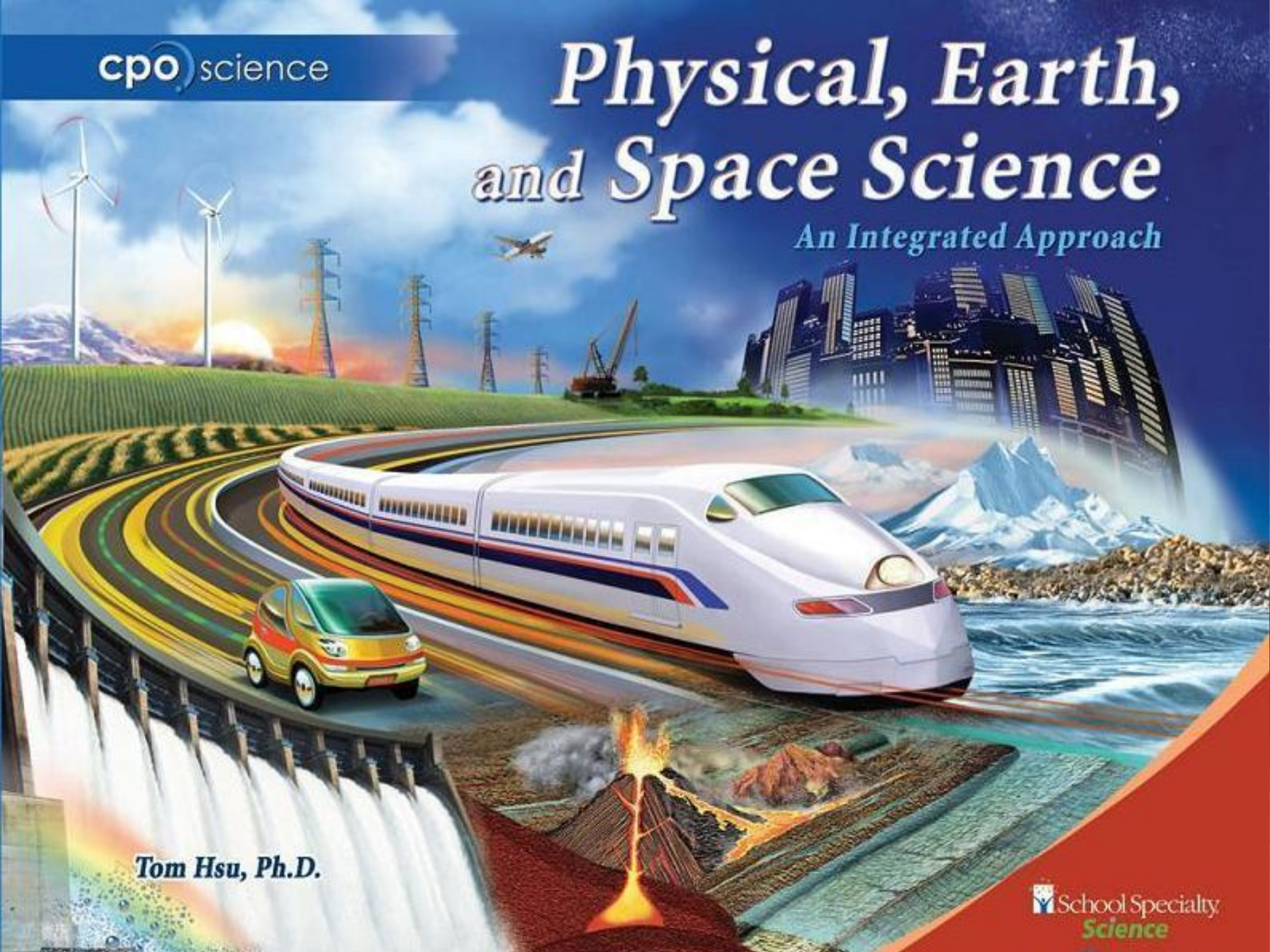
cpo science

Physical, Earth, and Space Science

An Integrated Approach

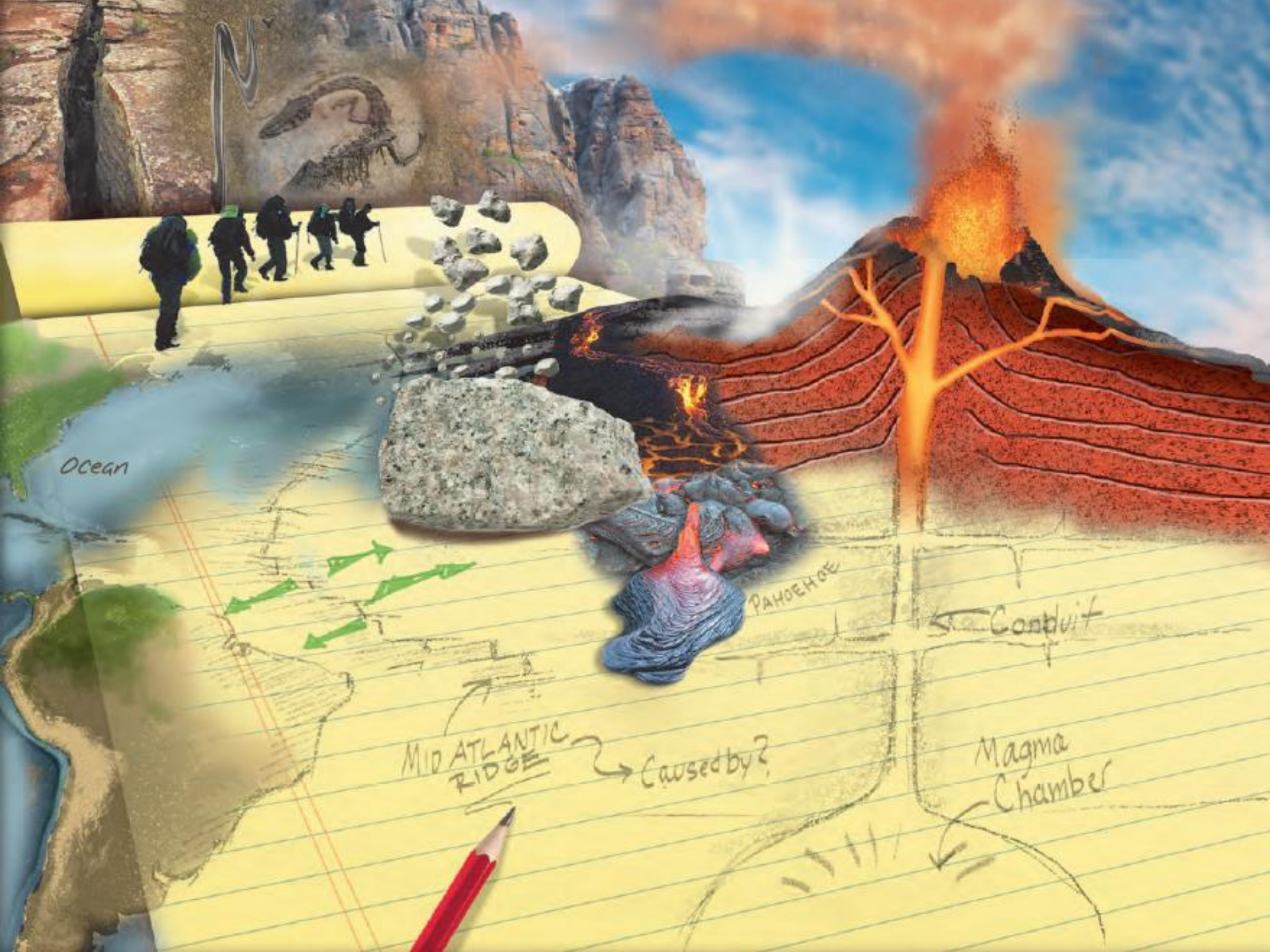


Tom Hsu, Ph.D.

School Specialty Science

UNIT SIX: Earth's Structure

- Chapter 18 Earth's History and Rocks
- Chapter 19 Changing Earth
- Chapter 20 Earthquakes and Volcanoes


Ocean
PAHOEHOE
Conduit
MID ATLANTIC RIDGE
Caused by?
Magma Chamber

Chapter Twenty: Earthquakes and Volcanoes

- 20.1 Earthquakes
- 20.2 Volcanoes
