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Warm-Up | Earthquakes

Lesson Question

What causes earthquakes?

Lesson Goals

- **Describe** the causes of an earthquake.
- **Explain** how the energy of an earthquake travels.
- **Describe** methods used to measure earthquakes.
- **Explain** how geologists locate the epicenter of an earthquake.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

earthquake	the shaking that results from movement under Earth's surface
epicenter	the place on Earth's surface directly over the focus of an earthquake
focus	the place deep inside Earth where a shift in Earth's crust occurs, causing an earthquake
magnitude	a number that characterizes the relative energy of an earthquake

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Words to Know

seismic wave	a wave produced by an earthquake
seismograph	an instrument that measures and records details of earthquakes
wave	a movement that transfers energy through a substance

Stress and Faults

The movement of Earth's plates causes stress in the crust.

- The three types of stress are:
  - tension.
  - compression.
  - shearing.

Stress adds energy to the crust, which then bends and breaks, forming faults.

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Causes of Earthquakes

An **earthquake** is the [shaking] that results from movement under Earth's surface. Earthquakes are caused by forces of [plate] movement.

Plate movement	causes stress.
[Stress]	increases along faults.
Excess stress	leads to [rocks] breaking, and an earthquake begins.

Even though we feel the effects of an earthquake on Earth's surface, the earthquake actually begins about [100] km [below] Earth's surface.

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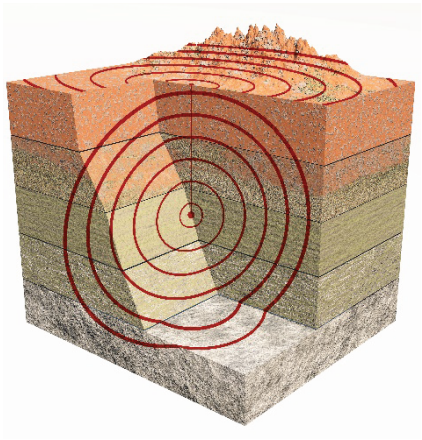
Focus and Epicenter

Earthquakes begin in the [lithosphere], usually about 100 km below the surface.



- Earthquakes have [two] centers.
  - The **focus** is the area beneath the surface where rocks break under stress. It is the [starting] point of an earthquake.
  - The **epicenter** is the point on the surface directly [above] the focus.

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Energy Released by Earthquakes

Earthquakes produce vibrations called [waves].

- Waves carry [energy] as they travel.
- The waves produced by an earthquake are called [seismic waves].

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Categories of Seismic Waves

Seismic waves are classified into [three] categories.

P Waves (Primary)

- Arrive first, travel [fastest]
- Compress and expand the ground like an accordion
- Travel through solids and [liquids]

S Waves (Secondary)

- Arrive after P waves
- [Vibrate] from side to side and up and down
- Shake [structures] violently
- Travel only through [solids]

Surface Waves

- Travel only on the [surface]
- Were P and S waves
- Move slowly
- Can produce dramatic [ground] movement

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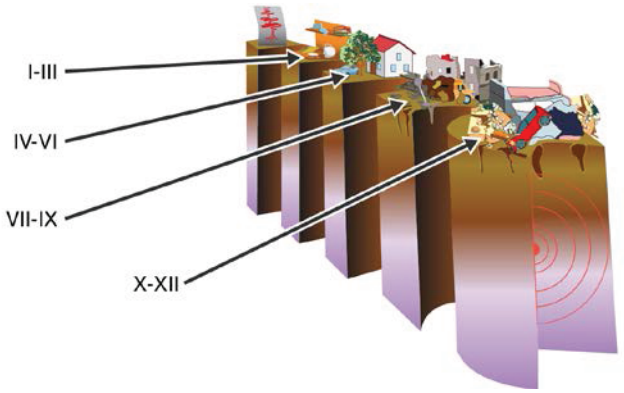
The Mercalli Scale

The Mercalli scale rates an earthquake according to how much [damage] it causes.

The scale uses [Roman] numerals one through [twelve], I–XII, to rank the damage caused by an earthquake.



The Richter Scale

The Richter scale measures **magnitude** based on the size of [seismic] waves.

- Magnitude is determined by measuring seismic waves and [fault] movement.
- Seismic waves are measured by a [seismograph].
- This scale is good for measuring small, nearby [earthquakes].

