

# LANDSLIDES OF MOUNT ST. HELENS ACTIVITY BOOK

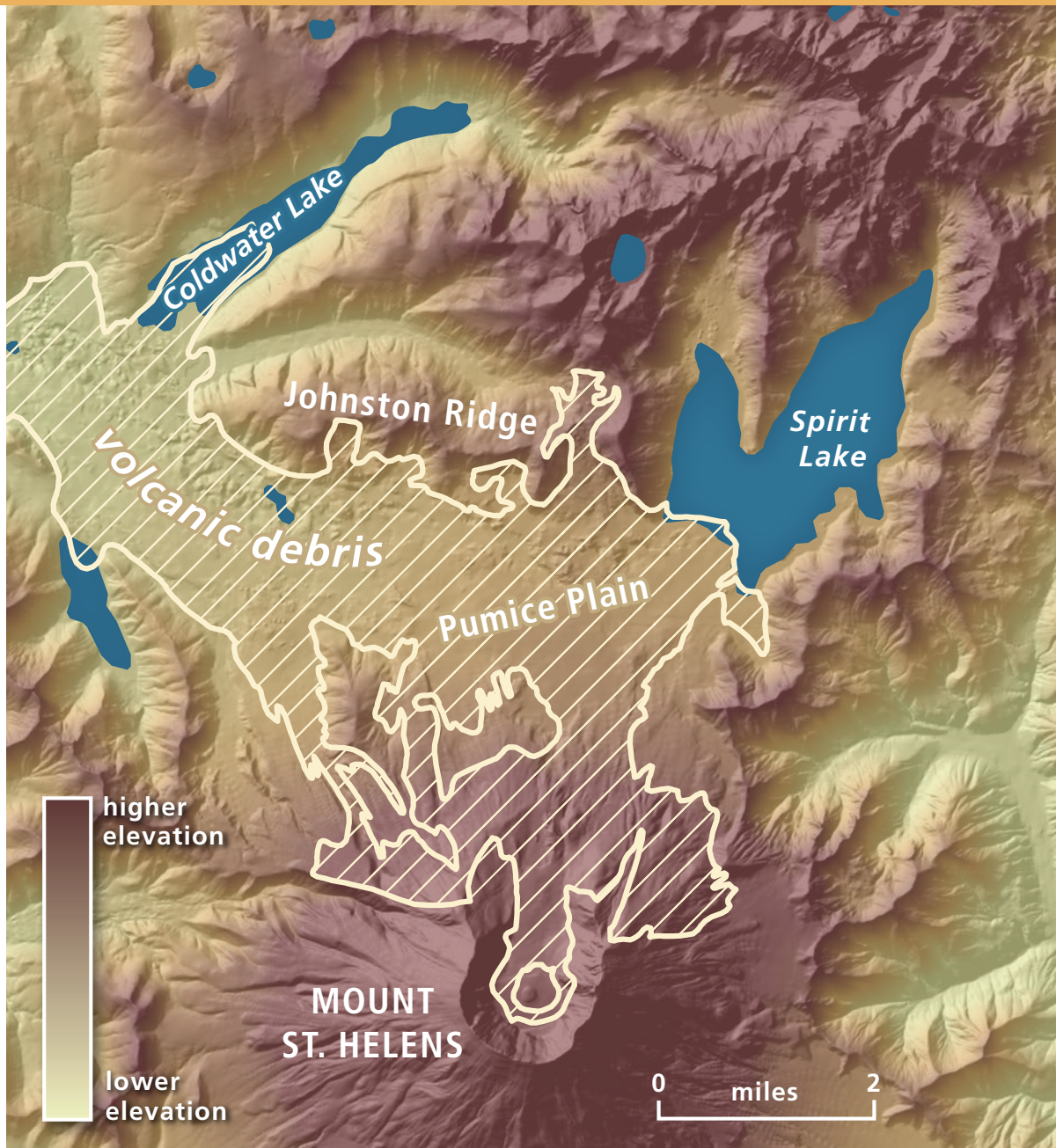


WASHINGTON  
GEOLOGICAL  
SURVEY



*Spirit  
Lake*

**MOUNT ST. HELENS is a great laboratory for learning about landslides. After all, it is the home of the largest landslide EVER. Here's what it looked like before the big eruption in 1980.**

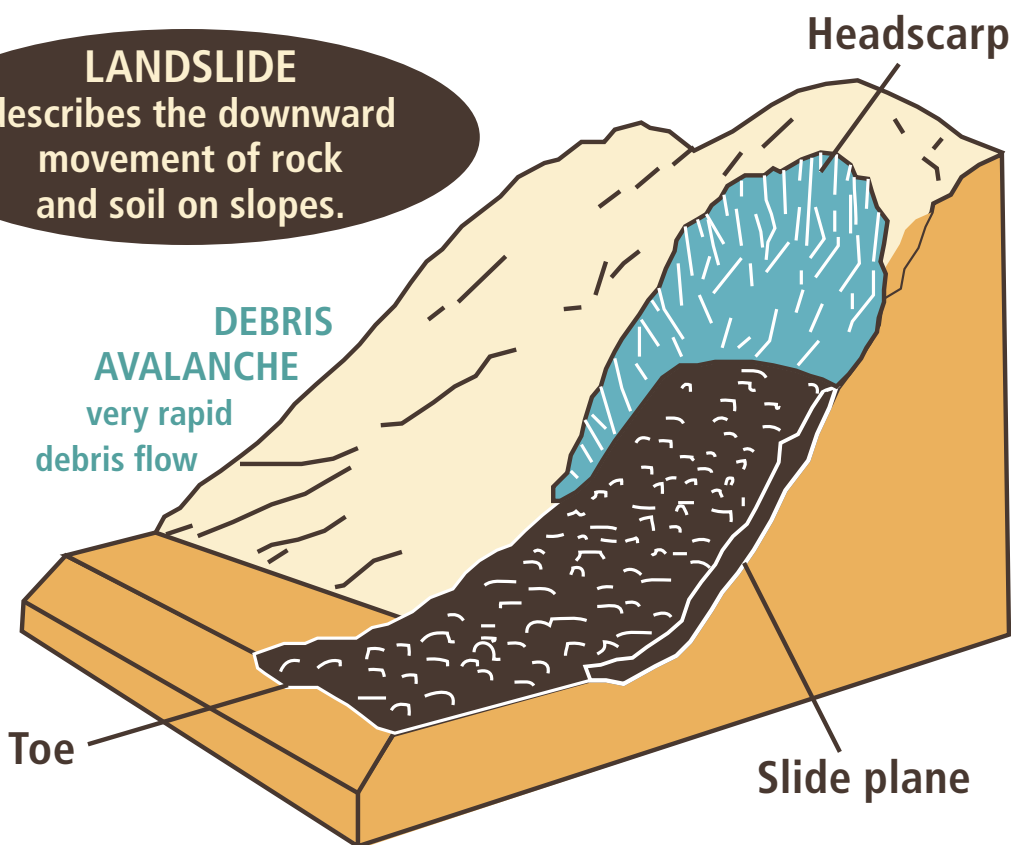


And here's what it looks like now. The 1980 landslide changed the shape of the mountain and volcanic debris blocked Coldwater Creek, forming Coldwater Lake.

