Mass Gas Blast

Outdoor Activity:

Time Commitment: 45 minutes to 1 hour
Trail: The Eruption Trail
Location: Johnston Ridge Observatory
Group Size: This is a very popular trail with the visiting public. Groups need to be respectful and not block the trail. The activity is Not recommended for groups larger than 30. Larger groups should divide into smaller groups and start at different time intervals to enhance learning opportunities and to prevent off trail travel caused by overcrowding.

Materials Needed: Pencil, clipboard or notebook to write on, download copies of the '*Mass Gas Blast'* worksheet for students and copies of '*Mass Gas Blast Answer Sheets'* for chaperones.

Materials Provided: Prop boxes are available to borrow at the front desk at the Johnston Ridge Observatory on a first come, first serve basis. Check on their availability upon arrival to the Johnston Ridge. They include: a transparent soda bottle to illustrate the concepts of gas dissolved in magma and pressure, pictures of Mount St. Helens before and after the bulge formed between March 20 and May 18, 1980, and of May 18th landslide and lateral blast, and ash, dacite lava and pumice rock samples.

Purpose:
Familiarize students with the role volcanic gasses play in explosive eruptions.

Goal:
Students will examine concepts such as pressure, weight, mass and volume as they observe tephra deposits and blast features along the Eruption Trail.

Objectives:
Students will use the facts provided on the worksheet and landscape features to identify May 18, 1980 lateral blast features and factors that influenced the lateral blast's movement, composition and impacts.

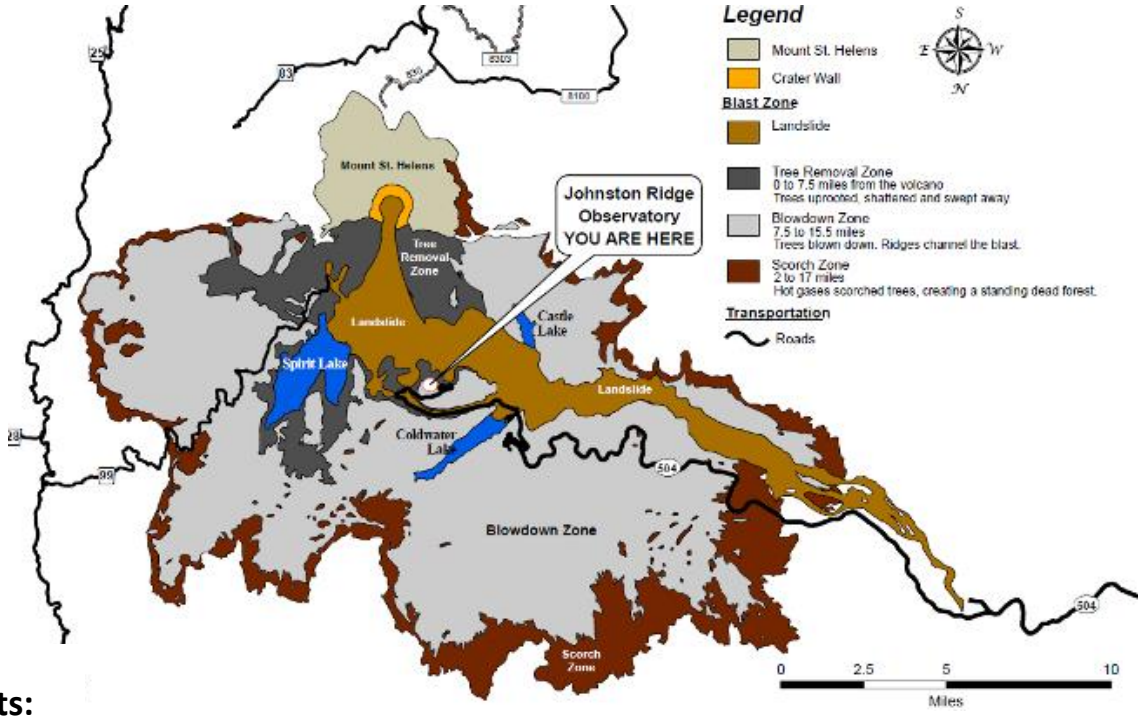
Washington Essential Academic Learning Requirements

