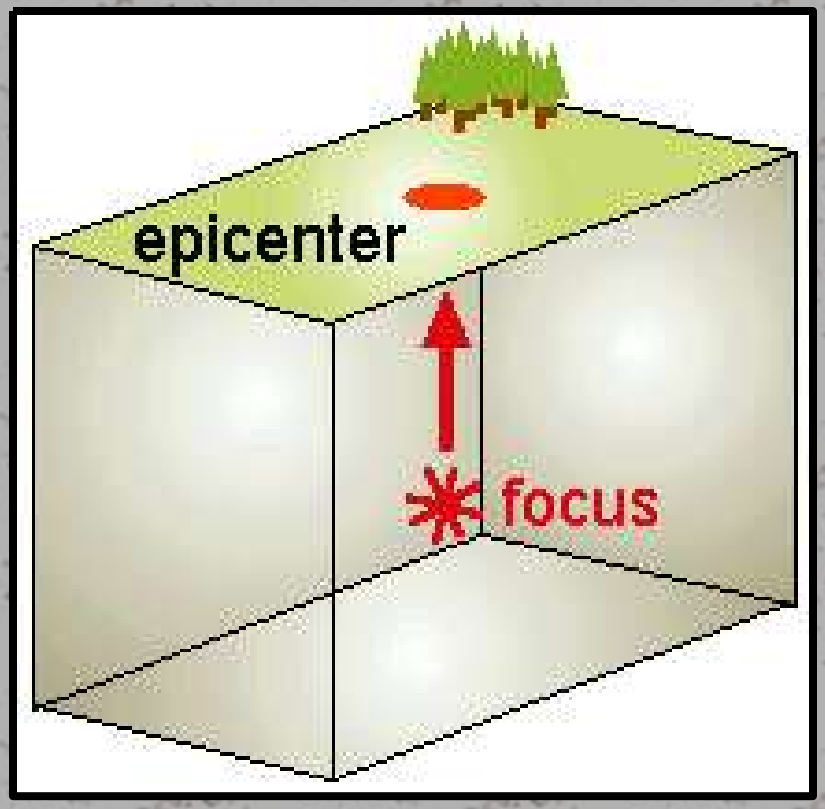
Seismic Waves of Earthquakes

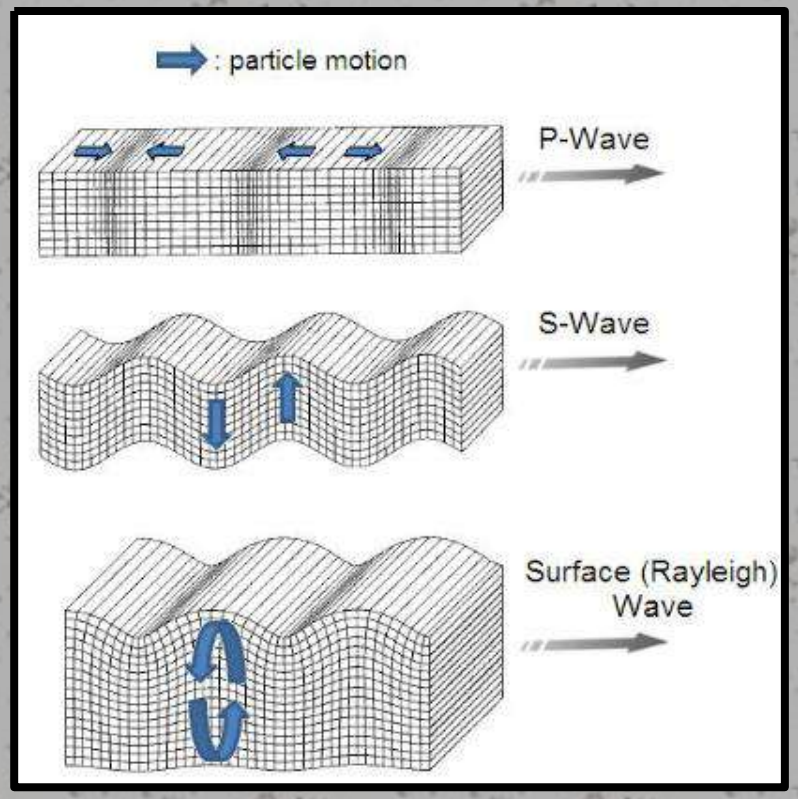
By: Annette Miles

The location of the beginning of an earthquake is its **focus**. This is the **underground** point in the crust where the built-up pressure of the caught plates is released. A focus can be at any **depth** in the Earth's crust.



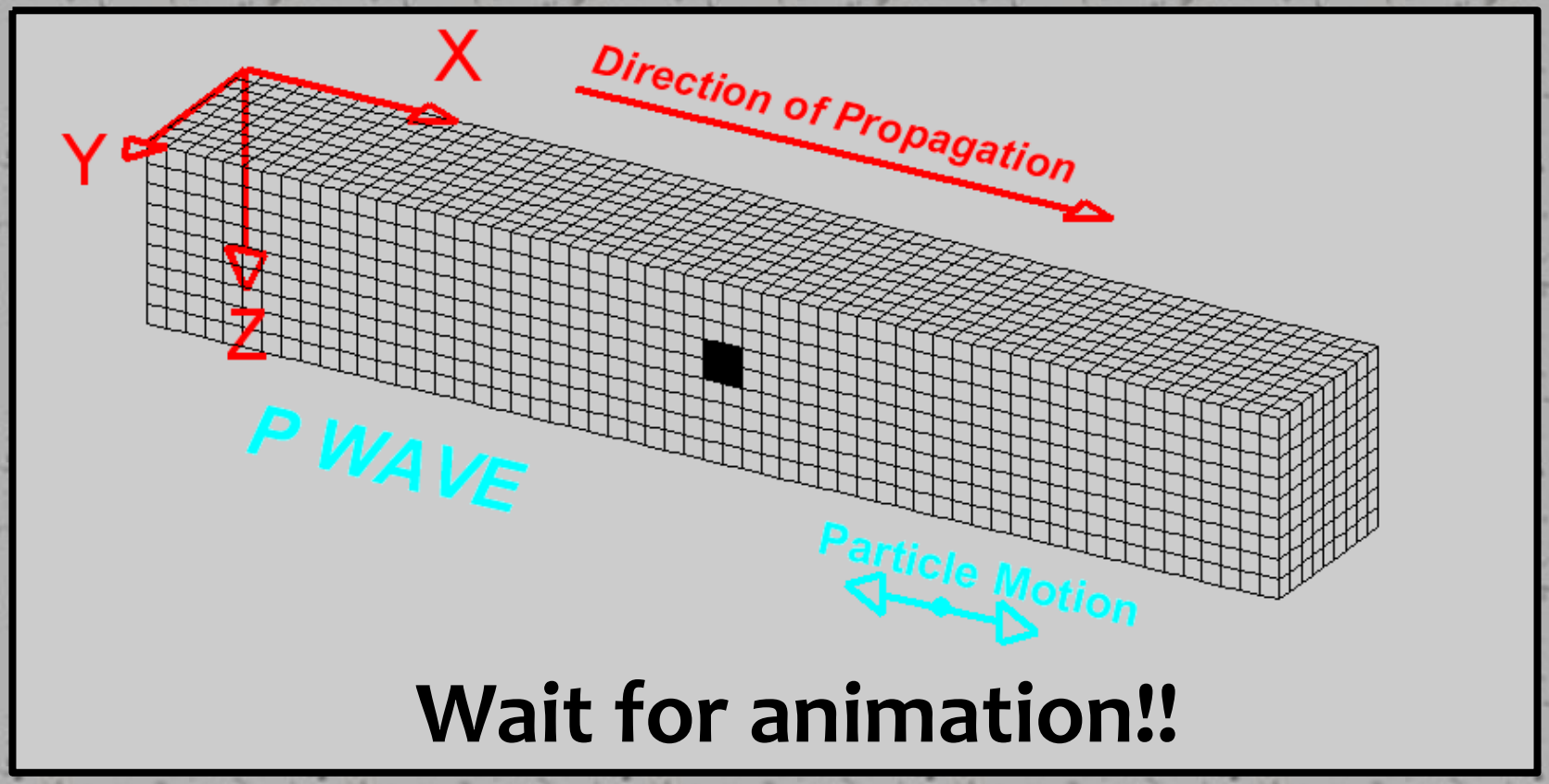
The point on the ground surface directly above the focus is known as the **epicenter**.