## THE FOLLOWING PAGES WILL TEACH YOU:

- How to recognize different types of landslides (p. 5 and 6)
- How a landslide kicked off the May 18<sup>th</sup>, 1980 Mount St. Helens eruption (p. 7 & 8)
- How to recognize landslides from aerial imagery (p. 8 & 9)
- Why geologists use lidar (p. 11 — 14)
- How to map landslides on your own (p. 15 & 16)
- How to recognize landslides in the field (p. 17 — 19)
- How to find more information about landslides (back cover)

**LANDSLIDE**  
describes the downward  
movement of rock  
and soil on slopes.



## BUT FIRST, HERE'S A HANDY GLOSSARY FOR TRICKY WORDS:

**Angular** — Sharp-edged, or rough-shaped clasts (rock fragments)

**Drainage** — Any valley that is a pathway for water

**Grain size sorting** — The relative amounts of large and small material sizes in a rock or deposit

**Headscarp** — The uppermost limit of a landslide

**Hummocky** — Bumpy and irregular ground

**Lateral blast** — A sideways blast from a volcano (most blasts are vertical)

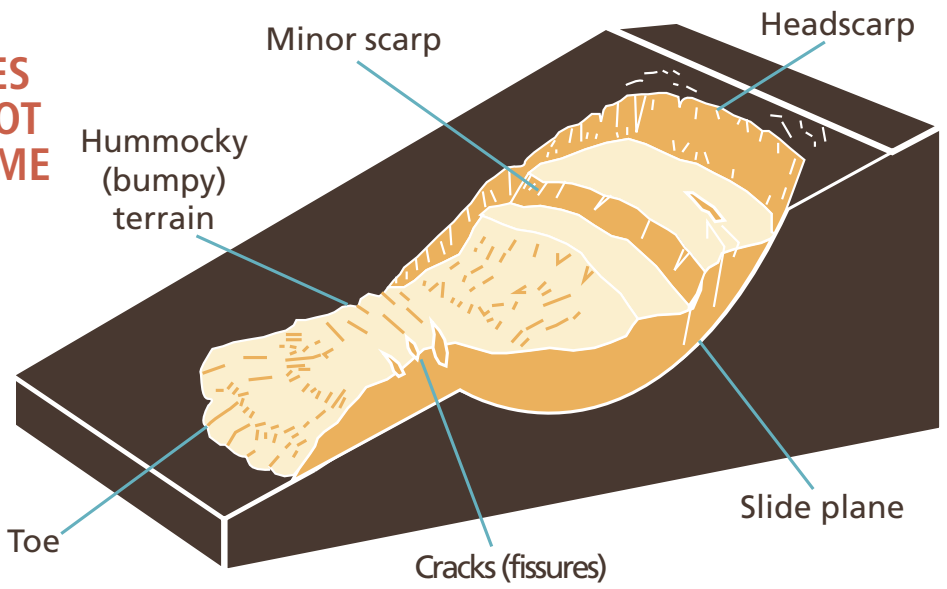
**Pyroclastic flow** — A hot, fast-moving volcanic debris flow

**Rounded** — Smooth and spherical-shaped clasts (rock fragments)

**Slide plane** — The surface on which a landslide moves

**Toe** — The lowermost down-slope part of a landslide

# MOST LANDSLIDES SHARE A LOT OF THE SAME FEATURES



## FIVE TYPES OF LANDSLIDES

Landslides come in all shapes and sizes—the way a landslide looks can tell you a lot about how it formed.

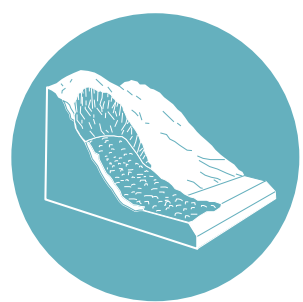
### 1) FLOWS are landslides that behave like liquids

**EARTHFLOW**  
flow on steep slopes on wet ground



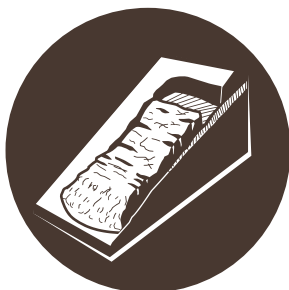
**DEBRIS FLOW**  
rapid flow of loose material from intense rain on steep slopes

**DEBRIS AVALANCHE**  
very rapid debris flow

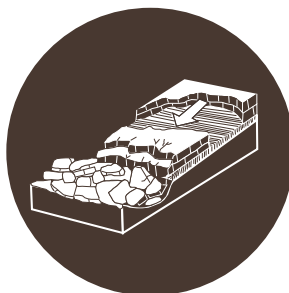


**CREEP**  
slow, steady downslope movement of soil or rock

2) **SLIDES** are landslides where a mass of slope material moves along a discrete plane in mostly intact blocks



Translational  
slide



Block  
slide



Rotational  
slide

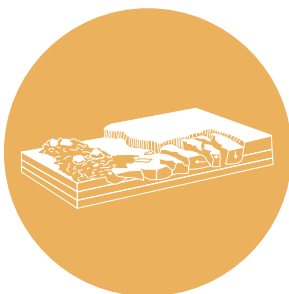
3) **TOPPLES** are landslides that involve rock tipping over



4) **FALLS** are landslides of rock that detach from steep slopes or cliffs and tumble



5) **SPREADS** are landslides on gentle slopes formed by ground shaking



Factors affecting the type of landslide include slope, water content, grain size sorting, weathering, vegetation, and climate.

THE MAY 18<sup>TH</sup>, 1980 ERUPTION OF MOUNT ST. HELENS BEGAN WITH THE LARGEST RECORDED DEBRIS AVALANCHE IN HISTORY, ANYWHERE.

