G200: Mt. St. Helens Field Trip: South Side  Name

Head north on I-5 to exit 21 (in Washington). Take exit 21 Woodland/Cougar and head east on Washington 503. At the exit from I-5, SET THE TRIP COUNTER TO ZERO. If you’ve forgotten gas, this is a good place to get it.

Heading east on 503 you are driving on a flat surface. This is a bench – a floodplain for the Lewis River. Before mile 51 we start to climb out of the floodplain.

STOP 1: Trip counter 17.6 miles, just past milepost 37.

Schematic view of recent road cut:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
<th>Answer to Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>dark, massive; most of outcrop</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>whitish vein-like material</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>dark, massive; linear body</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>reddish material (note how it may differ far and close to unit c)</td>
<td></td>
</tr>
</tbody>
</table>

Q1: Take a close look at these different units. What rocks or minerals do you think they are made of? (Hint: for unit “d”, the use of a streak plate would be useful. For unit “b”, look carefully at cleavage directions.) Write your answer in the space provided above.

Q2. How do you think unit “b” formed? (Hint: use your knowledge of chemical weathering.)

Q3. What type of rock body does unit “c” represent?

Q4. Units “d” and (especially) “a” compose most of the outcrop. One or both of these could represent the “country rock” or main rock type in the area. What do you think the country rock in this local area is made of, and why? (Hint: look at the spatial relationships of units a-c.)
### Geologic Time Scale

<table>
<thead>
<tr>
<th>Period</th>
<th>Era</th>
<th>M.Y.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precambrian</td>
<td></td>
<td>4.6-4.7 billion years</td>
</tr>
<tr>
<td>Cambrian</td>
<td></td>
<td>570 m.y.</td>
</tr>
<tr>
<td>Ordovician</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silurian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Devonian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mississippian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triassic</td>
<td></td>
<td>250 m.y.</td>
</tr>
<tr>
<td>Jurassic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cretaceous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Major geologic events in the Mount St. Helens area

- 1980 eruption
- Spirit Lake eruptive stage
- Swift Creek eruptive stage
- Cougar eruptive stage
- Ape Canyon eruptive stage—birth of Mount St. Helens
- >40 enormous outburst floods from glacial Lake Missoula inundate the lower Columbia River
- Marble Mountain shield volcano
- >4 episodes of alpine glaciation during the ice age
- Goat Mountain dacite dome erupted
- Troutdale Formation—deposits of the ancestral Columbia River
- continued Cascade Range eruptions
- widespread intrusions north and east of Mount St. Helens area
- Wilkes Formation tuffaceous sandstones and siltstones deposited within a syncline during regional folding
- flood basalts of the Columbia River Basalt Group erupted
- warping of Cascades strata into broad gentle folds; clockwise tectonic rotation
- intrusion of the Spirit Lake pluton
- extensive eruption of early Cascades volcanoes; Goble volcanic rocks deposited
- earliest Cascade volcanoes erupt as volcanic arc shifts to the west
- Cowitz and Puget sediments deposited in deltas and adjacent marine basins
- Siletz and Crescent volcanic terranes dock with North America

**Fig. 2**
Figure 12. Miocene geography of the Pacific Northwest, showing the present location of Mount St. Helens; redrawn from Allen (1979). About 42,000 mi$^3$ (175,000 m$^3$) of lava was erupted between about 17 Ma and 6 Ma, most of it within the first several million years. During this time, more than 100 major eruptions of the Columbia River basalt inundated more than 63,000 mi$^2$ (163,000 km$^2$). Data from Tolan and others (1989).
Q5. Summarize the geologic processes and history recorded by the rocks in this outcrop by putting together a reasonable scenario. Note: there are at least 3 plausible scenarios.

Q6. Using "geologic reasoning", determine the age sequence (from oldest to youngest) of units a-d. Give justification. (Hint: younger features cross-cut older features.)

Washington 503 splits – take 503 spur east to Cougar (DON’T GO SOUTH). We will stop in Cougar for at last chance at snacks and bathroom for a while. This is your last chance for gas.

STOP 2: Trip counter 27.9, bathroom stop.

