What is a seismogram? How do I read a seismogram?

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What is a Seismogram ?

A seismogram is the record of ground movement. Seismograms are the records (paper copy or computer image) produced by **seismographs** used to calculate the location and magnitude of an EQ. They show how the ground moves with the passage of time. On a seismogram, the HORIZONTAL axis records the passage of time (measured in seconds) and the VERTICAL axis shows ground displacement (amplitude; usually measured in millimeters). During periods of no earthquakes the seismogram records a straight line except for small wiggles caused by local disturbance or "noise" and the time markers.

How is the movement of the seismometer converted into a seismogram?

1. a pen drawing an ink line on paper revolving on a drum (see movie above)
2. a light beam making a trace on a moving photographic film
3. electromagnetic system generating a current that is recorded electronically by a computer

How do I read a seismogram?

Seismograms (fig. 1, 2, 4) are used to calculate the location and magnitude of an earthquake. They show how the ground moves with the passage of time. When no ground movement is detected, the seismogram records a straight line.

More commonly there will be wiggly lines all across it caused by ambient ground noise (fig. 2) . These are all the seismic waves that the seismograph has recorded. Ground vibrations are similar to sound waves in air, but span a wide frequency range that extends well below the threshhold for human hearing. Most of the blips in fig. 2 were so small that nobody felt them. These tiny microseisms can be caused by heavy traffic near the seismograph, waves hitting a beach, the wind, and any number of other ordinary things that cause some shaking of the seismograph (fig. 3).

So which wiggles are the earthquake? It isn't always clear, depending on the background noise. For a large earthquake, the P wave (fig. 4) will be the first jog that is bigger than the rest of the little ones (the microseisms). Because P waves are the fastest seismic waves, they will usually be the first ones that your seismograph records. The next set of seismic waves on your seismogram will be the S waves. These are usually bigger than the P waves.

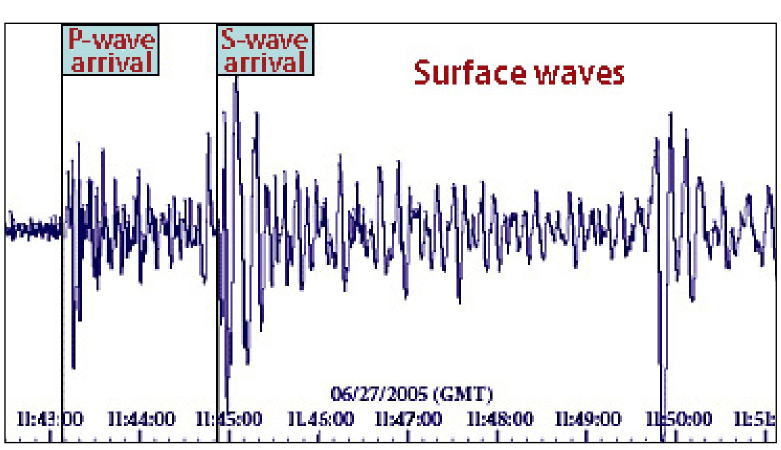


Figure 4—Image (from **REV**)shows a seismogram with the P wave and S wave arrival times marked. According to this example, the P wave arrived at the recording device shortly after 11:43 AM and the S wave arrived shortly before 11:45 AM. [**MORE on P & S waves-below**]

Watch cartoon animation of the effect of different waves on a building [LIN

The surface waves (Love and Rayleigh waves) are the other, often larger, waves marked on the seismogram. Surface waves travel a little slower than S waves (which are slower than P waves) so they tend to arrive at the seismograph just after the S waves. For shallow earthquakes (earthquakes with a focus near the surface of the earth), the surface waves may be the largest waves recorded by the seismograph. Often they are the only waves recorded a long distance from medium-sized earthquakes.

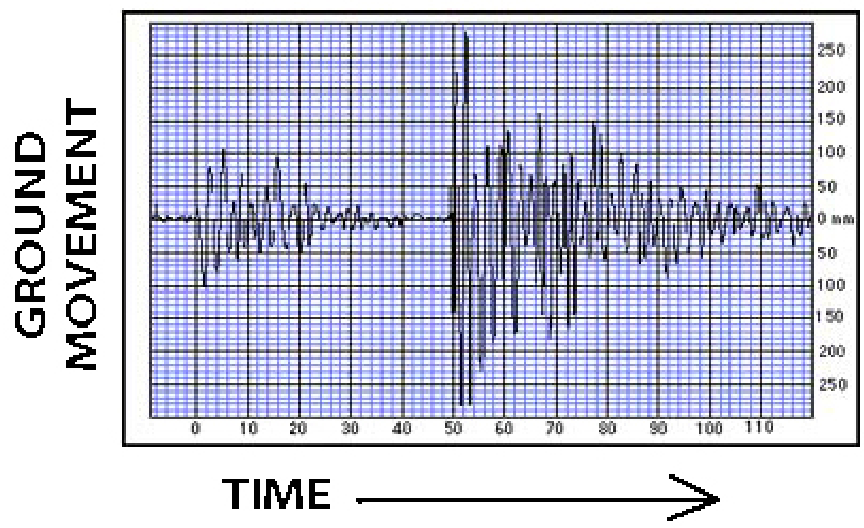


Figure 1— Seismogram showing a large earthquake.
HORIZONTAL axis = time (measured in seconds)
VERTICAL axis = ground movement (usually measured in millimeters).