**SOUTH**

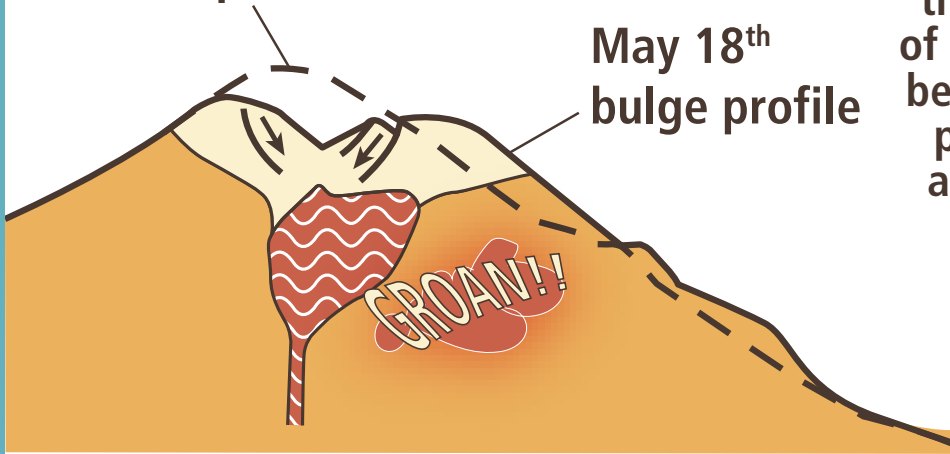
**NORTH**

1

1979 profile

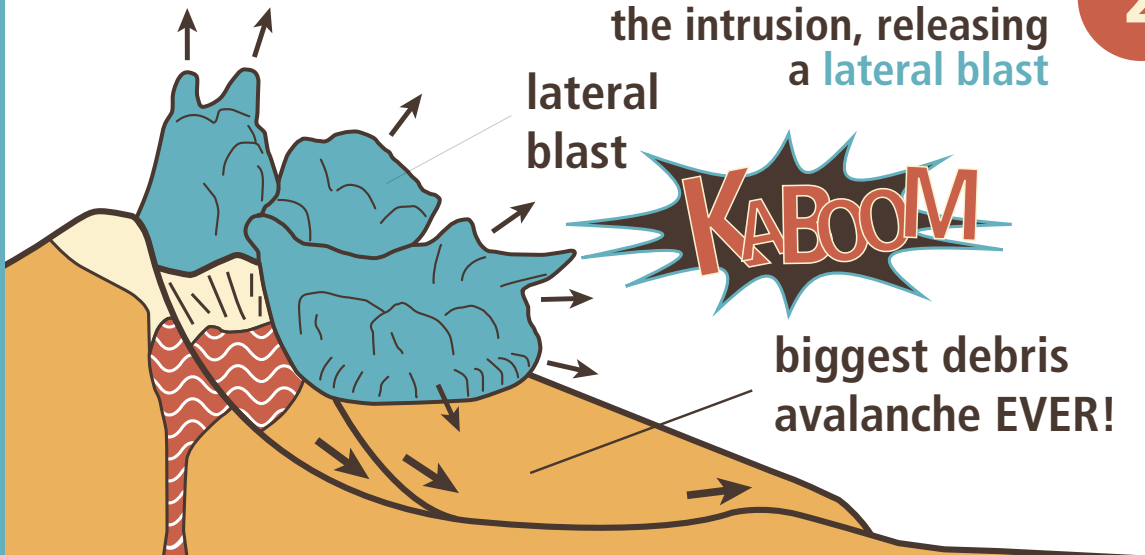
May 18<sup>th</sup>  
bulge profile

Prior to eruption, the north flank of the mountain began to bulge, probably from an **intrusion of new magma**



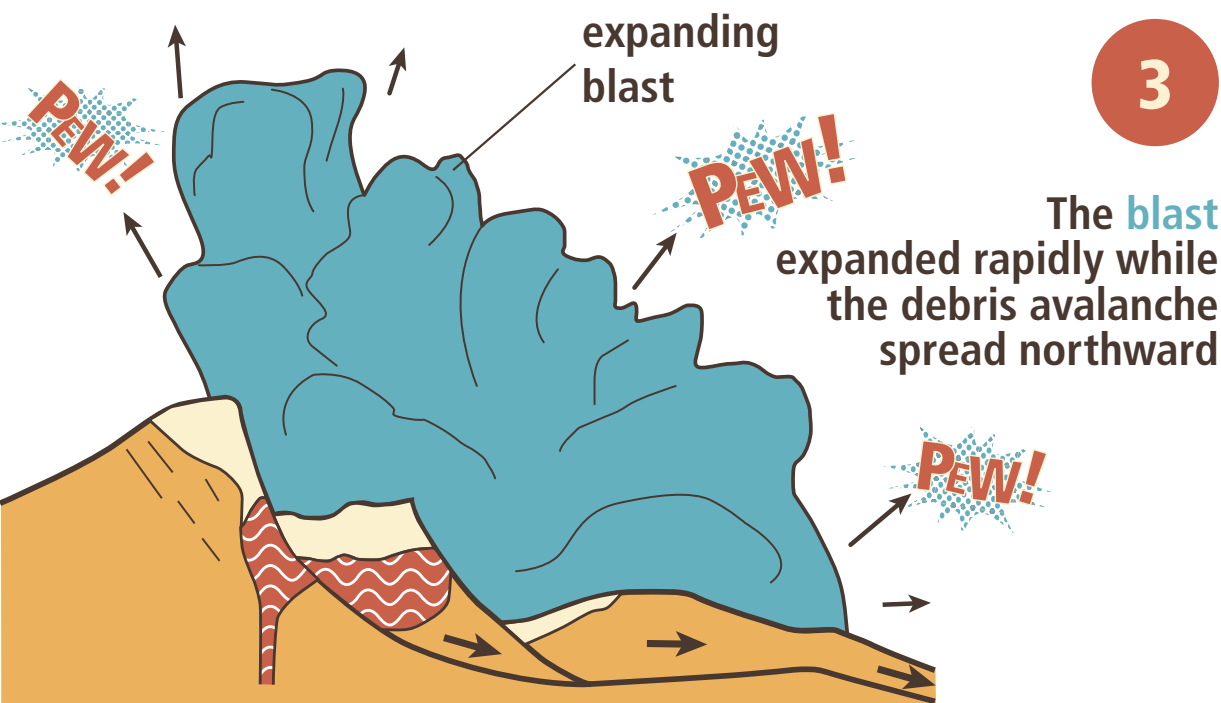
The explosive debris avalanche uncovered the intrusion, releasing a **lateral blast**