STOP 3: Trip counter 30.3, Swift Reservoir Dam.
   a.) What caused the failure of this dam?
   b.) How was it fixed?

STOP 4: Trip counter 31.4 miles, after milepost 39 (they’re increasing at this point). Parking is in short supply here, so park close together and put your hazard lights on.

Q1. This rock has a distinctive texture. What is the texture called?

Q2. What type of rock is visible here?

Q3. What does the texture from Q5 represent?

Q4. Define tumulus.
Q5. Define kipuka.

When your trip counter reads 34.3 miles, turn left onto Road 83 towards Ape Cave. 2.7 miles later turn left on Road 8303 towards Ape Cave. 0.3 miles later turn left into Trail of Two Forests Parking Lot.

STOP 5: Trail of Two Forests – this will also be our lunch spot and a bathroom break.

Q1. What rock type are we looking at here?

Q2. Where have we seen this particular flow unit before?

Q3. Define pahoehoe.

Q4. Looking at the pahoehoe texture, how would you describe the viscosity of the flow? Express your answer in terms of the viscosity of things you are familiar with (a wrong example: the lava flow was about as viscous as a peanut butter flow).

Q5. What interesting features are found along the main trail and how were they formed? List and define 3 of them.

Turn back onto Road 8303 (go left towards Ape Cave). Go about 0.7 miles and turn right into Ape Cave parking lot.
Eruptive history of Mount St. Helens. Left columns show eruptive stages and dormant intervals; right columns show the eruptive periods and dormant intervals of the Spirit Lake eruptive stage. Only major tephra units are shown. Ash from possible earlier eruptions (100 ka-50 ka) has recently been discovered in eastern Washington (Busacca and others, 1992). Data in table from Mullineaux (1986) and Crandell (1987); redrawn from Hopson and Melson (1990).

<table>
<thead>
<tr>
<th>Years B.P.</th>
<th>Eruptive stage or layer</th>
<th>Tephra set</th>
<th>Eruptive period</th>
<th>Tephra set or layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Present</td>
<td>1980 layer</td>
<td>debris avalanche and lateral blast</td>
<td>layer T</td>
</tr>
<tr>
<td>500</td>
<td>Goat Rocks</td>
<td>set X</td>
<td>Goat Rocks dome</td>
<td>set X</td>
</tr>
<tr>
<td>1000</td>
<td>Sugar Bowl</td>
<td>set W</td>
<td>pre-1980 summit dome</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>Pine Creek</td>
<td>set P</td>
<td>Sugar Bowl dome; East dome</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Castle Creek</td>
<td>set B</td>
<td>small lateral explosion</td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>Cave Basalt</td>
<td></td>
<td>Cave Basalt erupted</td>
<td>set B</td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td></td>
<td>domes constructed during this time crop out in the crater and on the north side in canyons</td>
<td>set P</td>
</tr>
<tr>
<td>3500</td>
<td></td>
<td></td>
<td>Ynt tephra layer deposited by large Plinian eruption</td>
<td>set Y</td>
</tr>
<tr>
<td>4000</td>
<td>Smith Creek</td>
<td></td>
<td></td>
<td>set Y</td>
</tr>
<tr>
<td>45,000</td>
<td>Ape Canyon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50,000</td>
<td>Swift Creek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55,000</td>
<td>Cougar</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- dacite
- andesite and dacite
- basalt
CAVE BASALT FLOW - LOCATION OF LAVA TUBES
R. Greeley and J. Hyde

Figure 8. Map showing location of lava tubes and road to Ape Cave.
STOP 6: Ape Cave.

Take notes as best you can. You might want to team up with someone else, so that one person takes notes and the other holds a flashlight. Write down and describe all the interesting features we see in the cave.
LOWER APE CAVE SECTION

- Grooved lava in west wall and multiple flow lines
- Multiple linings exposed in wall
- Small tube in floor flow
- Grooved lava in west wall and multiple flow lines
- Tangle lining with viscoelastic rupture, country rock in west wall
- Main entrance

LOWER APE CAVE SECTION

- Cupola, surface expression as dome, 20 m in diameter
- Slabs of lining spilled from walls and transported by lava
- Small collapse
- Tube lining 30 cm thick
- Lava leaves on floor flow

