WASHINGTON GEOLOGICAL SURVEY

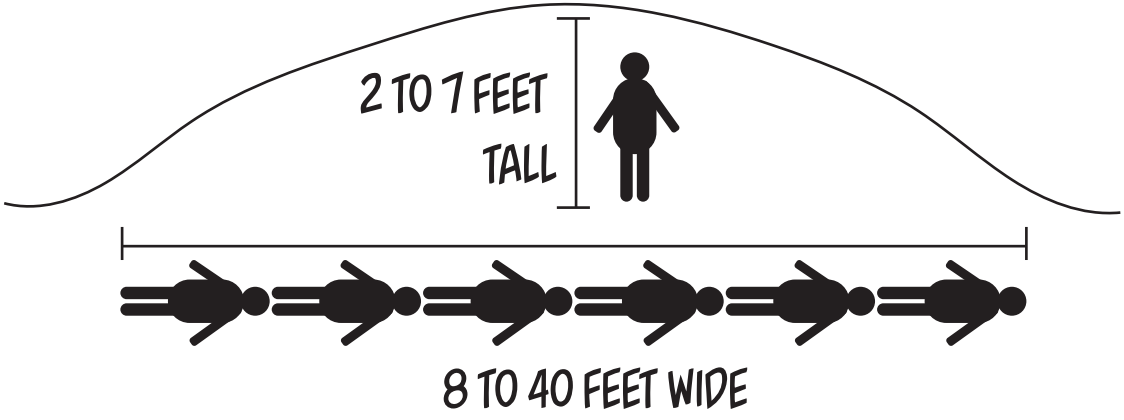
GUIDE TO THE MIMA MOUNDS

1 WHAT ARE THE MIMA MOUNDS?

The Mima mounds are small, irregularly spaced hills, described by some as “soil pimples” because they are piles of silt, sand, and pebbles.

They are found throughout the landscape around the southern Puget Sound. Similar mounds located outside of this area are said to be “mima-like”. One of the best places to view the Mima mounds is at the Mima Mounds Natural Area Preserve, located in Thurston County, Washington, near the town of Littlerock.

The mounds in the preserve occupy an area that is roughly 5 square miles (the Seattle-Tacoma International Airport is about 4 square miles, equivalent to 3,000 football fields). Each Mima mound is a different size, but many of them are a few feet tall by tens of feet wide.



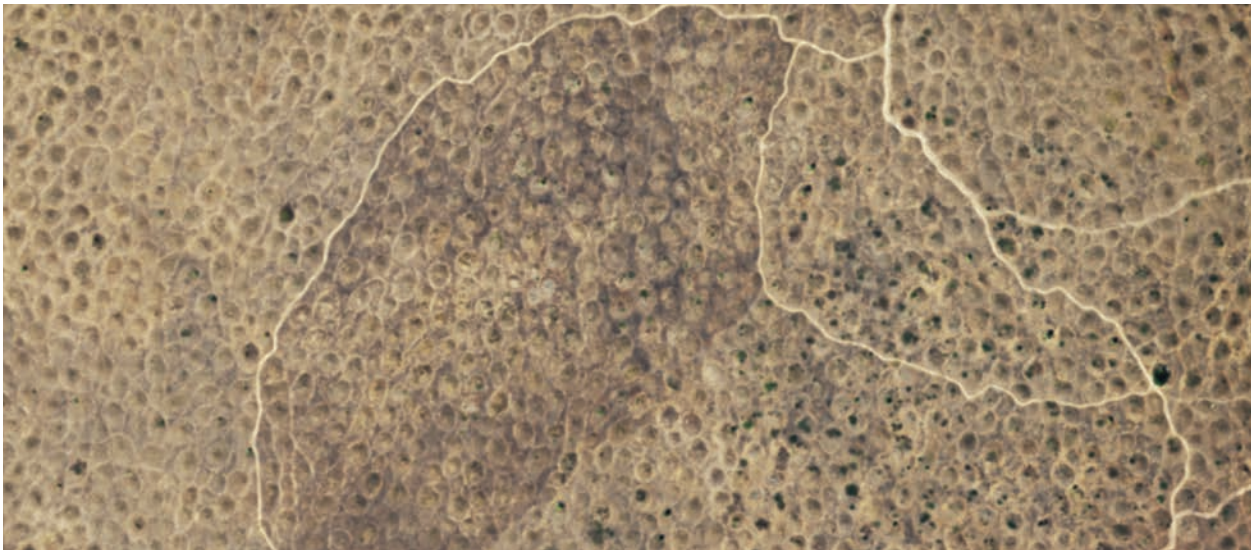
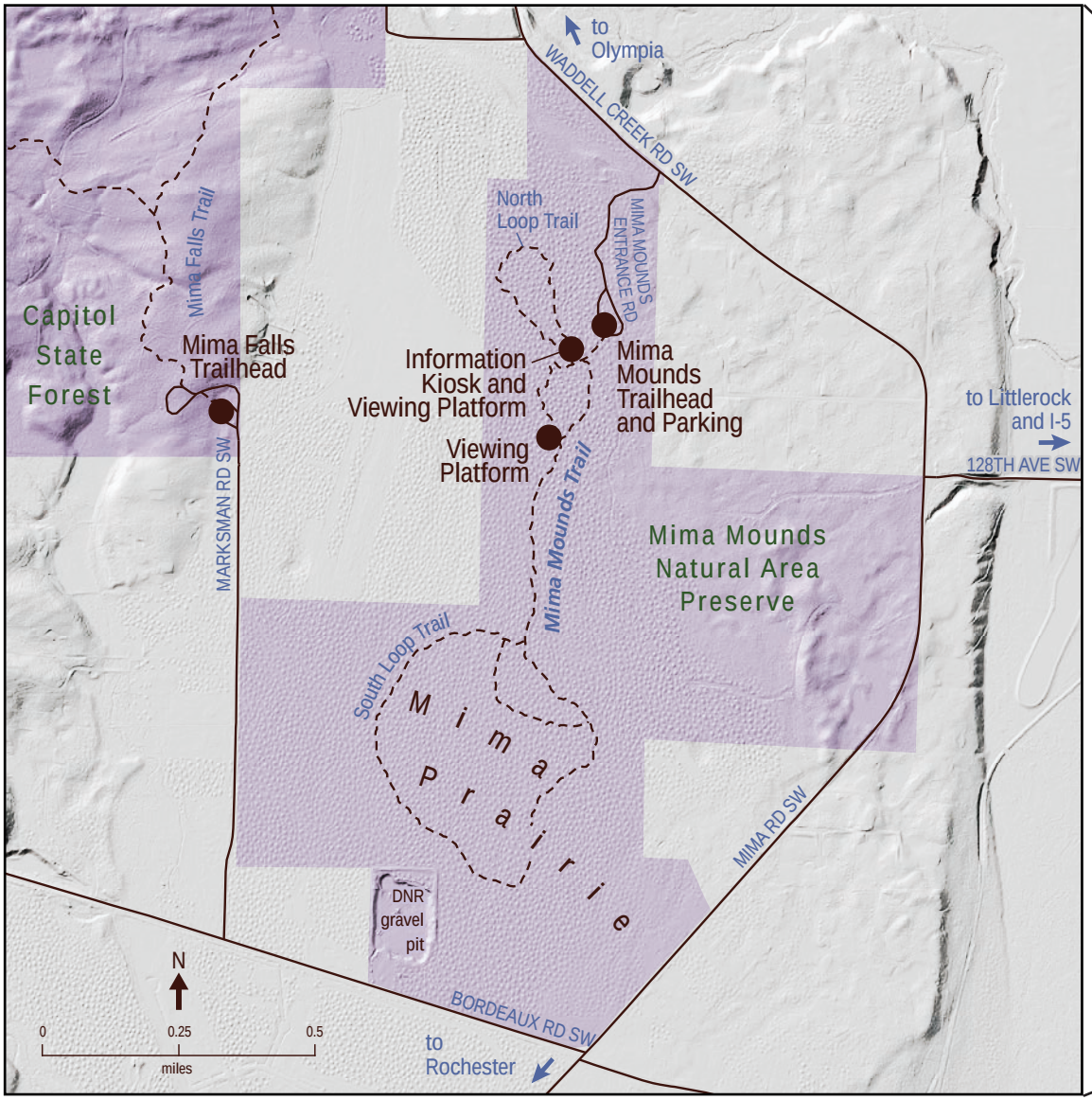


