

Protecting People from a Volcanic Eruption

INTRODUCTION

Use this document to facilitate student work as they complete this Project-Based Learning (PBL) Pack. Students will complete the *PBL Project Organizer* sheets as they progress through the project. See the *PBL Overview* for more in-depth instructional tips for teaching with Project-Based Learning Packs.

PBL Topic: Protecting People from a Volcanic Eruption

This PBL Pack is part of the Changing Landforms unit (grades 5–6) and focuses on how volcanic eruptions affect land and people.

Driving Question: How can you protect people from a volcanic eruption?

PROJECT OBJECTIVES

- Students will learn about how and where volcanoes form and the impacts that volcanic eruptions have on the surrounding land.
- Teams will select and research a volcano on Earth that has a human population living nearby.
- Each team will develop a plan to protect the nearby human population from the volcanic eruption.
- At the culmination of the project, teams will prepare and deliver a presentation to share the outcome of their project with the class. The presentation will ideally incorporate technology and the arts.

CONNECTIONS TO NEXT GENERATION SCIENCE STANDARDS*

Below is a list of key national science standards supported by this pack.

Performance Expectations

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Science and Engineering Practices

Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions
Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas

ESS2.B: Plate Tectonics and Large-Scale System Interactions

The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.

ESS3.B: Natural Hazards

A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

Crosscutting Concepts

Systems and System Models (the geosphere, or solid parts of Earth, represents a system)

Cause and Effect (volcanic eruptions cause changes that can affect people)

CONNECTIONS TO COMMON CORE STATE STANDARDS

Below is a list of selected key ELA/Literacy standards supported by this pack.

- RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
- RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.
- W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

CONNECTIONS TO 21ST CENTURY SKILLS†

- Work Creatively with Others: Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
- Communicate Clearly: Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
- Use and Manage Information: Use information accurately and creatively for the issue or problem at hand
- Apply Technology Effectively: Use technology as a tool to research, organize, evaluate and communicate information

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PROJECT TIMELINE

The following timeline is a guide to help prepare for and schedule this Project-Based Learning Pack. It is meant to be used as an approximate guide and can be adapted to meet the needs of the class. The project timeline will vary, depending on the number of Science A–Z resources used to build background and the time allocated for students to develop their project.

Activity	Estimated Time	Date(s)
GETTING STARTED		
Introduce the Topic (p. 3)	1 day	
Conduct an Entry Event (p. 3)	1–2 days	
Preteach Vocabulary (p. 4)	1 day	
Build Background Knowledge (p. 4)	5–15 days	
PLAN AND CREATE		
Plan the Project (p. 7)	1–2 days	
Pitch the Project (p. 7)	1 day	
Develop and Conduct the Project (p. 8)	5–15 days	
PRESENT, ASSESS, AND EXTEND		
Practice the Presentation and Complete Peer Review (p. 8)	1–2 days	
Present and Assess the Final Project (p. 9)	2–3 days	
Extensions and Variations (p. 9)	0–5 days	
ESTIMATED TOTAL SCHEDULE		
4–8 weeks		

BACKGROUND AND MISCONCEPTIONS

Use this section as a resource for more background knowledge about volcanoes and to clarify the content for students if misconceptions arise. The *Unit Guide* from the Changing Landforms unit provides additional background information for this PBL Pack.

Q: *What is inside Earth?*

A: Earth has three primary layers: the core, the mantle, and the crust. The core is in the center of Earth. The outer layers of Earth press and squeeze the core tightly, putting it under extreme pressure. The core is also intensely hot—as hot as the surface of the Sun! Moving outward, the next layer is the mantle. The mantle is the thickest layer of Earth. It is 2,900 kilometers (1,800 mi.) thick and makes up almost 80 percent of Earth’s volume. The mantle is made of weak rock that is kept hot by the heat of Earth’s core and has the texture of playdough. On top of the mantle lies the relatively thin, outermost layer of Earth—the crust. The crust is Earth’s hard outer shell. It is where landforms, including volcanoes, are found.

Q: *Should I be concerned if I live near a volcano?*

A: Many volcanoes are dormant (not active), and others are considered extinct or dead. These volcanoes pose very little risk, if any, to people. But if you live near an active volcano, it would pay to be prepared for a volcanic eruption. Living near a volcano is much like living in other areas, such as earthquake zones, that have a higher likelihood of natural disasters. It is important to have an emergency plan, just in case. Scientists called *volcanologists* help by alerting communities when data indicate that a volcano is highly likely to erupt. They measure volcanic gases, seismic activity (earthquakes and tremors that occur before a volcano erupts), steam vents, and new cracks or other changes in Earth’s surface. Volcanologists can often alert people of a possible eruption in time for evacuation.

