

Overview:

In this lesson, students learn about two records of past seismic events: stratified layers and indigenous oral histories.

Targeted Alaska Grade Level Expectations:

Science

- [5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [6] SD2.1 The student demonstrates an understanding of the forces that shape Earth by describing the formation and composition (i.e., sand, silt, clay, organics) of soils.
- [7] SD2.2 The student demonstrates an understanding of the forces that shape Earth by describing how the movement of the tectonic plates results in both slow changes (e.g., formation of mountains, ocean floors, and basins) and short-term events (e.g., volcanic eruptions, seismic waves, and earthquakes) on the surface.
- [5-6] SF1.1-SF3.1 The student demonstrates an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives by telling a local or traditional story that explains a natural event (e.g., animal adaptation, weather, rapid changes to Earth's surface) and relating it to a scientific explanation.
- [7] SF1.1-SF3.1 The student demonstrates an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives by investigating the basis of local knowledge (e.g., describing and predicting weather) and sharing that information.

Reading

- [5-6] 2.8.1 The student analyzes literary elements and devices by identifying or describing in fiction: plot (e.g., main conflict or problem, sequence of events, resolution); settings (e.g., how they affect the characters or plot); characters (e.g., physical characteristics, personality traits, motivation, growth and change); point of view (who is telling the story).
- [7-8] 3.7.3 The student analyzes and evaluates literary elements and devices by analyzing and evaluating the importance to the story of plot, setting, character, point of view, and theme.

Objectives:

The student will:

- model tsunami layering with sand and ash;
- infer the number of waves based on actual data; and
- read and analyze an indigenous oral narrative for literary and geologic elements.

Materials:

- 12-inch – 18-inch long clear plastic tube (T12 tube guards cut to length)
- Bucket
- Water
- Sand
- Ash or cat litter
- Funnel
- Ruler

- STUDENT WORKSHEET: “What’s in a Wave?”
- VISUAL AID: “Middle Bay Tsunami Deposit”
- STUDENT WORKSHEET: “How the Prairie Became Ocean”
- VISUAL AID: “Salmon River, Oregon”

Whole Picture:

Determining the geologic history of a place helps in understanding potential hazards. This lesson explores two ways in which history is recorded. One way, is through the collection and analysis of core samples by paleoseismologists. Core samples contain stratified layers that illustrate past events. Some of the basic layers that may be found consist of soil or peat (decomposed organic matter mixed with small rock particles), ash from volcanic eruptions, and layers of sand or mud stirred up and deposited by tsunamis.

Close analysis of the tsunami sand layer can shed light on details of the tsunami event itself. When tsunamis get close to the shore they scour the bottom and stir up sand. As the wave inundates land, it deposits the sand. In southern and western regions of Alaska, ash from the Katmai eruption of 1912 forms a layer. This also can mix in with the stirred up sand from a tsunami. As this mixture settles out, the coarser sand particles tend to remain towards the bottom of a deposit and the finer ash particles settle on top. As each tsunami wave washes in, a layer of ash is at the top of each wave layer. In this way, paleoseismologist Gary Carver was able to interpret the layers to find that 4 tsunami waves struck Middle Bay on Kodiak Island during the 1964 tsunami.

History is also recorded in the oral traditions of indigenous people. Several indigenous groups of North America’s west coast tell stories of earthquakes, flooding and tsunamis. One story in particular told among the Yurok people of Northern California, “How the Prairie became Ocean,” includes coseismic subsidence (ground dropping due to earthquakes). After hearing this story, paleoseismologists found a wealth of geologic evidence of coseismic subsidence in the Humboldt Bay area. Clearly the Yurok people were aware of coseismic subsidence hundreds of years ago.

Activity Preparation:

For younger students, it may be more appropriate to model the sand and ash demonstration on STUDENT WORKSHEET: “What’s in a Wave?” as a teacher-led activity. For older students, groups may be more appropriate.

