Science & Literacy Activity

GRADES 6-8

OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to natural hazards. Students will read content-rich texts, visit the *Nature's Fury: The Science of Natural Disasters* exhibition, and use what they have learned to complete a CCSS-aligned writing task by creating an illustrated text about natural hazards.

Materials in this activity include:

- Teacher instructions for:
    - o Pre-visit student reading
    - o Visit to *Nature's Fury* and Student Worksheet
    - o Post-visit writing task
- Text for student reading: "Avoiding Earthquake Surprises in the Pacific Northwest"
- Student Worksheet for the *Nature's Fury* visit
- Student Writing Guidelines
- Teacher rubric for writing assessment

Common Core State Standards:
WHST.6-8.2, WHST.6-8.8, WHST.6-8.9, RST.6-8.1, RST.6-8.2, RST.6-8.4, RST.6-8.10

New York State Science Standards:
PS2.2a

Next Generation Science Standards:

- Disciplinary Core Idea ESS3.B: Natural Hazards. Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.
- Science and Engineering Practice 8: Obtaining, Evaluating, and Communicating Information

SUPPORTS FOR DIVERSE LEARNERS: An Overview

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, locating information in the exhibition) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. We have provided ways to adapt each step of the activities for students with different skill-levels. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

1. BEFORE YOUR VISIT

This part of the activity engages students in reading a non-fiction text about natural hazards. The reading will prepare students for their visit by introducing them to the topic and framing their investigation.

Student Reading

Have students read "Avoiding Earthquake Surprises in the Pacific Northwest." Ask them to write notes in the large right-hand margin. For example, they could underline key passages, paraphrase important information, or write down any questions.

Discussion Questions:

- What causes earthquakes?
  (Earthquakes are powerful waves that pass through the ground. They are caused by the sudden release of stored up strain in rocks. When the rocks break, this stored energy surges through Earth.)
- How do scientists compare the power of different earthquakes? How does the magnitude scale work?
  (Scientists compare earthquakes based on the amount of energy they put out. They use the magnitude scale to measure this energy. Each step up the magnitude scale represents a thirty-fold increase in power.)
- What evidence did scientists find that "great" quakes were possible in the Cascadia region?
  (Scientists have found evidence that past earthquakes flooded and killed forests, filled cracks in rock with quicksand, and even caused massive waves called tsunamis.)

- How does this research help scientists forecast the locations and likelihood of future earthquakes? What measures are being taken to protect humans from future earthquakes?
  (Scientists have been able to determine that very large earthquakes have occurred in the Cascadia region in the past. They may be rare, but these "great" quakes are very powerful. In order to withstand them, structures like dams, bridges, schools, and hospitals in regions that are at risk are strengthened.)

Students can work in pairs, small groups, or as a class. During discussion, remind them to use evidence from the text to explain their thinking, and to use specific examples.

SUPPORTS FOR DIVERSE LEARNERS: Student Reading
- "Chunking" the reading can help keep them from becoming overwhelmed by the length of the text. Present them with only a few sentences or a single paragraph to read and discuss before moving on to the next "chunk."
- Provide "wait-time" for students after you ask a question. This will allow time for students to search for textual evidence or to more clearly formulate their thinking before they speak.
- After the reading, show students the following:
  - o Tsunami Science: Reducing the Risk: amnh.org/explore/science-bulletins/(watch)/earth/documentaries/tsunami-science-reducing-the-risk
  - o Plates on the Move: amnh.org/ology/features/plates

2. DURING YOUR VISIT

This part of the activity engages students in exploring the *Nature's Fury* exhibition.

Museum Visit & Student Worksheet
Explain to students that they will learn about earthquakes, volcanoes, tornadoes, and hurricanes, and use worksheets to gather information about these natural hazards. Tell students that back in the classroom they will refer to these notes when completing the writing assignment.