Required Vocabulary:

1) **Landslide:** a rapid and unusually sudden sliding or flowage of unsorted masses of rock and other material moving under the force of gravity
2) **Lateral Blast:** a large explosion directed out of the side of a volcano containing a turbulent mixture of hot gas, ash, and rock that flow over the ground at high speeds under the influence of gravity.
3) **Basalt** a volcanic rock characteristically dark in color, containing 45 to 54% silica, and is generally rich in iron and manganese. Shield volcanoes like Kilauea in Hawaii typically erupt basalt lava.
4) **Andesite** a volcanic rock characteristically dark in color, containing 54 to 62% silica, and moderate amounts of iron and manganese.
5) **Dacite:** a volcanic rock usually light in color, containing 62 to 69% silica, and moderate amounts of sodium and potassium. Dacite erupted explosively from Mount St. Helens on May 18, 1980.
6) **Viscosity:** the ability any of any liquid to flow.
7) **Erosion:** The process in which soil and rock are removed from the Earth's surface by natural processes such as wind and water, and then transported and deposited to new locations.
8) **Tephra** is a general term for ash and fragments of volcanic rock explosively blasted out of a volcano.

Mass Gas Blast

Directions:
Read the facts listed below and observe landscape features to answer the questions.



Facts:

1) **Magma** pushed Mount St. Helen's north side out sideways 300 to 450 feet between March 20 and May 17, 1980. Stiff pasty gas-rich magma lay just beneath the bulging mountainside.
2) **Volcanic Gasses** dissolve in magma and exert pressure. The rapid expansion of these gasses--water vapor (H_2O), carbon dioxide (CO_2), sulfur dioxide (SO_2) and other rarer gases provide energy that blasts magma to Earth's surface during an explosive volcanic eruption.
3) **Pressure** is the force that a gas, liquid, or solid exerts on another. Extreme pressure exerted by the weight of overlying and surrounding rock dissolves gasses into magma.
4) **Weight** is the gravitational force acting on an object. i.e. The north side of Mount St. Helens exerted force on the bulging mountainside until 8:32 a.m. on May 18, 1980.
5) On May 18, 1980, the bulging mountainside collapsed in a landslide, causing gas bubbles in magma to burst and expand thousands of times their original size. Escaping gasses increased the volume of the magma 3 to 4 times and generated energy that powered a **lateral blast**.
6) **Mass** is the amount of matter in an object. Mass does not change when an object moves or if its' shape is altered, unless material is added or removed.
7) **Volume** is the quantity of three-dimensional space occupied by a liquid, solid or gas.

STOP 1: Find a stump or log beside the trail between the trailhead and the first interpretive sign and answer questions 1-7.

1) Use your fact sheet to determine the landslides and volcanic gasses role in providing the energy to power the lateral blast. Circle "T" for true or "F" for false.

   T or F The landslide released gas bubbles dissolved in the bulge magma from a low-pressure environment inside the volcano to a high-pressure one outside of it.

   T or F As gas bubbles dissolved in magma were released from pressure, they expanded and increased the total volume of the magma.

2) Speed = *Distance* divided by *Time*. If the lateral blast reached this site 5.5 miles from the volcano in 40 seconds, what was the blast's speed in miles per hour? Show your work.

3) "Tephra" is a general term for ash and fragments of volcanic rock explosively blasted out of a volcano. The tephra covering the ground here reveals the composition of the lateral blast. Observe and describe the characteristics of the tephra deposit.

   _____

   _____

4) Towering evergreen trees grew here before the eruption. The lateral blast created 3 distinct "impact zones". Make observations to determine the impact zone here. Circle your answer.

   A. *Tree Removal Zone:* Trees uprooted, shattered and swept away from 0 to 7.5 miles away from the volcano.

   B. *Blown down Zone:* Trees are blown down in distinct patterns. Ridges and topography channel or direct the blast 2.5 to 15.5 miles away from the volcano.