Activity Procedure:

1. Explain that students will learn how two records of history, stratified layers (layers deposited in the ground) and indigenous oral histories, can inform us of past seismic events.
2. Explain that tsunami deposits often consist of sand. In areas near volcanoes, tephra (or ash) deposits may also be present. Allow students to touch samples of sand and ash and ask them to describe the texture (sand is more granular, ash particles are finer). Tsunamis stir up sand on the bottom of the ocean and carry it. In southern and western regions of Alaska, ash from the Katmai eruption of 1912 forms a layer. This also can mix in with tsunami sand layers. Explain the way in which these two layers settle out from a wave make it possible to determine the number of tsunami waves that washed ashore. Distribute STUDENT WORKSHEET: “What’s in a Wave?” and proceed with the modeling as a teacher-led activity or group activity.
3. After students have completed the worksheet, discuss student responses. Display VISUAL AID: “Middle Bay Tsunami Deposit” to show how paleoseismologist Gary Carver interpreted the number of waves.
4. Explain that indigenous people tell stories that have been passed down for generations. Several in-

digenous groups of North America's west coast tell stories of earthquakes, flooding and tsunamis. One story in particular told among the Yurok people of Northern California, "How the Prairie became Ocean," includes coseismic subsidence (ground dropping from earthquakes). After hearing this story, paleoseismologists found a wealth of geologic evidence of coseismic subsidence in the Humboldt Bay area. Clearly the Yurok people were aware of coseismic subsidence hundreds of years ago. Distribute STUDENT WORKSHEET: "How the Prairie Became Ocean" for students to read and complete.

- Review student responses and display VISUAL AID: "Salmon River, Oregon." Explain this image displays what scientists found near the Salmon River in Oregon that corroborates Native American stories like "How the Prairie Became Ocean." In this picture, Native American firepits are covered with a layer of tsunami sand.

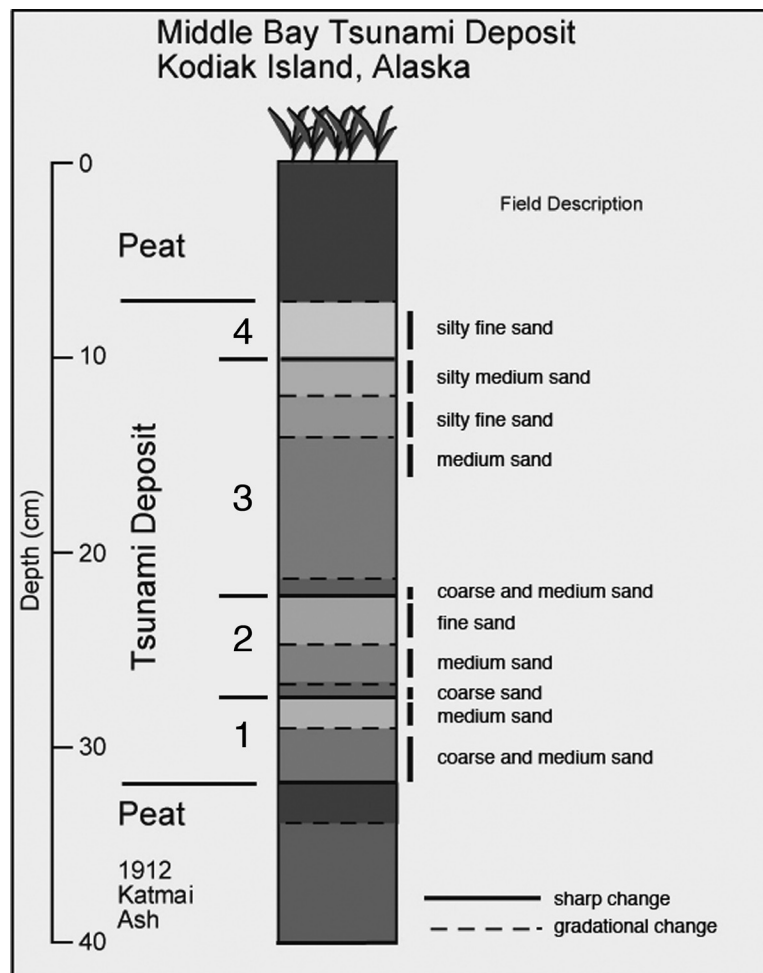
Extension Idea:

Find the locations noted in the story on Google Earth.

Answers:

STUDENT WORKSHEET: "What's in a Wave?"

- Answers will vary. Sand and ash layers should be illustrated with ash above the sand. Layers should be labeled and include measurements made using a ruler.
- Students should infer that four waves struck Middle Bay on Kodiak Island in the 1964 tsunami.