When you toss a pebble into a pond, it creates waves in the water. The energy released during an earthquake also travels in waves called seismic waves. There are three types of seismic waves:

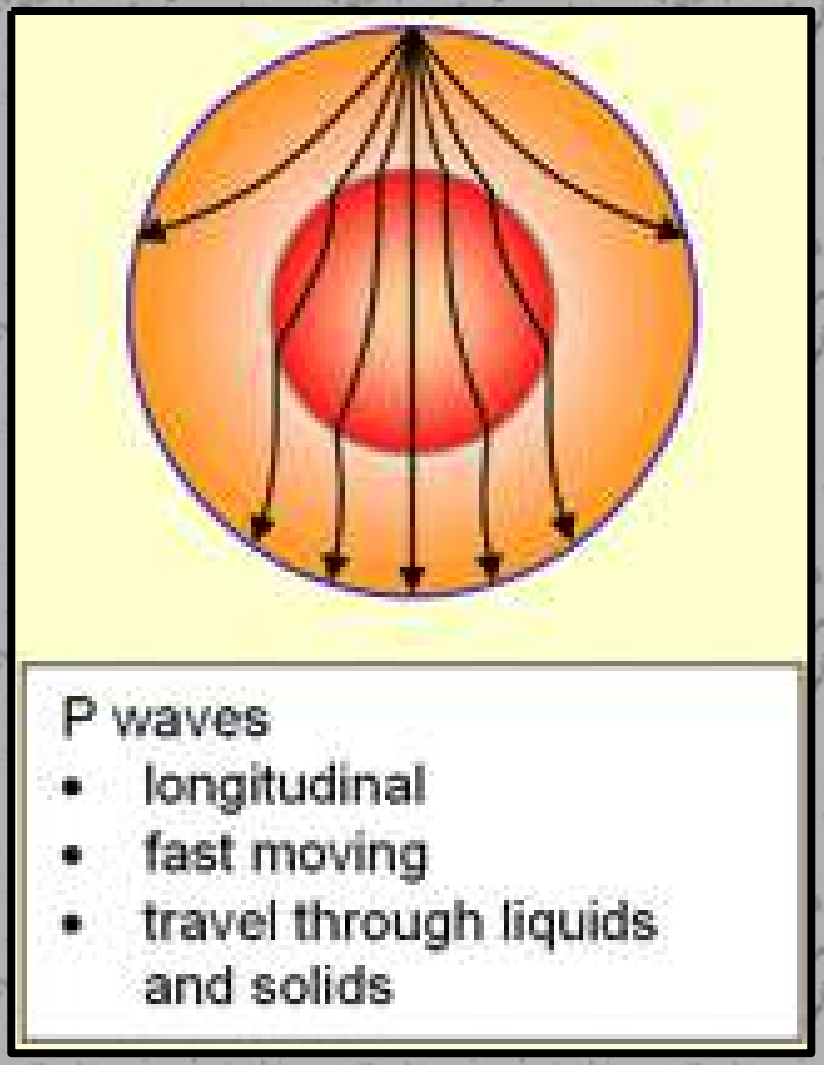


- P Waves
- S Waves
- Surface Waves

P-waves are _primary_ waves. These longitudinal waves are the _fastest_ moving waves, traveling at 1 to 5 miles per _second_ through _solids_, _liquids_, and gases.



Wait for animation!!



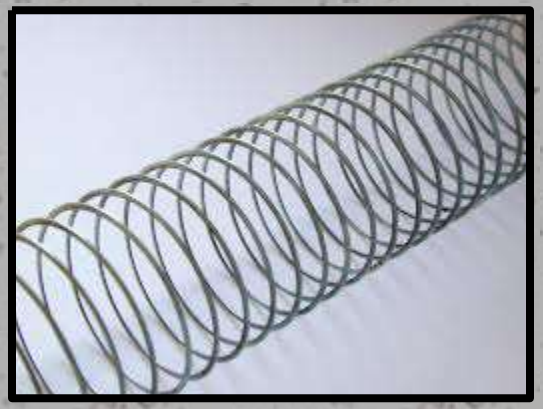
As the P waves travel through the interior of the planet it encounters both solid and liquid layers. The waves will change direction suddenly and curve at the boundary between these layers of the Earth.

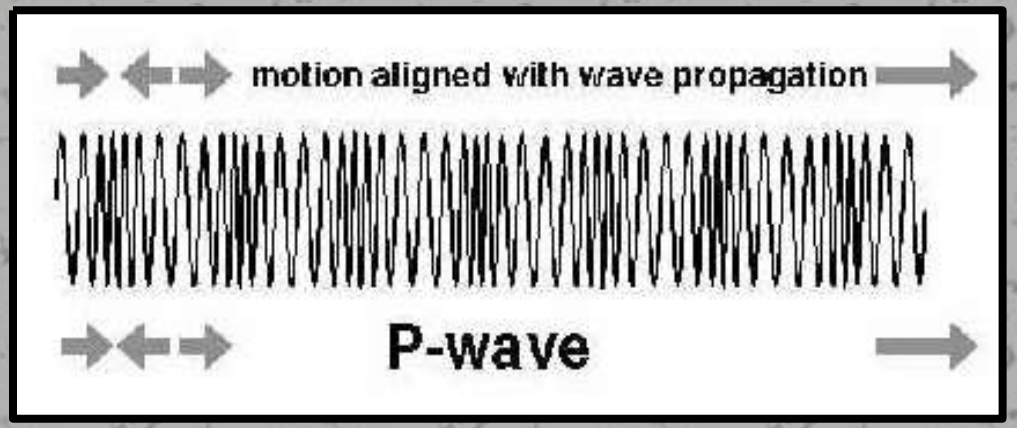
This is due to refraction caused by the different densities of the layers.

Activity: Place a slinky on a flat surface. Have a partner hold one end.

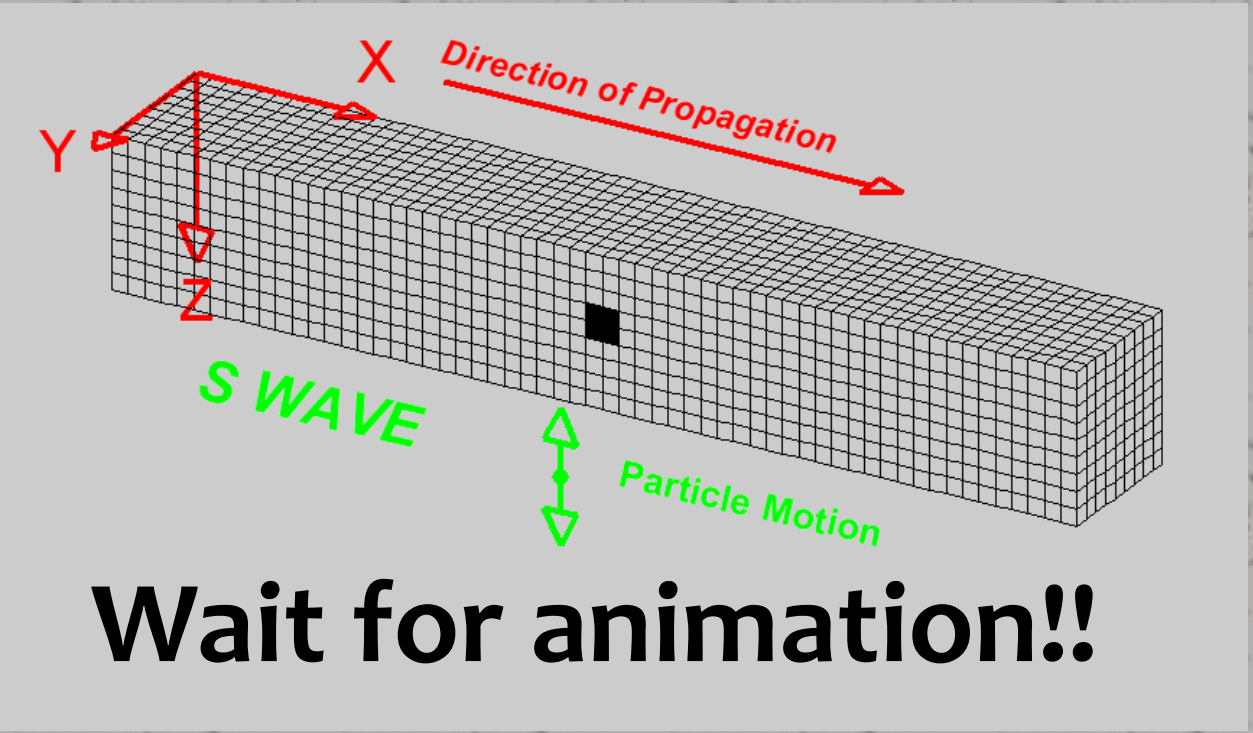
You are at the focus, the underground starting point of the earthquake. Use a quick push-pull motion to show how P-waves are transmitted through the crust.

