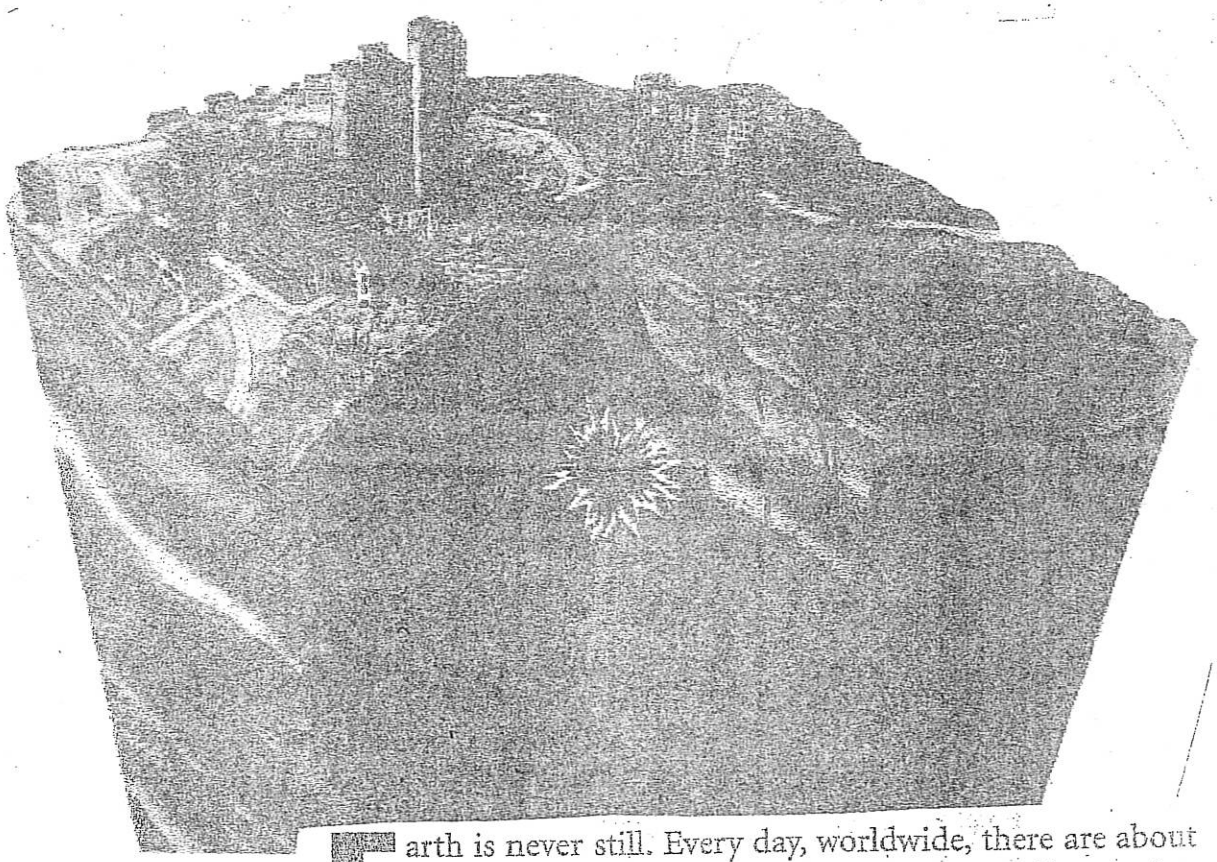
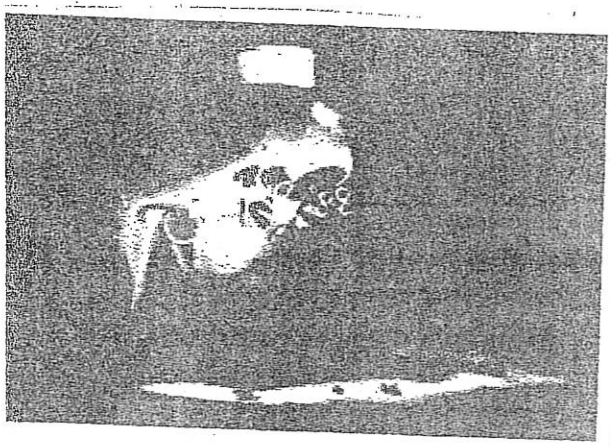
Measuring Earthquakes





Submersibles

Earth is never still. Every day, worldwide, there are about 8,000 earthquakes. Most of them are too small to notice. But when an earthquake is strong enough to rattle dishes in kitchen cabinets, people sit up and take notice. "How big was the quake?" and "Where was it centered?" are two questions just about everyone asks after an earthquake.