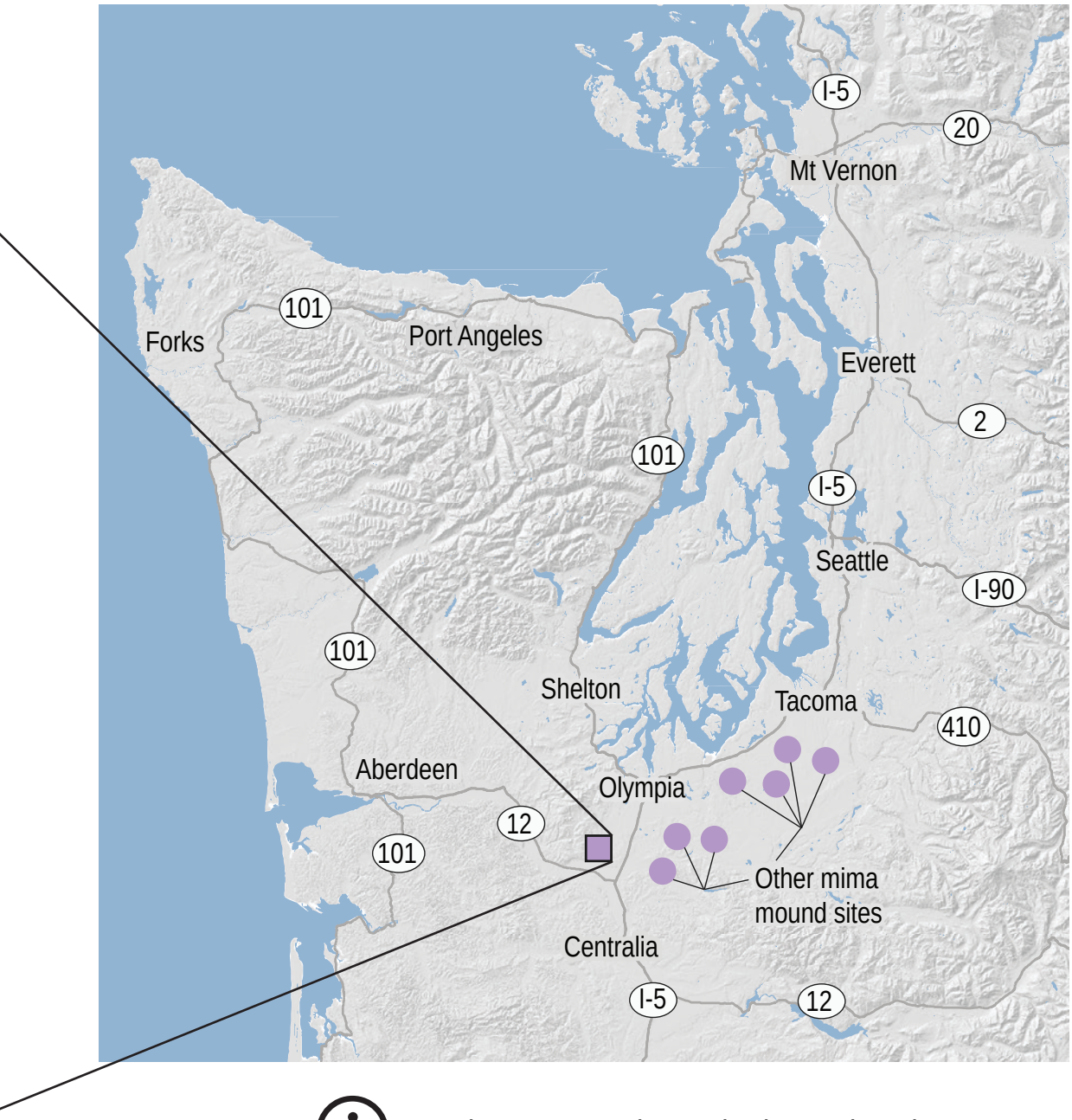
Photo of the Mima Mounds Natural Area Preserve from above. The Natural Area Preserve is managed by the Washington State Department of Natural Resourcs.

Image of the Mima Mounds Natural Area Preserve (same area as shown above) using bare-earth lidar, a technique that shows the ground surface without plants, trees, or buildings.

Location and trail information

The Mima Mounds Preserve has a short ADA accessible trail as well as non-paved trails. Combined, these trails total 3.3 miles and take about 1 hour to explore.





A Discover Pass is required to park at the preserve.

Protected lands

The Mima mounds are both a Natural Area Preserve and a National Natural Landmark. There are 57 Natural Area Preserves in Washington State and 600 National Natural Landmarks within the United States and its territories.

The Mima mounds include special rocks and well-draining soils (geology) as well as plants and animals (biology). In fact, the type of soil in an area can influence the types of plants that can grow there. Plants are dependent on the nutrients found in soil in order to survive.

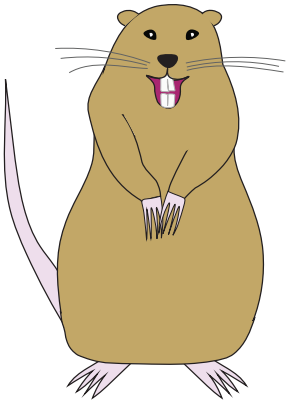
These nutrients come from rocks, minerals, vegetation, and animals, which contribute to the ecosystem of the prairie grasslands. The nutrients in a soil determine which plants can grow, and the types of plants serve as food for bugs and critters. It's a beautiful cycle of life!

Illustration by Joyce Bergen

A special place for the first people

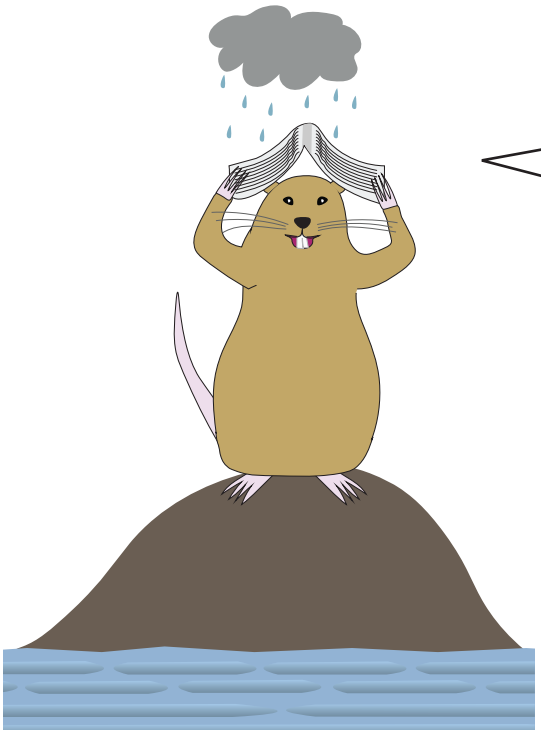
Prairies, including the Mima mounds, are farmlands where the first people harvested plants for food and medicine. The Camas flower and bulbs from the Mima mounds are particularly high quality, and were widely traded amongst the tribes of western Washington. The Mima mounds area was an intertribal center of trade.

The word “mima” comes from a word in the Chehalis language meaning “newness”, and a similar Chehalis word “mianumn” means “to be surprised”. The very name “Mima mounds” might echo this deeper meaning: the mounds represent a new and wondrous landscape that was drastically changed in a sudden event.



