Challenges in Determining Reference Input Ground Motions for Site Response Analyses and Application to Wellington Basin

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DT1 Kick-off meeting

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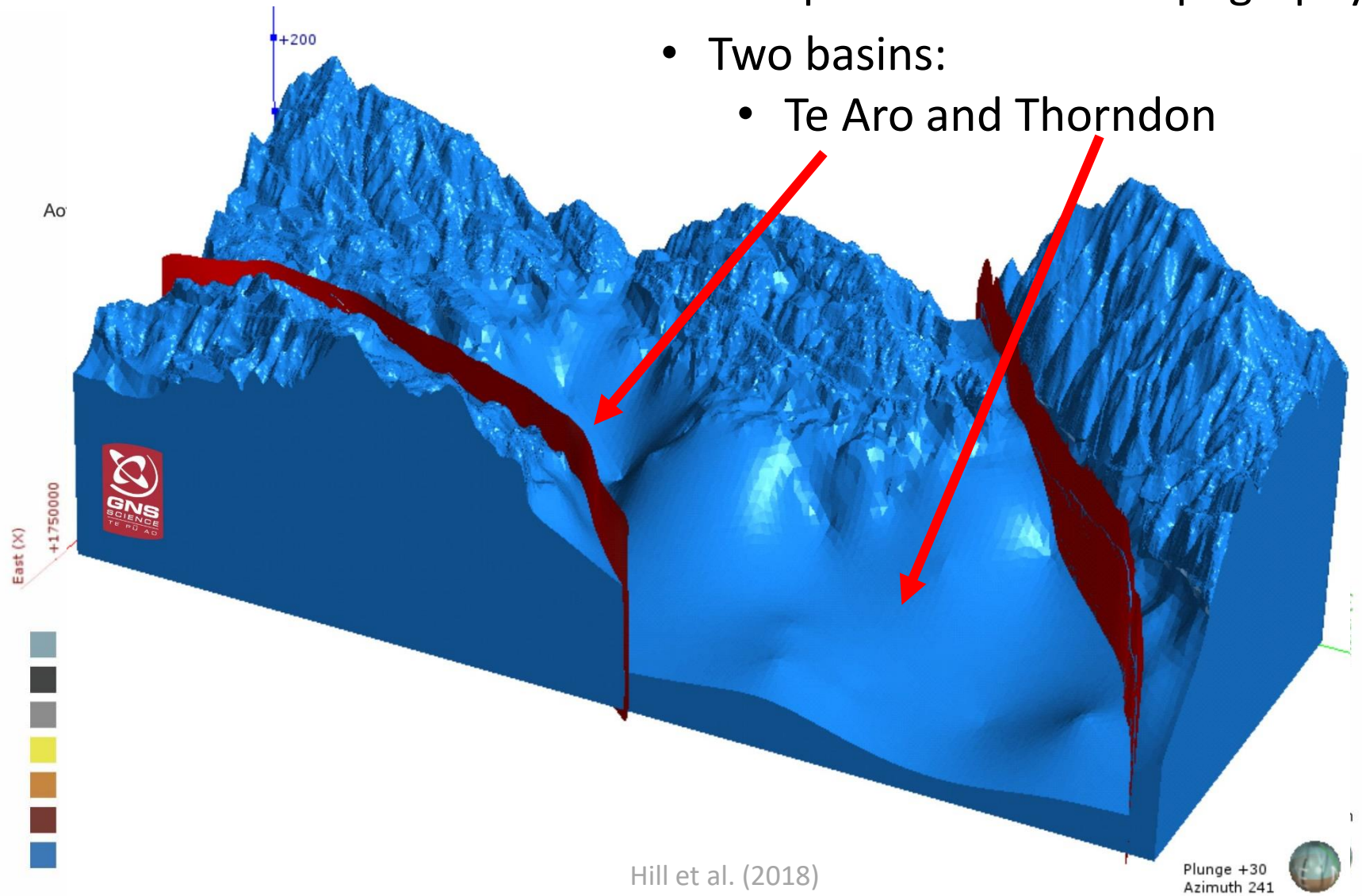
QuakeCoRE
NZ Centre for Earthquake Resilience

Options for Reference Input Motions

- Nearby rock outcrop
  - Lacks 3D effects (basin effects, surface waves)
- Nearby soil sites
  - Different 3D effects?
  - Uncertainty in deconvolution through soil (nonlinearity??)
  - Good for liquefaction mechanism, not GM prediction
- Downhole/vertical array
  - Challenges with downgoing wave effect
- Simulated ground motions
  - Uncertainty in simulations

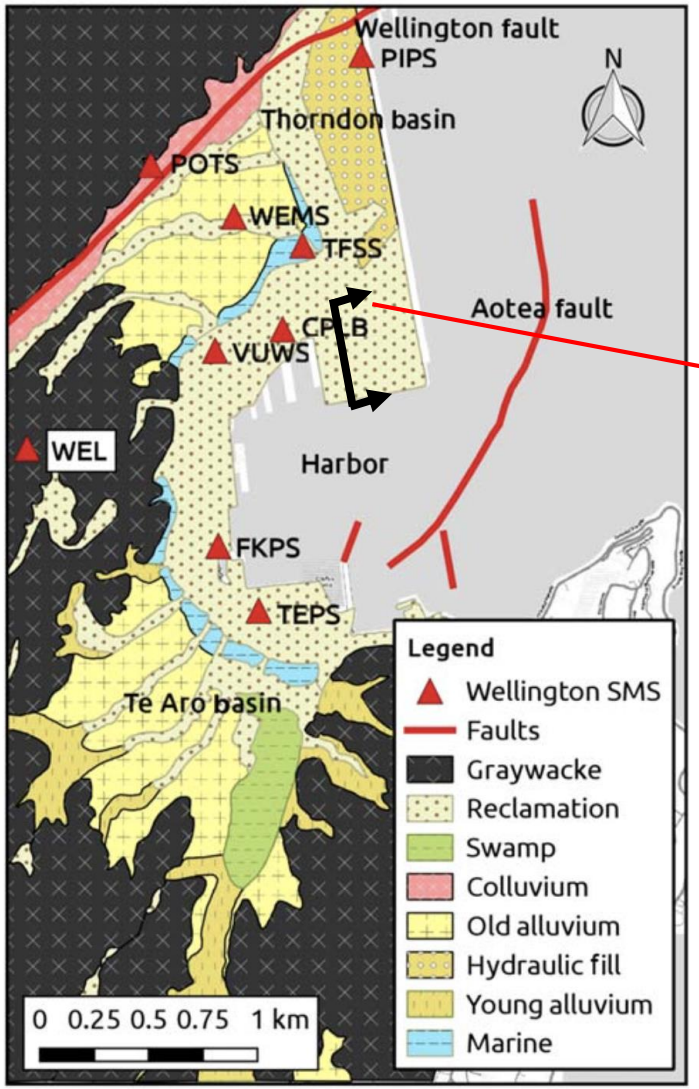
Wellington: Complexity in Basin Structure

