



SECTION 19.3 Measuring and Locating Earthquakes

Measuring and Locating Earthquakes

- More than one million earthquakes occur each year.
- More than 90 percent of earthquakes are not felt and cause little, if any, damage.

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Earthquake Magnitude and Intensity

- **Magnitude** - measurement of the amount of energy released during an earthquake.
- The **Richter scale** - a numerical scale based on the size of the largest seismic waves generated by a quake that is used to describe its magnitude.

- Each successive number in the scale represents an increase in seismic-wave size, or amplitude, of a factor of 10.
- Each increase in magnitude corresponds to about a 32-fold increase in seismic energy.

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Moment Magnitude Scale

- The **moment magnitude scale** - takes into account the size of the fault rupture, the amount of movement along the fault, and the rocks' stiffness.
- Moment magnitude values are estimated from the size of several types of seismic waves produced by an earthquake.

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Earthquake Magnitude and Intensity

Modified Mercalli Scale

- The **modified Mercalli scale**, which measures the amount of damage done to the structures involved, is used to determine the intensity of an earthquake.
- This scale uses the Roman numerals I to XII to designate the degree of intensity.
- Specific effects or damage correspond to specific numerals; the higher the numeral, the worse the damage.

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Table 19-1 Modified Mercalli Intensity Scale

I.	Not felt except under unusual conditions.
II.	Felt only by a few persons. Suspended objects may swing.
III.	Quite noticeable indoors. Vibrations are like the passing of a truck.
IV.	Felt indoors by many, outdoors by few. Dishes and windows rattle. Standing cars rock noticeably.
V.	Felt by nearly everyone. Some dishes and windows break, and some plaster cracks.
VI.	Felt by all. Furniture moves. Some plaster falls and some chimneys are damaged.
VII.	Everybody runs outdoors. Some chimneys break. Damage is slight in well-built structures but considerable in weak structures.
VIII.	Chimneys, smokestacks, and walls fall. Heavy furniture is overturned. Partial collapse of ordinary buildings occurs.
IX.	Great general damage occurs. Buildings shift off foundations. Ground cracks. Underground pipes break.
X.	Most ordinary structures are destroyed. Rails are bent. Landslides are common.
XI.	Few structures remain standing. Bridges are destroyed. Railroad ties are greatly bent. Broad fissures form in the ground.
XII.	Damage is total. Objects are thrown upward into the air.

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Modified Mercalli Scale

- Earthquake intensity depends primarily on the amplitude of the surface waves generated.
- Maximum intensity values are observed in the region near the epicenter; Mercalli values decrease to I at distances very far from the epicenter.
- Modified Mercalli scale intensity values of places affected by an earthquake can be compiled to make a seismic-intensity map.

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Depth of Focus

- Earthquake intensity is related to earthquake magnitude.
- The depth of the quake's focus is another factor that determines the intensity of an earthquake.
- An earthquake can be classified as shallow, intermediate, or deep, depending on the location of the quake's focus.
- A deep-focus earthquake produces smaller vibrations at the epicenter than a shallow-focus

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- All epicenter locations, as well as times of occurrence, however, can be easily determined using seismograms and travel-time curves.

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Distance to an Earthquake

- The P-S separation determines the epicentral distance, or distance to a quake's epicenter from the seismic station that recorded the waves.
- By measuring the separation on a seismogram as well as the distance on a travel-time graph at which the P-

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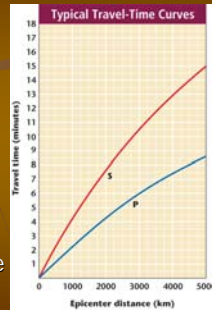
Distance to an Earthquake

- The earthquake could have occurred anywhere on a circle around the seismic station.
- The radius of the circle is equal to the epicentral distance.
- If the epicentral distances for three or more seismic stations are known, the exact location of the epicenter can be

Locating an Earthquake

Time of an Earthquake

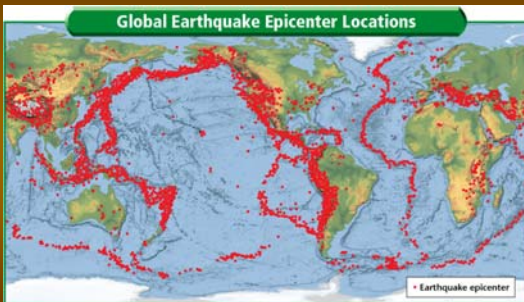
- The travel time of either wave at the epicentral distance of that station can be read from the travel-time graph.
- The time of occurrence of the earthquake is then determined by subtracting the appropriate travel time from the known arrival time of the wave.



Seismic Belts

- The majority of the world's earthquakes occur in relatively narrow seismic belts that are associated with tectonic plate boundaries.
 - Almost 80 percent of all earthquakes occur in the Circum-Pacific Belt.
 - About 15 percent take place across southern Europe and Asia.
 - Most of the remaining earthquakes occur in narrow bands that run along the crests of ocean ridges.
 - A very small percentage of earthquakes happen far from tectonic plate boundaries.

Seismic Belts



Section Assessment

1. Match the following terms with their definitions.
- | | |
|------------------------------------|---|
| <u>C</u> magnitude | A. rates intensity through the type of damage and other effects of an earthquake |
| <u>B</u> Richter scale | B. takes into account the fault rupture, the amount of displacement along the fault, and the rock's stiffness |
| <u>A</u> moment magnitude scale | C. describes a quake based on its largest seismic waves |
| <u> </u> modified Mercalli scale | D. the amount of energy released during an earthquake |

Section Assessment

2. How can a high magnitude earthquake rank relatively low on the modified Mercalli scale?
- The modified Mercalli scale measures the damage that it causes. A high magnitude, deep-focus quake would probably have a lower Mercalli rating than a moderate, shallow-focus quake. The Mercalli rating will generally go down with distance from the epicenter, regardless of the magnitude.

Section Assessment

3. Identify whether the following statements are true or false.
- true A Mercalli rating of VI would indicate less damage than a rating of VIII.
 - false A quake with a magnitude of 7 on the Richter scale would have 10 times the amount of seismic energy as magnitude 6 quake.
 - true Most earthquakes occur along plate boundaries.
 - false Less than 10,000 earthquakes occur