5. SEDIMENT MOVES

MOUNT ST. HELENS INSTITUTE

Learning Experience	In this lesson, students begin by receiving a question from a community member asking whether debris flows could occur even when the volcano is not erupting. As members of the city council, students are responsible to investigate this question to learn more about the hazard that debris flows present to their community. Students then visit with a scientist at the U.S. Geological Survey Cascades Volcano Observatory and learn more about how scientists study volcanoes. By viewing a variety of media content, including photographs, videos, and other interactive slides, students learn more about how sediment moves away from volcanoes. Students conduct their own investigation to explore what factors contribute to large or small debris flows from volcanoes. At the end of the activity, students write back a response to the question they initially received informed by what they learned. **Estimated time** 60 minutes (or two 30 min sessions) plus time for the student-led investigation. Investigation can be conducted at home or in the classroom, based on availability of materials and time. Instructions for the investigation including supplies are listed in the student Storypack.
Outcomes	**At the end of this activity, students should be able to:** • Observe, describe and explain erosion processes at volcanoes • Describe the difference between types of debris flows: smaller debris flows with less risk for human communities (debris flows) and larger debris flows with more risk for human communities (lahars) • Describe why volcanic debris flows have different names and think about the process of naming these phenomena • Develop a conceptual model of the erosion processes • Plan and carry out an investigation to learn about what factors influence the type of debris flows (smaller debris flows and/or lahars) that come from volcanoes • Identify ideas, evidence, observations, and further questions that they will later apply to the unit question "How can my community live safely with our volcano?"
Connecting Idea	Sediment carried by rivers that flow from volcanoes affects and sometimes damages human communities that live along these rivers. Sediment (broken up pieces of rocks and debris) is created on all mountains. Sediment from all mountains is carried from the mountain by rivers, rain, wind and other forms of erosion. Eventually all of this sediment is carried out to the ocean. Volcanoes produce especially large amounts of sediment because explosive eruptions create lots of pieces of broken rock (sediment). Volcanoes can contain glaciers, snow and ice on their slopes which are forms of water that can carry sediment down river valleys. Large amounts of sediment that are created by volcanoes during eruptions is more likely

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to be carried downstream because the deposits are not stable. Natural processes of erosion will inevitably wash these deposits downstream. Often volcanic sediments are on loose, steep slopes. It is very easy for all of this sediment to be carried by water and often large piles of sediment exist in river valleys where water is already carrying sediment downstream. It is helpful to think of sediment as being on a train that is always on the move, stopping at stations briefly, but always continuously moving downstream towards the sea.

Debris flows occur when large amounts of sediment are carried away from volcanoes by water. Debris flows occur when there is a larger amount of water than the average river flow. Debris flows can be triggered by many processes including heavy rainstorms, the melting of glaciers, or volcanic eruptions. Scientists and emergency managers classify debris flows in two categories: debris flows and lahars. Debris flows describe events that are relatively small and are not as likely to affect communities of people that live nearby. Lahar is an Indonesian word that describes large debris flows from volcanoes that have the potential to travel far from the volcano and to damage communities of people that live nearby. Scientists study debris flows from volcanoes to better understand how they affect human communities and to mitigate the effect of this hazard in future events.

Materials

Supplies

- **STUDENT STORYPACK**

Access to a variety of resources, including short videos and images, are provided in the student Storypack. These materials can be accessed and edited digitally by students by saving students individual copies of the slideshow or can be printed. Many of the video links are embedded within Google slides. These links are provided in the slide notes as direct links to view on Youtube.

This lesson includes a hands-on investigation that involves creating a model volcano with debris flows that can be conducted by the students at home or in the classroom. A complete list of suggested supplies is found in the student Storypack. Supplies include: plastic tray or stream table, materials to build a 3-D volcano, clay, sand, silt, pebbles or other

Setup

- ❏ **In-person**: Small groups follow along with viewing the videos, photographs and completing prompts in the student Storypack individually or in small groups. Throughout the activity, encourage students to discuss what they are learning with each other. Students can share their email responses in small groups or one-on-one by answering questions accompanying each piece of media in person. The investigation can be done individually by students at home or in small groups in the classroom. See recommendations for setup in the investigation section of the student Storypack for more information.