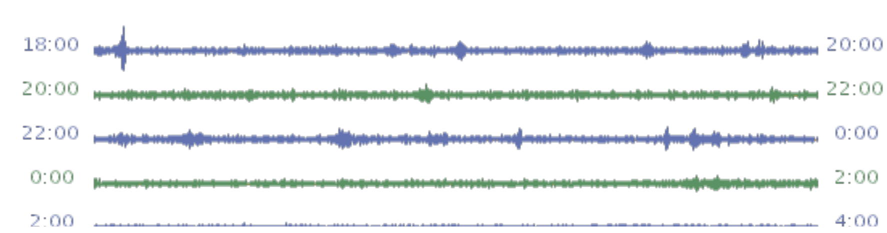


Figure 2— Seismogram taken from a USArray Seismic Station shows wiggles of ambient "noise" and some possible small regional earthquakes.

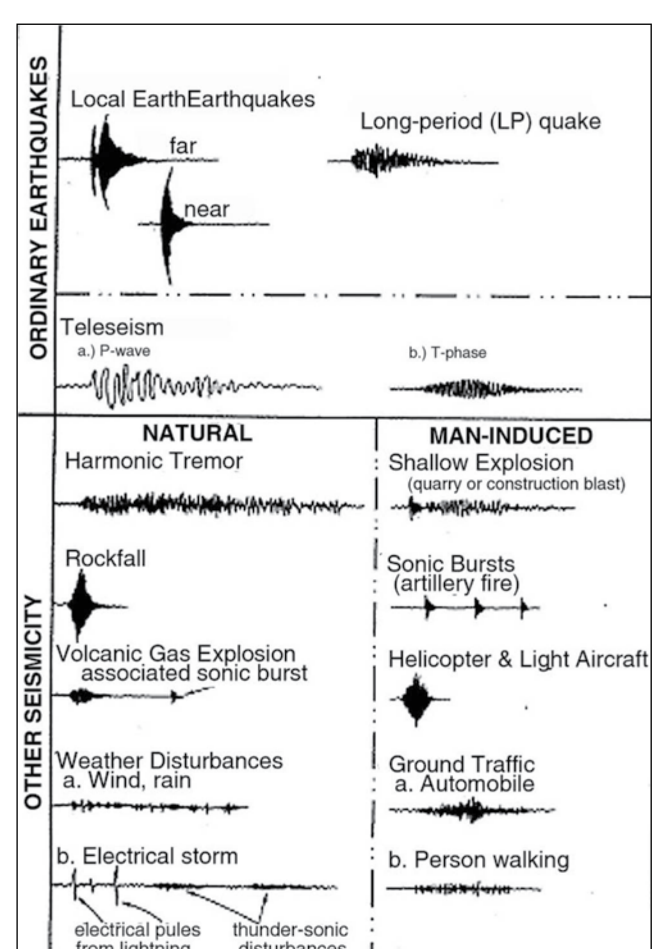
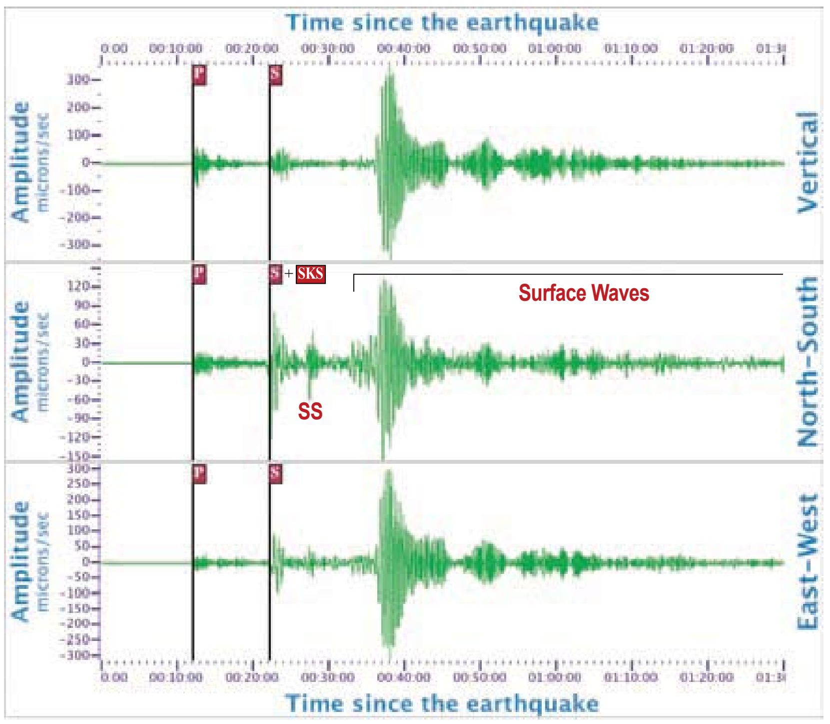


