EAS 4803/8803 - Obs Seismology
Lec#5: Seismometers and Seismic Networks

- Dr. Zhigang Peng, Spring 2019

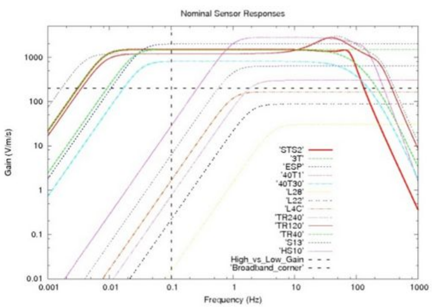


Figure 6.6-1: Diagram of a vertical seismograph.

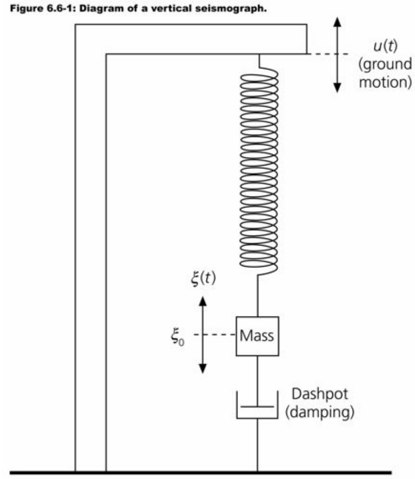


Figure 6.6-2: Amplitude response and phase delay for a pendulum seismometer.

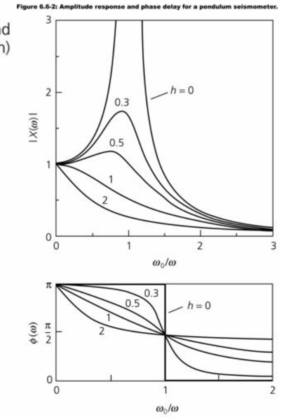
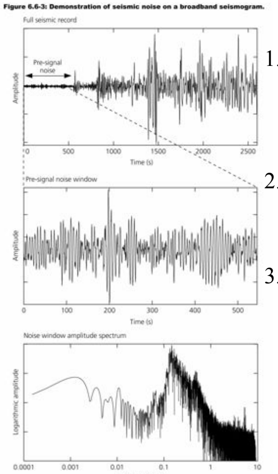


Figure 6.6-3: Demonstration of seismic noise on a broadband seismogram.



1. A microseism is defined as a faint earth tremor caused by natural phenomena, such as winds and ocean waves. (from wikipedia)
2. Thus a microseism is a small and long-continuing oscillation of the ground.
3. The term is most commonly used to refer to the dominant background seismic noise signal on Earth, which arises from wave action in the oceans, i.e. the low-frequency part of the Ambient Vibrations.

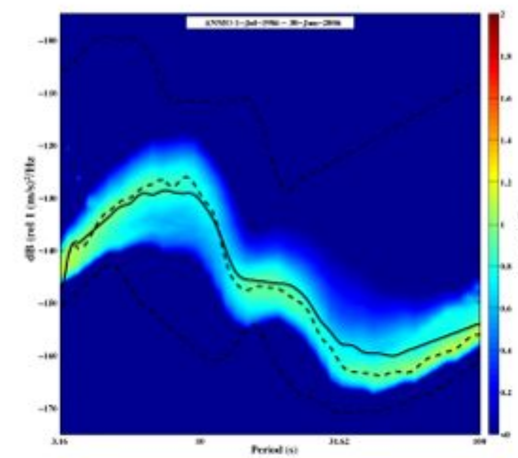


Figure 6.6-4: Examples of seismoscope recordings.