LOWER APE CAVE SECTION

- Small cave entrance, ends in breakdown, slight breeze from entrance
- Stream terrace with graded bedding, 80 cm thick
- Cupola
- Small tumulus

Fig 6
An Uncommon Eruption

The formation of Ape Cave marks an unusual period in Mount St. Helens' eruptive history in that it is the only known basaltic eruption of the volcano. Eruptions of fluid basaltic lava, much like those in Hawaii, are rare occurrences in the Cascade Mountain Range. The Cascades usually erupt lava of a thicker consistency. When this type of magma is coupled with suspended gases, explosive eruptions tend to occur. The eruption of Mount St. Helens on May 18, 1980, exemplifies this tendency.

About 2,000 years ago, fluid basaltic lava poured down the southern flank of the volcano. As the lava flowed, chunks of the lava's surface cooled, crashed and fused together creating a hardened crust. In turn, the crust insulated the molten lava beneath, allowing it to remain fluid and travel down to the Lewis River Valley.

The hot flowing lava began melting into the pre-existing rock and soil. This thermal erosion deepened and widened the channel of the flow. The level of lava in the tube rose and fell as the eruption surged and slowed, contributing to the unique contours of the walls.

During this eruptive period, hot fluid lava pulsed through the tube for months, possibly up to a year, until the eruption subsided. As a result of this rare eruption, a spectacular 13,042 foot (3976m) long lava tube, the third longest in North America, was created.

Cavers, Expect the Unexpected! Take:

- Three sources of light - Clean-burning lanterns (propane or white gas) or flashlights with strong batteries and bright bulbs.
- Sturdy shoes/boots - The lava tube floor is uneven and covered with jagged rocks.
- Warm clothing - The temperature remains near 42°F/6°C year round. It can also be windy and wet in the lava tube.
- A friend - Also, let someone else know where you are going and for how long.

Protecting Ape Cave Requires Your

Unfortunately, through the years, careless explorers have damaged many cave formations. Unlike the environment above ground, once a cave is damaged it remains damaged forever. For this reason, the following regulations apply:

- No food, beverages, alcohol or littering - These items attract animals and bacteria that do not belong in the cave. Food and litter decompose at an extremely slow rate in the cool temperatures of cave ecosystems.
- No smoking - Smoke lingers in the cave and is harmful to cave creatures and humans.
- No flares, fireworks, firearms or any kind of open flame. These leave a residue and blacken cave walls.
- No rock collecting or damaging cave features ($200 fine). Damage to features prevents you and future visitors from enjoying them.
- No pets - Dog paws are easily cut on the jagged rocks. Animal feces damage cave ecosystems and is unpleasant to those who follow.
- Do not touch the walls. A bacteria with fungus-like characteristics, called "cave slime," lives on the cave walls. This slime is a food source for other cave life, is easily wiped off when touched, and takes many years to re-grow.

Remember the cave explorer's motto:
"Take nothing but pictures, leave nothing but footprints, kill nothing but time."

For more information contact:

Mount St. Helens National Volcanic Monument
42218 NE Yale Bridge Rd.
Amboy, WA 98601
(360) 449-7800
www.fs.fed.us/gpnf/mstmvm

The National Speleological Society
2813 Cave Avenue
Huntsville, AL 35810-4413
(256) 852-1300
www.caves.org

Produced by the Northwest Interpretive Association in cooperation with the US Forest Service
What's in a Name?

Ape Cave was discovered in 1947 by a logger named Lawrence Johnson. However, the cave was not explored until the early 1950's when a scout troop, led by Harry Reese, lowered a team of scouts down a 17-foot overhang to the cave floor. Leaving footprints where no one ever had, these explorers were able to travel through a pristine lava tube full of fragile formations. Ape Cave was named by the Scout Troop in honor of their sponsor, the St. Helens Apes. This local group was made up primarily of foresters. The sponsor's name, St. Helens Apes, may have come from an old term used for foresters in the area, "brush apes," or from the legend of Bigfoot.

Which Way Do I Go?

Lower Cave (easier route)

The main entrance divides the cave into two sections, the upper cave and lower cave. The 1-mile (2000 m) lower portion takes about 1 hour roundtrip to complete. Interesting geological features include the meatball and the railroad tracks.

