Plane strain models of basin-edge effects in Wellington

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Introduction and Motivation

Primary objective is to create and validate numerical models for capturing the response of a soil-structure system including:

- Soil response
- Structural response
- Soil-foundation-structure interaction

SH-1D site response models cannot reproduce key features of observed ground motions across several seismic events

- Particularly spectral accelerations in the 1-3 s range

Plane strain models of the Thorndon basin have been developed as a first step in determining an appropriate input ground motion for the SFSI validation study. Work to-date includes:

- Examination of effects of bedrock structure
- Development of random field models for soil shear wave velocities

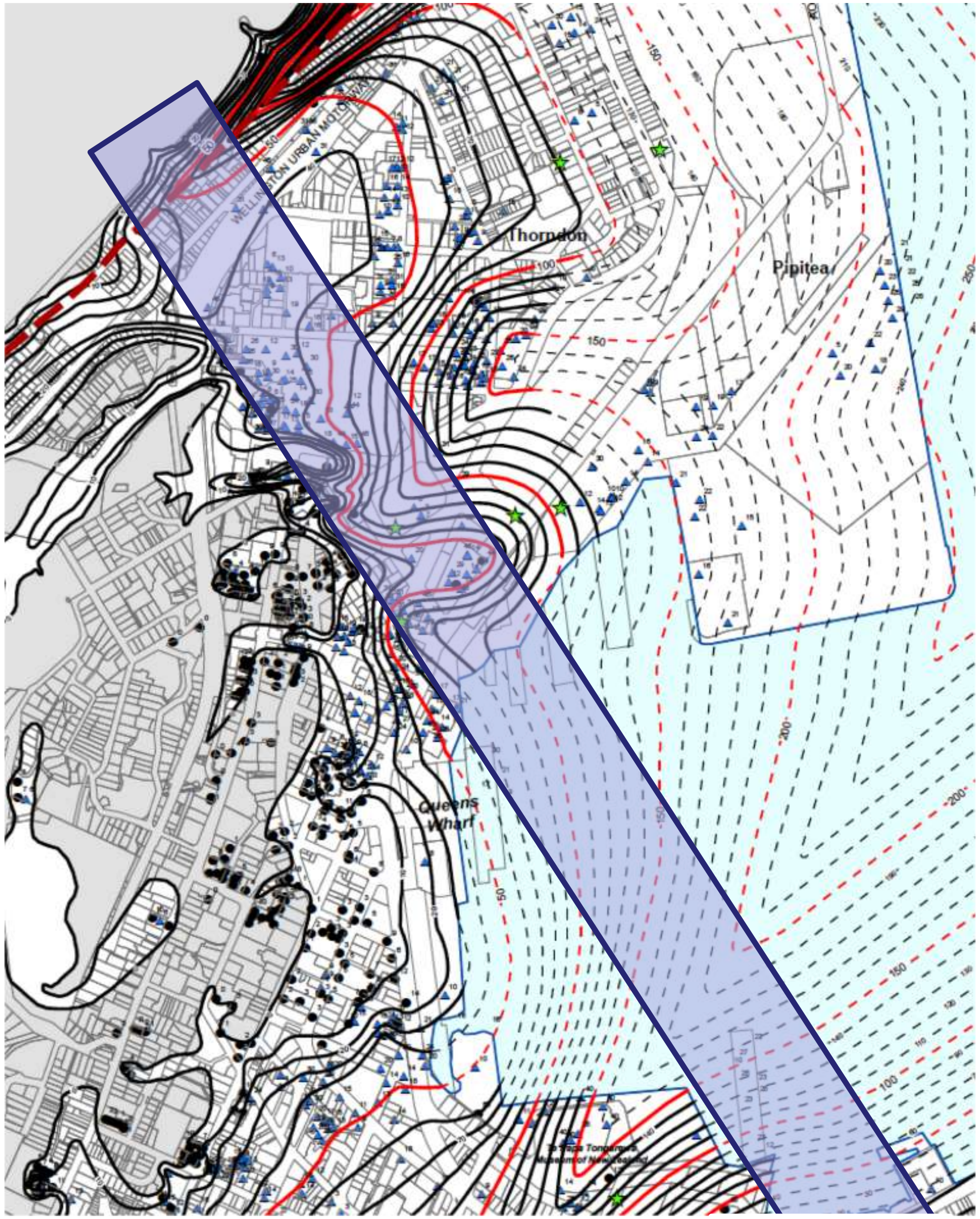
Plane Strain Model Development

Depth to bedrock based on the Semmens et al. (2012)

- Contour map (shown here)
- Boreholes
- SPAC microtremor

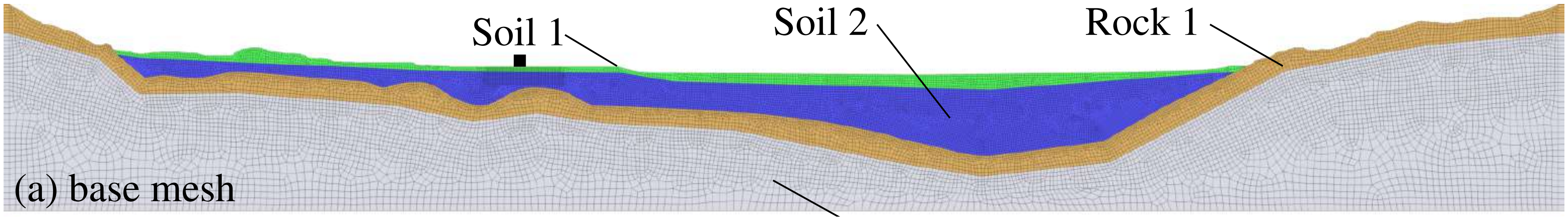
Simplified soil profile based on:

