

Science & Literacy Activity

GRADES 9-12

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 *Nature's Fury: The Science of Natural Disasters*, 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:
 - Pre-visit student reading
 - Visit to *Nature's Fury* and Student Worksheet
 - Post-visit writing task
- Text for student reading: "Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster"
- Student Worksheet for the *Nature's Fury* visit
- Student Writing Guidelines
- Teacher rubric for writing assessment

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 "Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster." 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. They may also use this space for drawings or diagrams of volcanic eruptions.

Discussion Questions:

Ask:

- Why did the American Museum of Natural History send geologist Edmund Otis Hovey to the Caribbean?
(*Hovey was sent by the Museum President, Morris K. Jesup, to investigate two recent and devastating volcanic eruptions.*)
- What were the effects of those volcanic eruptions?
(*The eruptions caused massive clouds of hot gases, ash, and mudslides traveling at speeds of up to 300 mph. The eruptions destroyed communities and killed more than 30,000 people.*)

Common Core State Standards:

WHST.9-12.2, WHST.9-12.8, WHST.9-12.9, RST.9-12.1, RST.9-12.2, RST.9-12.7, RST.9-12.10

New York State Science Standards:

PS4 2.1h

Next Generation Science Standards:

- Disciplinary Core Idea ESS3.B: Natural Hazards. Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.
- Science and Engineering Practice 8: Obtaining, Evaluating and Communicating Information

- How has scientific research improved our understanding of volcanic eruptions? How can this knowledge protect people in the future?
(Scientists monitor volcanoes to detect sudden changes, especially volcanoes close to large populations. Using instruments like seismometers, they can now predict eruptions.)
- The title of this article refers to an "expedition to a modern Pompeii." What does the author mean by this?
(Pompeii was the site of a devastating eruption in the year 79 that destroyed a large human population. The "modern" eruptions described here occurred in 1902 were of the same type as the eruption of Mt. Vesuvius and also caused great loss of life and property.)

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 formulate their answers more clearly before they speak.

2. DURING YOUR VISIT

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

Museum Visit & Student Worksheet

Explain to students that they will learn about earthquakes, volcanoes, tornadoes, and hurricanes, and use worksheets to gather information about 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 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 the article "Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster," your visit to the *Nature's Fury* exhibition, and your discussions, write an essay in which you describe the eruption of Mt. Pelée and one other natural disaster and explain the impact they had on human populations.

Go over the handout with students. Tell them that they will use it while writing, and 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 exhibition notes. 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

Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster

On May 14, 1902, Museum geologist Edmund Otis Hovey boarded the U.S. cruiser *Dixie*, bound for the Caribbean. He had been sent by Museum President Morris K. Jesup to investigate volcanic eruptions that had killed nearly 30,000 people in less than 24 hours the previous week.

The first came on the afternoon of May 7, when Mt. Soufrière, on the island of St. Vincent, erupted in a boiling mudflow of steam and ash, killing 1,565 people. The next morning, 75 miles to the north on Martinique, Mt. Pelée exploded in a cloud of hot gases, volcanic ash, and rocks. Traveling at a speed of 300 miles an hour, the searing mass rushed down the mountainside, incinerating everything in its path, including the picturesque seaside town of Saint-Pierre and nearly all the ships in the harbor. Within two minutes, some 27,000 people were dead. On May 20, the day before Hovey's arrival in Martinique, a second equally powerful eruption covered the now uninhabited town of Saint-Pierre again.

The scene he encountered defied words. "The devastation wrought by the eruption cannot be appreciated from a verbal description," Hovey wrote in

The American Museum Journal of 1902, "and even photographs do not convey an adequate idea of what has happened" to a city that had enjoyed a reputation as the Paris of the Caribbean. Once a hub of trade in rum, sugar, cocoa, and coffee, its boulevards lined with handsome homes and showy shops, Saint-Pierre, as Hovey found it, was now a smoldering ruin with barely a brick left standing. Lying as the city did in a cul-de-sac in the path of incandescent volcanic discharge, Hovey wrote, Saint-Pierre and its residents had been "as helpless as an animal in a trap."



Museum geologist Edmund Hovey, second from right, at Mt. Soufrière volcano in 1902.

© AMNH



Rubble covers a side street in northern Saint-Pierre in 1902.