You will be able to see them move together and apart as they travel in one direction away from you toward your partner.





S-waves are secondary waves. These transverse waves travel slower than primary waves. They can only pass through solids and are therefore stopped on the liquid inner core of the Earth.



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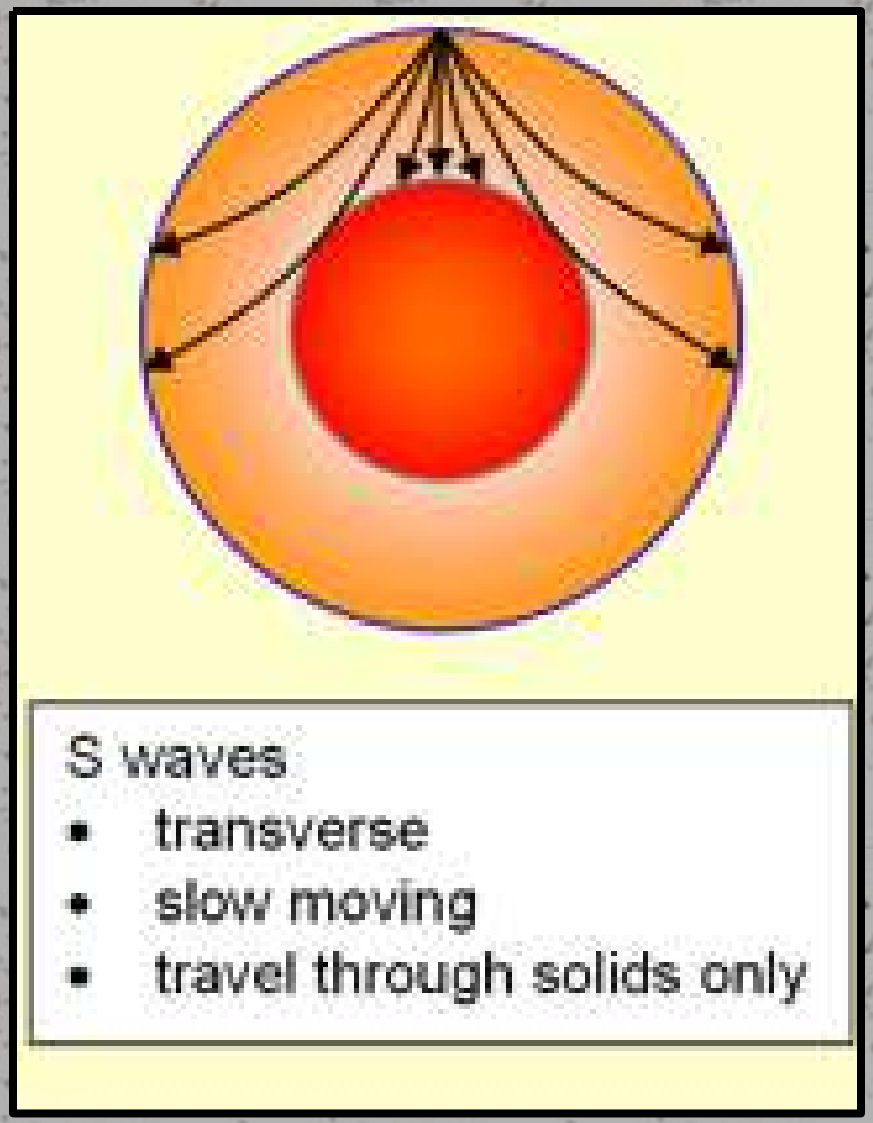
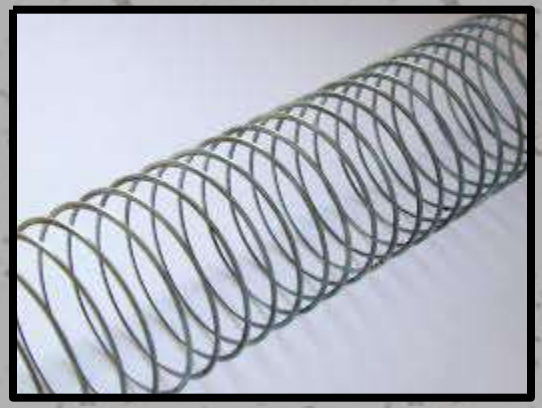
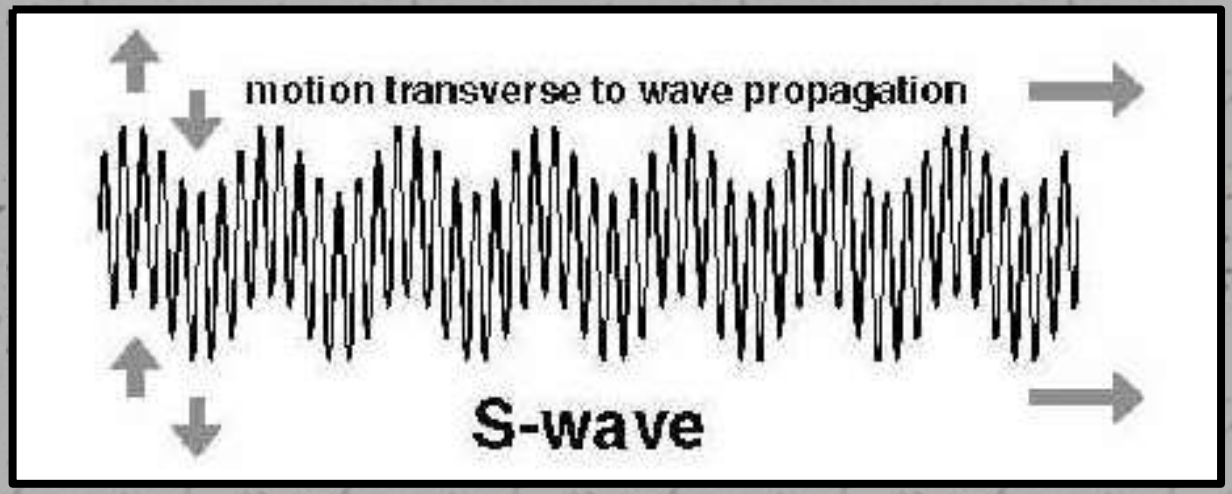


This diagram shows how S waves travel through the interior of the Earth.

Activity: Place a slinky on a flat surface. Have a partner hold one end.

