

Waikato/Hauraki basin model and illustrative Hauraki rift rupture simulations

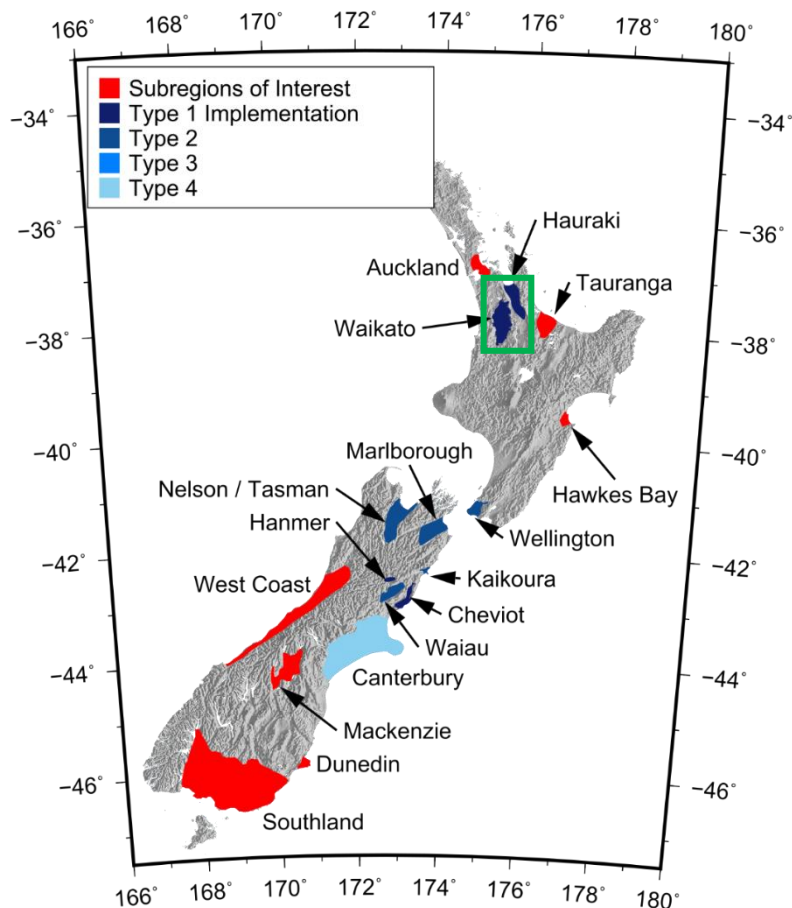
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Seokho Jeong (UoW) and Liam Wotherspoon (UoA)

FP1 GMSV Call

22 August 2019

NZ Basin Models



Basin Models:

- Type 1 – geology & topography
- Type 2 – simple field data
- Type 3 – additional field data
- Type 4 – data + robust modelling

Refinement of models through field testing:

- H/V \rightarrow Site Period
- Surface wave testing $\rightarrow V_s$

Outline

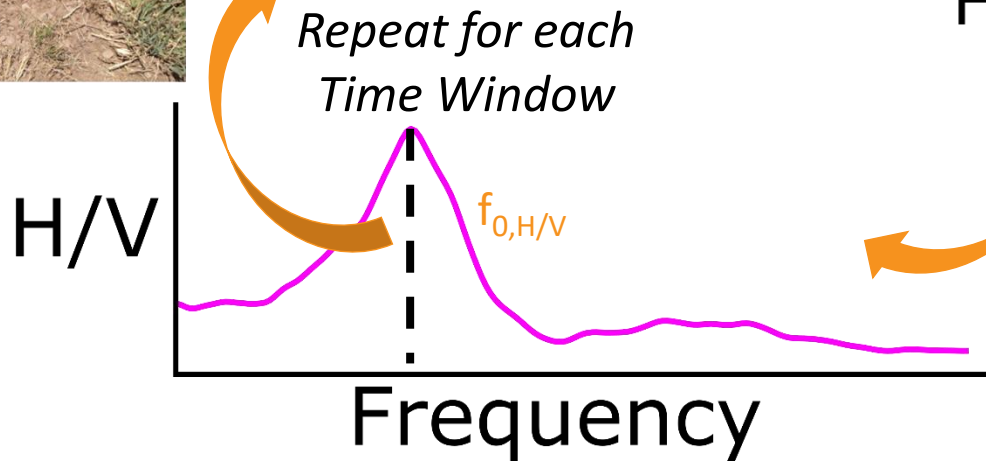
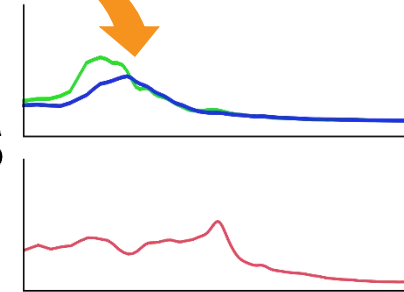
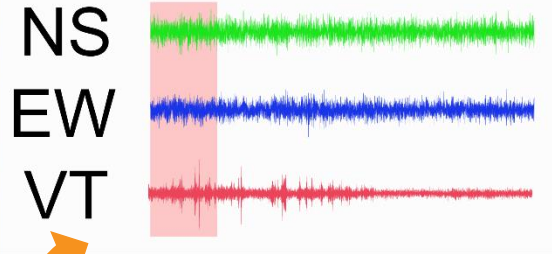
- Field Testing
 - Hauraki: H/V
 - Waikato: H/V and Surface Wave Testing
- Waikato/Hauraki Type 1 basin model
 - geologic maps, cross-sections, and DEM
- Illustrative simulations of Kerepehi Fault rupture