Q: Can volcanic eruptions be dangerous even if you aren't at the base of the volcano?

A: Yes. Oozing lava can overtake structures and roadways, putting nearby people in danger. Some lava, such as aa lava, moves very quickly. It can spew from a volcano and overtake homes up to 6 kilometers (3.7 mi.) away. Depending on the location of the volcano, the lava can reach the ocean, where lava haze, called *laze*, forms. This haze is made of poisonous gas that can kill people who inhale the vapors. Other volcanic eruptions can send a large amount of ash into the air, covering both land and bodies of water. This can pose serious health risks for people, particularly those with breathing problems.

Q: Are volcanic eruptions always considered bad or harmful?

A: No, not always. Volcanoes create new land. Kilauea is a volcano located on the Big Island of Hawaii. Kilauea's lava moves quickly and spreads down the steep volcano to the sea. When the lava meets the sea, it is cooled by the water and turns from liquid to solid. The lava becomes either solid rock or sand, thus creating new land. The Big Island is the youngest of Hawaii's islands and is still growing.

GETTING STARTED

Introduce the Topic

Place students in teams. They will remain in these teams for the duration of the project. Having an odd number of students on each team will help avoid split votes when decisions need to be made.

Give each team a copy of the entire Changing Landforms *PBL Project Organizer*. Explain to students that they will fill in different pages as they complete this project. Consider also printing out an enlarged version of *PBL Sheet 1: Project Outline* to display in the classroom for the duration of this PBL Pack.



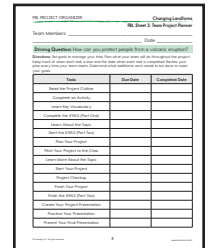
TIP Prepare each team's *PBL Project Organizer* by printing it and placing it in a folder or binder. It may be useful to hand out these folders at the beginning of each class session and collect them for storage each day.

Begin by asking teams to read *PBL Sheet 1: Project Outline*.

Explain to students that as they work on this project, they will learn about volcanic eruptions and the effect they have on the land and people. This information will help students complete their project and ultimately answer the Driving Question.



Introduce *PBL Sheet 2: Team Project Planner*, which students can use to track milestones and be sure the project remains on schedule. Assign due dates and have students fill in the due date for each task. As each team finishes a task, have students record the date in the last column.



Conduct an Entry Event

Lead an entry event that supports the Driving Question: How can you protect people from a volcanic eruption?

Sample Entry Events

Select one or more entry events to help students start thinking about the PBL Pack topic. Encourage students to use key vocabulary related to the topic (see Preteach Vocabulary).

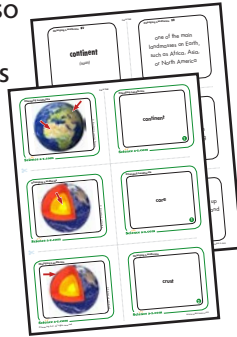
- **FOCUS Book:** Complete the back-cover activity from the *Heat of Kilauea FOCUS Book* in which students model how lava flows down volcanoes. Set up stations in the classroom with the materials needed to complete the activity. This activity will prepare students to develop their PBL project.
- **Field Trip:** As a class, go to a local science museum to explore exhibits and information about plate tectonics and volcanoes. Alternatively, search online for simulations and videos of these natural forces.
- **Vocabulary Games:** Complete the *Changing Landforms Game Pack*, which is centered around the *Image Cards*. Divide students into teams and lead games and activities from the *Game Pack Guide*. Games and activities such as Word Sort, Which Word, Story Train, and Wordo expose students to unit vocabulary and prepare them to develop their PBL project.

Preteach Vocabulary

Refer students to *PBL Sheet 3: PBL Vocabulary*. Have them read the Background, Problem, and Driving Question again. Ask students to identify any important or unfamiliar words related to the topic. Have them write the words in the *Words About the Topic We Need to Learn* section. Ask students to identify any other important or unfamiliar words, including academic vocabulary, and write them in the *Other Important Words We Need to Learn* section. Ask teams to look up each word's definition and write the meaning next to it.

The terms listed below appear in one or more of the Recommended and Supplemental Resources. Have students add these terms to their vocabulary sheet or *SAZ Journal*. You may also choose to display key vocabulary on a Word Wall for ongoing access during the Entry Event and throughout the entire project.

Use the Changing Landforms *Vocabulary Cards* and *Image Cards* to teach related content vocabulary in multiple ways.