- Surface-wave V_s testing at the strong motion station (Cox and Vantassel, 2018)
- Nearby downhole V_s tests
- Nearby CPT and SPT records
- Surficial geology maps

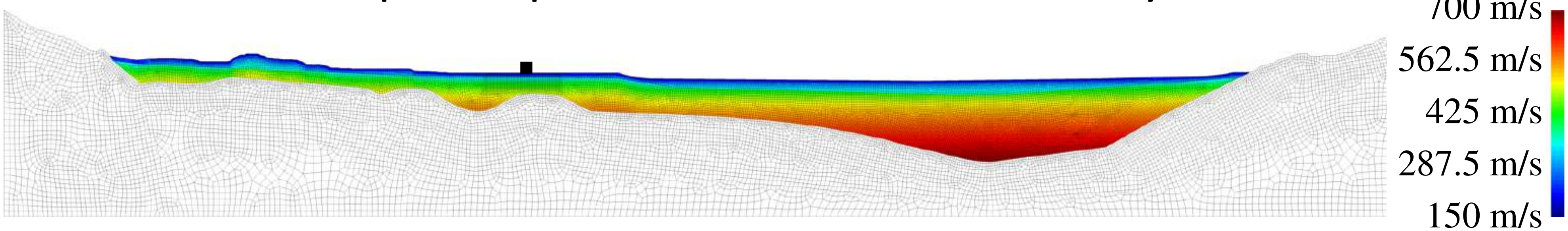


Plane Strain Model Development

Basic Model Structure



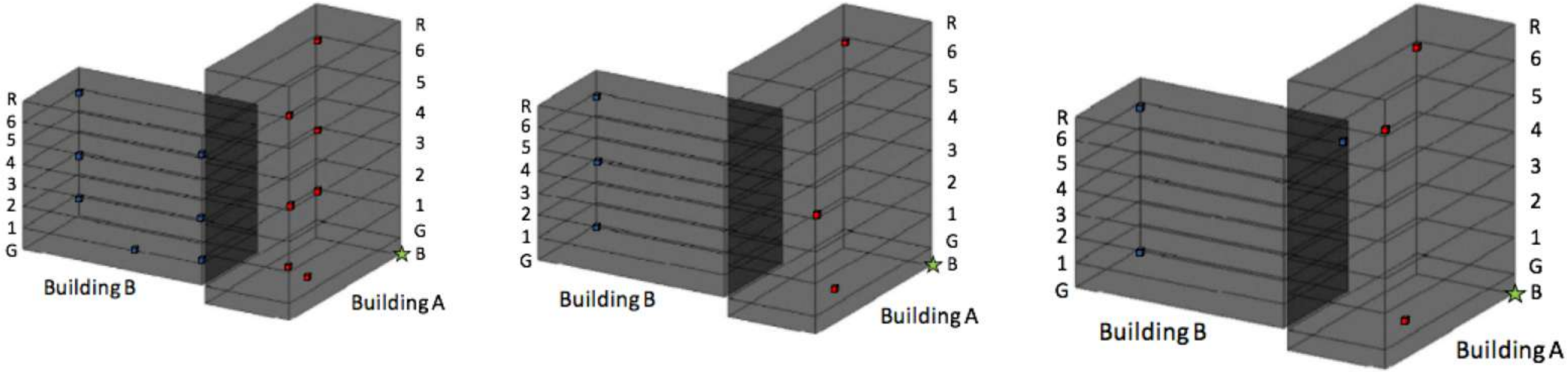
Depth-Dependent Shear Wave Velocity Profile



$$V_s(z) = 160z^{0.25}$$

$$V_s(z) = 190z^{0.25}$$

Instrumentation Locations/Times



Period 1 | Period 2 | Period 3

Key :

, : accelerometers

: reference point

Instrumentation period	Instrumentation duration	Number of accelerometers per building
Period 1	24 July to 12 August 2013	7
Period 2	12 August to 9 September 2013	3
Period 3	16 November to 7 December 2016	3

(Simpkin et al., 2015; Gultom et al.)

Ground Motions Considered

Date/Time	M_w	POTS PGA x (g)	POTS PGA y (g)	Site PGA x (g)	Site PGA y (g)
16/08/2013 02:31	6.47	0.048	0.040	0.113	0.18
16/08/2013 03:51	5.53	0.009	0.007	0.033	0.038
16/08/2013 05:31	5.95	0.011	0.009	0.026	0.035
17/08/2013 08:58	5.50	0.005	0.002	0.014	0.014
04/12/2016 15:47	5.52	0.005	0.0025	0.014	0.010

