Regional Spectral Analysis of Moderate Earthquakes in Northeastern North America

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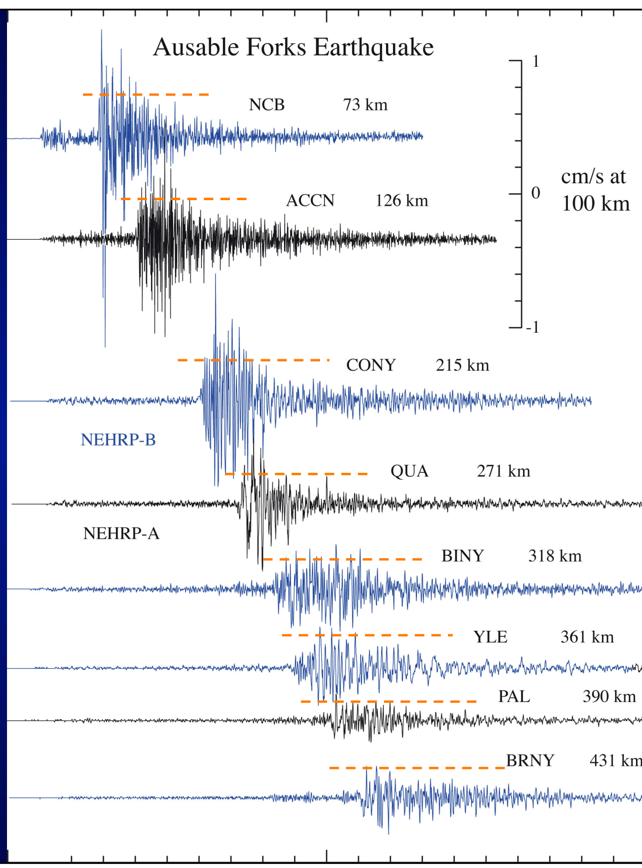
We analyzed the Virginia earthquake using the same technique that we used for the Canadian earthquakes, considering stations $r < 600$ km

✧ We analyzed spectra from many new stations. The Mid-Atlantic broadband and accelerograph stations are generally sited on stiff rock instead of hard rock and can be somewhat quirky

✧ We had to consider directivity, which had not been necessary for the Canadian earthquakes



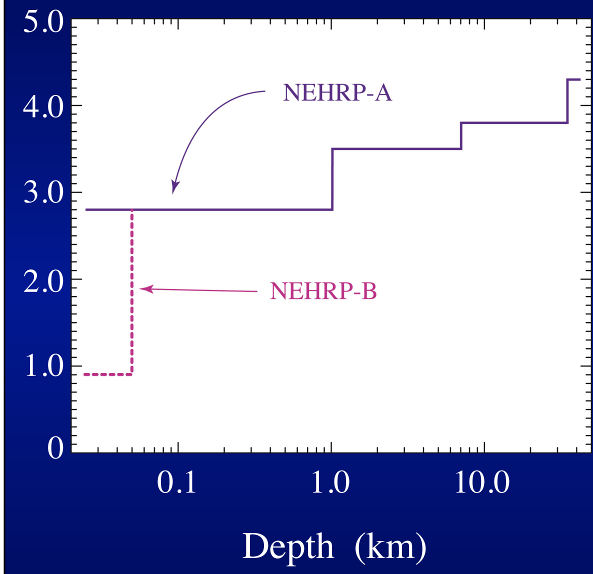
"Record Section" EW-Component Seismograms

Amplitudes Normalized for Distance as $r^{1/2}$

Hard Rock (NEHRP-A) & Soft Rock (NEHRP-B)

