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Site Amplification in the Washington DC Area During the Mineral, Virginia Earthquake

1

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Acknowledgements

Piedmont Geotechnical, Inc.

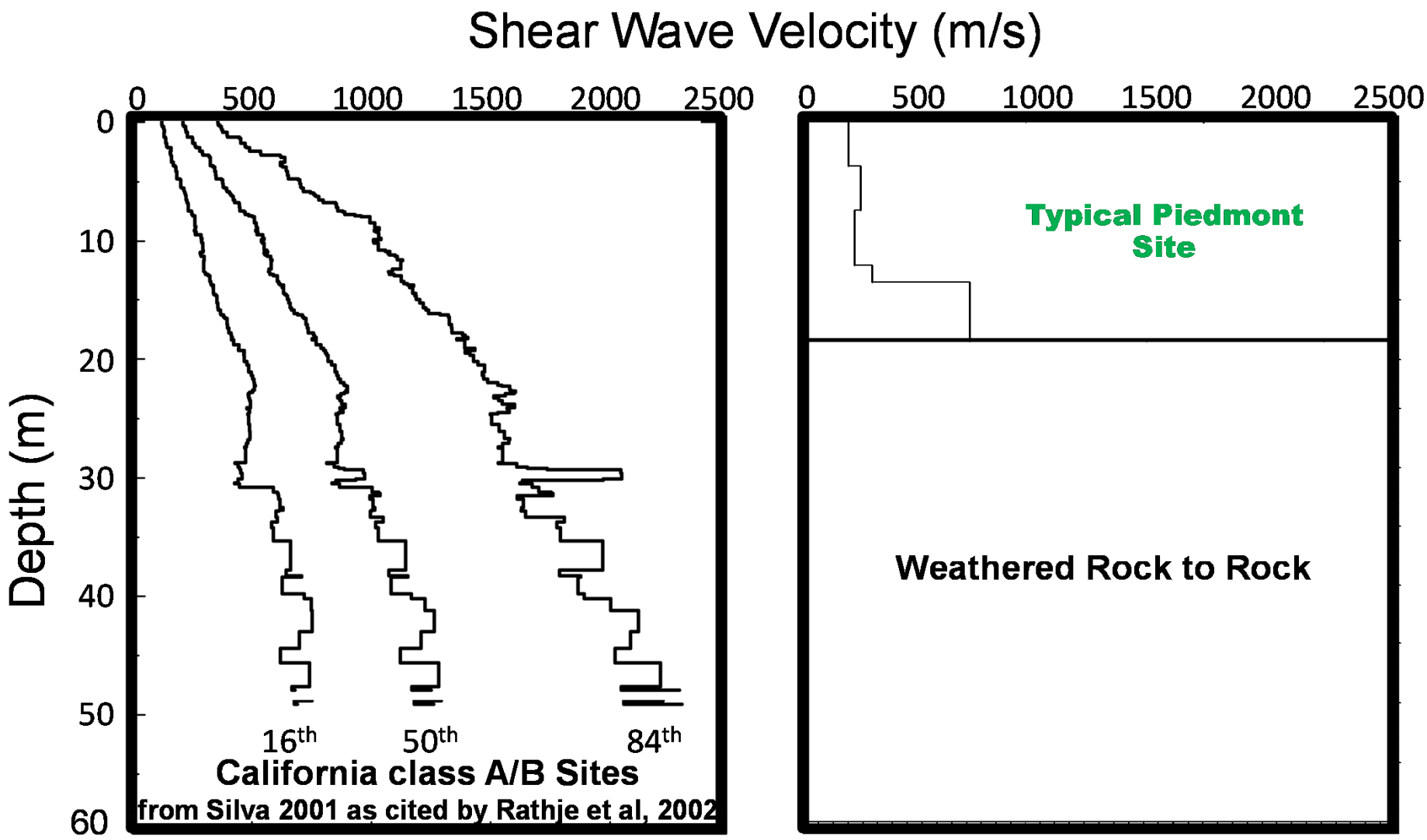
Outline

- Motivation and Background
- NEHRP/IBC Seismic Design Provisions
- DC Region Geology and Study Sites
- Reston Fire Station Recordings
- Conclusions