- 20.3 Igneous Rocks

20.1 Learning Goals

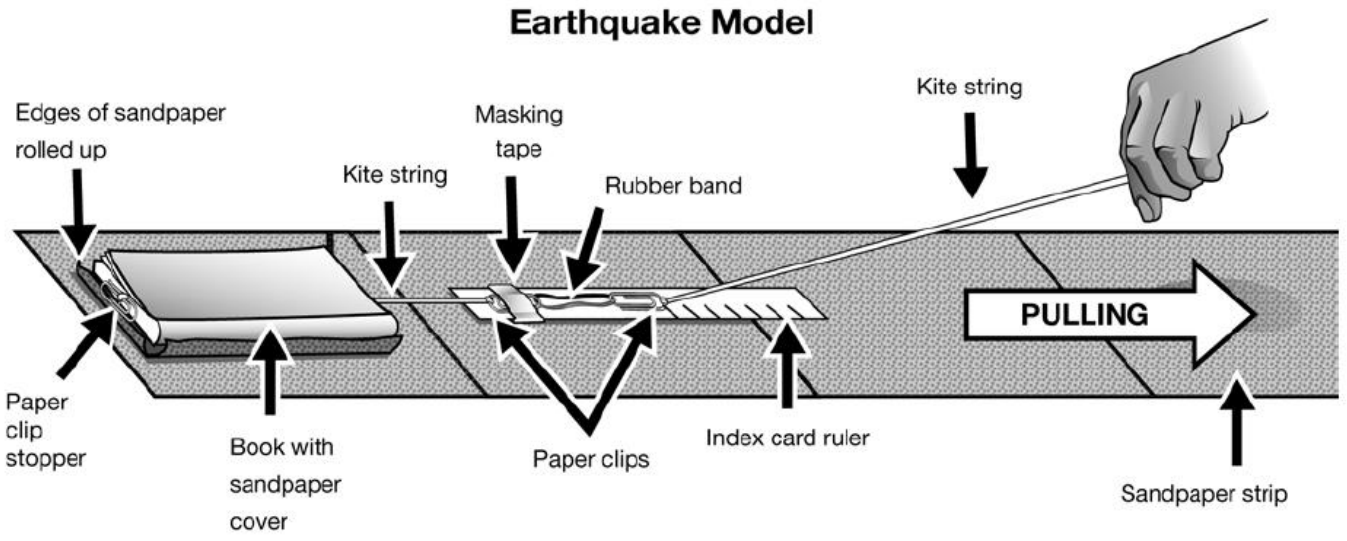
- Describe the plate interactions that causes earthquakes.
- Discuss the types of information scientists learn from seismograms.
- Compare and contrast the scales used to measure and describe earthquakes.

Investigation 20A

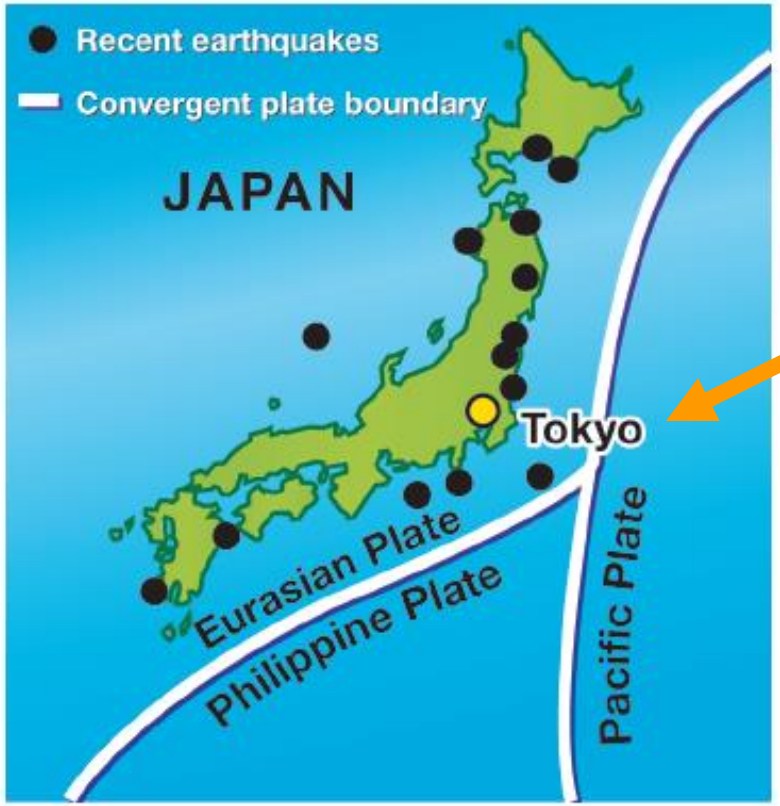
Earthquakes

- ***Key Question:***

  What conditions affect the timing, duration, and intensity of an earthquake?



