Energy, Mines and Resources Canada / Énergie, Mines et Ressources Canada

Geofacts

SEISMOGRAPHS

What Is a Seismograph?

Seismographs are instruments used to record and measure earthquakes. During an earthquake, vibrations initiated by fracturing of the earth's crust radiate outward from the point of fracture. Seismographs detect and record these vibrations for further study. The visual record produced by a seismograph is called a seismogram.

How Seismographs Work

The motion of the earth during an earthquake is measured in terms of its movement relative to some object that remains independent of the ground motion. In a seismograph this object consists of a mass suspended on springs within a case. The unit is called a seismometer. During an earthquake, the mass remains still while the case around it moves with the ground motion.

Most modern seismographs work electromagnetically. A large magnet is used for the mass and the outside case contains numerous windings of fine wire. Movements of the case relative to the magnet generate small electric signals in the wire coil. These signals are then amplified electronically and played out on a recording device such as a paper chart recorder, or stored on magnetic tape.

Earthquake waves decrease in strength as they travel through the earth. High-frequency waves attenuate most severely; consequently, seismographs designed for monitoring local earthquakes must respond to a different frequency of ground motion from those used for recording distant earthquakes. Instruments sensitive to seismic waves that vibrate several times per second, called short period seismographs, are used to record local earthquakes, during which the waves reaching the seismograph are still very rapid and close together. Long period seismographs respond to lower frequency waves and are used to record distant events.

Some short period seismographs magnify ground motion several hundred thousand times. Such sensitive instruments can detect earthquakes too small to be felt by a human being, but will 'go off scale' if the ground motion is too intense. To record large local earthquakes accurately a third type of seismograph is needed. Strong motion seismographs apply minimal magnification (less than 100x) and, unlike the more sensitive instruments, do not operate continuously. Strong motion seismographs are triggered by strong ground movement and record only until the ground motion returns to an imperceptible level.

For a complete characterization of the earth's movement, it must be measured in three perpendicular directions. Consequently, seismographs are often deployed in groups of three, with one instrument recording each of the north-south, east-west and vertical (up and down) components of the ground motion.

What Is Shown on a Seismogram

Seismograms are used to determine the location and magnitude of earthquakes.

An earthquake's magnitude may be thought of as the amount of energy released at the fracture point. When an earthquake occurs, two main types of vibratory waves move through the body of the earth from the point of fracture. The primary, or P, waves travel most quickly and are the first to be registered by the seismograph. Secondary, or S, waves travel more slowly.

As S waves have a greater amplitude than P waves the two groups are easily

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distinguishable on the seismogram. By measuring the time interval between the arrivals of the P and S wave groups seismologists are able to calculate the distance between the seismograph and the origin of the earthquake. Magnitude is then derived from the amplitude of the waves on the seismogram and the distance of the earthquake from the seismograph.

When P and S waves strike the surface of the earth they initiate a third kind of wave, called a surface wave, which travels over the earth's surface. These are the slowest waves. On recordings of local earthquakes the surface waves are small and can seldom be distinguished from the S waves that preceded them. However, since surface waves attenuate much more slowly than do P or S waves they are generally the largest waves to appear on long period seismograms of distant earthquakes.

If an earthquake is recorded by three or more seismograph stations its precise location can be determined from the set of distances. In seismically active areas, a network of sensitive seismographs may be installed to locate even very minor tremors.

Seismograph Installations in Canada

At present, a system of more than one hundred seismograph installations across Canada continuously records local and global seismic activity. Locally sensitive seismographs deployed in the Charlevoix, Quebec, region of the St. Lawrence Valley and along the coast of British Columbia monitor the high incidence of earthquakes in these areas.

A seismograph's seismometer and amplifier can be at a remote location, linked to the recorder by radio or telephone. The seismic signal is then said to be 'telemetered'. Signals from networks of isolated stations may be telemetered to a central location for simultaneous recording and analysis. The two largest such networks in Canada are monitored from the Geological Survey of Canada earthquake research centres in Sidney, British Columbia and Ottawa, Ontario.

