Seismic Observations in the Washington, D.C. Area With a Raspberry Shake Network

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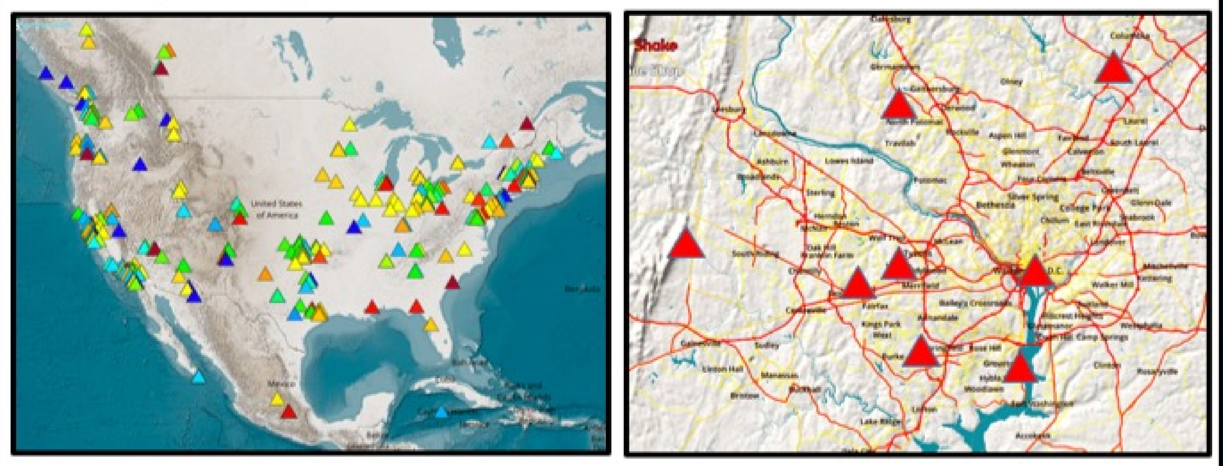
The recent availability of the low-cost, turnkey, IoT Raspberry Shake seismograph has resulted in numerous seismic installations in areas that might not normally be thought of as areas of seismic interest. The greater Washington, D.C. area, home to many scientists with backgrounds in geophysics and acoustics, now includes six Raspberry Shake stations covering an area of approximately 60X35 km. These units are typically installed in home basements in suburban areas and are subject to mechanical noises from HVAC and other in-home activity, as well as local traffic. Measured ambient noise levels in the 1-10 Hz band are usually 20-30 dB higher than, for example, the very quiet seismic station TKL at Tuckaleechee Caverns, TN. In spite of these high noise levels, regional and teleseismic events are well recorded across the network and provide the opportunity to fill in seismic monitoring coverage gaps, as well as the potential for inversion for Earth structure.

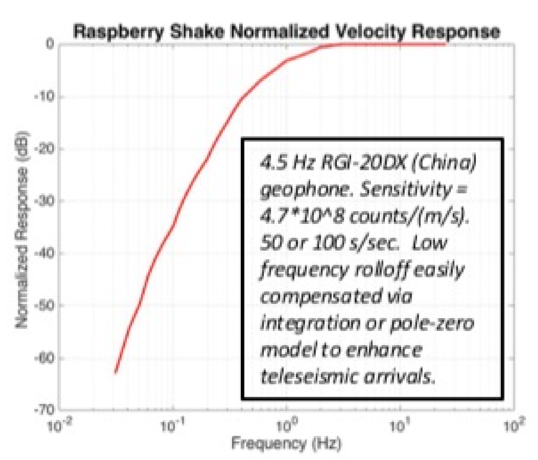
An example of a well-recorded regional event is the November 30, 2017 Dover, DE earthquake, located approximately 150 km east of Washington, D.C. Regional seismic phases are highly correlated across the network below 10 Hz and enable velocity calculations across short distances. We measure a P_n velocity of 8.4 km/sec and a P_g velocity of 5.9 km/sec with some amplitude variations likely due to site effects. Higher frequencies are observed for the west stations on the Piedmont than for stations to the east on the Coastal Plain. We also observe L_g phases for the larger events in Oklahoma. Teleseismic events of magnitude greater than 5.5 from North and Central America are also well-recorded across the network. When corrected for instrument response or simply integrated to displacement, precise phase and group velocity measurements can be made for the Rayleigh waves. With station separations from 6 to 50 km, as more data are accumulated, the potential for structural inversion, tomography and interferometry comes into play.

