ShakeAlert™

Mapping Earthquakes

Description: In this activity, visitors observe a giant map to hypothesize seismic patterns and gain a better understanding of seismic hazards based on their current location. This is also an opportunity for mutual learning and for visitors to share their lived experiences during seismic events.

Supplies:

Supplies	Amount	Notes
Tectonic Plates Map	1	Suggested: https://www.metskers.com/product/DynamicEarthPlateTectonicsMapbyNationalGeographic# Or: https://www.metskers.com/product/ThisDynamicPlanetWorldTectonicsMapbyUSGS
Tape, paper weights, or large clips or clamps	As needed	To secure map to the table
Small sticky notes	As needed	For visitors to log their own earthquake experiences on the map
Fine point pens	2-3	
Laptop or tablet	1	OPTIONAL. Can supplement paper map with interactive map in IRIS Earthquake Browser (https://ds.iris.edu/ieb/)
Signage	1 copy	See Appendix

Advance Preparation:

- Familiarize yourself with the map and use the map's legend to understand what the different symbols indicate.

Setup:

- Lay map on the table and secure with tape, clips, clamps, or paper weights.
- Set out sticky notes and pens.
- If using laptop or tablet to display interactive map, set up device and navigate to: https://ds.iris.edu/ieb/

Activity:

Facilitator Script	Notes
Have you ever felt an earthquake? Where in the world was it? What was that experience like?	*Invite participants to write the date and/or location of the earthquake on a sticky note and place it on the map. You may also invite them to write a word describing that experience.*
Where do you live on the map? Is there another place in the world that is significant to you? What do you notice about those places?	*See if participants notice tectonic plates, prevalence of volcanoes, or other geological differences.*
Looking at the map, what kind of symbols or marks do you see that interest you? Let's see if we can figure out what they mean.	*See your map's legend for the complete list of symbols and their significance.*
Our earth's crust is broken into many different pieces called tectonic plates. They fit together like puzzle pieces and are all pushing and pulling and sliding against each other. *(Show on map)*. Can you find the biggest tectonic plate? What about the smallest?	*The largest major plate is the Pacific Plate, and the smallest major plate is the South American plate. There are, however, other plates that are smaller and are called minor plates, and ones that are even smaller than that and are called microplates.*
What parts of the world do you think have lots of earthquakes? How about places that have very few earthquakes? I wonder why some places have so many more earthquakes than others. What do you think about that? Any ideas why?	*Earthquakes happen most frequently on or near tectonic plate boundaries—the place where two tectonic plates meet. Some of the largest earthquakes occur in subduction zomes, where an oceanic plate is diving beneath a continental plate. Examples of these places are near Chile, Alaska, and Japan.*
	If using the IRIS earthquake browser, you can help the participant navigate through the interactive site to see recent and historic earthquakes in different parts of the world.

Extension Activity: Puzzle Map

Advance Preparation:
Purchase an additional copy of a tectonic plate map and cut it along the plate boundaries. When you are done, you should have each tectonic plate as a separate "puzzle" piece.

Setup:

- Mix up the pieces and set them up on a flat surface (a table can work, but this can also be done on the floor for younger kids who might want to participate)

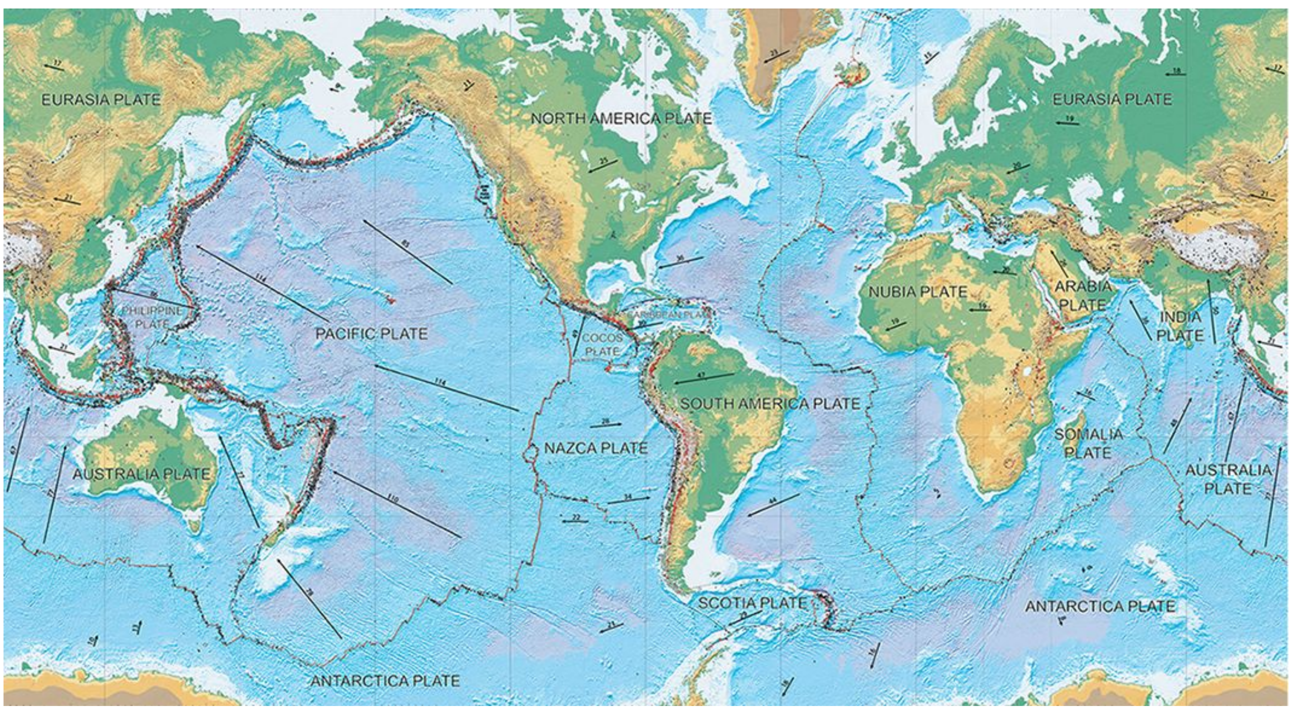
Activity:

Have learners work together to assemble this world map puzzle. When they are done, prompt participants to speculate as to what each "puzzle piece" represents. This is a helpful transition into a conversation about plate tectonics and plate boundaries.

You can choose to use the puzzle independently, or as an introduction to a Plate Tectonics activity or the Mapping Earthquakes activity above.

Mapping Earthquakes

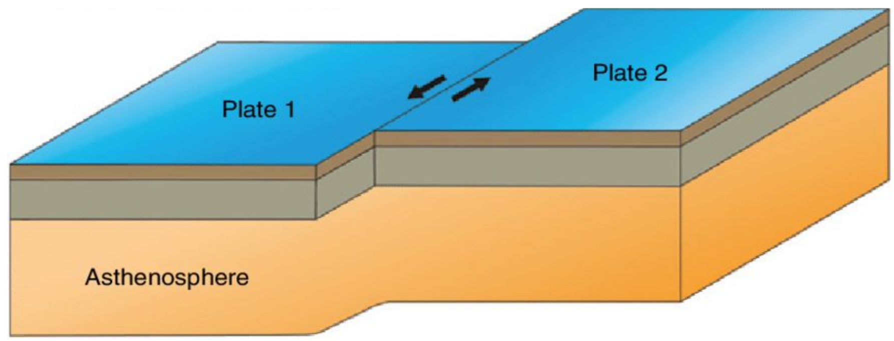
The earth's crust is made up of **tectonic plates**, which are constantly and slowly moving.