   C. *Scorch Zone:* Hot gasses scorch trees, creating a standing dead forest, 2.5 to 17 miles.

5) Did the total *mass* of debris in the lateral blast *increase, decrease or remain the same* as it surged through the forest on Johnston Ridge? Circle your answer.

Increase Decrease Remain the Same

6) What evidence do you use to support the answer to question 5?

_____

_____

7) Notice that the lateral blast killed trees on both sides of this and other ridges. Expanding gasses provided energy that enabled the blast to flow up and over ridges. Did the **mass** or the **weight** of the blast cloud exert force that held it to the ground? Circle your answer.

Mass Weight

STOP 2: A landscape locator is found at the circular plaza on the top of the hillside. Answer questions 8-14 at the circular plaza.

8) Find Coldwater Peak on the landscape locator and observe the blast features below and around it. Circle which "impact zone" Coldwater Peak belongs in.

A. *Tree Removal Zone:* Trees uprooted, shattered and swept away from 0 to 7.5 miles away from the volcano.

B. *Blown down Zone:* Trees are blown down in distinct patterns. Ridges and topography channel or direct the blast 2.5 to 15.5 miles away from the volcano.

C. *Scorch Zone:* Hot gasses scorch trees, creating a standing dead forest, 2.5 to 17 miles.

9) How is a blown down tree like a compass needle?

_____

_____

10) Slowly turn and look for blown down trees on Johnston and nearby ridges as you turn. Use the landscape locator to identify the direction the blown down trees lay. Circle your answer.

A. West

B. North-Northwest

C. North-Northeast

11) Find north on the landscape locator and observe the shape of the hillsides and patterns of blown trees. Circle "T" for true or "F" for false.

T or F Landscape features did not influence the direction the lateral blast traveled.

12) Use the landscape locator and find the scorch zone between Coldwater and Minnie Peaks. Note the fine line between standing dead trees killed by the blast and green living trees. Circle "T" for true or "F" for false.

T or F The weight of the blast cloud decreased as it traveled away from the volcano, because rock and debris dropped out. Hot gasses rose upward when the weight of the blast debris could no longer exert enough force to hold it to the ground.

13) Minutes after the eruption began at 8:32 a.m. a vertical column of gas and ash soared upward. If the ash column rose at a rate of 144 feet/second, how many minutes did it take to reach a height of 15 miles? Time = *Distance* divided by *Speed*. Show your work.

14) Use the landscape locator to find Windy Ridge and Spirit Lake. Lightweight pumice rocks dominate the tephra deposits from the vertical ash column at Windy Ridge, but pumice is not found at Johnston Ridge. Circle the answer that explains the differences in deposits.

A. The wind blew towards the north on May 18, 1980

B. The wind blew towards the east-northeast on May 18, 1980

C. Wind direction had no role in the difference in the depths of the deposits at each site.

Answer Sheet to Mass Gas Blast

STOP 1: Find a stump or log beside the trail between the trailhead and the first interpretive sign and answer questions 1-7.

1) Use your fact sheet to determine the landslides and volcanic gasses role in providing the energy to power the lateral blast. Circle "T" for true or "F" for false.

T or (F) The landslide released gas bubbles dissolved in the bulge magma from a low-pressure environment inside the volcano to a high-pressure one outside of it.

(T) or F As gas bubbles dissolved in magma were released from pressure, they expanded and increased the total volume of the magma.

2) Speed = *Distance* divided by *Time*. If the lateral blast reached this site 5.5 miles from the volcano in 40 seconds, what was the blast's speed in miles per hour? Show your work.

$$\textbf{Speed} = \frac{\textbf{5.5 miles}}{\textbf{40 seconds}} = \textbf{.1375 miles/second}$$

.1375 miles/second x 60 seconds/minute = 8.25 miles/minute

8.25 miles/minute x 60 minutes/hour = 495 miles/hour

3) "Tephra" is a general term for ash and fragments of volcanic rock explosively blasted out of a volcano. The tephra covering the ground here reveals the composition of the lateral blast. Observe and describe the characteristics of the tephra deposit.

Answers vary depending on where the student stops. The lateral blast deposit is composed of gray sand-sized ash particles, and pea to 18" in diameter light gray, dark gray and black rocks.