Horizontal to Vertical Spectral Ratio (HVSR, H/V)



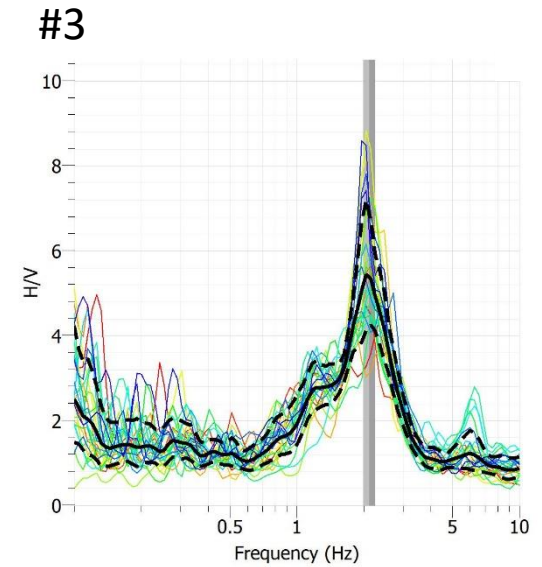
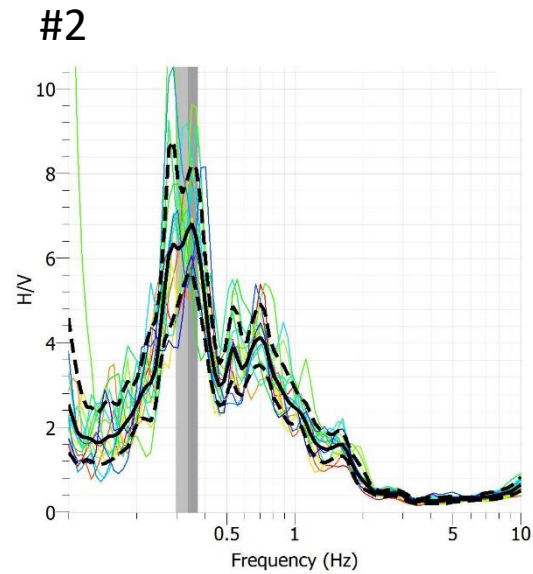
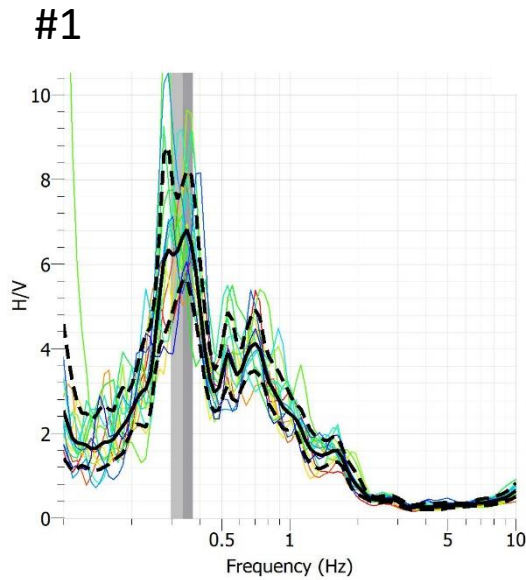
Record Ambient Signal