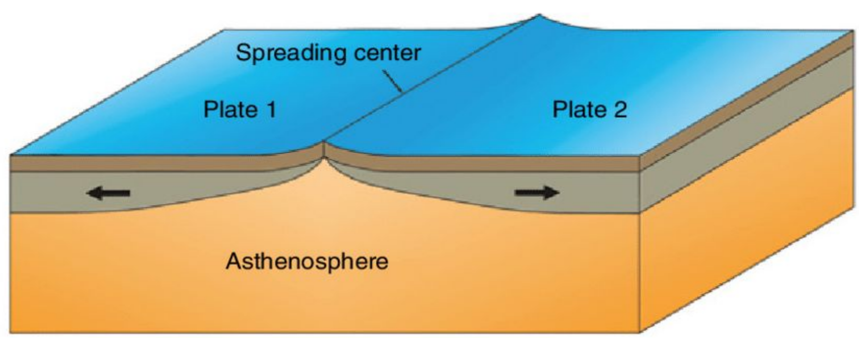
Mapping Earthquakes

At each plate boundary, you can have three different types of movement:

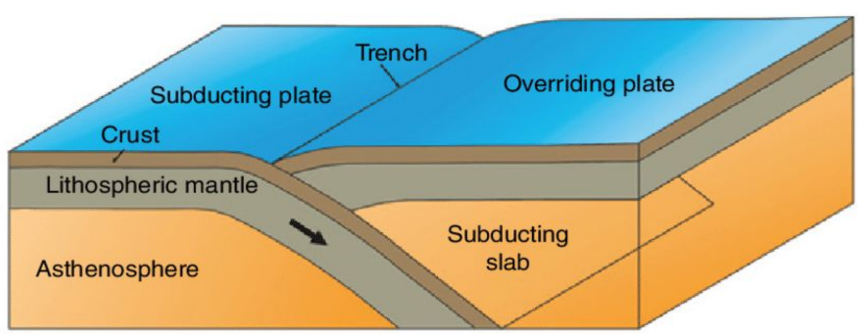
1. Transform boundary:
Two plates sliding past each other, side to side



2. Divergent boundary:
Two plates pulling away from each other



3. Convergent boundary:
Two plates pushing towards each other



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Graham Cracker Plate Tectonics

Description: In this activity, learners use edible ingredients to examine different types of plate tectonic movement.

Supplies:

Supplies	Amount	Notes
Graham crackers	2 squares per student	
Frosting	1 container	
Red food coloring	As needed	OPTIONAL
Rice krispie treats	2 squares per student	
Paper plates	1 per student	
Paper towels	1 roll	
Hand sanitizer, wet wipes, or access to sink + soap	As needed	
Signage	1 copy	See Appendix
Large foam blocks	2	OPTIONAL

Advance Preparation:

1. If using white frosting, add optional red food coloring to better represent mantle
2. Prepare pieces of rice krispie treats, cutting each piece horizontally as if slicing a hamburger bun

Setup:

- Prepare each plate with a smear of frosting "mantle," two squares of graham crackers, and two slices of rice krispie treats.
- Lay out paper towels, wet wipes, and hand sanitizer. Make sure everyone uses hand sanitizer or properly washes their hands before handling food items.

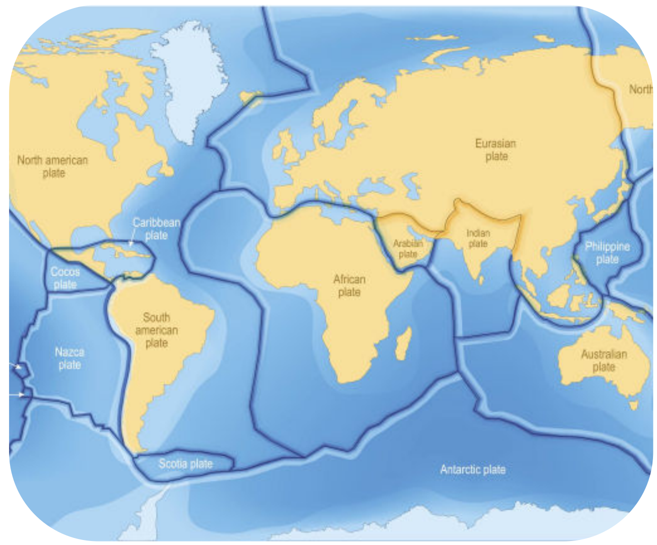
Activity:

Facilitator Script	Notes
The surface of the Earth is called the crust. There are two kinds of crust: oceanic crust,	*Show the graham cracker and the rice krispie treat side by side and encourage*

which we will represent with the graham cracker, and continental crust, which we will represent with the rice krispie. What do you think might be some differences between them?	*learners to point out the differences they see. One of the main differences is that continental crust is a thick layer of solid but lightweight rock, while oceanic crust is a thin layer of solid and dense rock.*
Inside the Earth's crust is something called the mantle. This is partially melted rock, which is represented by the frosting in this activity.	*Show the frosting on the graham cracker.*
A tectonic plate is just a piece of crust (oceanic or continental) and the uppermost layer of mantle beneath it.	*Model types of motion. For each type of plate motion, demonstrate the setup and offer an explanation. If you have large foam blocks to show plate movement, you can illustrate it here.*
In this activity, we are going to model what can happen when one or more plates are being pushed together or pulled apart.	*Give students time to try the plate movements with both types of crust, prompting them to point out what they noticed*
Two plates sliding past each other, side to side, is called a Transform boundary. Real life examples include the Pacific Plate and North American plate in CA.	*Encourage students to press plates together as they slide them past each other, to model the friction locking the plates together and resisting motion until a slip or break occurs.*
Two plates pulling apart from each is called a divergent boundary. Real life examples include boundaries at mid-ocean ridges, which form a chain of underwater volcanoes.	*Encourage students to press plates down into the mantle as they pull them apart, so that mantle upwells, as in a mid-ocean ridge.*
Two plates pushing towards each other is called a convergent boundary. Real life examples include the Himalayas (continental-continental) and Cascadia (oceanic-continental).	*Encourage students to try with oceanic-oceanic, continental-continental, and oceanic-continental.*

Plate Tectonics

The earth's surface is broken into many **tectonic plates.**



A tectonic plate is a layer of solid **rock crust** over a layer of semi-solid **mantle.**

