



## Axial Seamount: A Volcano on the Verge

### Summary:

Students will explore volcanoes and their atmospheric impact before diving into the data surrounding the best documented submarine volcano off the shores of the Pacific Northwest - the Axial Seamount. Teams will be tasked with finding the monthly averages of the vertical movement of the floor surrounding the volcano. They'll then take those averages, graph them and explore why their plots are inconsistent and suddenly drop. Are their calculations incorrect? Is the sensor broken? Or is there something far more explosive (hint, hint, wink, wink) going on below the surface? This intel will then lead to the biggest question of all.... When will the Axial Seamount blow next?

### Background Information:

The Axial Seamount is an active submarine volcano located on the Juan de Fuca Ridge. With new equipment collecting and reporting real time data, we've discovered that consistent increases in vertical movement, followed by dramatic drops in said movement indicate volcanic eruptions on the sea floor. The data also reflects a fairly consistent threshold somewhere between 3 and 4 meters of vertical movement, where the system becomes too stressed and erupts, relieving the pressure and beginning the cycle again. More information can be found at the links below:

- [Seismic constraints on caldera dynamics from the 2015 Axial Seamount eruption](#)
- [Inflation-predictable behavior and co-eruption deformation at Axial Seamount](#)
- [Forecasting Volcanic Eruptions: Beyond the Failure Forecast Method](#)
- [Geodetic Monitoring at Axial Seamount Since Its 2015 Eruption Reveals a Waning Magma Supply and Tightly Linked Rates of Deformation and Seismicity](#)
- [Voluminous eruption from a zoned magma body after an increase in supply rate at Axial Seamount](#)

Students should also know how to plot points and find the slope of a line :)

### Materials

| Teacher Resources                  | Student Resources                                                    |
|------------------------------------|----------------------------------------------------------------------|
| Lesson plan                        | <a href="#">StoryMap Fill in Notes</a>                               |
| <a href="#">Slides</a>             | <a href="#">Volcano Seafloor Data</a>                                |
| <a href="#">Graph Keys by Year</a> | Yearly Graphs Worksheet <a href="#">PDF</a>   <a href="#">Sheets</a> |
| <a href="#">StoryMap Key</a>       | <a href="#">5 Year Data</a>                                          |
| <a href="#">CER Rubric</a>         | <a href="#">Averaging in Sheets Guide</a>                            |
| <a href="#">Volcano Data Key</a>   |                                                                      |

## Performance Expectations:

- Analyzing and Interpreting Data
  - HS-ESS2-2:** Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth's systems.

## Specific Learning Objectives:

- Apply their understanding of averages, plotting points and linear graphs to create a visual data set that can be evaluated
- Evaluate the data set (graphs) to predict what is happening with the system and predict when the cycle will reset and begin again

## NGSS Dimensions:

### Science & Engineering Practices:

- Using Mathematics and Computational Thinking ▾
- Analyzing and Interpreting Data ▾

### Disciplinary Core Ideas:

- ESS2.A: Earth Materials and Systems ▾
- ESS1.B: Earth and the Solar System ▾
- LS2.A: Interdependent Relationships in Ecosystems ▾

### Crosscutting Concepts:

- Cause and effect ▾
- Stability and change ▾

## Ocean Literacy Principles:

- 1: The Earth has one big ocean with many features. ▾

## 5E Lesson Plan

| <b>ENGAGE : <u>Slide 1-2</u></b>                                                                                                |                                                                                                                                                           |                                                                          |
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| <i>Teacher Does</i>                                                                                                             | <i>Student Does</i>                                                                                                                                       | <i>Concept</i>                                                           |
| Play this 3 minute <a href="#">video introducing the Axial Seamount</a> and the researchers responsible for collecting the data | Watch the video and engage in a think pair share: <ul style="list-style-type: none"><li>What did you see or notice?</li><li>What do you wonder?</li></ul> | Introduction of the Axial Seamount, its location and why it is relevant. |

| <b>EXPLORE: <a href="#">Slide 3</a></b>                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                          |                                                                                                            |
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| <i>Teacher Does</i>                                                                                                                                                                                                                                                                                                                                                                                 | <i>Student Does</i>                                                                                                                                      | <i>Concept</i>                                                                                             |
| <b>Prior to the lesson:</b> <ul style="list-style-type: none"> <li>Post a link to the <a href="#">StoryMap</a></li> <li>Print or post a digital version of the <a href="#">fill in the blank notes</a> <ul style="list-style-type: none"> <li><a href="#">Teacher Key</a></li> </ul> </li> </ul><br><b>During Lesson:</b><br>Circulate the room to answer questions and provide support to students | <ul style="list-style-type: none"> <li>Navigate to the <a href="#">StoryMap</a></li> <li>Complete the <a href="#">Fill in the Blank Notes</a></li> </ul> | Explore how volcanoes directly impact the atmosphere and what systems are in place to measure said impact. |