- ❏ **Remote learning**: Set up discussion group(s) in a learning management system. Students can share their email responses in small groups or one-on-one by answering questions accompanying each piece of media online. Encourage students to record what happened during their

	materials, and water. For recommendations on how to use FOSS Soils Rocks and Landforms Kit (distributed to schools through Education School District 112 in Washington State) to support the hands-on investigation, please view our "Supporting Sediment on the Move with FOSS Soils, Rocks and Landforms Kit" guide.	investigation using video so it can be more easily shared and viewed by their classmates.

Instructional Sequence

ENGAGE	After writing a newsletter article about what happened to a nearby community affected by debris flows triggered by a volcanic eruption, students receive a question from a member of their community asking whether debris flows can occur even when a volcano is not erupting. Students realize that they do not know how to answer this question. Students give a call to Jackie, a scientist, who invites them to visit the Cascades Volcano Observatory.
EXPLORE	To learn more, students are guided through a virtual visit to the U.S. Geological Survey Cascades Volcano Observatory in the student Storypack. Information on the narrative for this storyline is outlined in the student Storypack. Encourage students to roleplay in this exploration! At the volcano observatory, students evaluate a set of sources including photographs and videos that provide more information about the source of debris flows from volcanoes. Encourage students to share what they learn with each other or to work in small groups. Throughout the activity, students accumulate notes about what they are learning in a notebook embedded in the student Storypack. As students are filling out the slides titled "My Notebook" and are asked to think about processes of erosion in the real world, encourage students to go outside and observe these processes in their backyards, local parks, or school yards. Encourage students to think about the real-world career example provided of this volcano scientist and if they ever thought about this as a possible science career.
EXPLAIN	Students are asked to take notes on what they learned using the prompts provided in the student Storypack and also in the "My Notebook" slides of the student Storypack. Encourage students to share what they are writing with each other or in small groups. Provide some structure for students to provide feedback on the writing of others using post-it notes, digital comments, etc. Remind students how

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	to provide feedback in a supportive way and/or share information about the "feed-forward" model (https://www.cultofpedagogy.com/feedforward/).
EXTEND	Assist students in designing and leading their own investigation to explore how sediment moves from volcanoes. Specifically, students are asked to run their investigation to explore what factors can cause small or large debris flows from volcanoes. Instructions for the investigation are provided in the student Storypack. In the investigation, students are asked to construct a model volcano and layer it with sediment (rocks, sand, clay, flour, other materials). Students are then asked to make a model "debris flow" by investigating how water moves these materials (sediment) down the slope of their volcano. Encourage students to be creative with their materials and investigation setup. We specifically use the language "investigation" vs. "experiment" to encourage students to define their own setup, variables and to be creative in trying to answer the investigation question. The guidelines for this investigation intentionally align with the Next Generation Science Standards. Depending on where students conduct their investigations, encourage them to share what they did and what they learned with each other and to provide feedback on the experiment setup. Students are asked to run their investigation more than once and to modify their investigation design and setup.
EVALUATE	Ask students to review what they learned by taking their findings to their KLEWS chart. • In the L column, students answer the question: What did you learn about how sediment from volcanoes can damage communities? • In the E column, students are asked to list at least 3 pieces of evidence, observations, or data to support your explanation. • In the W column students are asked to write something that they still wonder. • In the S column students are asked to write about two new science words that you learned? What do these words mean? Encourage students to think about the guiding question of this activity: "Can debris flows occur even when a volcano is not erupting?" and to think about whether the activities and their investigation helped them feel more equipped to answer this question. Consider asking students to do further research using suggested links in the educator resource guide we include in this unit to allow for further student learning.

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	Student ideas, evidence, observations, and further questions apply to the unit question "How can my community live safely with our volcano?"

