Investigation 6: What happens when plates collide?

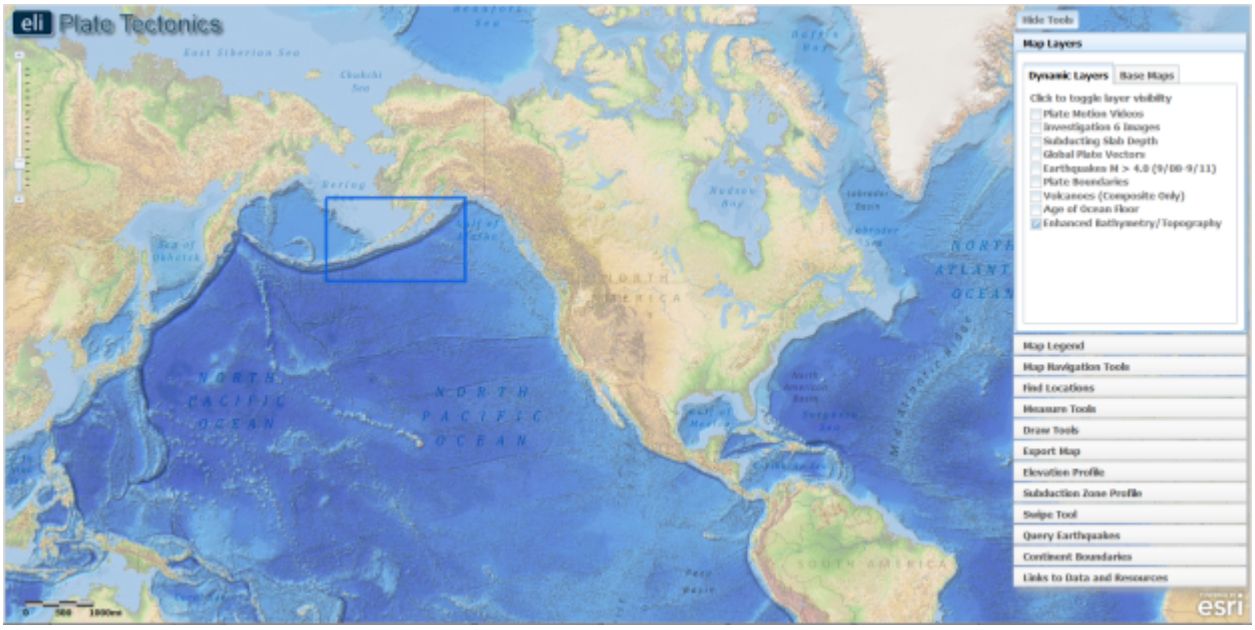
In this activity, you will use the distribution of earthquakes and volcanoes in a Web GIS to learn about plate collision at an ocean-ocean subduction zone and ocean-continent subduction zone. You will also recreate a continent collision to learn about convergent zones. You will:

1) Discover the relationship between the subduction zones and volcanoes.
2) Determine the slope of subduction along a convergent plate boundary.
3) Learn the types of landforms created by continents colliding at convergent zones.

Read **all** instructions and answer **each** question on your investigation sheet.

Part 1: Subduction Zones

Step 1: Open Web GIS



a. Open your Web browser. Go to **www.ei.lehigh.edu/learners/tectonics/**

b. Click on: Investigation 6: ***What happens when plates collide?***

c. The Web GIS will open to a map focused on North America with a blue box around the study area.

Click on **Map Navigation Tools tab** in the toolbars menu and select "**Aleutian Islands.**"

Step 2: Identify and trace the plate boundary.

