Become a Seismologist

The picture shows ________________________________.	From this observation it can be inferred that ____.

This image makes me wonder ____________________, because _____________________.
The image makes me ask ______________________, because _________________________.
From what I observe in the image, I infer ____.

1. ____
____.
2. ____
____.

The picture shows ____.	From this observation it can be inferred that ____.

This image makes me wonder _________________________, because _________________________.
The image makes me ask ___________________________, because ______________________________.
From what I observe in the image, I infer ____.

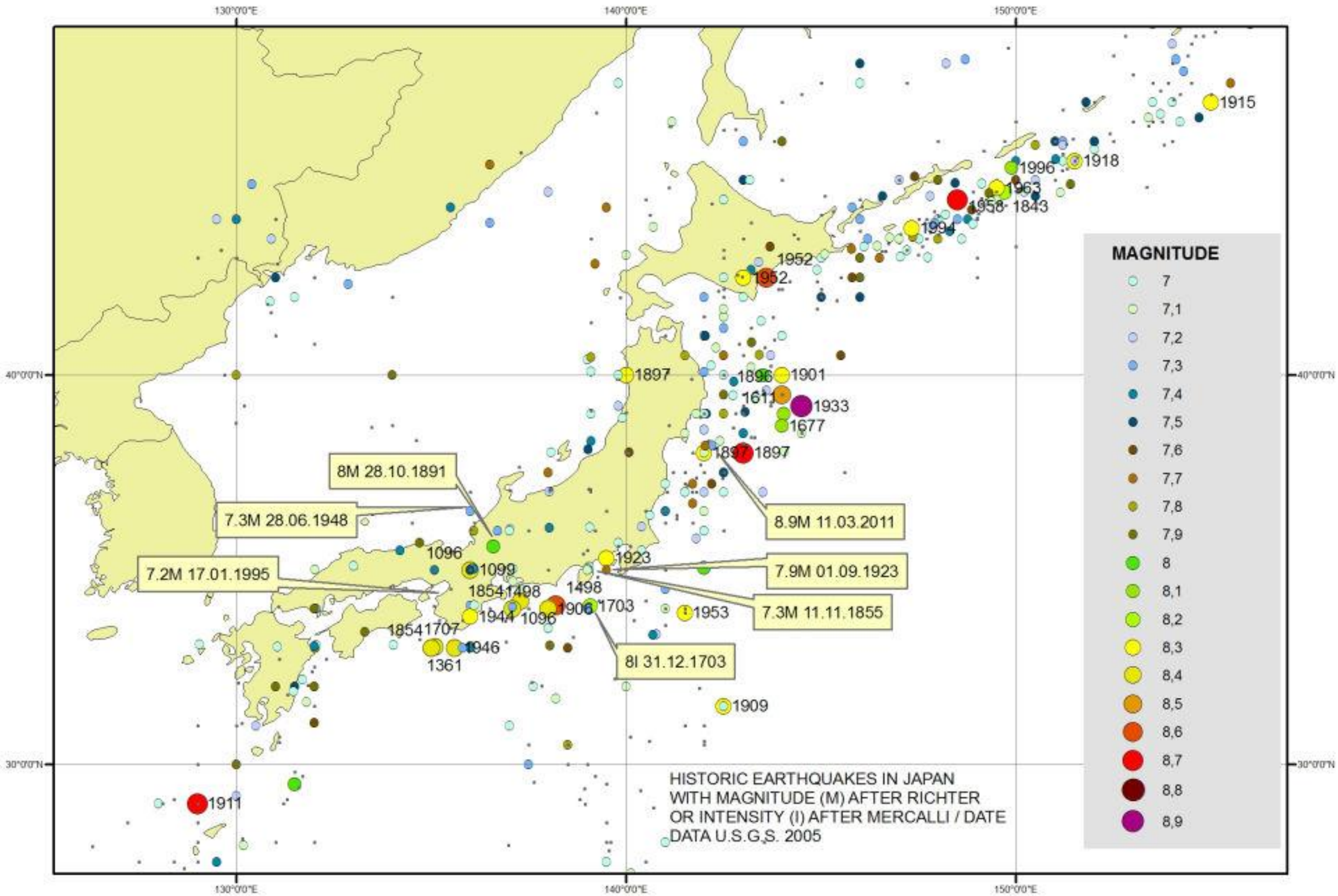
1. ____

____.

2. ____

____.

Map of Japan Showing Earthquakes Greater Than Magnitude 7



How to Read the Map Like a Seismologist

- Step 1: Interpret the map title. What does it tell you about your map? ____.
- Step 2: Analyze the map legend. What information does it provide? ____.
- Step 3: Analyze and interpret the map. What does the map demonstrate? Are there any trends?
- Step 4: Synthesize! Develop your conclusion. What can you infer from the map?