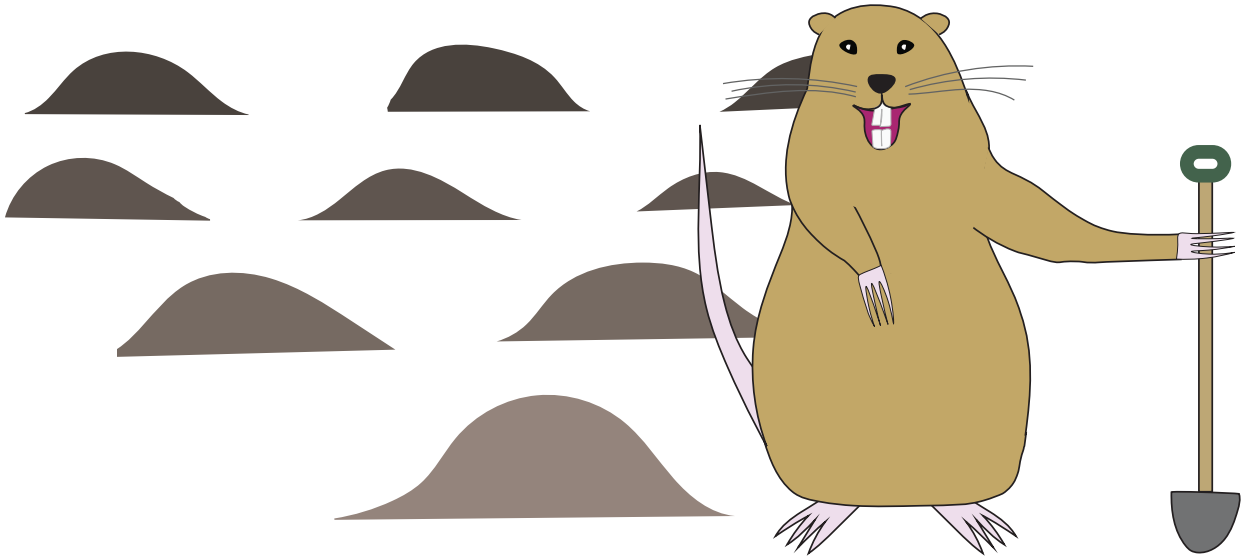
Hi! I'm Goodwin the gopher. Some people say that we gophers built the Mima mounds, but there are many other hypotheses, too. I'm going to tell you about some of my favorite ideas for the creation of the mounds, listed in no particular order of likelihood, and then you can decide which one you think makes the most sense.

In the 1940s, biologists Victor Scheffer and Walter Dalquest suggested that gophers built the Mima mounds. Gophers dig tunnels in the ground, pushing the soil they excavate into a pile. This is known as the *gopher hypothesis*.

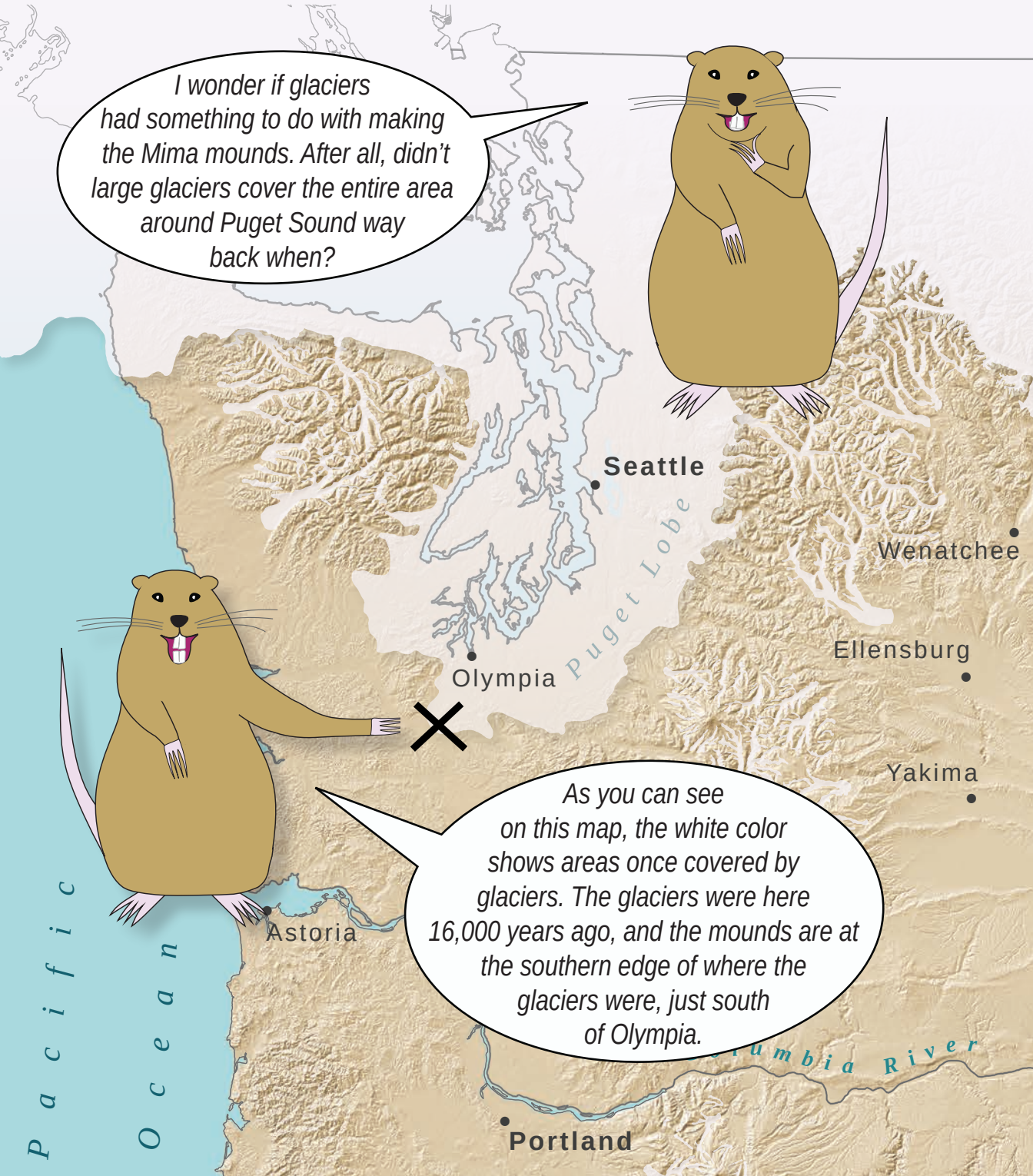


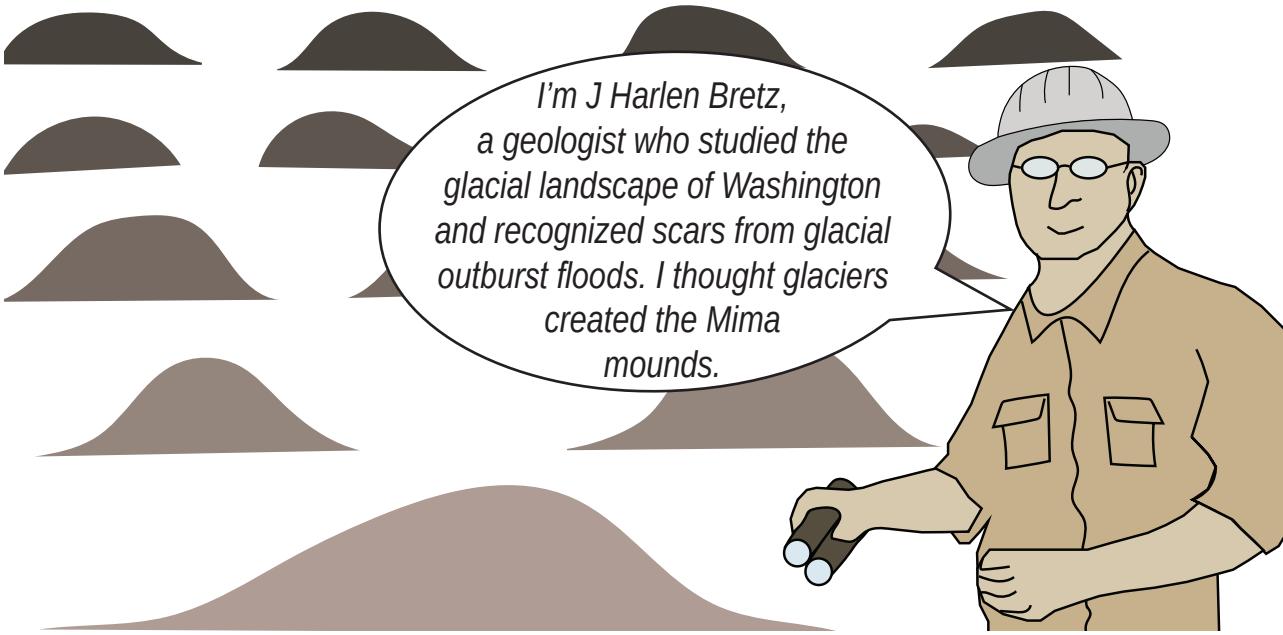
Because we live underground, we build our piles so that we have a high and dry place to go when rainstorms soak the soil significantly.