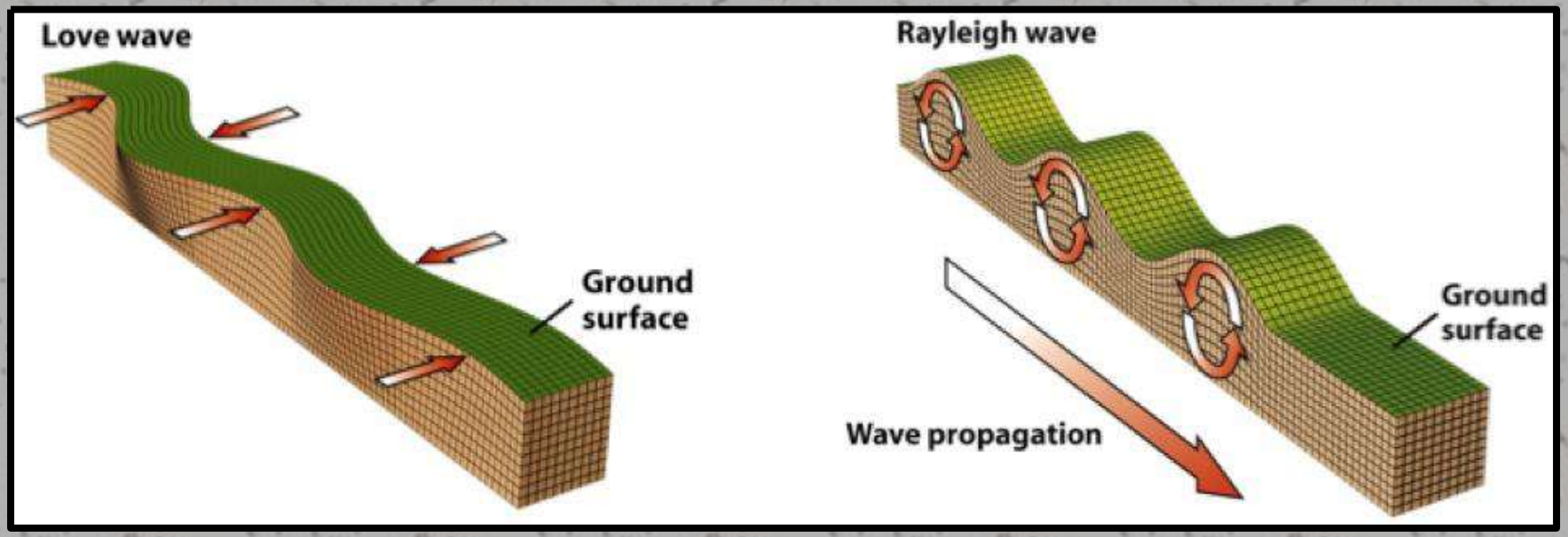
You are at the focus, the underground starting point of the earthquake. Shake one end of the slinky up and down or side to side to produce an S-wave. These waves move through the ground like a snake.

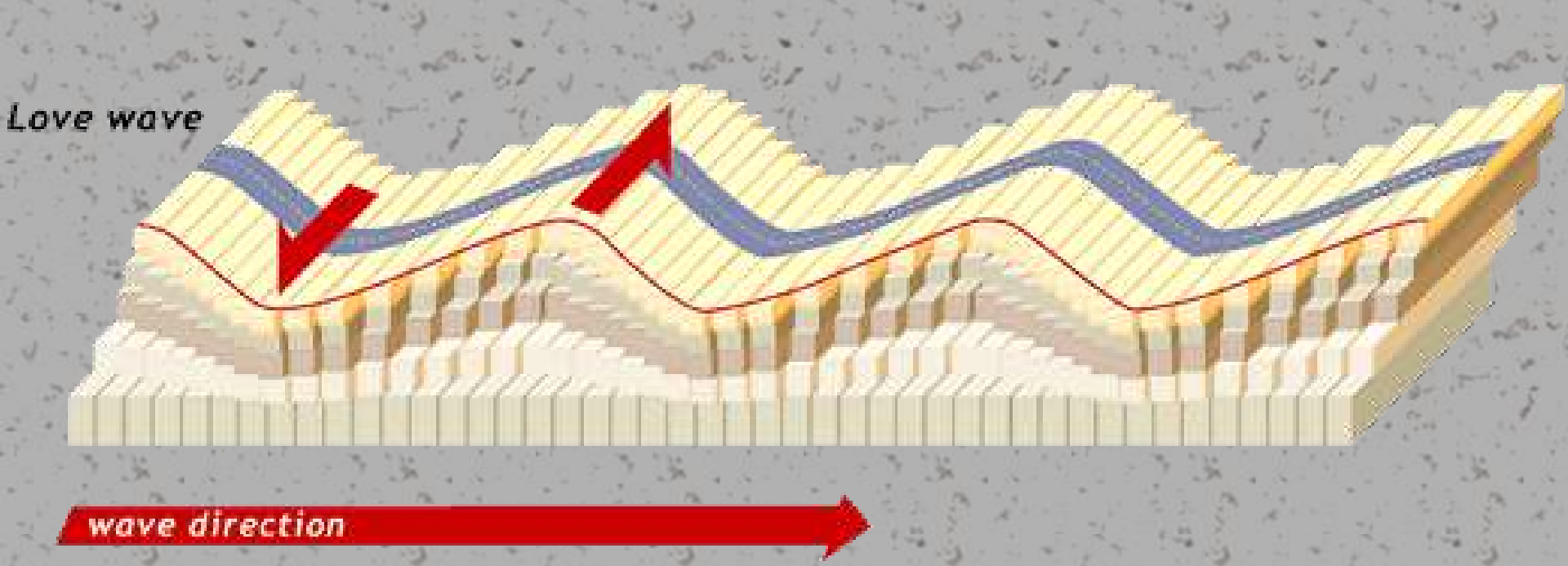




Surface waves are the last type of seismic waves. These waves move up and down along the surface of the Earth. They are the slowest moving of all waves. There are two kinds of surface waves:

- Love Waves
- Rayleigh Waves



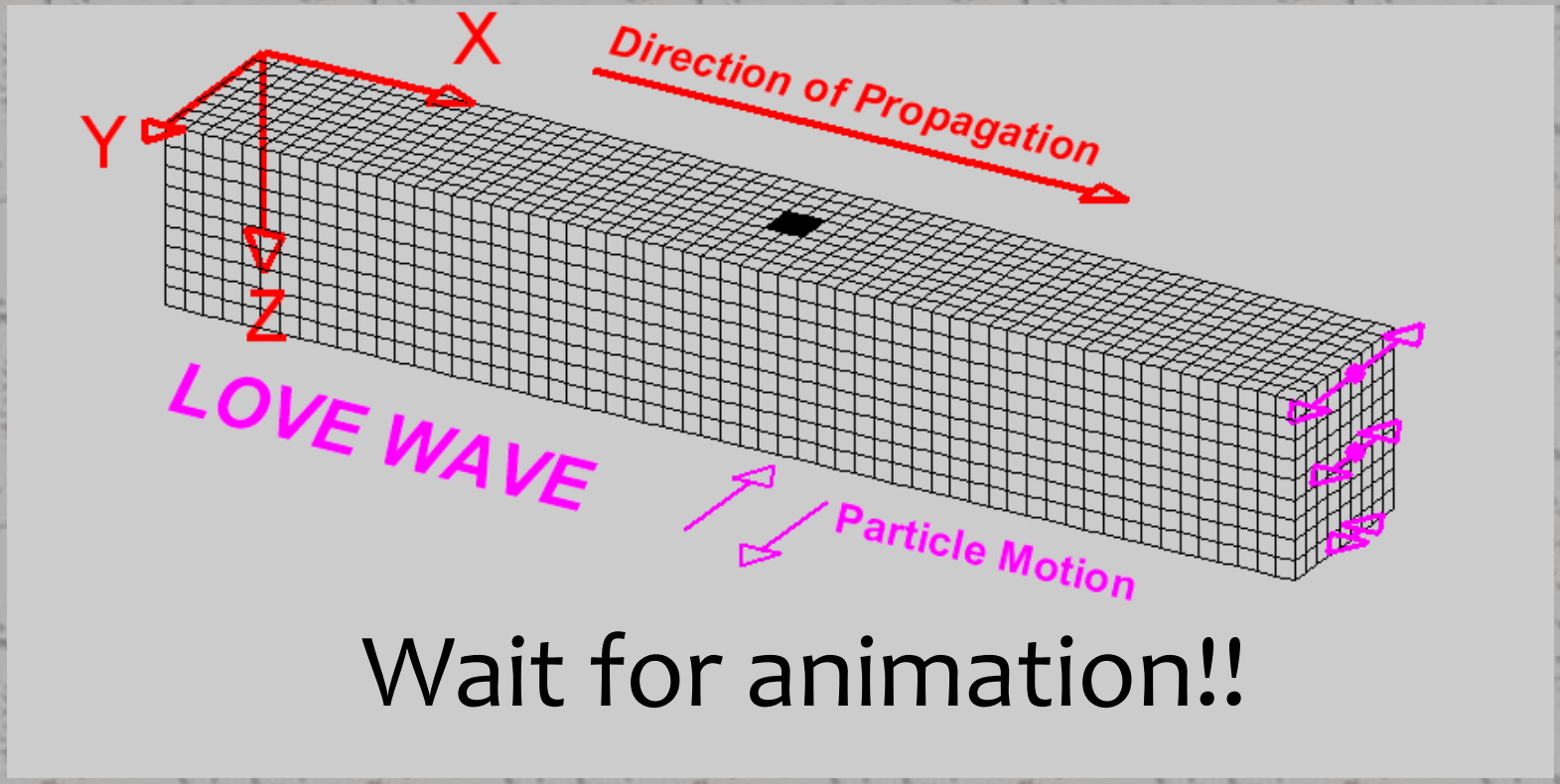


Love waves move the ground from side to side. These waves are the most destructive outside the area of the epicenter. They are what most people feel directly during an earthquake.