The data on the map shows ______________________________.	From the data on this map we can infer that ____.

This map makes me wonder ____________________, because ____________________.
The map makes me ask ______________________, because ________________________.
From what I observe in the map, I infer ______________________________________.

1. ____
____.

2. ____
____.

Earthquake Magnitude Scale

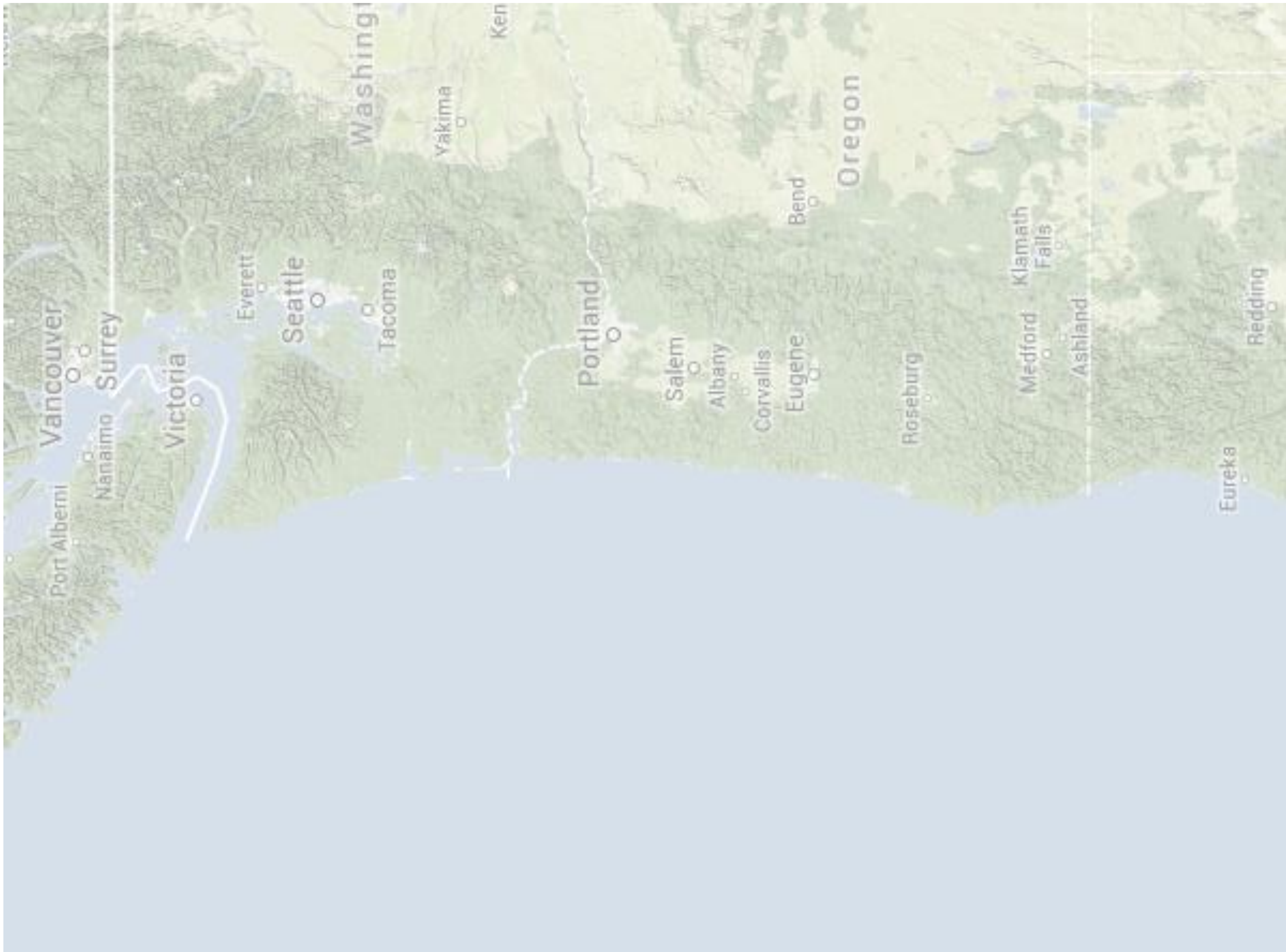
Magnitude	Earthquake Effects	Estimated Number Each Year
2.5 or less	Usually not felt, but can be recorded by seismograph.	900,000
2.5 to 5.4	Often felt, but only causes minor damage.	30,000
5.5 to 6.0	Slight damage to buildings and other structures.	500
6.1 to 6.9	May cause a lot of damage in very populated areas.	100
7.0 to 7.9	Major earthquake. Serious damage.	20
8.0 or greater	Great earthquake. Can totally destroy communities near the epicenter.	One every 5 to 10 years