The meatball is a block of cooled lava which fell from the lava tube ceiling while lava was still flowing through the cave. It floated on the surface of the lava flow and was furred downstream until it became wedged in a narrow spot 12 feet (4 m) above the present cave floor.

The railroad tracks are levees that formed along the side of a tongue of flowing lava. As the fluid lava drained out of the tube, the levees remained intact.

There is a skylight in the tube near the upper exit. However, to finish the upper cave, continue through the tube to a permanently attached metal ladder. Serious injuries have occurred when individuals have attempted to exit the cave through this skylight.

Upper Cave (more difficult route)

The 1-mile (2100 m) upper portion of the cave takes about 2 hours to complete, returning on a surface trail. Cavers must climb over approximately 27 boulder piles and scale an 8-foot (2.5 m) high lava fall.

The boulder piles, called breakdown, formed after the eruption subsided and the fluid lava drained from the tube. As the lava tube cooled, it began to shrink and crack. These cracks weakened the ceiling and walls causing parts of them to collapse. The entrances to Ape Cave formed in this way.
Go left from the Ape Cave Parking lot, then left on Road 83 (trip counter about 39.1 miles) towards Lava Canyon.

STOP 7: trip counter 40.7, just past Climbers Bivoac.

a.) What formed the deposit here? What is the white line in the middle?

STOP 8: At trip counter of about 48.1 turn right into the parking area for Lahar Viewpoint.

The following excerpt was taken from the Road Guide to the Geology of Mt. St. Helens, by Patrick Pringle, and was pieced together by geologists from various photos and eyewitness accounts:

*Within two minutes of the May 18 eruption, a pyroclastics surge consisting of rocks, ash, and volcanic gas boiled over the edge of the crater and descended the east flank of Mount St. Helens at high velocity. It scoured as much as 27.4 ft (9m) of snow and ice from the glacier. By the time it reached the base of the mountain – about 90 seconds later – it had generated a lahar. The average velocity of the pyroclastic surge was more than 110 mi/hr (about 50 m/s) over this distance. The surge slowed down, and after about 80 seconds, came to a stop on the upper reaches of Muddy Fan.*

Q1. What is the difference between a lahar and a pyroclastics flow?

Q2. What kinds of rocks are found on the surface of the ground here?

Q3. Describe what the surface looks like after a lahar has passed through. If this solidified and became a rock, what would you call it?

Q4. How can you tell the maximum height that this lahar attained?

Leave the parking lot at Lahar Viewpoint and continue north on Road 83. 0.5 miles further you will see a pullout on the left side of the road for Stratigraphy Viewpoint. Get out here.
truncated lava flow of Cougar age is the oldest (20,000 yr B.P.) exposed rock on the volcano

Figure 2. Panorama northeast from Lahar Viewpoint toward Mount St. Helens, 3.5 mi (6 km) away. Shoestring Glacier was decapitated during the catastrophic May 18, 1980, eruption and lost much of its zone of accumulation. A pyroclastic surge moved down the east flank of the mountain, eroded nearly 30 ft (9 m) of ice and snow from the glacier, and generated lahars that swept into Ape Canyon, across Muddy fan, and into Muddy River and Pine Creek. One lahar left a prominent trimline on the toe of a ridge composed of Tertiary volcanic rock north of the fan. The sinuous Worm Flows are rubbly andesite lava flows of Kalama age, probably erupted during the early to mid 1500s. The truncated lava flow to the left in this view is apparently an erosional remnant of a large lava flow erupted during the Cougar eruptive period (about 20,000 yr B.P.) It may be the oldest visible component of the Mount St. Helens edifice, most of which is less than 3,000 years old. Dogs Head dacite dome was erupted during the early part of the Castle Creek eruptive period. East Dome, also a dacite dome, was erupted sometime between the Castle Creek and Kalama eruptive periods. On clear days, Mount Hood volcano in Oregon is visible to the southeast, off to the left.
Q1. What are the deposits exposed in the banks? Give a name and a process for them. How did you come to these conclusions.

STOP 9: Lava Canyon and bathroom break.