Initial Analysis: Effects of Rock Structure

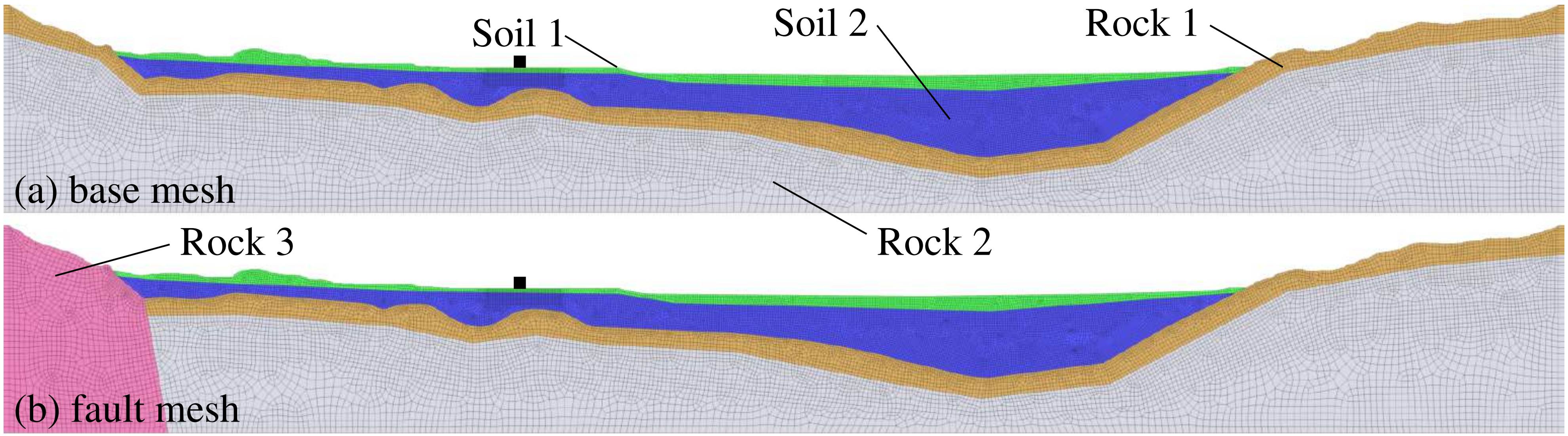
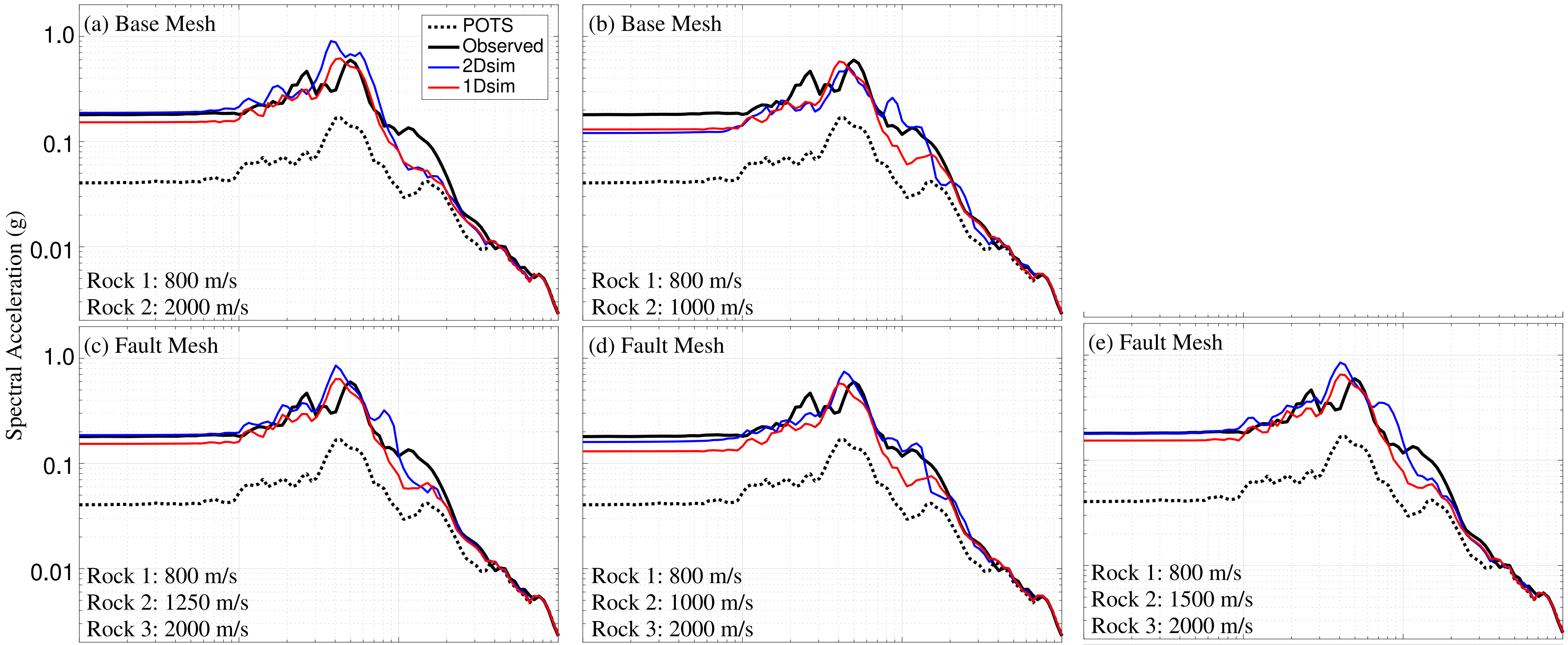


Table 1. Rock velocity structure cases considered for three computational mesh configurations of Figure 2.