| <b>EXPLAIN: <a href="#">Slides 4-5</a></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                          |
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| <i>Teacher Does</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <i>Student Does</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <i>Concept</i>                                                                                                                                                                                                           |
| <b>Prior to the lesson:</b> <ul style="list-style-type: none"> <li>Post a link to the <a href="#">Volcanic Sea Floor Data Spreadsheet</a></li> <li>Print or post the <a href="#">student spreadsheet cheat sheet</a></li> <li>Print the <a href="#">graphs</a> for each group to plot their data when they are done <ul style="list-style-type: none"> <li><a href="#">Graph Keys</a></li> </ul> </li> </ul><br><b>During Lesson:</b> <ul style="list-style-type: none"> <li>Break students into 10 groups of 2-4 and assign them a year between 2005 - 2025</li> <li>Explain that the data they are receiving is from a live volcano and the units are recorded in meters</li> <li>Have students make a</li> </ul> | <ul style="list-style-type: none"> <li>Break into 10 teams of 2-4</li> <li>Navigate to the data spreadsheet and make a copy</li> <li>Navigate to the tab of the year your team has been assigned</li> <li>Look at the data and fill in the names of the months your data was collected at the top of the sheet</li> <li>Use the cheat sheet to find the monthly average of the vertical sea floor movement throughout your year</li> <li>Take the averages you've derived and plot them on your graph</li> <li>Post your work in order by year on the</li> </ul> | Students are analyzing the data collected over the last 20 years to discover patterns, trends, and maxima in the graph. They will then discuss their data to figure out WHY their data is trending in the pattern it is. |

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| <p>copy of the <a href="#">Data spreadsheet</a>. Students need to fill in the months at the top of each column and find the monthly averages of the vertical movement for their year.</p> <ul style="list-style-type: none"> <li>- <a href="#">Teacher Key</a></li> <li>• Have students plot their points on their <a href="#">graphs</a> and then post their work side by side on the wall with tape so it can be connected and analyzed as a class</li> <li>• During the discussion you ultimately want them to realize the dips in movement = an eruption</li> </ul> | <p>wall with a piece of tape to make one long graph that is in order by year</p> <ul style="list-style-type: none"> <li>• Discuss with your team and others: <ul style="list-style-type: none"> <li>- What do you notice about the graphs?</li> <li>- What is happening to the line?</li> <li>- What could be causing the graph to trend this way?</li> </ul> </li> </ul> |  |
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### ELABORATE: [Slides 6-7](#)

| <i>Teacher Does</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <i>Student Does</i>                                                                                                                                                                                                                                                                                                                                                              | <i>Concept</i>                                                                                                                |
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| <p><b>Prior to the lesson:</b></p> <ul style="list-style-type: none"> <li>• Post a link to the <a href="#">formal data</a> for reference (don't publish until after the data discussion)</li> <li>• Print the <a href="#">5 year graphs</a> - enough to provide 10 teams with one graph each</li> </ul> <p><b>During the Lesson:</b></p> <ul style="list-style-type: none"> <li>• Use the <a href="#">slide deck</a> to explain how the magma below the surface leads to the ground lifting, providing us the data</li> </ul> | <ul style="list-style-type: none"> <li>• Engage in the lecture about how the process works</li> <li>• Take the graph given, choose the section of the graph where the system is refilling</li> <li>• Number the X-Axis and then calculate the slope of the line segment that is reflecting a positive trend.</li> <li>• CHALLENGE: Convert the metric slope to inches</li> </ul> | <p>Students further analyze a data set to determine the slope (the rate at which the seafloor is rising at that location)</p> |

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| <p>seen. Explain that once the system can no longer sustain the pressure the lava will exit the system and the ground elevation will decrease.</p> <ul style="list-style-type: none"> <li>• Instruct students to calculate the slope of the lines they've been given.</li> <li>• CHALLENGE: Have the students take the slope value and convert it to inches</li> </ul> |  |  |
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### EVALUATE: [Slide 8](#)

| <i>Teacher Does</i>                                                                                                                                              | <i>Student Does</i>                                                                                                                        | <i>Concept</i>                                    |
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| <ul style="list-style-type: none"> <li>• Distribute and discuss the <a href="#">evaluation rubric</a></li> <li>• Circle the room and support as needs</li> </ul> | <ul style="list-style-type: none"> <li>• Complete a CER paper, answering the question: When will the Axial Seamount next erupt?</li> </ul> | Use data to make predictions and defend reasoning |

### Differentiation / Modifications

#### Elementary:

- Participate in the Engage and Explore Sections only

#### Middle School:

- Guide the students through the data averaging

#### Students with IEPs & 504s

- Pair students with a strong partner and offer their resources exclusively online for the purpose of using text to speech and speech to text

#### Foreign Language Learners

- Provide their resources exclusively online to allow for translation tools
- Watch the video with language subtitles attached

### Enrichment:

- Watch this [episode](#) about the researchers pulling this great data
- Investigate the [data about seismic activity](#) surrounding the area and its correspondence to the vertical movement data
- Update the data with realtime data found through [OOI](#)

**Helpful Resources:**

[All research papers, data, graphs, and a powerpoint from researcher Bill Chadwick](#)