Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Guided Notes: Earthquakes and the Earth’s Interior

**Earthquakes**

**◆** An **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is the vibration of Earth produced by the rapid release of energy

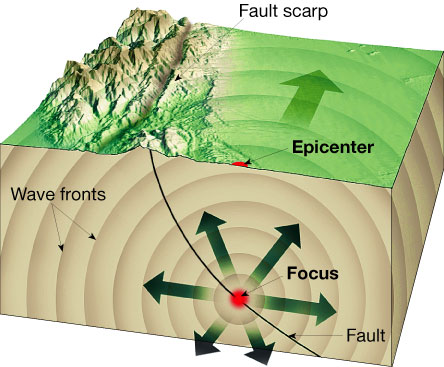
**◆** Focus and Epicenter

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is the point within Earth where the earthquake starts.

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is the location on the surface directly above the focus.

**◆** Faults

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** are fractures in Earth where movement has occurred.



**Cause of Earthquakes**

**◆ Elastic Rebound Hypothesis**

• Most earthquakes are produced by the rapid release of elastic **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** stored in rock that has been subjected to great forces.

• When the strength of the rock is exceeded, it suddenly breaks, causing the vibrations of an earthquake.

◆ Aftershocks and Foreshocks

• An **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is a small earthquake that follows the main earthquake.

• A **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is a small earthquake that often precedes a major earthquake.

**Earthquake Waves**

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** are instruments that record earthquake waves.

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** aretraces of amplified, electronically recorded ground motion made by seismographs.

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** are seismic waves that travel along Earth’s outer layer.

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Identified as P waves or S waves

• **P waves**

- Are push-pull waves that push (compress) and pull (expand) in the direction that the waves travel

- Travel through solids, liquids, and gases

- Have the greatest velocity of all earthquake waves

• **S waves**

* Seismic waves that travel along Earth’s outer layer

- Shake particles at right angles to the direction that they travel

- Travel only through solids

- Slower velocity than P waves

**◆** A seismogram shows all three types of seismic waves—surface waves, P waves, and S waves.

**Locating an Earthquake**

**◆** Earthquake Distance

• The **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is located using the difference   
 in the arrival times between P and S wave

recordings, which are related to distance.

**◆** Earthquake Direction

• Travel-time graphs from three or more seismographs can be used to find the exact location of an earthquake epicenter.

**◆** Earthquake Zones

• About **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** percent of the major earthquakes occur in a few narrow zones.

**Measuring Earthquakes**

**◆** Historically, scientists have used two different types of measurements to describe the size of an earthquake  
—**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** and **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** .

**◆** Richter Scale

• Based on the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** of the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** seismic   
 wave

• Each unit of Richter magnitude equates to roughly a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** energy increase

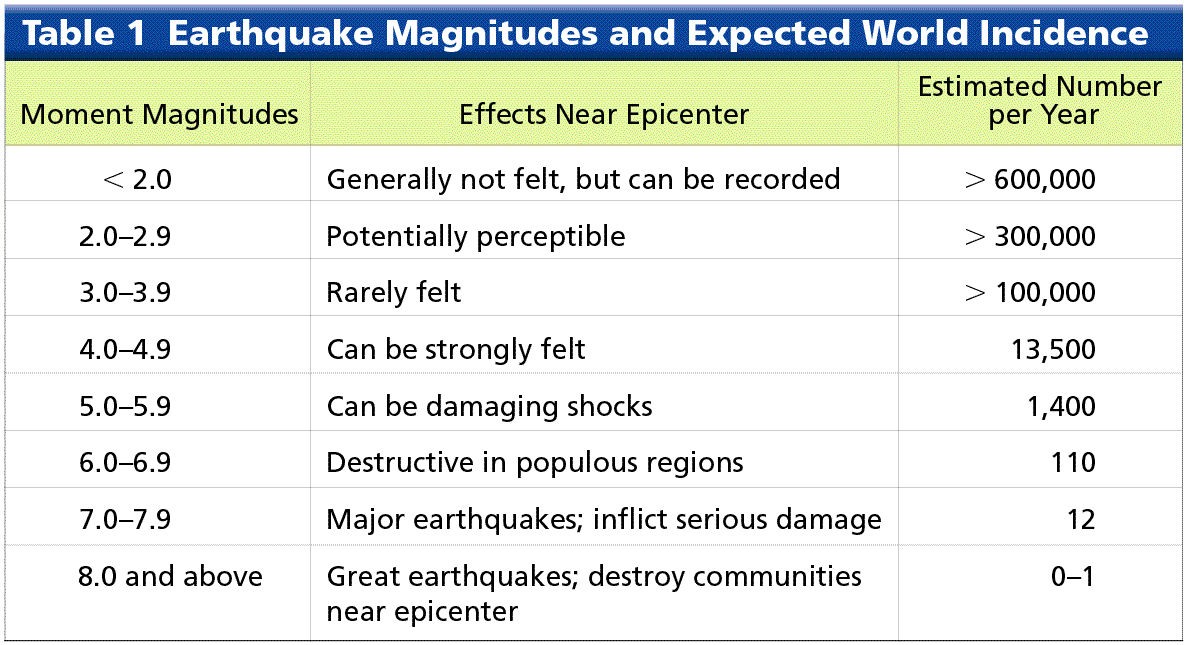
• Does not estimate adequately the size of very large earthquakes

**◆ Momentum Magnitude**

• Derived from the amount of **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** that occurs along the fault zone

• Moment magnitude is the most widely used measurement for earthquakes because it is the only magnitude scale that estimates the energy released by earthquakes.