- Complex subsurface topography
- Two basins:
  - Te Aro and Thorndon

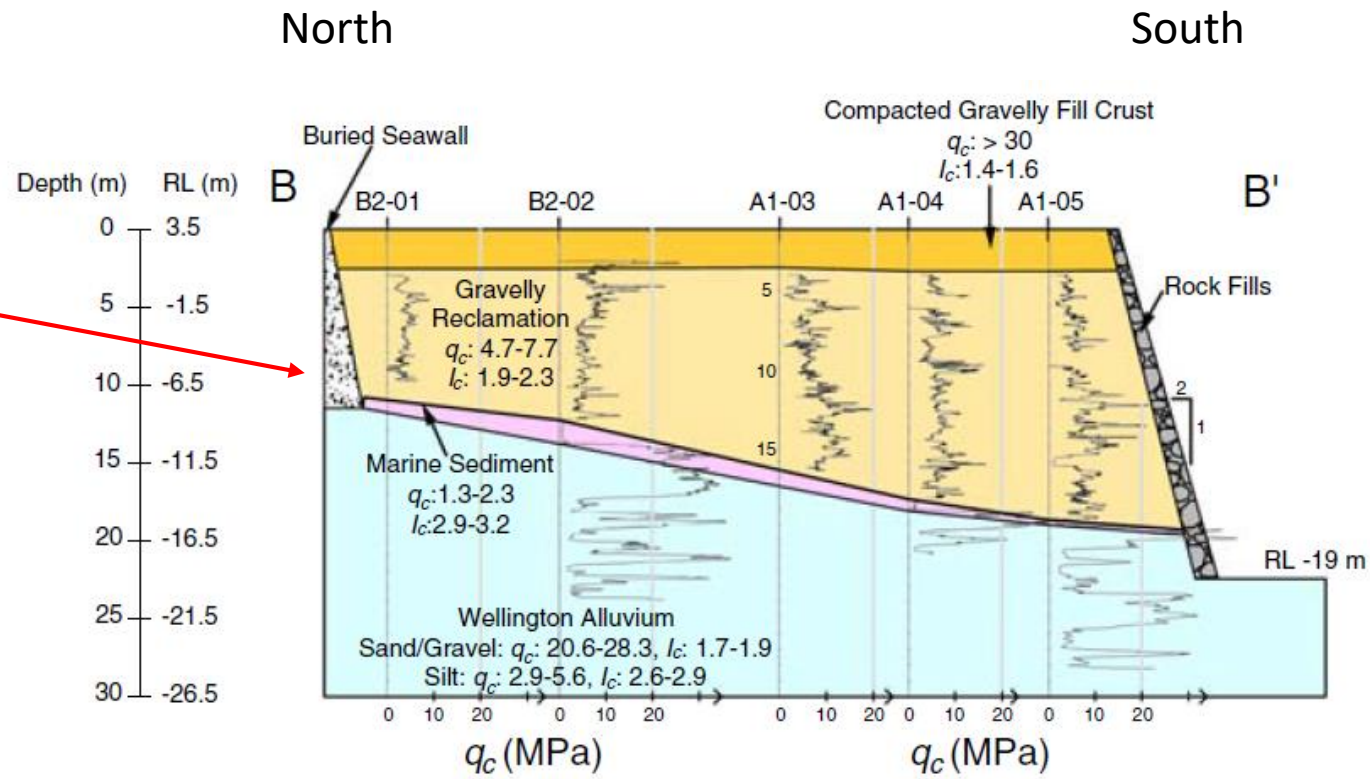


Hill et al. (2018)