Raspberry Shake Network & Instrumentation

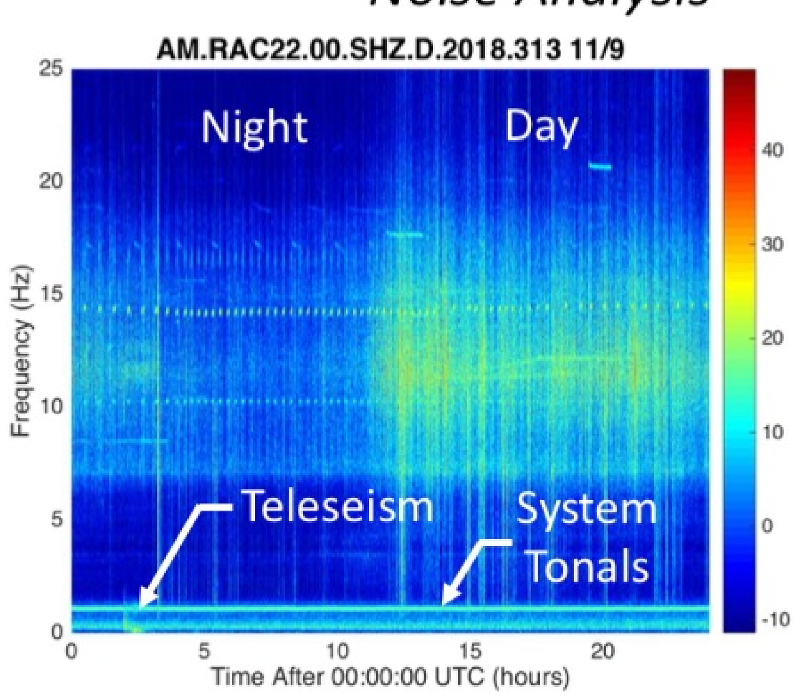


Waveform data downloadable from SeisComP3 FDSNWS server or via USGS Swarm

Raspberry Shake available in a number of configurations: 1-C, 3-C, Strong Motion, Infrasound. Inexpensive.



Noise Analysis



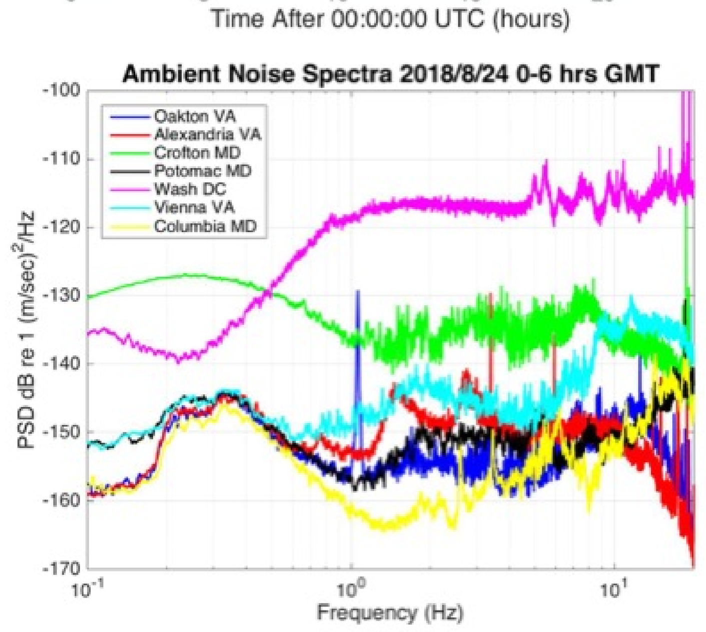
Typically suburban home basement installations