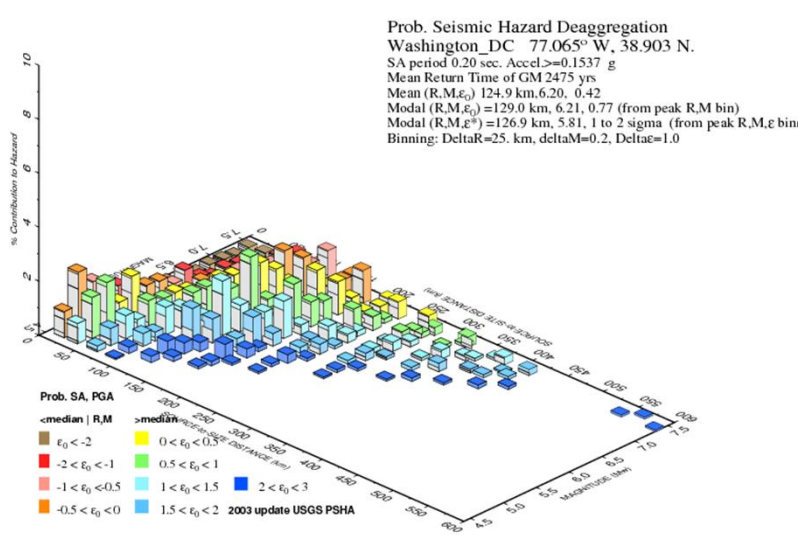
Motivation and Background

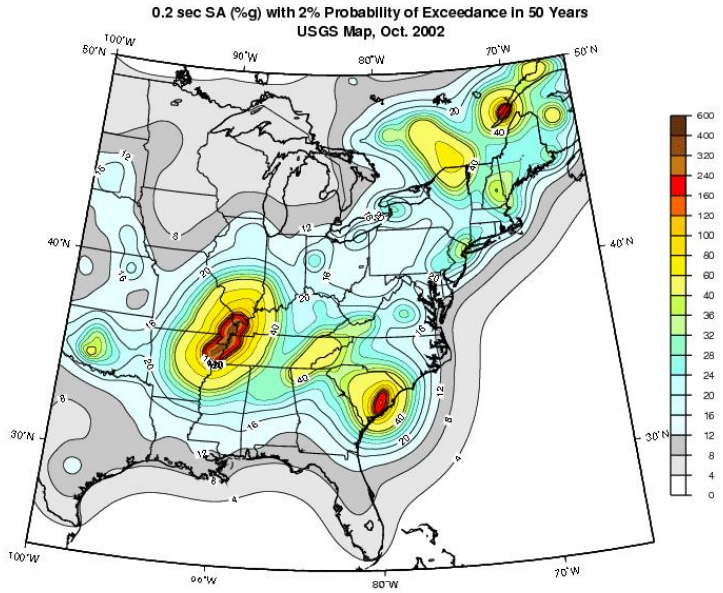
- Wide usage of NEHRP/IBC model based on WUS experience
- Unique CEUS Geology
  - *Hard rock (V_s > 2,000 m/s) close to the ground surface*
  - *Deep sediment stack on hard rock*
- Higher than realized seismic risk
- Lack of seismic experience in CEUS
- Mineral EQ damage focused to Coastal Plain unreinforced masonry