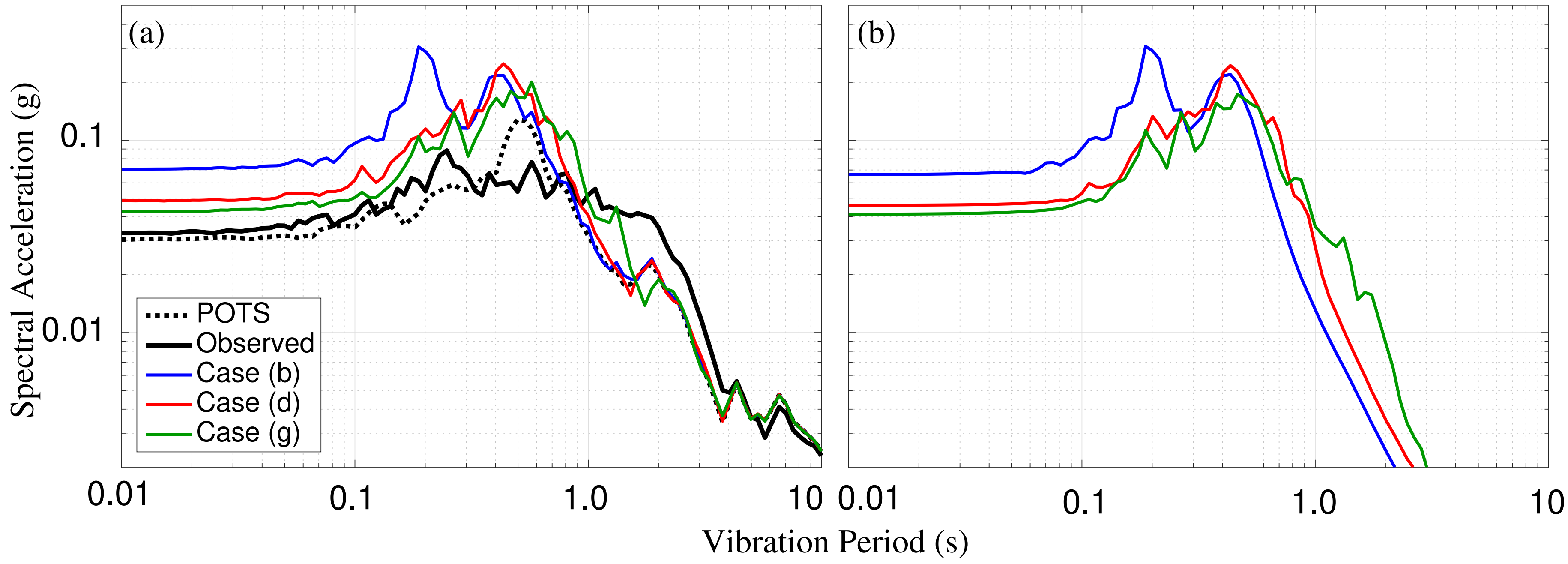
Mesh Configuration	V_s Rock 1 (m/s)	V_s Rock 2 (m/s)	V_s Rock 3 (m/s)
Base mesh	800	2000	–
	800	1000	–
Fault mesh	800	1250	2000
	800	1000	2000
	800	1500	2000

Initial Analysis: Effects of Rock Structure



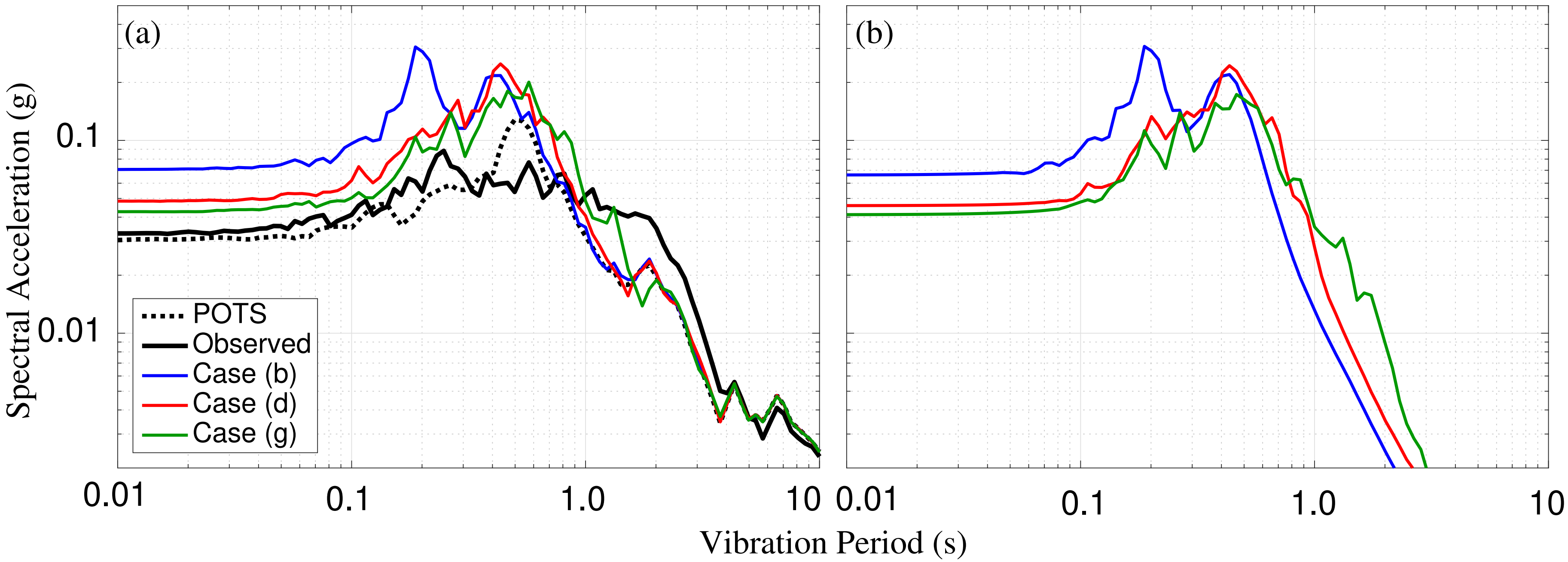
Horizontal Response Spectra for Lake Grassmere Event