Gopher social rules make us dig our holes a few feet apart. But these hills are easy work for us. My family and I can build 20 mounds each year!

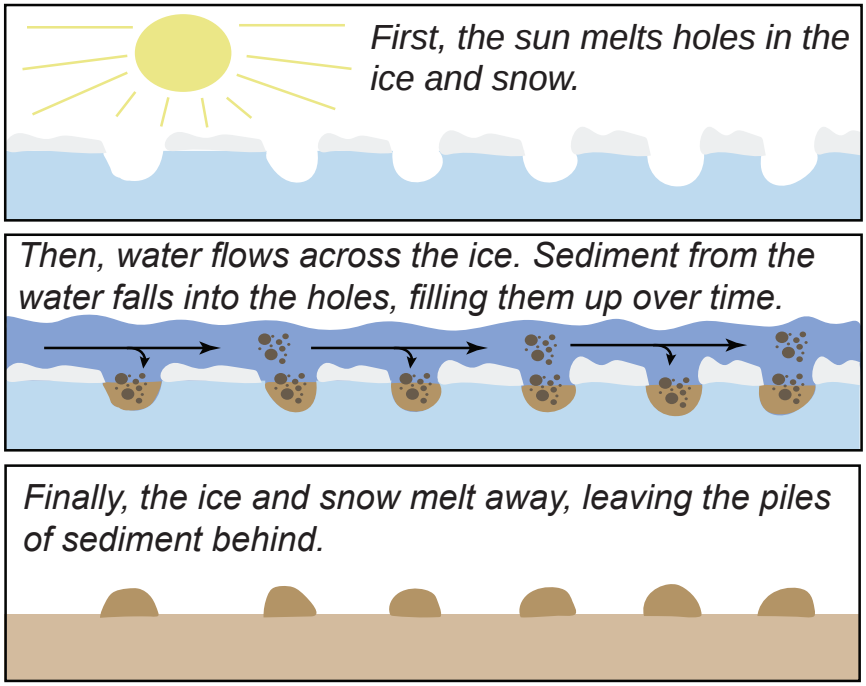


WHAT MADE THE MIMA MOUNDS?




I'm J Harlen Bretz, a geologist who studied the glacial landscape of Washington and recognized scars from glacial outburst floods. I thought glaciers created the Mima mounds.


In 1913, I developed the sun cup hypothesis to explain the Mima mounds.

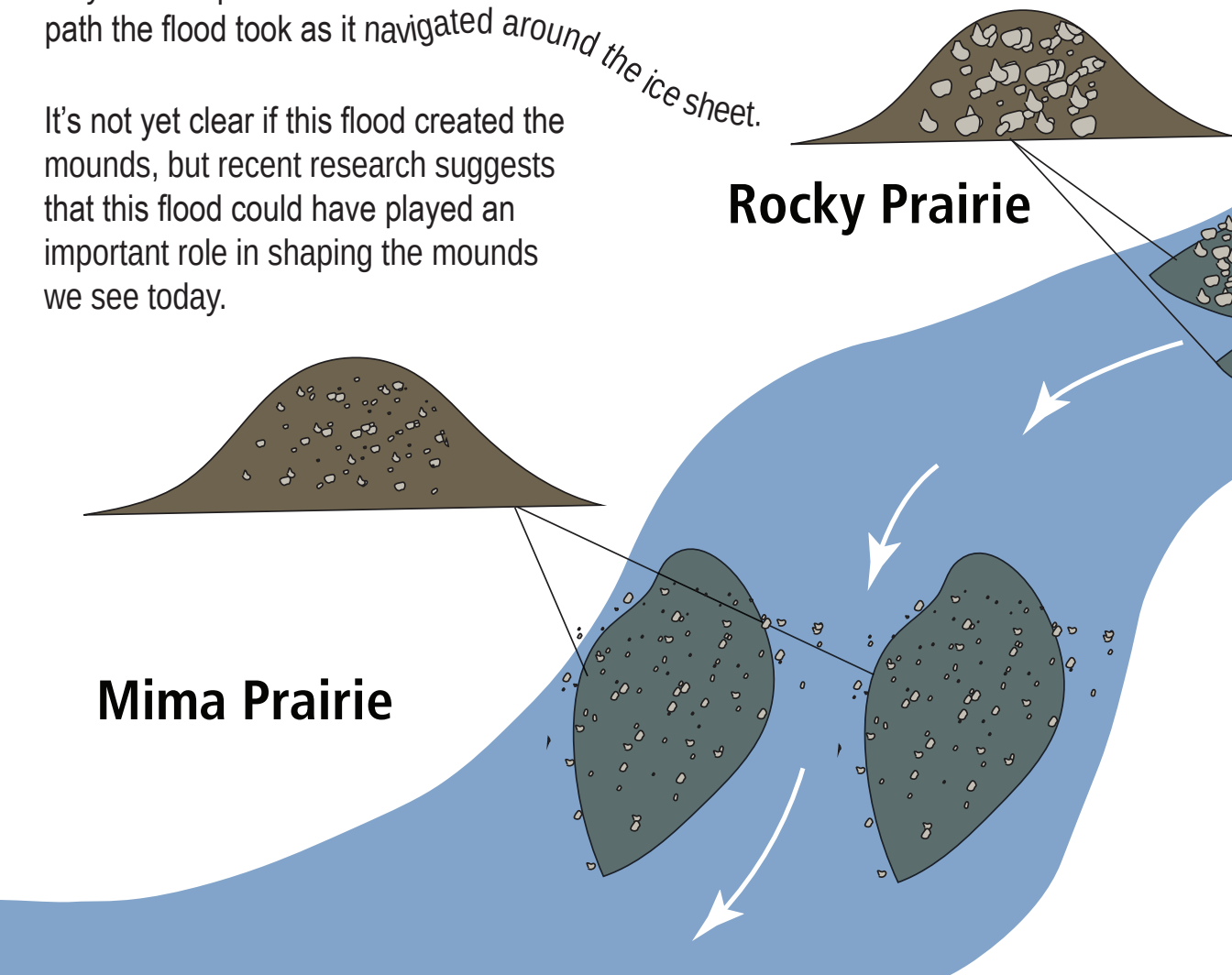

First, the sun melts holes in the ice and snow.
Then, water flows across the ice. Sediment from the water falls into the holes, filling them up over time.
Finally, the ice and snow melt away, leaving the piles of sediment behind.