Q1. What has happened to form this canyon? Give the 5-6 stages of development.

Q2. What features suggest that the surface of the lava flow has been scoured by water?

Q3. What is the yellow/brown material on the rocks (Tertiary volcanics) that underlie the lava flow that fills this canyon?

Q4. What does the presence of the material in Q3 tell us?

Q5. What kinds of joints do you see in the main lava flow?

Q6. After crossing the suspension bridge, you will be standing on an intrusion. What is the name for this kind of intrusion? What sort of rock does it appear to consist of?
Q7. You will be handed some samples of the main flow that fills Lava Canyon. What is the name of the white rectangular mineral that you can see?

Q8. Compare this sample to some of the samples from the previous stops. What is the name of this rock?
May 18, 1980 Eruption Facts

**Triggered by:**
5.1 magnitude earthquake @ 8:32 am

**Original Height:**
9,677 ft / 2950 m

**Present Height:**
8,363 ft / 2550 m

**Total Volume Removed**
2/3 cu mi / 2.76 cu km

**Debris Avalanche**
- **Speed:** 180 mph/290 km/h (max)
- **Temperature:** 160-213 deg F / 70-100 deg C
- **Distance Traveled:**
  - 14 mi / 22 km West (Toutle R.) (approx)
  - 5 mi / 8 km North (approx)
- **Depth:**
  - 640 ft / 195 m (in NF Toutle R.) (max)
  - 150 ft / 45 m (average)
- **Volume Removed:**
  - 0.6 cu mi / 2.5 cu km

**Lateral Blast**
- **Speed:**
  - Range: 225-730 mph/60-1100 km/h
  - Average: 450 mph/724 km/h
- **Temperature:**
  - Sing Zone: 120-390 deg F / 50-200 deg C
  - Blast Zone: 575-750 deg F / 300-400 deg C
  - Blast Area: 230 sq mi / 600 sq km

**Vertical Plume**
- **Height:**
  - 15 mi / 24 km (approx)
- **Duration:**
  - 9 hours (approx)

**Pyroclastic Flows**
- **Speed:**
  - 50-80 mph / 80-130 km/h
- **Temperature:**
  - Near Crater: 1380-1500 deg F / 750-850 deg C
  - Most Flows: 570-1350 deg F / 300-730 deg C (aveg)
- **Distance Traveled:**
  - 3 mi / 5 km
- **Depth:**
  - 130 ft / 40 m (cumulative)

**Lahars**
- **North Fork Toutle River**
  - 6.4 million cu yd / 50 million cu m
  - **Speed:** Up to 90 mph / 145 km/h
  - **Volume:** 0.288 cu mi / 12 cu km

- **Upper Muddy River**
  - 17 million cu yd / 13 million cu m

**Dome Dimensions**
- **Height:** 1000 ft / 305 meters
- **Width:** 3450 ft / 1.1 kilometers

**From Coldwater Ridge**
- **Lava Dome:**
  - 8 miles / 12.8 kilometers
  - **Base of Mountain:**
    - 6.3 miles / 10 kilometers

**From Johnson Ridge**
- **Lava Dome:**
  - 5.5 miles / 8.8 kilometers
  - **Base of Mountain:**
    - 4.5 miles / 7.2 kilometers

**From Windy Ridge**
- **Lava Dome:**
  - 4.5 miles / 7.2 kilometers
  - **Base of Mountain:**
    - 2.5 miles / 4 kilometers

**Coldwater Lake**
- **Length:** 4.5 miles / 7.2 kilometers
- **Elevation:** 2472 ft / 753 meters
- **Area:** 800 acres / 324 hectares
- **Maximum Depth:** 203 feet / 62 meters

**Castle Lake**
- **Length:** 1.5 miles / 2.4 kilometers
- **Elevation:** 2558 ft / 780 meters
- **Area:** 200 acres / 81 hectares
- **Maximum Depth:** 105 feet / 32 meters

**Spirit Lake**
- **Length:** 3.2 miles / 5.2 kilometers
- **Elevation:** 3475 ft / 1060 meters
- **Area:** 3098 acres / 1254 meters
- **Maximum Depth:** 151 feet / 46 meters