

# Earthquakes and Seismic Waves

## Lesson 4-2

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What are seismic waves?



How are earthquakes measured?



How is an earthquake located?

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## What are seismic waves

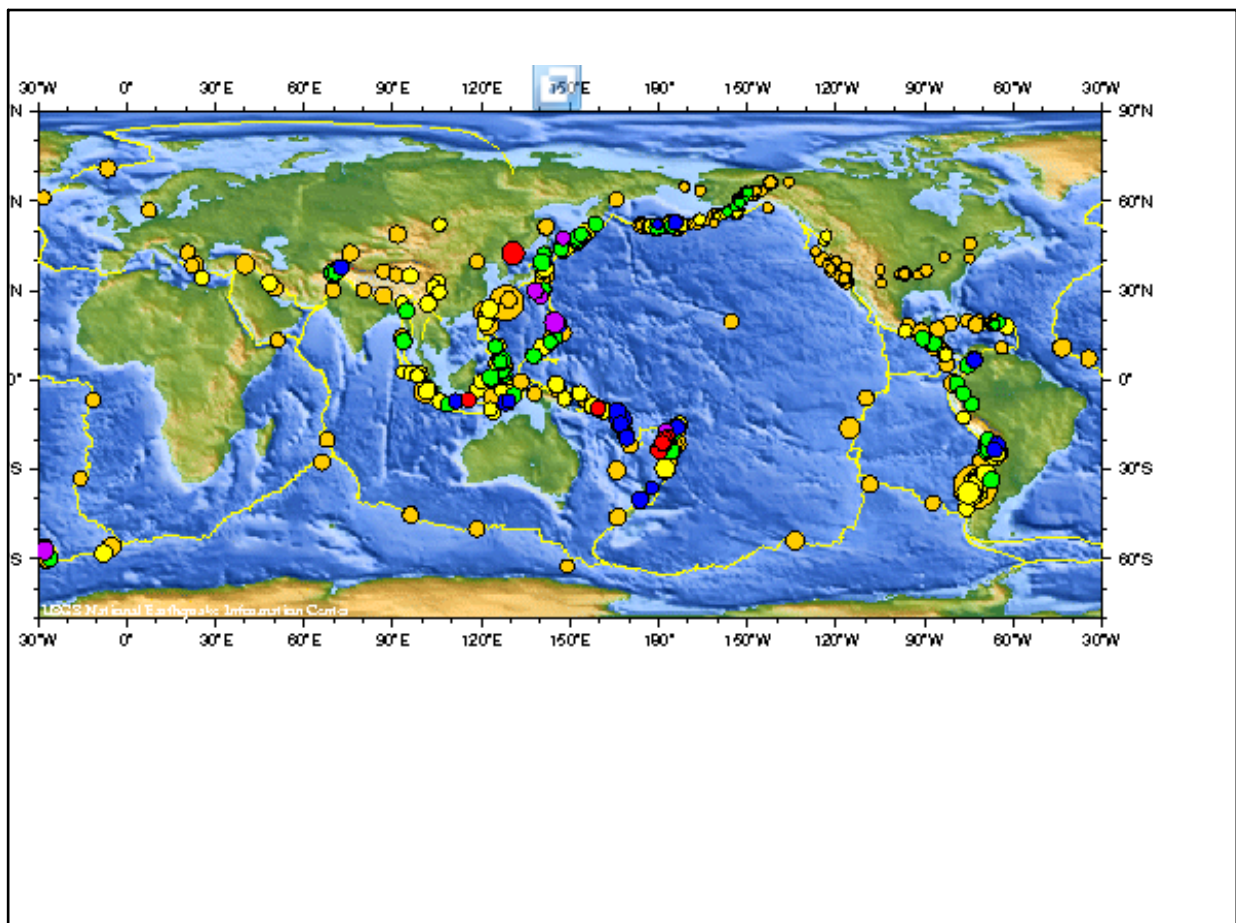
An earthquake is the shaking and trembling that results from movement of rock beneath the Earth's surface

several thousand are detected worldwide

most are too small to notice

large earthquakes can crack the ground, shift mountains and cause damage

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## Cause of earthquakes

### Forces of plate movement cause earthquakes

plate movement produces stress

adding energy to rock

forming faults

stress increases until rock slips/breaks

enormous amounts of stored energy is released

travel as seismic waves


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seismic waves are vibrations similar to sound waves

carry energy released by the earthquake

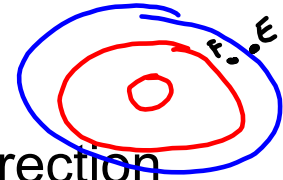
speed and path of the waves depends on the

material the waves travel through

 seismic waves

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## Types of seismic waves



Seismic waves move out in every direction from the earthquake focus

focus- area beneath the surface where the rock under stress begins to break or move. Earthquake starts here