Fourier Transform & Smoothing



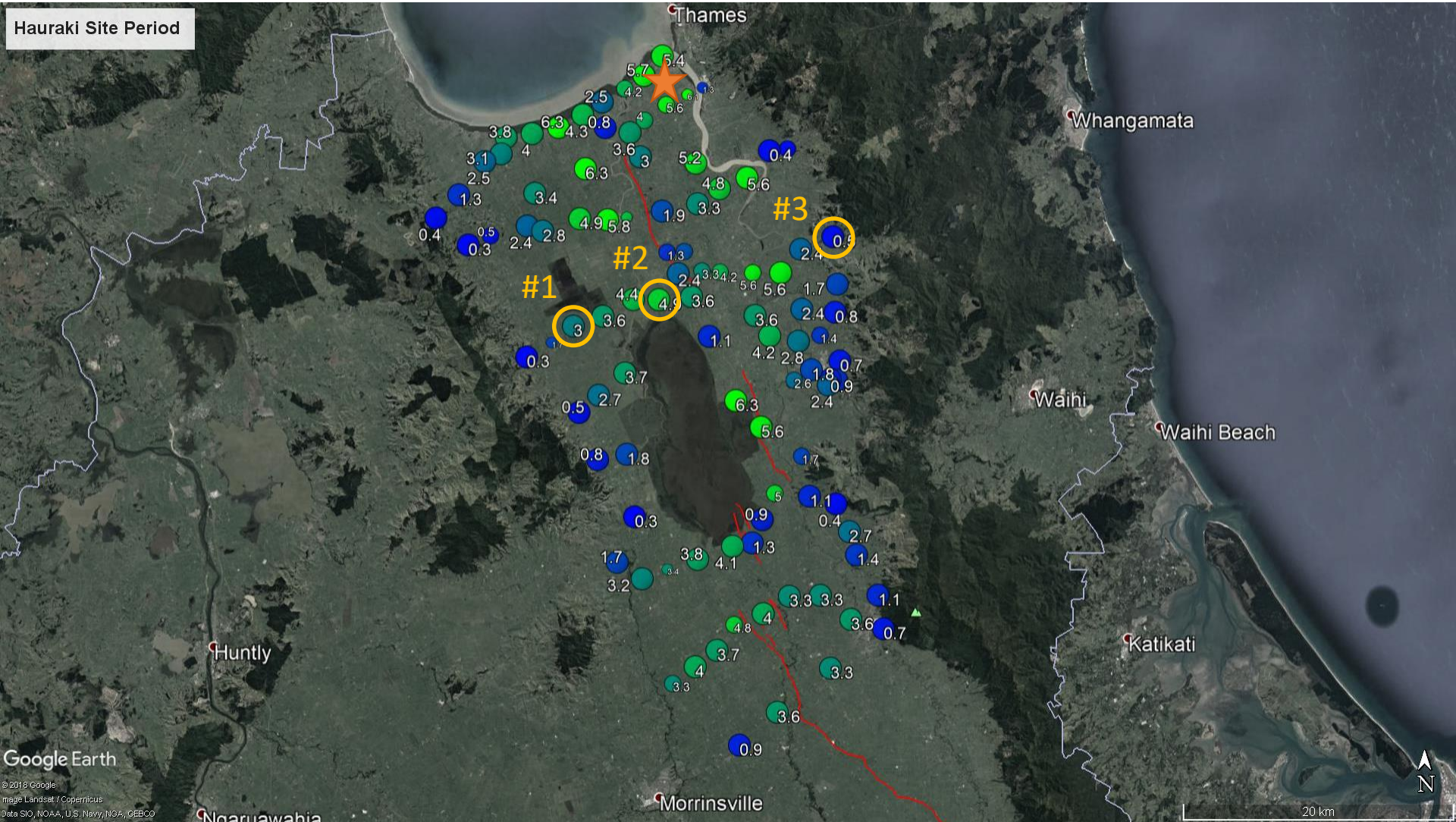
Divide combined NS and EW FAS by VT FAS

Hauraki HVSR Curves

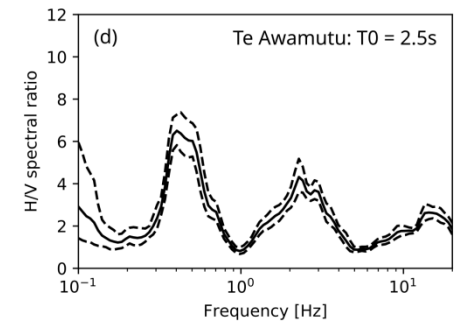