2



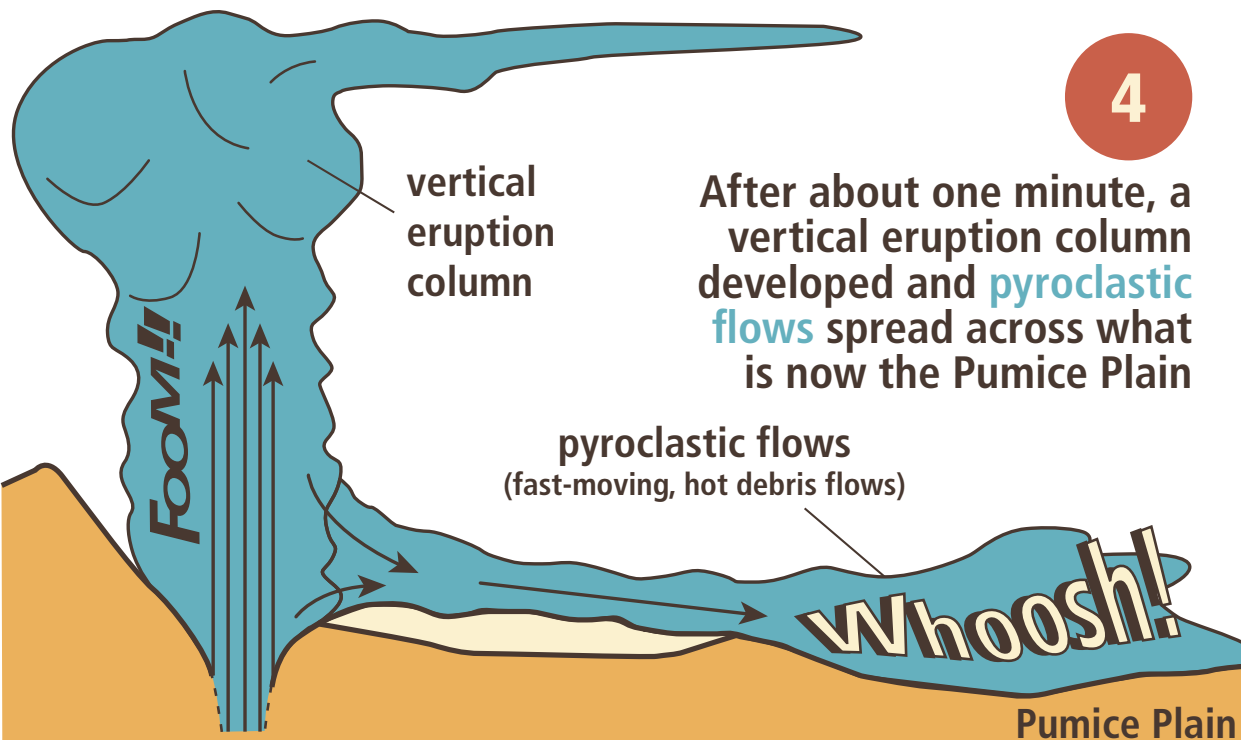
biggest debris  
avalanche EVER!





3

The **blast** expanded rapidly while the debris avalanche spread northward



4

After about one minute, a vertical eruption column developed and **pyroclastic flows** spread across what is now the Pumice Plain

pyroclastic flows  
(fast-moving, hot debris flows)

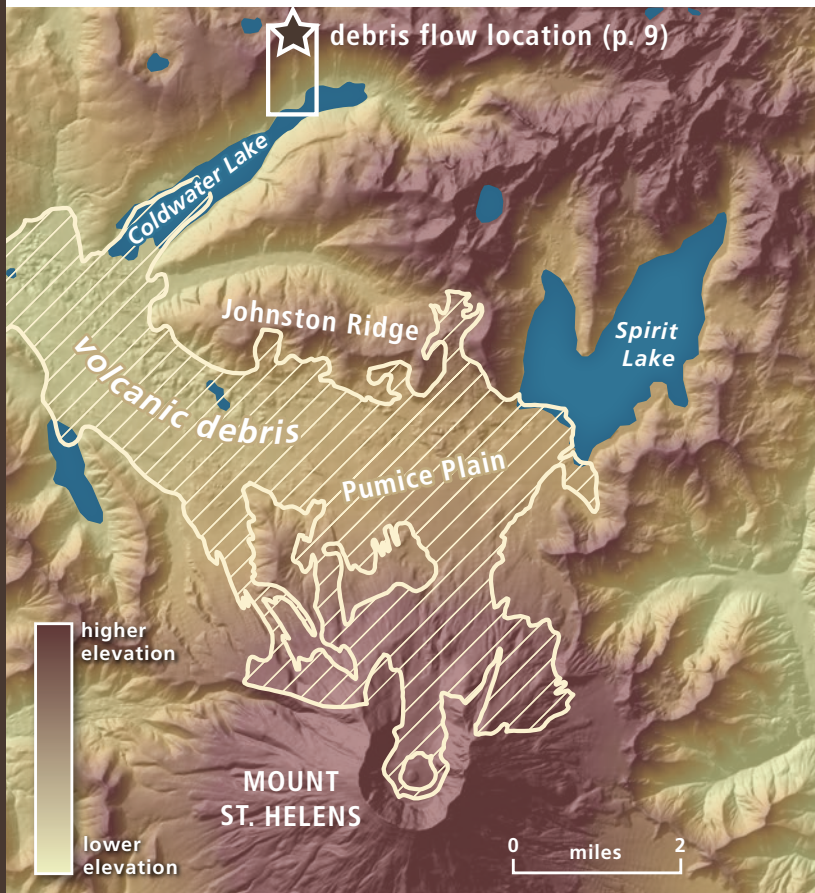
Pumice Plain

GEOLOGISTS USE SEVERAL METHODS TO MAP LANDSLIDES. THE MOST COMMON METHODS ARE **AERIAL PHOTOGRAPHY AND LIDAR**.

**Aerial photos** are taken downward from an airplane that is equipped with special cameras. After flying is complete, the pictures are all stitched together to make one big picture.

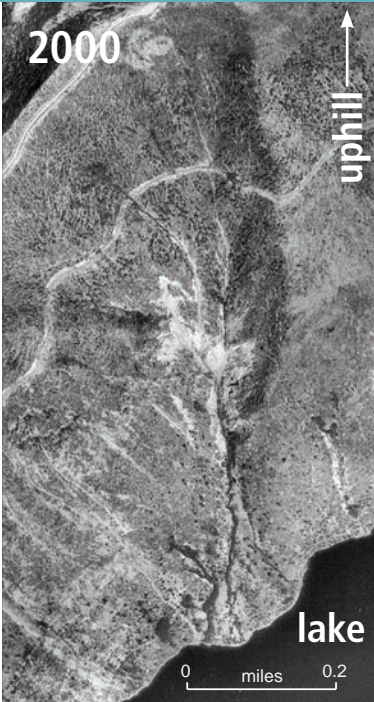
Repeated image collection over several years sometimes allows geologists to map ground movement over time.

### COLDWATER LAKE EXAMPLE



The shore of Coldwater Lake is steep and has several debris flows in the steep drainages surrounding the lake.

Take a look at the images on the next page and compare the progression of one large debris flow over the years.

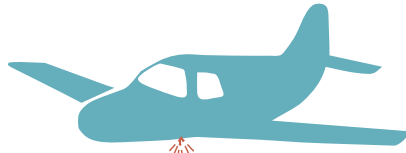


### Things to consider:

- What differences can you see between the years?
- Is there something in some of these pictures that makes it hard to see changes over time?