© AMNH

The eruptions were of a type called *nuée ardente*, French for “glowing cloud.” Magma or molten rock, supercharged with gases, is less dense than rock and so rises to the surface through cracks and crevices. If the gases can boil off gradually at the surface, the potential force is diffused, sometimes creating the effusive flow of lava we tend to associate with volcano eruptions. But in a *nuée ardente*, the gaseous magma is blocked and pressure builds until it is eventually released as a dense, swirling mass of hot gas, incandescent dust, and rock fragments known as a pyroclastic flow.

The explosive cloud can first rise high into the air and then collapse downward, as Pliny the Younger observed in what is thought to be the earliest recorded description of a volcanic eruption. In letters written years after the AD 79 eruption of Vesuvius, the Roman magistrate gave a remarkably detailed description of what he had seen as an 18-year-old across the bay. Vesuvius is sited east of what is now Naples, Italy, and the AD 79 *nuée ardente* killed some 20,000 people in the towns of Pompeii and Herculaneum.

Add water to the mix – as at Mt. Soufrière, which was known for its beautiful crater lake – and the result is the addition of a mudflow, or lahar. The mass of gaseous magma also can create chemical changes that eat away at rocks, weakening them, until the cloud of ash and gas blows out the mountainside before rushing fast and furiously downward. This was documented firsthand at Mount St. Helens in 1980 and is believed to have happened at Mt. Pelée in 1902.

“This type of volcano is the most explosive, literally analogous to twisting off the top of a soda bottle,” explains geologist James Webster, curator in the Department of Earth and Planetary Sciences. “When the mountain is ripped open, the volcanic blast is faster and potentially more deadly because it has less distance to travel to reach the surface... What Hovey observed about trees at Mont Pelée is consistent with Mount St. Helens.”

Hovey described an odd sight. “The line between scorched and unscorched areas was strikingly sharp,” he wrote. “In many places the line of demarcation passed through single trees, leaving one side scorched and brown while the other side remained as green as if no eruption had occurred.”

During his Martinique expedition, Hovey also collected and sent back to the Museum invaluable specimens, molten household objects, pulverized street signs, and lumps of halfmelted lava – called “bread-crust bombs” for their cracked tops – which had been thrown out of the volcano during the eruption.



© AMNH/D. Finnin

This “bread-crust bomb” was formed when a partly molten mass of lava cooled and contracted causing the solid exterior to crack.



© AMNH/D.Finnin

A stack of café glasses were fused together by the heat of the deadly volcanic cloud.



© AMNH/D.Finnin

Heat and pressure softened and twisted this Champagne bottle.



© AMNH/D.Finnin

A glass doorknob melted on one side, just as trees observed by Hovey were scorched on one side and, on the other, "green as if no eruption had occurred."

At the time, volcanology was still in its infancy. A crude seismometer was first introduced in 1840, but even with that technology, scientists simply lacked a clear understanding of how volcanoes erupt. "Since that time we have learned much more about gases, the relationship between seismic activity and magma movement, even about gas opening the rock and providing a pathway for magma to follow," says Dr. Webster.

Hovey's research was part of that long, steady progression toward a better understanding of volcanoes, of which better prediction is the goal and in which the Museum continues to play an important role. Webster, for example, has explored Vesuvius eight times and teaches a course in Naples every fall. The Museum's collection of samples from Vesuvius is among the best in the world, after the University of Naples Federico II and the University of Pisa.

With little knowledge of how volcanic eruptions occurred, the residents of Mt. Pelée woefully underestimated the risks of living in its vicinity and ignored signals that it was still active. Occasional spewings of steam and ash were taken less as a warning than an occasion for picnics near the mouth of the volcano. As J. Chatenay of Seaboard National Bank, who had lived in Saint-Pierre until shortly before the 1902 eruption, told *The World* newspaper on May 10, 1902: "No one ever thought of fearing the volcano, which all thought to be extinct...The people wandered about by thousands, never dreaming that there was any danger."

Even ominous signs in the months and weeks before the May 8 eruption failed to raise adequate alarm. On April 23, earthquakes dislodged dishes from shelves in Saint-Pierre. The next day, fine ash fell for two hours on a town nearby. On May 2, a lightning-lit column of ash and fumes rose nearly two miles high above the mountain, and an inch of ash covered Saint-Pierre. On May 5, a mudflow from the volcano killed 23 people north of the city, and a tsunami reached the harbor 15 minutes later. On May 6, the mountain flung huge molten rocks in the air.