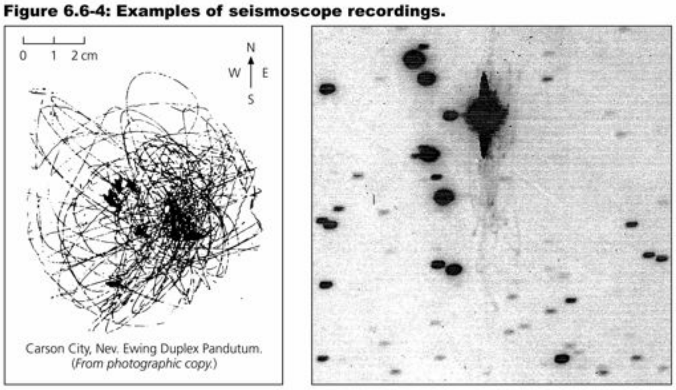


Figure 6.6-5: Illustration of an electromagnetic seismograph.

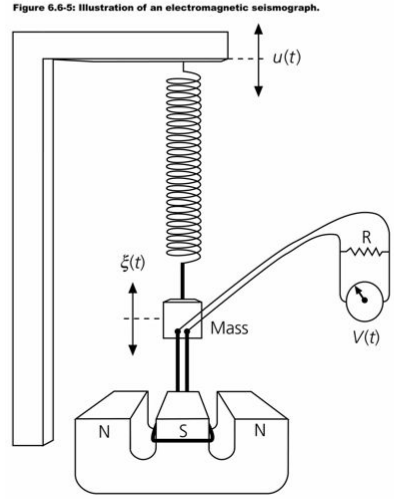


Figure 6.6-6: Coupling of the transducer of an electromagnetic seismograph to a galvanometer.

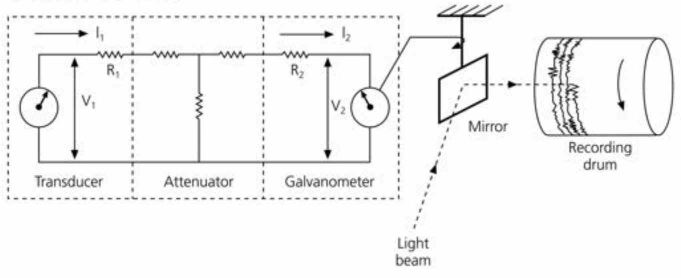


Figure 6.6-7: Responses of the components of an electromagnetic seismograph.

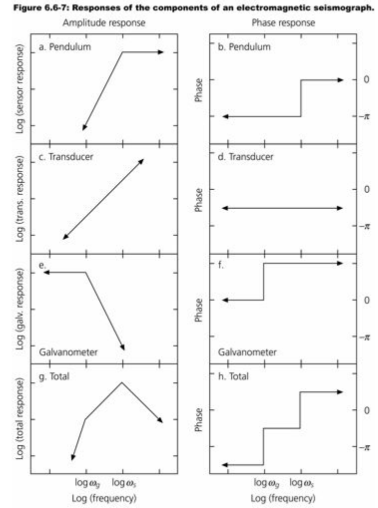


Figure 6.6-8: Instrument responses for several types of seismometers.

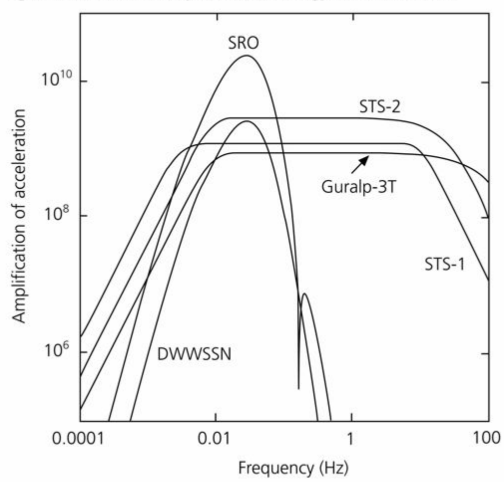
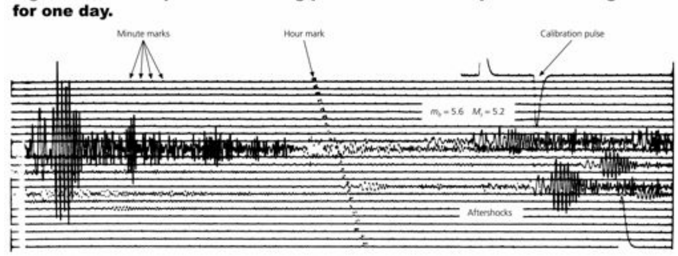