Wellington: Complexity in Surficial Soils

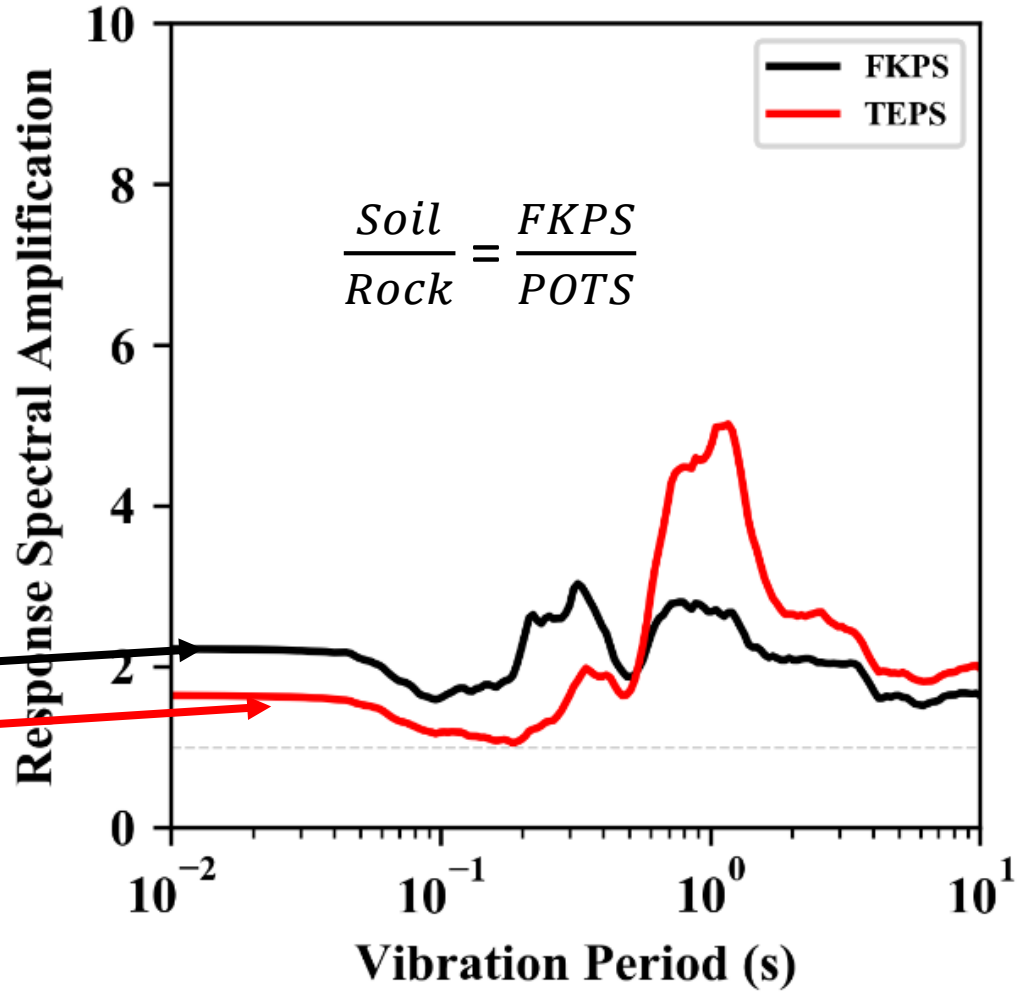


Bradley et al. (2018)



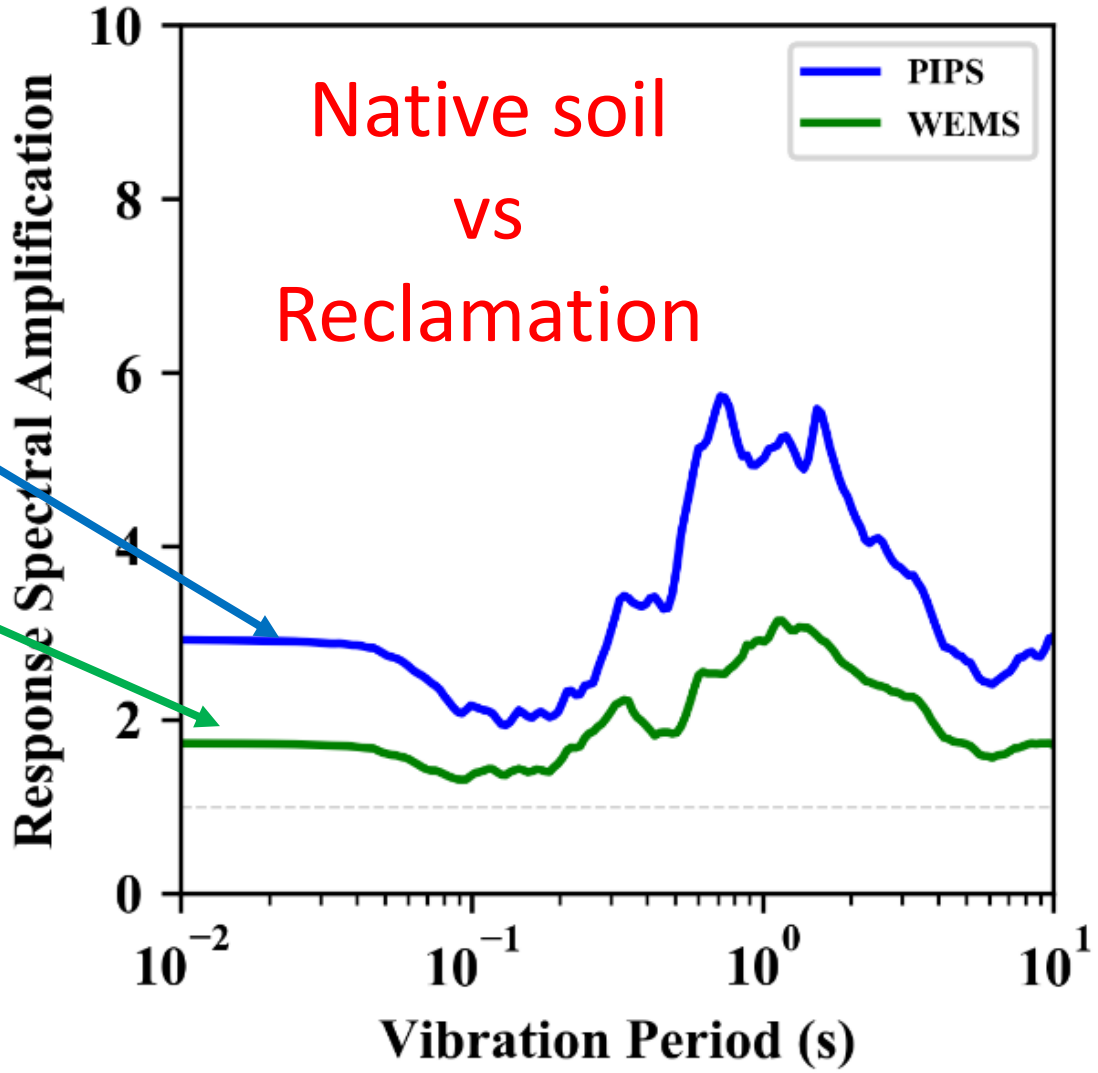
Cubrinovski et al. (2018)