20.1 Earthquakes and plate boundaries

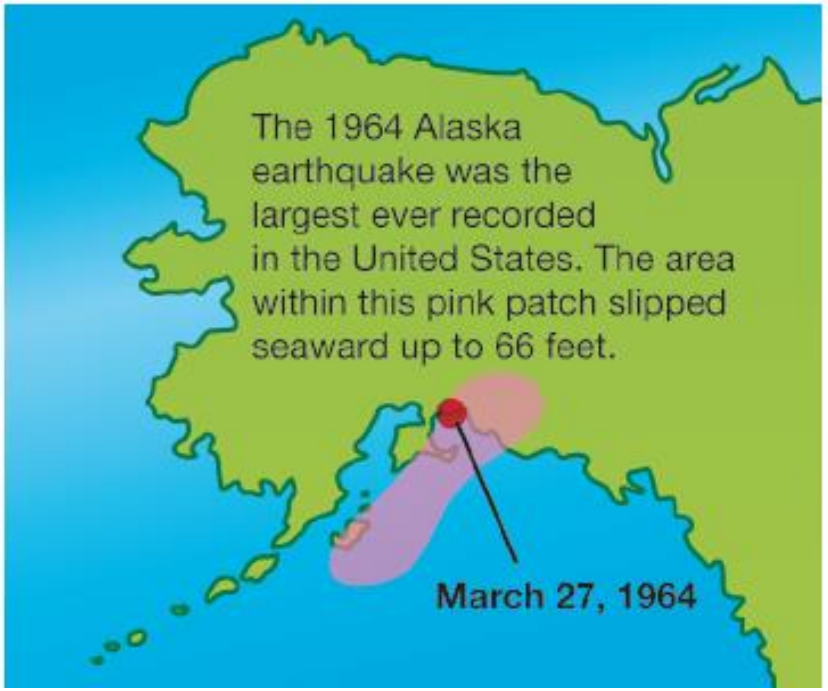


- * Earthquakes commonly occur at the boundaries of lithospheric plates.
- This is because plate boundaries tend to be *zones* of seismic activity.

Earthquakes and Plate Boundaries

20.1 Earthquakes

- **The second longest ever recorded earthquake occurred in 1964 in Alaska and lasted for four minutes.**
- **During an earthquake, strong shaking makes the ground move up and down and back and forth.**



20.1 When an earthquake occurs

- * An *earthquake* is the movement of Earth's crust resulting from the release of built-up potential energy between two stuck lithospheric plates.