**WHAT IF  
THERE WAS AN  
EASIER WAY?**

**LIDAR** STANDS FOR



**L**IGHT **D**ETECTION **A**ND **R**ANGING

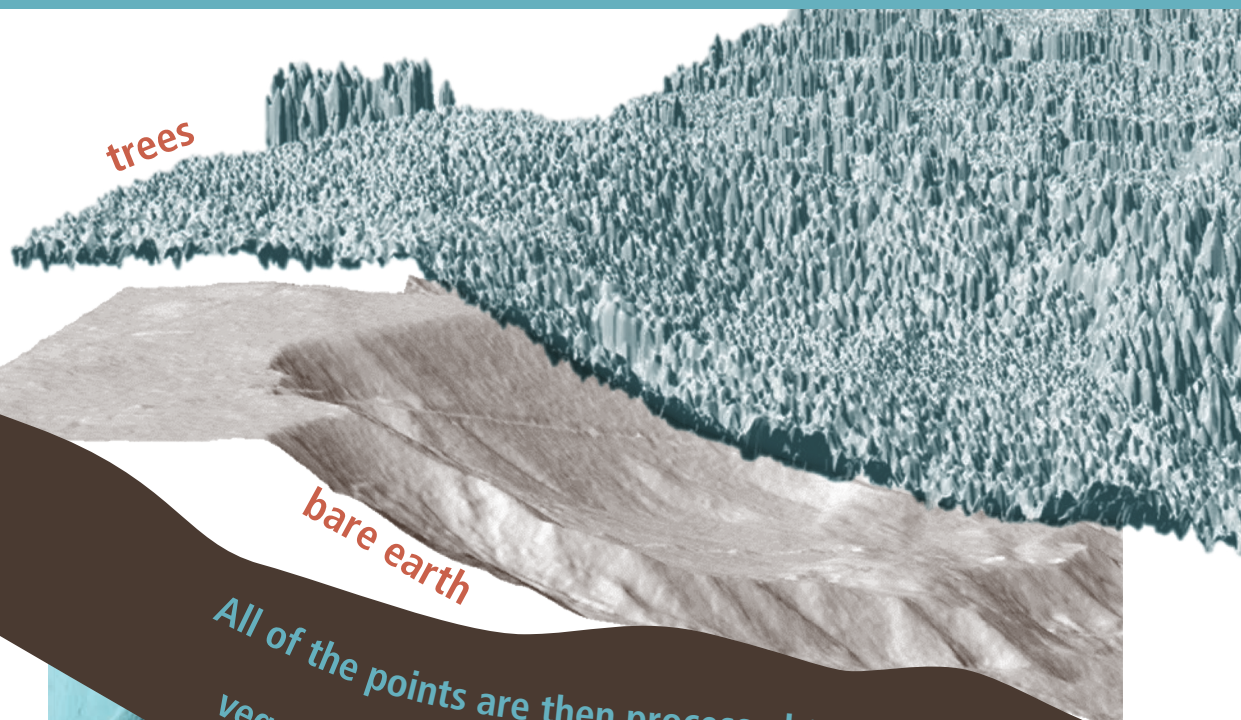
and it involves shooting **millions** of laser pulses at the ground out of a moving plane equipped with a very accurate GPS (global positioning system).

The laser pulses hit the ground and bounce back—the time it takes the pulses to return tells lidar scientists how far away the ground and other features are from the plane.

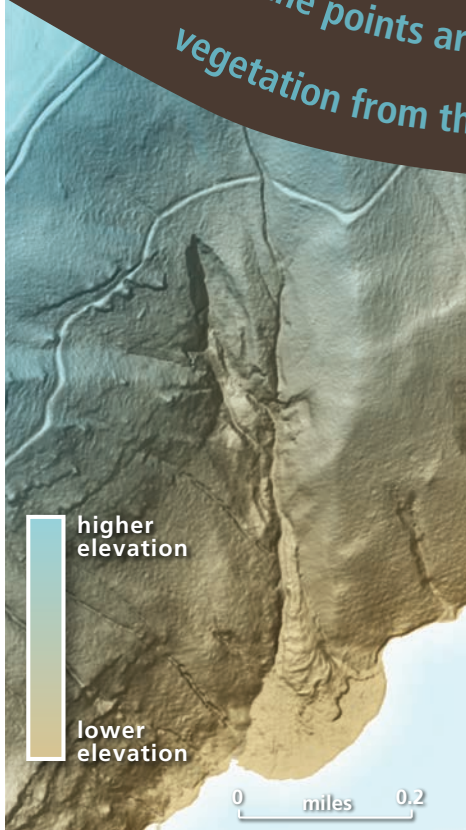


trees

bare earth



All of the points are then processed to remove the vegetation from the underlying bare earth surface



## HEY, REMEMBER COLDWATER LAKE?

Here's what that same debris flow from page 10 looks like using bare earth lidar.

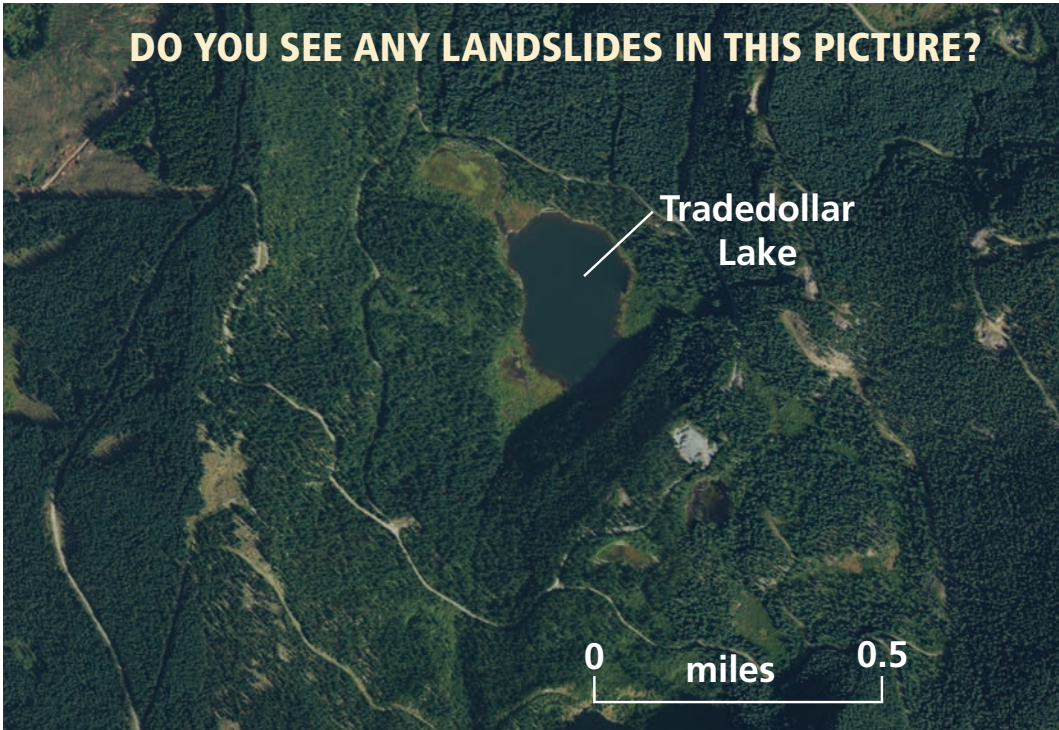
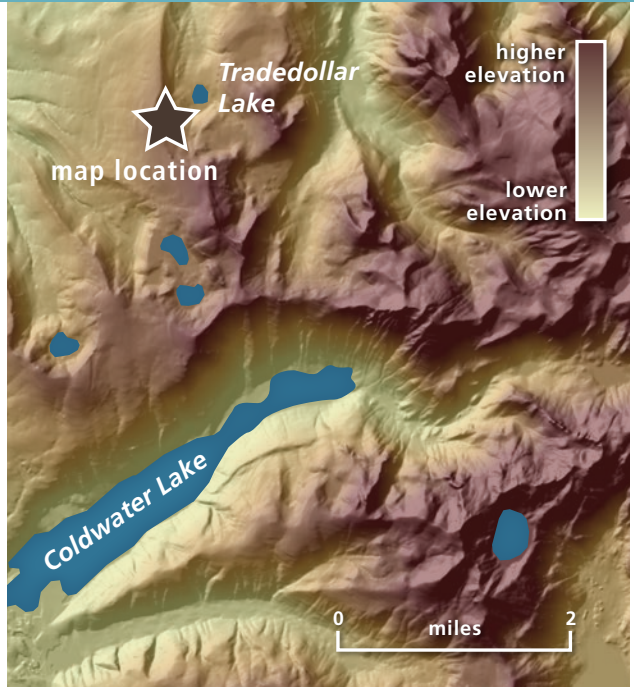
The image to the left is called a hillshade, where steeper areas appear darker than less steep areas based on shadows from simulated sunlight.