To know where an earthquake was centered, you need to know where it began. Earthquakes always begin in rock below the surface. Most earthquakes begin in the lithosphere within 100 kilometers of Earth's surface. An earthquake starts at one particular point. The **focus** (FOH kus) is the point beneath Earth's surface where rock that is under stress breaks, triggering an earthquake. The point on the surface directly above the focus is called the **epicenter** (EHP uh sen tur).

Seismic Waves

If you have ever played a drum, you know that the sound it makes depends on how hard you strike it. Like a drumbeat, an earthquake produces vibrations called waves. These waves carry energy as they travel outward through solid material. During an earthquake, seismic waves race out from the focus in all directions. Seismic waves are vibrations that travel through Earth carrying the energy released during an earthquake. The seismic waves move like ripples in a pond. Look at Figure 11 to see how seismic waves travel outward in all directions from the focus.

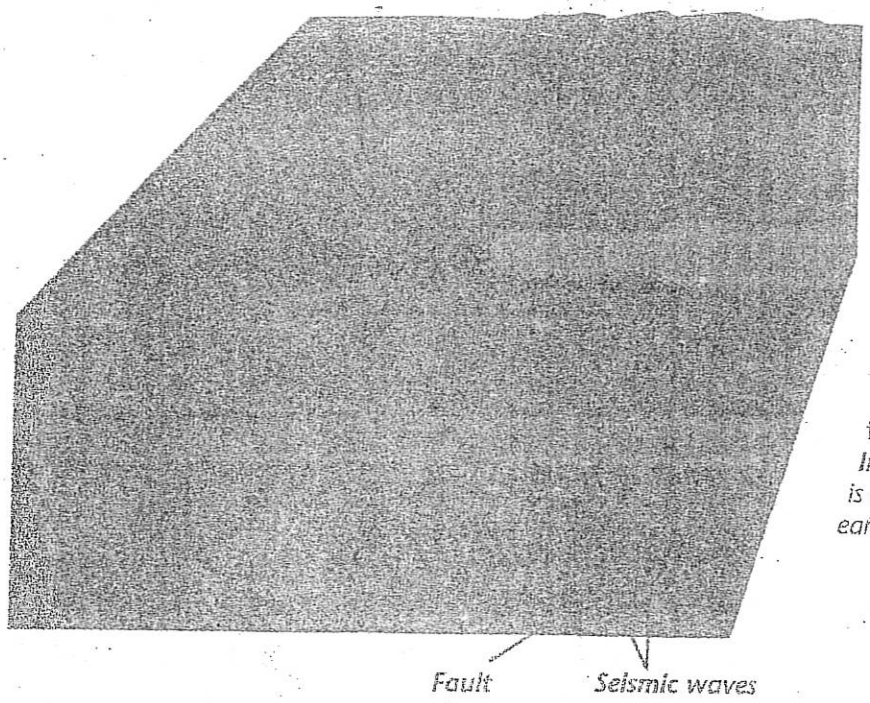


Figure 11 An earthquake occurs when rocks fracture at the focus, deep in Earth's crust. *Interpreting Diagrams What point is directly above the focus of the earthquake?*

Seismic waves carry the energy of an earthquake away from the focus, through Earth's interior, and across the surface. The energy of the seismic waves that reach the surface is greatest at the epicenter. The most violent shaking during an earthquake, however, may occur kilometers away from the epicenter. The types of rock and soil around the epicenter determine where and how much the ground shakes. You will learn more about the effects of seismic waves in Section 3.

There are three categories of seismic waves: P waves, S waves, and surface waves. An earthquake sends out two types of waves from its focus: P waves and S waves. When these waves reach Earth's surface at the epicenter, surface waves develop.

Primary Waves The first waves to arrive are primary waves, or P waves. P waves are earthquake waves that compress and expand the ground like an accordion. P waves cause buildings to contract and expand. Look at Figure 12 to compare P waves and S waves.