Initial Analysis: Effects of Rock Structure



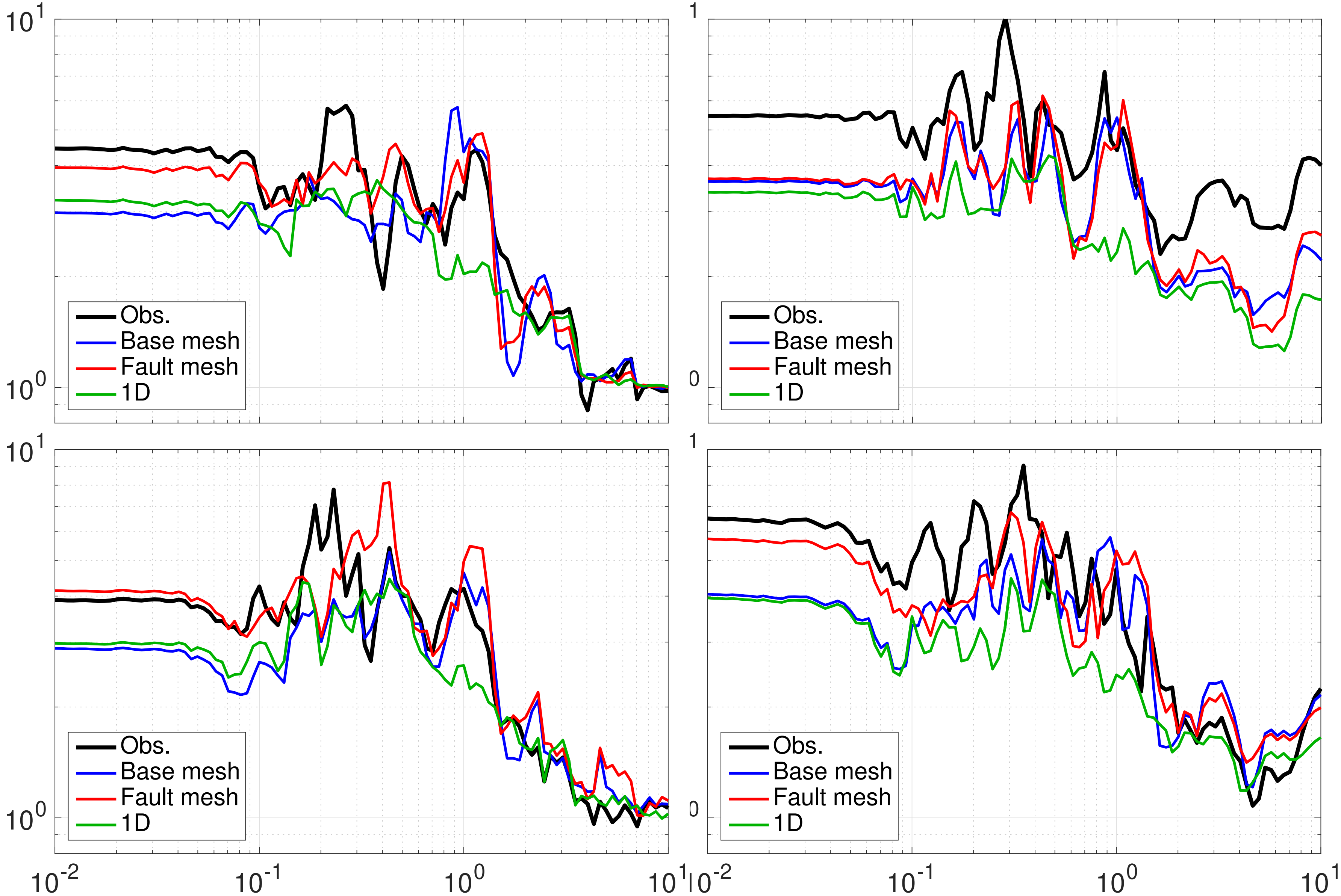
Vertical Response Spectra for Lake Grassmere Event

