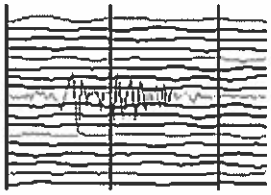
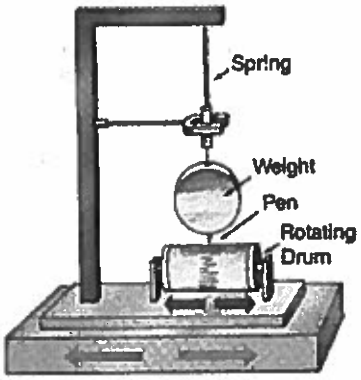
Shake it Up with Seismographs!



Student Resource: What is a Seismograph?

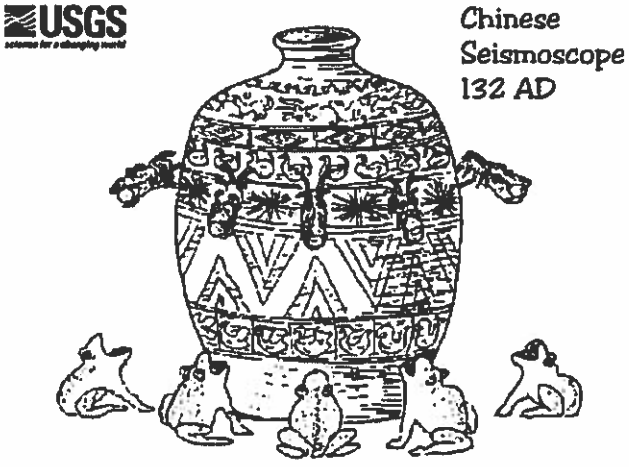
Seismometers are instruments that measure and record motions of the ground, including those of seismic waves generated by earthquakes, nuclear explosions, and other seismic sources. Records of seismic waves allow seismologists to map the interior of the Earth, and locate and measure the strength of these different sources. The word derives from the Greek σεισμός, seismós, a shaking or quake, from the verb σείω, seíō, to shake; and μέτρον, métron, measure.

A seismograph, or seismometer, is an instrument used to detect and record earthquakes. Generally, it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass does not. The motion of the base with respect to the mass is commonly transformed into an electrical voltage. The electrical voltage is recorded on paper, magnetic tape, or another recording medium. This record is proportional to the motion of the seismometer mass relative to the earth, but it can be mathematically converted to a record of the absolute motion of the ground. Seismograph generally refers to the seismometer and its recording device as a single unit.

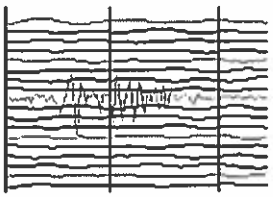


◆ **Chang Heng's Seismoscope**

In 132 CE, Chang Heng of China's Han dynasty invented the first seismoscope, which was called Houfeng Didong Yi. It was a large bronze vessel, about 2 meters in diameter; at eight points around the top were dragon's heads holding bronze balls. When there was an earthquake, one of the mouths would open and drop its ball into a bronze toad at the base, making a sound, and indicating the direction of the earthquake. On at least one occasion, probably at the time of a large earthquake in Gansu in 143 CE, the seismoscope indicated an earthquake even though one was not felt. The available text says that inside the vessel was a central column that could move along eight tracks; this is thought to refer to a pendulum, though it is not known exactly how this was linked to a mechanism that would open only one dragon's mouth. The first ever earthquake recorded by this seismograph was supposedly somewhere in the east. Days later, a rider from the east reported this earthquake. The image to the right is a drawing of Chang Heng's seismoscope, as visualized by Wang Chen-To (1936).