STUDENT WORKSHEET: "How the Prairie Became Ocean"

1.

<p>Plot</p> <ul style="list-style-type: none"> • Main conflict or problem • Sequence of events • Resolution 	<p>Thunder wanted to make it so that people may live there and have animals to subsist on. Earthquake and Pibir traveled to the ends of the world sinking the land, pouring water from their abalone shells, and urinating to bring water and animals. Thunder stayed in Sumig to break down trees. In the end, the prairie was transformed into ocean to provide subsistence for the people.</p>
<p>Setting</p>	<p>The Yurok world in northern California. Locations include Pulekuk in the North, Opis at the edge of the water, Sumig (Thunder's house), Espeu, and Perwerhkuk in the South.</p>
<p>Characters</p> <ul style="list-style-type: none"> • Physical characteristics • Personality • Motivation 	<p>Thunder, Earthquake and Pibir (water panther) were motivated to help the human beings have something to subsist on. Earthquake was able to sink and shake the land. He and Pibir were able to bring water to the land. Thunder broke down trees to help.</p>
<p>Point of View</p> <ul style="list-style-type: none"> • Who is telling the story? 	<p>Ann of Espeu, a Yurok Indian, told the original recorded version. This version was adapted.</p>

2.

<p>Earthquake</p>	<p>"The Earth would quake and quake."</p>
<p>Coseismic Subsidence (the land dropping from an earthquake)</p>	<p>"[Earthquake] ran about and made the ground sink as a means of letting the water out." "Earthquake sank the ground..."</p>
<p>Damage</p>	<p>"Thunder had knocked down trees."</p>
<p>Tsunami</p>	<p>Earthquakes happen before water flows into the area. "Pibir poured the water out of one shell" "They stopped occasionally to look at their work as water filled in the new low-lying areas."</p>

Lesson Information Sources:

Carver, D. (1998). *Native stories of earthquakes and tsunamis*. Orick, California.

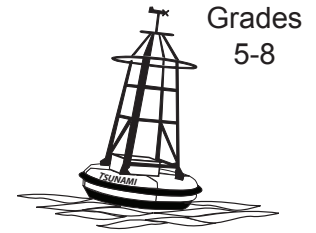
Carver, G. (n.d.) *Some things about Kodiak tsunamis: 1964 tsunami deposits and the people of Afognak River* [PowerPoint presentation].

Kroeber, A. L. (1976). *Yurok myths*. Berkeley: University of California Press.

Name: _____

What's in a Wave?

Student Worksheet (1 of 3)



When a tsunami wave reaches shallow water off the coast, it scours the bottom, picks up sand, and deposits it as it inundates the land. When ash, or tephra, is mixed in, the sand and ash settle in such a way that makes it possible to determine the number of tsunami waves that have washed ashore.

You will need:

- Clear tube
- About one cup of sand
- About $\frac{1}{2}$ cup of ash
- Funnel
- Water
- Bucket
- ruler

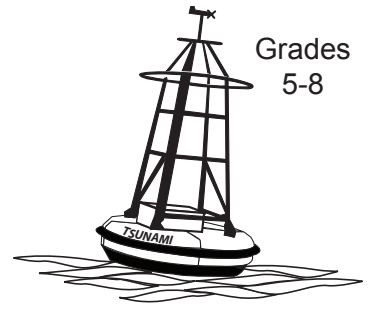
Directions:

- STEP 1:** One person will need to hold the tube over the bucket. One hand should cover the bottom opening of the tube.
- STEP 2:** Another person pours in the sand and ash using the funnel. Then add water to fill the tube.
- STEP 3:** The person holding the tube covers both ends of the tube with his or her hands and shakes the contents of the tube over the bucket. Then stop and hold the tube upright.
- STEP 4:** Wait a few minutes. Slowly let some water drain through your hand into the bucket. Observe how the sand and ash settle in the tube. Make measurements using a ruler.

Name: _____

What's in a Wave?

Student Worksheet (2 of 3)



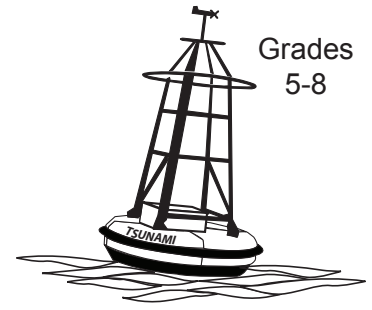
1. Sketch and label observations in the box below. Include measurements.