Complexities → Spatial Variability in Ground Motion

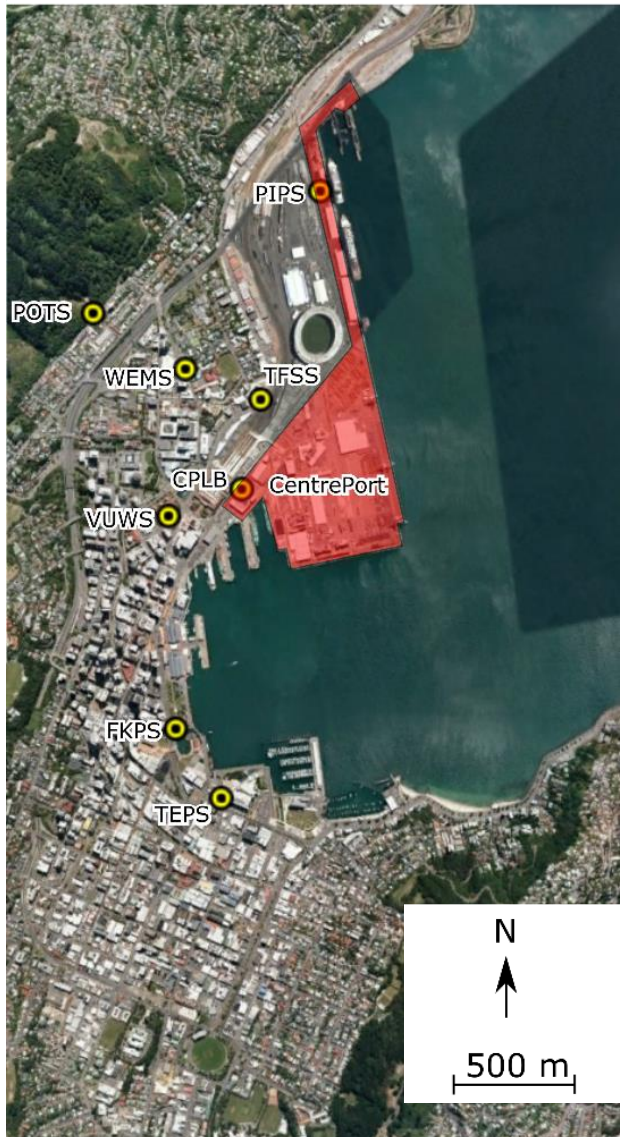


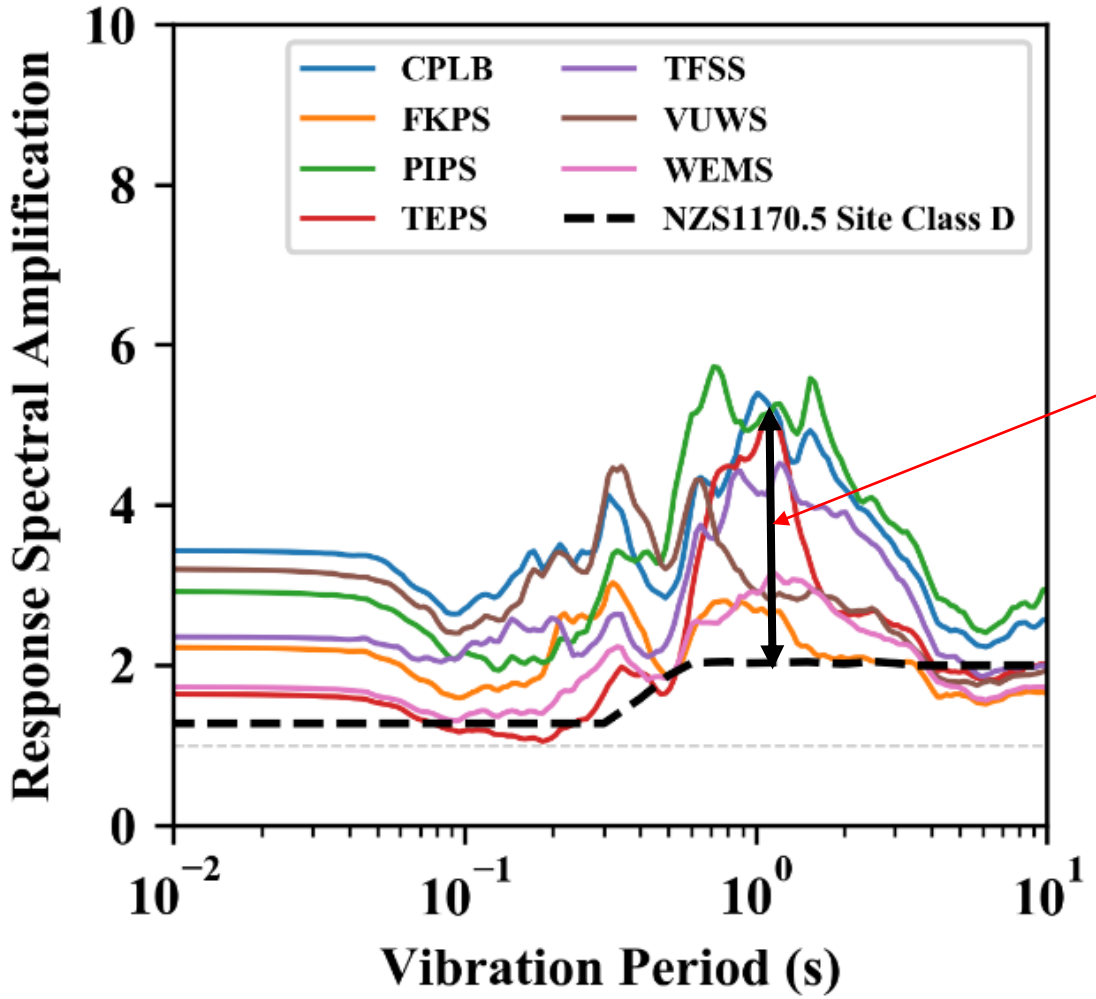
Fault geometry