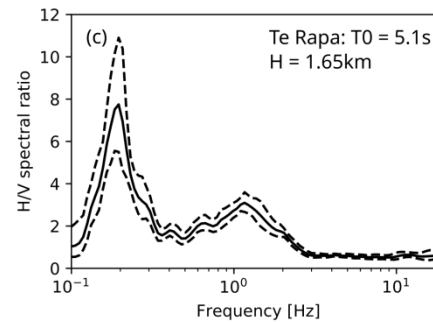
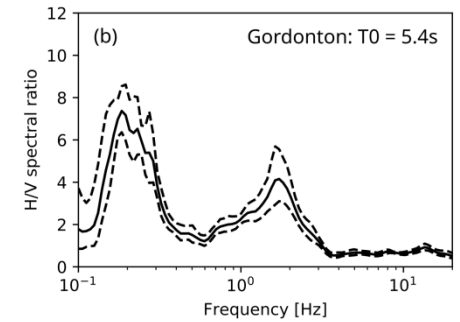
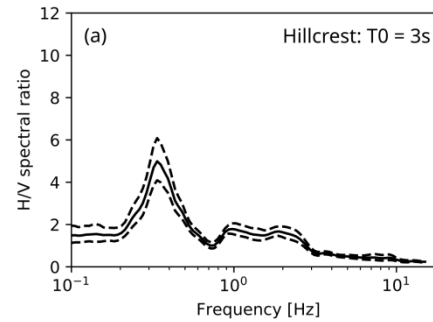
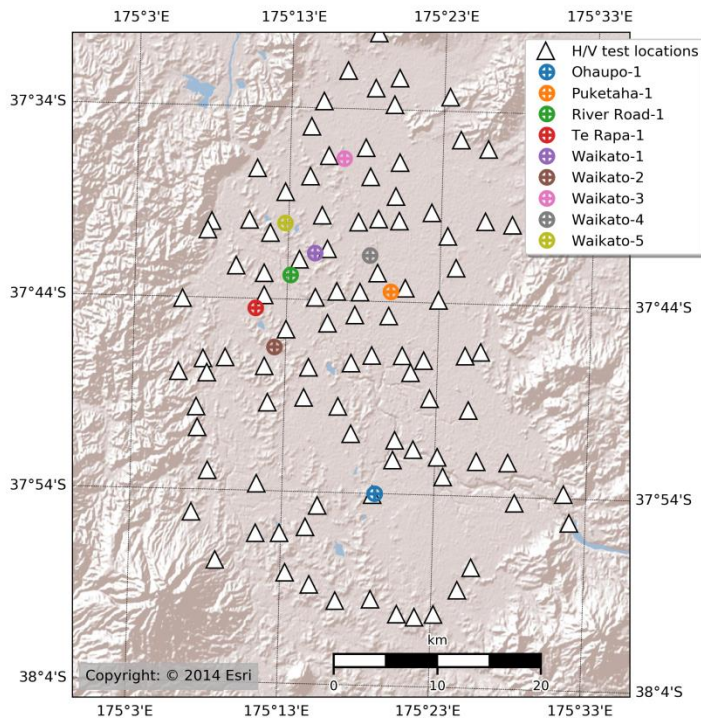