Fact: For each step up in magnitude the ground movement is *ten times* greater! The amount of ground movement is called the **shaking amplitude**.

Earthquake Magnitude Classes

Earthquakes are also classified in categories ranging from minor to great, depending on their magnitude.

Class	Magnitude
Great	8 or more
Major	7 - 7.9
Strong	6 - 6.9
Moderate	5 - 5.9
Light	4 - 4.9
Minor	3 -3.9



Vancouver
Surrey
Nanaimo
Port Alberni
Victoria
Everett
Seattle
Tacoma
Yakima
Portland
Salem
Albany
Corvallis
Eugene
Bend
Oregon
Roseburg
Klamath Falls
Medford
Ashland
Redding
Eureka

Mapping Earthquakes In Our Area

1. You have been given a set of data about earthquakes in our area. What information does the data give about each earthquake?

2. Plot the earthquakes on a big piece of paper so that the location (latitude and longitude) and magnitude of each quake is shown. You may depict the magnitude data any way you want. Create a legend.

This map makes me wonder ______________________, because ______________________.
The map makes me ask ________________________, because __________________________.
From what I observe in the map, I infer ____.

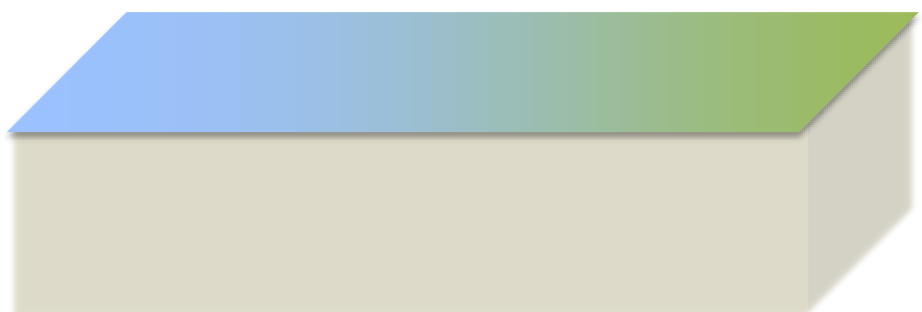
1. ____

____.

2. ____

____.

My Model for How Earthquake Energy Travels



Explain in words how your model works:

____

____

____

____

____

____

Modeling Earthquake Energy
Using Wave Pulses

Background
How can energy be transmitted from one place to another? Some examples of energy are sound, light, heat, and the shaking caused by an earthquake. We will use a slinky spring to model how shaking energy can travel from one place to another.

Explore
1. With a partner, carefully stretch your slinky spring on the floor. Be careful not let go of your end.

2. Partner A: Create a **transverse** wave pulse: While holding the spring in one hand, pull the spring out sideways and let go. Partner B: Hold the end of your spring. Describe what you feel. Switch roles.