Given the state of the science in the 1900s, the people of Saint-Pierre couldn't possibly have foreseen what was to befall them. But even today, with better science to back up predictions, an estimated half a billion people live within range of an active volcano, including more than 4,000 townspeople of the rebuilt Saint-Pierre and, perhaps more strikingly, roughly 4 million people who live in and around Naples. In fact, Naples recently built an emergency response hospital on the slopes of Vesuvius. "It's a strange concept," says Webster. "The first place you'd go is the first place that would be destroyed."

Bear in mind that as natural disasters go, the risks worldwide associated with earthquakes and hurricanes are orders of magnitude greater in loss of life and property damage than those associated with volcanic eruptions. Earthquakes alone affect the lives of some five million people a year. And where volcanoes are being monitored, scientists can generally predict eruptions in advance.

Still, the prospect of evacuating a population as dense as that around Vesuvius is daunting. In modern history, Vesuvius had relatively large eruptions in 1631 and 1944, with smaller ones in between – so it is by no means dead. But complicating the assessment of actual risk is the difficulty humans have appreciating geological time scales in which patterns are measured not in decades but in thousands and tens of thousands of years. In addition, even scientists disagree. Vesuvius operates on a very long cycle of major eruptions every 500 to 1,000 years, says Webster, and there is one camp that theorizes a large eruption is not imminent and another that believes Vesuvius could erupt catastrophically soon.

Asked which side he falls on, he says, "I don't know enough. But it definitely warrants heavy monitoring."

This reading was adapted from Rotunda, the member magazine of the American Museum of Natural History. Fall 2014.

Student Worksheet

This exhibition contains four sections about four natural hazards: earthquakes, volcanoes, tornadoes, and hurricanes.

As you explore each section, record information about that type of hazard and about the impact of specific events on human populations.

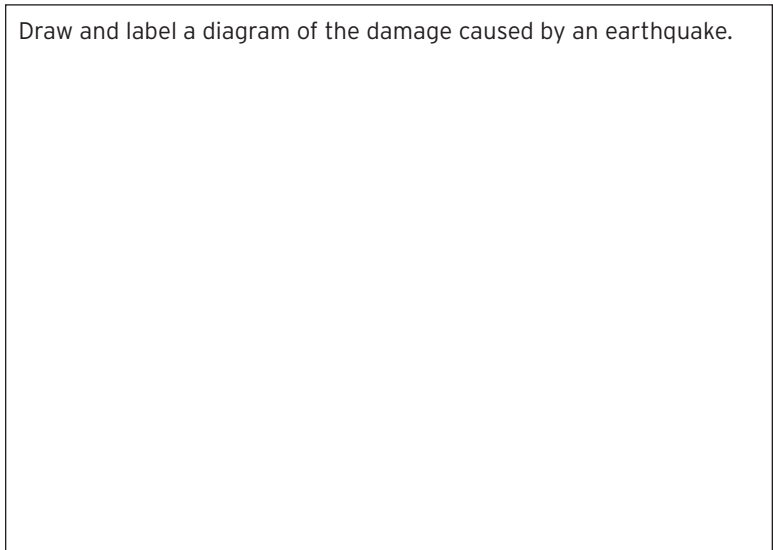
1. Earthquakes

How do earthquakes harm human populations?

Pick one earthquake and record where and when it took place:

How did this earthquake impact the people who lived there?

Draw and label a diagram of the damage caused by an earthquake.



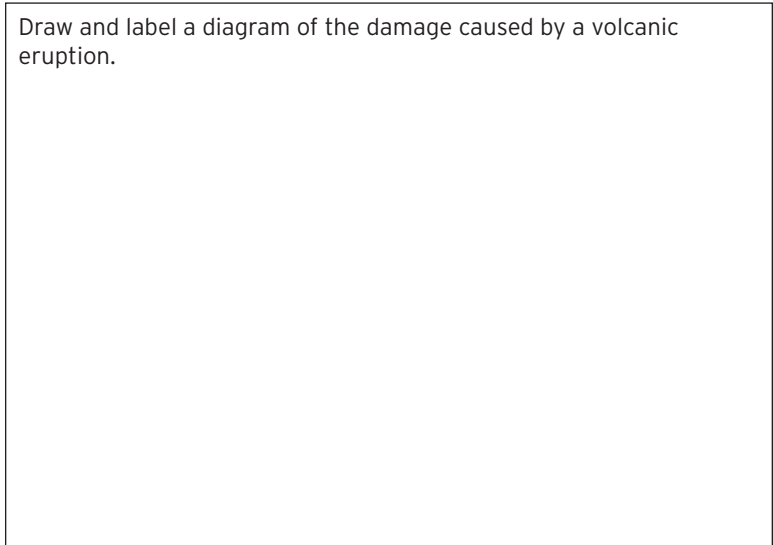
2. Volcanoes

How do volcanoes harm human populations?