Enriching Vocabulary

dormant	not active but able to become active again
erupt	to forcefully eject something that has been stored, such as lava from inside a volcano
magma	melted, liquid rock beneath Earth's surface
plate tectonics	the theory that the plates of Earth's crust move due to movement in Earth's mantle
volcano	a place in Earth's crust where gases, ash, and/or lava spew onto the surface

Academic Vocabulary

benefit	help, profit, or an advantage gained from something
context	the conditions that surround a situation or event
demonstrate	to show another person how something works
protect	to guard or defend from harm or danger
strategy	a careful plan for solving a problem or achieving a goal

Build Background Knowledge

Before students begin research, introduce *PBL Sheet 4: KWLS (Part One)* and explain the purpose of its sections. Have students write what they already know about the topic (K section) and what they still want to know (W section).

Begin by having students read the *Nonfiction Book* titled *Earth's Changing Face* to provide a foundation of understanding about the science content. Select the most appropriate reading level—high, mid, or low—for each student.

The *Nonfiction Book Teacher's Guide* provides a guided reading lesson plan to accompany the books, including vocabulary support and a set of discussion questions differentiated by reading level.




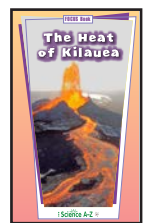

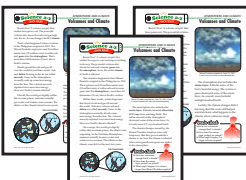



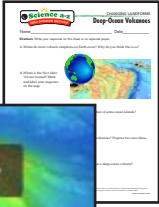


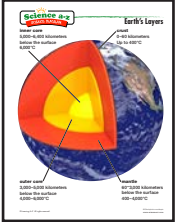
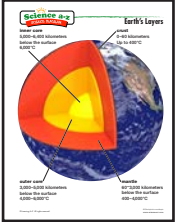


The other recommended resources listed below will provide additional information and practice for students before they begin their project. In addition, consider using the supplemental resources listed in the chart to further develop students' understanding of and experience with the content.

The *PBL Project Organizer* used by student teams contains a similar list of resources on *PBL Sheet 5: Recommended Reading*. As students plan their project, they may need to conduct more research or may come up with new questions that can be answered by selecting from these additional resources. Some resources listed below do not appear on the student list, since they require teacher management.

To view a list of all the resources from the Changing Landforms unit, use the *Unit Resource List* or visit the unit page on the Science A-Z website.

Recommended and Supplemental Resources – Teacher's List

Recommended			
Resource Type	Title	Summary	Preview
Nonfiction Book	<i>Earth's Changing Face</i>	This book explores some of the many ways our physical planet changes, including by volcanic eruption. It is offered at three reading levels.	
Vocabulary Cards	<i>Changing Landforms Vocabulary Cards</i>	Unit vocabulary terms are defined on clipable cards, along with parts of speech and the levels of reading materials in which each term appears.	
Quick Read	<i>From Fire to Land</i>	This one-page sheet describes how volcanic activity in the Hawaiian Islands results in land formation. It is offered at three reading levels.	
FOCUS Book	<i>The Heat of Kilauea</i> (Grades 3–4 Heat Energy unit)	This book explains that magma reaching Earth's surface via hot spots can create active and hazardous volcanoes such as Kilauea.	
I.File	<i>Lava</i> (Grades 3–4 Solids, Liquids, and Gases unit)	This two-page file describes how lava flows from active volcanoes and the dangerous conditions that lava can produce.	
Quick Read	<i>Volcanoes and Climate</i> (Grades 5–6 Atmosphere and Climate unit)	This one-page sheet explores the atmospheric effects of volcanic eruptions. It is offered at three reading levels.	

Supplemental			
Resource Type	Title	Summary	Preview
Science Video	<i>Deep Ocean Volcanoes</i>	This video shows the West Mata volcano during an active eruption. Discussion questions are included.	 
Career File	<i>Volcanologist</i>	This one-page file describes the dangerous and important work of volcanologists—people who study volcanoes.	 
Science Diagram	<i>Earth's Layers</i>	This diagram illustrates the layers of Earth and represents the extreme heat of the core and mantle.	 
Science Video	<i>MLK Fountain</i>	This video (no sound) shows lava flowing from the MLK Vent on the Pu'u 'O'o volcano in Hawaii. Discussion questions are included.	 

Additional Research

Students may need to conduct additional research before planning their project and while working on the project as a team. Some of this research can be done in a library, and some can be done online during a supervised search. The following are examples of websites that may be useful resources for students as they complete this PBL Pack:

- <http://geology.com/volcanoes>
Watch videos and read information about volcanoes and volcanic eruptions.
- <http://spaceplace.nasa.gov/volcanoes2/en>
Explore NASA's Space Place website for information about volcanoes on Earth and elsewhere in the solar system.