4) Towering evergreen trees grew here before the eruption. The lateral blast created 3 distinct "impact zones". Make observations to determine the impact zone here. Circle your answer.

A. *Tree Removal Zone:* Trees uprooted, shattered and swept away from 0 to 7.5 miles away from the volcano.

B. *Blown down Zone:* Trees are blown down in distinct patterns. Ridges and topography channel or direct the blast 2.5 to 15.5 miles away from the volcano.

C. *Scorch Zone:* Hot gasses scorch trees, creating a standing dead forest, 2.5 to 17 miles.

5) Did the total *mass* of debris in the lateral blast *increase, decrease or remain the same* as it surged through the forest on Johnston Ridge? Circle your answer.

Increase Decrease Remain the Same

6) What evidence do you use to support the answer to question 5?

Tree trunks, branches, bark and foliage were incorporated into the blast cloud as it shattered the forests, greatly increasing the mass of debris within the lateral blast. Forest fragments incorporated into the blast helped blow down forests further from the volcano.

7) Notice that the lateral blast killed trees on both sides of this and other ridges. Expanding gasses provided energy that enabled the blast to flow up and over ridges. Did the **mass** or the **weight** of the blast cloud exert force that held it to the ground? Circle your answer.

Mass Weight

STOP 2: A landscape locator is found at the circular plaza on the top of the hillside. Answer questions 8-14 at the circular plaza.

8) Find Coldwater Peak on the landscape locator and observe the blast features below and around it. Circle which "impact zone" Coldwater Peak belongs in.

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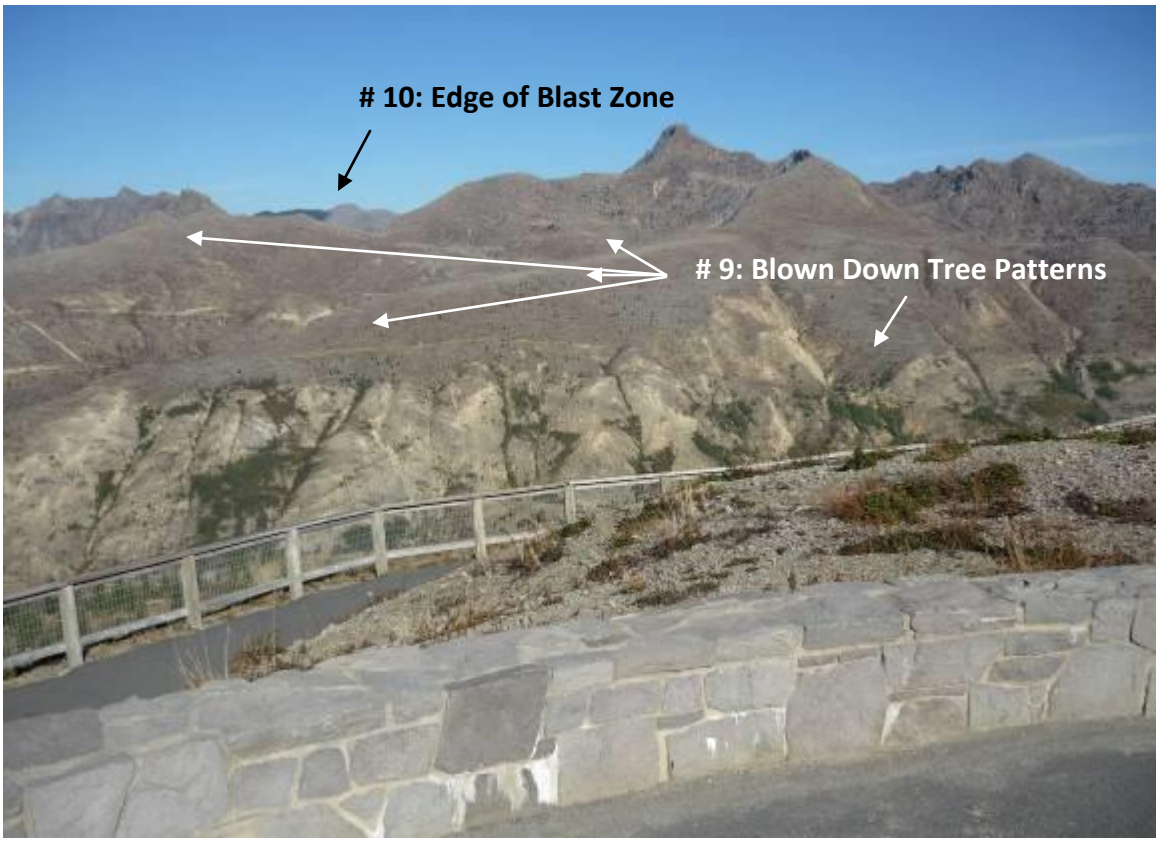
C. *Scorch Zone:* Hot gasses scorch trees, creating a standing dead forest, 2.5 to 17 miles.