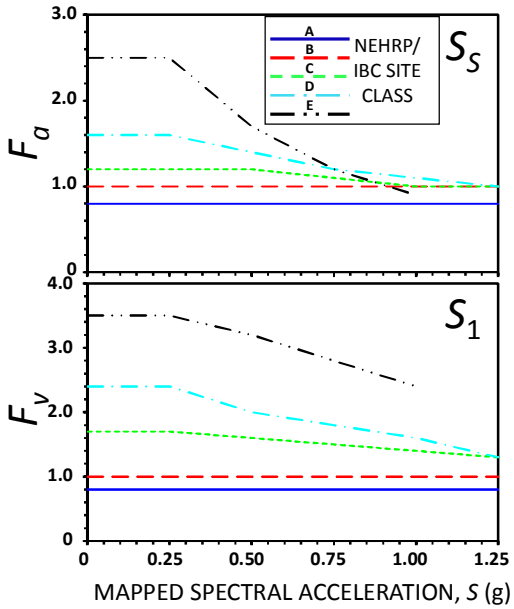
TYPICAL WUS & CEUS PROFILES

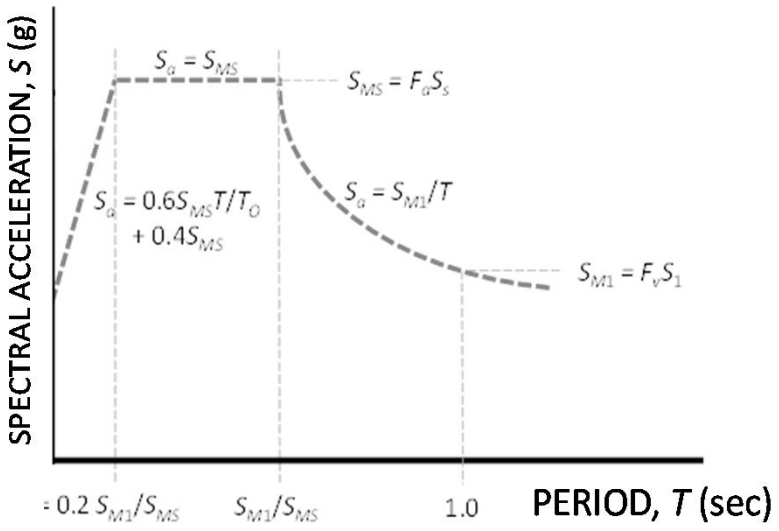


USGS PSHA, Hazard Maps & Smoothed/Capped Spectrum

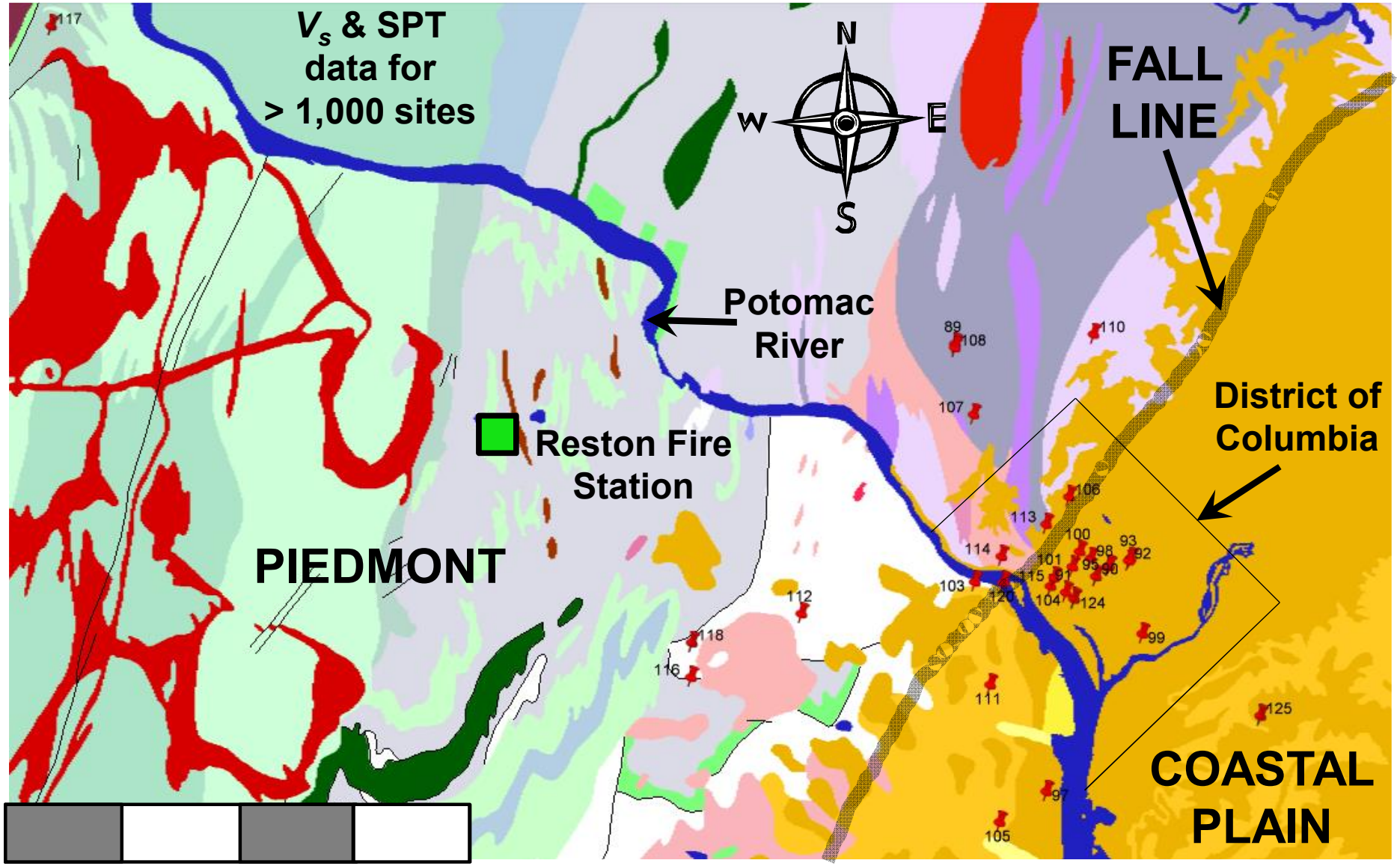


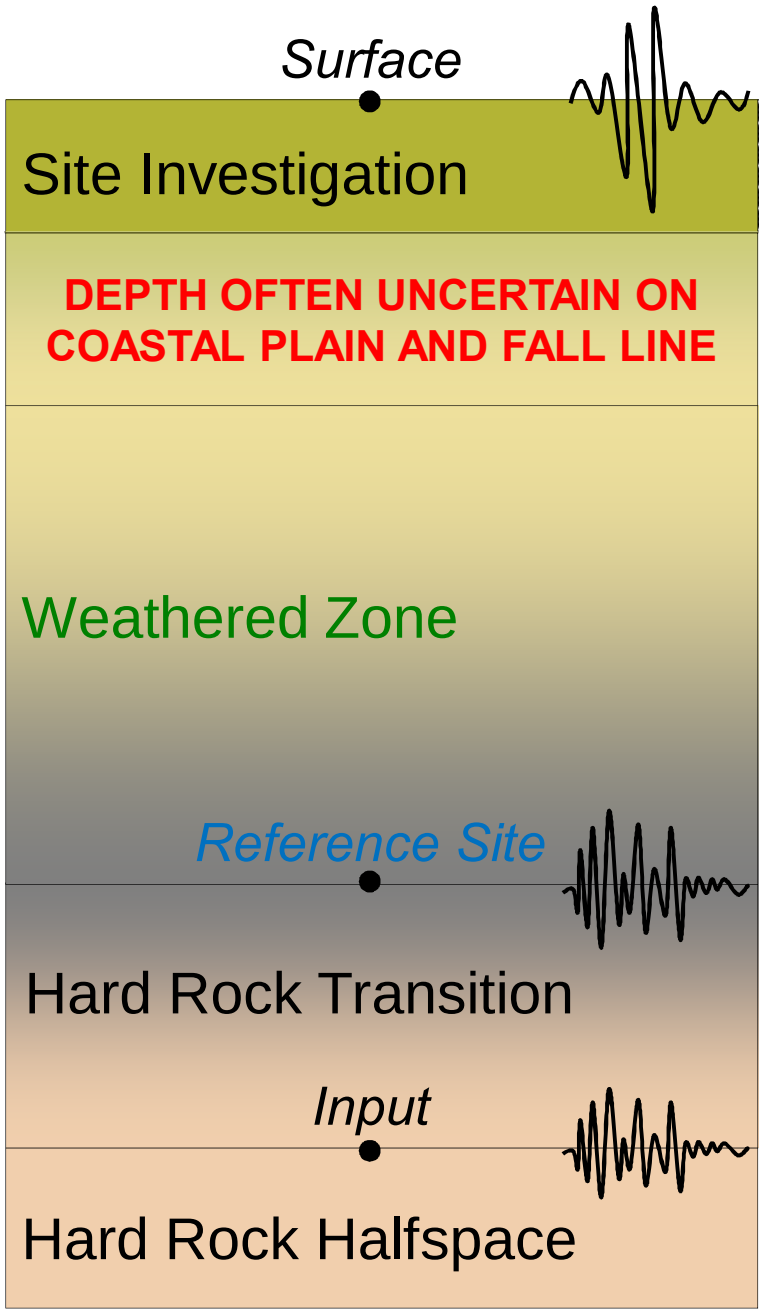






DC Region Geology and Study Sites





Near-Surface Soil to Hard Rock Model:

- Depth to the weathered zone is relatively simple to define in the Piedmonté uncertain for Fall Line and Coastal Plain

- 60m thick weathered zone:
  - Top: V_s = 2,000m/sec , ¨Y= 25kN/m^3
  - Base: V_s = 3,000m/sec, ¨Y= 27kN/m^3

- Reference site (Hashash et al., 2014):
  - V_{sref} = 3,000m/sec
  - ¨Y_{ref} = 27kN/m^3

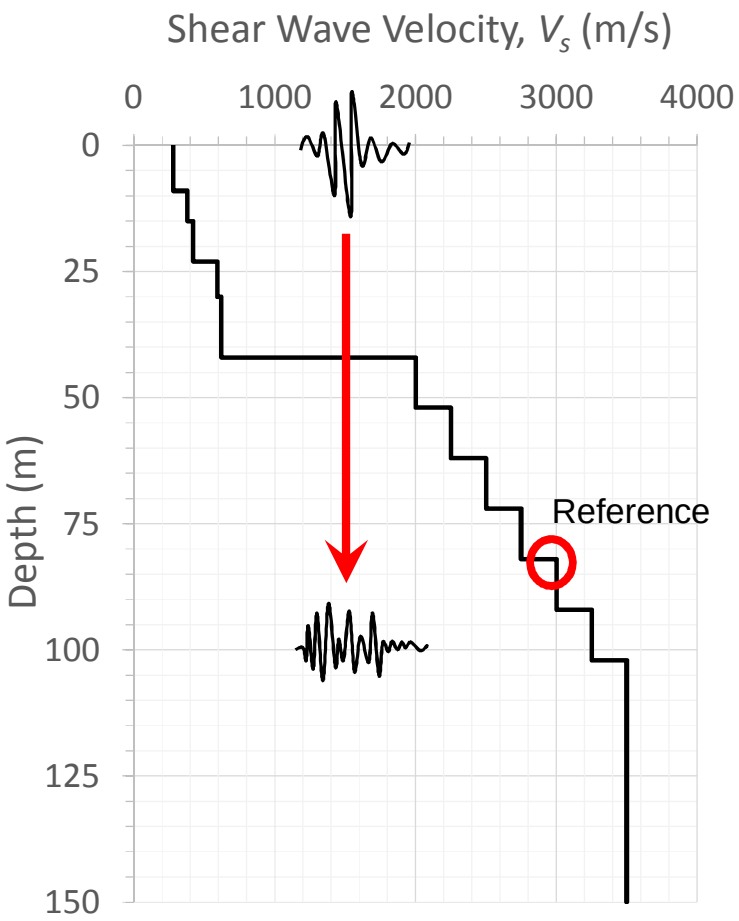
- Hard rock transitions from 3,000 to 3,500m/sec