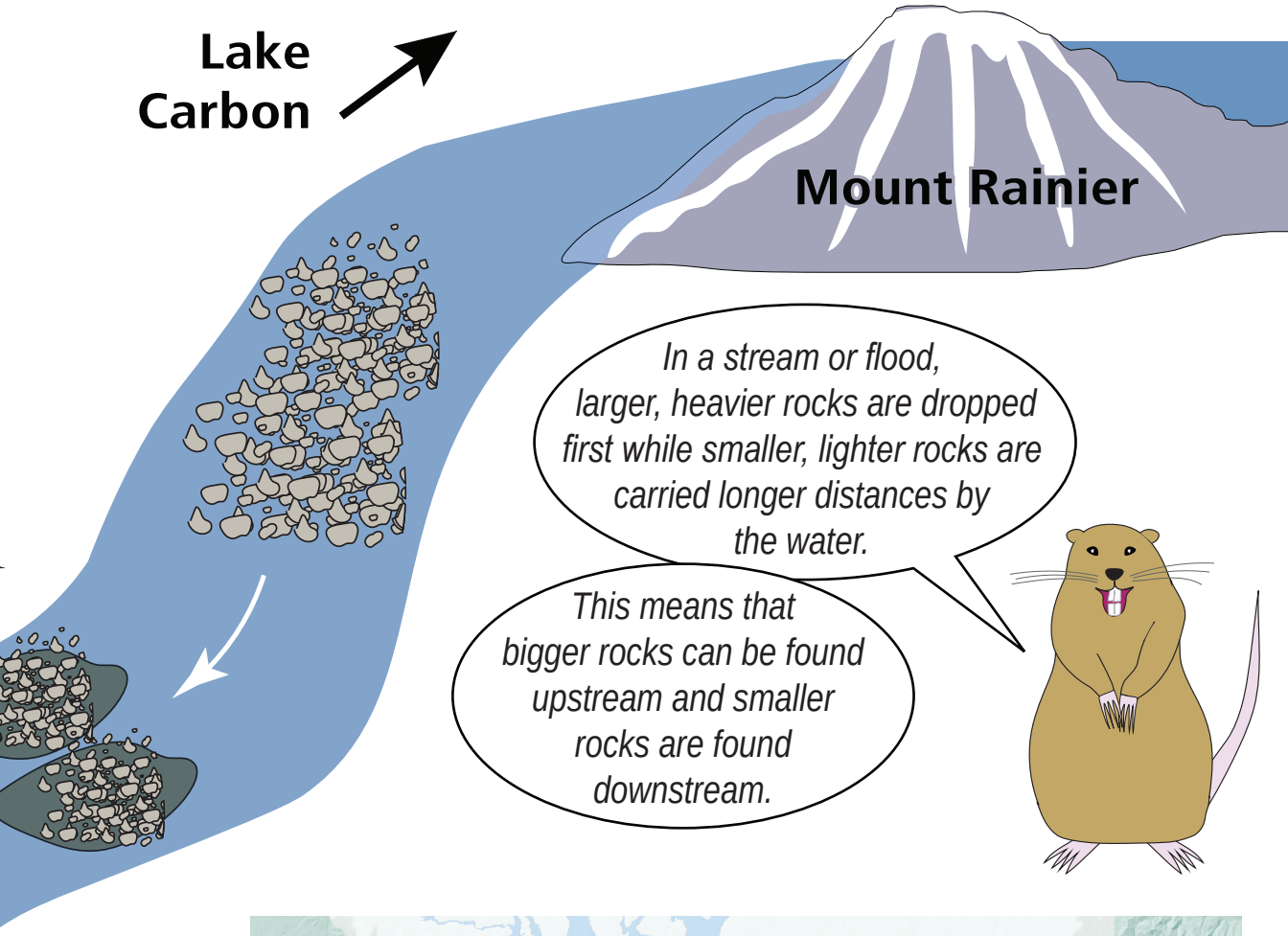
WHAT MADE THE MIMA MOUNDS?

Some researchers think a flood spread from the glacially-dammed Lake Carbon, which was located northwest of Mount Rainier.The flood picked up volcanic rocks from the Cascade mountains nearby Rainier and carried them around the ice sheet that covered this area 16,000 years ago. The flood left piles of volcanic rocks in many mounds.

The mounds in Rocky Prairie (located upstream of Mima Prairie) contain more volcanic rocks and larger volcanic rocks than the mounds in Mima Prairie. In addition, the mounds in each prairie are stretched in the direction parallel to the valleys that they were deposited in. The mound orientations could be related to the path the flood took as it navigated around the ice sheet.

It's not yet clear if this flood created the mounds, but recent research suggests that this flood could have played an important role in shaping the mounds we see today.





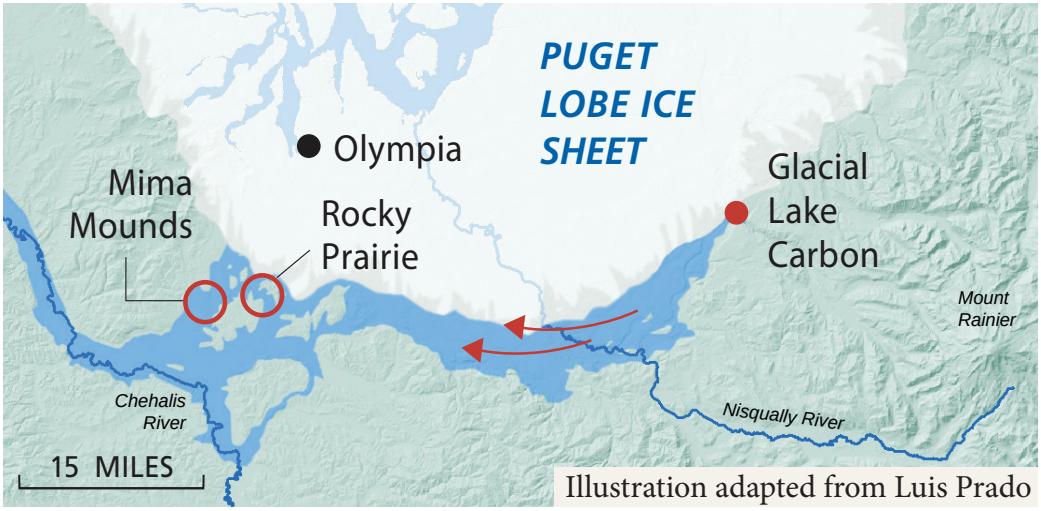
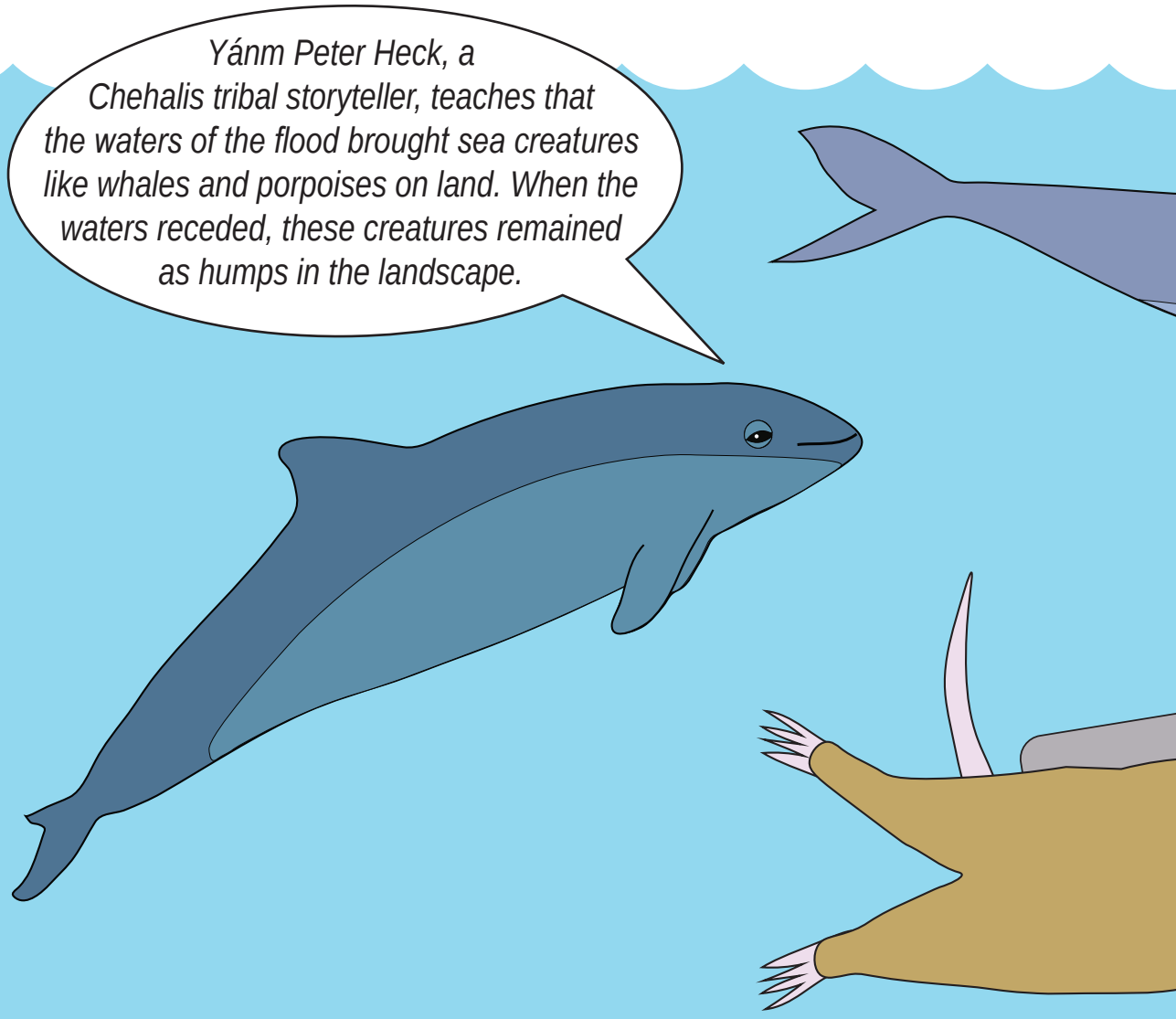
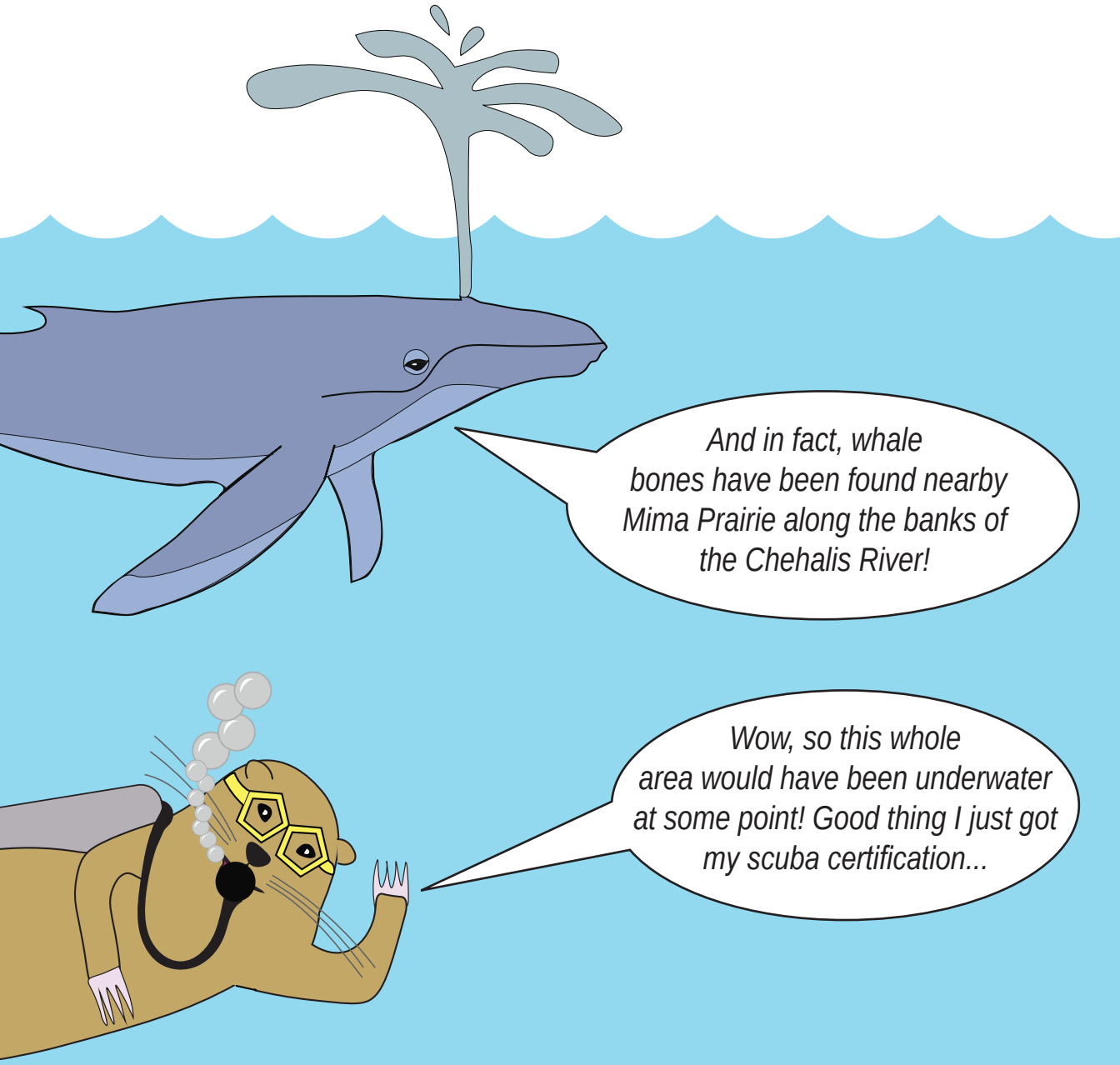