Activity: Place a slinky on a flat surface. Have a partner hold one end.

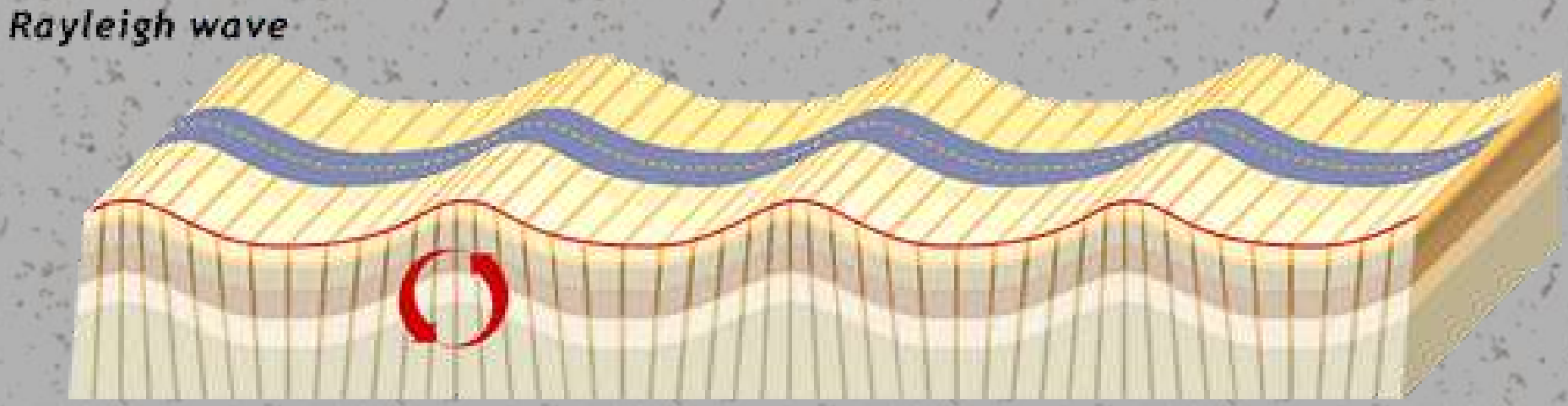
You are at the focus, the underground starting point of the earthquake. Move the Slinky in a back and forth motion to show a love wave.

These waves shake things at the surface from side to side.



Wait for animation!!

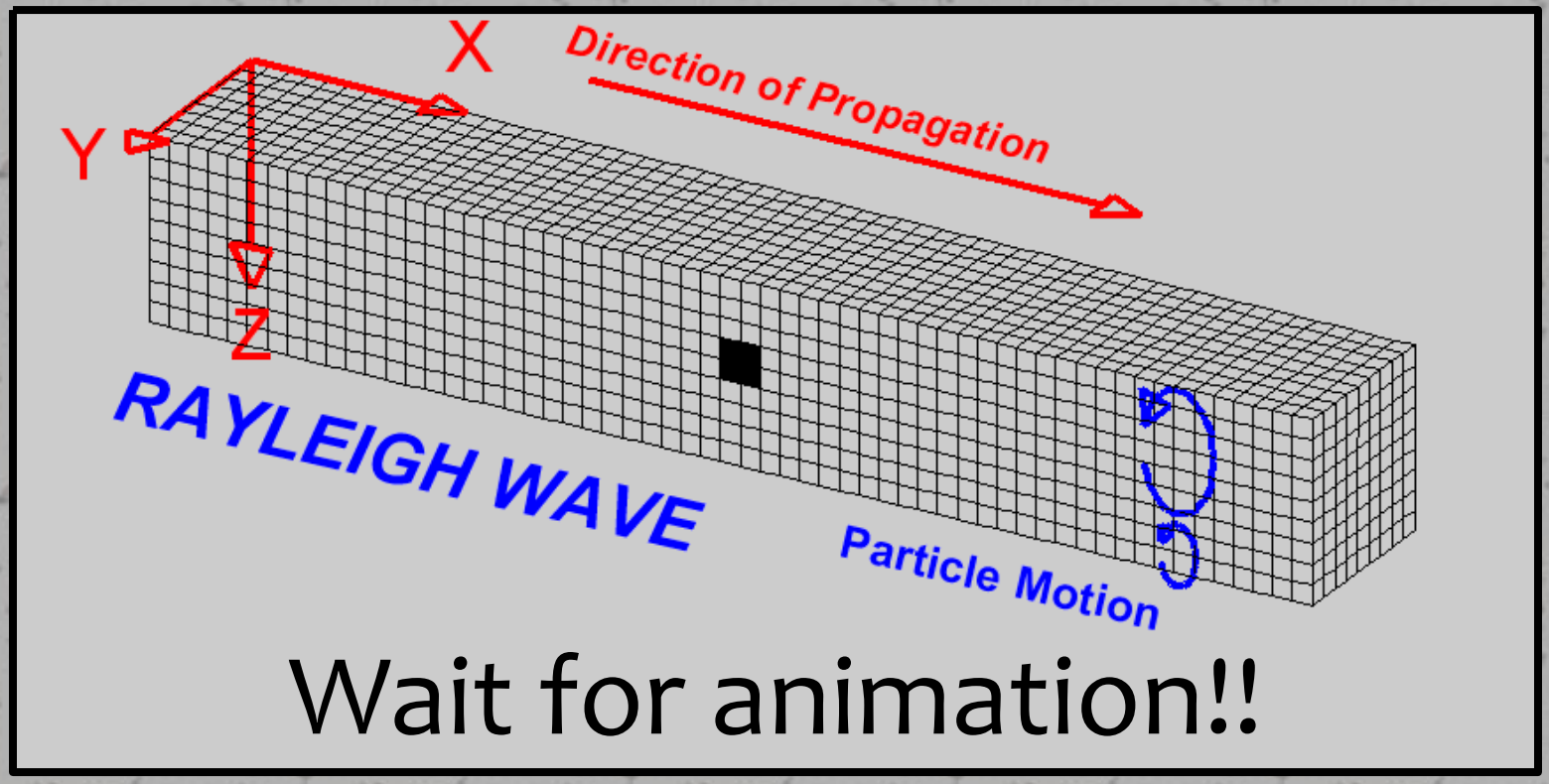
A rayleigh wave rolls along the ground just like a wave rolls across a lake or an ocean. Because it rolls, it moves the ground up and down, and side-to-side in the same direction that the wave is moving.



Activity: Place a slinky on a flat surface. Have a partner hold one end.

You are at the focus, the underground starting point of the earthquake. Rotate your hand in a circle while pushing and pulling the Slinky to demonstrate a Rayleigh wave.

This is a surface wave moving outward from the epicenter, the point of the surface above the focus. It produces a rolling motion.