SUPPORTS FOR DIVERSE LEARNERS: Museum Visit
- Review the Student Worksheet with students, clarifying what information they should collect during the visit.
- Have students explore the exhibition in pairs, with each student completing their own Student Worksheet.
- Encourage student pairs to ask you or their peers for help locating information. Tell students they may not share answers with other pairs, but they may point each other to places in the exhibition where answers are located.

3. BACK IN THE CLASSROOM

This part of the activity engages students in an informational writing task that draws on the pre-visit reading and on observations made at the Museum.

Writing Task
Distribute the Student Writing Guidelines handout, which includes the following prompt for the writing task:

> Based on your reading, your visit to the *Nature's Fury* exhibition, and your discussions, write an essay in which you describe the cause of earthquakes and one other type of natural hazard, and explain how scientists can help forecast future events.

Go over the handout with students. Tell them that they will use it while writing, and use it afterwards to evaluate and revise their essays.

Before they begin to write, have students use the prompt and guidelines to discuss the information that they gathered in *Nature's Fury,* and compare their findings. They can work in pairs, small groups, or as a class. Referring to the writing prompt, have students underline or highlight all relevant passages and information from the reading and from their notes from the exhibition. As they compare findings, students may take notes on information gathered by their peers. Students should write their essays individually.

SUPPORTS FOR DIVERSE LEARNERS: Writing Task
- Re-read the "Before Your Visit" assignment with students. Ask what they saw in the exhibition that helps them understand natural hazards.
- Allow time for students to read their essay drafts to a peer and receive feedback based on the Student Writing Guidelines.

Student Reading

Avoiding Earthquake Surprises in the Pacific Northwest

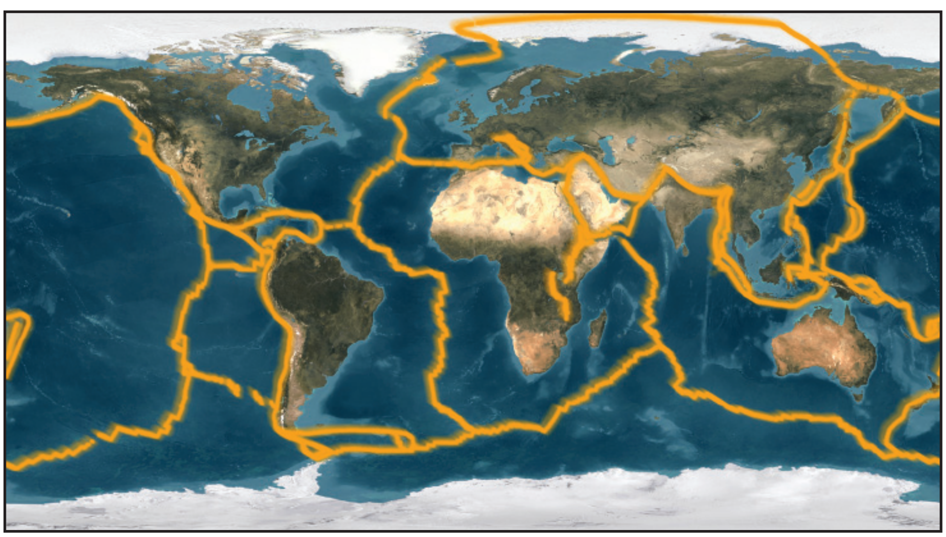
How Vulnerable Is the Pacific Northwest?

Cascadia is a region in the Pacific Northwest. It includes southern British Columbia, Washington, Oregon, and northern California. This region is at risk of being hit by earthquakes. Until the mid-1980s, Earth scientists thought that the threat was limited to quakes of magnitude 7[1] or below.

But more recently, Earth scientists discovered evidence that more intense earthquakes repeatedly struck the region over the past several thousand years. And they are likely to occur again. Earthquakes of magnitude 8 and 9 are considered "great" quakes. An earthquake of magnitude 8 releases about thirty times as much energy as a quake of magnitude 7. A quake of magnitude 9 is another thirty times larger.