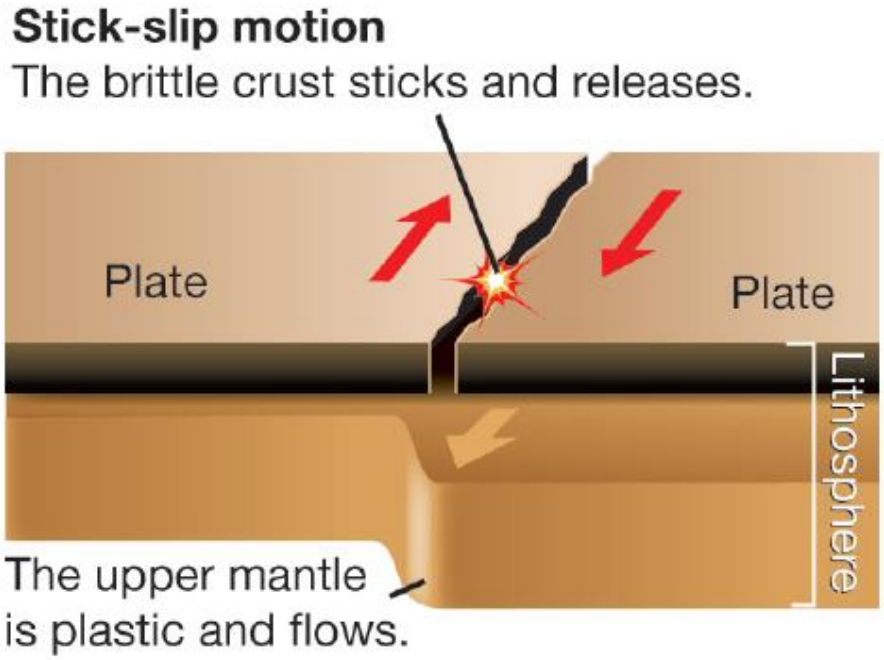
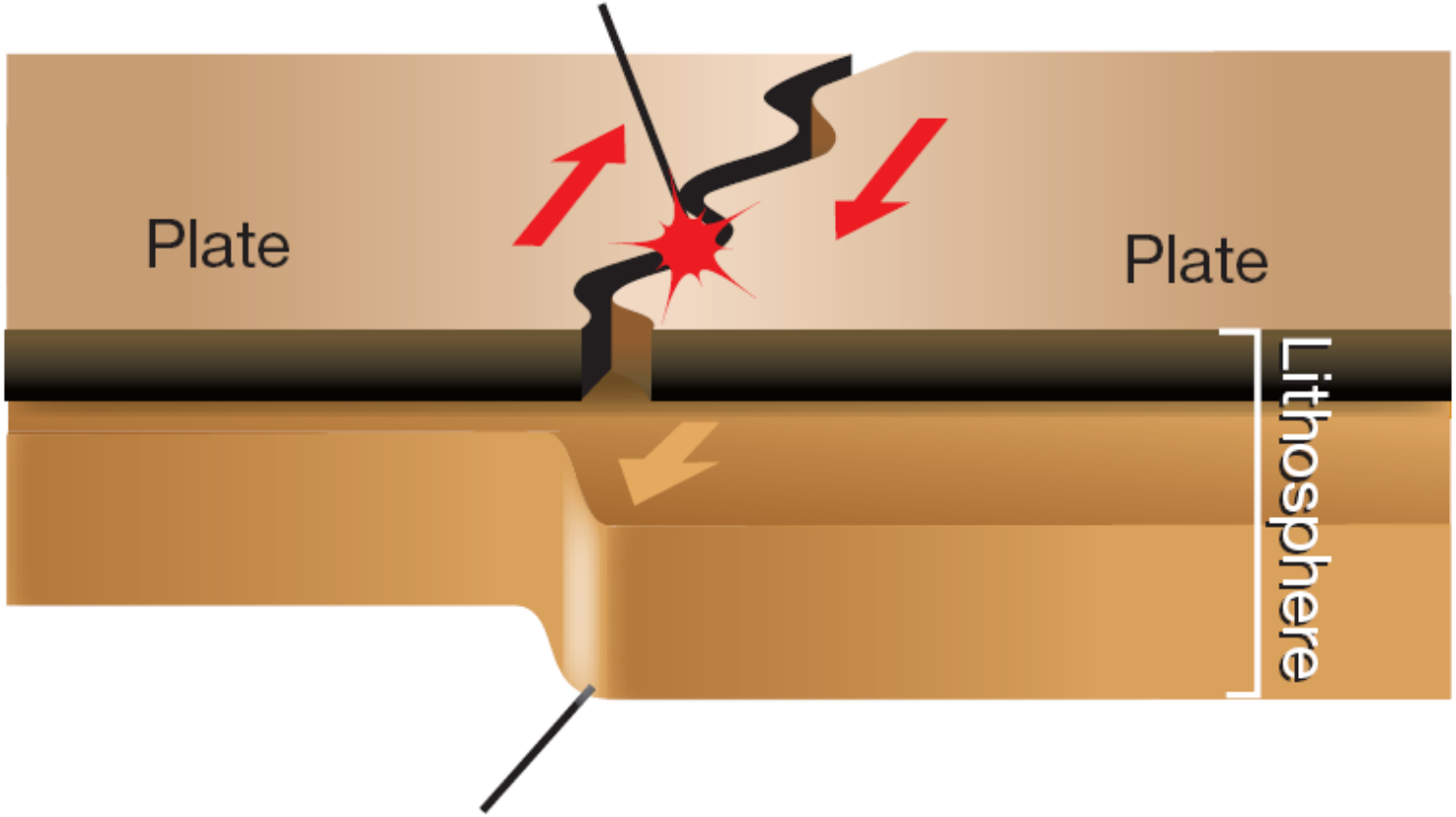


Plate Stick-Slip Motion

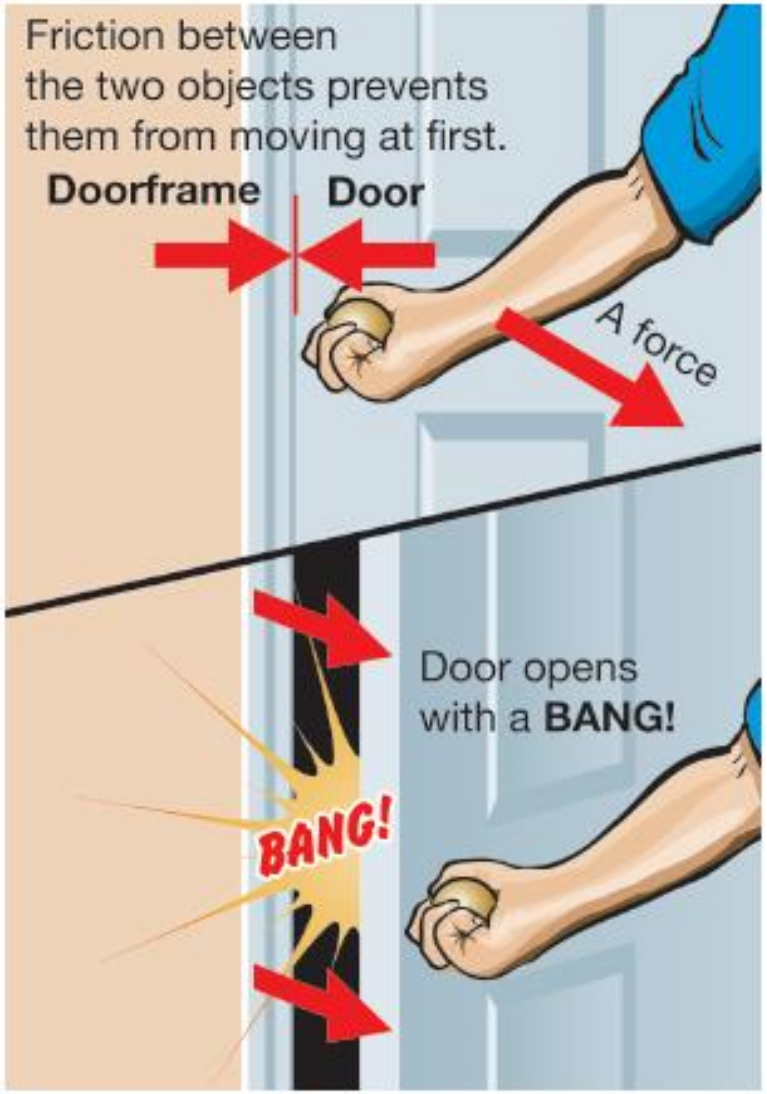
Stick-slip motion

The brittle crust sticks and releases.