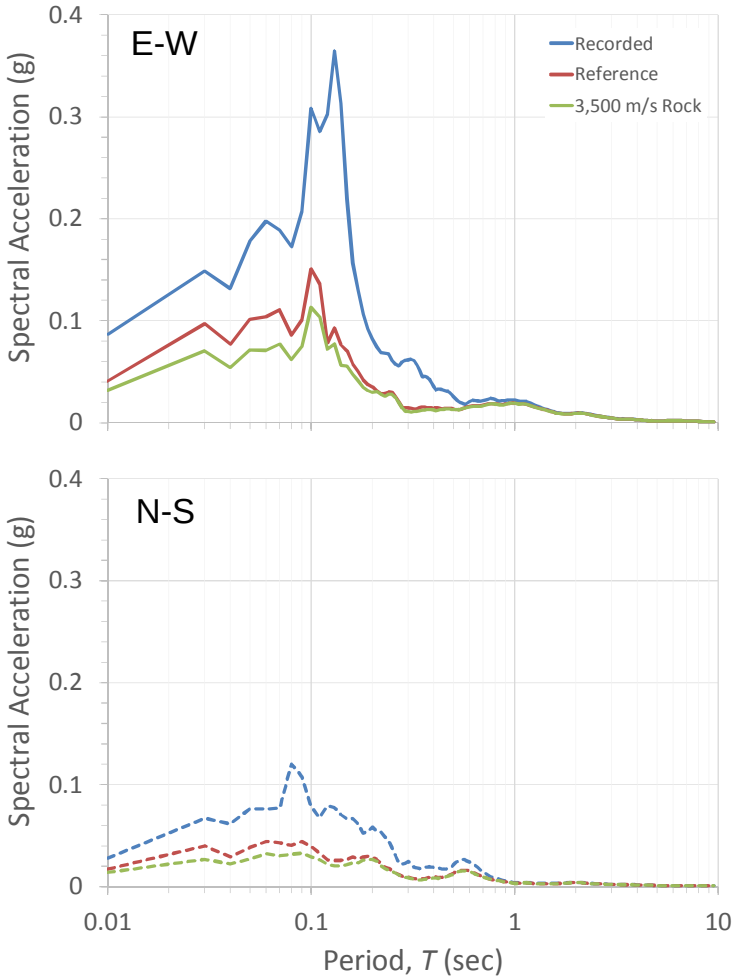
- Hard rock halfspace:
  - V_r = 3,500m/sec
  - ɣ$_r$ = 27kN/m^3
  - 0.03% damping
  - linear

Rock Elevation

Darton (1944)