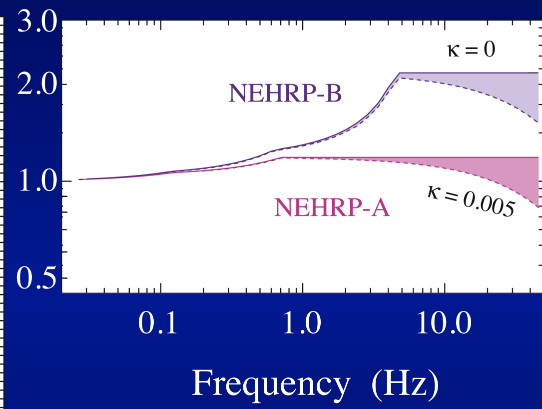
Avoid resonant sites (sediment on rock)

S-Wave Velocity (km/s)



There are approximately twice as many NEHRP-A as B sites.

Site Amplification $S_I(f)$



Using only NEHRP-A and B stations greatly reduces the site variability. NEHRP-B sites can exhibit resonances.

$$|\dot{u}(r,f)| = \frac{\vec{F}F^S S(f)}{g(r,r_o)} \exp(-\pi f r/\beta Q) \frac{\dot{M}_o(f)}{4\pi\rho_o\beta_o^3}$$

FF^s - free surface amplification and average radiation pattern

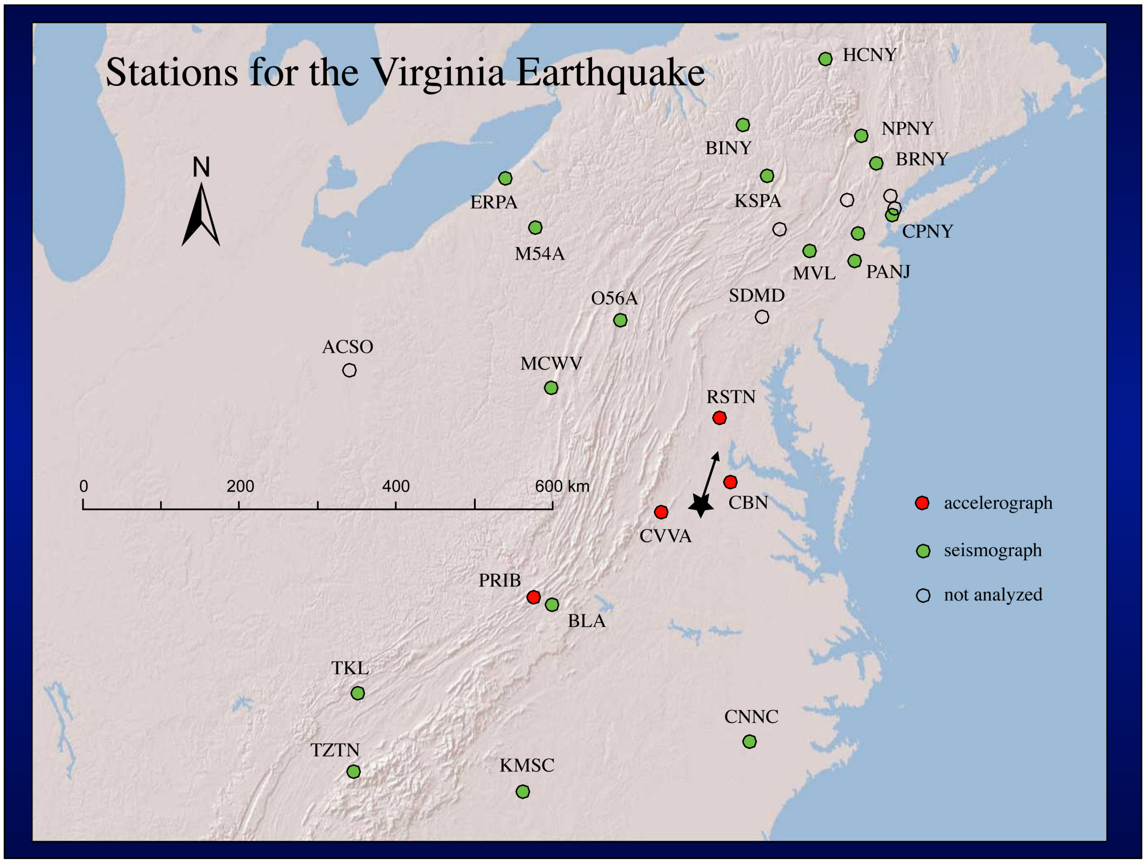
$S(f)$ - site amplification computed using average impedance from Boore and Joyner (1997)