20.1 Stick-slip motion

- ***An earthquake is a form of *stick-slip* motion.**
- ***Stick-slip motion can be compared to a stuck door.**



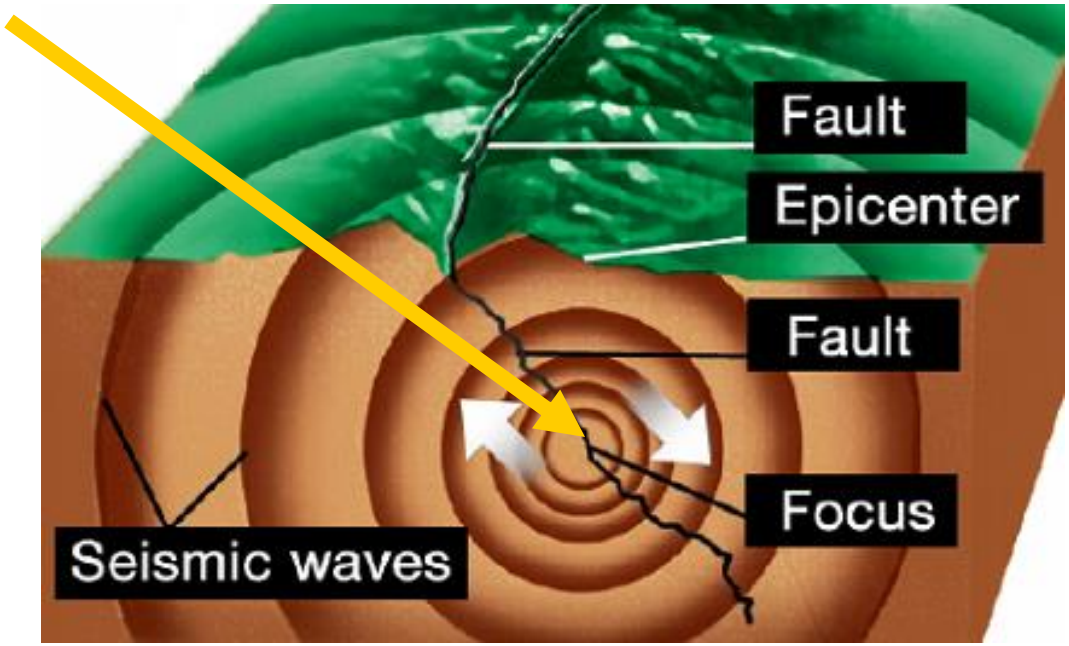
20.1 Stick-slip motion

- * Three conditions are needed for stick-slip motion:
  1. Two objects that are touching each other where at least one of the objects can move.
  2. A force, or forces, that will cause the movement.
  3. Friction strong enough to temporarily keep the movement from starting.

Use the stick-slip door model to identify these conditions.

20.1 When an earthquake occurs

- ***The point below the surface where the rock breaks is called the earthquake *focus*.**