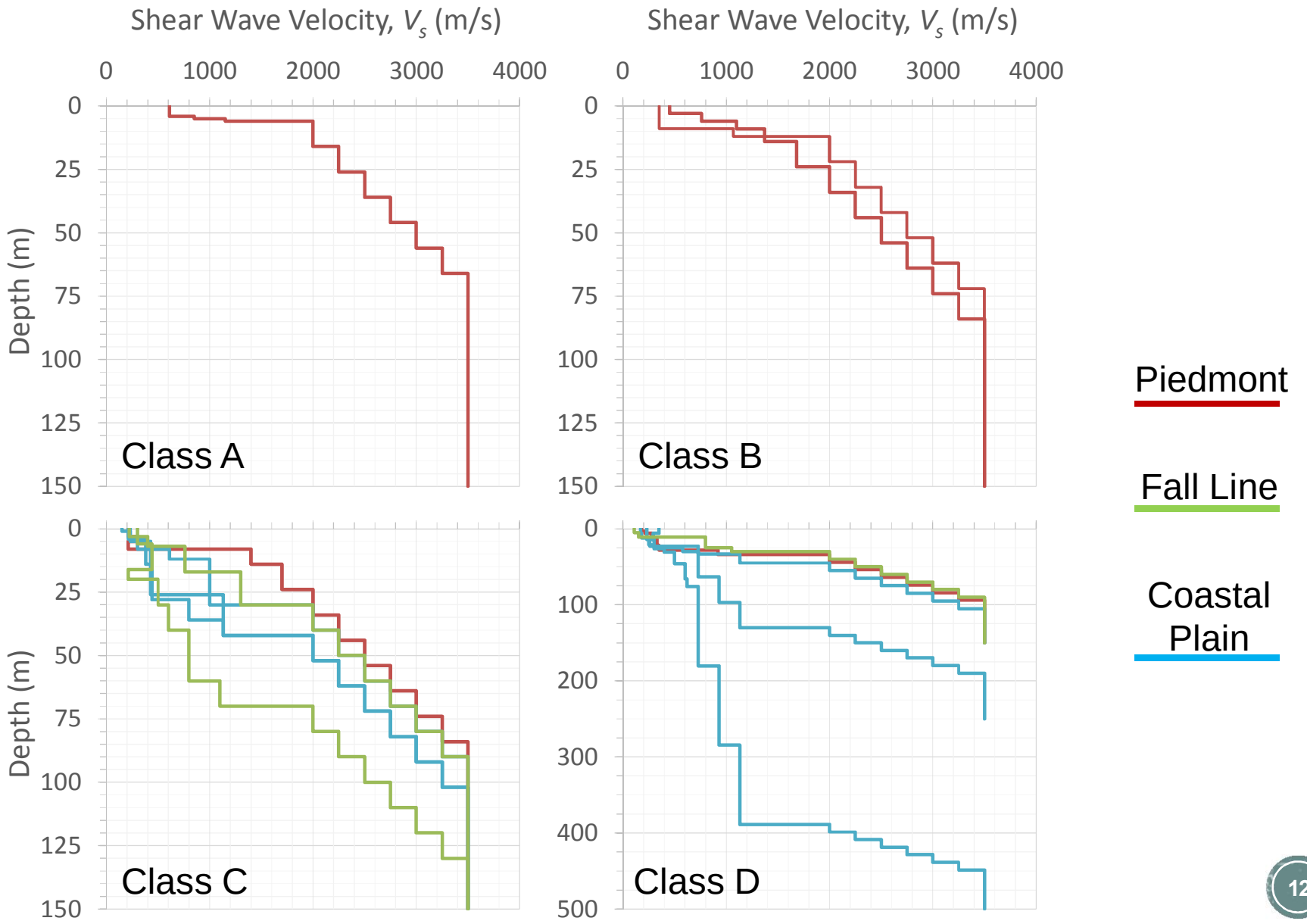
Reston Fire Station Recordings



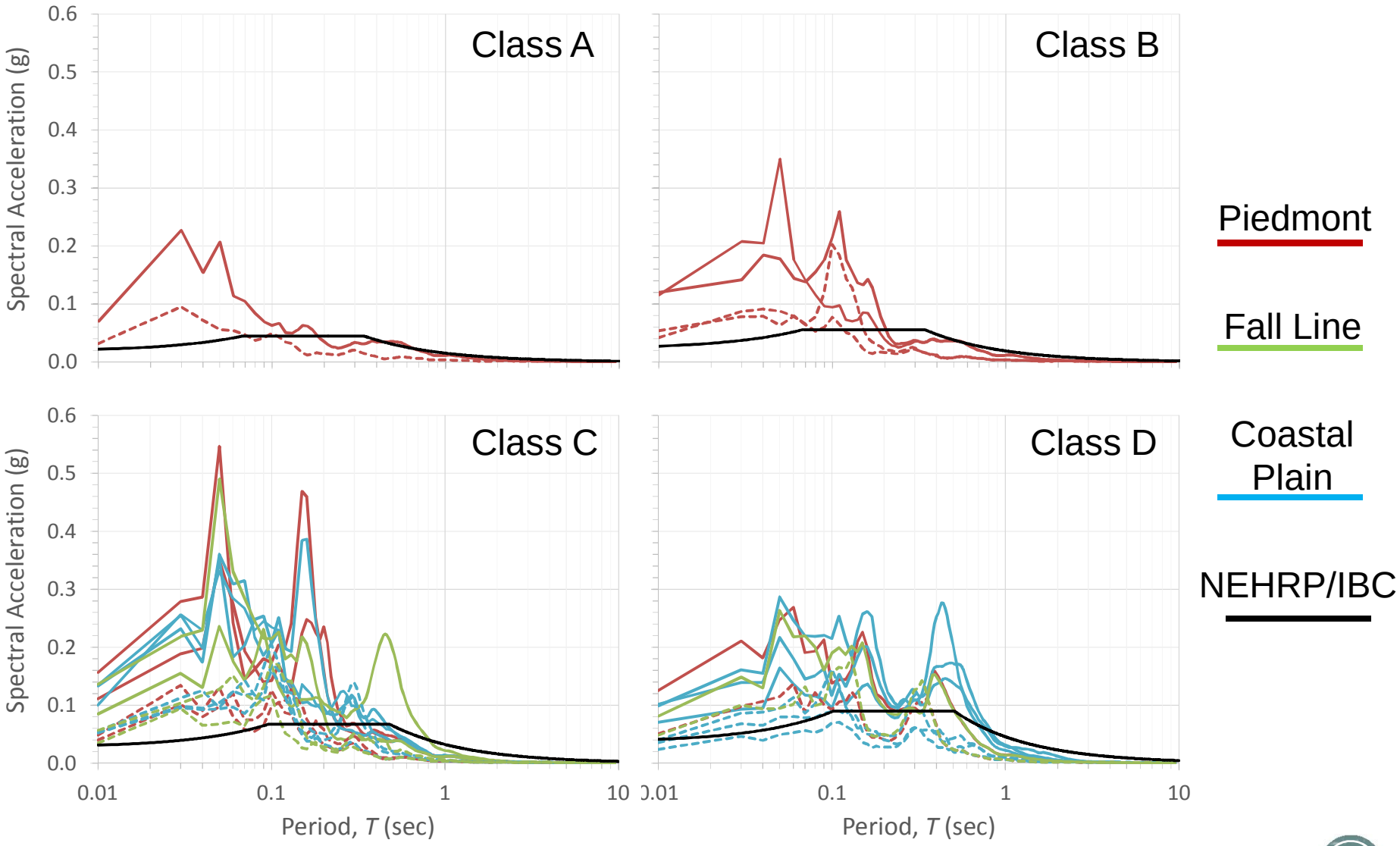


Deconvolute recorded ground surface motions to 3,500 m/s hard rock → use to analyze DC region study sites