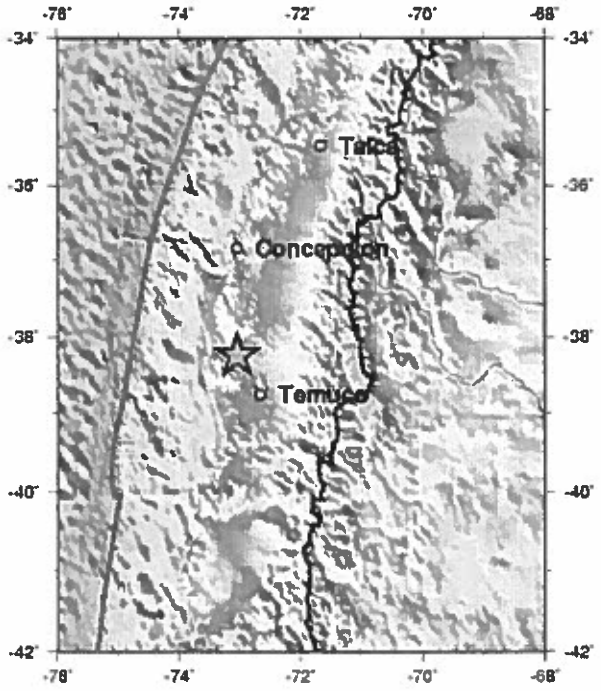
Shake it Up with Seismographs!



Student Resource: Earthquake Tracking

◆ The Richter Scale

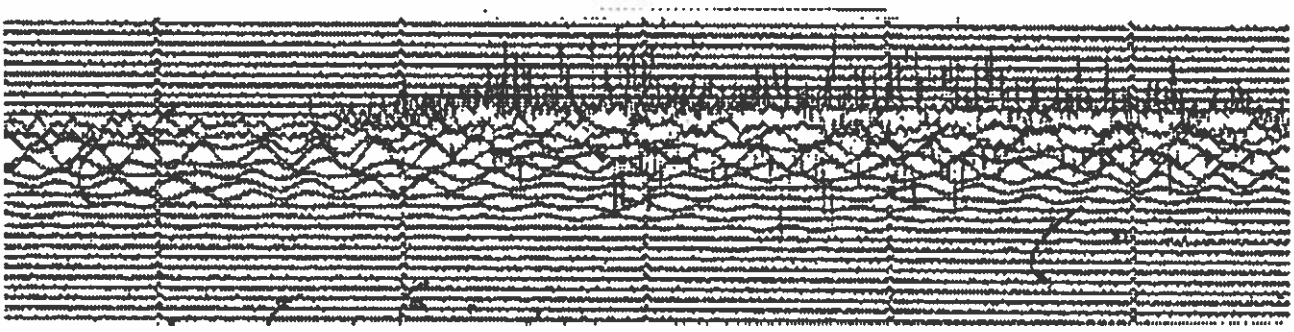
The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the strength of earthquakes. At first, the Richter Scale could be applied only to the records from instruments of identical manufacture. Now, instruments are carefully calibrated with respect to each other. Thus, magnitude can be computed from the record of any calibrated seismograph. The scale indicates the strength of earth movement on a scale from 1.0 to 10.0. The weakest earthquakes are 1.0, or less. Each level of the Richter scale increases by powers of 10. So an increase of 1 point means the strength of a quake is 10 times greater than the level before it. A 2.0 earthquake is 10 times stronger than a 1.0 quake. A 6.0 earthquake is 10 X 10 or 100 times stronger than a quake registering a 4.0.



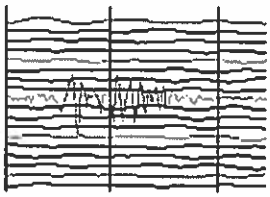
Chile

◆ The Biggest Earthquake

The largest earthquake ever recorded took place May 22, 1960 in Chile. Approximately 1,655 people were killed and 3,000 injured. Over 2,000,000 ended up homeless, and there was about $550 million in resulting damage. This quake registered 9.5 on the Richter Scale. The seismograph record of this quake is below!



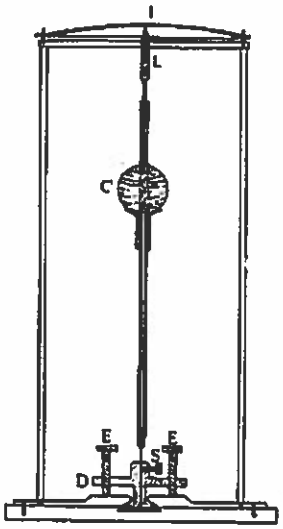
Shake it Up with Seismographs!