Tectonic forces cause plates to collide, pull apart, and slide past each other causing earthquakes. Also, volcanoes tend to form where plates are colliding or pulling apart. Therefore, we can identify areas that have many earthquakes and volcanoes as a boundary where plates are either colliding or pulling apart. A **subduction zone** is an area where two tectonic plates move towards one another and one plate sinks beneath the other. Aging and cooling ocean lithosphere becomes denser than the mantle and becomes a subducting slab when it collides with another plate.

a. Locate the Aleutian Trench and the Aleutian Islands on the map. The Aleutian Islands are located north of the Aleutian Trench. A **subduction zone** occurs in the area of the Aleutian Trench.

b. Click on the **Elevation Profile tab** in the toolbars menu. Click on Investigation 6 to view an elevation profile across the Aleutian Trench.

c. An elevation profile of the line will appear in the **Elevation Profile** tab. You can place your cursor on the elevation profile to view corresponding points on the profile line on your map.

d. The deepest point is the trench formed at the subduction zone.

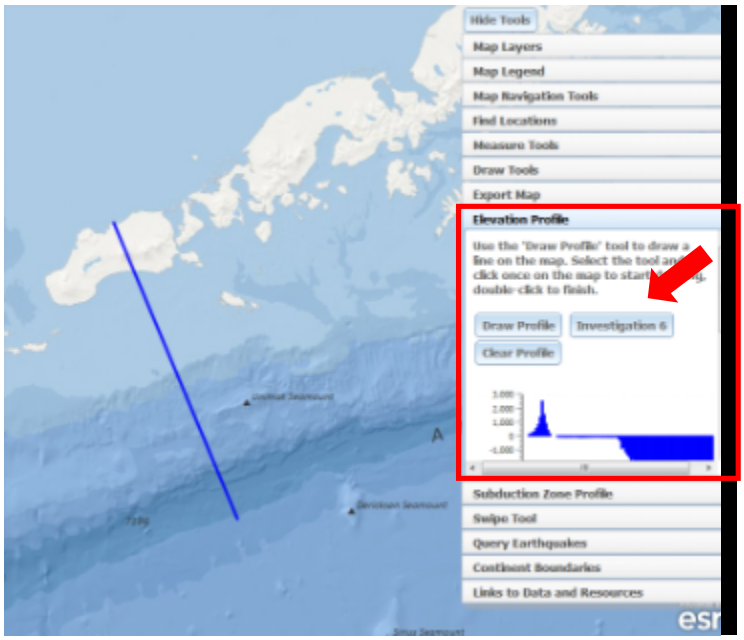
e. Click on the **Map Layers tab** in the toolbars menu. Activate the **Volcanoes (Composite Only)** layer. To learn more about an individual volcano, click on it and a box will appear with the elevation, type, and location of that volcano.

f. Identify the plate names on the north and south of the Aleutian Trench.

   To identify a plate name, click on the GIS map. When you click on a location, a box will appear with that location's plate name. For example, when you click on North America, a box that says "**Plate Name**: North American Plate" will appear.

Answer **Questions 1-4** on your investigation sheet.

g. Click Clear Profile to erase the **Elevation Profile** and turn off the tool.



h. Turn off the **Volcanoes (Composite Only)** layer.

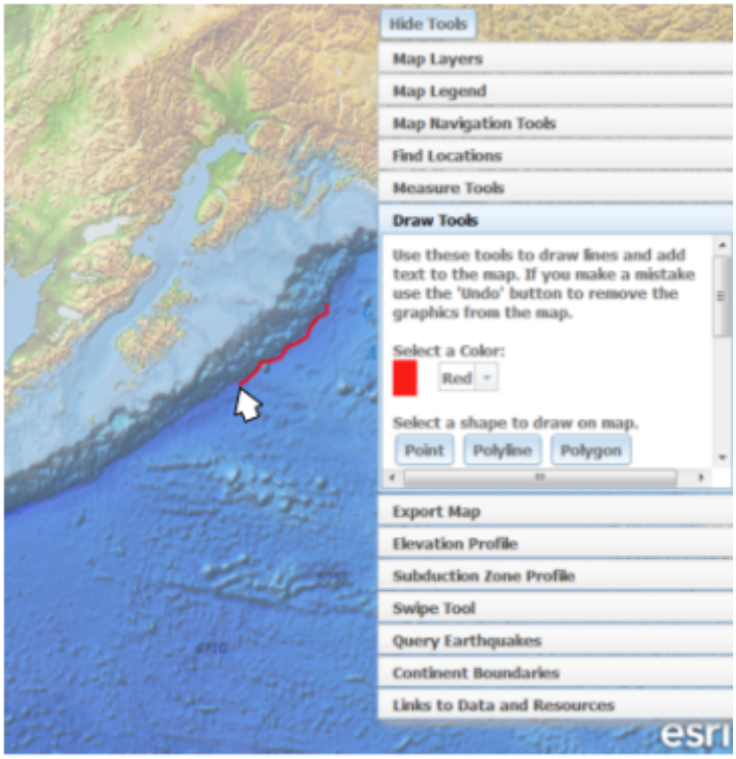
i. You will use the **Polyline Tool** to outline the Aleutian Trench subduction zone plate boundary.