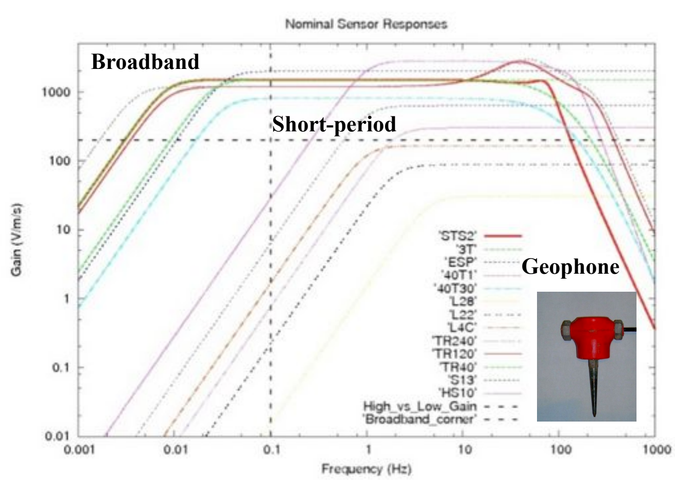
Figure 6.6-9: Sample WWSSN long-period vertical-component seismogram for one day.



Passive Source: naturally occurring seismic events at depth, or ambient background noise

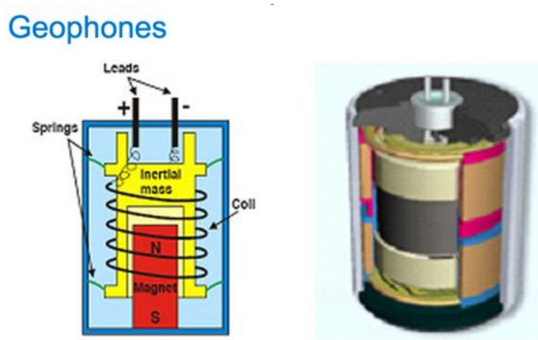
Streckeisen STS-2 Broadband Sensor

Home ◇ Instrumentation ◇ Sensors ◇ Broadband



https://www.passcal.nmt.edu/content/instrumentation/sensors/sensor-

Geophone: a device that converts ground motion into

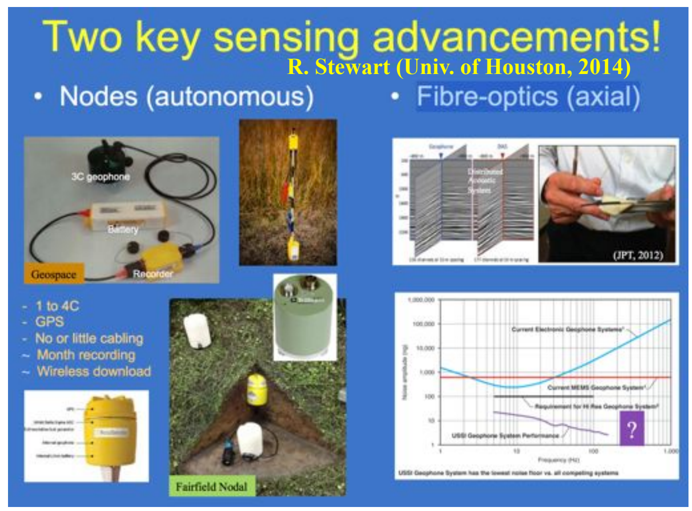


Recording Differences

- Active – mostly in triggered mode (short-period of recording time), very high sampling rate (500 to 5000 sample/s), up to 10,000 units per survey
- Passive – typically in continuous mode (a few months to a few years), various sampling rate (1 to 100 sample/s), a few tens (up to hundreds) units per experiment

Traditional Active-Source Deployment

Figure 1. Seismic field technician with 20+ Kg cable. Carrying this heavy weight on rough terrain is hazardous, even with experienced personnel.