Student Resource: Pendulum Seismographs

◆ The Power of Pendulums

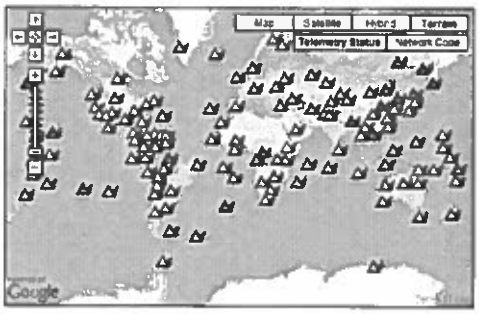
Before electronics allowed recordings of large earthquakes, scientists built large spring-pendulum seismometers in an attempt to record the long-period motion produced by such quakes. The largest one weighed about 15 tons. There is a medium-sized one three stories high in Mexico City that is still in operation.



Another example is an inverted-pendulum "seismometer", designed by James Forbes (Forbes, 1844). The seismometer is shown to the right. It consisted of a vertical metal rod that was supported on a vertical cylindrical steel wire. By adjusting the stiffness of the wire, or the height of the ball that hung from it, the swing of the pendulum could be changed. A pencil hung from the rod would "write" a line on paper that showed the movement of the earth.

◆ Current Technology

The Advanced National Seismic System (ANSS) is a United States Geological Survey initiative to upgrade and expand seismic monitoring capabilities in the United States. Major elements of the ANSS include national, regional, urban and structural monitoring systems. The ANSS will eventually be a nationwide network of at least 7000 shaking measurement systems, both on the ground and in buildings that will make it possible to provide emergency response personnel with real-time earthquake information, provide engineers with information about building and site response, and provide scientists with high-quality data to understand earthquake processes and solid earth structure and dynamics. Find out more at http://earthquake.usgs.gov/research/monitoring/anss/. In addition, the Global Seismographic Network (http://earthquake.usgs.gov/research/monitoring/gsn/) is a permanent digital network of state-of-the-art seismological and geophysical sensors connected by a telecommunications network, serving as a multi-use scientific facility and societal resource for monitoring, research, and education. The GSN provides near-uniform, worldwide monitoring of the Earth, with over 150 modern seismic stations distributed globally.



In addition, both 2-D and 3-D land and marine seismic data processing is used showing motion in both depth and time. Norway's Spectrum ASA focuses on this 2-D and 3-D data processing and maintains a library of multi-client data and reports cover all the major oil producing regions of the world.

Shake it Up with Seismograph Reading

Name: _____

Date: _____

Period: _____ Page: _____

Directions: Reading the seismograph reading, and locate the missing words and phrase from the reading

1. _____ are instruments that measure and record _____ _____, including those of _____ _____.

2. Records of _____ allow _____ to map the interior of the Earth, and _____ _____.

3. A _____, or _____, is an instrument used to _____.

4. During an earthquake, the base moves and the mass does not. The motion of the base with respect to the mass is commonly transformed into an _____.

5. The electrical voltage is recorded on paper, magnetic tape, or another recording medium. This record is _____ to the motion of the seismometer mass relative to the Earth.

6. In 132 CE, Chang Heng of China's Han dynasty invented the first _____.

7. When there was an _____, one of the mouths would open and drop its ball into a bronze toad at the base, _____, and indicating the _____.

8. The _____ was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to _____ _____.

9. The scale indicates the _____ on a scale from _____.

10. Each level of the Richter Scale increase by powers of _____.

11. So an increase of 1 point means the strength of a quake is _____ than the level before it.

12. The largest earthquake ever recorded took place _____.

13. The quake registered _____ on the Richter Scale.

14. Before electronics allowed recording of large earthquakes, scientists built _____ _____ in an attempt to record the long – period motion produced by such quakes.

15. A _____ hung from the rod would " _____ " a line on paper that showed _____.

16. The _____ is a _____ _____ initiative to upgrade and expand _____ _____ in the United States.

17. The ANSS will eventually be a nationwide network of at least _____ _____ both on the ground and in buildings.

18. It will make it possible to provide _____ with real-time _____, provide engineers with information about building and site response, and provide scientists with _____ to understand _____

19. The GSN provides near-uniform, world-wide monitoring of the Earth, with over _____ modern _____ distributed globally.

20. In addition, both _____ land and _____ _____ is used showing _____.