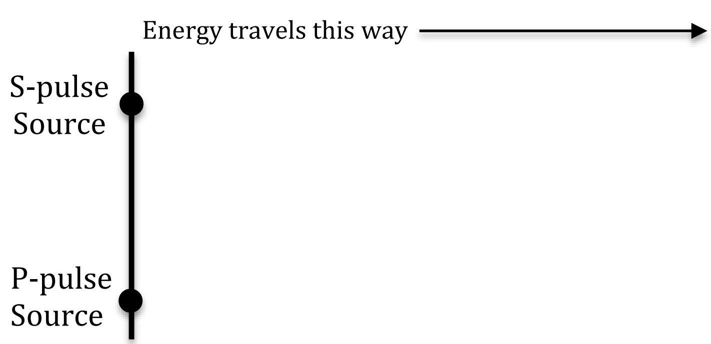
3. Partner A: Create a **compression** wave pulse: While holding the spring in one hand, pull the spring toward you without letting it move sideways; then let go. Partner B: Hold the end of your spring. Describe what you feel. Switch roles.

Explain
What is happening?

When a pulse of energy is created at one end of the spring, it ____________________________
____, because ____
____

> A **transverse wave pulse** is defined as a disturbance that causes vibrations of individual particles perpendicular to the direction of the traveling.
> A **compression wave pulse** is defined as a disturbance that causes vibrations of individual particles parallel to the direction of the traveling

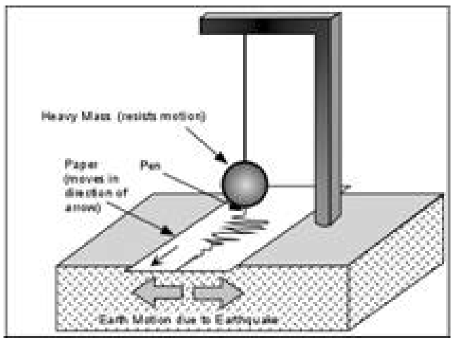
Diagram a 1) transverse, or "S" pulse, and 2) a compression, or "P" pulse in a spring.

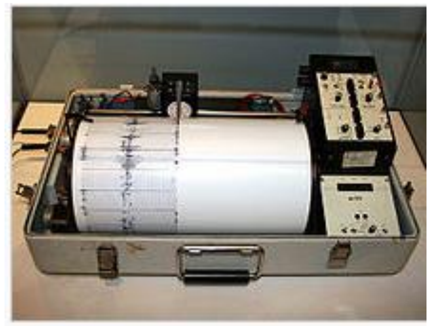


Extend

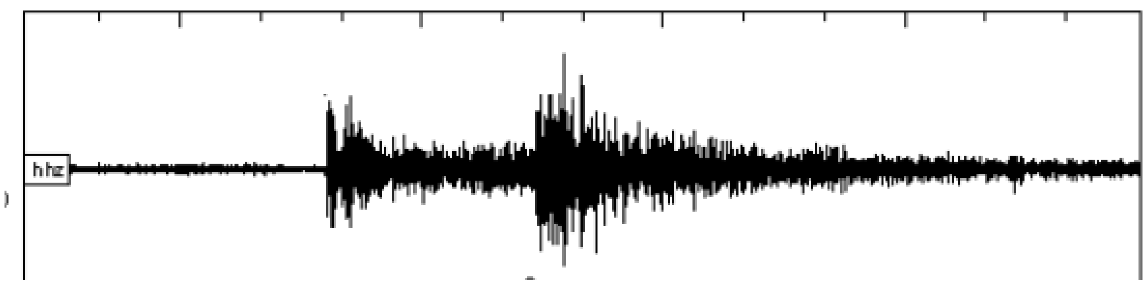
A **seismograph** is an instrument used to record how the ground shakes.

It's Greek: Seismo- "shaking" + graph – "draw"





A seismograph made the graph below. The shaking recorded is due to an earthquake.



Time in seconds →

What story is this graph telling about the way the ground shook?

For the first _______ seconds, the graph is ______________________. This means that ___________________. Then, the graph _________________, showing that _______________.

Model: Seismologists used the wave model of energy transfer to explain the seismograph results. Their model explained the data by assuming that that one pulse was made by a P-type wave and the other is made by an S-type wave. How can we test this model?

Hypothesis: Using the wave model of energy transfer, we predict that P-type pulses and S-type pulses travel at _______________ speeds through a spring.