j. Use the Polyline tool to trace the path of the deepest water (**darkest blue color**). First, click on a point at the eastern edge of the trench to start drawing a line (see figure to the right). Next, hold your mouse down while you drag it along the path of the deepest water. To finish your line, let go of your mouse at the western edge of the Aleutian Trench. If you make a mistake, you can erase a line segment by clicking Undo.

Helpful hint: Zoom out to see the entire Aleutian Trench.

k. Use the **Draw tools tab** to 'Add Text' to label your map with your name and a descriptive title about the map. Submit your map by taking a screenshot or by using the **Export Map tool**. (Note: Your teacher will provide information on submitting the map).

First, click on the **Export Map tab** in the toolbars menu and click Prepare Map for Export. This will create an image of your work that is ready to be exported. Next, follow directions in the toolbars for Macintosh or PC depending upon the computer you are using. Your teacher will instruct you with specific file naming instructions and with a computer or network location to save your image to. When you are finished, click Return to Map Navigation to return to your map.



l. Activate the **Global Plate Vectors** layer and the **Volcanoes (Composite Only)** layer. Please note that stratovolcanoes are refered to as composite volcanoes.

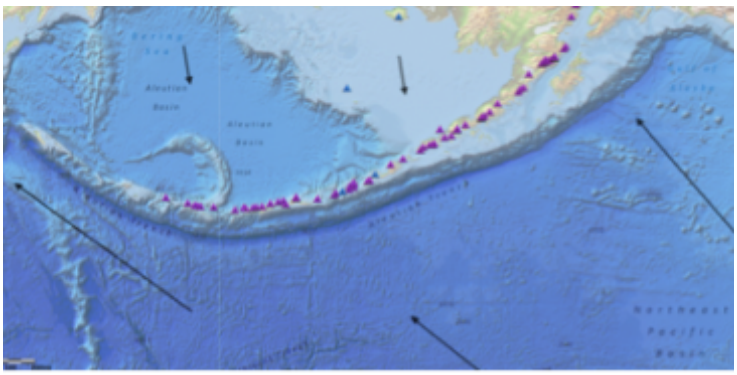
m. Using the **Volcanoes (Composite Only)** and **Global Plate Vectors** layers, determine what types of plate boundaries lay on the plate boundary line you just drew.

Click 

to remove your line after you submit your map.

 Answer **Questions 5-7** on your investigation sheet.

n. Activate the **Plate Motion Videos** layer. Click on the Subduction Zone video  located near Alaska along the Aleutian trench and click  to play.



Step 3: Determine the slope of the subducting slab.

The slope of the subducting slab usually varies along the plate boundary. Use the **Subduction Zone Profile** tab to investigate the subducting slab at two locations along the subduction zone.

a. Turn off the **Global Plate Vectors** layer. Click on the **Subduction Zone Profile** tab and click on **O\O (Atka Island)** to investigate a profile across the western part of the subduction zone. O\O represents an ocean-ocean plate boundary.

b. The **Subduction Zone Profile** tab shows a profile view of the subducting slab. Surface elevation is represented by the blue filled circles, composite volcanoes are shown as purple triangles, earthquake foci are shown as red circles, and the top of the subducting slab depth is shown as gray connected circles. All units are in **kilometers**.

c. Use the **Distance measure tool**

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 to measure the distance of the volcanoes to the convergent plate boundary.
(i) Go to the Measure Tools tab.
(ii) Click on the Distance measure tool.
(iii) Click on a volcano on the subduction zone profile.
(iv) Drag your mouse to the convergent boundary until you reach the trench.
(v) Double click to display the measurement result.