New types of sensor/recording system

Controller-processor

Flash memory

Li-ion Batteries (up to months of recording)

GPS Receiver

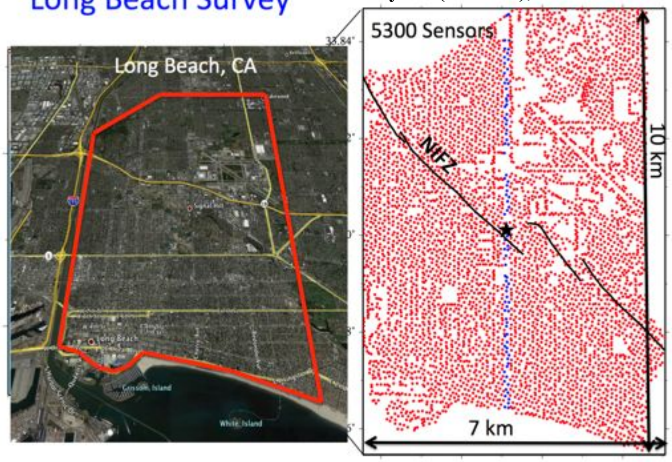
24bit A/D Convertor

Internal Geophone

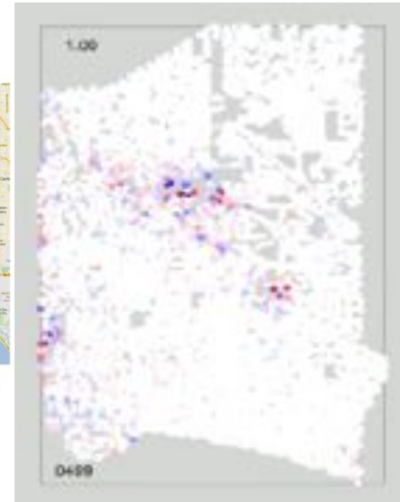
Spike

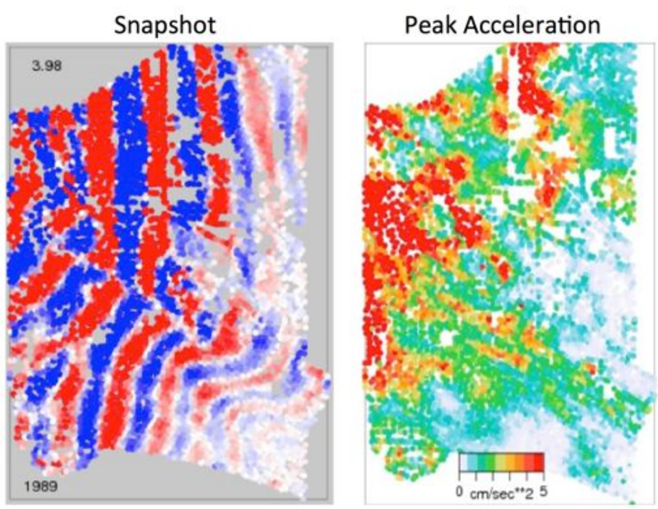
Long Beach Survey

Rob Clayton (Caltech), NodalSeismic

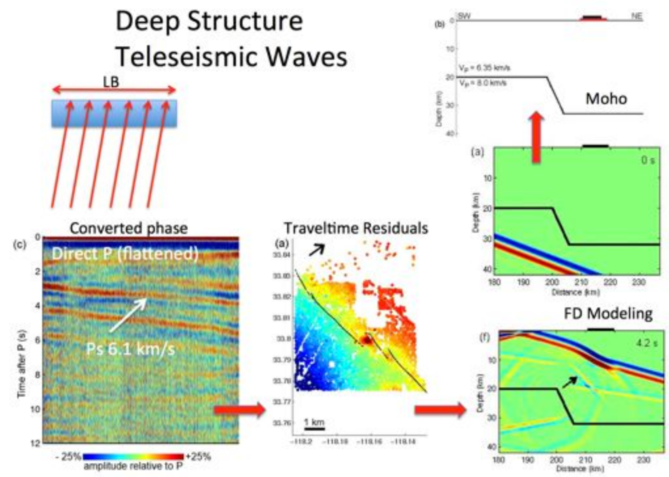


Carson Earthquake
2011/05/14
Mb 2.5 depth 12 km



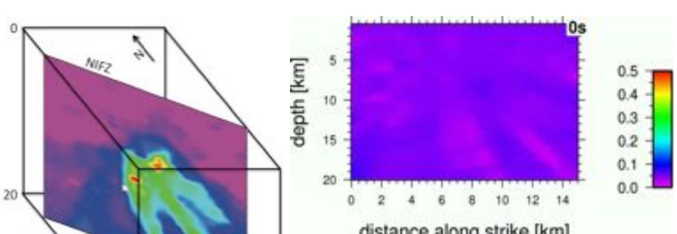


Deep Structure