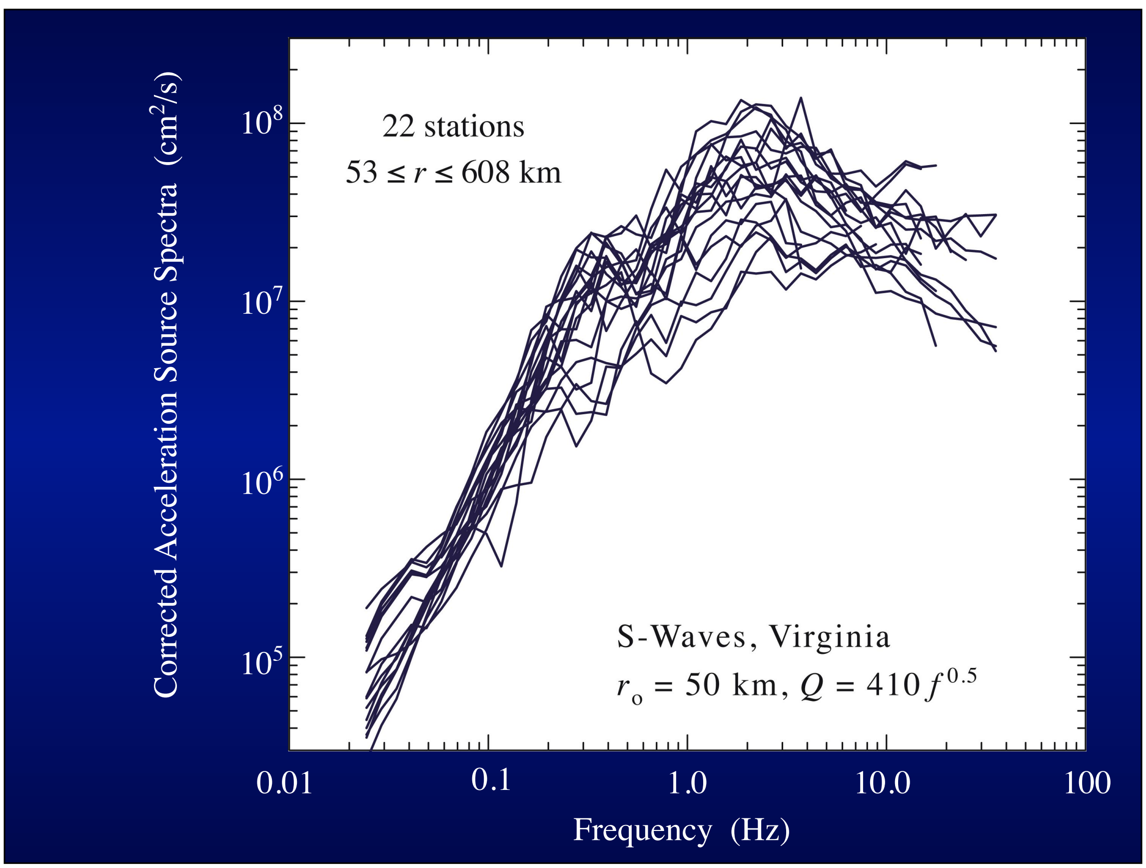
$$g(r,r_o) = \begin{cases} r & r \le r_o \\ (r_o r)^{1/2} & r > r_o \end{cases}$$