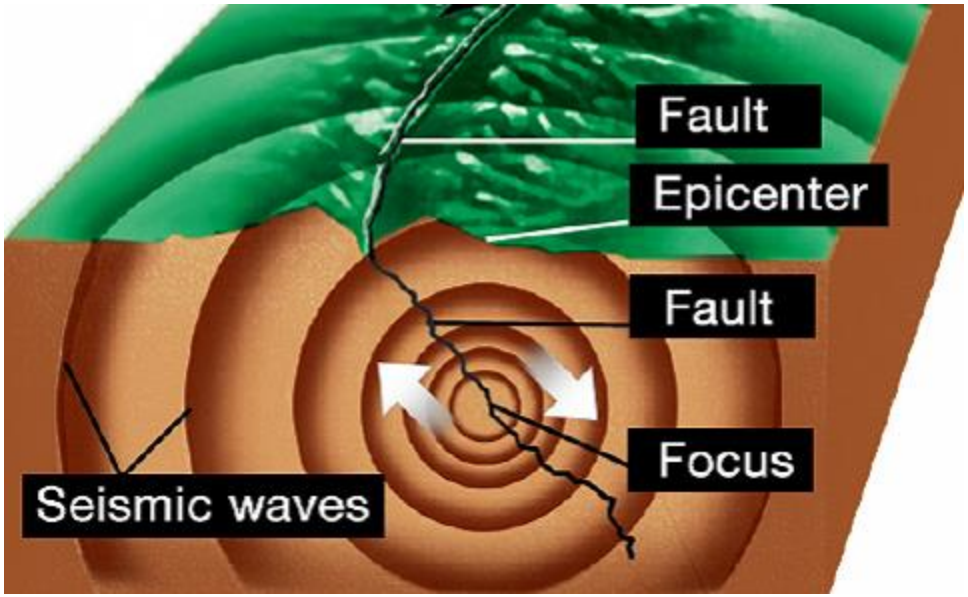


20.1 When an earthquake occurs

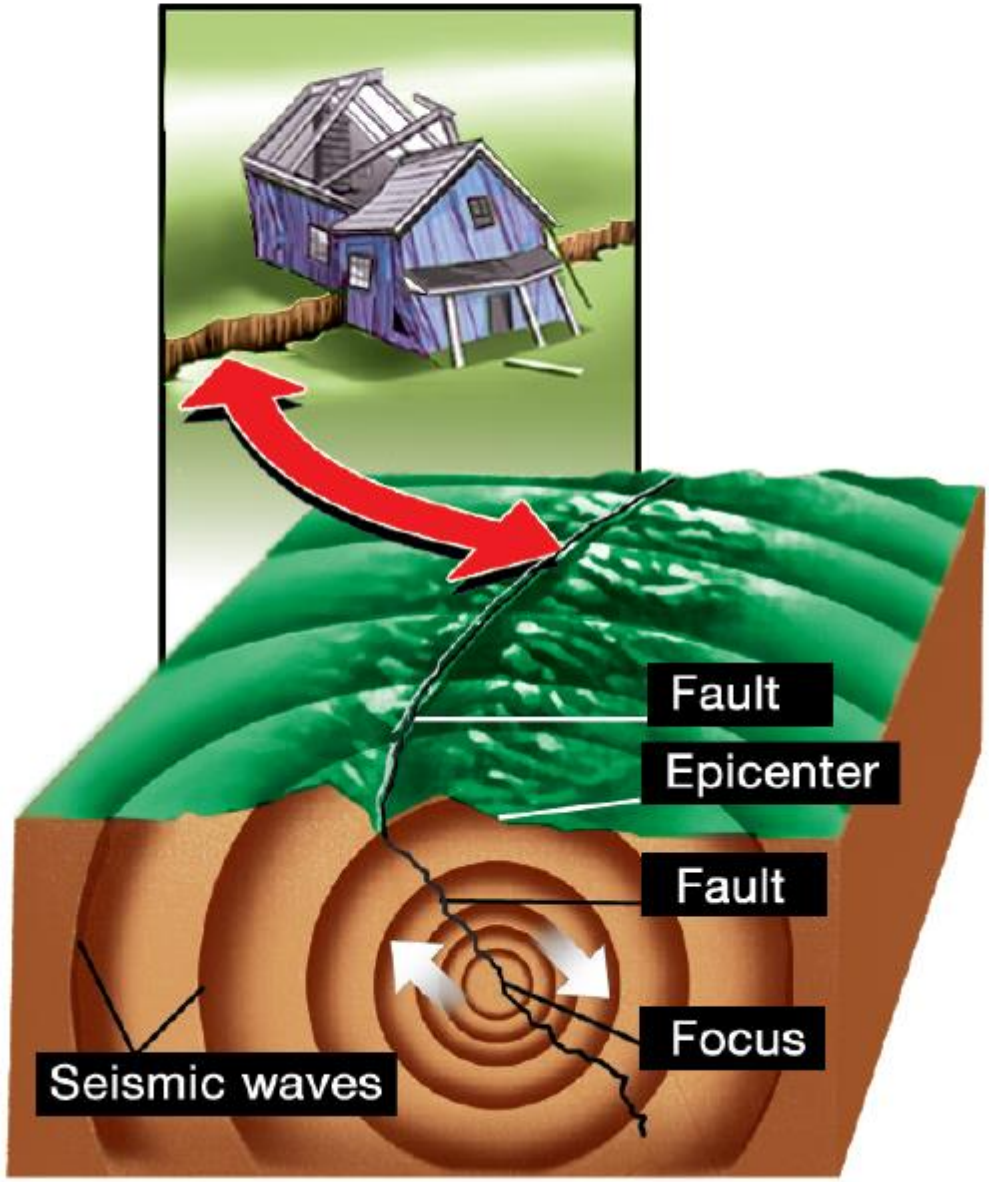
- * As soon as the rock breaks, there is movement along the broken surface causing a split in the surface called a *fault*.

20.1 What causes earthquakes?

- *** The seismic waves from an earthquake are usually strongest at the *epicenter*, the point on the surface right above the focus.**



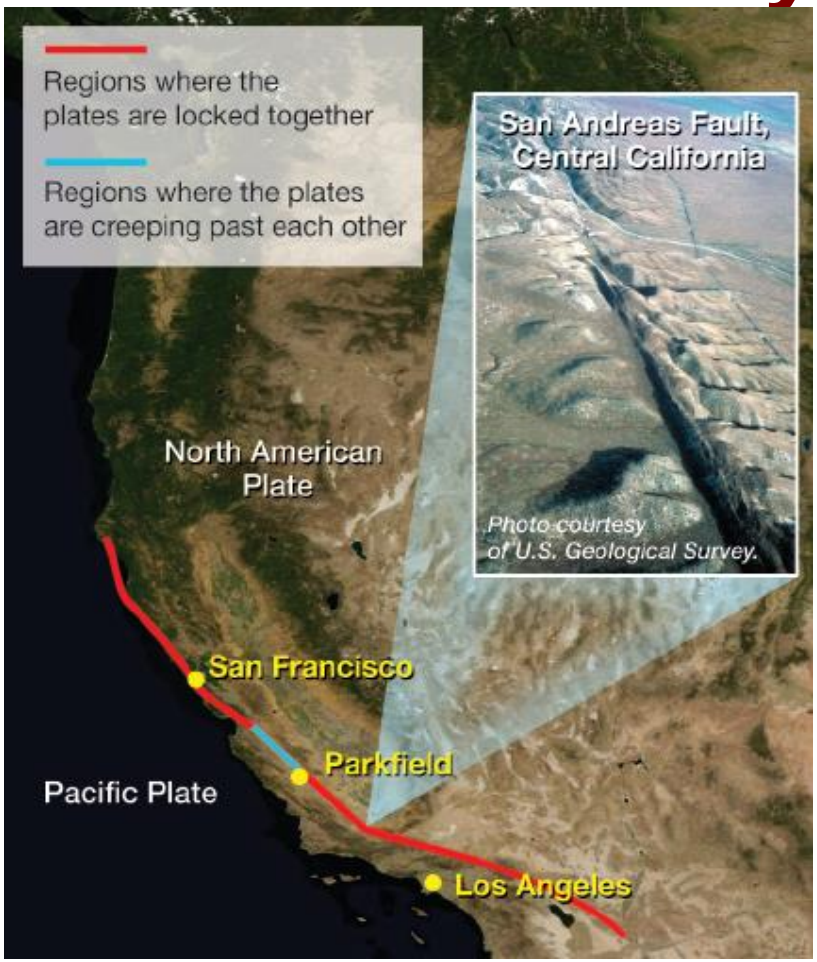
Parts of an Earthquake



20.1 Lithospheric plates have many sections

- A moving line of grocery carts is a good analogy of a moving lithospheric plate.
- Although a plate may be moving as a single unit, its boundaries act like they were made of many small sections like the line of carts.