Teleseismic Waves



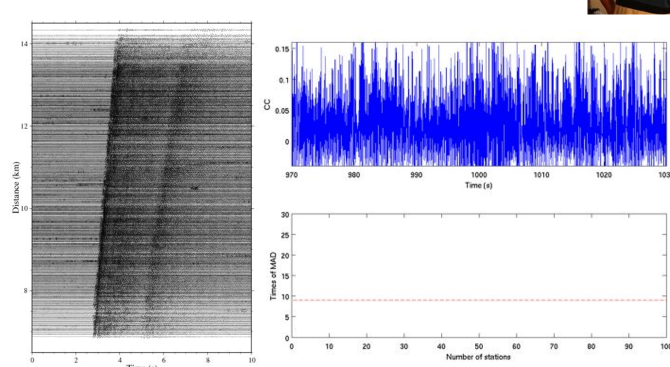
Schmandt and Clayton, 2013, JGR

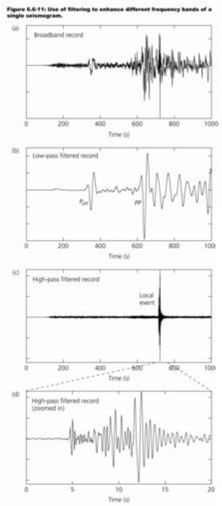
Mapping Micro Slip on a Fault by Back-projection



Asaf Inbal (Caltech)

Waveform matched filter detection of microearthquakes





Examples of broadbroad recordings with both long-period waves and high-frequency local signals.

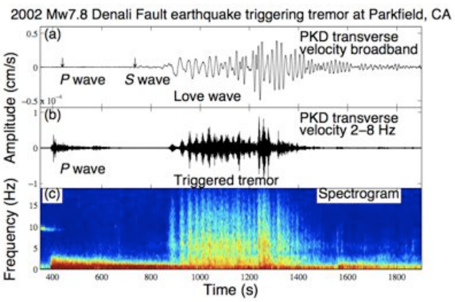


Figure 6.6-16: Station map of the Federation of Digital Broad-Band Seismographic Networks (FDSN).