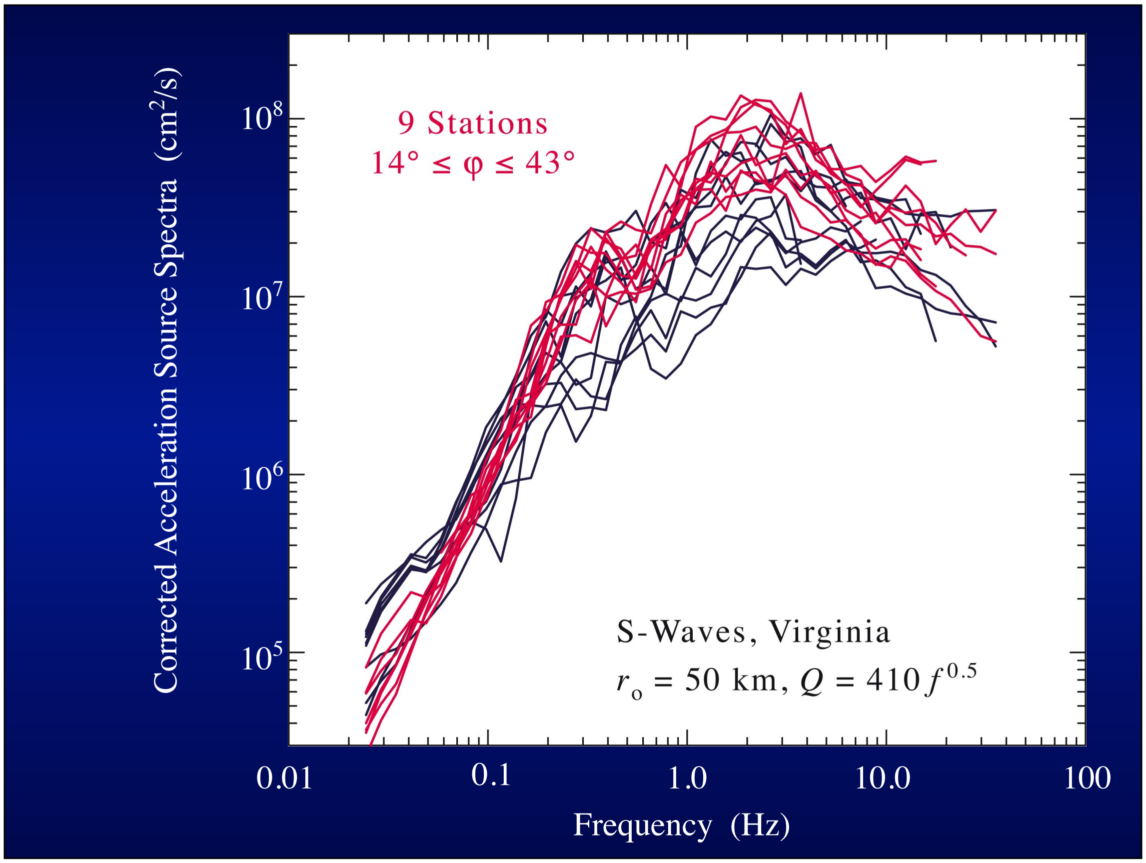
- geometrical spreading from Street et al. (1975) with r_o = 50 km

$Q = Q_o f^q$ - anelastic attenuation form of Aki and Chouet (1975)

