**Sample Axial Seamount Lesson**

This activity uses bottom pressure data from the Axial Seamount cabled array to examine the dynamic nature of the seafloor before, during and after an eruption. It was designed for an Introduction to Oceanography course and implemented after discussion of plate tectonics and plate boundary features. Students should be familiar with reading time series graphs and bathymetric maps.

*Learning goals*

* Connect divergent plate boundaries to volcanic activity of a seamount
* Compare and contrast the time series graphs of different variables to describe an eruption event
* Describe how you can use data collected on the seafloor to predict an eruption

*Activity description*

1. Introduce OOI cabled array site, display map of Axial Seamount & caldera
2. Students work through the first page of the worksheet: “Geologic Features of a Seamount” Exploration questions. Important points to discuss with the class:
   1. What are the variables and scale of each graph? (time, depth; time, x and y tilt)
   2. How do these variables change over time?
      1. When do you see an abrupt change? (Answer: April 25, 2015)
   3. Click boxes to load data from the other two locations. How are the patterns similar or different at the other sites?
3. Video on Axial Seamount research (2015 expedition post-eruption): <https://youtu.be/_chP9yb73Ck>
4. Students work through the second page of the worksheet: “Seamount Diking-Eruption Event Science” Application questions. Important discussion points:
   1. Why does the seafloor rise slowly over time and then drop suddenly? (Caldera inflation and deflation)
   2. Make a prediction for seafloor elevation into the future (draw on the screen if possible)
   3. Turn on the “estimated threshold” and refine prediction. What year do you expect the next eruption?
   4. Why is this research useful? (Volcanic hazards)

*Teaching tips*

Students need access to a web browser and internet connection to use the interactive graphs (individually or in small groups). The interactive graphs work on laptops, tablets and smartphones. Touchscreen devices are not able to draw an eruption prediction line (Question 2d). As a backup, most aspects of this activity can be completed with printed copies of the graphs.

The Data Explorations pages have maps of the site and a photo of the bottom pressure/tilt instrument.

Seafloor tilt is a challenging concept for students. To help them visualize changes in tilt, I have them hold up a textbook or notepad and tilt it left to right or forward to back of the classroom. We define the axes (positive x = East, positive y = North) and practice various combinations of x and y tilts (e.g., positive x and y slopes up to the northeast, positive x and negative y slopes up to the southwest, etc.).

It may be helpful to review global plate tectonic boundaries and associated earthquake/volcanic activity, such as displayed on the IRIS Earthquake Browser (<https://ds.iris.edu/ieb>).

*Resources*

Sample worksheet below

Data Exploration: Geologic Features of a Seamount <https://datalab.marine.rutgers.edu/explorations/geology/activity2.php?level=exploration>

Data Exploration: Seamount Diking-Eruption Event Science <https://datalab.marine.rutgers.edu/explorations/geology/activity3.php?level=application>

University of Washington Cabled Array website <https://interactiveoceans.washington.edu/>

* Includes descriptions of instrumentation, scientific expeditions to the Axial site, and educational resources

Axial Seamount Earthquake Catalog (Wilcox et al., 2016): <http://axial.ocean.washington.edu/>

Realtime data from the OOI instruments at Axial Seamount (NOAA PMEL): <https://www.pmel.noaa.gov/eoi/rsn/index.html>

Wilcock, W. S. D., M. Tolstoy, F. Waldhauser, C. Garcia, Y. J. Tan, D. R. Bohnenstiehl, J. Caplan-Auerbach, R. P. Dziak, A. Arnulf, and M. E. Mann (2016). Seismic constraints on caldera dynamics from the 2015 Axial Seamount eruption, Science, 354, 1395-1399.

**Axial Seamount Data Exploration Worksheet**

1. Go to the “Geologic Features of a Seamount” page and practice interacting with the graphs. Answer the following questions about the graphs:
   1. What is the time range on the x-axis?
   2. What variables appear on the y-axes? What are their units?
   3. In which direction (North, South, East West) does the seafloor slope when the x-tilt is positive? What about when the y-tilt is positive?
   4. When did a major change in depth at the Central Caldera occur? What was the change?
   5. What happened to x-tilt and y-tilt at the same time as the change in depth?
   6. Did the same changes in depth and tilt occur at the other two sites?

*Pause and wait for instructions before moving on to #2*

1. Go to the “Seamount Diking-Eruption Event” page and review the graph of seafloor elevation over time
   1. When does this graph start and end?
   2. What are the trends in seafloor elevation over time?
   3. Click the box next to Show Estimated Threshold. What does this line mean? (Hint: read the Data Tips below the graph)
   4. If you have a mouse, you can click and drag your cursor on the graph to make a prediction for what will happen to seafloor elevation next (if not, trace by eye). In what year do you think the elevation will reach the threshold? What event might happen then?