Elaborate

Goal: Test the wave model of energy transfer by comparing the speed of P- and S-type waves through a spring.

Materials: meter stick, spring, stopwatch

Procedure

1. While one group member grasps one end of the spring, another group member should stretch it. Stretch the spring so it is taut, but not overstretched. CAUTION: *Coiled springs can be damaged permanently by overstretching or tangling.*

2. Create a transverse S-wave by having one group member pull some of the spring off to the side. Time several waves as they travel from one end of the spring to the other and back. Record the time for each trial and the average time in your data table on the next page.

3. Repeat step 2 using waves that have slightly larger amplitudes. Record the time for each trial and the average time in the data table in the Data section.

4. Create a compression P-wave by compressing some of the spring towards you and letting go of the compression. Record the time it takes for the wave to return to its source.

Data

Length of Stretched Spring: __________m.

Distance = 2 x Length of Spring = ________________m.

Wave Pulse Data

Type of Wave	Time in sec for wave to travel ____ **m**				Speed (m/sec) =
	Trial 1	Trial 2	Trial 3	**Average**	(Distance/time)
S-type (small amplitude)					
S- type (large amplitude)					
P-type					

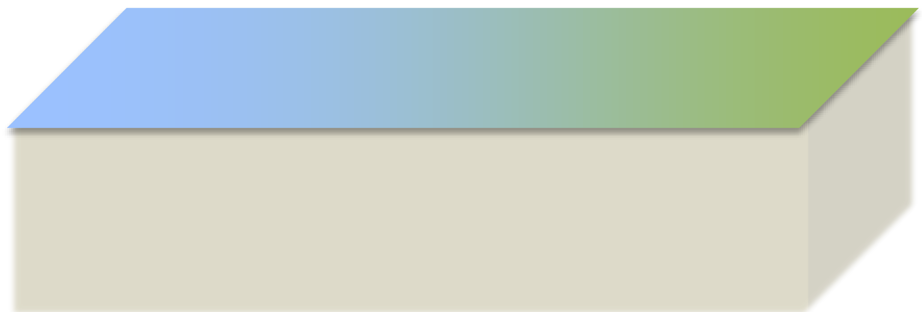
Results

The data show that ______________________________________.

This experiment ____the wave pulse model of earthquake energy transfer.

Apply
Look back at your first model of how energy travels away from the site of an earthquake to shake faraway buildings. Redraw your model based on what you learned from this investigation.

My Model for How Earthquake Energy Travels



Explain in words how your model works:

magnitude

latitude

longitude

plot

wave

compression

Draw lines connecting these words

transverse

wavelength

frequency

energy

seismic/seismology/seismologist

hypothesis

amplitude

CSZ (Cascadia Subduction Zone)

How Can We Make Buildings Earthquake-Safe?

1. Today you will work as seismic engineers. You will make models of buildings and conduct an experiment to test how well their structures stand up under the stress of an earthquake.

2. Sketch the display model of a structure.

Observations and Ideas:

3. <u>Problem</u>: Build an earthquake-resistant structure made of toothpicks and marshmallows. Here are some **criteria** and **constraints** for your building:

Criteria (what your building must do)	Constraints (limits to your design)
• Must withstand during **testing** both S- and P- **sudden acceleration** (shaking) without **failure** • Must be at least 2-toothpick lengths tall • Must have a top floor at least one toothpick square area.	• Can use no more than 30 toothpicks and 30 marshmallows • Must fit onto a small pan of Jello

4. Sketch your **solution** below.

5. Share your sketches with your partners for two minutes, explaining your thinking, uninterrupted.

   Say: “This is my design. Some of the features I think we should include are ________________________________. I include these because I know that ________________________________.”

6. Together as a group, create a **prototype** design. Each member must have their ideas incorporated into the final product, and all students have access to the materials.

7. Test your structure by placing the structures on the pans of Jell-O and creating P- and S- pulses.

Results

Q: Did your model meet the test criteria for compression waves? For transverse waves?

My structure met (or failed) the criteria for P-wave (or S-wave) shaking because ____________________.

Q: How would you improve your design?

Q: Suppose you wanted to reinforce an old building to better withstand a Willamette Valley earthquake. What changes or modifications could you make to the building? Why?