Get to know our seismic station!

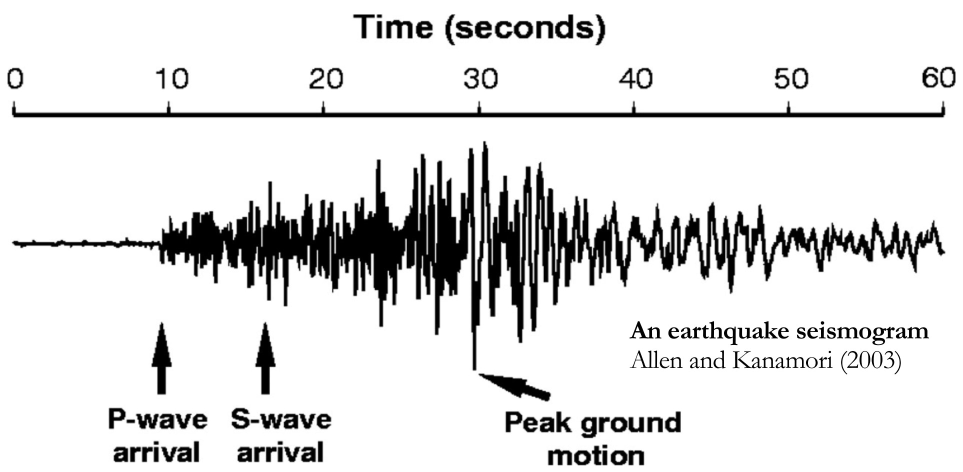
Welcome to our seismic station! It contains a seismometer and a small computer.

This station is part of a network of 10 broadband seismometers deployed across Seattle in April 2019 by Harvard University earthquake researchers.

What is a seismometer?

A **seismometer** is a highly-sensitive instrument that detects ground motion. It can measure everything from the small vibrations caused by your footsteps to large earthquakes felt around the world.

Connected to the seismometer is a small computer, which records these ground motions. This recording, called a **seismogram**, displays the up and down displacement of the ground as waveforms. The characteristics of these waveforms, such as shape, timing, and direction, tell us what the waves traveled through, helping us understand the Earth's underground structure.

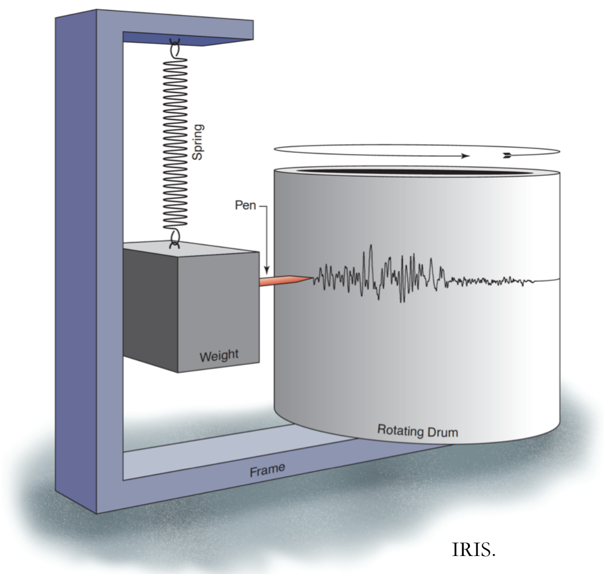


An earthquake seismogram
Allen and Kanamori (2003)

How does a seismometer measure ground motion?

A typical seismometer design consists of a weight suspended within a frame. Seismometers work on the **principle of inertia**: the weight will not move unless a force is applied. With the weight suspended in the frame, it tends to remain stationary, while the frame surrounding it moves with the earth during any sort of disturbance. This produces a relative motion between the weight and frame, which is recorded as the ground motion.

In the typical modern electronic research seismometer, relative displacement between the weight and frame produces a corresponding electrical voltage which is precisely recorded by a computer.



IRIS.

A historic analog seismometer.

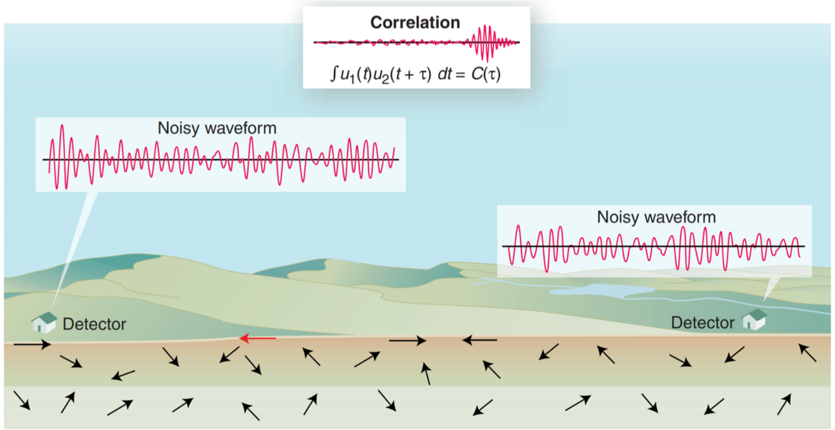
Seismic instruments were historically designed to monitor earthquakes—but seismometers can detect much smaller events. In fact, seismometers are so sensitive that they can measure displacements almost as small **1/10,000,000 centimeters**!

This sensitivity allows us to investigate **ambient seismic noise**—the constant, low-amplitude vibrations happening in the ground. Ambient noise is generated by a wide range of sources, both natural and man-made. From waves crashing on the shore to wind in the trees, highway traffic to passing pedestrians, all of these daily processes are picked up by the seismometer.

The very footsteps you took as you made your way over to read this sign have been digitally recorded by our underground instrument, and contain information about the earth structure and composition beneath your feet. We will be able to analyze these recordings, along with those caused by myriad other sources, to create a subsurface model of the Seattle Basin and how seismic waves behave within it. This information can help us understand and prepare for earthquakes that will rupture on the Cascadia subduction zone and Seattle Fault.

What can noise waveforms tell us about the subsurface?

Seismic noise travels in random directions. But when a noise wave passes **through** two stations, the waves observed at each station can be **cross-correlated**—compared with other noise waves traveling along the same paths over time, and **matched up**. By cross-correlating between stations, the **common signal** can be extracted from the chaos, and the incoherent energy cancels out. This remaining signal gives us information about the Earth's subsurface structure between the two seismometers.



R. L. Weaver, *Science* **307**, 1568 (2005).

The red arrow in the figure above represents a noise wave that passes through both detectors. When this happens, the signals recorded at each station are correlated. Stacking these correlations over time gives us coherent information and the chaotic noise (the black arrows in the subsurface) can be cancelled out.

A modern research seismometer.

Can you find this station on the map?

HARVARD UNIVERSITY

Interested? Look us up!
https://www.quake.fas.harvard.edu