Complexities → Spatial Variability in Ground Motion



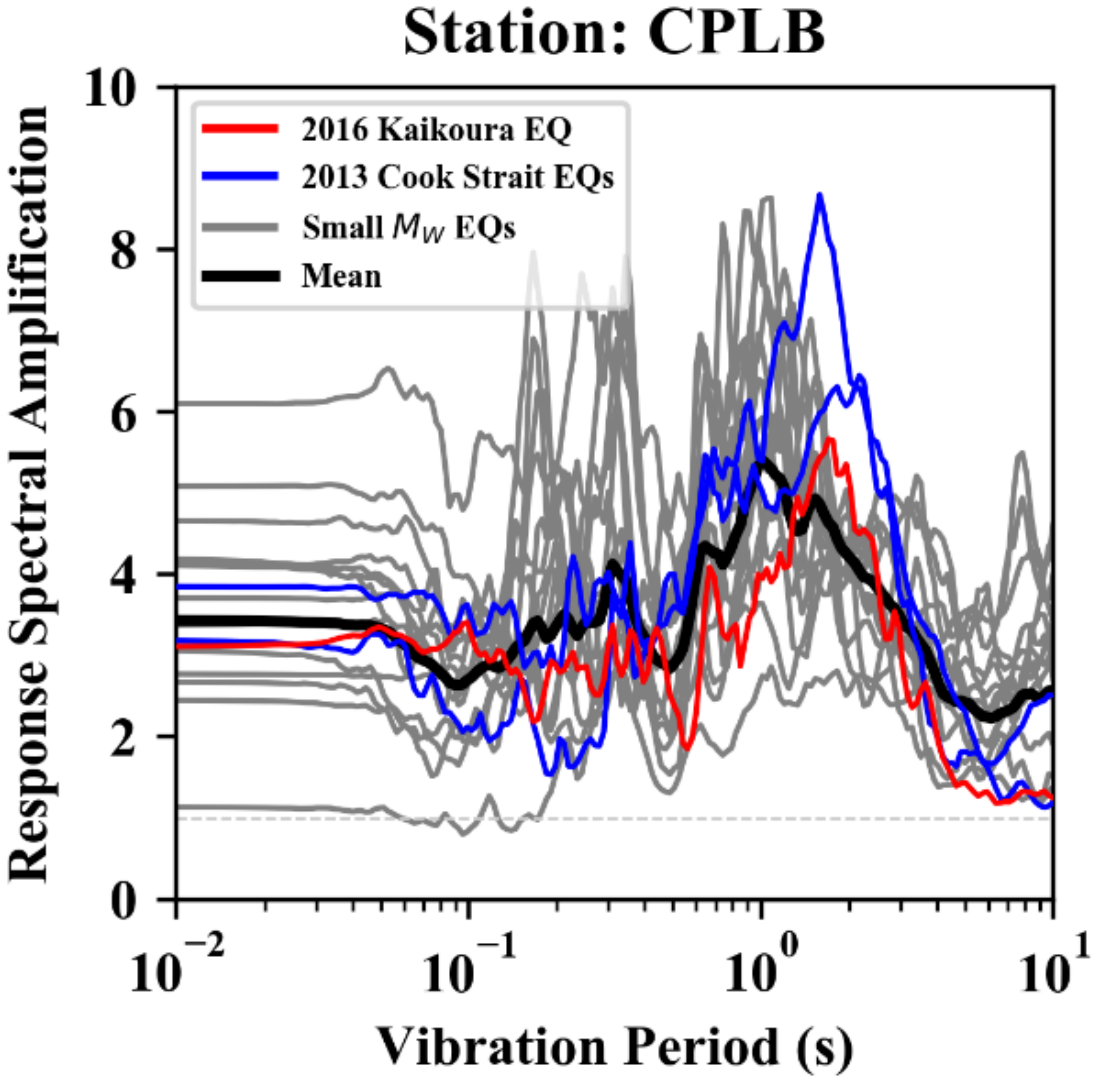
NZS1170.5 Site Amplification