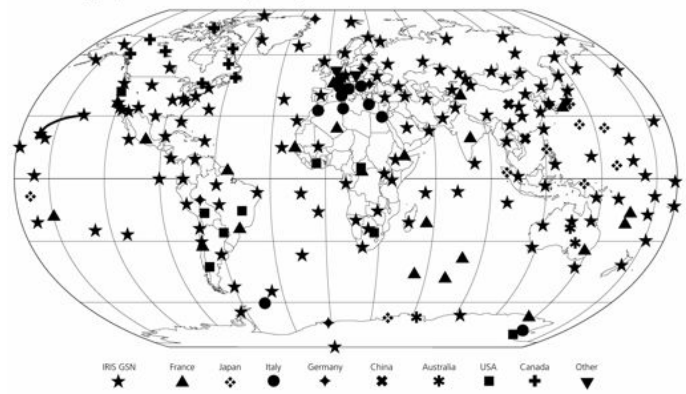
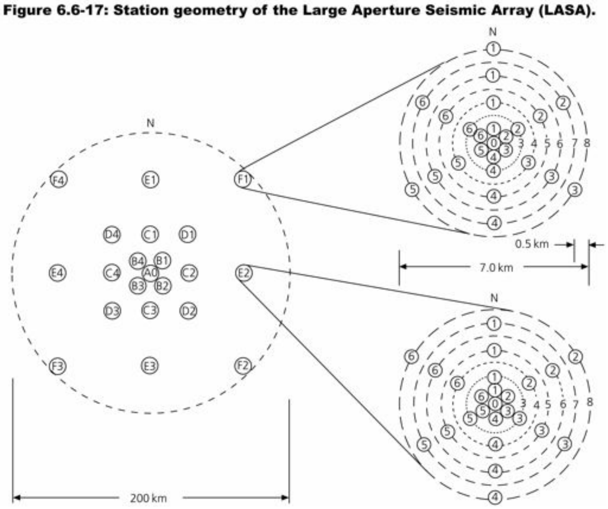
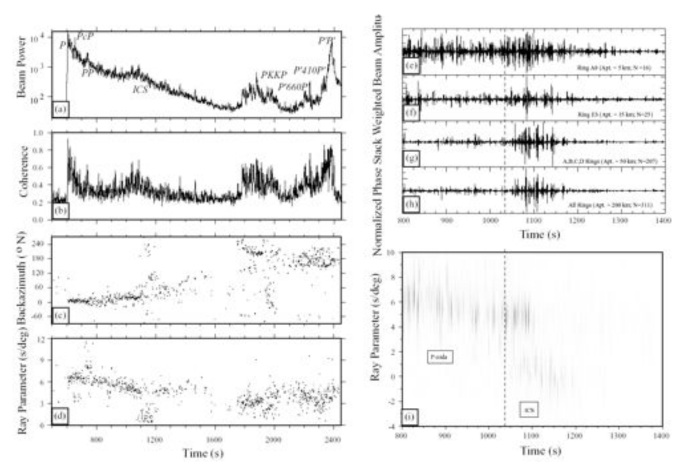


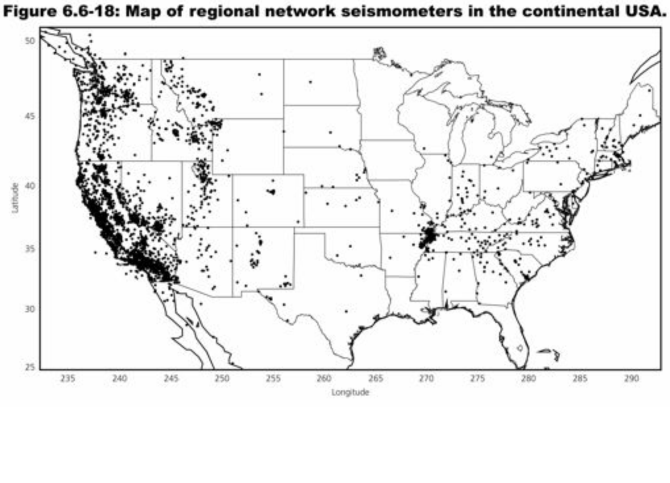
Figure 6.6-17: Station geometry of the Large Aperture Seismic Array (LASA).





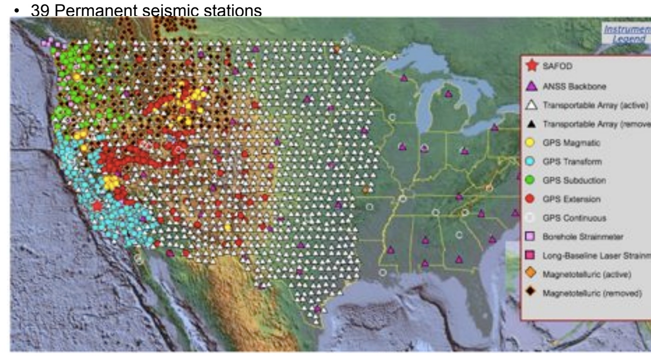
Peng et al. (JGR, 2008)

Figure 6.6-18: Map of regional network seismometers in the continental USA.