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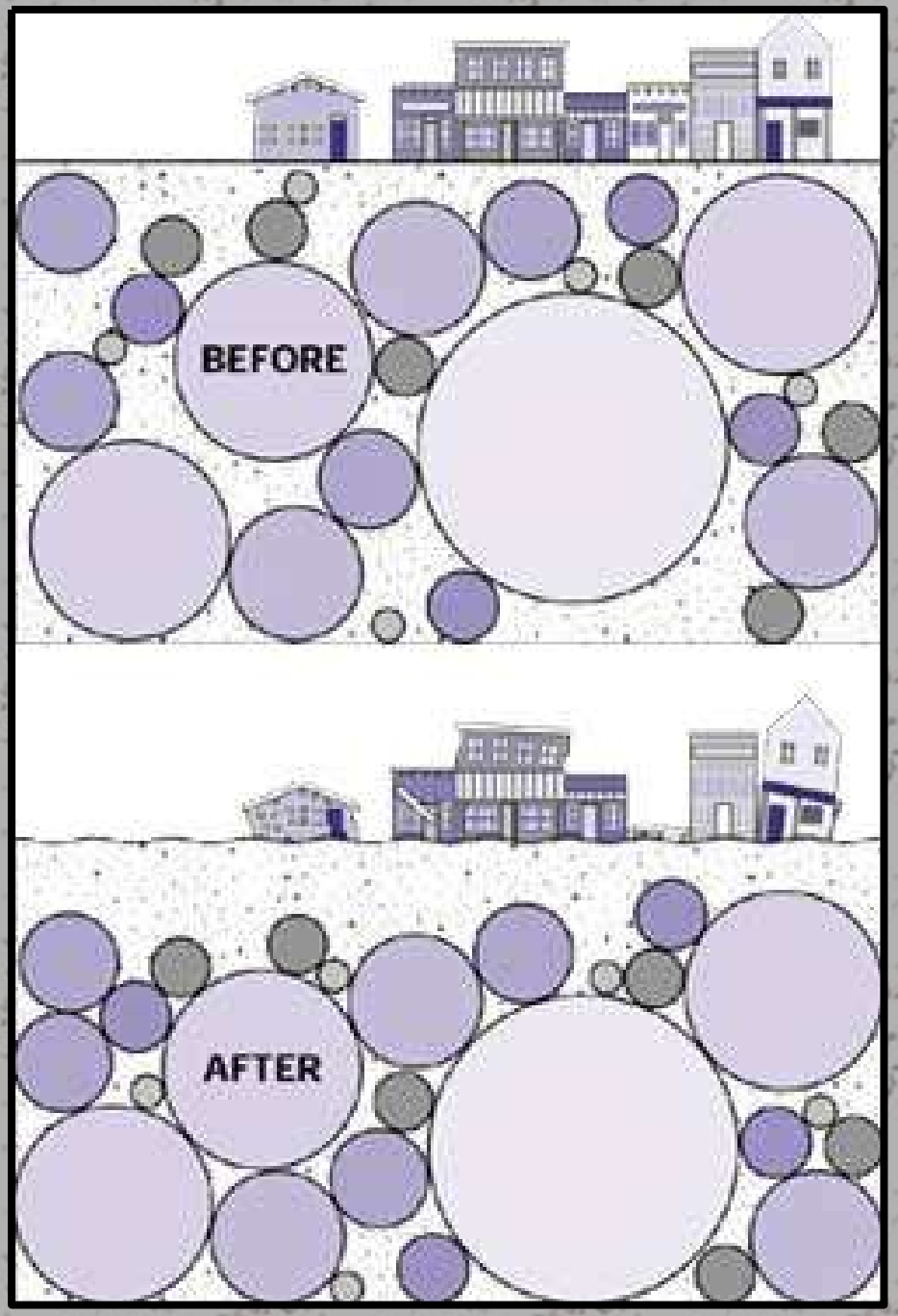
Liquefaction is the process by which soil loses strength and acts like a liquid instead of a solid during an earthquake. This effect on structures and buildings can be devastating.

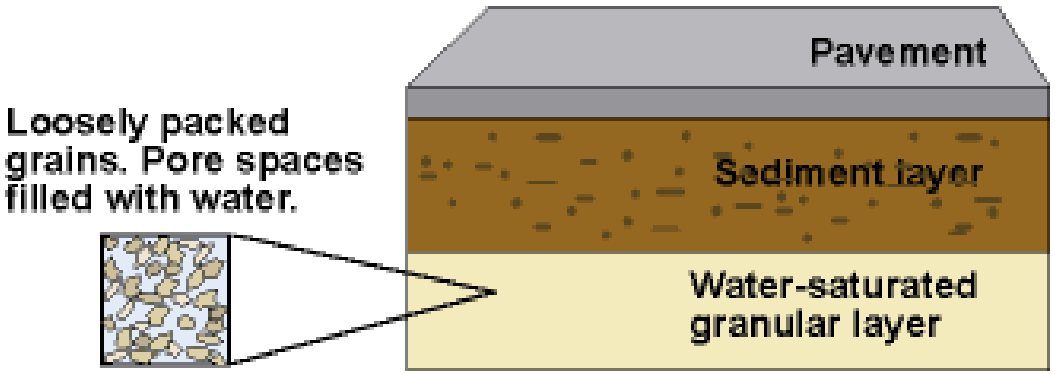


This happens especially in sandy soil. When the soil becomes saturated with water, the soil compresses and the water increases in pressure and attempts to flow out from the soil to an area of low pressure. The water usually flows upward towards the ground surface.

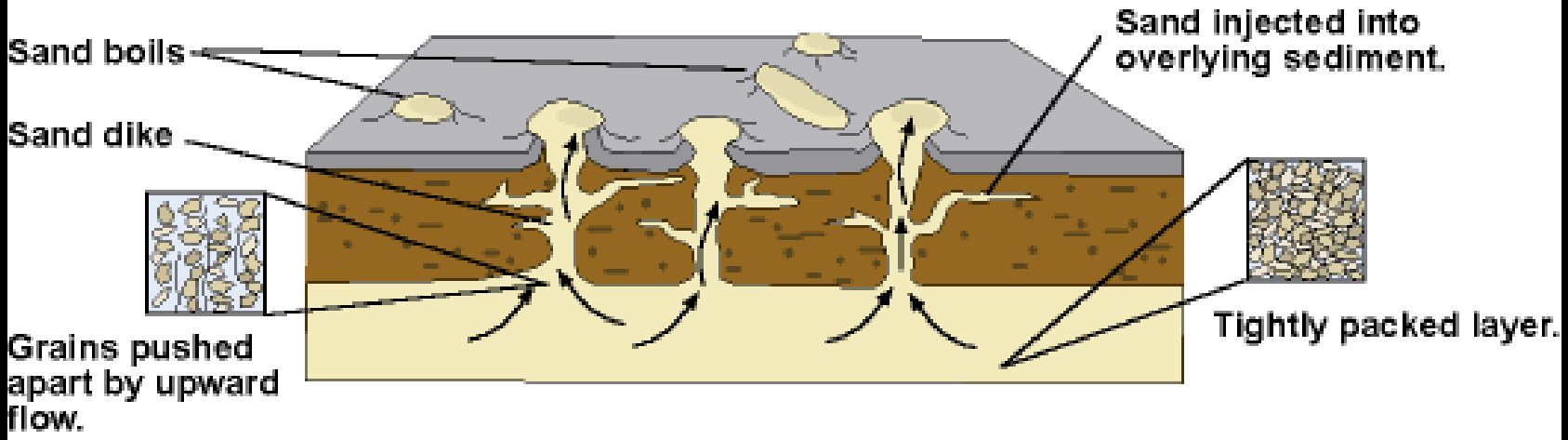
VIEW VIDEO ON LIQUEFACTION

http://www.youtube.com/watch?v=qmVYbjiNWds

Before the earthquake



During the earthquake



EARTHQUAKE-INDUCED LIQUEFACTION

The next few slides show what is probably the result of liquefaction caused by an earthquake.

Damage to railway near Lyublino.

EXPERIMENT

This experiment demonstrates what happens to sandy soils when they liquefy. You will create a model river valley, then watch how and why houses get damaged or collapse during an earthquake in a seemingly stable geologic environment.