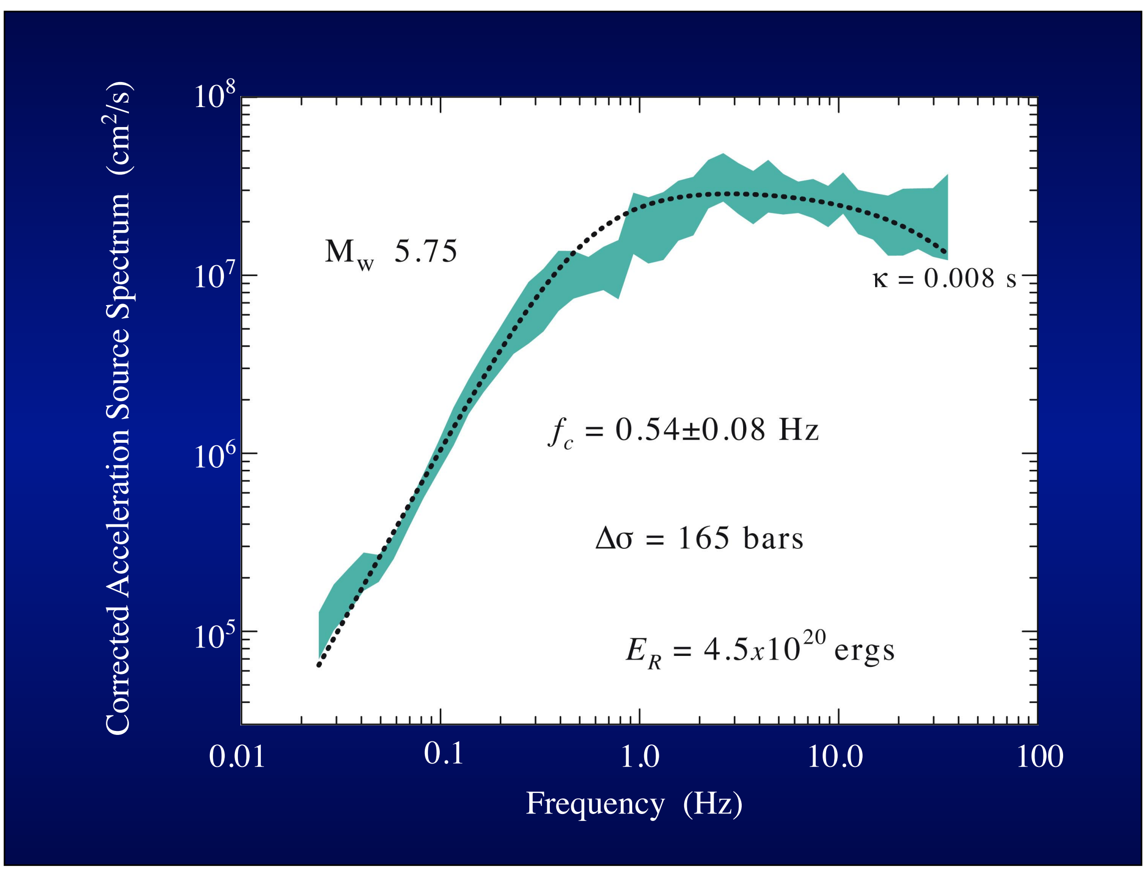
$\rho_o\ \beta_o$ - density and S-wave velocity at the source depth


Stations for the Virginia Earthquake
N
0
200
400
600 km
HCNY
BINY
NPNY
BRNY
ERPA
KSPA
CPNY
M54A
MVL
PANJ
O56A
SDMD
ACSO
MCWV
RSTN
CBN
CVVA
PRIB
BLA
TKL
CNNC
TZTN
KMSC
accelerograph
seismograph
not analyzed