Suggested Reading

"The Amateur Scientist", *Scientific American*, July 1957 and July 1979: Basic principles and how to build a simple seismograph.

Hodgson, John. *Earthquakes and Earth Structure*. New Jersey, Prentice Hall, 1964, p. 60-69: How seismographs work and interpretation of seismograms.

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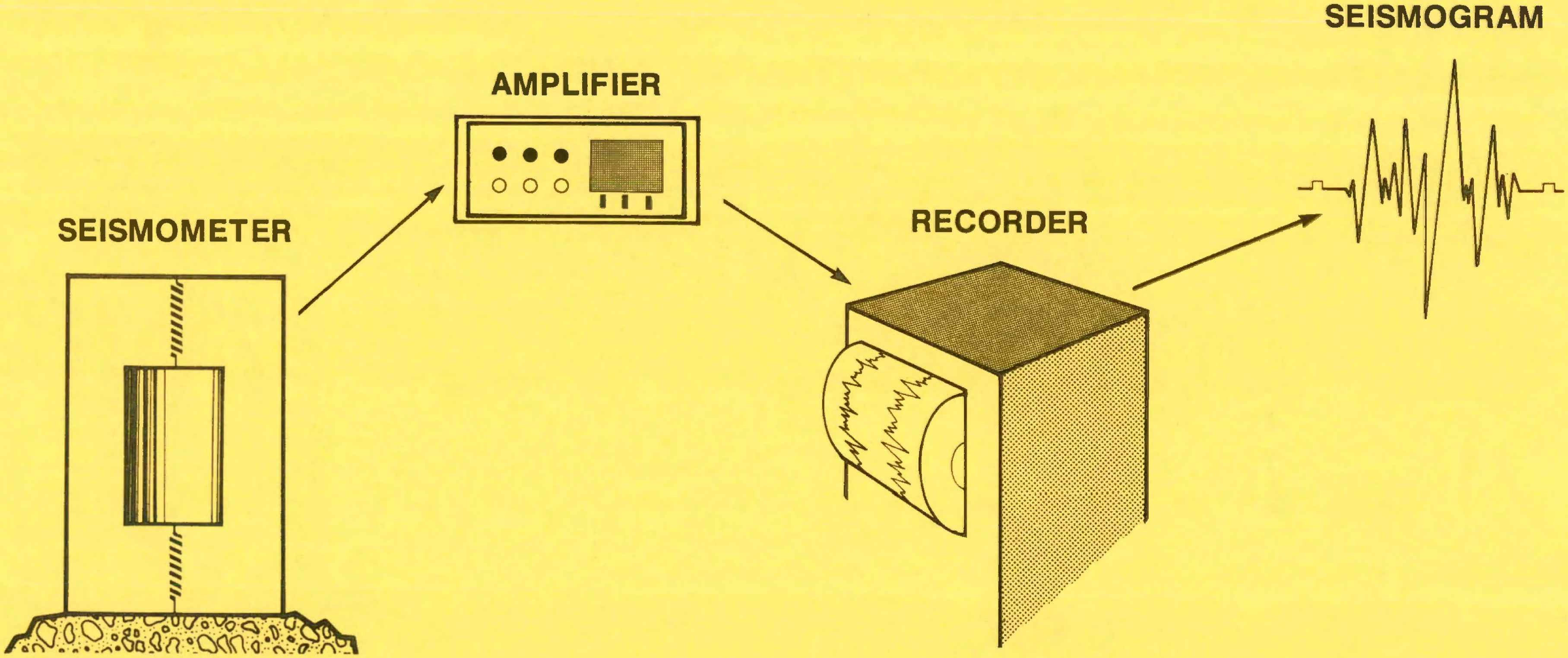
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