Why the Pacific Northwest Is at Risk

Earth's rigid outer shell is made up of vast rocky pieces called tectonic plates. These plates move as slowly as fingernails grow. They separate, collide, or grind against each other at plate boundaries. Where the plates grind together, pressure builds up and the rocks eventually break. This sends stored-up energy surging through Earth. This energy is what causes earthquakes.



Earth's surface is broken into massive rocky plates called tectonic plates.

[1] Over the years, seismologists devised various magnitude scales as measures of earthquake size. The "moment magnitude" scale is used today.

Most earthquakes occur along certain plate boundaries called subduction zones. A subduction zone is where a more dense oceanic plate subducts, or sinks below, a continental plate. Decades ago, scientists recognized that a subduction zone runs along the Pacific coast. It lies between southern British Columbia and northern California. It's called the Cascadia subduction zone.

The two largest earthquakes since 1900 occurred along subduction zones. They were a Chilean earthquake of magnitude 9.5 in 1960, and an Alaskan earthquake of magnitude 9.2 in 1964. During each of these earthquakes, the continental plate lurched 20 meters toward the sea. This movement thinned the plate by stretching its rocks. The thinning lowered the coast enough for tides to drown coastal forests. Today, ghostly tree trunks provide natural clues that the huge earthquakes occurred.

Clues of Ancient Quakes

Earth scientists have found similar, much older, remains of flooded forests in Cascadia. They were discovered along bays and river mouths on the coasts of British Columbia, Washington, Oregon, and northern California. Scientists also found other evidence of strong earthquakes in the same locations. These include sheets of sand that were deposited by floods from the sea and ground cracks that were filled with quicksand. Scientists concluded that earthquakes of magnitude 8 or larger have struck Cascadia repeatedly in the past several thousand years.

Teams of scientists worked together to determine the exact date and an approximate size for the most recent of these Cascadia earthquakes. First, American scientists discovered clues in some dead trees. The trees recorded sudden lowering of coastal land during this earthquake. Radiocarbon dating showed that they died between 1680 and 1720.

Courtesy of Brian F. Atwater

Scientists study dead trees in a tidal marsh along the Pacific coast of Washington. They provide evidence that a great earthquake occurred in January 1700.

Japanese researchers were paying attention to these discoveries in North America. They knew that if the Cascadia earthquake was big enough, it would have started a tsunami in the Pacific Ocean. And they had been looking for the mysterious source of a tsunami that caused flooding and damage in Japan in January 1700. They proposed that a great Cascadia earthquake occurred in the evening of January 26, 1700. They estimated its size as magnitude 9.

To test this proposed date and size, American scientists returned to some of the earthquake-killed trees in Washington. By measuring thin and thick rings, they assigned dates to individual tree rings. They were able to narrow the time of the earthquake to the months between August 1699 and May 1700. This evidence supported the date proposed by Japanese researchers. The findings combined to give the 1700 Cascadia earthquake a place in history.

Northwesterners Respond to the Risk

Earthquakes can't be prevented. However, people can take measures to minimize the damage they cause. In some cases, communities can strengthen structures that already exist. These include dams, bridges, water systems, schools, hospitals, and lifelines (electrical, gas, and water lines). They can also design and build earthquake-resistant structures in the future.

Until 1994, the Uniform Building Code placed an area of Washington in a zone with the second highest hazard level (out of six). Most of the rest of Oregon and Washington was placed in a zone with a lower hazard level. The 1994 edition of the Uniform Building Code redrew the map for the Pacific Northwest. All parts of Oregon and Washington that are at risk of great earthquakes were upgraded to the higher-level hazard zone.

This revision of the code was an important first step toward meeting the great-earthquake threat in the Pacific Northwest. In the areas upgraded to the second highest level, new buildings are designed to withstand earthquakes fifty percent stronger than under the old code.

How Safe Are Other Parts of the United States?