Equipment needed:

- Glass baking pan or plastic bin
(so contents of pan can be observed)

- Enough dry sand to fill pan 1-2 inches deep

- A few toy houses or blocks
water

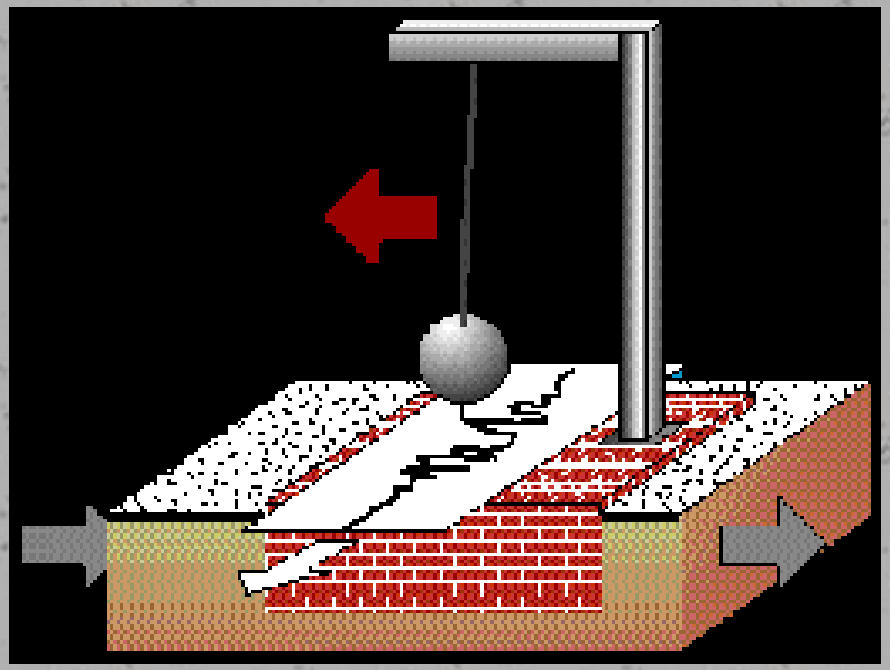
Procedure:

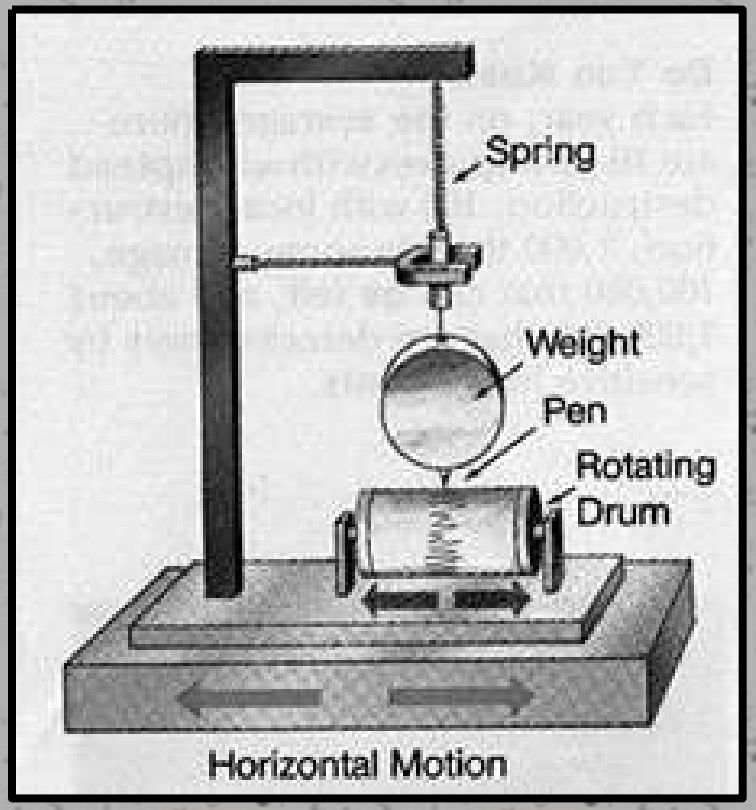
Evenly pour the dry sand into the pan.
Mark the level of the sand on the side of the pan or bin (use a washable marker).
Place houses or blocks gently on the surface.
Slowly add water until about two-thirds of the thickness of the sand is saturated.
Gently shake the table on which you have placed your pan (or gently shake the pan itself). If using a plastic bin, you can use a rubber mallet to tap the side of the pan 10 times).

Observations:

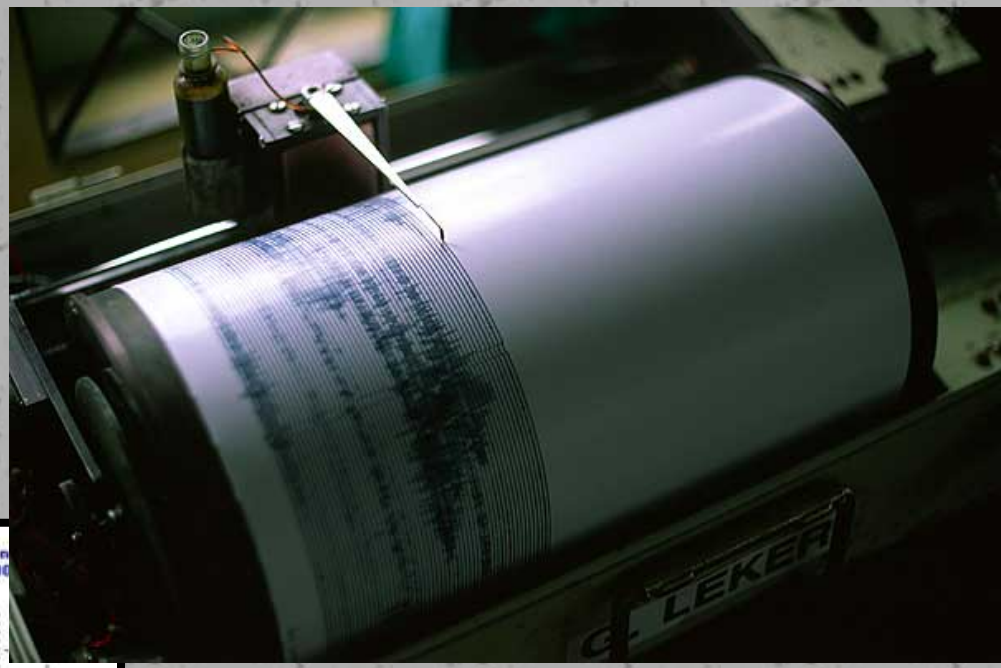
You should see the following:
The water will work its way to the surface, flooding the area around the houses.
The houses will start leaning over and sinking into the sand.
The volume of the sand should decrease by a small amount. Note where the surface is after shaking in relation to the mark denoting the surface before shaking.

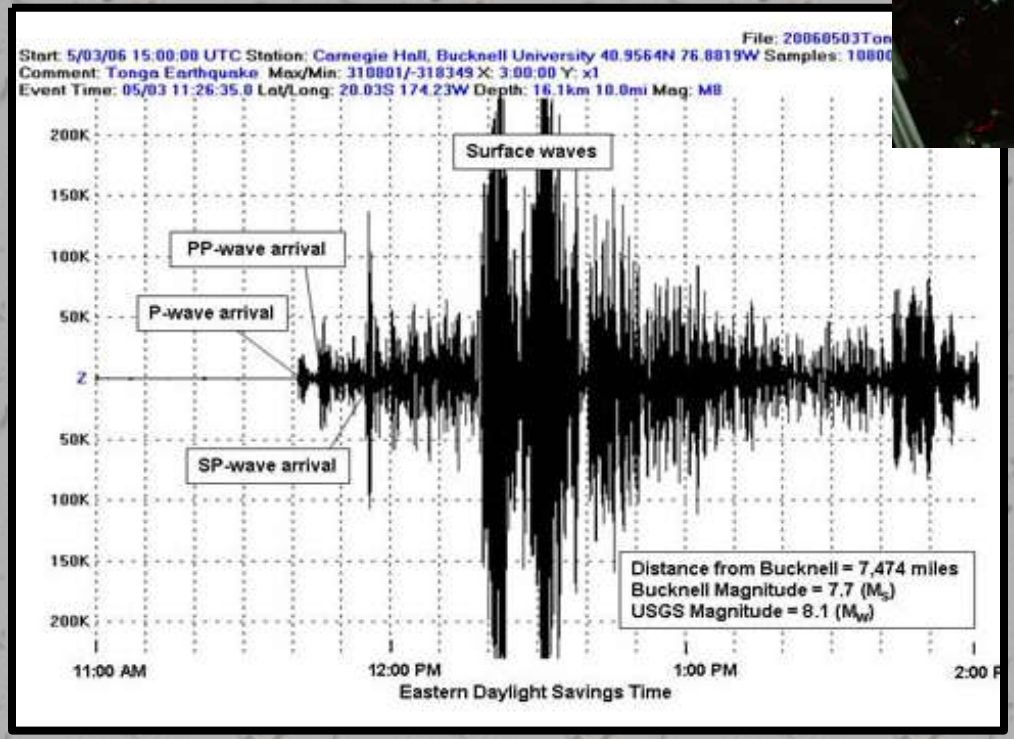
Scientists use instruments called a seismograph to detect and record earthquakes. There is generally a pen hanging at the bottom of a weight. As the earth shakes, the pen will make marks on a rotating drum.