In this image, we've also colored the hillshade to show elevation.

### WHICH WOULD YOU USE TO MAP LANDSLIDES?

North of Coldwater Lake, there's a smaller lake called Tradedollar Lake that is surrounded by trees. It looks innocent enough...

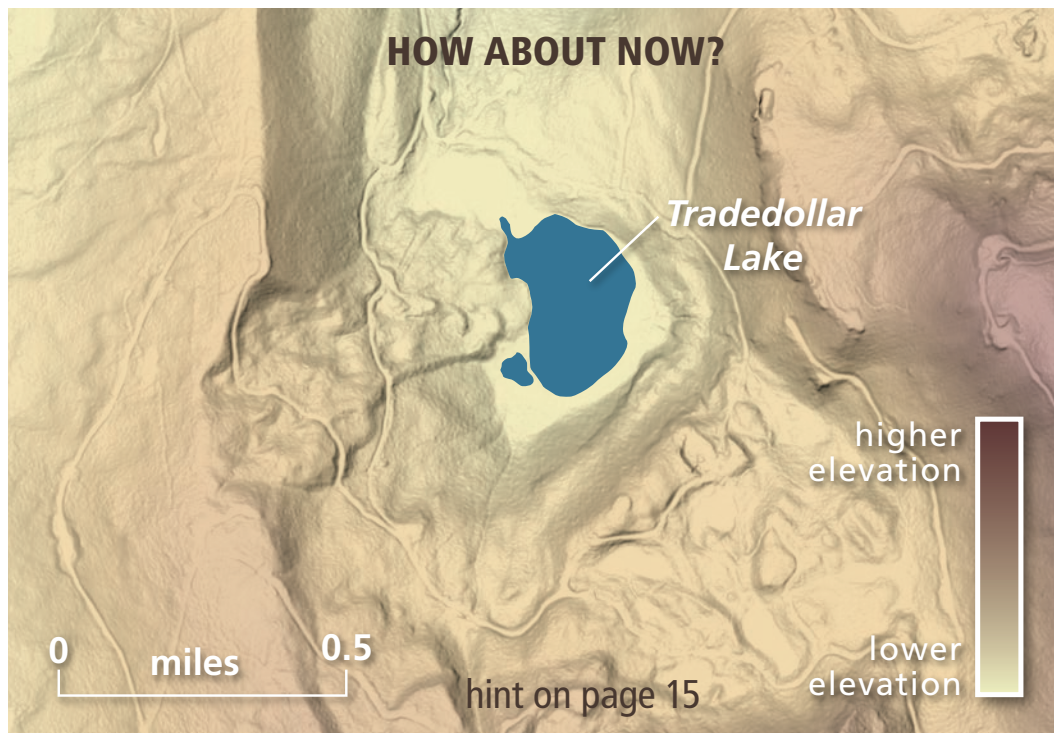
Compare the aerial image on this page (below) to the lidar image of the same lake (facing page).



# Activity

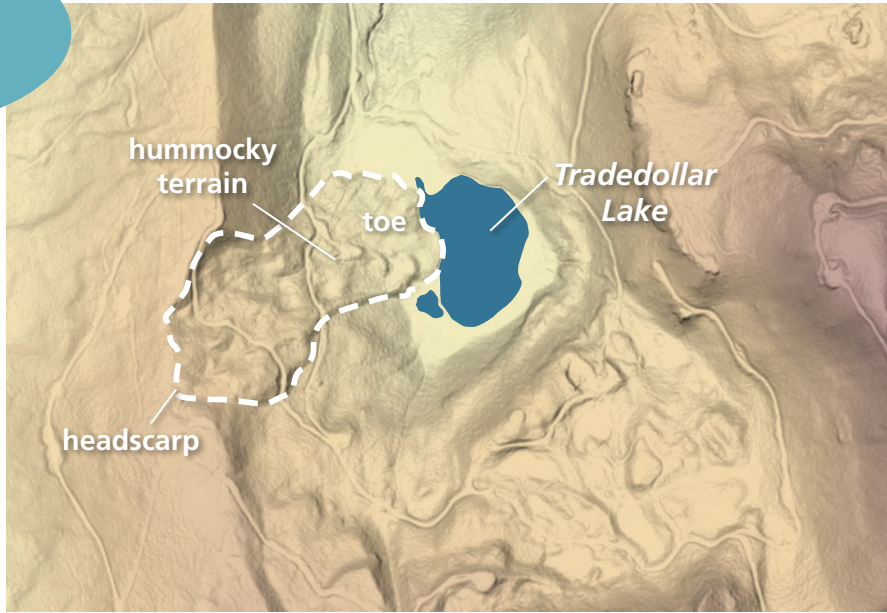
Trace the landslide on the map below. What kind of landslide do you think it is and why? Go back to pages 5 and 6 if you're unsure.

What method would you use to map landslides—  
aerial photos or lidar? Why?