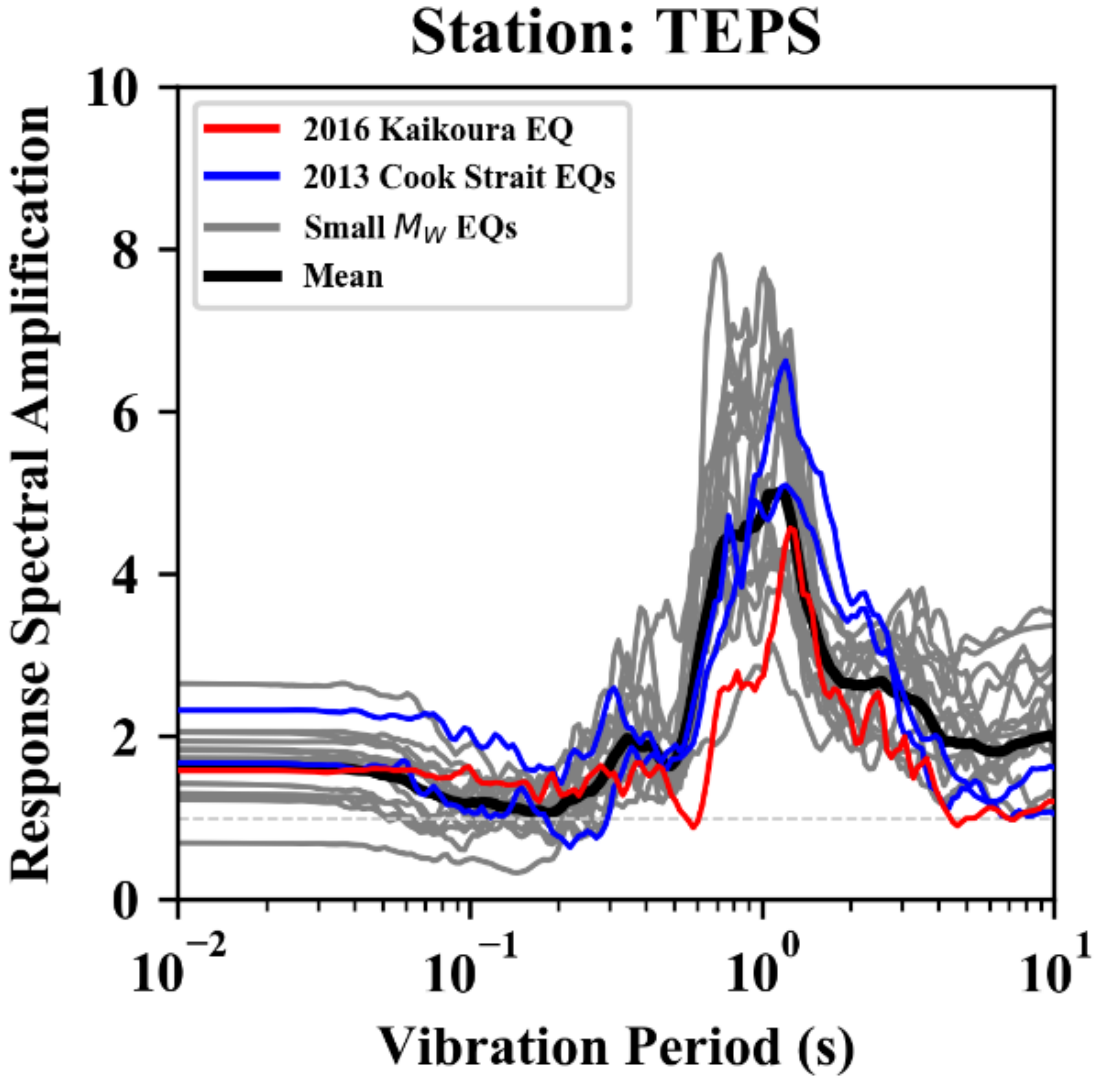




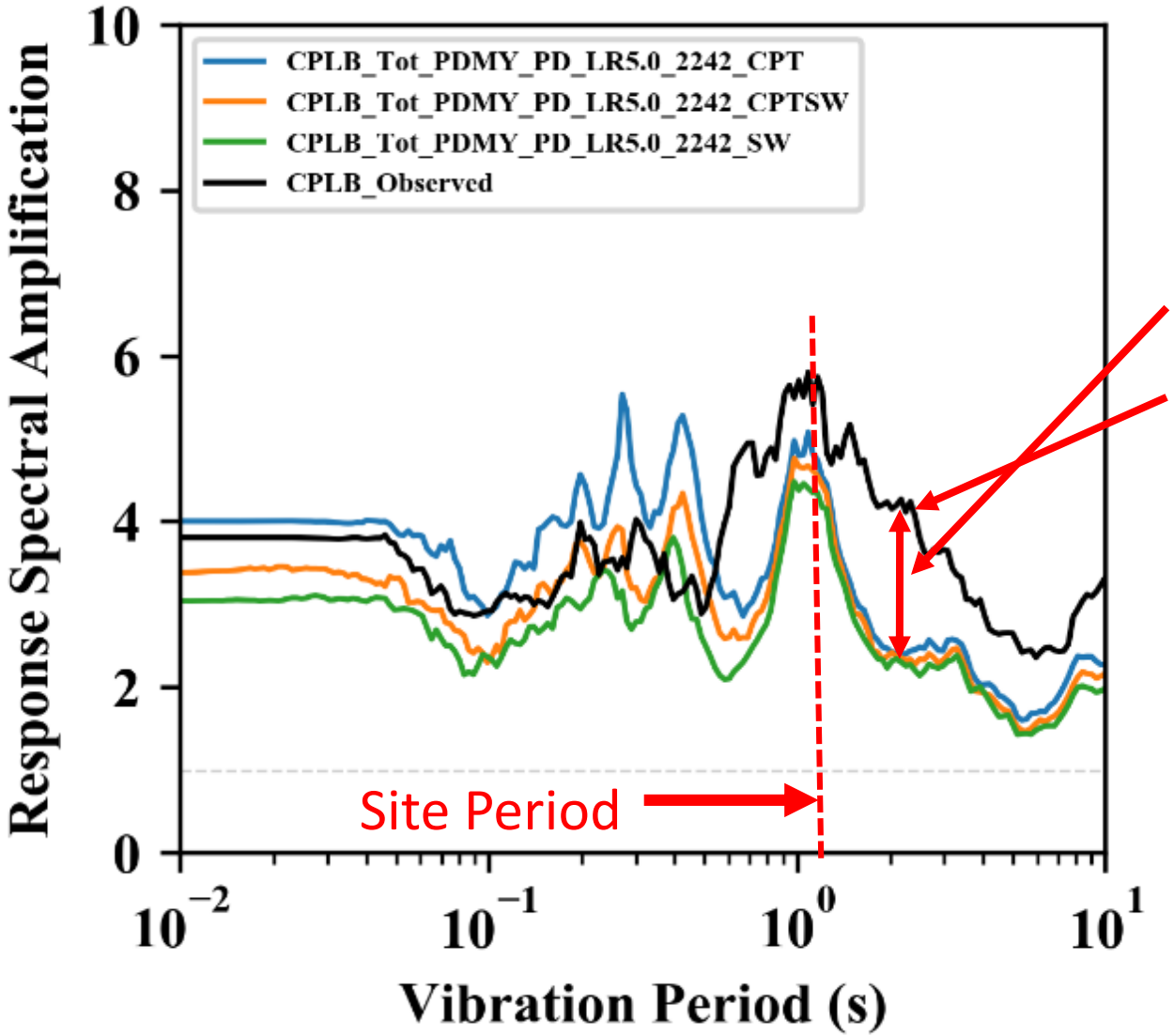
2-3 x greater amplification than code

Are Site/Basin Effects Repeatable?