Pick one specific volcanic eruption and record where and when it took place:

How did this eruption impact the people who lived there?

Draw and label a diagram of the damage caused by a volcanic eruption.



3. Tornadoes

How do tornadoes harm human populations?

Pick one specific tornado and record where and when it took place:

How did this tornado impact the people who lived there?

Draw and label a diagram of the damage caused by a tornado.

4. Hurricanes

How do hurricanes harm human populations?

Pick one specific hurricane and record where and when it took place:

How did this hurricane impact the people who lived there?

Draw and label a diagram of the damage caused by a hurricane.

Epilogue

In this final section, select one quote and record this person's name and location:

What did this person say about being in the path of a natural hazard?

How do you think this person will respond to that threat in the future?

ANSWER KEY

Student Worksheet

This exhibition contains four sections about four natural hazards: earthquakes, volcanoes, tornadoes, and hurricanes.

As you explore each section, record information about that type of hazard and about the impact of specific events on human populations.

1. Earthquakes

How do earthquakes harm human populations?

(Earthquakes can cause structures to collapse and may also cause tsunamis.)

Pick one earthquake and record where and when it took place:

(Sample answer: San Francisco, 1906)

How did this earthquake impact the people who lived there?

(Sample answer: More than 28,000 buildings were destroyed and 3,000 people died.)

Draw and label a diagram of the damage caused by an earthquake.

2. Volcanoes

How do volcanoes harm human populations?

(Lava, hot gases, and mudslides from eruptions can harm humans and destroy buildings. They can also cause tsunamis, and even affect global climate.)

Pick one specific volcanic eruption and record where and when it took place:

(Sample answer: Krakatoa, Indonesia, 1803)

How did this eruption impact the people who lived there?

(Sample answer: This eruption created a massive tsunami that killed more than 38,000 people.)

Draw and label a diagram of the damage caused by a volcanic eruption.

ANSWER KEY

3. Tornadoes

How do tornadoes harm human populations?
(Winds of more than 200 miles per hour can destroy homes and other structures.)

Pick one specific tornado and record where and when it took place:

(Sample answer: Greensburg, 2007)

How did this tornado impact the people who lived there?

(Sample answer: 95% of the structures in the town were destroyed and 10 people died.)

Draw and label a diagram of the damage caused by a tornado.

4. Hurricanes

How do hurricanes harm human populations?
(Hurricanes can destroy structures with powerful winds, and also cause widespread flooding.)

Pick one specific hurricane and record where and when it took place:

(Sample answer: Galveston hurricane, 1900)

How did this hurricane impact the people who lived there?

(Sample answer: Entire towns were destroyed and more than 8,000 people died.)

Draw and label a diagram of the damage caused by a hurricane.

Epilogue

In this final section, select one quote and record this person's name and location:
(Sample answer: Joseph S., Staten Island)

What did this person say about being in the path of a natural hazard?
(Sample answer: "If you stay, you're rolling the dice. And I don't feel lucky.")

How do you think this person will respond to that threat in the future?
(Sample answer: "He will leave and move to a location that is less exposed to hurricanes.")

Student Writing Guidelines

Based on the article "Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster," your visit to the *Nature's Fury* exhibition, and your discussions, write an essay in which you describe the eruption of Mt. Pelée and one other natural disaster and explain the impact that they had on human populations.

Be sure to include:

- a description of the eruption of Mt. Pelée and the impact it had on human populations
- a description of an earthquake, hurricane, or tornado, and the impact it had on human populations
- labeled diagrams of each natural hazard event

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 natural hazards.
- I clearly named two natural hazards and described how they impacted human populations.
- I included labeled illustrations of two different events.
- I only included relevant information about natural hazards.
- I used information from "Expedition to a Modern Pompeii: Museum Geologist on the Scene of a 1902 Disaster" to explain natural hazards in detail.
- I used information from *Nature's Fury* to explain natural hazards 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. |
| | 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. |
| | 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. |
| | 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. |