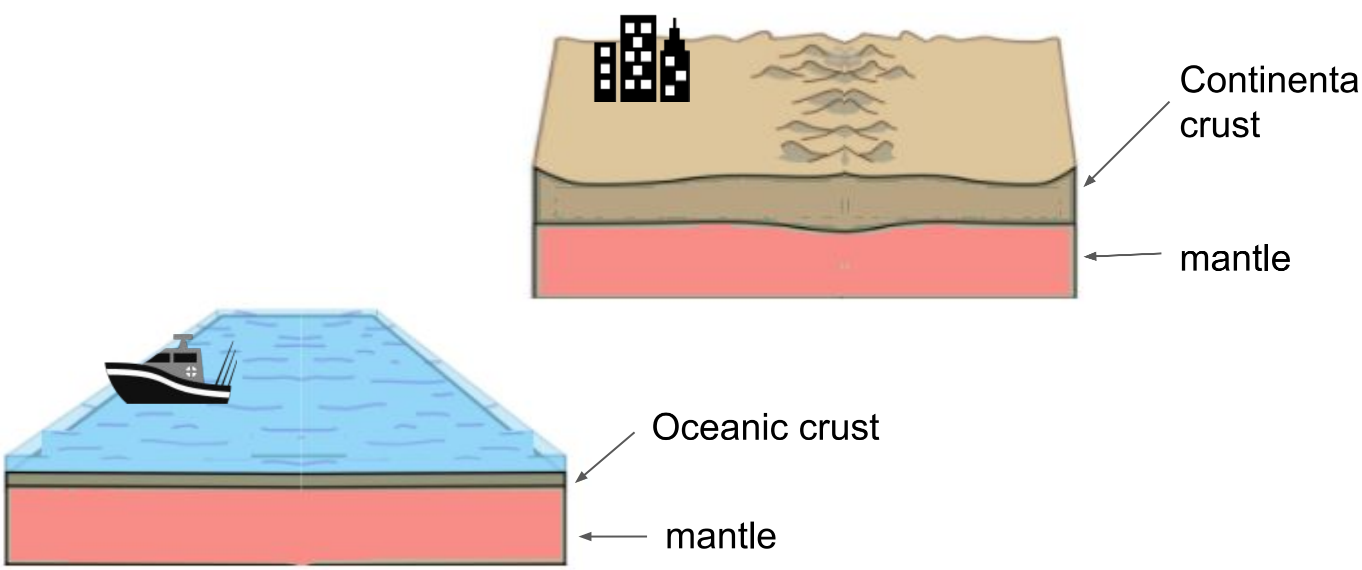


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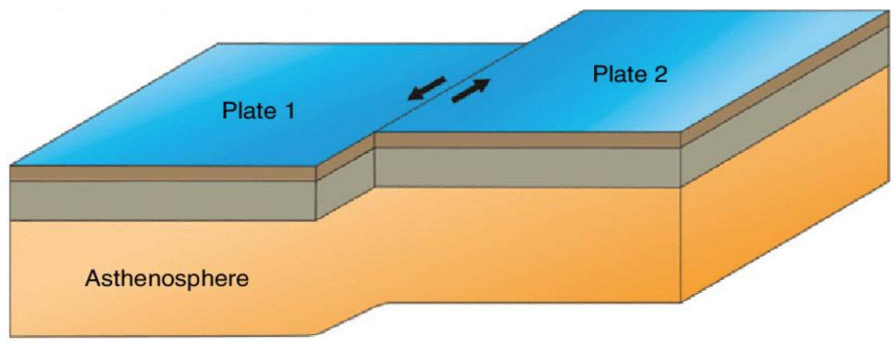
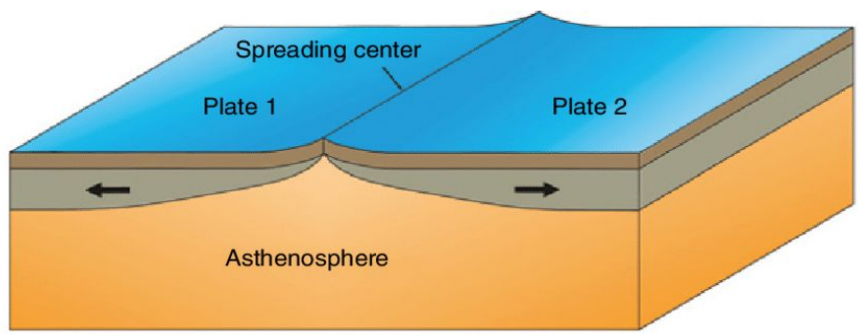
Plate Tectonics

Plates can move in three main ways:

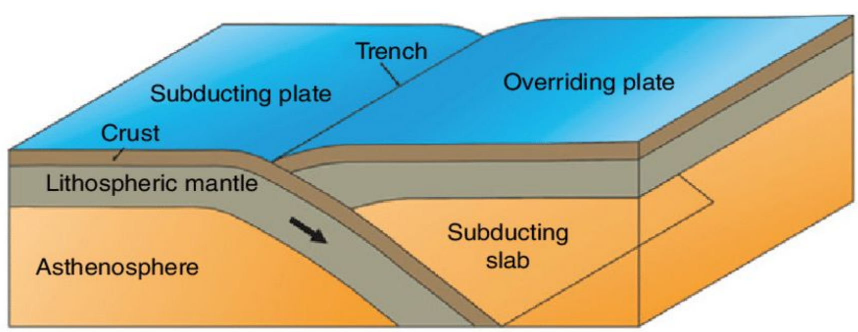
1. Transform boundary: Two plates sliding past each other, side to side



2. Divergent boundary: Two plates pulling away from each other



3. Convergent boundary: Two plates pushing towards each other



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Earthquake Machine

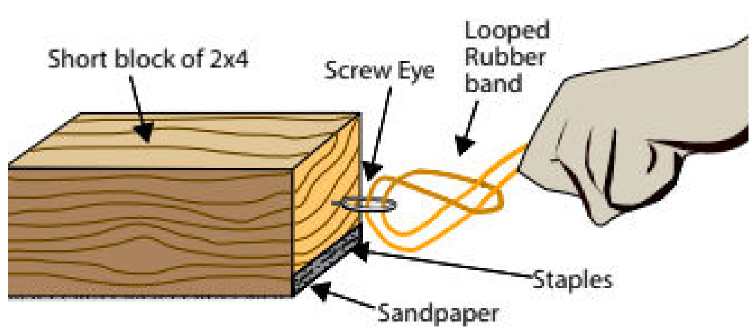
Description: Learners use a simple mechanical model to understand earthquake processes (including force, friction, and elastic rebound). If using the extension activity, learners may also develop awareness and understanding of technology for earthquake detection and alerting, including ShakeAlert®.

Supplies:

Supplies	Amount	Notes
Wooden block	1	Approximately 1.5×3.5×5 inches
Screw eye hook	1	
Rubber bands	3–5	Can experiment with various sizes and thicknesses to get the desired effect
Sandpaper belt	1	Approximately 4×36 inches, 80 grit
Sandpaper sheet	1	80 grit
Heavy duty stapler or glue	1	To secure sandpaper to the wooden block.
Duct tape	Varies	To secure the sanding belt to the table. Can also use clamps.
Smartphone with MyShake app downloaded	1	MyShake is available for free download in Android and iOS app stores
Signage	1 copy	See Appendix
ShakeAlert "Quick Facts" printable one-pager	1/person	Optional. See https://drive.google.com/drive/folders/1-6VRTM2EeV9JjLJn9thbml0DJnL-b0Ix?usp=drive_link

Advance Preparation:
Using the image to guide your assembly, prepare the earthquake machine as follows:

- Take a wooden block and attach a screw eye hook to one side
- Firmly paste or staple a piece of sandpaper that covers the entire bottom of the wooden block
- Loop a rubber band through the eye screw



Setup:

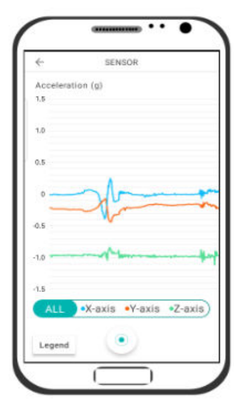
- Using duct tape and/or clamps, secure the strip of sanding belt to a flat surface with the rough side up
- Place the wooden block on top of the sanding belt, with the rough side down. (Both sandpaper surfaces should be facing each other)
- To test, gently pull on the rubber band. The rubber band should stretch at first while the block stays put. At some point, the block will slip and release the strain on the rubber band.

Activity:

Facilitator Script	Notes
This activity is called Earthquake Machine! Have you ever felt an earthquake before?	*Invite learners to share their experiences with earthquakes, if any.*
This wooden block represents a block of rock—part of Earth's crust. The table below it represents another block of rock. The place where they touch is called a fault. All these rocks are being pushed, pulled, squeezed, and squished, due to the motion of the Earth's tectonic plates.	*Explain what tectonic plates are if learners are not familiar with the term.*
Let's imagine that this upper section of Earth's crust is being pulled forward. How do you predict it will move?	*Encourage learners to try the model by slowly and gently pulling on the rubber band, parallel to the table's surface.*
What did you notice?	*Responses may include observations about how the block initially resisted movement, the rubber band stretched, and then eventually the block slipped forward.*

The sudden movement you just saw is what happens during an earthquake. The rocks under our feet are being pushed and pulled, just like this wooden block. However, the movement is rarely smooth and gentle. Sometimes big sections of earth's crust stick together, like we see with this model. Why do you think it sticks at first, instead of moving right away?	*Friction between two blocks (or two tectonic plates) keeps them together until enough strain builds up and makes them slip. Elasticity also contributes! Just like this rubber band, rocks are elastic. That means that they can stretch, bend, and twist, but they want to "snap" back to their original shape.*
Can you predict exactly *when* the block will slip? Can you predict exactly *how far* the block will slip?	*No. In the same way, it's impossible to predict exactly when an earthquake will occur, or how big it will be.* *We know where many faults are, and we know where strain is building up; we can use that information to understand where earthquakes are more or less likely to happen. But predicting the exact location, time, or size of an earthquake is impossible.*

Extension Activity: Earthquake Machine with MyShake Sensor



Advance Preparation:

- Assemble Earthquake Machine as in the basic activity above.
- On a smartphone or tablet, download the app "MyShake" by Berkeley Labs from the Android or iOS app store.

Setup:

- Set up the Earthquake Machine activity as above.
- Open the app and from the menu, select "Sensor." The phone should display a motion detector, similar to the image shown on the right.