Standards & Assessment:

All of the activities in this unit support:

- **NGSS Performance Expectation 4-ESS3-2.** *Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*
- **CCSS.ELA-LITERACY.W.4.10** *Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.*

Standards for this activity:

	Standard	Assessment
NGSS Science and Engineering Practices	Planning and Carrying Out Investigations: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or to test a design solution.	
NGSS Disciplinary Core Ideas	ESS2.A Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity breaks rocks, soils, and sediments into smaller particles and move them around.	Use student responses from  that they write in their KLEWS chart
NGSS Crosscutting Concepts	Patterns: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.	
Social Studies Learning Standards	G1: Understands the physical characteristics, cultural characteristics, and location of places, regions, and spatial patterns on the Earth's surface.	

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Common Core ELA	LITERACY.W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly	
Common Core Math	N/A	

Modifications/Adaptations

- This activity introduces students to real-world science careers. Option for students to do independent research to learn more about the work of the U.S. Geological Survey Cascades Volcano Observatory at https://www.usgs.gov/observatories/cascades-volcano-observatory/who-we-are-and-what-we-do
- Note that in this unit we are being deliberate in the vocabulary we are introducing and using to describe debris flows. We explicitly do not use the term mudflow because that vocabulary word is too general and has been replaced by scientists with more accurate and descriptive words such as "debris flow" and "lahar." Mass movement of sediment and debris carried downstream by water is described as a "debris flow." The term "lahar" is used more specifically and has different uses in different regions. In the Pacific Northwest, the term lahar is used for the really big debris flows that affect people down valleys and debris flows is reserved for small seasonal events.
- Why do scientists have different names for "debris flows" and "lahars?" The difference in these names is used to describe debris flows that have different effects on human communities. ***Debris flows*** happen often on the slopes of the stratovolcanoes because they produce so much loose sediment on steep slopes. ***Lahar*** is a term used to describe debris flows of a certain size and scale, that can flow far from the volcano and affect human communities that live much further from the volcano.
    - The difference in how scientists and emergency managers name and describe these events can make a difference in how human lives and communities are affected.
    - This can be a great opportunity to talk about science vocabulary and why it is developed to be very specific. Scientists who study and communicate about these events have learned that it is important to be specific in how they describe debris flows. When "debris flows" and "lahars" are used interchangeably, people become confused about how they should react: whether they should move to high ground, or whether the flooding is just a recurring seasonal event.
    - Remember, debris flows (the movement of sediment/debris from the slopes of the volcano) are a very common geologic process! The term "mudflow" is still used at Mount St. Helens because that was a word that was used during the May 18, 1980 eruption, and that word has become "ingrained" in the way that people describe and remember events of that eruption. In the Pacific Northwest, the use of a single term has caused great problems due to uncertainty about whether a big or little event is occurring, and its nature. Note that in this unit we are being

deliberate in the vocabulary we are introducing and using to describe debris flows.

Credit

The scientist characters in the student Storypack are based on the work of real scientists from the U.S. Geological Survey Cascades Volcano Observatory who work monitoring sediment at Mount St. Helens and other volcanoes in the Pacific Northwest. The names and characters are fictional and are not based on the names of any real USGS employees. Learn more about the work of real scientists at the Cascades Volcano Observatory by watching their web shorts series: https://www.usgs.gov/observatories/cascades-volcano-observatory/web-shorts-videos which highlight the different work of volcano scientists.

This lesson introduces several new science vocabulary words: sediment, erosion, mudflow, debris flow, lahar. Note that the distinction between lahars and debris flows is fairly specific based on the region in which people are using this term. Scientists use the word lahar for large flows of eruption or landslide origin with potential to travel to densely populated valleys, and use the term debris flow for much smaller, more common events caused by glacier floods and precipitation, which generally stay closer to the volcano and do not flow as far downstream.

Learn more about these terms and how they are defined in this unit in our Glossary document: https://docs.google.com/document/d/1eo1WzFaO9Cj2yaE4Y-xEbNFIu5xrA5-F9Q6hRurkjfA/edit?usp=sharing