Subject to HVAC, appliance, traffic noise, unidentified clutter

Most acoustic noise (e.g. planes) is out of band

Helps to isolate unit from home power line tonal and wandering line noise

Some older units suffer from low level digitization noise at 1Hz



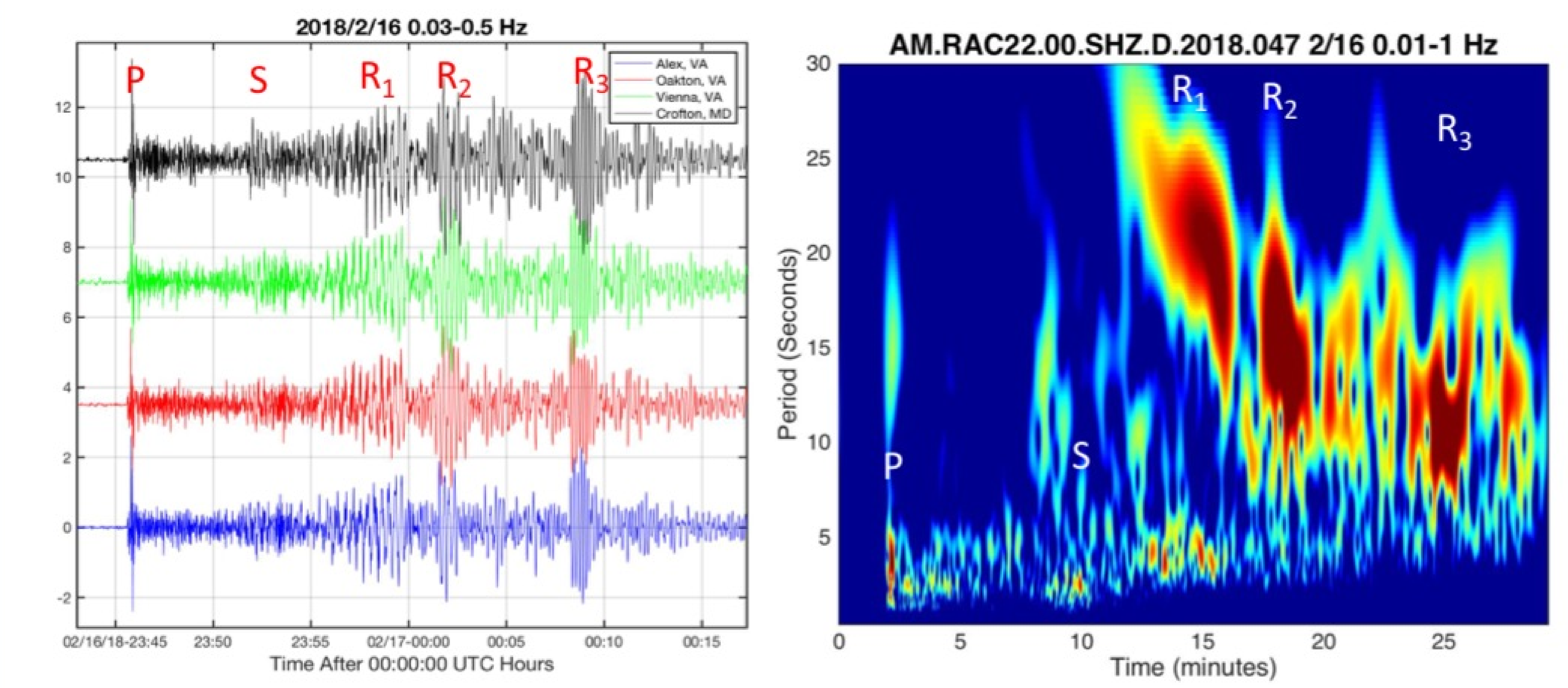
Washington DC station RF1CA, located downtown, is very noisy but does record large teleseisms.

Greater DC area has been seismically quiet during 2017-18, only Delaware & VA event recordings so far.