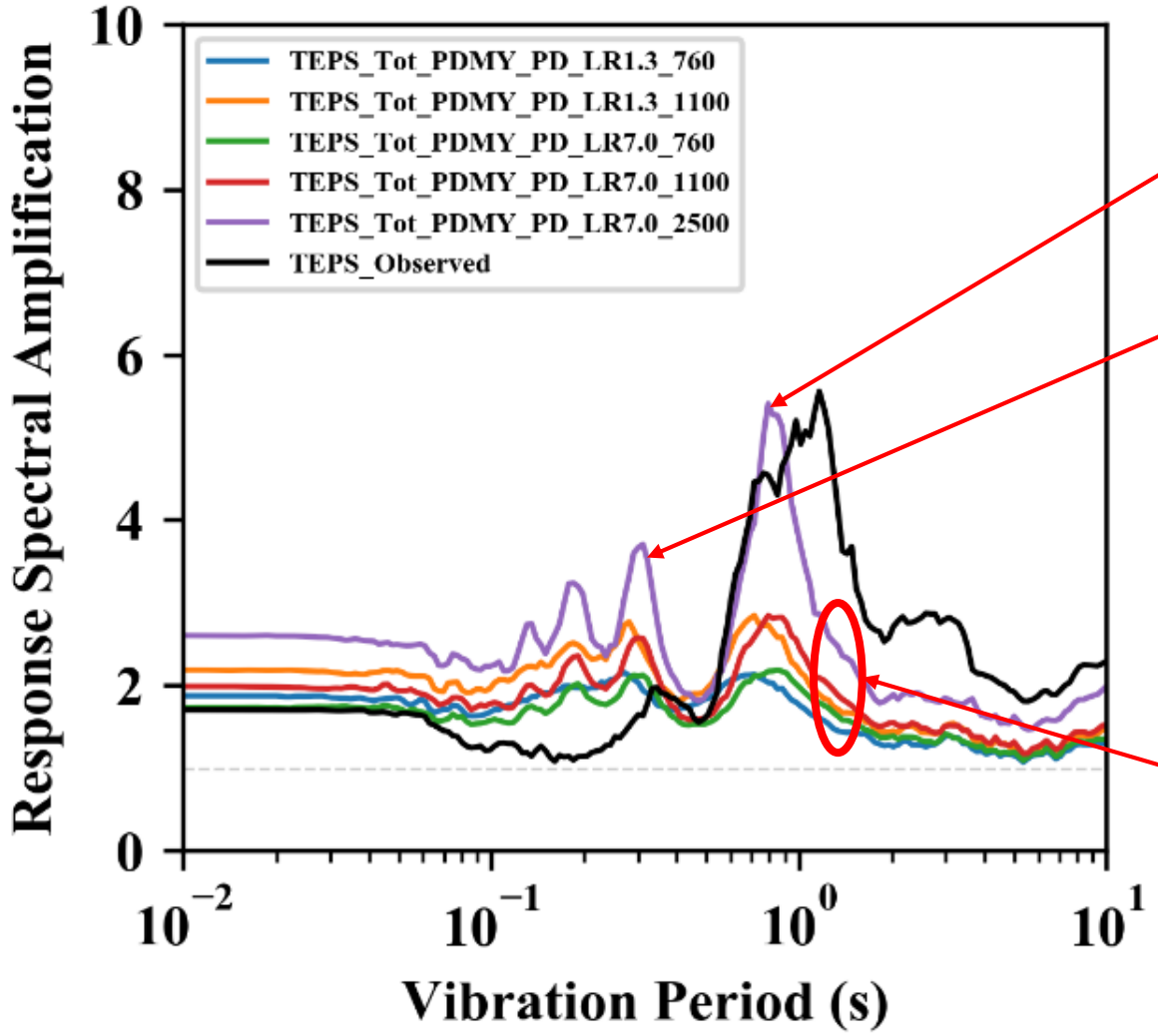


1D Analysis with Rock Outcrop Input



- Underpredict by a factor of 2
- Likely caused by 3D effects

1D Analysis with Rock Outcrop Input

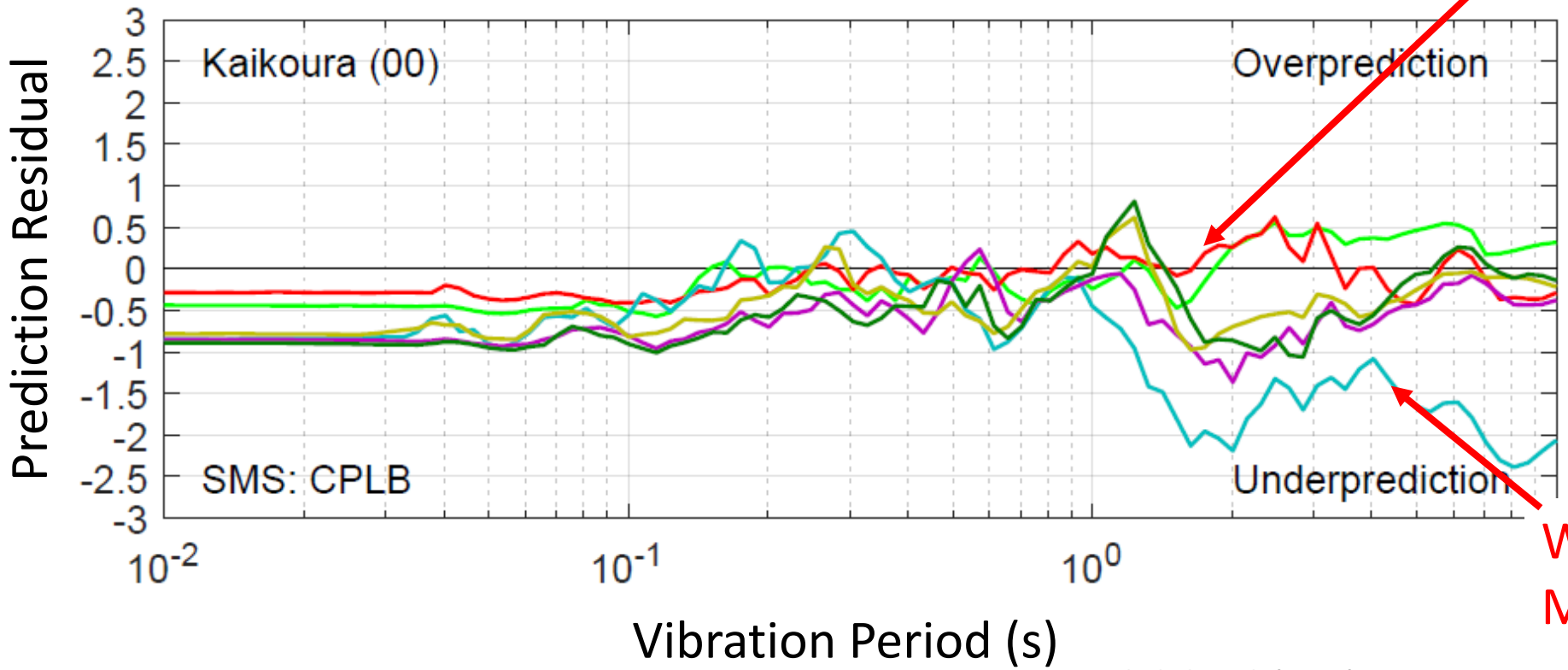


- Improve prediction at site period
- But largely overpredict short periods

Vs Uncertainty alone does not explain underprediction

1D Analysis with Nearby Soil Reference Site

- Site response at CPLB (CentrePort)
- Deconvolve all other nearby sites for use as input



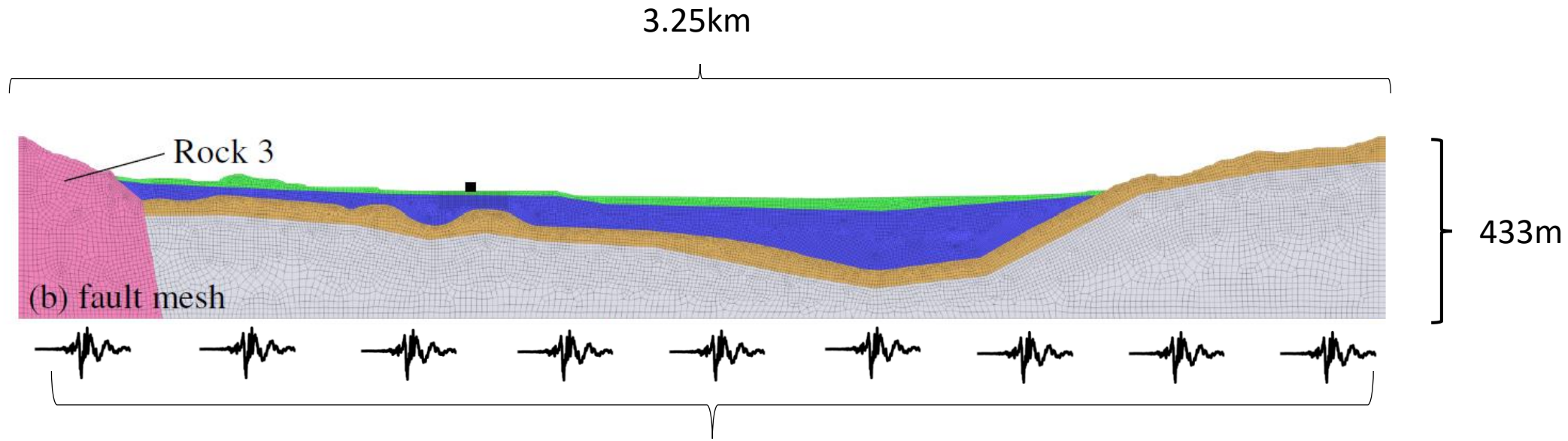
VUWS – Best agreement

WEMS – Order of Mag difference

Dhakal et al. (2019)