Figure 3—[Large Image] This USGS graphic shows typical seismograms from ordinary earthquakes, plus the signals that you might see from other ground-shaking events.

From OnSite publication's "Ask a Seismologist"

Seismograms are records of motions that travel as seismic waves within the Earth. All seismic waves are variations of two types: P and S. Interpreting these waves teaches us much about the Earth.

Pick up a stick. Now close your eyes and start bending the stick. At some point the stick is going to break. How do you know when the stick breaks if you can't see it? First, you hear the stick break. What you just experienced is a P wave. When earthquakes occur, they cause compressional waves, or P waves, that behave just like the sound of the breaking stick. The snap pushes on the air, which pushes the next bit of air, and so on, all the way to your eardrum. Second, you feel the stick break. This is an S wave. Unlike P waves, S waves travel in a direction that is perpendicular to the motion at any point. You cannot hear the S waves because they only propagate through rigid materials – not in air or water. In the figure above, you can see the P and S waves labeled on the seismograms that recorded the Earth's motions in all directions (vertical, or up and down; north-south; and east-west) at a given location.



Seismograms from the magnitude 8 earthquake in the Tonga Islands on May 3, 2006, as recorded by Transportable Array station H04A in Detroit Lake, Oregon. The data are displayed by the Rapid Earthquake Viewer (http://rev.seis.sc.edu/).

The paths that the P and S waves take through the Earth are shown in the figure below. There are many other waves that are recorded in the seismograms because the P and S waves break up into many different paths as they travel through the Earth. As you can see, some waves *reflect* off of the surface, like the SS wave. This is like an echo off of a canyon wall. Some waves pass through the Earth's core, like the SKS wave, bending as they pass between layers. The waves with the largest heights, or amplitudes, and which are the most spread out in time, are the rumbling *surface waves*. Sometimes waves travel different paths but arrive at the same time, like with the S and SKS waves shown here.

All of the different wiggles on a seismogram represent waves that have traveled different paths through the Earth. Each path is given a name composed of a series of letters that characterize how the wave traveled. The individual waves are very useful to geoscientists because they sample different regions of our planet. This allows us to learn more about the Earth's deep structure in regions where we will never be able to drill because the temperatures and pressures are too great. It is the Earth's structure that holds the key to extremely important unanswered questions about what our planet is made of, how it changes and evolves over time, and what the mechanisms are by which the continents move about the surface as part of the system of Plate Tectonics. By interpreting the many different P and S waves from many seismograms such as the ones shown here, we will have a much better idea of the geology of North America from the crust to the core.

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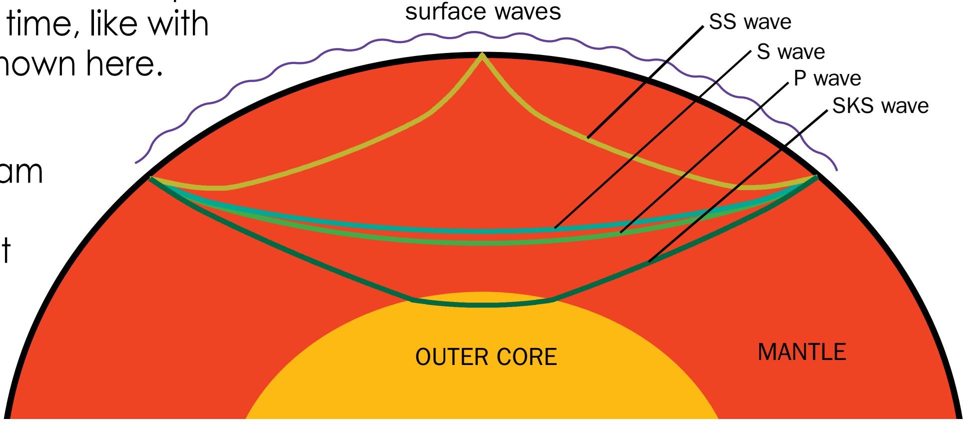

The paths of the P, S. SKS, SS, and surface waves through the Earth.