Secondary Waves After P waves come secondary waves, or S waves. S waves are earthquake waves that vibrate from side to side as well as up and down. They shake the ground back and forth. When S waves reach the surface, they shake structures violently. Unlike P waves, which travel through both solids and liquids, S waves cannot move through liquids.

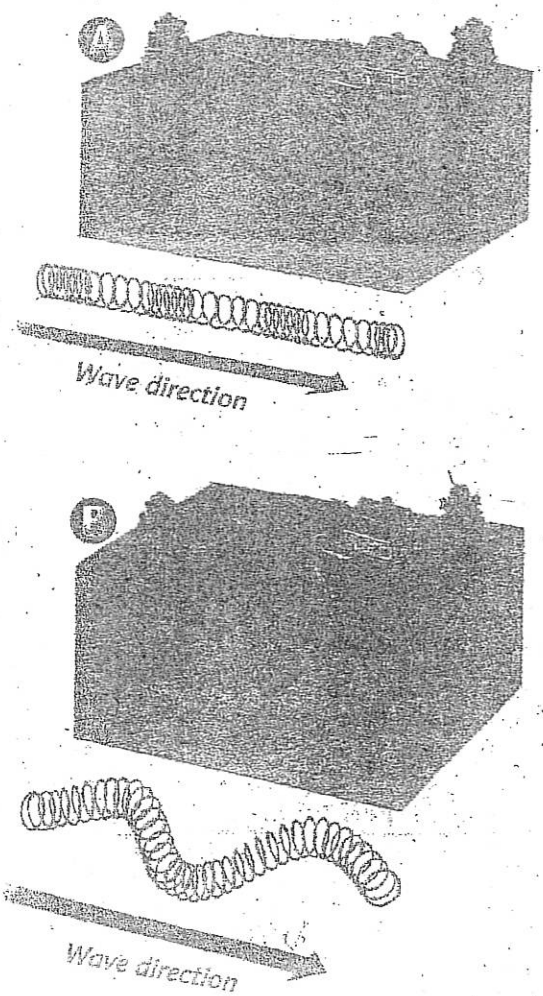
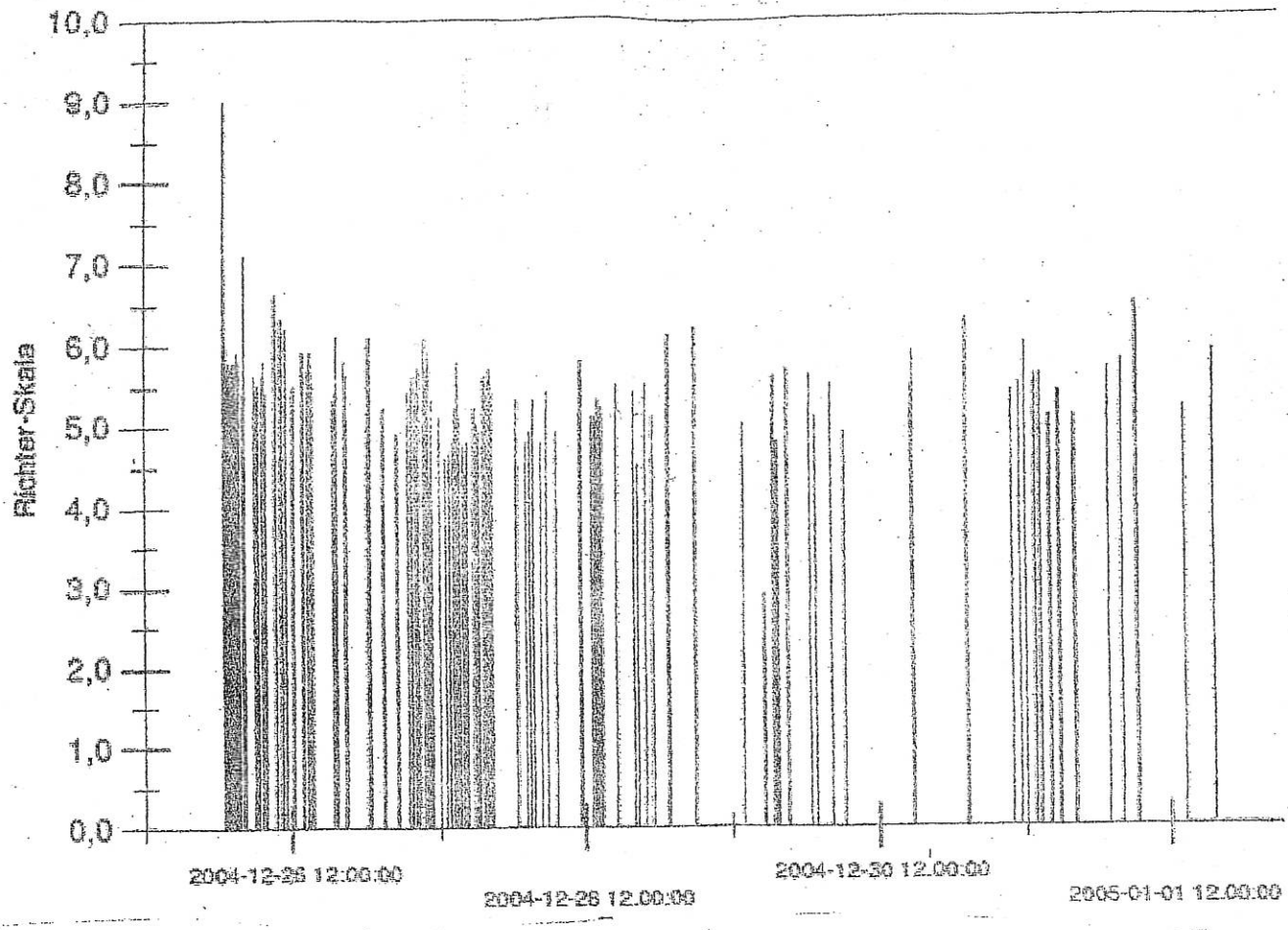