West ←————→ East

Hauraki Site Periods

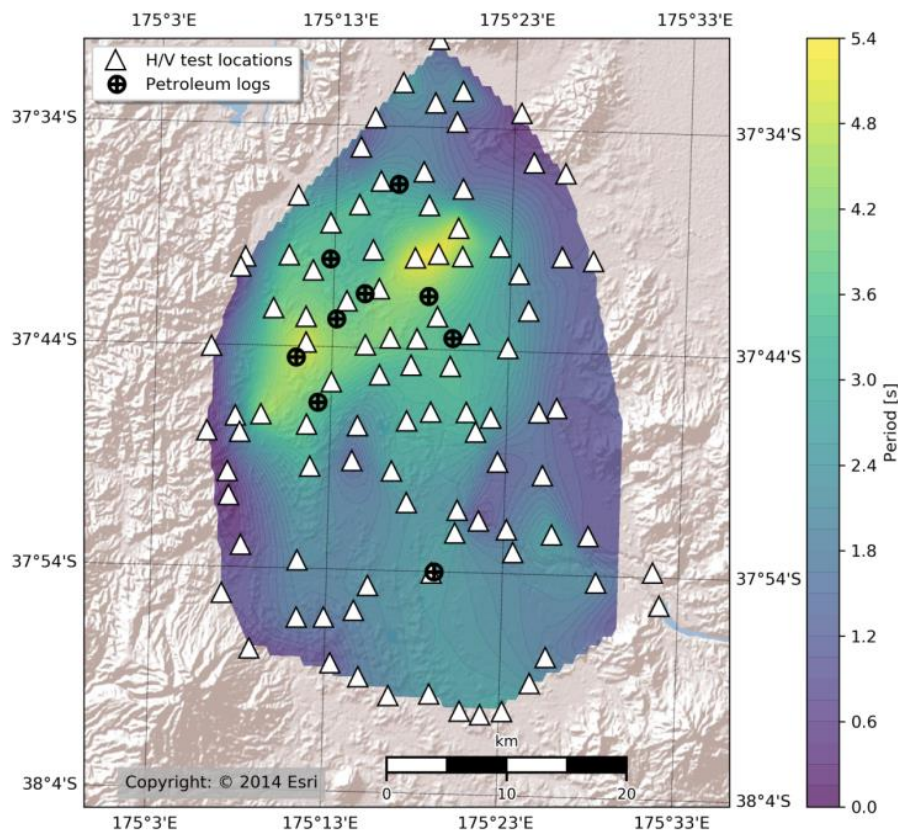


HVSR in Waikato

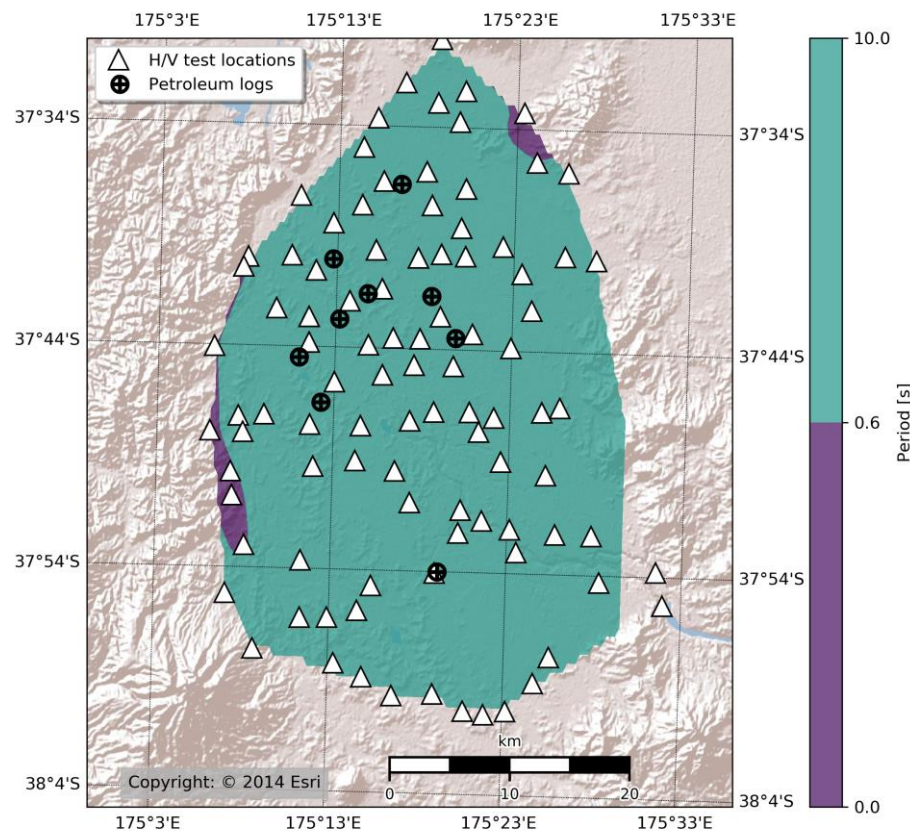


Site periods and site classes

T_0 map by spatial interpolation

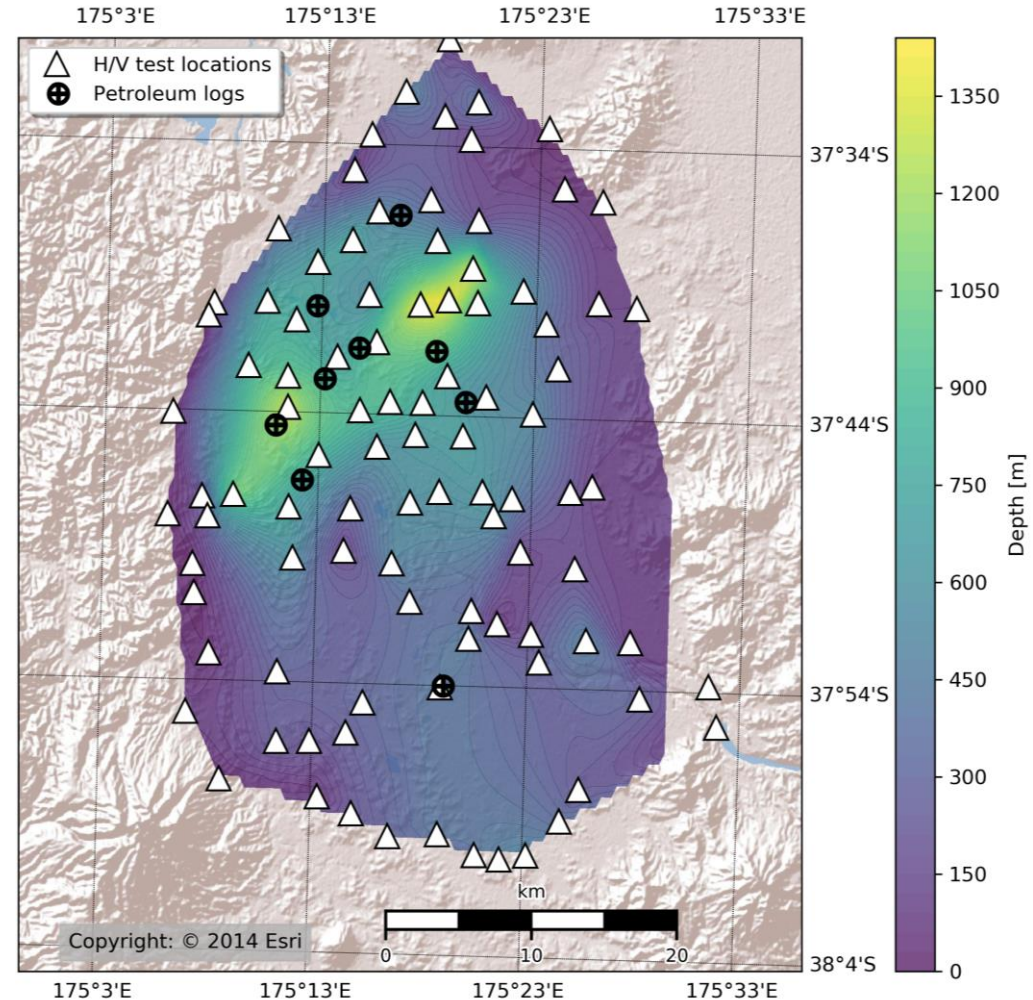