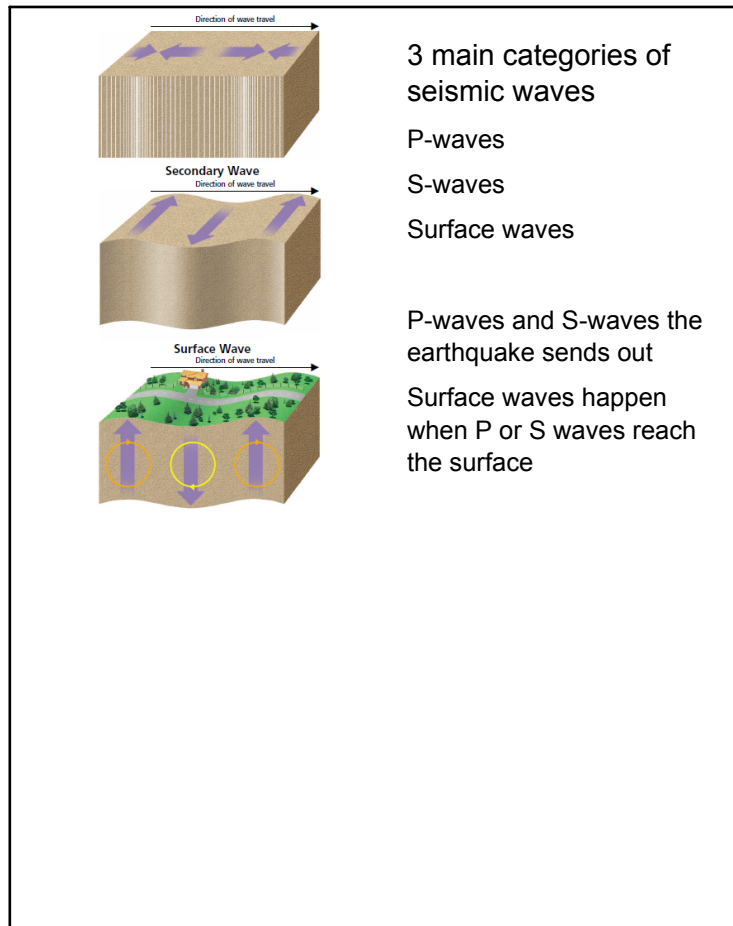
epicenter- point of the surface above focus

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Most earthquakes start in the lithosphere about 100 km beneath the surface

Seismic waves carry energy out from the focus, through the Earth's interior and across the surface

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## P-waves

primary waves ( pressure waves)  
compress and expand the ground  
can cause damage  
travel through solid and liquid

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## S-waves

secondary waves

vibrate side to side

travel at a direction of  $90^\circ$  from wave

can shake structures violently

travel only through solids

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## Surface Waves

when P and S waves reach the surface

some become surface waves

move more slowly

produce severe ground movements

produce a wave motion that is almost circular

makes ground roll like ocean waves or shake

buildings

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## How are earthquakes measured

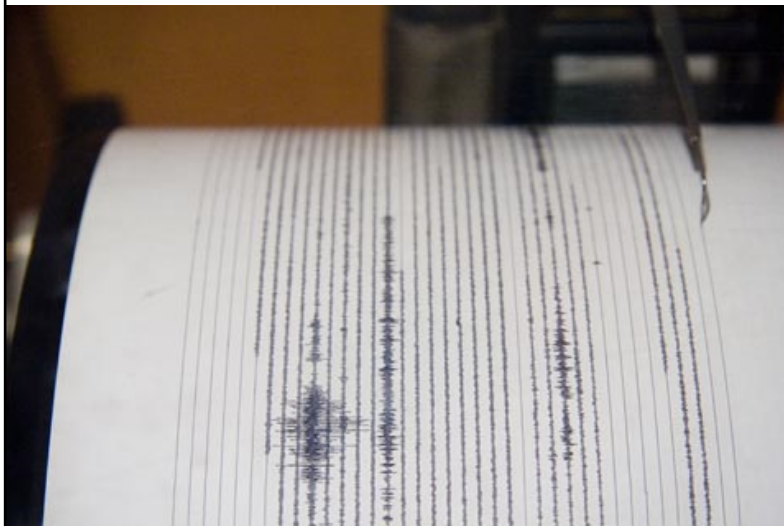
### Geologists monitor earthquakes by measuring seismic waves

2 ways to do this

compare the amount of damage or shaking felt during the quake = Modified Mercalli Scale

compare the magnitude or size measured on a seismograph using the Richter Scale or Moment Magnitude scale

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seismograph is an instrument that records and measures earthquake seismic waves

seismogram is the actual reading

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## Modified Mercalli Scale

Rates the amount of shaking

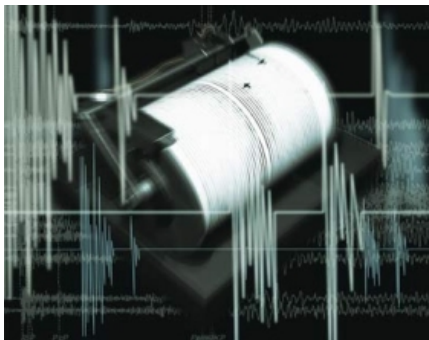
Rated by people's observations without instruments