9) How is a blown down tree like a compass needle?

The blown down trees point the direction the lateral blast traveled on May 18, 1980.



10) Slowly turn and look for blown down trees on Johnston and nearby ridges as you turn. Use the landscape locator to identify the direction the blown down trees lay. Circle your answer.

A. West

(B.) North-Northwest

C. North-Northeast

11) Find north on the landscape locator and observe the shape of the hillsides and patterns of blown trees. Circle "T" for true or "F" for false.

T or (F) Landscape features did not influence the direction the lateral blast traveled.

12) Use the landscape locator and find the scorch zone between Coldwater and Minnie Peaks. Note the fine line between standing dead trees killed by the blast and green living trees. Circle "T" for true or "F" for false.

(T) or F The weight of the blast cloud decreased as it traveled away from the volcano, because rock and debris dropped out. Hot gasses rose upward when the weight of the blast debris could no longer exert enough force to hold it to the ground.

13) Minutes after the eruption began at 8:32 a.m. a vertical column of gas and ash soared upward. If the ash column rose at a rate of 144 feet/second, how many minutes did it take to reach a height of 15 miles? Time = *Distance* divided by *Speed*. Show your work.

$$\textbf{Time} = \frac{\textbf{Distance}}{\textbf{Speed}} \qquad \frac{\textbf{80,000 feet}}{\textbf{144 feet/second}} \qquad \textbf{= 556 seconds}$$

556 seconds x 60 seconds/minute = 9.3 minutes

14) Use the landscape locator to find Windy Ridge and Spirit Lake. Lightweight pumice rocks dominate the tephra deposits from the vertical ash column at Windy Ridge, but pumice is not found at Johnston Ridge. Circle the answer that explains the differences in deposits.

A. The wind blew towards the north on May 18, 1980

(B.) The wind blew towards the east-northeast on May 18, 1980

C. Wind direction had no role in the difference in the depths of the deposits at each site.

Helpful Advanced Preparations:

An Eruption Trail Prop Box is available to borrow at the front desk at the Johnston Ridge Observatory. The prop box is available on a first come, first serve basis and includes: a transparent soda bottle to illustrate the concepts of gas dissolved in magma and pressure, laminated pictures of Mount St. Helens before and after the bulge formed between March 20 and May 18, 1980, a laminated poster of Gary Rosenquist's photographs of the landslide and lateral blast, samples of the main products of explosive eruptions—ash, dacite lava and pumice rocks. Check on the prop kits availability upon arrival to the Johnston Ridge.

Assign one chaperone to every five students. Talk to chaperones about their critical role in directing learning by maintaining small group focus, and about the importance of keeping students on the trail at all times. It has taken over 30 years for plant life to get a foothold on this ridge. Chaperones should encourage students to observe ash, rocks, stumps, and trees, while ensuring that they remain on the paved trail or collect any natural features.

Students will need a pencil, "***Mass Gas Blast***" worksheet and clipboard or notebook to write on. Send two chaperones up the eruption trail ahead of the group. Have one stop at the first interpretive sign on the right side of the trail where they can be seen from the trailhead. The answers to questions 1-7 are easiest to answer along this section of the trail. Have the second send adult proceed to the top of the hill to the intersection to the viewing plaza with sundial-like locater map. This adult's role will be to direct students to the landscape locator and circular plaza and prevent students from wandering past it. Questions 8-14 are answered at the landscape locator and circular plaza.