Figure 12 A. In P waves, the particles of the crust vibrate forward and back along the path of the wave. B. In S waves, the particles of the crust vibrate from side to side and up and down.

Course of the Earthquakes in the Indian ocean



According to the diagram above answer these questions; Give specific numeral answers when possible.

1. Do all of these observations occur in the same year? _____

2. In which month of what year did the most severe earthquake happen in India?

_____

3. What do you notice about the difference between 2004 12/30 and 2005 01/01 That might be a cause for concern?

_____

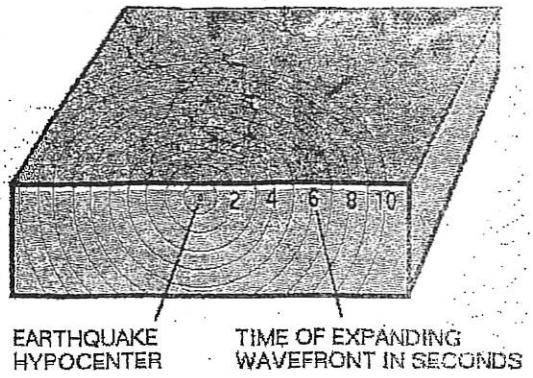
_____

4. According to the chart what happened in India in 2004 between 12/26 and 12/ 28?

_____

_____

Q: How do seismologists locate an earthquake?



Surface Waves When P waves and S waves reach the surface some of them are transformed into surface waves. **Surface waves** move more slowly than P waves and S waves, but they produce the most severe ground movements. Some surface waves make the ground roll like ocean waves. Other surface waves shake buildings from side to side.

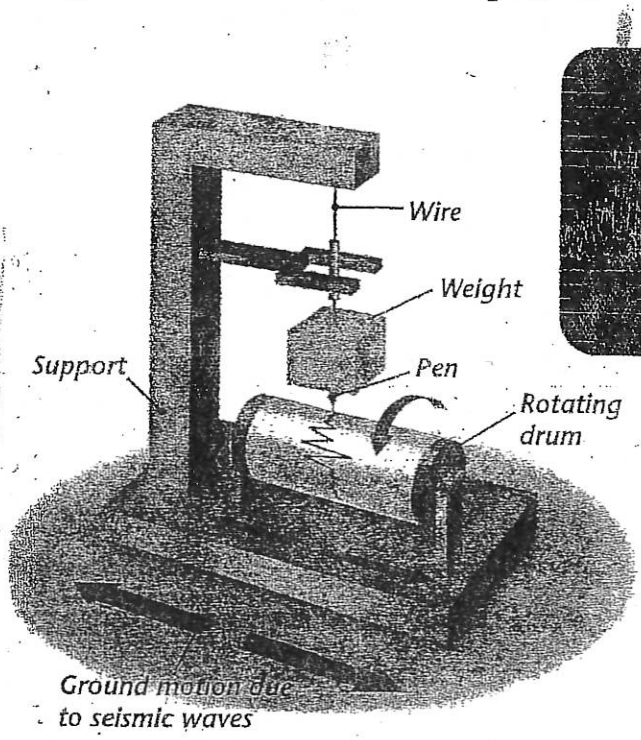
☑ *Checkpoint What are the three types of seismic waves?*