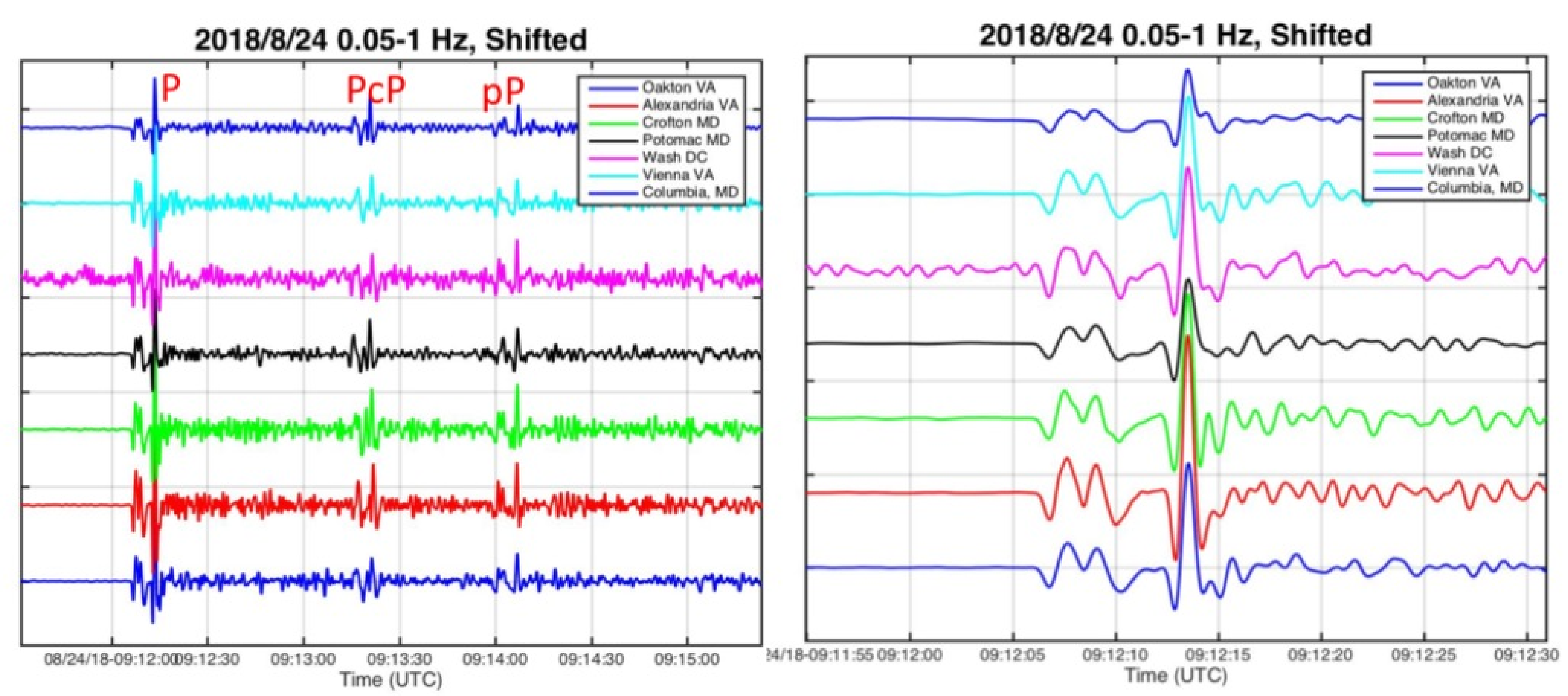
Most teleseisms in North & Central America above magnitude 6 are well recorded