What Have We Learned?

After teams conduct research, have them fill in *PBL Sheet 6: KWLS (Part Two)* by writing what they have learned about the topic (L section) and what they still want to learn (S section). Encourage students to refer back to this list of questions as they complete the project, and have them conduct additional research if needed.

PLAN AND CREATE

Plan the Project

Facilitate a class discussion to summarize what students have learned so far and discuss how this information will help them answer the Driving Question. Refer to *PBL Sheet 1: Project Outline*.

Using the information students learned during the Getting Started activities, encourage each team to brainstorm at least three project ideas that would solve the Problem while meeting all the project constraints. Teams should discuss how they would complete each project, including the materials they would need. Have students record all ideas in the table on *PBL Sheet 7: Project Ideas* without rejecting any student's ideas.

Next, challenge each team to evaluate its list of ideas to determine which will make the best project. Teams may find certain project ideas fun or appealing, but remind them that the best project will satisfy all requirements in the Project Outline. Review the project guidelines, including requirements regarding materials, time, cost, and any other constraints. Have teams circle their project selection and explain their decision at the bottom of the sheet.

Introduce *PBL Sheet 8: Project Description*. Instruct teams to describe the project they have chosen. They should give their PBL project a name that describes what they will do or learn. Then have students briefly explain what they plan to do and how they expect to do it. Finally, have them list the materials they think they will need. Explain that the list may change as they work on the project.

Pitch the Project

Have each team present its Project Plan to the class for review (refer to *PBL Sheet 8: Project Description*). One team at a time should explain to the class how it plans to complete the project and what materials it will use. Students should describe how their project will help answer the Driving Question while working within the project constraints.

Invite other students in the class to provide constructive feedback to the team presenting its project idea. The other students should make suggestions on how to improve portions of the project. The presenting team should record comments from classmates on *PBL Sheet 9: Pitch Your Project*. Allow each team to present its plan and record peer feedback.

Next, have each team review the comments it received and discuss how these ideas might affect the project plan. Once students agree on any changes, have them record their revised plan at the bottom of *PBL Sheet 9*. Before each team begins project development, review each team's plan. Ensure that the activities are safe, can be completed within the allotted time frame, are of suitable complexity, adhere to any project constraints, and are designed so that all team members will contribute.

Additional Research

If new questions arise, students may need to conduct additional research on their project topic. Consider using Science A–Z resources listed in the supplemental section of the Recommended and Supplemental Resources chart. Also help students locate resources in a library, online, or in the community.

Develop and Conduct the Project

Refer to the *PBL Overview* for management tips to help teams get their project started and how best to facilitate their work as they develop their project.

Review *PBL Sheet 2: Team Project Planner* to help students stay on track with project milestones.

Encourage students to use their *SAZ Journal* to record notes, draw sketches, and revise project plans.

Project

Students will investigate how current volcanic eruptions behave and how they can impact or even destroy the surrounding area. Teams will conduct research and select an actual volcano with a human population nearby, then devise a plan to protect the people from a future eruption. They will build a model of the volcano and nearby population centers in order to demonstrate how their plan could protect the people who live there. Ideas might include a barrier to protect roadways, a way to reroute flowing lava, a lake to cool the lava, or a fireproof shelter to protect people during an emergency. People might also wear masks to protect themselves from ash and smoke.

Materials

Listed below are materials that students may need during the course of this project. Teams may propose different or additional materials they need to complete their projects based on their unique plans.

- | | |
|---|---|
| <input type="checkbox"/> clay or plaster of paris | <input type="checkbox"/> empty plastic bottle |
| <input type="checkbox"/> baking soda | <input type="checkbox"/> paper towel rolls |
| <input type="checkbox"/> vinegar | <input type="checkbox"/> cardboard |
| <input type="checkbox"/> food dye | <input type="checkbox"/> craft sticks |

Project Checkup

Facilitate a touch-base meeting with each team partway through the project to ensure that the team is on track to successfully complete the project on time. Introduce *PBL Sheet 10: Project Checkup* and have each team complete the form.

What Have We Learned?

During and after the project, have students update *PBL Sheet 6: KWLS (Part Two)* by writing additional facts they have *learned* about the topic (L section) and what they *still* want to learn about the topic (S section).

PRESENT, ASSESS, AND EXTEND

Practice the Presentation and Complete Peer Review

Once teams have completed work on their project, they will get ready to present it to the class. First, have them plan their presentation as a team. Have them refer to *PBL Sheet 11: Presentation Rubric* and *PBL Sheet 12: Practice Presentation and Peer Review* as guides so they are aware of the expectations and elements of a good presentation. Provide time for preparation and practice.