Illustration adapted from Luis Prado

WHAT MADE THE MIMA MOUNDS?

There are many stories told by the Chehalis people which also describe a great flood washing over Mima Prairie. All of these stories indicate that the landscape was originally flat and then suddenly transformed to mounds by a wave of water.




And in fact, whale bones have been found nearby Mima Prairie along the banks of the Chehalis River!
Wow, so this whole area would have been underwater at some point! Good thing I just got my scuba certification...

WHAT MADE THE MIMA MOUNDS?

Frost polygons were another idea put forth by R.C. Newcomb in 1940 and later modified to *frost polygons + erosion* by Arthur Ritchie in 1953. The left image below shows frost polygons in Alaska, and the right image shows the Mima mounds.

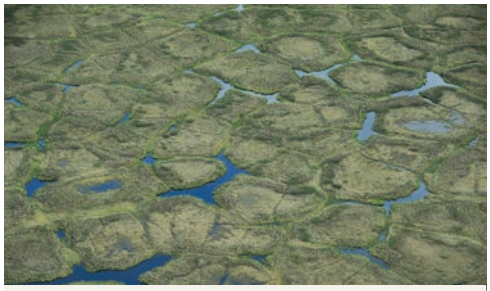


Photo by Chris Zimmerman, USGS

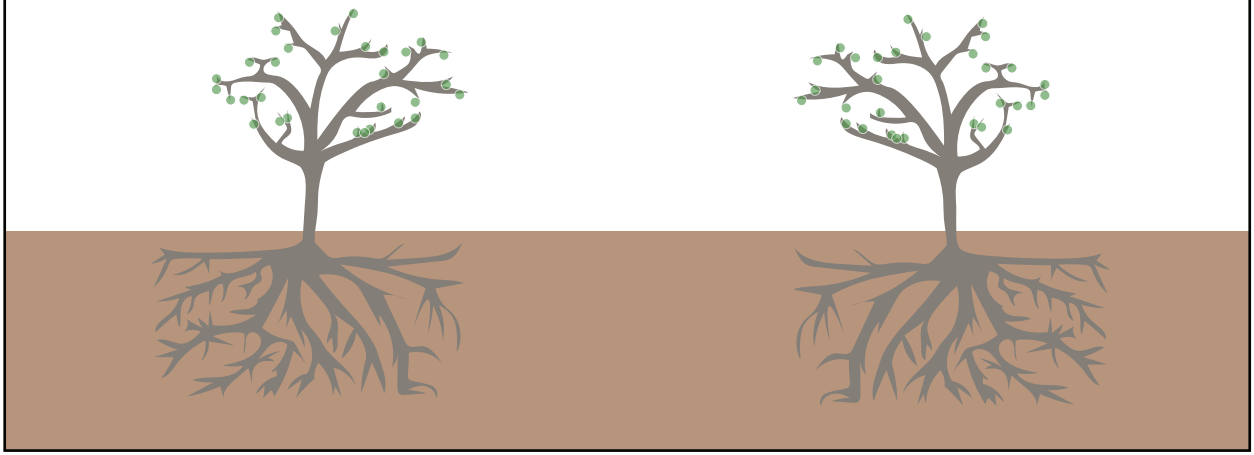
Frozen soils crack, just like your dry skin does in winter.

Cracks fill with water, and the water freezes. Ice takes up more space than water, which causes the cracks to expand.