Important note: Double-clicking on the map will complete your measurement for your line. Click anywhere on the map to begin a new line with the distance measure tool. Your previous line will disappear.

 Record this distance on the chart in #8 on your investigation sheet. Be sure to include the measurement units. Click the Distance Measure tool to make the line disappear.

Click the Map Layers tab to turn off the Distance measure tool.
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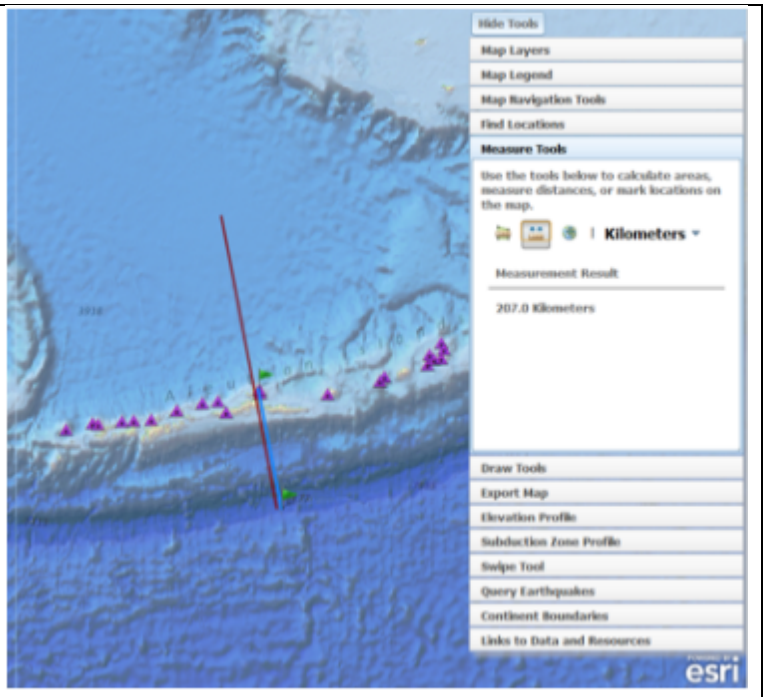

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d. Examine the focal depths of the earthquakes in the O\O (Atka Island) subduction zone. Hold your mouse over each earthquake in the profile to find out its focal depth.

 Record the depth of the deepest earthquake focus on the chart in #8 on your investigation sheet.
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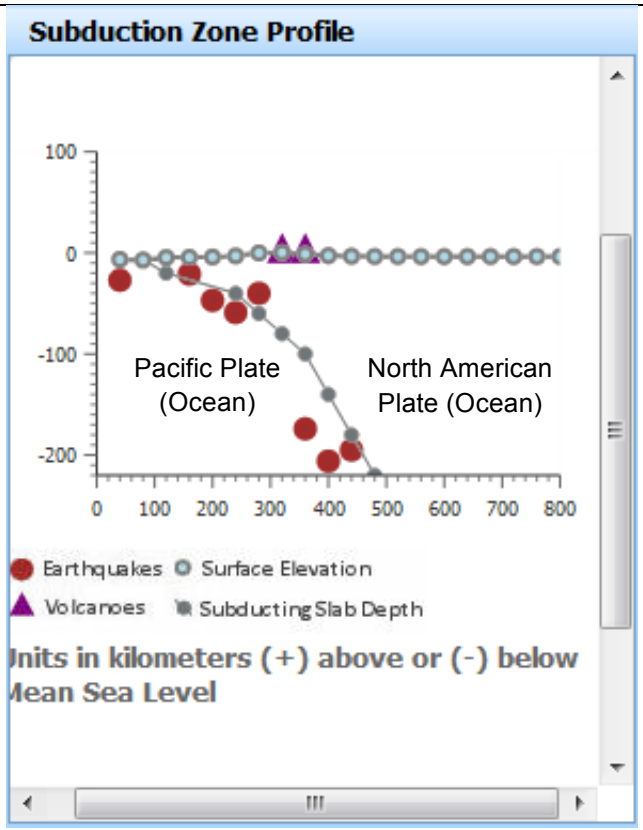
</table>