Initial Analysis: Effects of Rock Structure

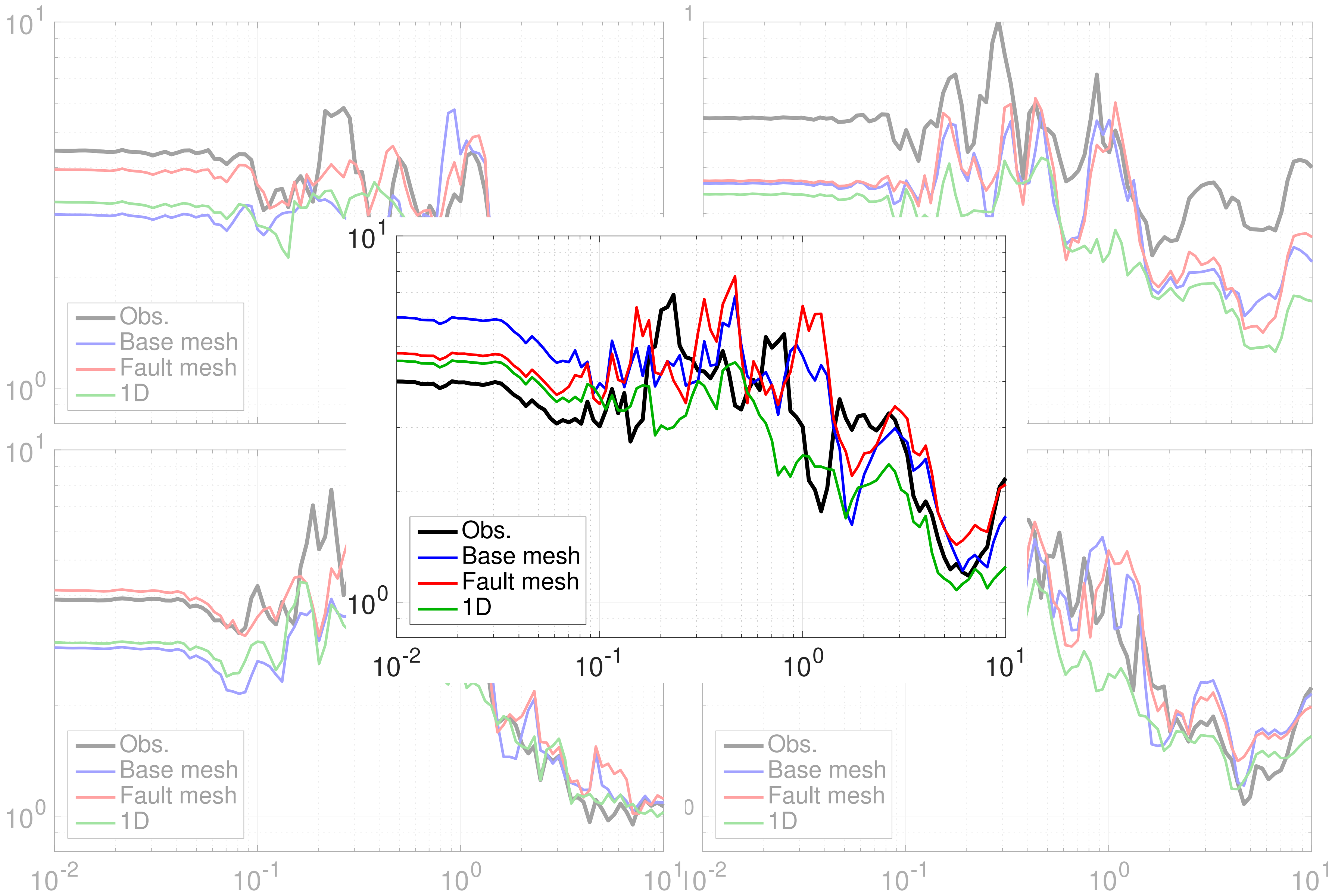


Vertical Response Spectra for Lake Grassmere Event

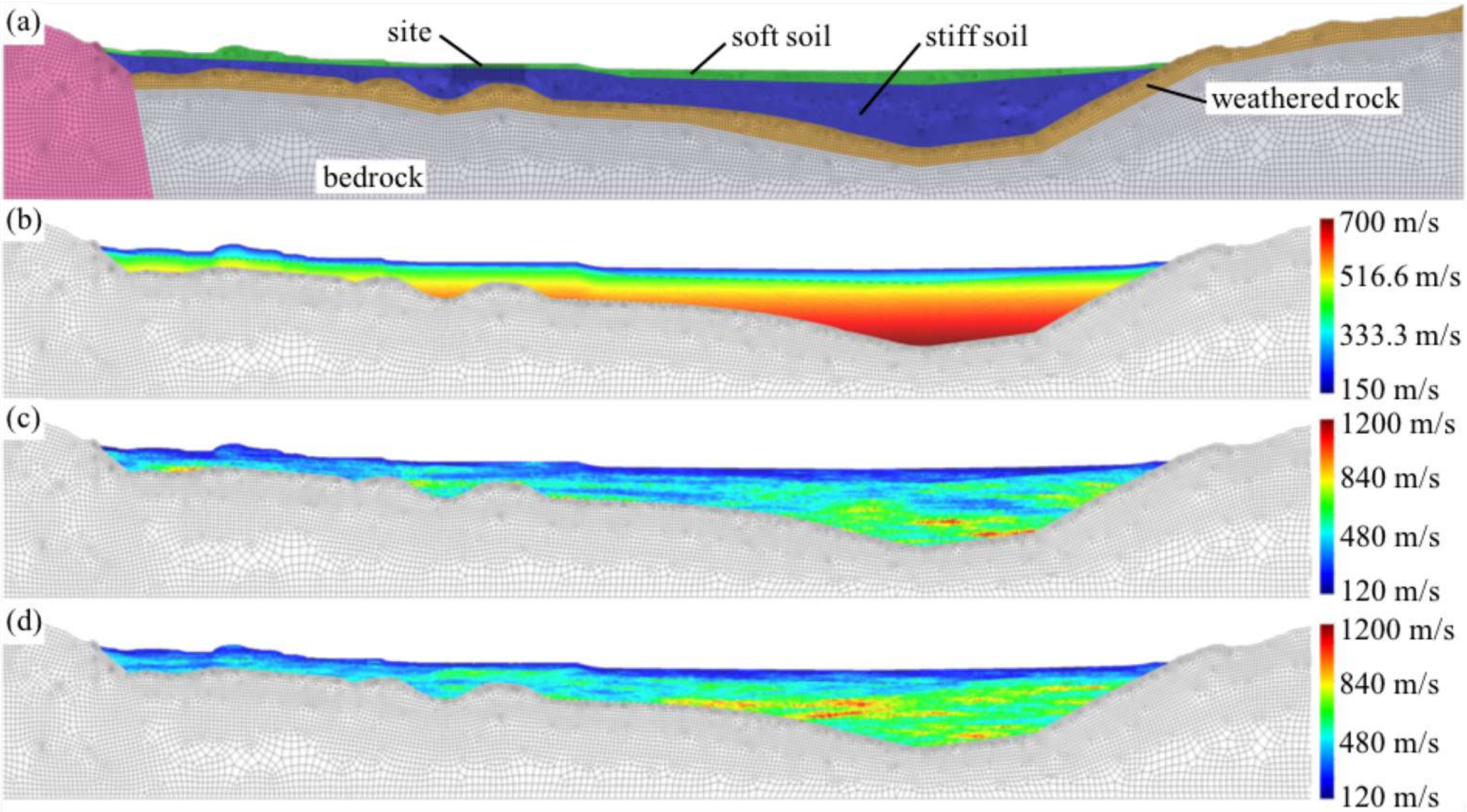
Response for Other Seismic Events



Initial Analysis: Effects of Rock Structure

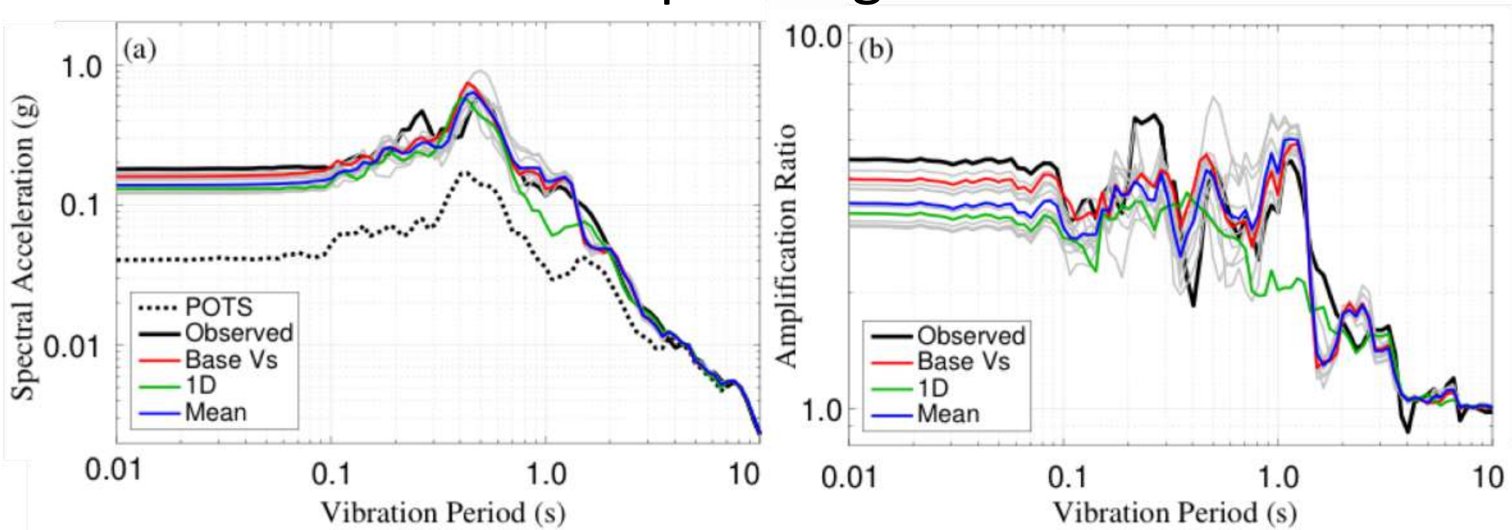


Random Field Analysis

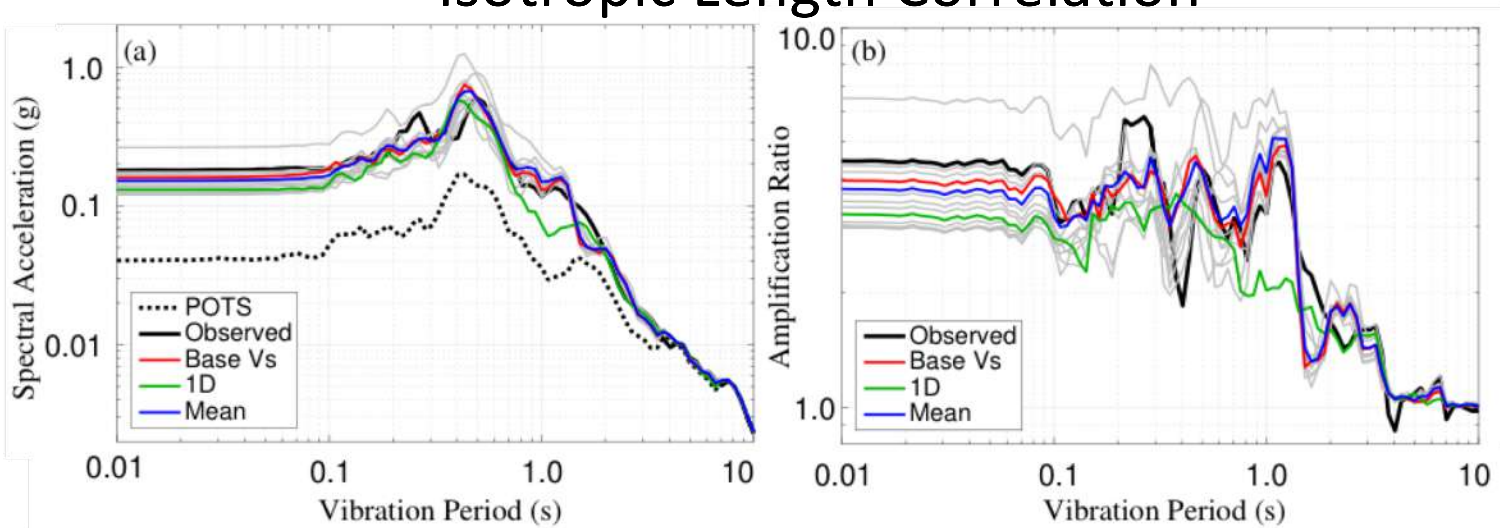


Random Field Analysis: Horiz. Spectra