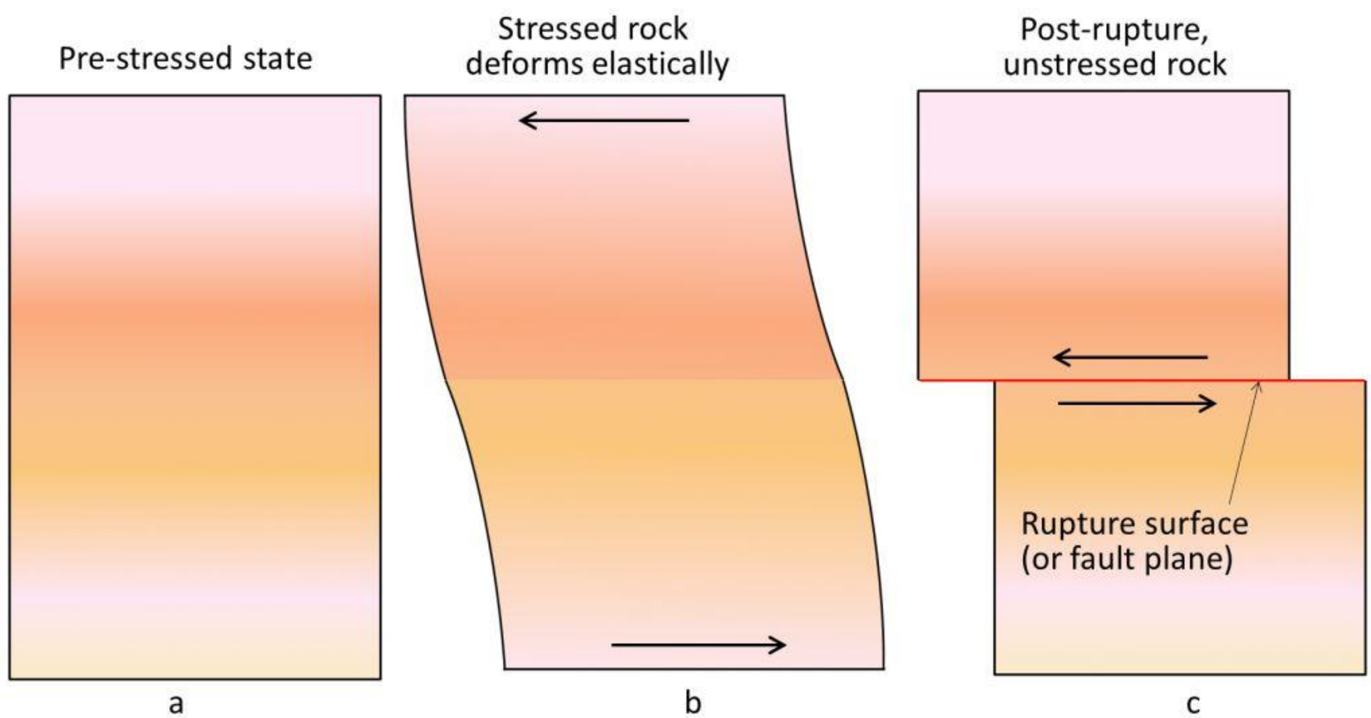
Activity:

Facilitator script	Notes
Have you heard of ShakeAlert before? ShakeAlert is the Earthquake Early Warning System for the US West Coast, and this next activity helps show how it works.	*Invite learners to share what, if anything, they've heard, learned, or experienced related to ShakeAlert.*
Here on the West Coast there are thousands of seismic sensors, all of them constantly "listening" for motion in the earth. Let's imagine that this phone is one of those seismic sensors, and it's placed here in [insert your city].	*Place the phone, with the MyShake sensor displayed, on the small block of wood.*
With the block at rest, what do you notice?	*Likely not much activity on the sensor.*
What if I give the table a tiny bump? What do you notice?	*Nudge the table slightly. Response may vary, but may include observations about how the motion is recorded as a spike or wiggle in the line.*
Now let's generate an earthquake, and tell me what you noticed.	*Encourage learners to try the model by slowly and gently pulling on the rubber band, parallel to the table's surface—while the phone rests on the block.* *When the "earthquake" occurs (i.e. when the block slips), that motion is recorded as a large spike on the seismogram.*
Any time there is an earthquake on the US West Coast, it is detected by multiple seismic stations in the ShakeAlert system. All those seismic stations then send information to a data processing center, where super fast computers can quickly determine: - Where the earthquake is located - How big the earthquake is - How much shaking is expected	

Then, all that information can be used to send out ShakeAlert-powered alerts to people, warning them that an earthquake has begun. The really cool thing is that electronic data travels really fast—even faster than earthquake waves. So in some cases, you can get the alert *before* you actually start to feel shaking.	
I'm going to play what the alert might sound like. It will make a loud sound, so be prepared!	*From the MyShake App menu, choose "Settings", then "Play the Alert Sound" and/or "See the Alert Image."*
What do you think you would do if you got an alert like this on your phone?	*Response may vary.* *The best response in most situations is to Drop, Cover, and Hold On!* *For more information about how to get an alert on your phone (via MyShake App and other means), see Quick Facts.*

Earthquake Model

An **earthquake** occurs when a block of rock slips along a fault.



- How far can you stretch the rubber band before the block slips?
- Can you predict exactly when or where it will slip?

ShakeAlert™

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Earthquake MythConceptions

Description: Using an interactive spinning wheel, visitors will learn some of the common misconceptions about earthquakes and replace it with current up-to-date information. This demo should be easy to replicate and use in other free-learning environments.

Supplies:

Supplies	Amount	Notes
Spinning wheel	1	Can be purchased online from various retailers, or at a party store
Markers or access to printer		To label wheel of myth-conceptions
Tape or glue		If using paper labels
Hand sanitizer	1	OPTIONAL
Printable labels for spinning wheel	1	Optional; see Appendix. Alternatively, you may label the wheel yourself

Advance Preparation:

1. Print the labels for each section of the wheel. Print at 85% of total size under print settings. Alternatively, you can use a marker to write them directly onto the wheel.
2. If labels were printed, glue or tape onto the spinning wheel.

Setup:

- Place signage
- Place spinning wheel and optional hand sanitizer on table

Activity:

Facilitator Script	Notes
During an earthquake, you should run outside or stand in a doorway	**FALSE** *Most common causes of injury in earthquakes include falling down and/or getting hit by falling debris. In the US, where buildings meet basic building standards, staying inside the building*

	(preferably under a table) is actually safer than trying to exit. *Standing in a doorway: This is a common misconception. In modern buildings, the doorway is no stronger than any other part of the building. You're better off dropping, covering, and holding on beneath a table. Or if no table is available, simply crouch on the floor and cover your head and neck with your hands.*
We are overdue for the next "Big One"	**TRUE-ish** *True, but misleading… Major earthquakes (Mag 9.0 and above) have occurred in the PNW on average every 300-500 years. The last one was in 1700. Does that mean we're "overdue"? Not necessarily. It could happen tomorrow, or it could happen 200 years from now. 300-500 years is just an average.*
Animals can predict earthquakes	**FALSE, as far as we know today** *They can detect it seconds or minutes before humans can, but we don't have scientific evidence that animals can predict an earthquake significantly earlier than that. However, it is something that people report anecdotally, and more research is needed to determine whether it is actually true or false.*
You should expect building to crumble during an earthquake	**FALSE** *Most modern buildings are designed to withstand some level of shaking, and in areas that are more prone to earthquakes buildings can survive significant shaking! While buildings might suffer damage during an earthquake, most well-built ones won't catastrophically collapse. You can*