Teacher Trailhead Instructions:

1. Gather students at the trailhead, located on the outdoor viewing plaza at the Johnston Ridge Observatory. Explain that the area around them was forested prior to the May 18, 1980 eruption, and that this ridge was heavily scoured and buried by the lateral blast. Their purpose today will be to become familiar with the role volcanic gasses play in explosive eruptions.

2. They will examine concepts such as pressure, weight, mass and volume as they observe features along the Eruption Trail. Review each "fact" provided on page one of the worksheet. Each fact is easier to comprehend with the visual aides available in the prop kit.

   a) Read aloud the "Magma" facts. Use the before and after pictures to illustrate how magma deformed the north side of Mount St. Helens by pushing it outward. Explain that the magma, called dacite, is very different than fluid Hawaiian basalt. Mount St. Helens magma is thick like toothpaste. It traps and pressurizes volcanic gasses.

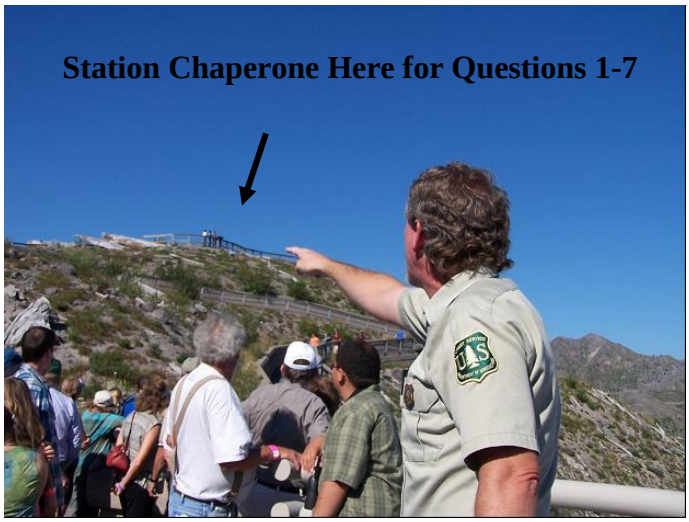
   b) Read aloud "Volcanic Gasses" facts. Use the transparent soda bottle to lead discussion on how the weight of overlying rock creates intense pressure, causing water vapor and carbon dioxide to dissolve into magma then later come out in the form of bubbles. Explain that the magma chamber and conduit under Mount St. Helens is similar to the shape of the soda bottle.

   c) Read aloud "Pressure" and "Weight" facts. As gas bubbles accumulate in the magma chamber upward pressure builds. When the upward pressure exceeds the downward pressure exerted by the overlying rock, cracks in rock form and widen. Eventually the accumulation and rise of gas bubbles break through the overlying roof of rock.

   d) Read aloud the "Lateral Blast" facts. Shake the soda bottle, point it at the students, and threaten to open it to illustrate how gas bubbles expand, burst and generate energy that powered the lateral blast. Explain that the lateral blast was like a hot stone-filled wind composed of hot volcanic gasses, ash and rock.

   e) Read aloud "Mass" and "Volume" facts. Remind students of the pictures shown earlier revealing how magma intruded into the volcano. The total mass of the magma did not change on May 18, 1980, but the 3-dimensional space occupied by the magma—its volume increased due to the expansion of gas bubbles.

3. Point to the chaperone standing by the interpretive sign. Students are not to proceed beyond the chaperone until you indicate it is time to continue. Explain that groups of students and chaperones will need to spread out along this stretch of the trail near a stump or log in order to answer questions 1-7. When they have completed these questions they should proceed to the top of the hill where another chaperone will be stationed. Stress that the "facts"' on front page of their worksheet will be essential to answering questions.



Station Chaperone Here for Questions 8-14

a) Allow the students 15 to 20-minutes to make observations and answer questions at each two stopping points. When finished, review the activity at the circular plaza, or return to the Observatory or continue on the eruption trail to the parking lot. If you return to the parking lot use your chaperones to safely direct students across the parking lot to the busses