Teleseismic Shake Recordings

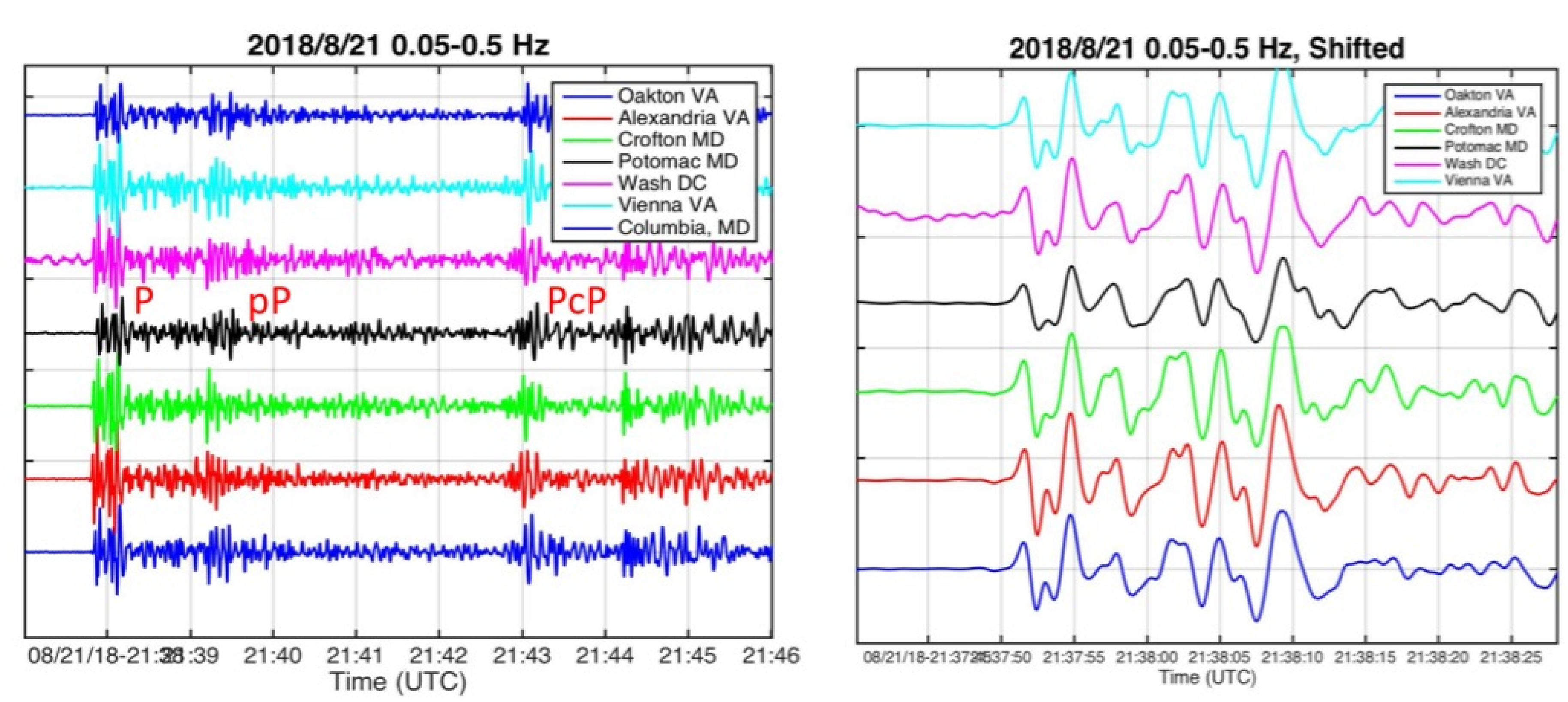
Feb. 26, 2018 Mexico, Mag 7.2, Δ = 3150 km, Surface Wave Dispersion Measurements



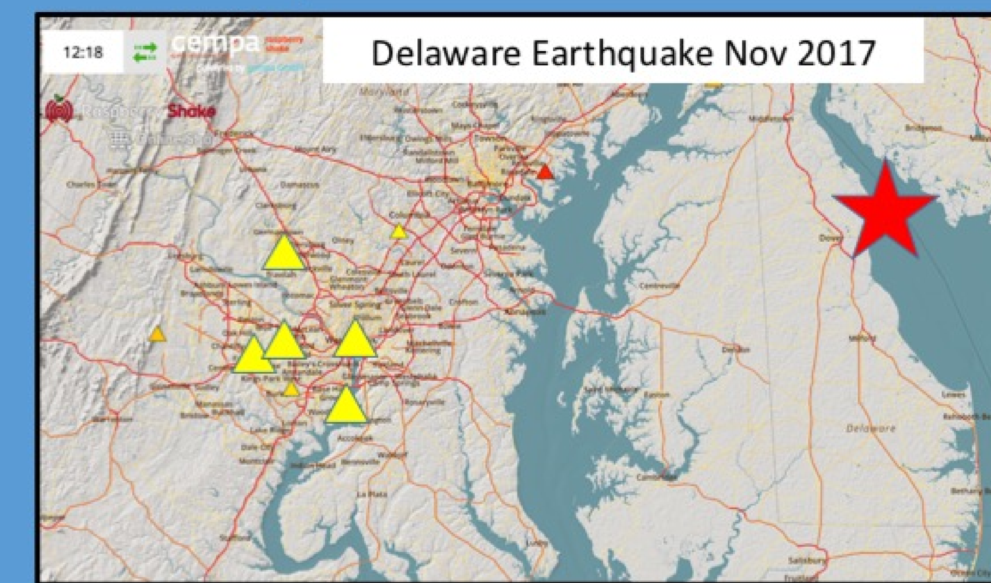
Aug. 24, 2018 Peru, Mag 7.1, Δ = 5560 km, 600 km deep, Depth Phases & Coherence