	also hire a seismic retrofit contractor that can prepare your home for a seismic event.
A magnitude 5 earthquake can sometimes feel *more* intense than a magnitude 6 earthquake	**TRUE** *There are many factors that affect how intense an earthquake will feel in a given area, and it's not just about the magnitude. Other factors include: soil/rock type, depth of the epicenter, distance from the epicenter, and more.*
Scientists can predict earthquakes	**FALSE** *Scientists cannot predict earthquakes. However, recent technology can send out alerts to people once the earthquake starts that may arrive to certain people before shaking begins in their area.*
An earthquake will happen today	**TRUE** *Earthquakes are happening all over the world, and all the time. There's likely one happening right now somewhere. Most of them might be too small for us to feel, but specialized machines are always recording seismic waves under the Earth's surface.*
The world's strongest earthquakes occur at subduction zones	**TRUE** *Subduction zones occur in multiple parts of the globe, including the PNW. They have the potential to produce the largest earthquakes (mag 9+). Examples include Chile (9.5), Alaska 1964 (9.2), and Tohoku (9.1). This is a USGS link to largest earthquakes recorded thus far:* https://www.usgs.gov/natural-hazards/earthquake-hazards/science/20-largest-earthquakes-world?qt-science_center_objects=0#qt-science_center_objects
A magnitude 6 earthquake is 32 times stronger than a magnitude 5	**TRUE** *On the Moment Magnitude Scale (which is*

	now used instead of the Richter Scale), a magnitude 6 earthquake is 32 times stronger than a magnitude 5. Moment Magnitude (Mw) is measured from 1–10, where each value is 32 times bigger than the last.
In the US, the main cause of earthquake injuries is buildings collapsing	**FALSE** *Most common cause of injury in the US is people trying to move during shaking and/or getting hit by things that are falling. That's why in the US the recommended action is to Drop, Cover, and Hold On during shaking.* https://library.seg.org/doi/pdf/10.1190/geo2021-0222.1
Have you ever felt an earthquake? What did it feel like? What did you do? If you haven't felt an earthquake, what would you do if you felt one?	*Encourage people to Drop, Cover, and Hold On!*

During an earthquake,
you should run outside
or stand in a doorway.

We are overdue
for the next
“Big One.”

Animals can
predict earthquakes

You should
expect buildings to
crumble during an
earthquake.

A magnitude 5 earthquake can sometimes feel *more* intense than a magnitude 6.

Scientists can
predict earthquakes.

An earthquake
will happen today.

The world’s strongest earthquakes occur at subduction zones.

A magnitude 6 earthquake is 32 times stronger than a magnitude 5.

In the US, the main cause of earthquake injuries is buildings collapsing.

Earthquake

Myth-conceptions

ShakeAlert™

Earthquake Lightbox

Description: In this activity, learners use light to understand earthquake magnitude and intensity. By manipulating small lights inside of a lightbox, learners gain an appreciation for how intensity can vary with magnitude, depth, and distance from the epicenter.

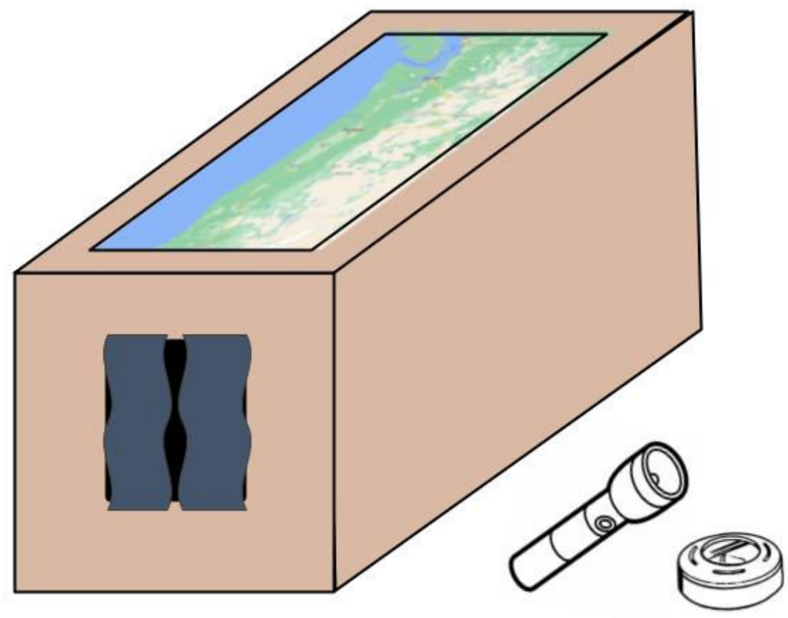
Supplies:

Supplies	Amount	Notes
Lightbox - 1 cardboard box (at least 10"x10"x12") - Felt (approx. 6"x6") - Utility knife - Tape and/or glue - Printed map (8.5"x11") - Paint or butcher paper (optional)	1	See Advance Preparation
Small battery operated lights of varying brightness	2-4	
Signage	1 copy	See Appendix

Advance Preparation:

Prepare the lightbox as follows:

1. Using tape or glue, secure all sides of the box so it remains in a closed position.
2. Optional: paint the box a solid color and/or cover in butcher paper.
3. Choose one long side of the box to be the top. Using a utility knife, carefully cut out a 7.5"x10" rectangular opening. Place the printed map over the opening and secure around the edges with glue or tape.
4. On a shorter end of the box, cut another hole, this one just large enough to comfortably reach a hand inside. About 6"x6" should be good.
5. Using the felt, make two small curtains for the hole, so that when you reach a hand inside the box less external light gets in.
6. When you put a small light (i.e., an "earthquake") inside the box, it will illuminate the map from below, indicating where "shaking" is felt. Experiment with the model and get a feel for how using different lights and/or placing the lights at different positions within the box changes the effect.



Setup:

- Place lightbox, lights, and optional signage on table

Activity:

Facilitator Script	Notes
How do you measure how big an earthquake is?	*Responses will vary and may include qualitative as well as quantitative factors.*
There are many different ways to talk about the size of an earthquake. Two measures that scientists often use are magnitude and intensity.	
When an earthquake happens, it releases energy. Because I can't hold an earthquake in my hand, we're going to use something else that releases energy to represent the earthquake: a light! These two lights (hold up lights and turn them on) represent two earthquakes. Which one releases more energy?	*Answer: the brighter light.*

The brighter one releases more energy. It's more powerful. If it was an earthquake, we would say it had a higher magnitude.	
Magnitude is the amount of energy that an earthquake releases. When we hear about an earthquake on the news, we usually hear "it was a magnitude 6," or "it was a magnitude 7," or something like that. Magnitude is measured on the Moment Magnitude Scale, which goes from 1-10. The most powerful earthquake ever recorded was a 9.5 in Chile in 1960.	
I also have this box, which represents a chunk of the Earth's crust. The top, where the map is, represents the surface of the Earth.	*Show the lightbox, and let participants get a closer look if they want.*
Let's see what happens when we put the smaller light, or the "smaller magnitude earthquake," inside the box. What do you notice?	*Answers will vary, but will likely include an observation about how the surface "lights up."*
In this model, the parts of the map that are lit up are the areas where people feel shaking. Intensity is a measure of how much shaking happened. Notice that, right above the light, shaking intensity is pretty high, but farther out from the center, shaking intensity is lower. The same is true of earthquakes. In general, the closer you are to the center of an earthquake (the epicenter), the more shaking you will feel.	

Ideas for Optional Extensions (in order of complexity):

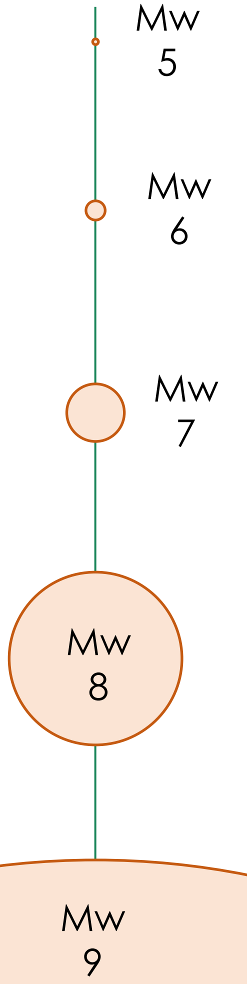
- Swap out the lights. Notice that, in general, higher magnitude earthquakes (i.e., higher powered lights) produce greater shaking intensity, spread out over a wider area.
- Identify points of interest on the map (cities, bodies of water, etc.). Experiment with moving the light north, south, east and west underneath the surface of the earth. Notice how shaking intensity varies; people in one city may experience intense shaking, while people 100 miles away experience mild shaking.
- Experiment with changing the depth of the earthquake (i.e. moving the light vertically up and down inside the box). Notice how deeper earthquakes tend to

produce lower intensity shaking at the surface, spread across a wide geographic area. Shallow earthquakes tend to produce higher intensity shaking at the surface, concentrated in a smaller geographic area.