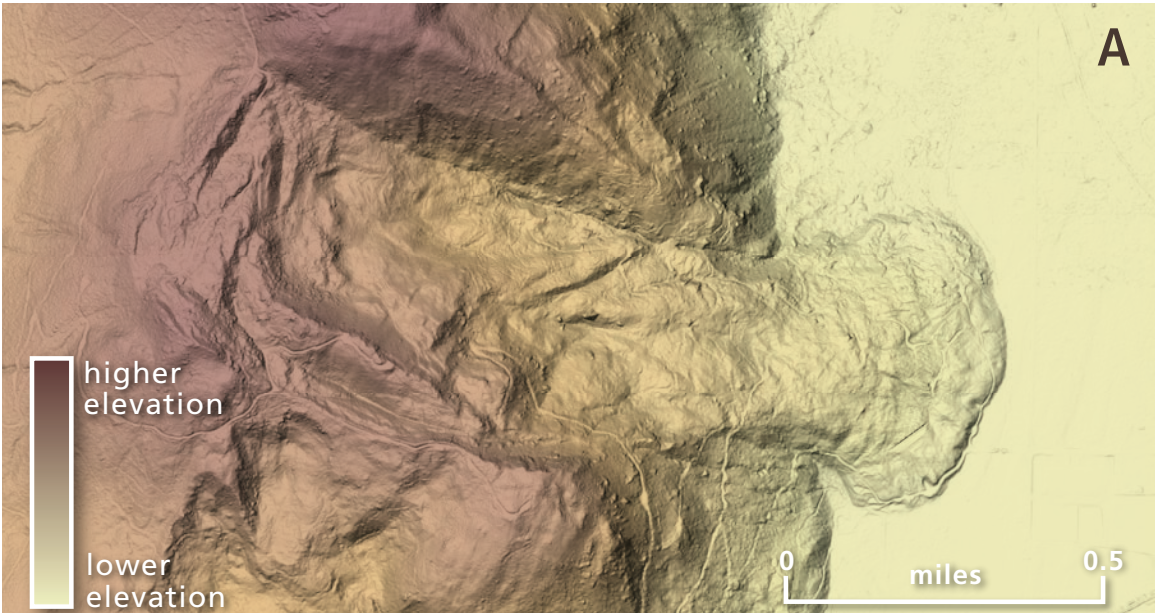
# Answer Key

Check out how we mapped the Tradedollar Lake landslide from page 14.

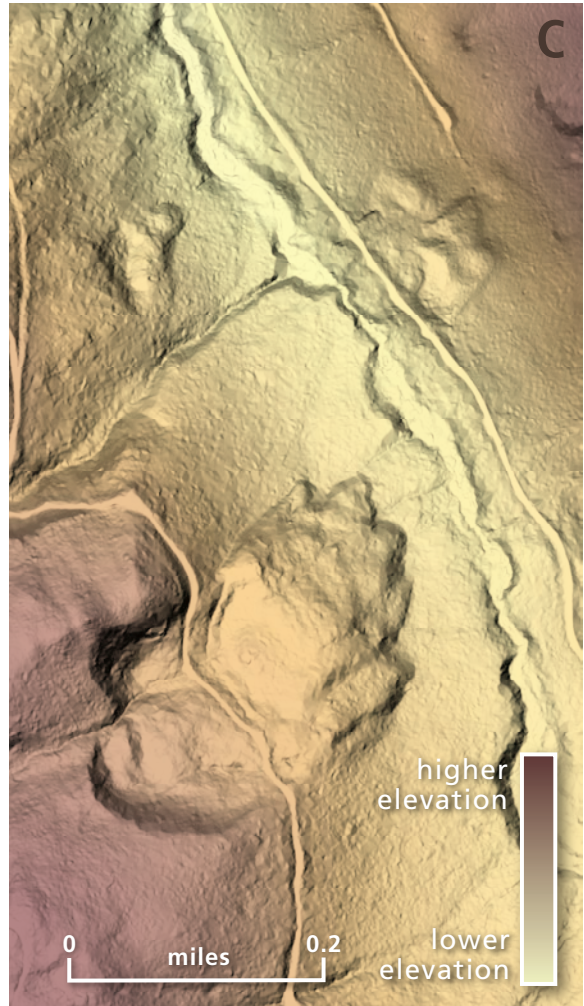
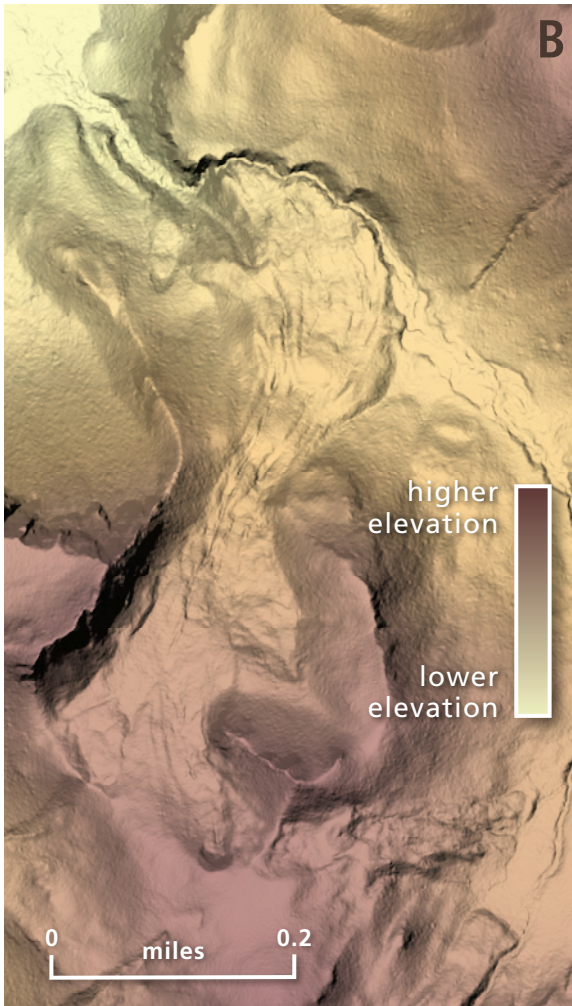


# Practice your Skills

Use the three lidar maps to find landslides. Outline each slide you find and label its parts. Look back to p. 5 for hints.







### SEE IF YOU CAN LABEL:

- Hummocky or undulating (rough) terrain
- A headscarp at the top of the landslide. Many headscarps look like a hungry giant took a bite out of the hill
- A toe at the bottom of the landslide
- Displaced rivers or ponding along a river, where the toe of a landslide blocked drainages

answers on page 21

# Coldwater Lake Hike

This hike takes you along the north shore of Coldwater Lake from the picnic area. You should see plenty of landslides of various types.

From the picnic area to Stop C is 6 miles round trip, so wear your comfy shoes and bring plenty of water. Never hike alone!

**STOP A:** Note the hummocks in the lake on your right as you start your hike. How do you think they got there?

**STOP B:** The trail crosses a deep-seated rotational landslide. Note how the landslide has changed the shoreline. Can you recognize any of the features shown in the diagram on page 3?