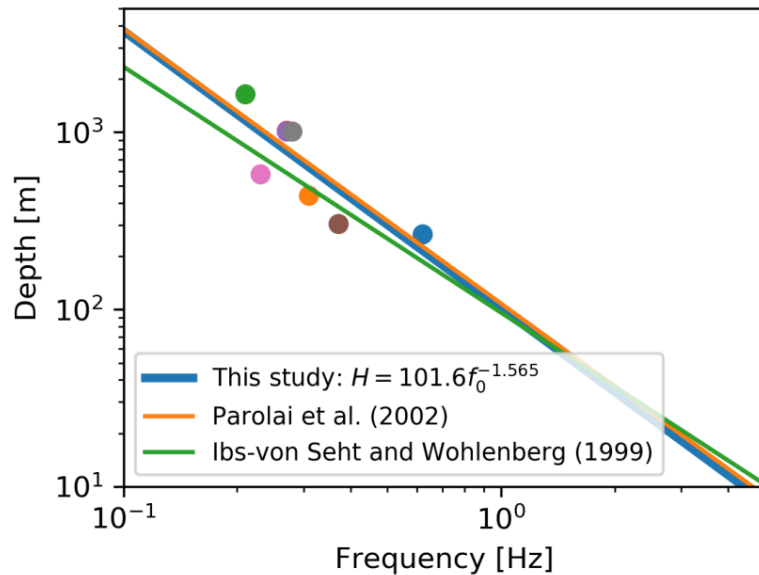


Mostly class D sites



Estimating depth to bedrock

- Depths to the basement from the petroleum log data (Edbrooke *et al.*, 2009)
- A power-law relationship between H and f_0

