



# Cracked plates

Target audience – Earth Science, grades 6-9

Time required – 15 minutes

## Activity

In this activity, students investigate dynamics in the earth's crust that explain multiple Earth Science phenomena.

## Science Standards

NGSS:MS-ESS2-1 – Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

## Learning Outcomes

- Students will explain the pattern of earthquakes globally to gain insight about the driving forces that cause them.
- Students will differentiate ways that large plates of the crust interact when they meet.

Map URL: <http://esriurl.com/earthgeoinquiry6>



## Engage

### Can earthquakes occur anywhere on the earth?

- Click the map URL link above to launch the map.
- ? Where have students have 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).]*
- ? 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 crash your car?

- 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 would have a direct collision, California 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, 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.

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## Elaborate

### How are earthquakes distributed differently at each plate boundary type?

- Turn on the layer, South American Quakes.
- Hover the mouse over the layer name, South American Quakes.
- Click the button, Change Style.
- Change the attribute (#1) from Show Location Only to Depth\_km.
- The new symbology draws dots larger according to how deep quakes occur. Click Done to apply these changes.
- ? Do these earthquakes occur only at the boundary between plates? *[No, they spread out - on one direction.]*
- ? Suggest a hypothesis for what is happening to these colliding earthquakes. *[Because quakes happen where plates touch and only on the continent side, South America must be on top of the Pacific crust.]*
- ? Ask students to fill in the three row table with where earthquakes occur compared to plate boundary types. (Repeat the steps above for divergent and transform boundaries.)

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

## Evaluate

### Which type of boundary separates the Caribbean and the Gulf of Mexico?

- Turn on the layer, Caribbean Quakes.
- ? Determine which type of plate boundary occurs here based on your table. *[This is a transform boundary.]*

#### MEASURE

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

#### BOOKMARK

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

## Next Steps

**DID YOU KNOW?** ArcGIS Online is a mapping platform freely available to U.S. public, private, and home schools as a part of the White House ConnectED Initiative. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://connected.esri.com>.

### 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 depth or time.

## TEXT REFERENCES

This GIS map has been cross-referenced to material in the plate tectonics sections of chapters from middle-school texts.

- *Earth Science by Glencoe McGraw Hill – Chapter 5*
- *Earth Science by McDougal Littell – Chapter 1*
- *Earth Science by Prentice Hall – Chapter 7*
- *Earth Science by Tarbuck and Lutgens – Chapter 7*