EarthScope Instrumentation

- 3.2 km borehole into the San Andreas Fault
- 875 permanent GPS stations
- 175 borehole strainmeters
- 5 laser strainmeters
- 39 Permanent seismic stations
- 400 transportable seismic stations occupying 2000 sites
- 30 magneto-telluric systems
- 100 campaign GPS stations
- 2400 campaign seismic stations



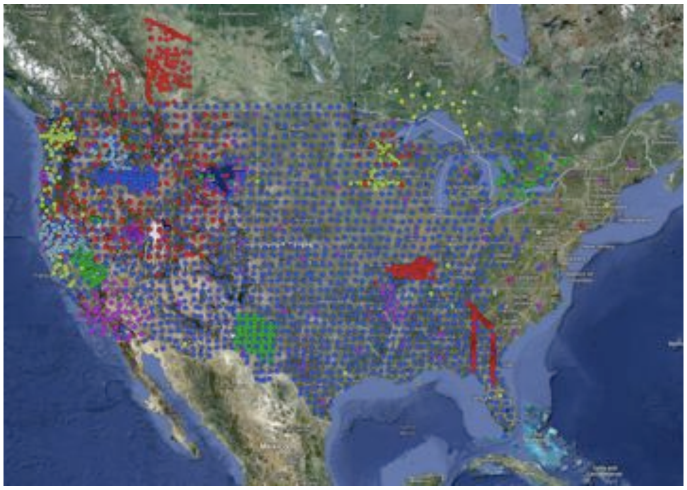


Figure 6.6-12: Diagram showing the analog-to-digital (ADC) process.

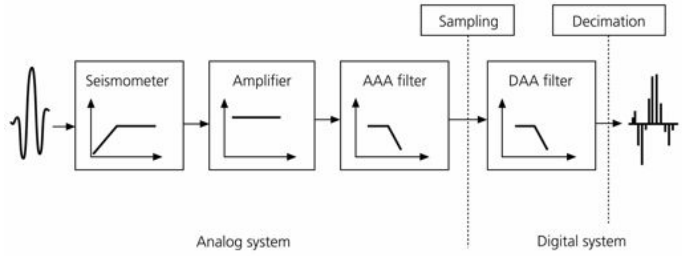


Figure 6.6-13: Example of a FIR filter and its effects on a seismogram.

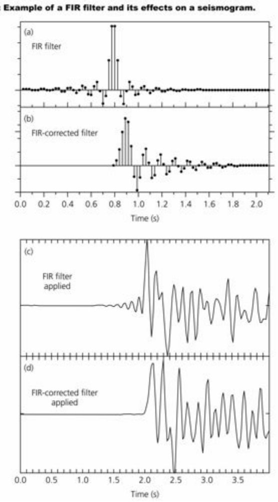


Figure 6.6-14: Relation between displacement, velocity, and acceleration in the time domain.

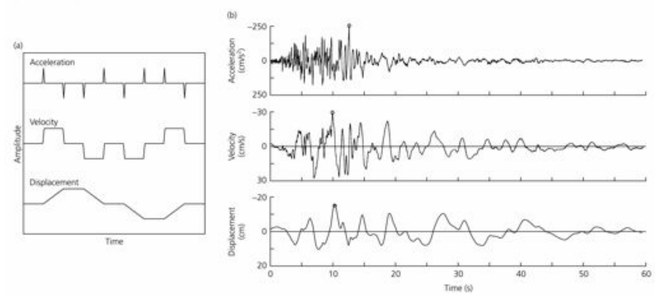


Figure 6.6-15: Relation between displacement, velocity, and acceleration in the frequency domain.