Name: _____

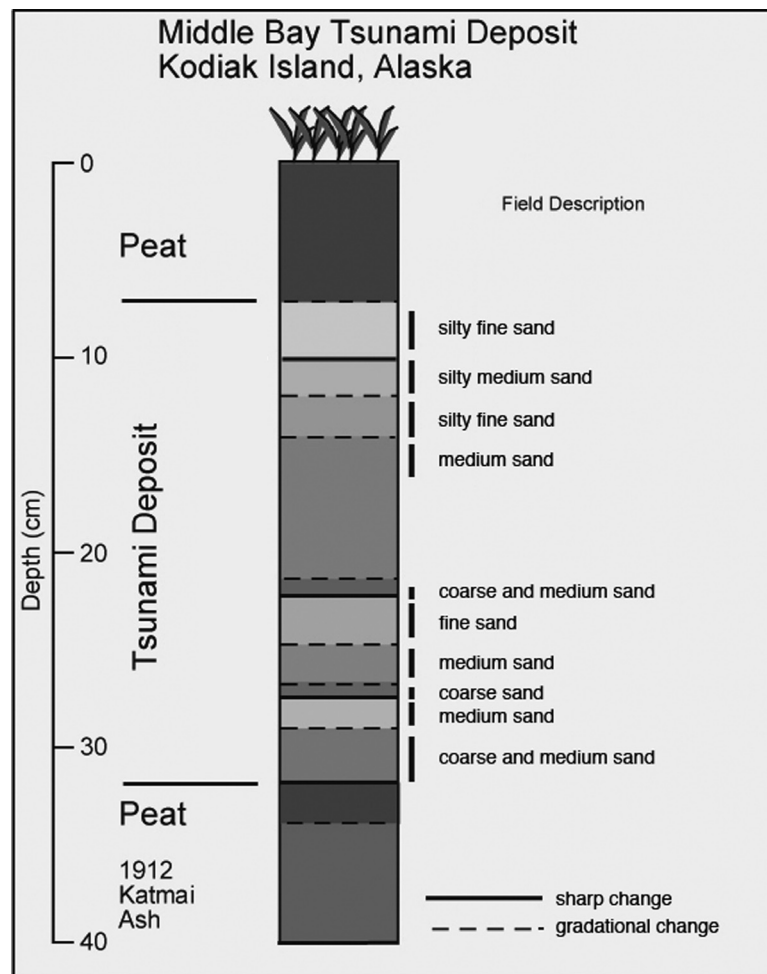
Grades
5-8

What's in a Wave?

Student Worksheet (3 of 3)



2. The following sample displays actual data from Kodiak Island gathered by paleoseismologist, Gary Carver. What can you infer about the number of waves?

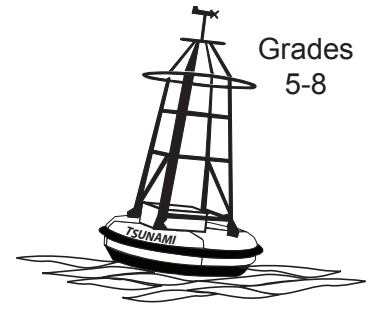


Name: _____

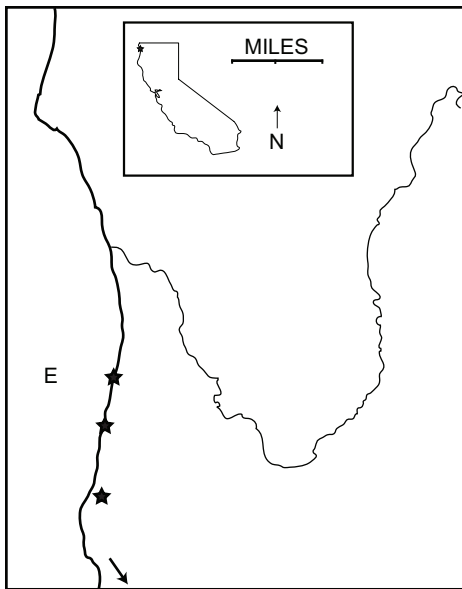
How the Prairie Became an Ocean

Student Worksheet (1 of 3)

Grades
5-8



Adapted from the version told by Ann of Espeu, recorded by A.L. Kroeber in Yurok Myths.



