



LEVEL

2

# Mountain Building: Volcanoes

from the Geolnquiries™ collection for Earth Science

Target audience – Earth science learners

Time required – 30 minutes

<b>Activity</b>	Analyze the relationship that mountains and volcanoes have with tectonic plate boundaries.
<b>Science Standards</b>	MS-ESS2-2. Earth's Systems. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
<b>Learning Outcomes</b>	<ul style="list-style-type: none"><li>• Students will calculate the movement of tectonic plates.</li><li>• Students will identify active mountain ranges.</li></ul>
<b>Level 2 Geolnquiry Requirements</b>	<ul style="list-style-type: none"><li>• A free school ArcGIS Online organization account. Instructors or students must be signed in to the account to complete this activity.</li><li>• Approximately 1.8 credits will be used per person in the completion of this activity as scripted.</li></ul>

Map URL: <http://esriurl.com/earthGeolnquiry9>

## Engage

### How far have the Appalachian Mountains moved?

- Click the link above to launch the map.
- In the upper-right corner, click Sign In. Use your ArcGIS Online organization account to sign in.
- With the Details button underlined, click the button, Content (Show Contents of Map).
- Ensure that only two layers are turned on: Tectonic Boundaries and World Mountain Ranges.
- The Appalachian Mountains were formed long ago by the collision of North America and Africa at an active plate boundary. Today, there is an entire ocean separating them.
- Using the Measure tool, find how far to the east of the Appalachians the divergent plate boundary is that separated those continents. *[The average distance is about 2,000 miles to the east.]*
- ? If the plates separate at an average rate of 1 inch per year, what is your calculation of how long ago the Appalachian Mountains were located at an active plate boundary? *[1,900 mi \* 5,280 ft \* 12 in = approximately 120,000,000 years. At a rate of 1 in/yr, the mountains were at the plate boundary about 120 million years ago.]*



## Explore

### Which mountain ranges are formed by active tectonic plate boundaries?

- Hover over the layer name, World Mountain Ranges. Click the button, Show Table.
- ? How many mountain ranges (features) are there? *[64]*
- See the Find Existing Locations ToolTip on the next page.
- Click the button, Analysis. Expand the Find Locations group. Choose Find Existing Locations.
- In the Find Existing Locations pane, set the following parameters:
  - 1 Choose World Mountain Ranges.
  - 2 Click the green Add Expression button, and then add the following expression: World Mountain Ranges Within A Distance Of **100** Miles From Tectonic Boundaries.
  - 3 Provide a unique name for the resulting layer, and uncheck the Use Current Map Extent box. Click Show Credits, and then run the analysis.
- Open the table of the new layer.
- ? How many mountain ranges are close to active plate boundaries? *[33]*



## Explain

### Where are the actively forming mountain ranges?

- Turn off the layer, World Mountain Ranges.
- ? Where are the locations of the most active mountain-building areas of the world? *[Western spine of the American continents and a southwest-to-northeast line running from north Africa through the Asian continent.]*

more ►

## Elaborate

### Which mountain ranges are volcanic?

- Turn off all layers, and then turn on the World Mountain Ranges and Volcanoes Global layers.
- Volcanoes and mountains are both formed at active plate boundaries, though the way they form are different. Some volcanic zones are not very mountainous, and some mountain ranges are not volcanic.
- See the Summarize Within ToolTip below.
- Click the button, Analysis. Expand the Summarize Data group. Choose Summarize Within.
- In the Summarize Within pane, set the following parameters:
  - ① Choose World Mountain Ranges.
  - ② Choose Volcanoes Global.
  - ④ Choose SimpleType.
  - ⑤ Provide a unique layer name, and uncheck the Use Current Map Extent box. Click Show Credits, and then run the analysis.
- Turn off all layers except for the new one.
- The resulting layer contains outlines of those mountain ranges that contain volcanoes. The ranges are automatically symbolized to show the number of volcanoes within each range.
- ? Which mountain range appears to have the most volcanoes? [*The Andes with 171 volcanoes*]

## Evaluate

### How can summarized data be displayed another way?

- Hover over the new layer name. Click the button, Change Style.
- Change the drawing style to Counts And Amounts (Color).
- ? Which mountain ranges are most volcanic? [*Darker polygons indicate a higher feature count—in this case, number of volcanoes*]
- ? Which type of volcano is most prominent in the Andes? [*Composite Volcano*]
- ? Check the graphs of the other most volcanic mountain ranges. How consistent is the most common volcano type? [*Out of six most volcanic ranges (Andes, Sierra Madre, Kenyan Highlands, Ethiopian Highlands, Pegunungan Barisan, and Sredinnyy Khrebet), five contain more Composite Volcanoes than any other type.*]

## FIND EXISTING LOCATIONS

- This tool selects existing features in your study area that meet a series of criteria that you specify.
- These criteria can be based on attribute queries and spatial queries (for example, within 1 mile of a river).

## SUMMARIZE WITHIN

- Summarizes an area layer to other features within its boundaries. The area layer is states in this operation.
- The result layer name must be unique, so consider adding three initials, school code, and a number after the layer name (example: FileName\_REED\_ABC1).

## Next Steps

Continue using an ArcGIS Online organizational account ([www.esri.com/schools](http://www.esri.com/schools)) to dig deeper into data using the analysis tools, and save your maps to your account.

THEN TRY THIS...

- Symbolize the mountain ranges by number of volcanoes per square mile to find their spatial density.
- Add recent earthquake data to find a correlation between volcanic mountain ranges and seismic activity.

## TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Earth Science by Glencoe McGraw Hill — Chapter 6*
- *Earth Science by McDougal Littell — Chapter 3*
- *Earth Science by Prentice Hall — Chapter 7*
- *Earth Science by Tarbuck and Lutgens — Chapter 9*