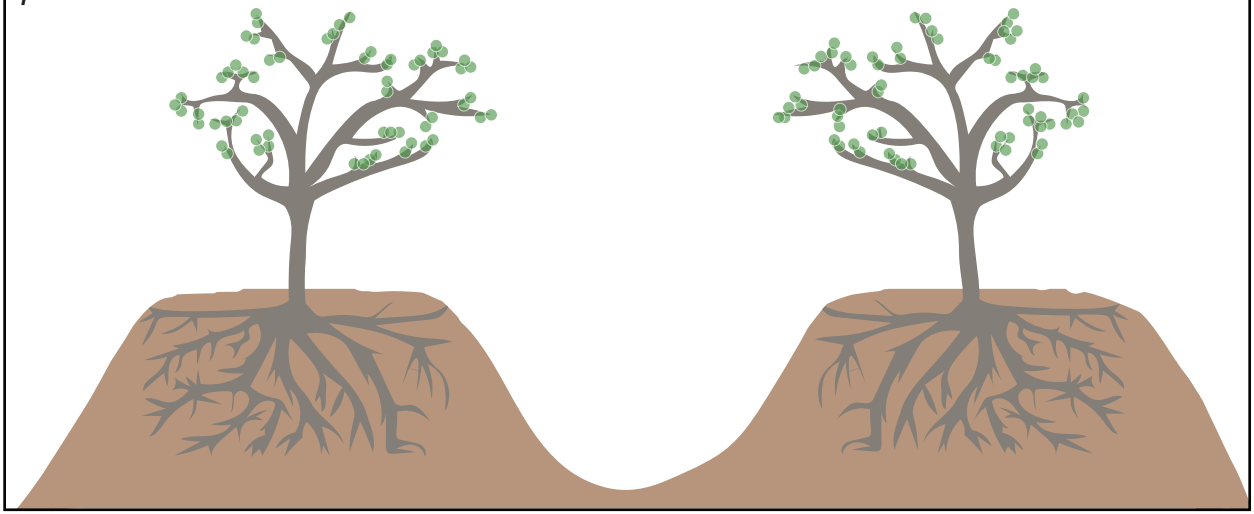
When the seasons warm, the ice melts. The water flows away and carries some of the soil with it. This leaves behind rounded mounds.

Other scientists prefer the *runoff erosion-root anchor* hypothesis, first proposed by George Gibbs in 1854:

Vegetation growing in the prairie would have established roots in the ground that protected the soil.

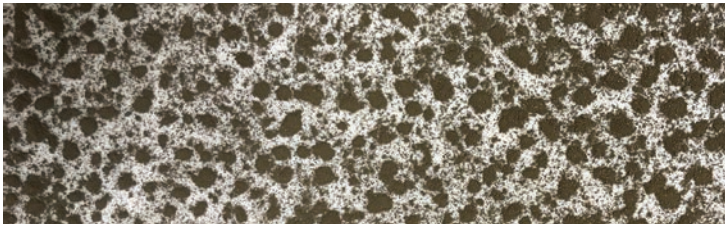


Weathering, including physical (wind and rain) and chemical (dissolving in water), would have removed the soils that were not protected by the roots of plants.



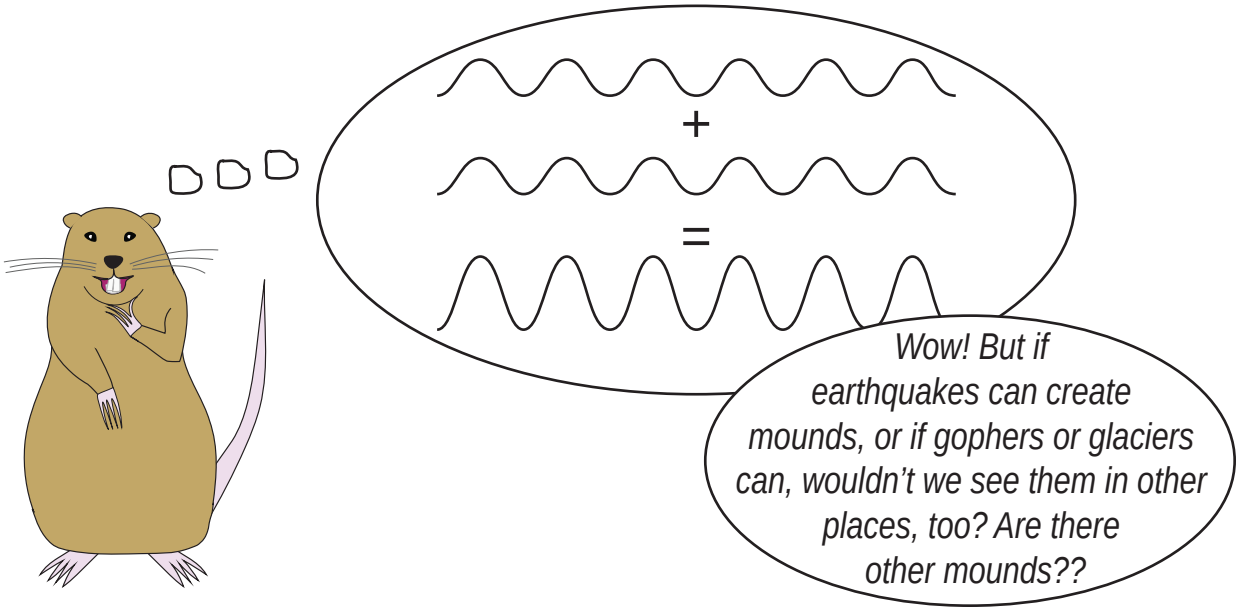
WHAT MADE THE MIMA MOUNDS?

In 1990, Andrew Berg proposed the *earthquake shaking hypothesis*. You can think of an earthquake like a drop of water that creates ripples in the water. An earthquake also sends ripples through the Earth. The image below shows what happens when you shake a table with Mima mound soil on it!

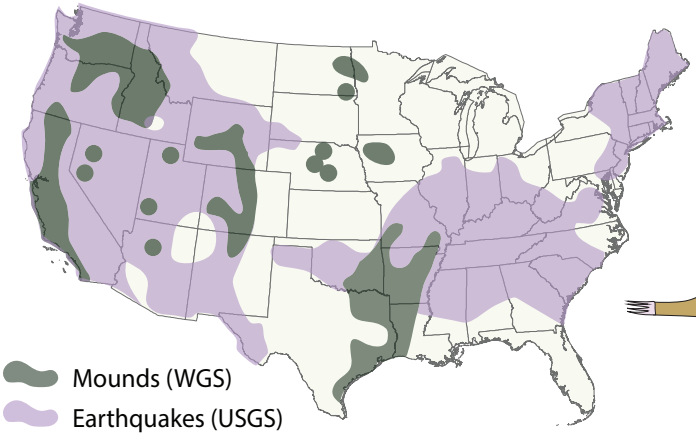


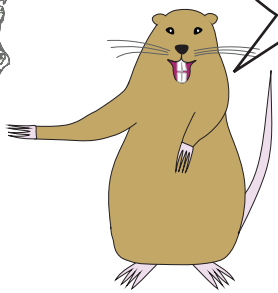
When a table of fine silt from the mounds is shaken with the strike of a hammer, mound-like piles form!

As the earthquake 'ripples' (*seismic waves)* travel around the Earth, they run into each other and combine. High points of the waves can combine into even higher points, and low points of the waves combine into even lower points. The really tall combined waves could create big piles of sediment like the Mima mounds.



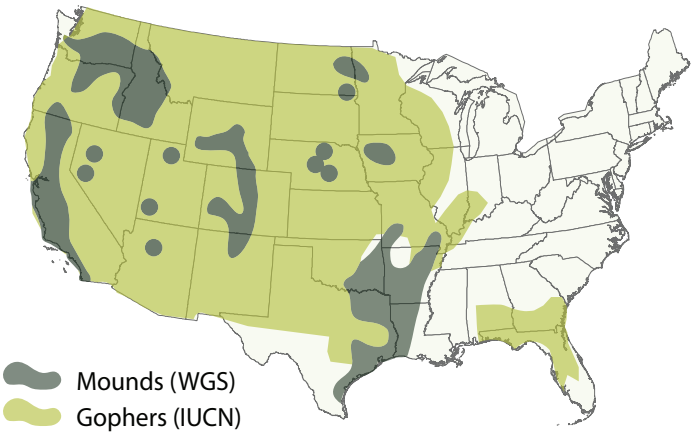
WHERE ELSE ARE MOUNDS FOUND?