Magnitude	Damage
0–1.9	Detected by seismograph
2–2.9	Hanging objects may swing
3–3.9	Comparable to passing truck
4–4.9	May break windows
5–5.9	Furniture moves
6–6.9	Well-built structures damaged
7–7.9	Visible cracks on the surface
8–8.9	Structures destroyed
9 and over	Total destruction

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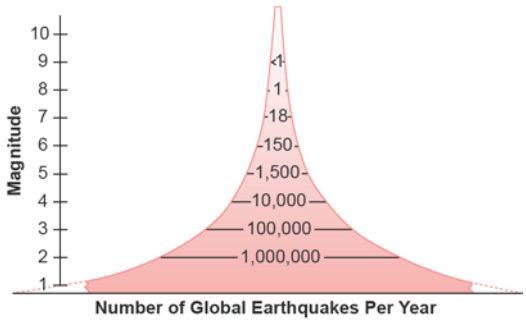
The Moment Magnitude Scale

Moment magnitude was introduced in [1979] by Thomas C. Hanks and Hiroo Kanamori, who wanted a more [accurate] method to measure earthquakes than the [Richter] scale

The moment magnitude scale estimates the total [energy] released by an earthquake.



- Useful for earthquakes of all [sizes] and all [distances]
- [Data] collected with seismographs
  - Shows what kind of seismic waves were produced and their [strength]

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Sumatra Earthquake of 2004

The Sumatra earthquake of 2004 is the [third] strongest earthquake ever recorded.

- Measured 9.1–9.3 on moment [magnitude] scale
- Measured at the maximum [intensity] on the Mercalli scale
- Lasted approximately 9 minutes, the longest duration ever measured
- Triggered a massive [tsunami] and killed approximately 250,000 people

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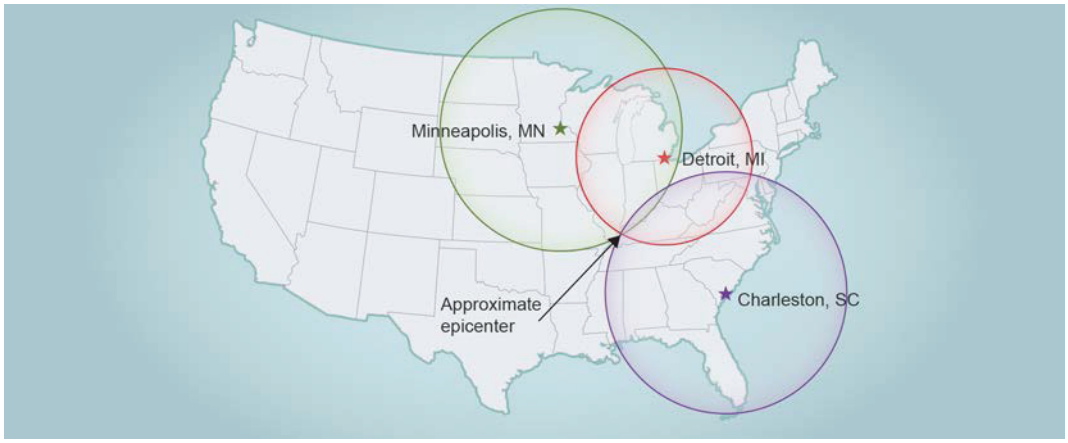
Locating an Earthquake's Epicenter

Geologists use [seismic] waves to locate an earthquake's epicenter.

- Use a [seismograph] to measure difference between arrival of P and S waves
- Compare [data] to seismographs from around the world



- Geologists draw a [circle] measuring the distance with a seismograph located in the [middle]—for example, the circle around Charleston, South Carolina.
- The point where the circles [intersect] is the location of the epicenter of the earthquake.
- The focus of the earthquake would be approximately [100] km below the epicenter in the [lithosphere].

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Lesson Question

What causes earthquakes?

Answer

(Sample answer) Excess stress in the tectonic plates causes the plates to break, which makes the plates release and move past each other with an abrupt movement. Then an earthquake begins.

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Review: Key Concepts

Earthquakes are caused by stress along faults due to [plate] movement.

Traveling of Energy

- Seismic waves travel in all [directions]
- Three types of waves:
  - P waves (primary)
  - S waves (secondary)
  - Surface waves

Measuring Earthquake Energy

- Mercalli scale
- Richter scale
- [Moment] magnitude scale

Locating the [Epicenter]

- Distance of epicenter measured from at least three seismographs
- Location of epicenter is where three measurements overlap

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Use this space to write any questions or thoughts about this lesson.

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