People in other earthquake-prone states started asking questions about whether they were adequately prepared for future earthquakes. These states include Massachusetts, New York, South Carolina, Missouri, Indiana, Utah, California, and Alaska. Many of the questions cannot be answered satisfactorily until we know more about past earthquakes. Deciphering the geologic past is one of the ways that Earth scientists help to protect people from loss of life and property.

This reading was adapted from a 1995 USGS Fact Sheet, "Averting Surprises in the Pacific Northwest," by Brian F. Atwater, Thomas S. Yelin, Craig S. Weaver, James W. Hendley, II.

[2] The Uniform Building Code was replaced in 2000 by the International Building Code.

Student Worksheet

This exhibition contains four sections about four natural hazards: Earthquakes, volcanoes, tornadoes, and hurricanes. In each section, record information about the type of hazard discussed there.

1. Earthquakes

What causes earthquakes?

Draw and label a diagram of this earthquake.

Pick one specific earthquake and record the location and year of that event:

What tools do scientists use to research earthquakes?

How do scientists forecast future earthquakes?

2. Volcanoes

What causes volcanoes?

Draw and label a diagram of this eruption.

Pick one specific volcano and record the location and year of that event:

What tools do scientists use to study volcanoes?

How do scientists forecast future volcanic eruptions?

3. Tornadoes

What causes tornadoes?

Draw and label a diagram of this tornado.

Pick one specific tornado and record the location and year of that event:

What tools do scientists use to study tornadoes?

What is tornado alley? What states are most likely to have a tornado in the future?

4. Hurricanes

What causes hurricanes?

Draw and label a diagram of this hurricane.

Pick one specific hurricane and record the location and year of that event:

What tools do scientists use to study hurricanes?

How do scientists forecast future hurricanes?

ANSWER KEY

Student Worksheet

This exhibition contains four sections about four natural hazards: Earthquakes, volcanoes, tornadoes, and hurricanes. In each section, record information about the type of hazard discussed there.

1. Earthquakes

What causes earthquakes?
(Earthquakes are powerful waves that pass through the ground. They are caused by the sudden release of stored up strain in rocks. When the rocks break, this stored energy surges through Earth.)

Draw and label a diagram of this earthquake.

Pick one specific earthquake and record the location and year of that event:
(Sample answer: Haiti Earthquake, 2010)

What tools do scientists use to research earthquakes?
(seismograph)

How do scientists forecast future earthquakes?
(Scientists can determine where earthquakes happen most often, such as near faults, and determine how frequently earthquakes happen in these locations.)

2. Volcanoes

What causes volcanoes?
(A volcano is an opening in Earth's crust that releases molten rock and gas. Magma and gas deep within Earth are under tremendous pressure. In an eruption, they are forced to the surface to the surface.)

Draw and label a diagram of this eruption.

Pick one specific volcano and record the location and year of that event:
(Sample answer: Mt. Vesuvius, 79 AD)

What tools do scientists use to study volcanoes?
(Scientists can use GPS to measure the change in elevation of a volcano.)

How do scientists forecast future volcanic eruptions?
(Scientists can monitor volcanoes for sudden changes or an increase in activity that can indicate that an eruption is likely.)

ANSWER KEY

3. Tornadoes

Draw and label a diagram of this tornado.

What causes tornadoes?
(A tornado is a rapidly rotating column of air. They form from the movement of air in powerful thunderstorms.)

Pick one specific tornado and record the location and year of that event:
(Sample answer: Greensburg, Kansas, 2007)

What tools do scientists use to study tornadoes?
(Scientists can use armored cameras to see inside of a tornado.)

What is tornado alley? What states are most likely to have a tornado in the future?
(Tornado alley is a region in the central United States where most tornadoes occur. Iowa, Kansas, Oklahoma, and Texas are the states with the most tornadoes.)

4. Hurricanes

Draw and label a diagram of this hurricane.

What causes hurricanes?
(A hurricane, or tropical cyclone, is an extremely large and powerful storm. They normally form over warm water in the tropics; they gain energy when this water evaporates.)