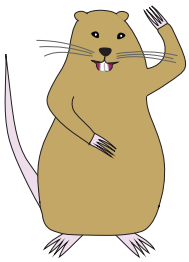


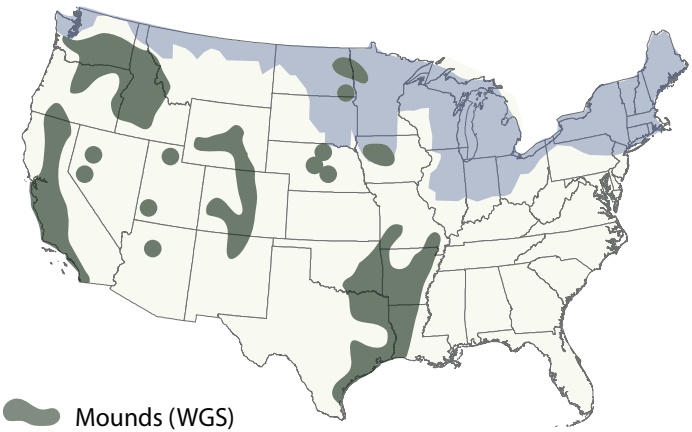
Yup! there are other mounds around the world. Just look at these maps showing mounds in the U.S.

These maps also show where mounds are and where there are earthquakes, gophers, and where glaciers used to be.



So what do you think? What made the Mima mounds? I've got to get digging, but let's talk about it when we meet again. Bye!





Inside a Mima mound

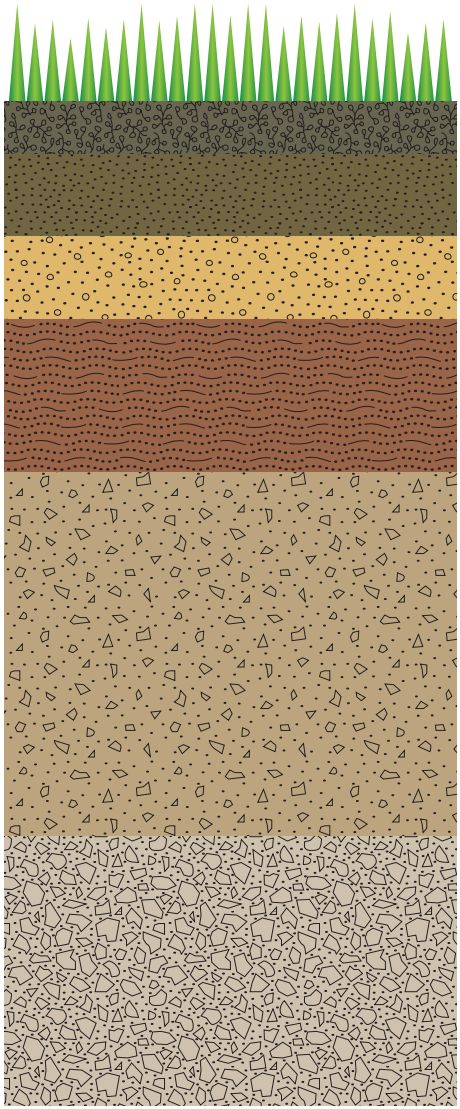
Look at the picture of the Mima mound below. This mound has been cut in half so that you can see what it looks like inside.

Take a careful look at the image and describe what you see. Do you see soil, rocks, or plant materials? Are all of the rocks the same size? Do you see soil horizons, like the diagram to the right? What colors are visible?

Photo by Patrick Pringle, Centralia College

The dirty hierarchy

Earlier, you learned that soils are unique. Maybe you've played in dirt before and you know firsthand that dirt can be black, brown, beige, or even red. If you've spent some serious time digging, perhaps you encountered different soils as you (or your dog!) dug a hole in your yard. Read below to learn about these different *soil horizons*. Not all soils have all of these horizons.



O horizon: Includes decaying, once-living (*organic*) materials like twigs or leaves.

A horizon: Includes severely decayed organic materials and crumbled rocks.

E horizon: Water moves minerals like iron or aluminum from this layer downward.

B horizon: Stores minerals moved by water from the layers above.

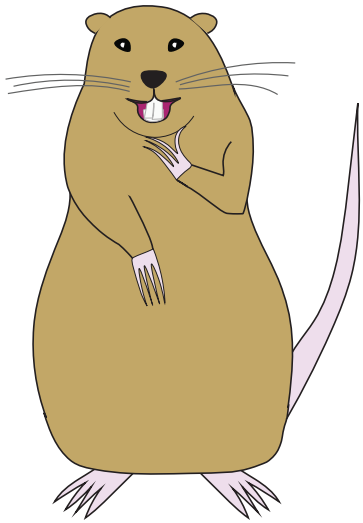
C horizon: Rocks that are starting to break into pieces.

R: Firm layer of rock (not soil)

NOTES

DISCUSSION QUESTIONS

Now that you've explored the Mima mounds, test your knowledge with the following questions.



1) What is a Mima mound? How many mounds did you see?

2) What was the most interesting thing you learned about the Mima mounds?

3) There are many theories about how the mounds formed. Compare and contrast two competing theories.

similarities	differences

4) What do you think created the Mima mounds? What evidence and reasoning do you have to support that?

5) Pick your favorite theory that you've read about and explain why it's your favorite.

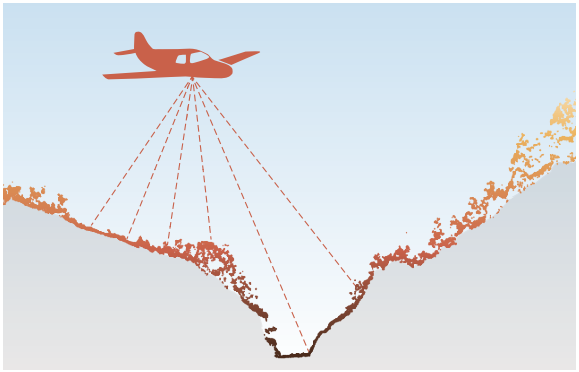
6) What is a prairie, and why are they unique?

7) How do the mounds look on the ground versus when viewed from above (refer to page 3)?

8) Look back at the illustration on pages 6 and 7. Did you see any of those prairie inhabitants at the mounds?

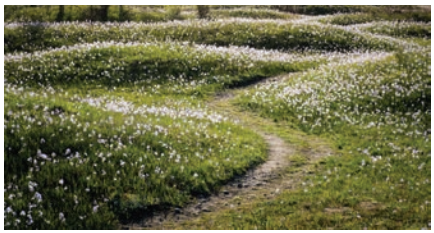
GLOSSARY OF TERMS

Lidar—Uses pulses of light to measure distance from an airplane to the ground. Light pulses sent by the plane are reflected off the ground and back to the plane. The time it takes for the light pulse to travel to the ground and back can be converted to distance. This distance reveals the elevation of the ground surface.



Ecosystem—A geographic area where the living things (plants and animals) and nonliving things (land, water, snow, sun) interact with each other. A desert, a coral reef, a rainforest, and a prairie are all ecosystems.

Prairie grassland—A large, flat, or rolling landscape covered in grasses. These exist all over the world where there is some rain but not too much.



Weathering—The impact of wind, rain, hail, snow, and sun over long periods of time causes rocks to break apart into tiny pieces.

*Continental glaciers, glacial lakes, **glacial floods***—*Continental glaciers* are huge sheets of thick ice that used to cover the northern portion of the U.S. The ice would melt to form *gigantic lakes* that were naturally dammed with ice. Sometimes, the ice dams broke and the lakes poured out in *giant floods* that spread across the landscape.

Decay—When dead animals and plants start to rot, they break down into the soil and provide nutrients for other plants and animals.

Clay, silt, sand, pebbles, cobbles, boulders (from smallest to largest)—Soils include clay, silt, sand, pebbles, cobbles, and boulders. Geologists classify these particles by size. *Clay and silt* are tiny and hard to see. *Sand* is large enough to see and feels scratchy when you pinch it. A *pebble* is a rock that you can hold with one hand. A *cobble* is a large rock that you might not be able to lift, let alone fit in one hand. A *boulder* is a big rock that can be larger than you!

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Special thanks to:

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- Patrick Pringle: *Professor Emeritus of Earth Science, Centralia College*
- Kenneth Tabbutt: *Professor of Geology, Evergreen State College*
- Barry Goldstein: *Professor Emeritus of Geology, University of Puget Sound*

For more information:

Mima mounds: An evaluation of proposed origins with special reference to the Puget Lowland by A. L. Washburn
© 1988 by Washington Geological Survey
https://www.dnr.wa.gov/Publications/ger_ri29_mima_mounds.pdf

Geology underfoot in western Washington by Dave Tucker
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Mima Mounds Natural Area Preserve
https://www.dnr.wa.gov/MimaMounds

Nick From Home - Mima Mounds
https://youtu.be/7-0d-Go4iSw