Select DC V_s Profiles by Class

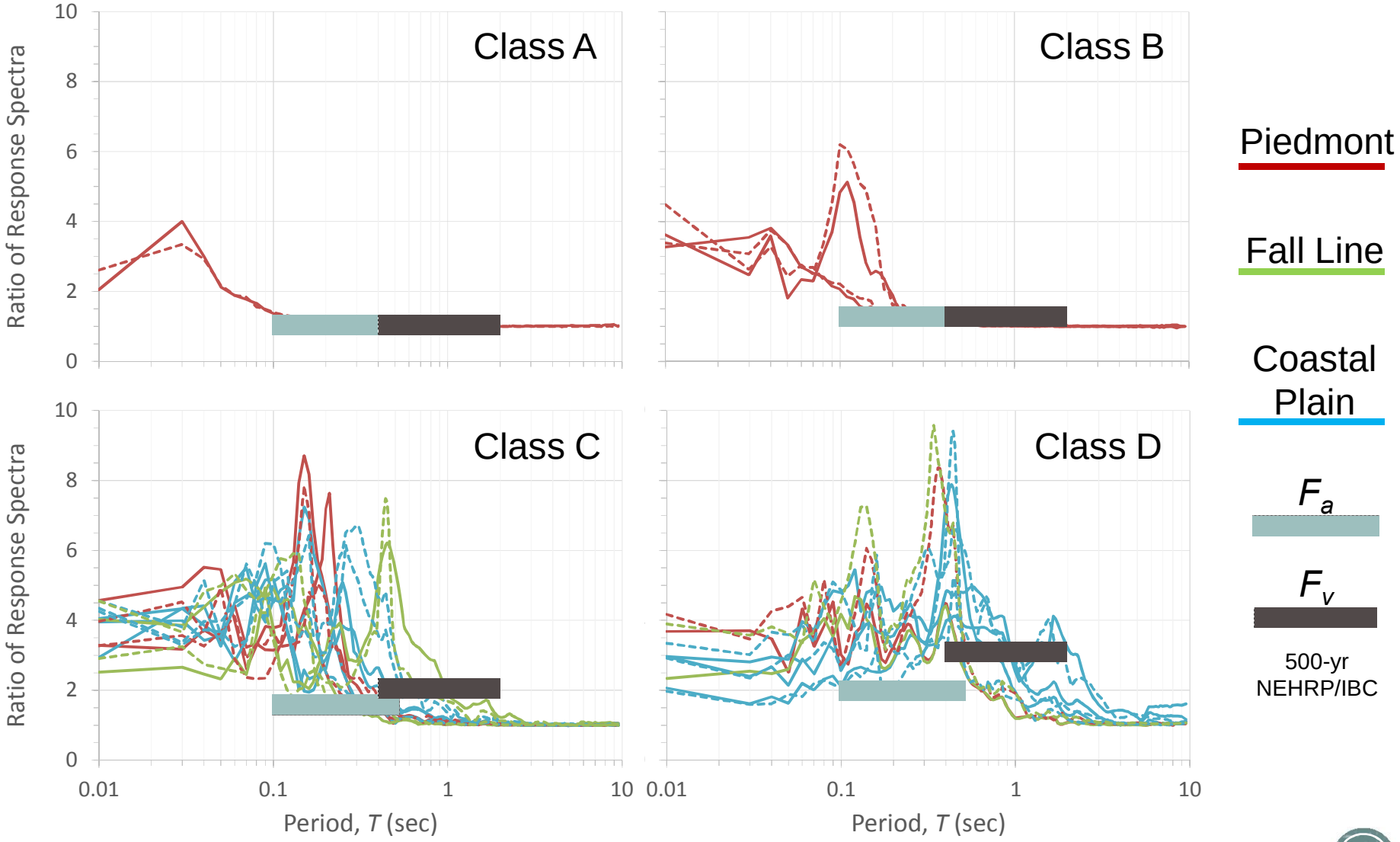


Response Spectra



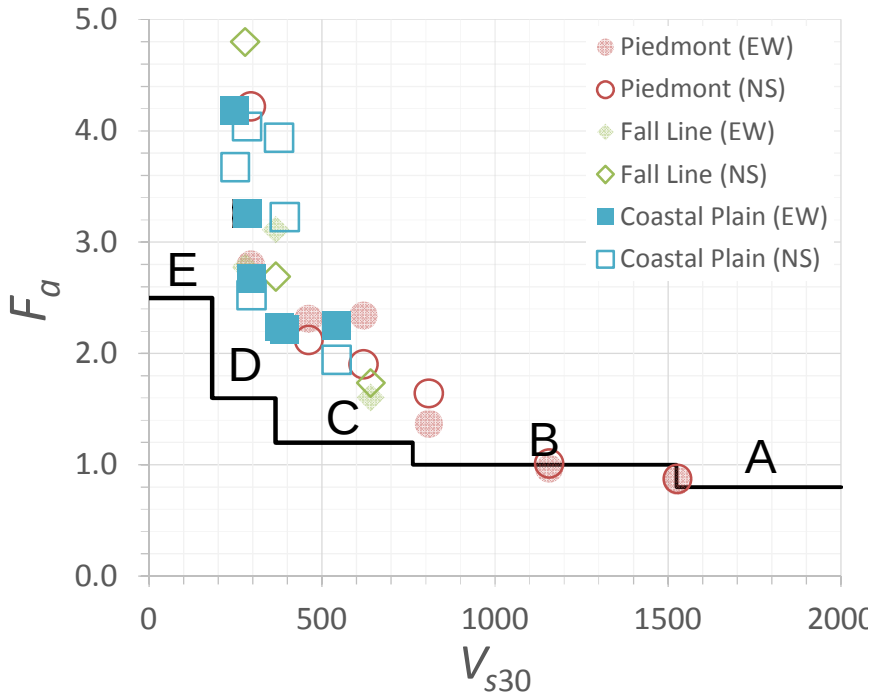
Equivalent linear ï 5% damping spectra ï **500 year** NEHRP/IBC spectra

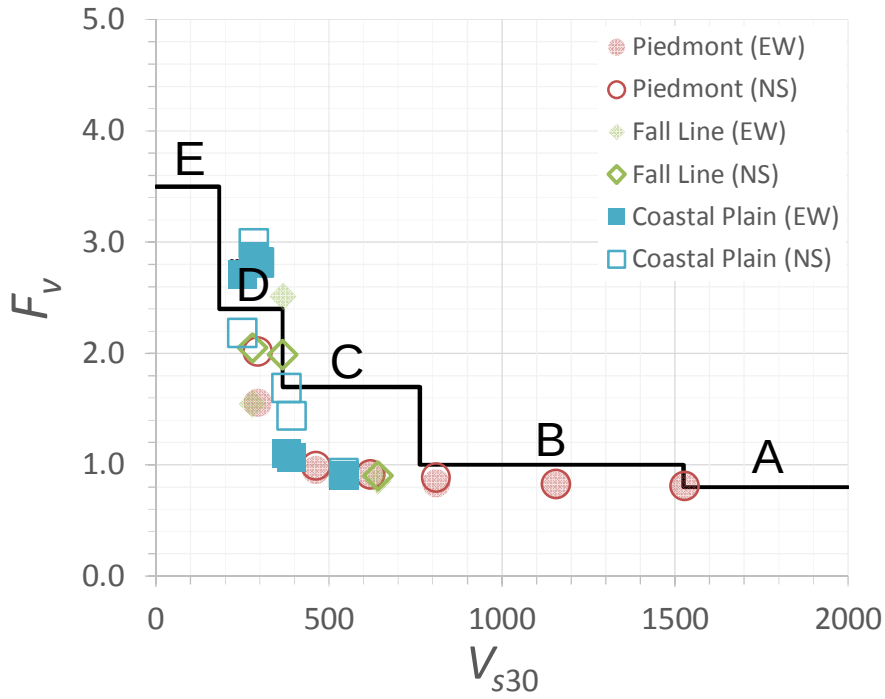
Ratio of Response Spectra



Divide ground surface response by reference response

Site Amplification Factors





- NEHRP/IBC fall below predicted F_a values
- NEHRP/IBC envelope predicted F_v values
  - except for class D Coastal Plain sites

Conclusions

- Damage generally focused to Coastal Plain unreinforced masonry
- NEHRP/IBC does not capture unique CEUS geology
- Hard rock close to surface amplifies short period motions
- Deeper stacks amplify long period motions
- F_a and F_v need region-specific adjustment

17

Thank you for your time!

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