Anisotropic Length Correlation

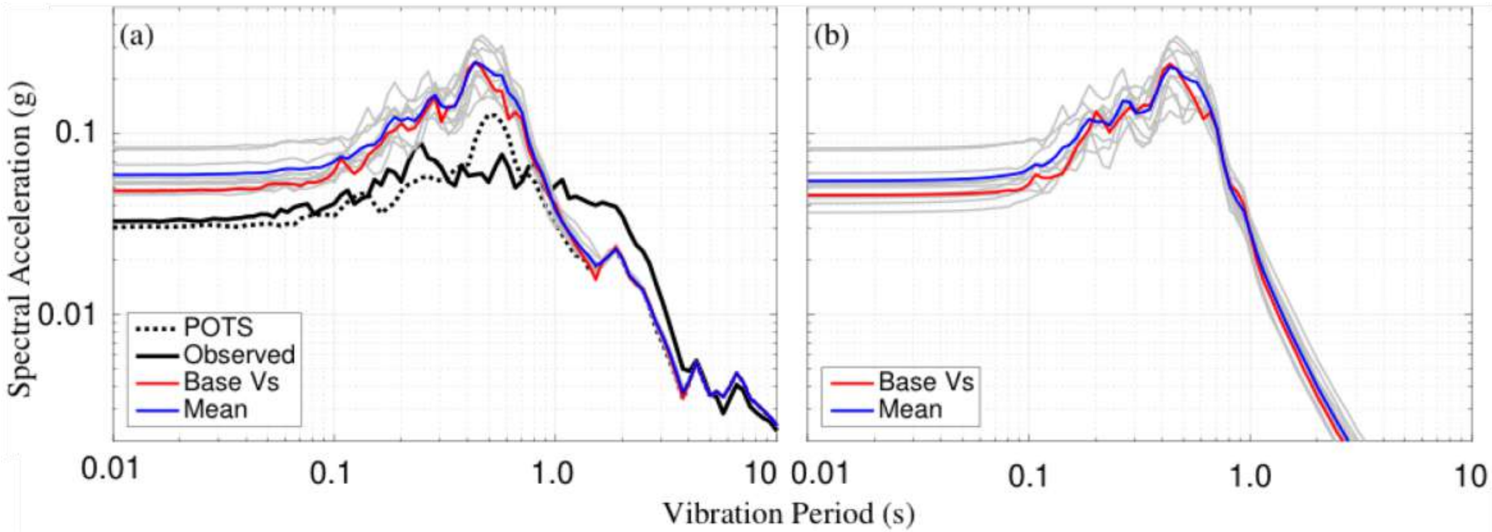


Isotropic Length Correlation



Random Field Analysis: Vertical Spectra

Anisotropic Length Correlation



Next Steps and Future Plans

Finalize soil model development and validation

- More ground motions to capture larger range of response
- Determine final desired modeling approach

Structural model development and validation

- Develop structural model(s) based on best available data
- Validate through comparison with recorded building response

Full system response model development/analysis/validation

- Put everything together with a focus on key research questions:
  - How well do conventional geotechnical models work here?
  - Structural models?
  - How well can these models capture the full system response?

Forward prediction analysis using final model