Discuss various options that teams might choose from to prepare a presentation, such as:

- Leading a talk with visual aids (display board, posters, dioramas, digital artwork, data, and so on)
- Producing a digital slideshow using presentation software
- Presenting a physical model and explaining its structure and function
- Producing a video and playing it for the class
- Performing a role-play or skit
- Writing a report and discussing it with the class

Teams should include the following in their presentation:

- Description of the project
- How they addressed the Driving Question
- How well they worked within the project constraints
- Materials used
- Steps followed
- Challenges faced
- How they dealt with challenges
- How well they worked as a team
- What they learned during the project
- What new investigable questions they have

Peer Review

The purpose of the peer review is to allow teams to practice and improve their presentations before speaking to the whole class. Pair each team with another team and ask the two teams to practice presenting to each other. Each team should complete *PBL Sheet 12: Practice Presentation and Peer Review* after receiving feedback from the other team.

Present and Assess the Final Project

Final Presentations

After practicing, each team will deliver its final presentation to the class. Allow teams time to review the peer-review suggestions from their practice presentation and incorporate this feedback into their planning for the final presentation.

Give each team between 5 and 10 minutes to deliver its final presentation. Encourage the audience to ask questions of the team after the presentation.

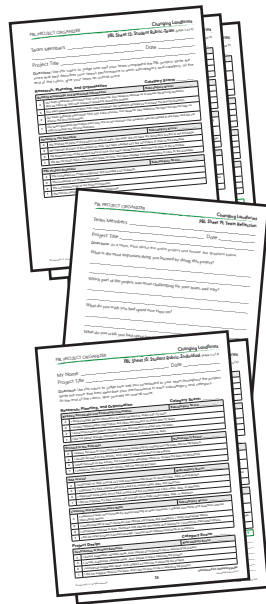


Consider inviting guests to observe the presentations and provide feedback. These may include content-area experts, scientists, engineers, community members, parents, or students from other classes.

Team and Individual Self-Assessment

After the final presentations, have teams complete *PBL Sheet 13: Student Rubric-Team* and *PBL Sheet 14: Team Reflection*. Also distribute a copy of *PBL Sheet 15: Student Rubric-Individual* to each student. Have students evaluate their team's performance and their own contributions to the project.

Collect each team's completed *PBL Project Organizer* sheets to assess how well students met the objectives of this Project-Based Learning Pack. Also collect each student's *SAZ Journal* to evaluate his or her note-taking skills and individual contributions to the team.



Teacher Rubrics

In addition to the assessments completed by students, use the *Teacher Rubric-Team* and *Teacher Rubric-Individual* to complete your own evaluation of each team and student.

Extensions and Variations

Extension activities are an important way for students to continue learning about a topic and to understand how it relates to the real world beyond the classroom. As each PBL experience concludes, new questions may lead to new project ideas. Unused ideas from the Sample Entry Events section may be used to

extend the learning. In addition to the following extensions and variations, also see the Extensions and Variations section in the *PBL Overview* for ideas that can be used with any PBL Pack.

- **Guest:** Invite a volcanologist or geologist to talk with students about how and why people study volcanoes as well as the science behind how and why volcanoes form where they do.
- **Field Trip/Multimedia:** If feasible, bring students to an area that shows evidence of past volcanic activity and have them analyze the rocks, shape of the land, and how plant life in this area might differ from other nearby locations. Alternatively, show videos and photographs of active volcanoes as well as areas where volcanoes were active long ago.
- **Geography:** Encourage each team to continue learning about actual volcanoes around the world. Have each group develop a world map with volcanoes labeled, or have all the groups collaborate to create a class map of the world's most active volcanoes. Encourage students to look for and explain patterns of where volcanoes are found.
- **History:** Have students conduct research on significant volcanic eruptions throughout recorded history and then create a timeline of these events. Instruct students to include the date, location, and key details of each eruption.
- **Writing:** Challenge each student to write a persuasive letter to the citizens of the community they studied during this PBL project, encouraging them to make plans and preparations to protect themselves in the event of a future volcanic eruption. See *Writing A-Z* for extensive writing instructions.
- **ELL/ESL/Social Studies:** Challenge each group to learn about the language and culture of the location they studied in this PBL Pack. What do the people call the volcano, and how has it become part of their local customs, storytelling, and everyday life? Have teams present what they learned in creative ways.
- **Variation:** This PBL Pack focused on protecting people from volcanic eruptions. Extend the learning by having teams study other Earth forces that can affect people—such as earthquakes and landslides—and design ways to protect people from these dangerous geologic events.