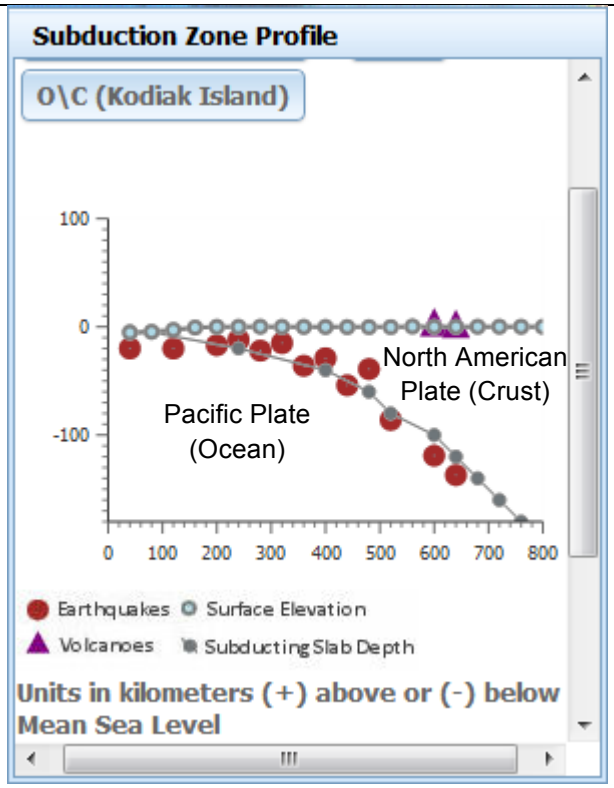
d. Examine the focal depths of the earthquakes in the **O\O (Atka Island)** subduction zone. Hold your mouse over each earthquake in the profile to find out its focal depth.

Record the depth of the deepest earthquake focus on the chart in **#8 on your investigation sheet**.



e. Click on the **Subduction Zone Profile** tab and click on **O\C (Kodiak Island)** to investigate a profile across the eastern part of the subduction zone. O\C represents an ocean-continent plate boundary.

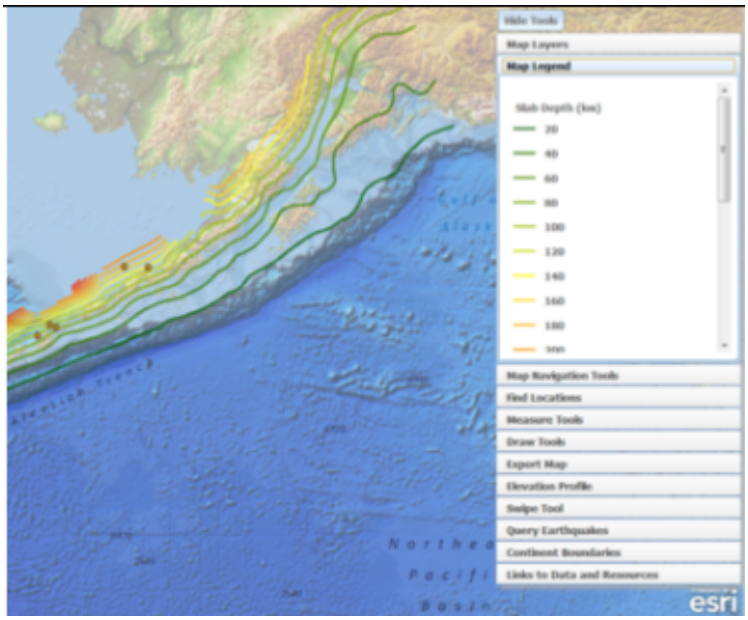
Complete the chart for **#8 on your investigation sheet** and answer **Questions 9-11** on your investigation sheet.



f. Turn off the **Subduction Zone Profile** tool by clicking Clear. Activate the **Subducting Slab Depth** layer. Using the **Map Legend** in the toolbars menu, identify the depths of the different colored lines.