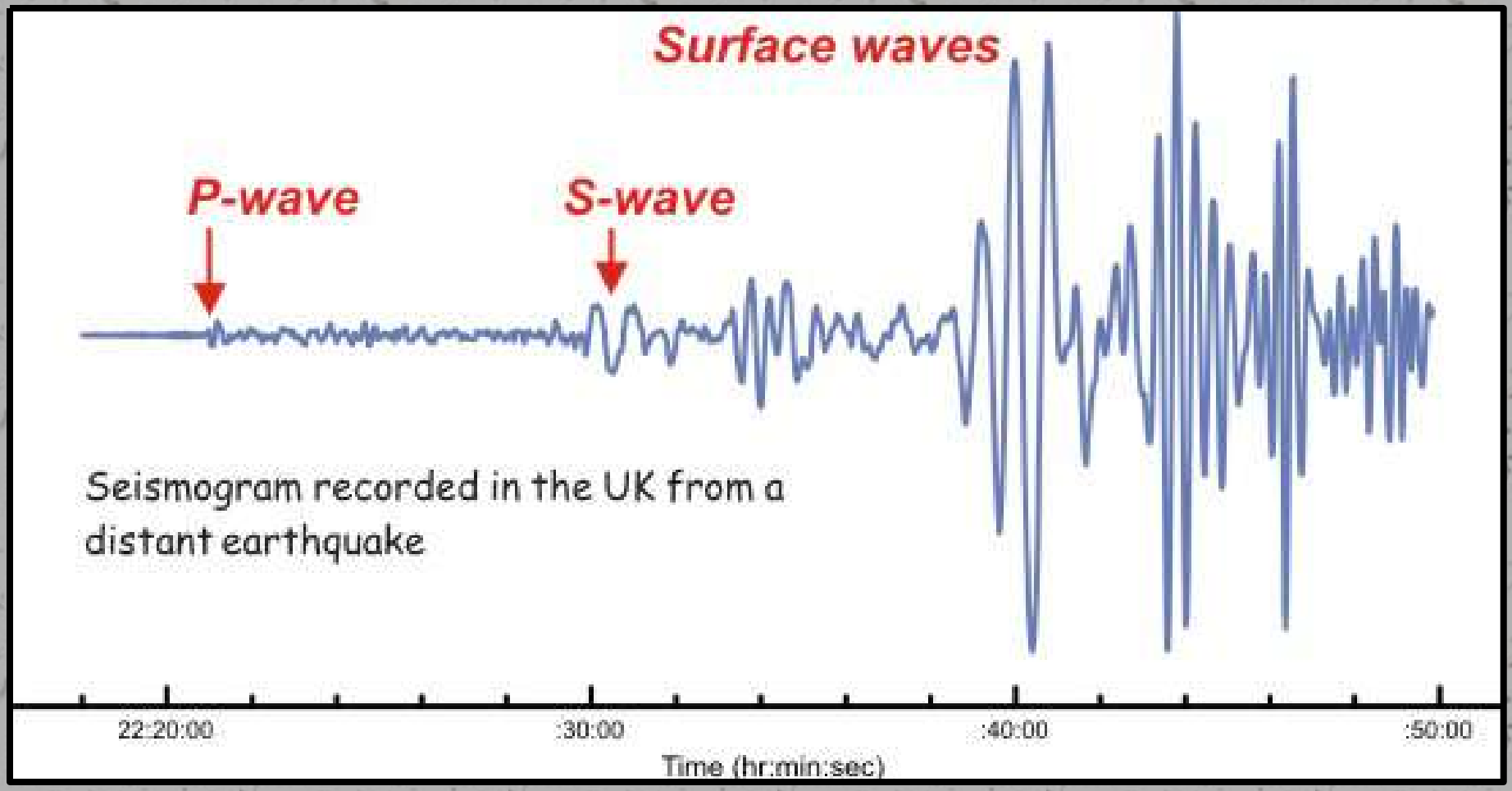




This shows the resulting markings from a seismograph during an earthquake.






Surface waves
P-wave
S-wave
Seismogram recorded in the UK from a distant earthquake
22:20:00
:30:00
:40:00
:50:00
Time (hr:min:sec)

There are around a half a million earthquakes across the Earth each year. Only about 100,000 are actually felt. The amount of energy released by an earthquake is measured with the Richter scale. The values typically fall between 0 and 9, with each increase of 1 representing a 10-fold increase in energy.

RICHTER SCALE of earthquake energy:

Each level is **10** times stronger than the previous level

	Description	Occurrence	In Population	Movement
1	SMALL	DAILY	every minute	small
2	SMALL	DAILY	every hour	small
3	SMALL	DAILY	every day	small
4	SMALL	DAILY	every week	moderate sudden
5	MODERATE	MONTHLY	every 10 years	strong sudden
6	MODERATE	MONTHLY	every 30 years	strong sudden
7	MAJOR	MONTHLY	every 50 years.	severe sudden
8	GREAT	YEARLY	every 100 years	very severe
9	GREAT	YEARLY	every 300 years	very severe
10	SUPER	RARELY	every 1000 years	extreme

Suggested Videos

Earthquake Destruction

http://www.youtube.com/watch?v=CtBXTvtFaCU

The Big Picture – Alaskan Earthquake (1964)

http://www.youtube.com/watch?v=6ApwG0QWhIs

The National Geographic archives: Earthquakes

http://www.guardian.co.uk/environment/video/2010/feb/15/natural-disasters-earthquakes

Brainpop: Earthquakes

RESOURCES

http://www.kids-fun-science.com/earthquake-focus.html

http://earthquakesandplates.files.wordpress.com/2008/05/epicenter.gif

http://science.howstuffworks.com/nature/natural-disasters/earthquake4.htm

http://www.frankswebspace.org.uk/ScienceAndMaths/physics/physicsGCSE/earthquakes.htm

http://classconnection.s3.amazonaws.com/934/flashcards/2198934/jpg/surface_waves1351638656348.jpg

http://geophysics.eas.gatech.edu/classes/Geophysics/misc/pics/Rayleigh_wave.jpg

http://www.consrv.ca.gov/cgs/information/kids_geozone/PublishingImages/liquefaction1.jpg

http://commons.wikimedia.org/wiki/File:Sink_holes_and_liquefaction_on_roads_-_Avonside_in_Christchurch.jpg

http://wapi.isu.edu/envgeo/EG5_earthqks/images/liquefaction.gif

http://www.ce.washington.edu/~liquefaction/selectpiclique/sandboils/sandboil1.jpg

http://www.thetech.org/exhibits/online/quakes/seismo/

http://earthquake.usgs.gov/learn/glossary/images/seismograph.jpg

http://www.bucknell.edu/Images/Depts/Communication/Quake%20image.jpg

http://www.liako.gr/news/images/stories/seismograph.jpg

http://www.google.com/imgres?imgurl=http://www.earthquakes.bgs.ac.uk/earthquakes/education/eq_booklet/dia_seismogram.jpg&imgrefurl=http://www.earthquakes.bgs.ac.uk/earthquakes/education/eq_booklet/eq_booklet_how_we_measure.htm&usg=__S7awvjLJO3iryRD9eE4ZVG30k6c=&h=285&w=550&sz=29&hl=en&start=39&itbs=1&tbnid=KlVSDgtVlPPm_M:&tbnh=69&tbnw=133&prev=/images%3Fq%3Dp%2Band%2Bs%2Bwaves%26start%3D36%26hl%3Den%26sa%3DN%26gbv%3D2%26ndsp%3D18%26tbs%3Disch:1

http://mishunderstanding.wordpress.com/2011/01/23/what-is-the-richter-scale/

http://www.google.com/imgres?imgurl=http://www.geo.mtu.edu/UPSeis/images/Rayleigh_medium.jpg&imgrefurl=http://www.geo.mtu.edu/UPSeis/waves.html&usg=__ma2Gg2WMgcz497mvQ5TD2sqhlwg=&h=499&w=433&sz=66&hl=en&start=1&itbs=1&tbnid=VWZJjvD9hu9r-M:&tbnh=130&tbnw=113&prev=/images%3Fq%3Drayleigh%2Bwaves%26hl%3Den%26sa%3DX%26gbv%3D2%26ndsp%3D18%26tbs%3Disch:1

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