Detecting Seismic Waves

To record and measure the vibrations of seismic waves, geologists use instruments called seismographs. A **seismograph** (SYZ muh graf) records the ground movements caused by seismic waves as they move through the Earth.

Until recently, scientists used mechanical seismographs. As shown in Figure 13, a mechanical seismograph consists of a heavy weight attached to a frame by a spring or wire. A pen connected to the weight rests its point on a rotating drum. When the drum is still, the pen draws a straight line on paper wrapped around the drum. During an earthquake, seismic waves cause the drum to vibrate. Meanwhile, the pen stays in place and records the drum's vibrations. The height of the jagged lines drawn on the seismograph's drum is greater for a more severe earthquake.

Today, scientists use electronic seismographs that work according to the same principle as the mechanical seismograph. The electronic seismograph converts ground movements into a signal that can be recorded and printed.



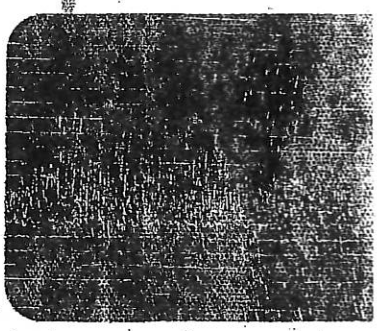
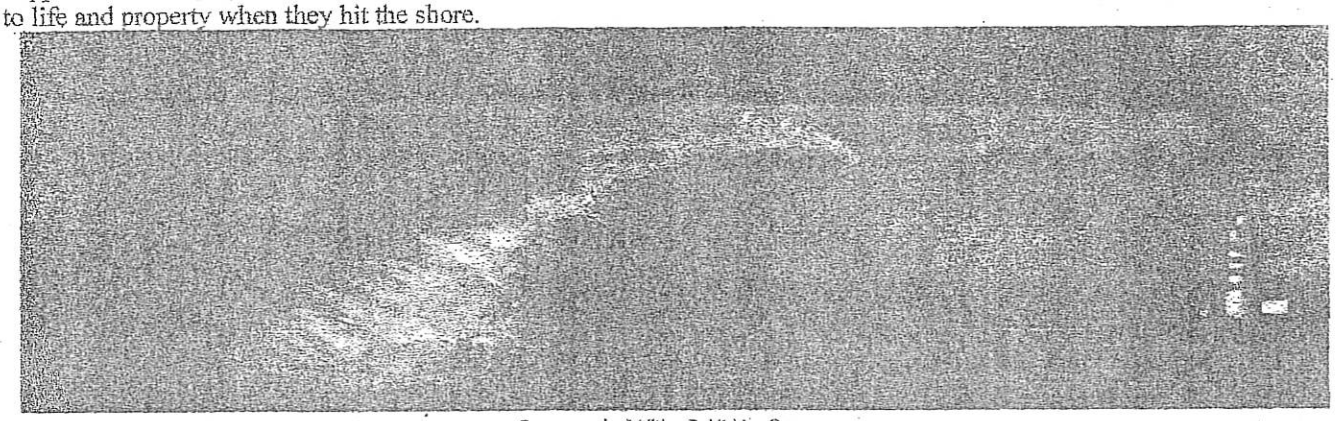


Figure 13 The mechanical seismograph records seismic waves. The record made by a seismograph shows the arrival times of different types of seismic waves.

WAVES!!