- Invite learners to consider whether, and under what circumstances, a magnitude 5 earthquake could cause more damage than a magnitude 6 earthquake, and to model those conditions using the lightbox. (A relatively low magnitude quake can cause significant damage if it occurs near a large population center and/or at shallow depth; a higher magnitude earthquake can be relatively harmless if it occurs far from populated areas and/or very deep in the earth).
- Using a geologic map for reference, draw plate boundaries and/or faults on the map. Note that earthquakes are most likely to occur along these boundaries.
- Invite learners to consider the limitations of the model. What *isn't* represented here?
    - For one, this model doesn't capture differences in soil or rock type, which significantly affect the intensity of shaking felt in different locations.
    - Also, this model doesn't emphasize the exponential nature of the magnitude scale, which increases by a factor of 32 for each degree magnitude. If a magnitude 5 is represented by a tiny electric candle (about 10 lumens), then a magnitude 6 would be represented by a powerful flashlight (about 300 lumens) and a magnitude 7 would have to be represented by an industrial flood light (about 10,000 lumens). Our model is far too small to accommodate this exponential scale

Magnitude

Magnitude (M) tells us **how much energy** was released by the earthquake.



Moment magnitude (Mw) is measured from 1-10, where each value is **32 times** bigger than the last.

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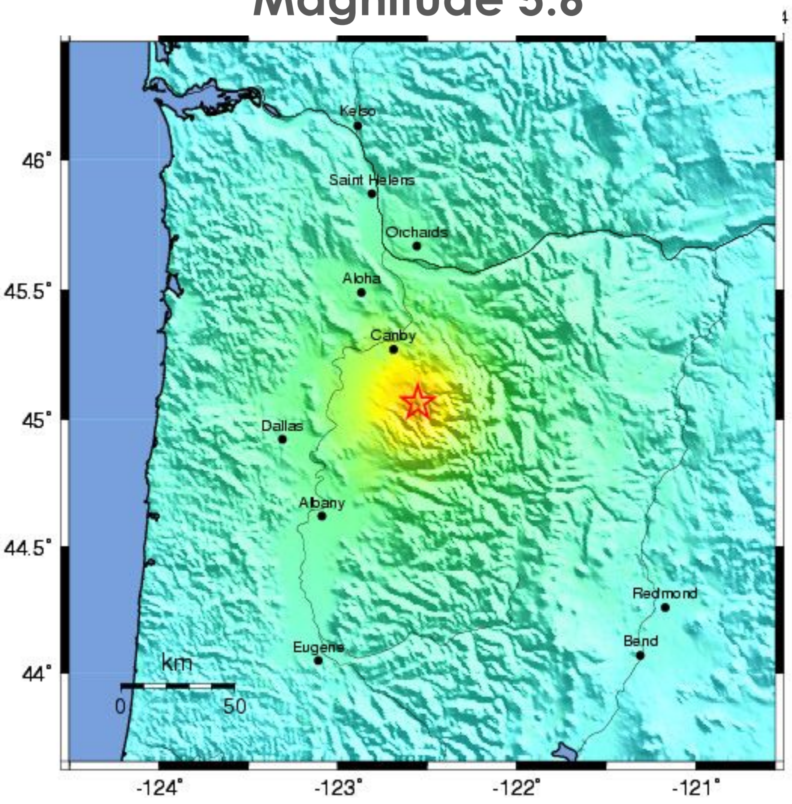
Intensity

Intensity tells us **how much shaking** was felt at a particular location.

Scotts Mills Earthquake, Magnitude 5.6



Intensity is measured on the Mercalli Scale, I-X.

A shake map shows intensity across a region for a particular earthquake.

Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
I	II-III	IV	V	VI	VII	VIII	IX	X+

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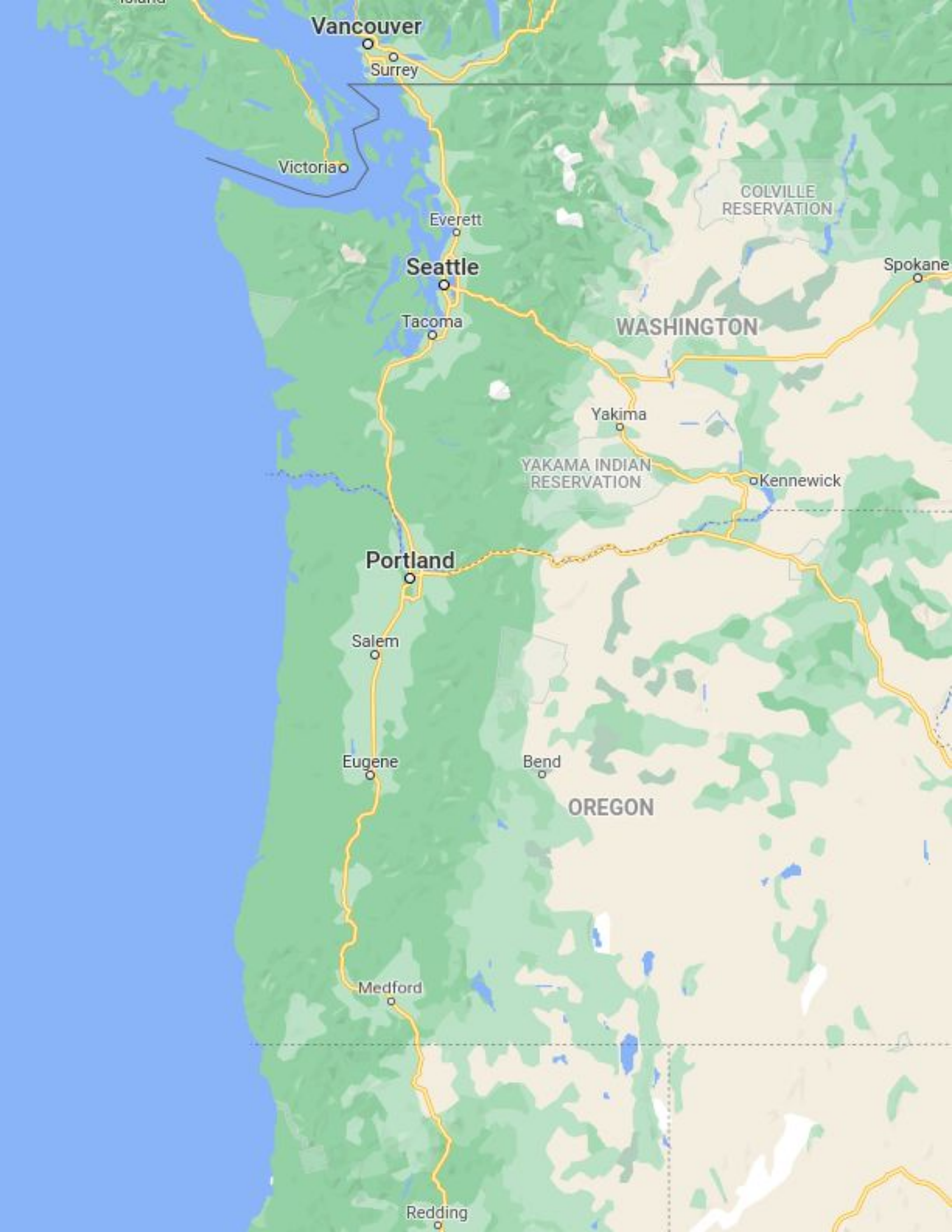
Vancouver
Surrey
Victoria
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Seattle
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Kennewick
Portland
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Medford
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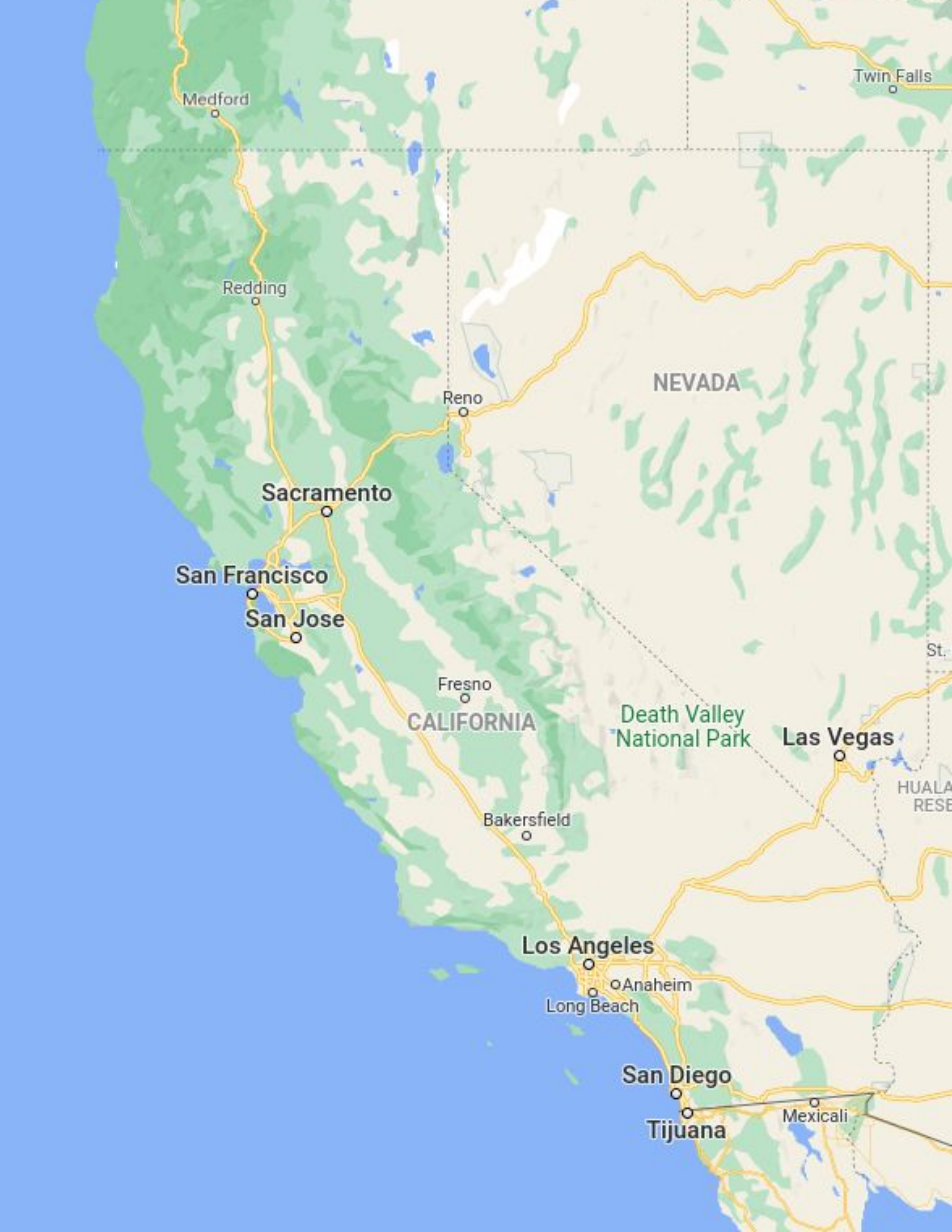
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NEVADA
Reno
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Death Valley
National Park
Las Vegas
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HUALA
RESE
Bakersfield
Los Angeles
Anaheim
Long Beach
San Diego
Tijuana
Mexicali