Near Oketo, at Sumig*, lived Thunder. He wondered about the wellbeing of the human beings that lived in the Yurok's world, "Where shall we make water to be? How will they live if we leave prairie there?" He asked Earthquake, "What do you think? I want water to be there so that people may live. Otherwise they will have nothing to subsist on." Earthquake said, "That is true. Far off I always see water and there are salmon at Opis." So they went with Pipir, the water panther, to get water at Opis. They brought two abalone shells and filled them with water. They decided that it would be best to go to Pulekuk, the north end of the world, and then go to Perwerhkuk, at the south end of the world. Thunder decided, "I shall stay at Sumig. For I shall do this: I shall bend the trees over, since in the gulches there grow big trees.

Earthquake and Pipir arrived at Pulekuk with the abalone shells to fetch water. First Earthquake thought, and then he ran about and made the ground sink as a means of letting the water out. Then they arrived at Opis, which is at the end of the water. They saw seals and salmon in the water and all kinds to be eaten, and

they decided that this was where they would take water in the abalone shells.

With shells full of water and sea animals, Earthquake and Pipir decided to go to back to Perwerhkuk. Along the way, Earthquake sank the ground as Pipir held the abalone shells. They traveled all the way from the north end of the Yurok world to the south end.

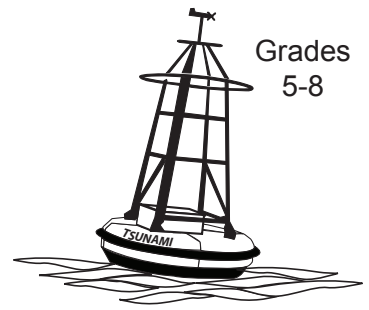
Earthquake and Pipir returned to Sumig and were pleased to see that Thunder had knocked down trees. Then they discussed what they should do next. They went to the coast in front of Sumig, and Pipir poured the water out of one shell; it only went halfway to Pulekuk. So Thunder said, "Pour some more!" Then they went all the way to Espeu and poured out all the water from the other shell. It ran downstream toward Pulekuk, but it was not enough since the brush still stuck out. Thunder asked Pipir to urinate and increase the water, which he did, and the brush disappeared.

Earthquake continued sinking the land and went south with Pipir. They stopped occasionally to look at their work as water filled in the new low-lying areas. They stopped and saw Thunder at Sumig. Thunder exclaimed, "Look at the water running down! It is as I wanted it to be." Earthquake said, "That is what human beings will thrive on. This stretch that was prairie – there will be ocean there." Then they continued north again and did the same. The Earth would quake and quake. The water was flowing all over, swarming with seals, salmon, whales and all kinds of fish. They looked upon this and said, "Now this is enough, enough for human beings to subsist on. Everything needed is in the water."

Name: _____

How the Prairie Became an Ocean

Student Worksheet (2 of 3)



That is how the ocean comes to be as it is: they are the ones who made it, Earthquake, Phipps, and Thunder. For it was Thunder who said, "Let us try to make it so that they may live."

*Sumig was at the site of Patrick's Point, California

*Espeu was near Orick, California

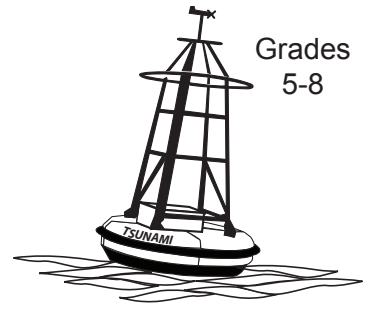
1. Write a description or quote that illustrates each literary element based on the story.

<p>Plot</p> <ul style="list-style-type: none">• Main conflict or problem• Sequence of events• Resolution	
<p>Setting</p>	
<p>Characters</p> <ul style="list-style-type: none">• Physical characteristics• Personality• Motivation	
<p>Point of View</p> <ul style="list-style-type: none">• Who is telling the story?	

Name: _____

How the Prairie Became an Ocean

Student Worksheet (3 of 3)



2. Write a description or quote that illustrates each geologic event based on the story.

Earthquake	
Coseismic Subsidence (the land dropping from an earthquake)	
Damage	
Tsunami	