Tsunami (sue nah me) are gigantic waves. Sometimes they are called tidal waves by mistake. The term "tidal wave" is not correct because tsunami are not caused by tides but by shock waves from earthquake and volcanic activity at the bottom of the ocean. Sometimes they occur as huge amounts of ice or rock fall into the water. ***Ocean Tsunami*** may be from 18 to 30 meters high. They can also travel at an average speed of 750 kilometers per hour. These waves are dangerous. ***Fjord tsunami*** occur when waves travel through a narrow channel of ice or rock. This type of tsunami usually happens when large pieces of ice or rock falls into the water. No matter what the type, tsunami can cause a lot of damage to life and property when they hit the shore.



Oceanography, Milliken Publishing Company

1. **The high point of a wave is called the _____.**
2. **The low point of a wave is called the _____.**
3. **This distance that is usually measured from crest to crest is called the _____.**
4. **The number of waves that pass by a particular point is called a wave's _____.**
5. **The type of wave that is can be formed from earthquake activity is called a _____.**
6. **Waves as white water, caused by strong winds pushing the water off the tops of waves, are called _____.**
7. **Waves that break into foam when they hit the shore are called _____.**
8. **_____ are gigantic waves. They may be from 18 to 30 meters high. They can also travel at an average speed of 750 kilometers per hour!**
9. **What is moving forward, the water or the energy? Explain.**

_____

_____

_____

Vibrations…vibraTIONS…. VIBRATIONS ! ! ! ! = EARTHQUAKES

Answer the following questions:

1. What two question are always asked when an earthquake happens:

A._____

B._____

2. Where do earthquakes always begin? _____

_____

3. What is the "focus" of an earthquake?_____

_____

4. What is the "epicenter" of an earthquake? _____

_____

5. What are "seismic waves?" _____

_____

6. What do Seismic waves do? _____

_____

7. What determines how much ground/earth shakes during an earthquake?

_____

8. What are "P" waves?

_____

_____Explain how they travel _____

_____

_____

9. What are "S" waves?

_____

_____Explain how they travel

_____

_____

10. Which form of matter can't "S" waves travel through? _____

11. Which type of wave produces the most severe ground movements, and can shake buildings from side to side?

_____

12. Name the original instrument that records ground movements_____.

How does this work? _____

_____

_____

_____

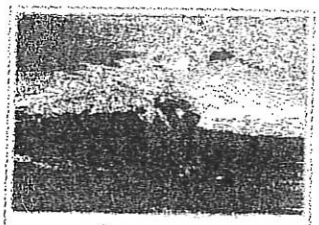
_____

13. When P and S waves reach the surface of the earth they become surface waves. Name two properties of surface waves that are not true of P and S waves.

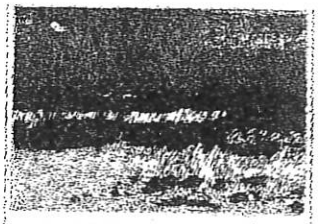
A._____

B. _____

14. All three types of seismic waves are caused by _____.



Ocean waves



Spilling type of surf

Wave Statistics

I. Use the following words on the lines to the left to explain what kind of wave causes the following to happen.

Light sound water seismic

_____ the earth shakes

_____ you hear a friend's voice

_____ you can see

_____ a large gaping trench in the land

_____ shorelines are eroded away

_____ makes plants grow

_____ fire alarms are heard

_____ destroys island villages

II. Short answer:

1. Anything that takes up space and has mass is _____.

2. The ability to do work (move something) is _____.

3. Solids, liquids, and gases, which all carry waves are called _____.

4. When something actually disturbs a medium, three kinds of waves can develop:

A._____ B._____ C._____

5. Light is an "Electromagnetic wave" - which means it can move without a medium in a

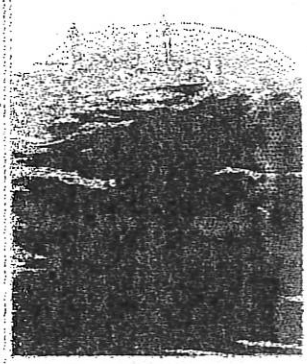
_____ (an area with no medium). Add this word to your vocab.

6. Waves carry ENERGY but not, never, no way _____.

7. What is the source of a wave? _____

_____

8. What is the most frequent source of water waves? _____



NOAA ship *Delaware II* in bad weather on Georges Bank.