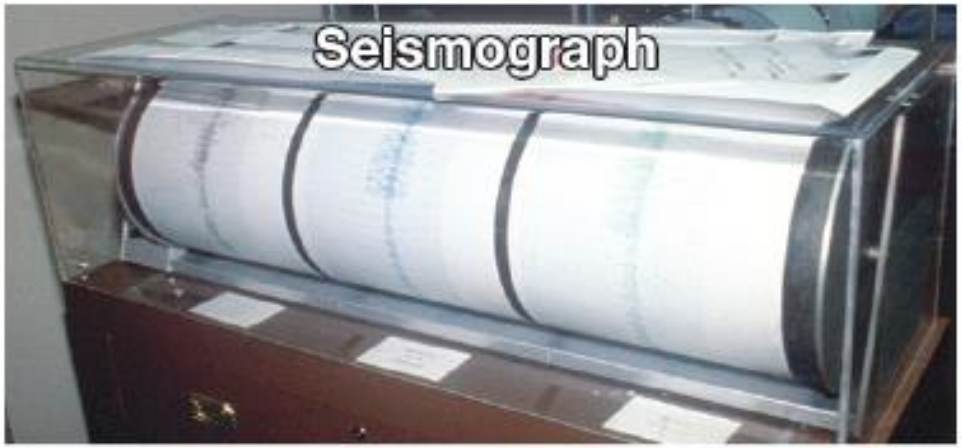
20.1 Lithospheric plates have many sections



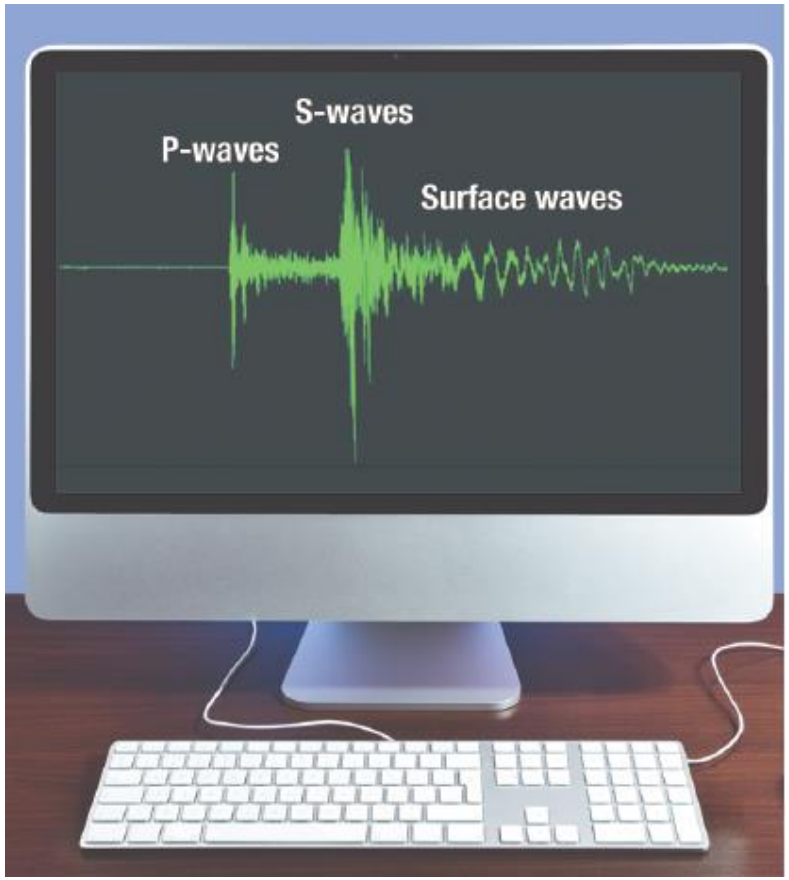
- A lithospheric plate may be thousands of km across.
- It takes a long time for movement on one end of the plate to affect a section further away.

20.1 Seismic waves

- ***Seismic waves are recorded and measured by an instrument called a *seismograph*.**
- ***Seismic waves inside Earth are called *body waves*.**
- ***The two main types of body waves are *P-waves* and *S-waves*.**

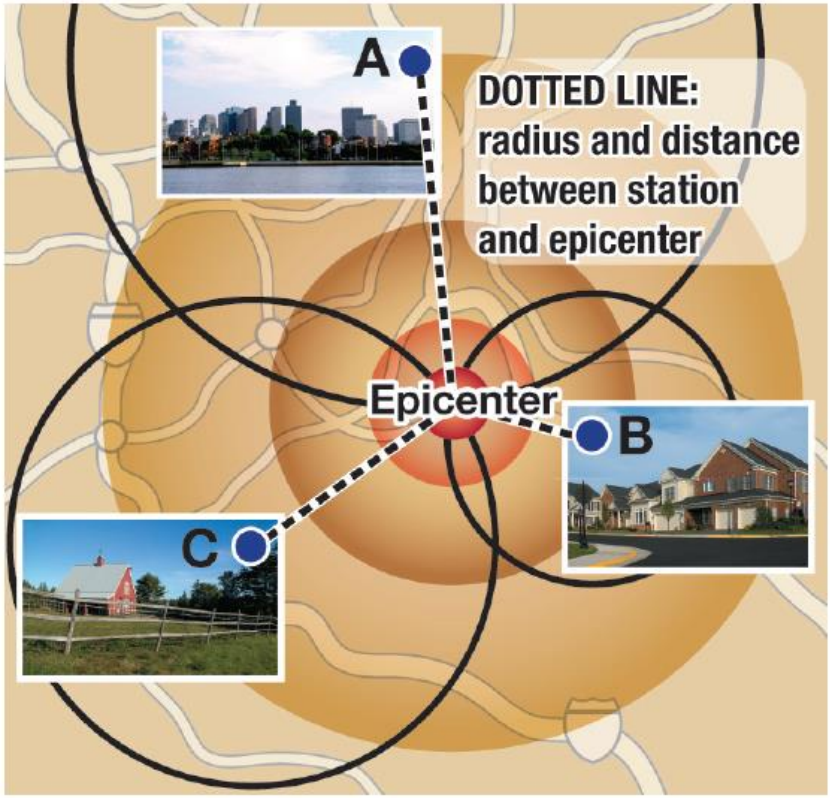


20.1 Seismic waves



- *After an earthquake occurs, the first seismic waves recorded will be P-waves.
- *S-waves are recorded next, followed by the surface waves.