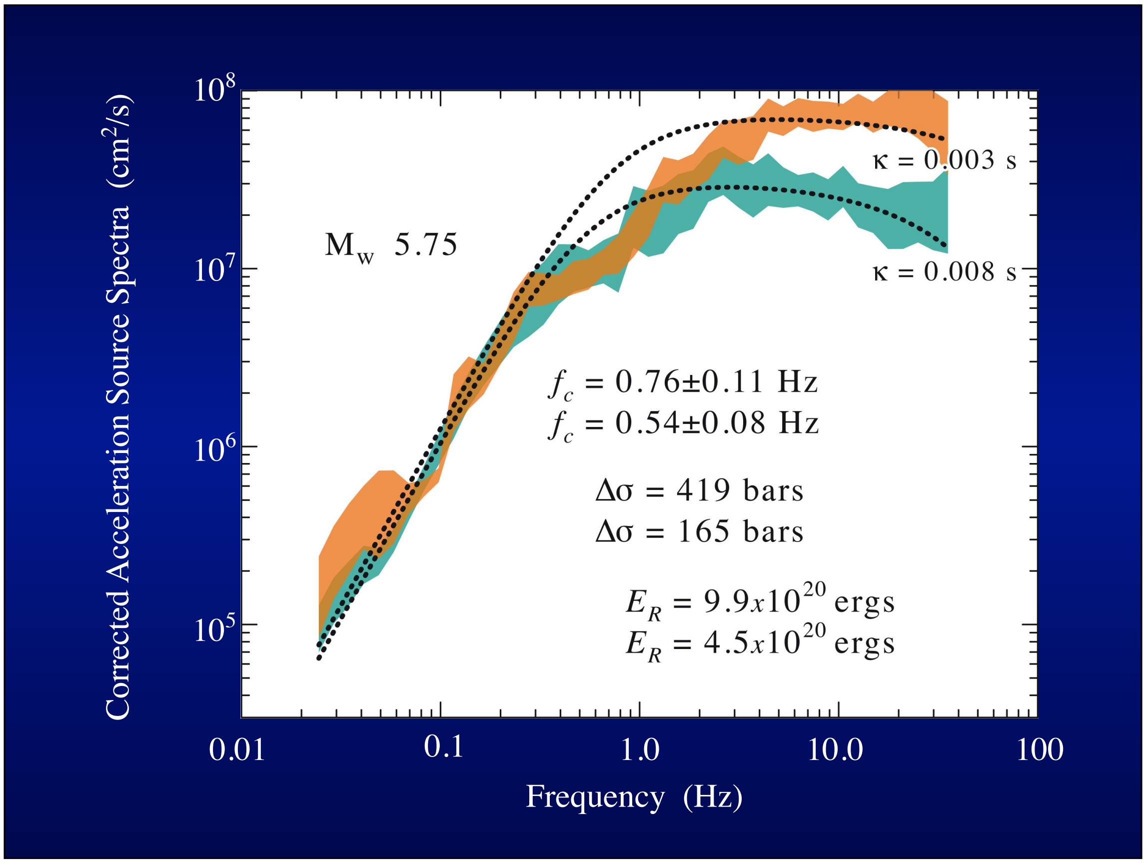

22 stations
$53 \le r \le 608$ km
S-Waves, Virginia
$r_o = 50$ km, $Q = 410 f^{0.5}$
Corrected Acceleration Source Spectra (cm^2/s)
10^8
10^7
10^6
10^5
0.01
0.1
1.0
10.0
100
Frequency (Hz)



9 Stations
14° ≤ φ ≤ 43°
S-Waves, Virginia
r_o = 50 km, Q = 410 $f^{0.5}$
Corrected Acceleration Source Spectra (cm^2/s)
10^8
10^7
10^6
10^5
0.01
0.1
1.0
10.0
100
Frequency (Hz)



M_w 5.75
κ = 0.008 s
f_c = 0.54±0.08 Hz
Δσ = 165 bars
E_R = 4.5x10^{20} ergs
Corrected Acceleration Source Spectrum (cm^2/s)
10^8
10^7
10^6
10^5
0.01
0.1
1.0
10.0
100
Frequency (Hz)



Corrected Acceleration Source Spectra (cm²/s)
10^8
10^7
10^6
10^5
0.01
0.1
1.0
10.0
100
Frequency (Hz)
M_w 5.75
κ = 0.003 s
κ = 0.008 s
f_c = 0.76±0.11 Hz
f_c = 0.54±0.08 Hz
Δσ = 419 bars
Δσ = 165 bars
E_R = 9.9x10^20 ergs
E_R = 4.5x10^20 ergs