to the location and scale set in the book- mark

Next Steps

DID YOU KNOW?: ArcGIS Online is a mapping platform freely available to New Zealand public and private schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.eagle.co.nz/gis-schools>.

THEN TRY THIS...

- Explore the 2015 Nepal earthquakes with the story map at <http://esriurl.com/Geo519>.
- Log in to the school's ArcGIS Online organizational subscription. Use Analysis tools to identify patterns in either the depth of earthquakes or the time of their occurrence.

Text References

- Motion of tectonic plates <http://arcg.is/2n7rMO8>
- Anderson, Lois. Nature's Fury Pearson NZ (2012)
- Peat, Justin, Lockyear. Geography on the Edge Level 1 Year 11 Geography (second edition) Cenage (2012)

NEW ZEALAND GEOINQUIRIES

<http://arcg.is/1GPDXe>