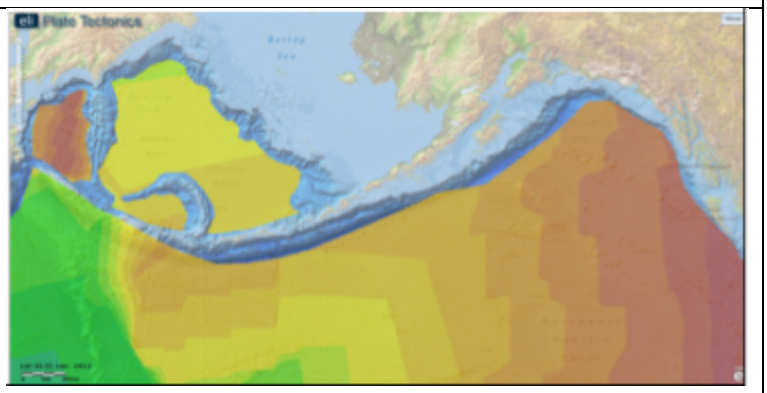
g. Using the **Subducting Slab Depth** layer, determine which direction the subduction slab is sloping (dipping).

Answer **Questions 12-13** on your investigation sheet.



h. Turn off the **Subducting Slab Depth** layer. Activate the **Age of the Ocean Floor** layer.

Answer **Question 14** on your investigation sheet.



Part 2: Colliding Creates Landforms

Step 4: Exploring plate subduction

You will explore the landforms created by volcanoes at different subduction zones in the Aleutian Islands and the Northwestern United States.

a. Use the **Map Navigation Tools** to zoom to the **Aleutian Islands** with the bookmark.

b. Turn off the **Age of the Ocean Floor** layer. Activate the **Plate Boundaries Layer**, the **Volcanoes (Composite Only)** layer, and the **Investigation 6 Images** layer.

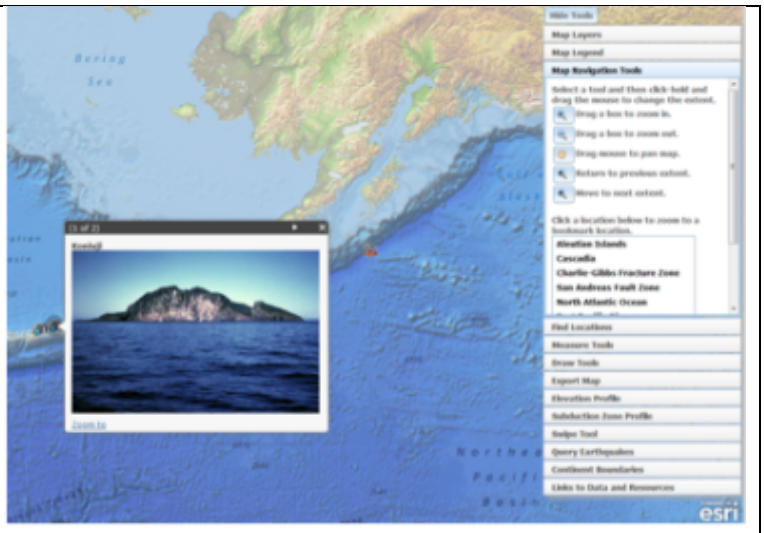
c. Recall the plate names on the north and south of the Aleutian Trench (see Step 2f if you need a refresher).

d. Pay particular attention to the types of lithospheric crusts at this location and the location of the volcanoes in relation to the plate boundary.