Useful in areas where there aren't instruments available

12 steps

Modified Mercalli Scale		Richter Magnitude Scale
I	Only felt by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors, delicate suspended objects may swing	2.0
III	Felt indoors, but may not be recognized as earthquake, vibrations like large passing truck	2.5
IV	Felt indoors by many, some outdoors, may awaken some sleeping persons; dishes, windows, doors may move, cars rock.	3.0
V	Felt by most; some windows, dishes break; tall objects may fall.	3.5
VI	Felt by all, falling plaster and chimneys, light damage but some fear.	4.0
VII	Very noticeable, damage to weaker buildings on fill; driving automobiles notice.	4.5
VIII	Walls, monuments, chimneys, bookcases fall; liquifaction; driving is difficult	5.0
IX	Buildings shifted off foundations, cracked and twisted; ground is cracked and underground pipes are broken.	5.5
X	Most structures severely damaged to destroyed; ground is cracked, rails are bent, landslides on steep slopes	6.0
XI	Few structures standing; bridges and roads severely damaged or destroyed, large fissures in ground	6.5
XII	Total damage: can see the earthquake wave move through the ground; gravity overcome and objects thrown into the air	7.0

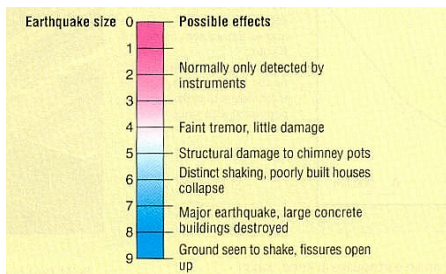
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## Richter Scale

Magnitude- single number based on the earthquake size

Many scale are based on an early model developed by Charles Richter in the 1930's



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They rate each earthquake based on the earthquake waves recorded by the seismograph

It take into account that seismic waves get smaller the farther the seismograph is away from the earthquake

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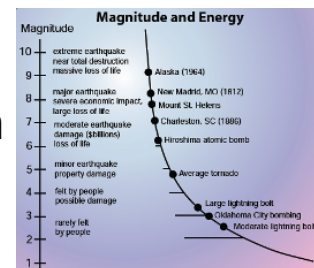
## Moment Magnitude Scale

Rates the total energy released

News reports the Richter scale but it really is the Moment Magnitude Scale

Geologists use data from seismographs and other sources

Allows geologists to estimate how much energy was released



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## Comparing Magnitudes

Moment Magnitude Scale tells how much energy was released

each 1 point increase represents roughly 32x more energy

example- 6 = 32x more energy than a 5

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Earthquake effects increase with magnitude

below 5 = small/cause little damage

above 6 = greater damage

8-9 = rare, but powerful

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## How is an epicenter located

### Geologists use seismic waves to locate an earthquake's epicenter

When an earthquake occurs, geologists try to locate the epicenter

This helps geologists identify areas where earthquakes may occur in the future

Geologists use information from thousands of seismographs set up all over the world

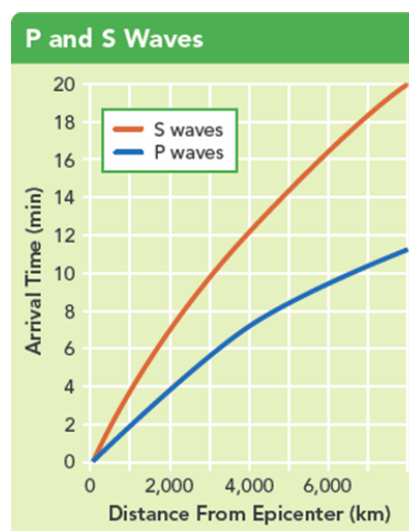
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## Seismic waves travel at different speeds

P-waves arrive at the seismograph first, followed by the S-wave

Looking at the P and S wave graph, if you know when the P-wave arrives and when the S-wave, you can find the distance from the seismograph to the epicenter

The farther away from the epicenter, the bigger the gap between the P-wave and S-wave



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If you know the distance of 3 seismograph stations, you can draw 3 circles to locate the epicenter

The center of each circle is a seismograph station

The radius is the distance to the epicenter

The point where all 3 circles meet is the epicenter



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## Lesson 2 Earthquakes and Seismic Waves

Seismic waves carry energy produced by an earthquake







The amount of earthquake energy that is felt is rated using the Richter Scale. An earthquake's magnitude or size is measured using the moment magnitude scale or the

triangulation method use seismograph stations to locate an earthquake's epicenter

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## Attachments

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-  <http://earthquake.usgs.gov/earthquakes/map/>
-  <http://www.iknowthat.com/mhscience/Earthquakes/Fixed.htm>
-  <http://www-rohan.sdsu.edu/~rmellors/lab8/l8maineq.htm#pwave>
-  seismic waves
-  focus and epicenter
-  alaska quake