2D Slice through Wellington Basin

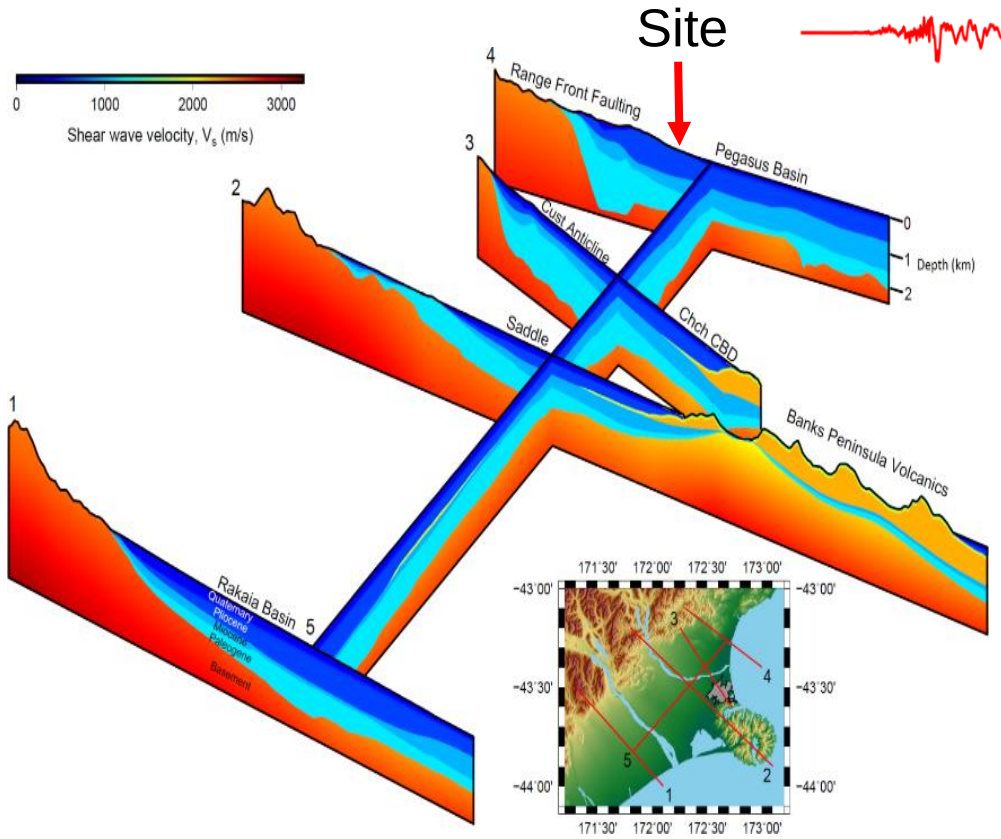
- Can we capture basin amplification in 2D analysis?
- Would expect spatial variability in input
  - Use 3D simulations with domain reduction method?



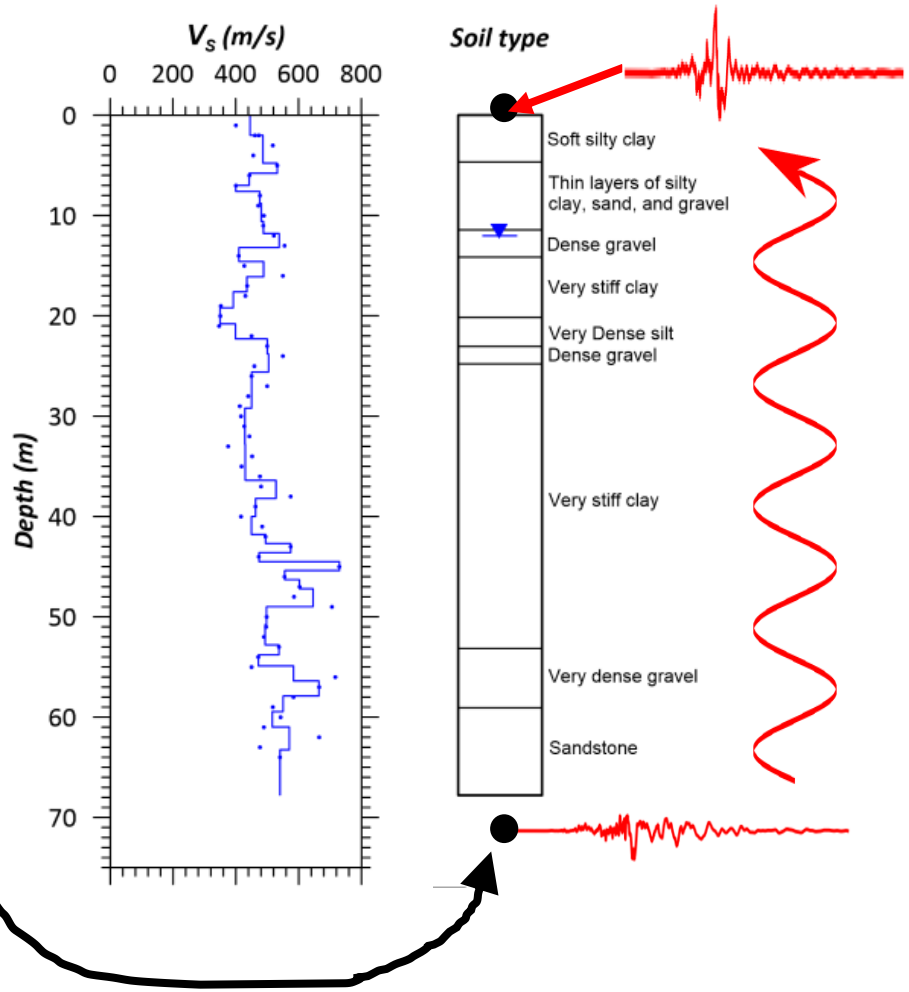
McGann et al. (2019)

Combining 3D Simulations and 1D Site Response

3D Simulation



Wave Propagation Site Response



Afshari and Stewart (2017)