Answer **Questions 15-16** on your investigation sheet.

e. Click on the **three** icons to view photos of some volcanoes. To view the elevation of each volcano, click on the arrow at the top of the volcano image box to move through the information slides. Elevation units are **meters**.

Answer **Question 17** on your investigation sheet.



f. Use the **Map Navigation Tools** to zoom to **Cascadia** with the bookmark.

g. Identify the plate names on the east and west of the Cascadia Subduction Zone at the convergent plate boundary.

Answer **Question 18** on your investigation sheet.

h. Pay particular attention to the types of lithospheric crusts at this location and the location of the volcanoes in relation to the plate boundary.

Answer **Question 19** on your investigation sheet.

i. Click on the **three**  **icons** to view photos of volcanoes in this region.

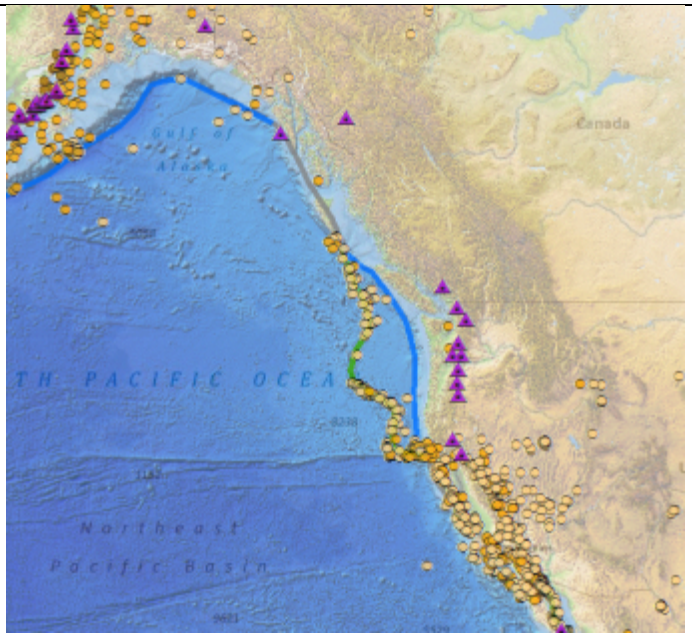
 Answer **Questions 20-22** on your investigation sheet.

j. Use your Map navigation tools to go to the Aleutian Islands.

 Answer **Questions 23-24** on your investigation sheet.

k. Turn off the **Investigation 6 Images** layer. Activate the **Earthquakes M > 4.0 (9/08-9/11)** layer. Zoom out so you can see the entire western coast of the United States.

 Answer **Questions 26-27** on your investigation sheet.

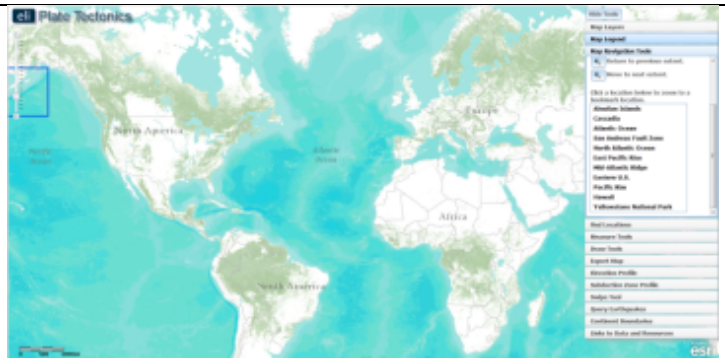


Step 5: Exploring continent collisions

When the oceans close completely at convergent boundaries, bordering continents collide. You will explore what happens when continents collide.

a. Turn-off the **Plate Boundaries**, **Volcanoes (Composite Only)**, **Earthquakes M > 4.0 (9/08-9/11),** and **Enhanced Bathymetry/Topography** layers.

b. Click on the **Map Layers** tab and select base maps. Turn on the **Topography** base map. Click on **Map Navigation Tools tab** in the toolbars menu and select **Atlantic Ocean**.



c. The continents that bordered the Atlantic Ocean collided approximately 300 million of years ago. You are going to virtually collide the North America and Africa continent boundaries. Turn on the **Investigation 6 Images** layer.