Swaying Buildings

Description: In this activity, learners use a simple model to explore *frequency* as it relates to earthquake waves. Learners may discover that higher frequency earthquake waves tend to cause more severe shaking in shorter buildings, while lower frequency earthquake waves tend to cause more severe shaking in taller buildings.

Supplies:

Supplies	Amount	Notes
Swaying Buildings Model	1	See Advance Preparation for options for building models and specific supplies (bolded below)
Paper Cities template	1 per participant	For extension; see Appendix
Strips of colored paper	3 per participant	For extension; approx 8.5x1"
Scissors	1 per participant	For extension
Tape	1 roll	For extension
Signage	1 copy	See Appendix
Slinky	1	OPTIONAL

Advance Preparation:

There are many ways to prepare a swaying buildings model—also called Building Oscillation Seismic Simulation, or BOSS model. The key components include: a base, three lengths of flexible material to represent three differently sized buildings, and three weights attached to the top of each "building."

Familiarize yourself with the model you have built, and how shaking frequency affects movement, before facilitating the activity.

Option 1: Easy and inexpensive model using **spaghetti, floral foam, and clay**:

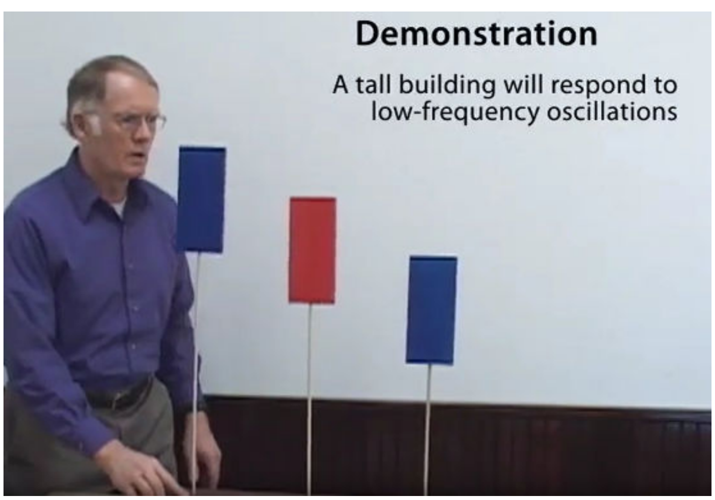
- Start with 3 strands of raw spaghetti. Take two of them and break off the ends so that each of the 3 strands is a different length: one long, one medium, and one short.
- Stick each piece of spaghetti upright into a piece of floral foam.
- Roll three small pieces of modeling clay, each about the size of a raisin. Stick one piece of clay on the top of each piece of spaghetti.

Option 2: Reusable model using **pool noodles, wood, and clay**:

- Start with three pool noodles. Trim two of them so that each of the three pool noodles is a different length: one long, one medium, and one short.
- Using hot glue, attach each pool noodle upright onto a wooden base.
- Roll three grape-sized pieces of modeling clay. Stick one piece of clay into the top of each pool noodle.
- Photo of finished model using pool noodles, wood, and clay:

Option 3: More robust model using **metal rods and wood**:

- Complete instructions available at https://www.iris.edu/hq/inclass/video/building_resonance__boss_model_construction__use



Setup:

- Place signage on table
- Place Swaying Buildings Model on table

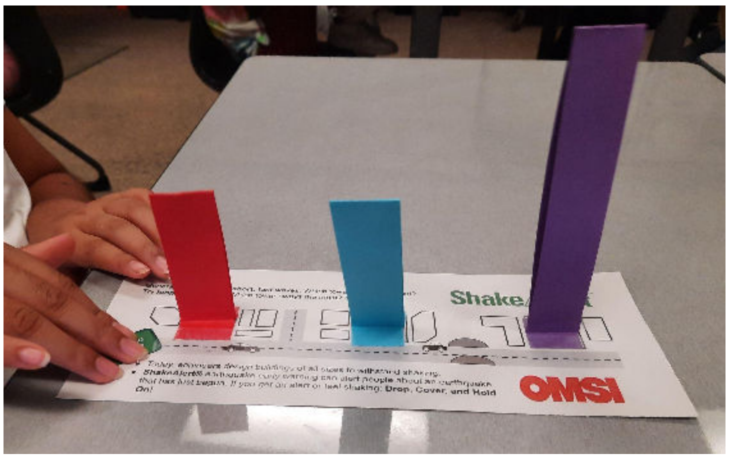
Activity:

Facilitator Script	Notes
This model represents a city that has buildings of different heights. In this city we have a tall building (like a skyscraper), a medium-height building, and a short, single-story building.	*Have learners name a city they would like to use for the activity. Point out the different parts of the model while describing.*
Imagine that in our city, an earthquake occurs! Which building do you think will shake the most during this earthquake? The tall, medium, or short building?	*Invite participants to make a prediction and explain their thinking.*
Let's start with low frequency shaking. That means the ground moves back and forth in very long, slow movements. What do you notice?	*Move the model using long, slow, back-and-forth movements.* *The tallest building will sway the most.*
Now let's pick it up and apply some higher frequency shaking. That means the ground moves back and forth in very short, fast movements. What do you notice now?	*Move the model using short, fast, back-and-forth movements.* *The medium and/or short buildings will sway the most.*
Frequency is the rate at which something moves back and forth. Earthquake waves come in different frequencies, both low (slow) and high (fast). Buildings also have a *natural frequency*—a rate at which they "want" to sway. If the natural frequency of that building matches the frequency of the earthquake waves, then that building will sway more than the others around it.	*Encourage learners to try the model themselves, exploring how different frequencies (low/slow and high/fast) affect the different "buildings."*

Extension Activity: Paper Cities

Setup:

- Set up supplies as above, with the addition of Paper Cities templates, paper strips, tape, and scissors.
- Make one Paper City as an example.
    - Start with three strips of paper. Fold each in half. Trim as needed so they are three different lengths.
    - Tape the three strips of paper to the template. It helps to fold little “feet” in the bottom of each paper strip, to help attach it to the base.
    - Your finished product should look something like this:



Facilitator Script	Notes
We are now going to build our own city model out of paper!	*Show the sample of the paper model, and help learners make their own using the steps described above.*
Now, make an earthquake in your paper city. Can you make each paper building wobble independently?	*Invite participants to play with the model. Try some high frequency shaking and low frequency shaking.*
Which building would be the safest to be in?	*It depends!*
Which kind of earthquake waves are most dangerous— high frequency or low frequency?	*It depends! Modern buildings are engineered to withstand earthquake shaking. Some are even designed to sway significantly without collapsing.*

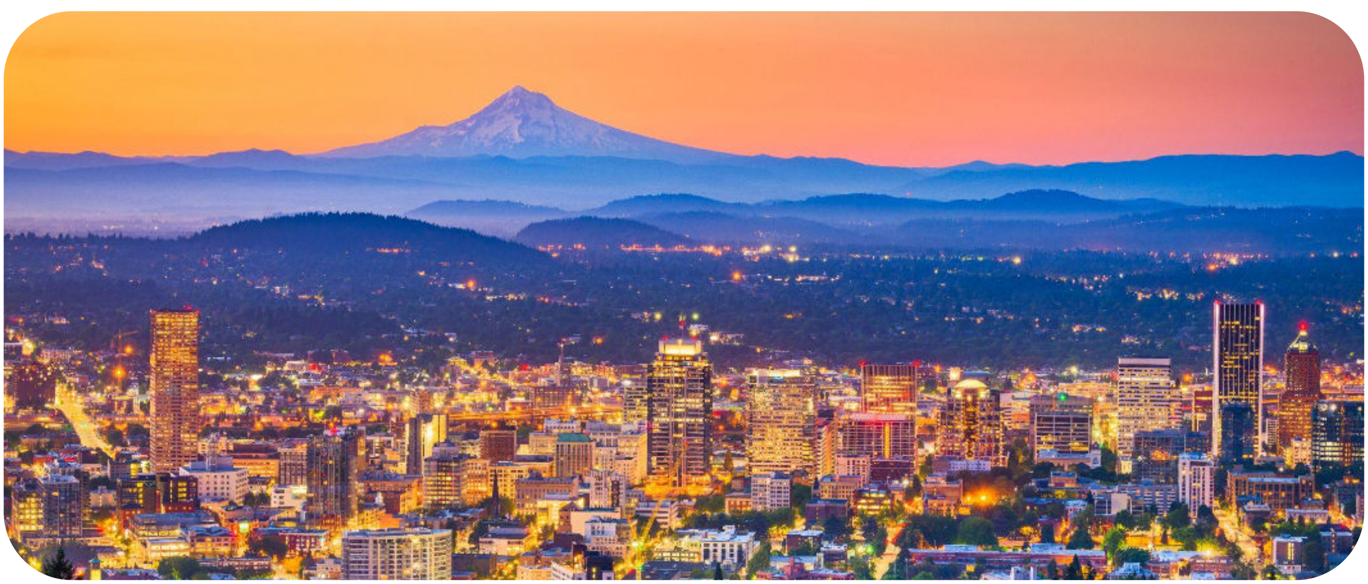
What would you do if you were in a building and got an earthquake alert, or if you started to feel the ground shake?	*Drop, Cover, and Hold On is the best thing to do during an earthquake! In nearly all situations, it is safest to stay inside the building rather than risk evacuating.*

Lesson adapted from:
Building Resonance: BOSS model construction & use, developed by the Incorporated Research Institutes for Seismology. See https://www.iris.edu/hq/inclass/video/building_resonance__boss_model_construction__use

Swaying Buildings

The height of a building affects its **natural frequency**, or rate of sway.

If a building's natural frequency matches the frequency of an earthquake wave, that building will sway even more.



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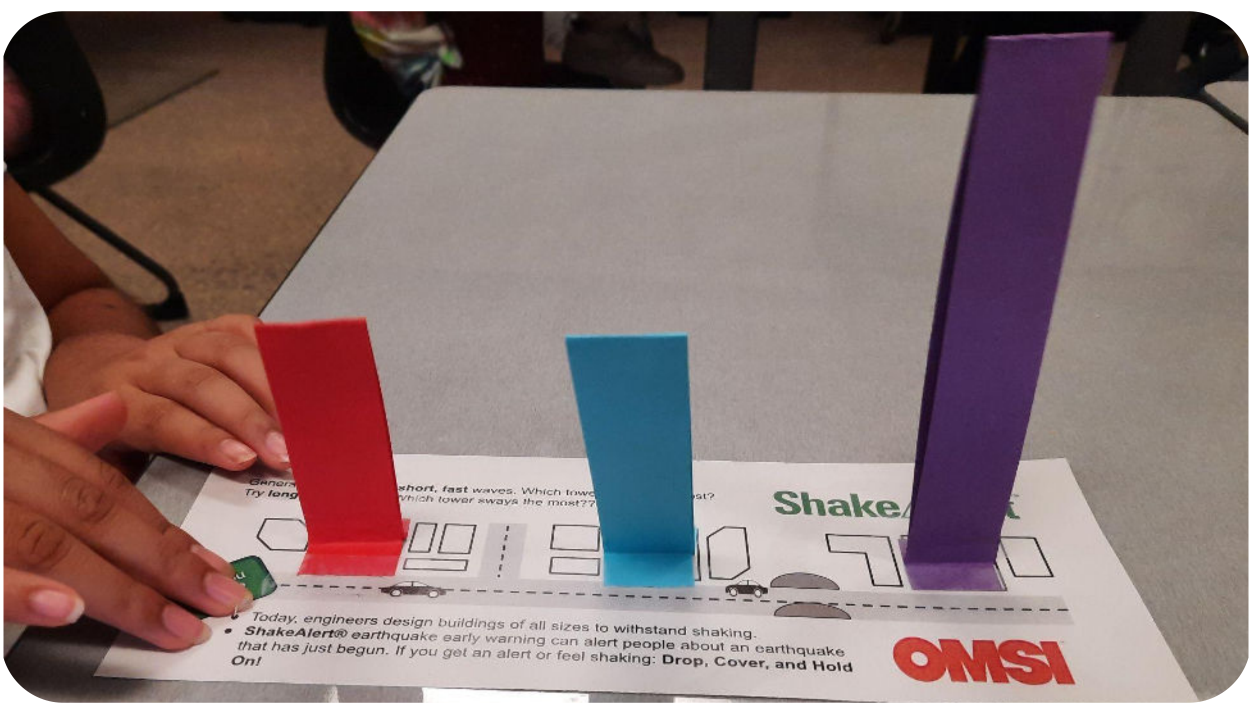
Swaying Buildings

Build a city skyline out of paper, with buildings of different heights.

Create an earthquake by shaking the paper back and forth at different speeds.

Notice what happens to the different buildings.



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