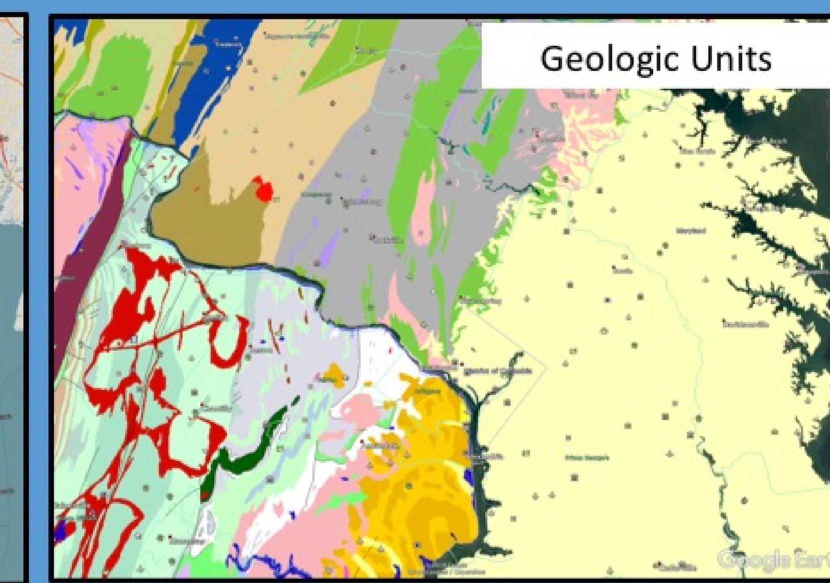


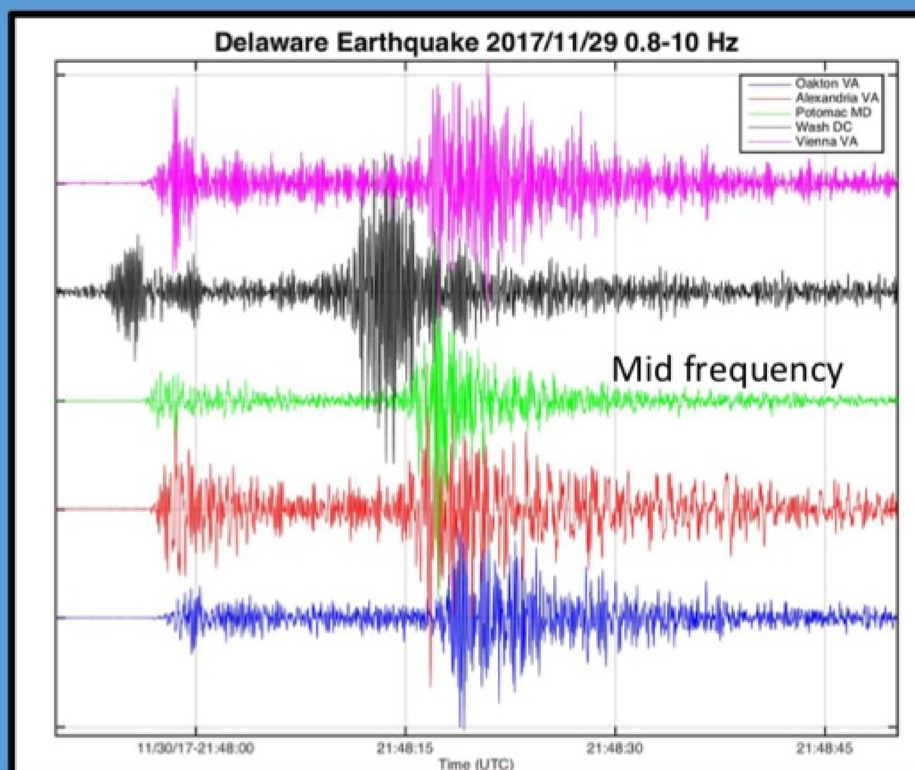
Aug. 21, 2018 Venezuela, Mag 7.3, Δ = 3380 km, 150 km deep, Depth Phases & Coherence