Click on the  on the eastern coast of the United States. This image shows what occurred 300 million years ago at the convergent boundary. Pay attention to what landforms are on the surface of the lithospheric crust.

d. Click on the **Continent Boundaries** tab in the toolbars menu and select "Add Boundaries".

e. You will now move the continents to the location on the map that represents the collision of the continents 300 million years ago.

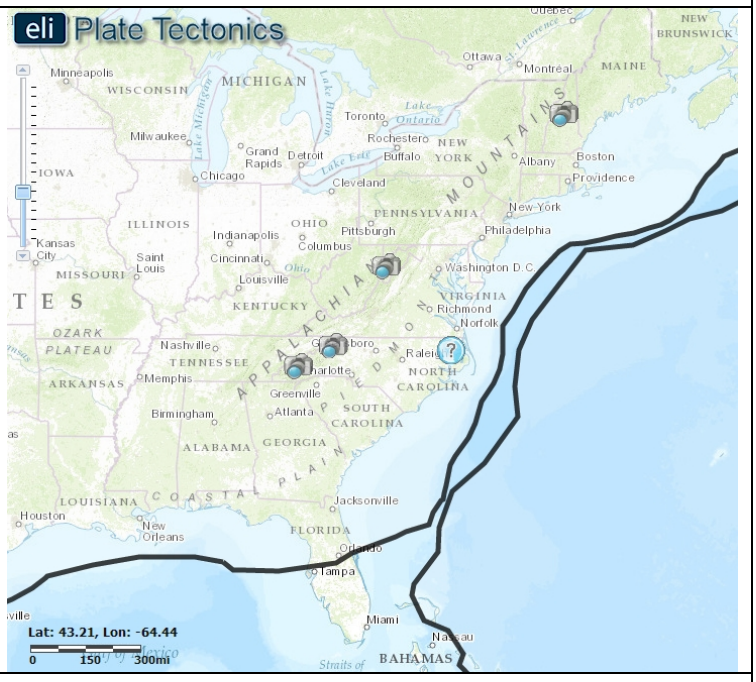
f. Place the part of the continent boundaries shown with the red arrow (see picture to the right) to the location of the continents from 300 million years ago.

g. Click your mouse to select a shaded shape on the map. Click your mouse a second time and hold to move the continent.

h. To rotate a selected shaded continent, click the white box located on top of the outlined area and then move your mouse to rotate it on the map.

i. Submit your map using the **Export Map tool**. (Note: Your teacher may ask you to take a screenshot instead).

j. First, click on the **Export Map tab** in the toolbars menu**.**

k. Click Prepare Map for Export. This will create an image of your work that is ready to be exported. l. Next, follow directions for Macintosh or PC depending upon the computer you are using. Your teacher will instruct you with specific file naming instructions and with a computer or network location to save you image to. m. When you are finished, click Return to Map Navigation to return to your map.	
n. Click on the **Map Navigation Tools** tab and select **Eastern U.S.** o. A continent-continent collision causes mountain building. A continent-continent collision creates new landforms. Look at the Eastern shore of the North American continent. What large landform is located parallel to the boundary of the colliding continents?	
p. You will now draw an elevation profile across the eastern United States. Follow the steps below. q. Click on the **Elevation Profile tab** in the toolbars menu. The **Elevation Profile** tool will not work if the **Continent Boundaries** tab is selected. r. Locate the Appalachian Mountain range (see image on the next page on the right). Begin your elevation profile line by clicking on the map on	

the western side of the Appalachian Mountains. Continue your line east to the coast (see image to the right).

s. The elevation profile along that line will appear in **Elevation Profile** tab on the right. The highest point corresponds to the highest elevation in the Appalachian Mountain range along that profile line.

t. These mountains have been eroding for millions of years. Click on the **Map Layers** tab, then click the  icons to see what these mountains look like today.

 Answer **Questions 28-30** on your investigation sheet.