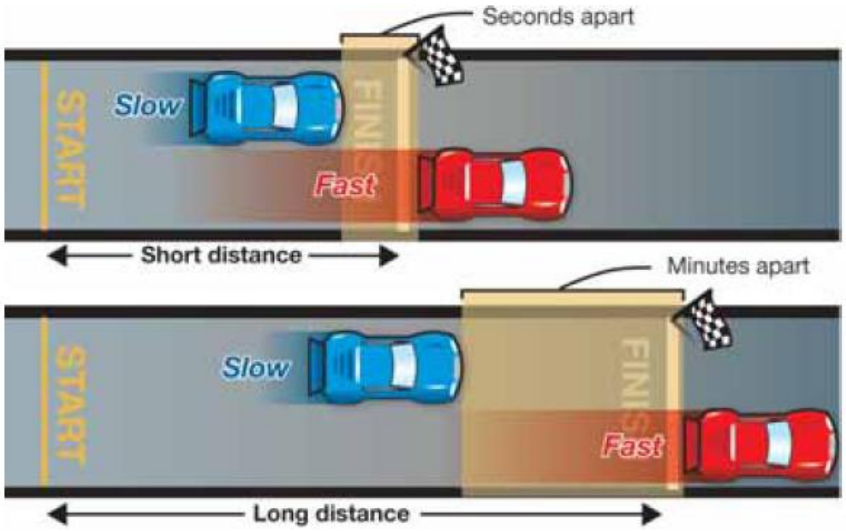
20.1 Seismic waves



- *Seismic waves radiate from the focus after the earthquake.
- *<u>Three</u> seismic stations can accurately determine the times of body wave arrival.
- The larger the difference in arrival time, the farther the epicenter is from the station

20.1 Seismic waves

- In a quarter-mile race, the track is so short that fast and slow cars are often just fractions of a second apart.
- In a long race, like the Indianapolis 500, the cars might be minutes apart.



- The time difference between slow and fast cars is related to the length of the race track.

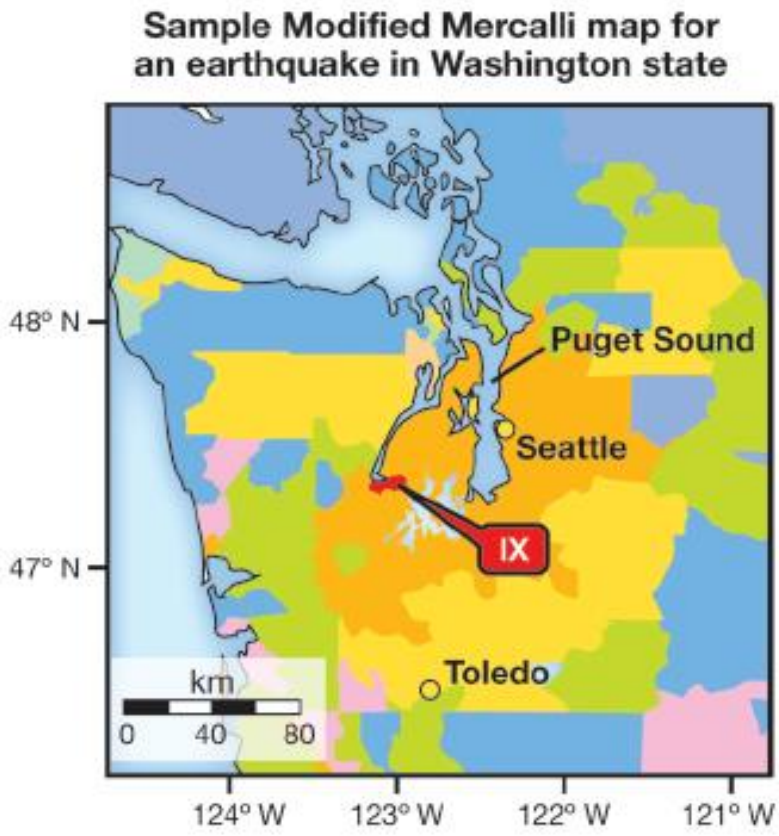
The Richter Scale		
Level	**Magnitude**	**Effects*** (*These descriptions are not part of the scale.)
Micro	Less than 2.0	Barely felt but recorded by seismographs
Very minor	2.0–2.9	Recorded but not felt by most people
Minor	3.0–3.9	Little damage but felt by people
Light	4.0–4.9	No serious damage; objects shake
Moderate	5.0–5.9	Major damage to poorly designed buildings
Strong	6.0–6.9	Serious damage over a 100-km area or less
Major	7.0–7.9	Serious damage over a larger area
Great	8.0–8.9	Serious damage over several hundred kilometers
Rare great	9.0 or greater	Serious damage over several thousand kilometers

20.1 Measuring earthquakes

- * The *Moment Magnitude scale* rates the total energy released by an earthquake.
- * The numbers on this scale combine energy ratings and descriptions of rock movements.
- * Seismologists tend to use the more descriptive Moment Magnitude scale to distinguish between strong earthquakes.

20.1 Measuring earthquakes

- ***The *Modified Mercalli scale* has 12 descriptive categories.**
- ***Each category is a rating of the damage experienced by buildings, the ground, and people.**



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
Shaking	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
Damage	None	None	None	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

The Modified Mercalli Scale		
Category	**Effects**	**Richter scale (approximate)**
I. Instrumental	Not felt	1–2
II. Just perceptible	Felt by only a few people, especially on upper floors of tall buildings	3
III. Slight	Felt by people lying down, seated on a hard surface, or in the upper stories of tall buildings	3.5
IV. Perceptible	Felt indoors by many, by few outside; dishes and windows rattle	4
V. Rather strong	Generally felt by everyone; sleeping people might be awakened	4.5
VI. Strong	Trees sway, chandeliers swing, bells ring, some damage from falling objects	5
VII. Very strong	General alarm; walls and plaster crack	5.5
VIII. Destructive	Felt in moving vehicles; chimneys collapse; poorly constructed buildings seriously damaged	6
IX. Ruinous	Some houses collapse; pipes break	6.5
X. Disastrous	Obvious ground cracks; railroad tracks bent; some landslides on steep hillsides	7
XI. Very disastrous	Few buildings survive; bridges damaged or destroyed; all services interrupted (electrical, water, sewage, railroad); severe landslides	7.5
XII. Catastrophic	Total destruction; objects thrown into the air; river courses and topography altered	8

Modified Mercalli Scale vs. Richter Scale

Modified Mercalli Scale

Category	Effects	Richter Scale (approximate)
I. Instrumental	Not felt	1-2
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