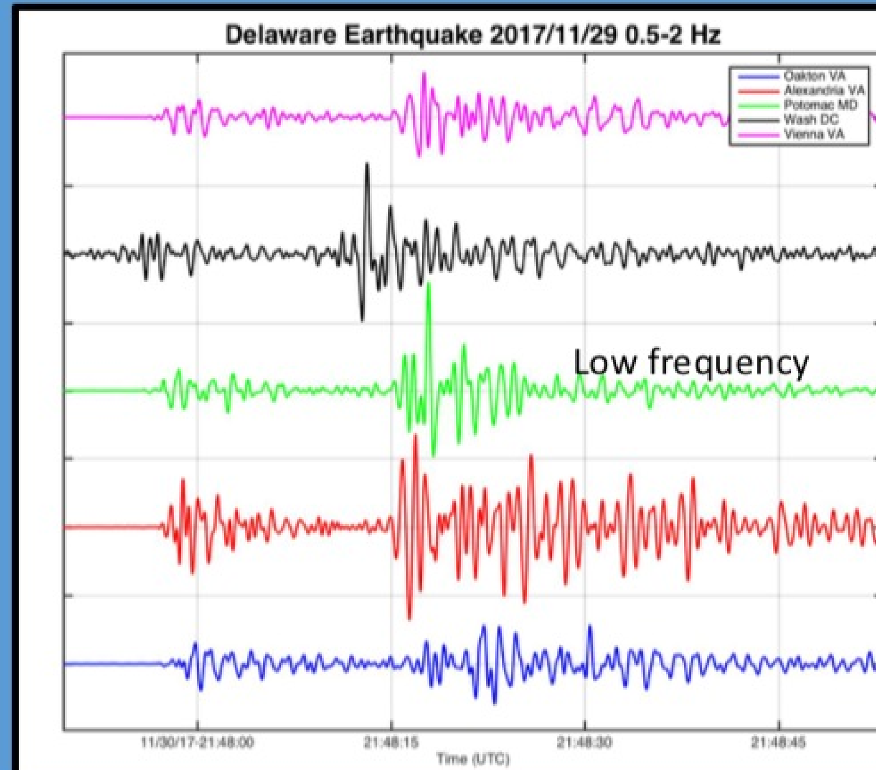


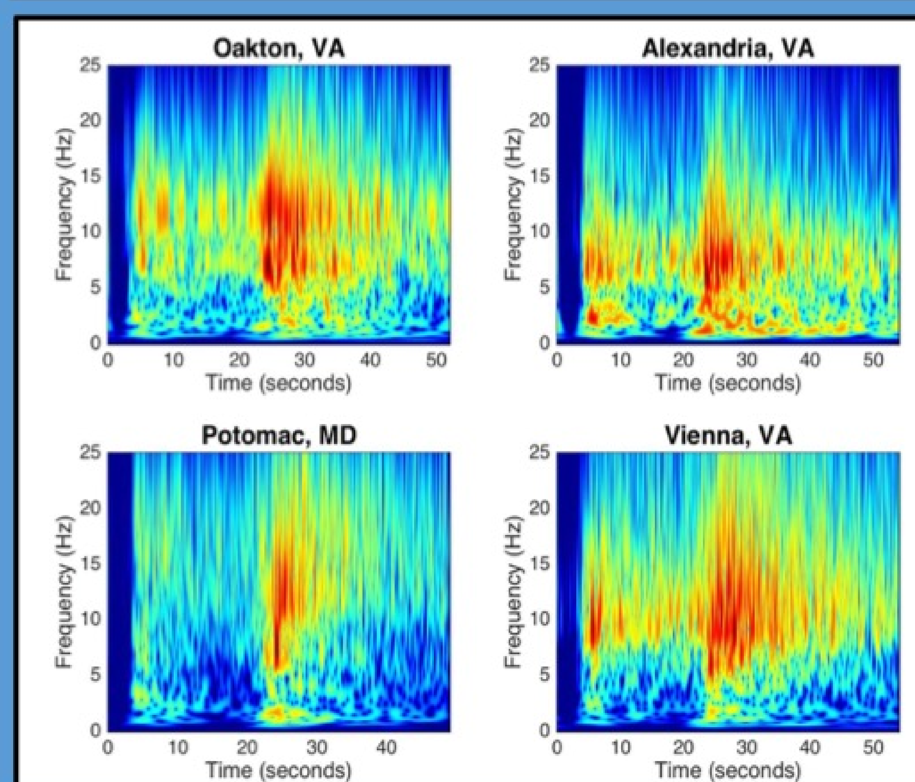
Local/Regional Shake Recordings

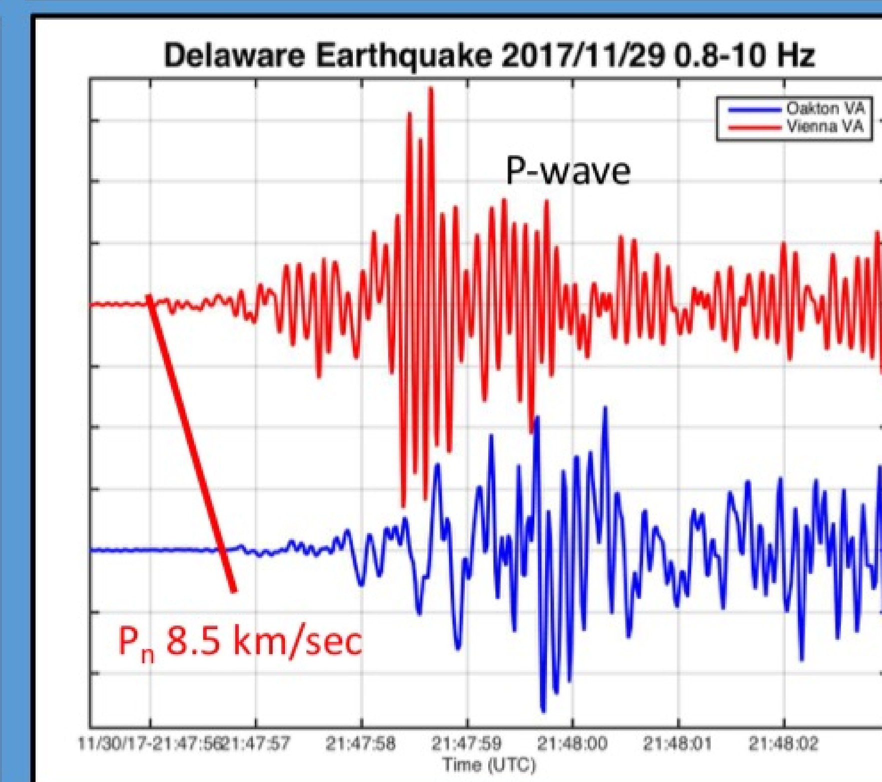




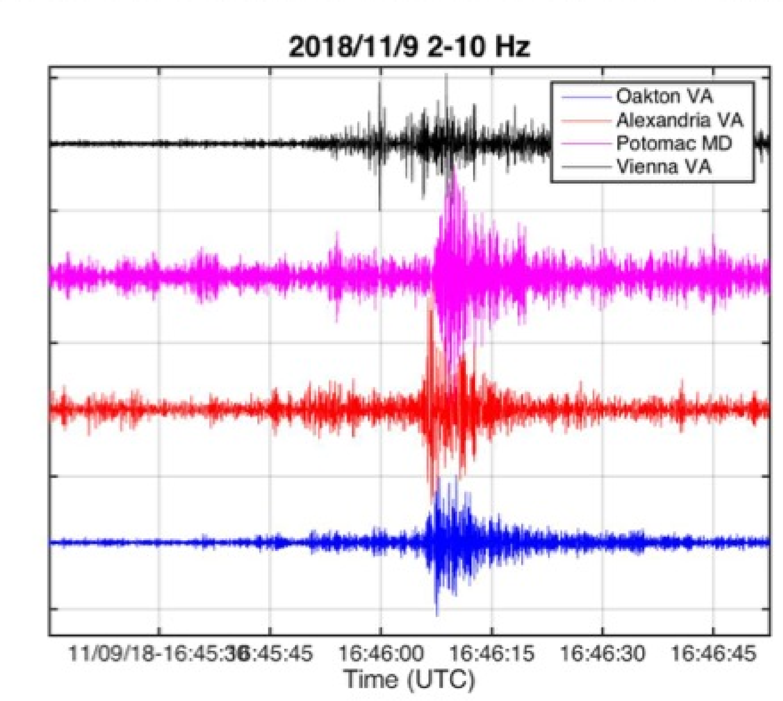








Local Earthquake: Goochland, VA, Mag 2.5



Research & Educational Opportunities with this Growing Dataset

- Inversion of surface wave dispersion for structure
- Surface wave tomography for velocity and attenuation
- F-k processing possible as station density increases
- Receiver functions
- Correlation with known structure
- Waveform correlation processing
- Web display of data for local schools