**STOP C:** This is the debris flow we looked at on pages 8 and 9. Are the rocks on the debris flow rounded or angular? How do these rocks





differ from rocks deposited by streams?

**STOPS D** and **E** are also debris flows. Did they all happened at the same time? How many landslides can you see across the lake to the southeast?

### IMPORTANT NOTE:

There are usually several ways to interpret what you see. Don't be afraid to not know the answer! Scientists don't always know all the answers either.

# Notes

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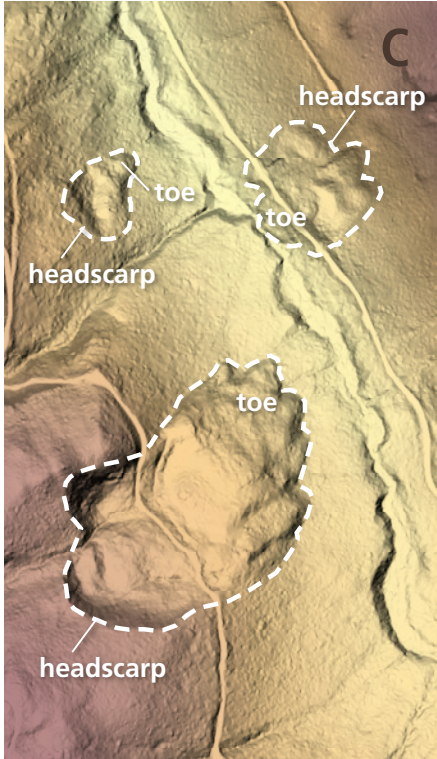
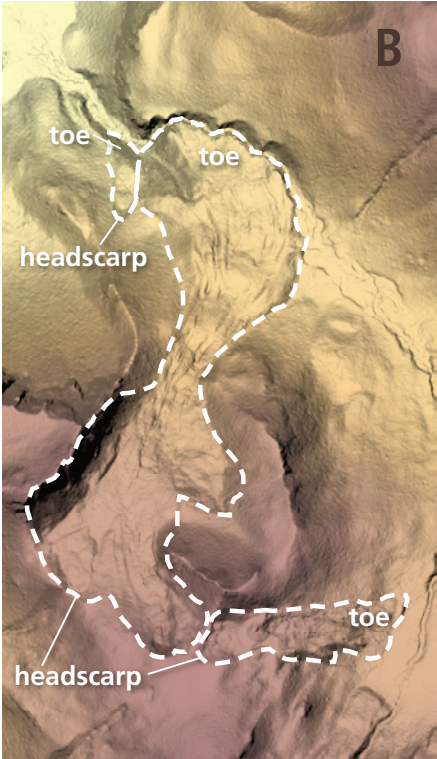
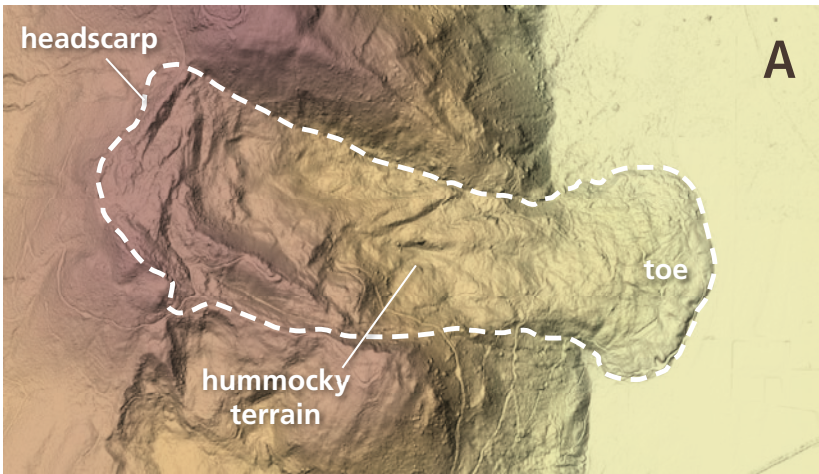
NOTES

**Sketches**

# Answer Key

Check out how we mapped the landslides shown on pages 15 and 16.

ANSWER KEY



# Discussion

## **On page 10 you were asked: “What differences can you see between the years?”**

The photography changed from black and white to color; the fan-shaped deposit above the lake grew as time went on; the debris flow was mostly vegetated in 2000, and then mostly fresh rock by 2003 because it moved between those years; the vegetation started to grow back on part of the fan-shaped deposit in 2008, and covered most of the fan-shaped deposit by 2015.

## **On page 10 you were asked: “Is there something in some of these pictures that makes it hard to see changes over time?”**

The big shadows in the 2011 and 2015 photos make it difficult to see if some areas of the landslide changed or not.

## **On page 14 you were asked: “What kind of landslide do you think it is?”**

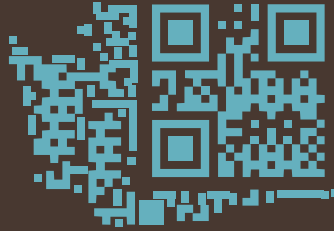
Comparing the features in the lidar to the landslide block diagrams, it looks most similar to a rotational slide; it has lots of hummocky terrain, a headscarp, a well-defined toe, and even a minor scarp within it. If you guessed one of the flow slides, like earthflow or debris flow, those wouldn't be bad guesses because this slide does have some flow-looking features in the toe.

## **On page 14 you were asked: “What method would you use to map landslides—aerial photos or lidar? Why?”**

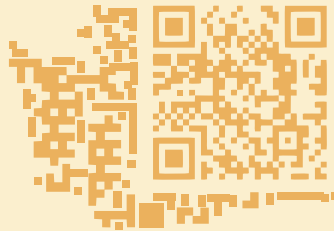
Lidar is almost always the better choice for landslide mapping, because it lets you see the ground surface whether there are trees there or not. Aerial photos aren't useless though—sometimes you can use them to figure out what year a slide moved, or to check if any parts of an older slide have fresh movement.

## FOR MORE INFORMATION:

1. Visit our Portal at [www.dnr.wa.gov/geologyportal](http://www.dnr.wa.gov/geologyportal) It's an interactive geologic map that lets you explore Washington's geology, landslides, volcanoes, and other fun features.
2. USGS Landslide Fact Sheet at [pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf](http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf) Learn more about types of landslides and how and when they occur.



3. USGS Mount St Helens, 1980 to Now—What's Going On? at [pubs.usgs.gov/fs/2013/3014/fs2013-3014\\_text.pdf](http://pubs.usgs.gov/fs/2013/3014/fs2013-3014_text.pdf). Learn all about the catastrophic 1980 eruption, the 2004–2008 dome building event, current volcano monitoring, and volcanic hazards.
4. USGS Professional Paper 1250 at [pubs.er.usgs.gov/publication/pp1250](http://pubs.er.usgs.gov/publication/pp1250). Read all about the 1980 Mount St Helens landslide and eruptions.



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