• Measures very large earthquakes



**Seismic Vibrations**

**◆** The damage to buildings and other structures from earthquake waves depends on several factors. These factors include the intensity and duration of the vibrations, the nature of the material on which the structure is built, and the design of the structure.

**◆** Building Design

• Factors that **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** structural damage

- Intensity of the earthquake

- Unreinforced stone or brick buildings are the most **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** safety threats

- Nature of the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** upon which the structure rests

- The **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** of the structure

**◆ Liquefaction**

• Saturated material turns **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Underground objects may float to surface

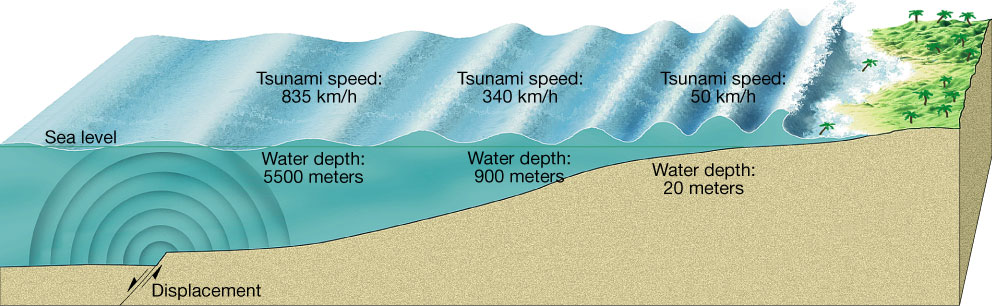
**Tsunamis**

**◆** Cause of Tsunamis

• A **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** triggered by an earthquake occurs where a slab of the ocean floor is displaced vertically along a fault.

• A tsunami also can occur when the vibration of a quake sets an underwater landslide into motion.

• *Tsunami* is the Japanese word for “seismic sea wave.”



**◆** Tsunami Warning System

• Large earthquakes are reported to Hawaii from Pacific seismic stations.

• Although tsunamis travel quickly, there is sufficient time to **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** all but the area closest to the epicenter.

**Other Dangers**

**◆** Landslides

• With many earthquakes, the greatest damage   
to structures is from **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** and ground subsidence, or the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** of the ground triggered by vibrations.

**◆** Fire

• In the San Francisco earthquake of 1906, most   
of the destruction was caused by **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** that started when gas and electrical lines were cut.

**Predicting Earthquakes**

**◆** Short-Range Predictions

• So far, methods for short-range predictions of earthquakes have **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** successful.

**◆** Long-Range Forecasts

• Scientists don’t yet understand enough about how and where earthquakes will occur to make **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** long-term predictions.

• A **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is an area along a fault where there has not been any earthquake activity for a long period of time.

**Layers Defined by Composition**

**◆** Earth’s interior consists of three major zones defined by their chemical composition—the **crust, mantle,** and **core.**

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** , rocky outer layer

• Varies in thickness

- Continental crust averages 8–40 km

- Roughly 7 km in oceanic regions

- Exceeds 70 km in mountainous regions

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** crust

- Upper crust composed of granitic rocks

- Lower crust is more akin to basalt

- Average density is about 2.7 g/cm3

- Up to 4 billion years old

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** crust

- Basaltic composition

- Density about 3.0 g/cm3

- **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** (180 million years or less) than the continental crust

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Below **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** to a depth of 2900 kilometers

• Composition of the uppermost mantle is the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** rock peridotite (changes at greater depths).

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Below **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Sphere with a radius of 3486 kilometers

• Composed of an **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** alloy

• Average density of nearly 11 g/cm3

**Layers Defined by Physical Properties**

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Crust and uppermost mantle (about 100 km thick)

• Cool, rigid, solid

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Beneath the lithosphere

• Upper **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• To a depth of about 660 kilometers

• Soft, weak layer that is easily deformed

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• 660–2900 km

• More rigid layer

• Rocks are very hot and capable of gradual flow.

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Sphere with a radius of 1216 km

• Behaves like a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** layer

• 2270 km thick

• Convective flow of metallic iron within generates Earth’s magnetic field

**Discovering Earth’s Layers**

**◆ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

• Velocity of seismic waves increases abruptly below 50 km of depth

• Separates **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** from underlying **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**◆** Shadow Zone

• Absence of P waves from about 105 degrees to 140 degrees around the globe from an earthquake

• Can be explained if Earth contains a core composed of materials unlike the overlying mantle

**◆** Crust

• Early seismic data and drilling technology indicate that the continental crust is mostly made of lighter, granitic rocks.

**◆** Mantle

• Some of the lava that reaches Earth’s surface comes from asthenosphere within.

• Composition is more speculative.

**◆** Core

• Earth’s core is thought to be mainly dense iron and nickel, similar to metallic meteorites. The surrounding mantle is believed to be composed of rocks similar to stony meteorites.