Pick one specific hurricane and record the location and year of that event:
(Sample answer: Galveston hurricane, 1900)

What tools do scientists use to study hurricanes?
(Scientists can use land stations, ships, balloons, aircraft buoys at sea, and satellites to make millions of measurements every day.)

How do scientists forecast future hurricanes?
(Scientists can track the formation and movement of hurricanes and compare them to previous storms. This allows them to forecast the path and strength of each new hurricane.)

Student Writing Guidelines

Based on your reading, your visit to the *Nature's Fury* exhibition, and your discussions, write an illustrated essay in which you describe the cause of earthquakes and one other type of natural hazard, and explain how scientists can forecast future events.

Be sure to include:
- one example of a natural hazard
- an explanation of this natural hazard
- an illustration of this natural hazard with at least three labels
- an explanation of how scientists study this type of natural hazard
- an explanation of how scientific research forecasts where such an event might occur in the future, what the likelihood is, and how to prepare for it

Support your essay with evidence from the reading and your visit to *Nature's Fury*.

Use this checklist to ensure that you have included all of the required elements in your essay.

- ☐ I introduced one natural hazard.
- ☐ I clearly named one type of natural hazard and described how it occurs.
- ☐ I included a labeled illustration of one natural hazard with at least three labels.
- ☐ I only included relevant information about natural hazards.
- ☐ I used information from the reading, "Avoiding Earthquake Surprises in the Pacific Northwest," to explain one kind of natural hazard in detail.
- ☐ I used information from the *Nature's Fury* exhibition to explain one kind of natural hazard in detail.
- ☐ I used academic, non-conversational tone and language.
- ☐ I included a conclusion at the end.
- ☐ I proofread my essay for grammar and spelling errors.

Assessment Rubric

	Scoring Elements	1 Below Expectations	2 Approaches Expectations	3 Meets Expectations	4 Exceeds Expectations
RESEARCH	**Reading**	Attempts to present information in response to the prompt, but lacks connections to the texts or relevance to the purpose of the prompt.	Presents information from the text relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the text relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the text.
RESEARCH	**AMNH Exhibition**	Attempts to present information in response to the prompt, but lacks connections to the Museum exhibit content or relevance to the purpose of the prompt.	Presents information from the Museum exhibit relevant to the purpose of the prompt with minor lapses in accuracy or completeness.	Presents information from the Museum exhibit relevant to the prompt with accuracy and sufficient detail.	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the Museum exhibit.
WRITING	**Focus**	Attempts to address the prompt, but lacks focus or is off-task.	Addresses the prompt appropriately, but with a weak or uneven focus.	Addresses the prompt appropriately and maintains a clear, steady focus.	Addresses all aspects of the prompt appropriately and maintains a strongly developed focus.
WRITING	**Development**	Attempts to provide details in response to the prompt, including retelling, but lacks sufficient development or relevancy.	Presents appropriate details to support the focus and controlling idea.	Presents appropriate and sufficient details to support the focus and controlling idea.	Presents thorough and detailed information to strongly support the focus and controlling idea.
WRITING	**Conventions**	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics.	Demonstrates an uneven command of standard English conventions and cohesion. Uses language and tone with some inaccurate, inappropriate, or uneven features.	Demonstrates a command of standard English conventions and cohesion, with few errors. Response includes language and tone appropriate to the purpose and specific requirements of the prompt.	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors. Response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt.
SCIENCE	**Content Understanding**	Attempts to include science content in explanations, but understanding of the topic is weak; content is irrelevant, inappropriate, or inaccurate.	Briefly notes science content relevant to the prompt; shows basic or uneven understanding of the topic; minor errors in explanation.	Accurately presents science content relevant to the prompt with sufficient explanations that demonstrate understanding of the topic.	Integrates relevant and accurate science content with thorough explanations that demonstrate in-depth understanding of the topic.