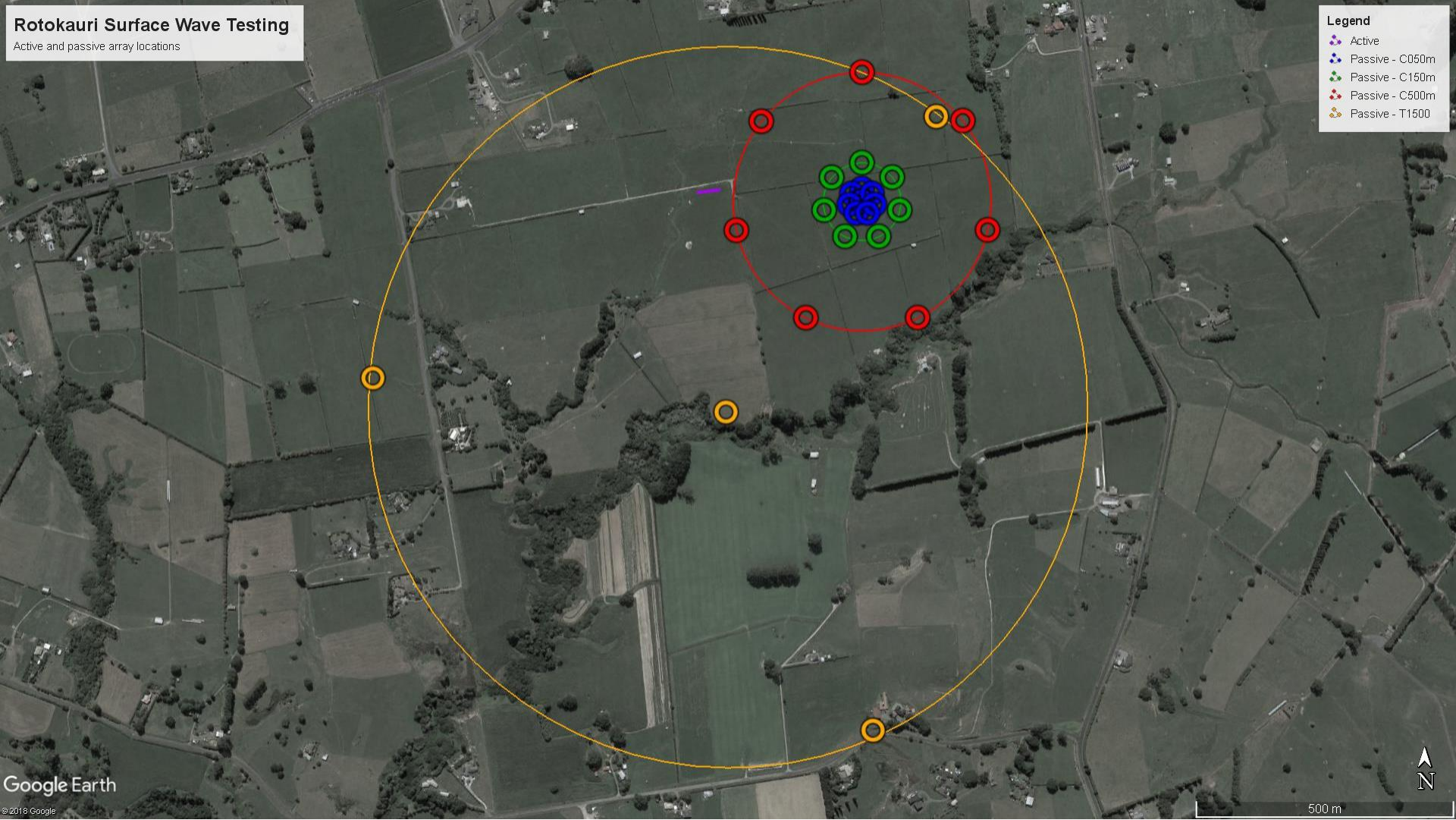


Rotokauri Site

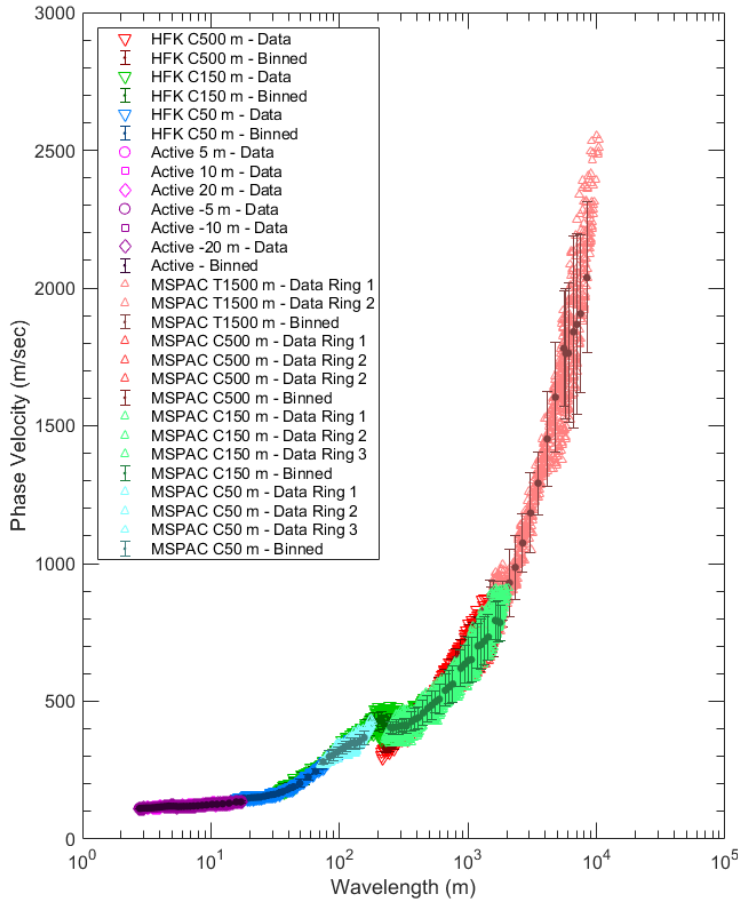
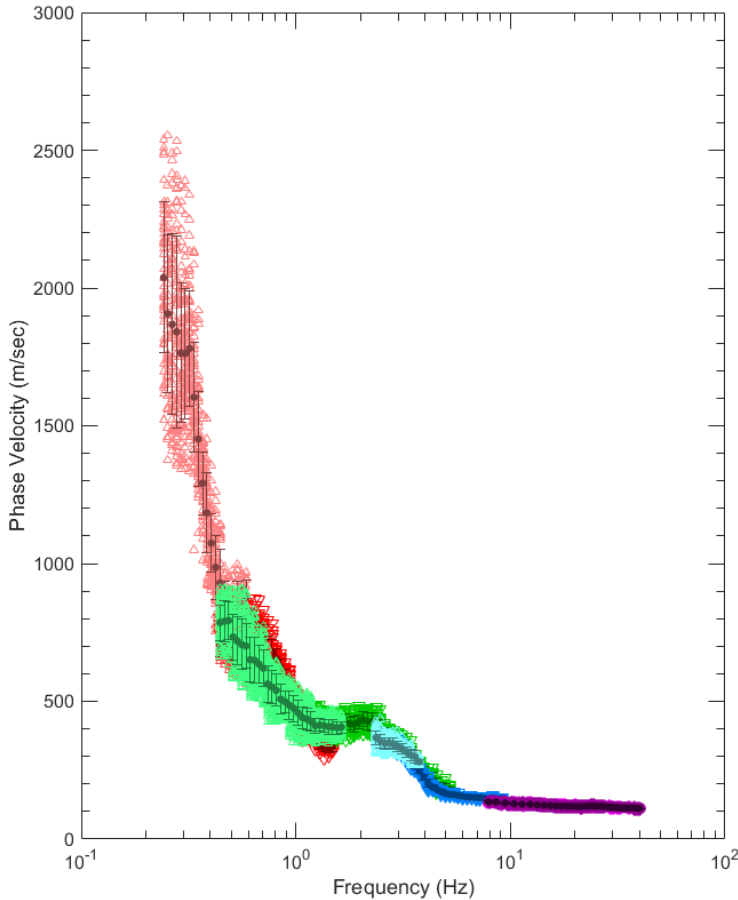
- Active Testing (MASW)
 - 24x Vertical 4.5 Hz geophones
 - 2-m geophone spacing
 - Source Offsets:
 - Both ends of the array
 - 5 m, 10 m, and 20 m
- Passive Testing (MAM)
 - Nanometrics Broadband Seismometers
 - Circular Arrays:
 - 50 m, 150 m, 500 m diameters
 - Triangular Array:
 - 1500 m “diameter”



Rotokauri Site

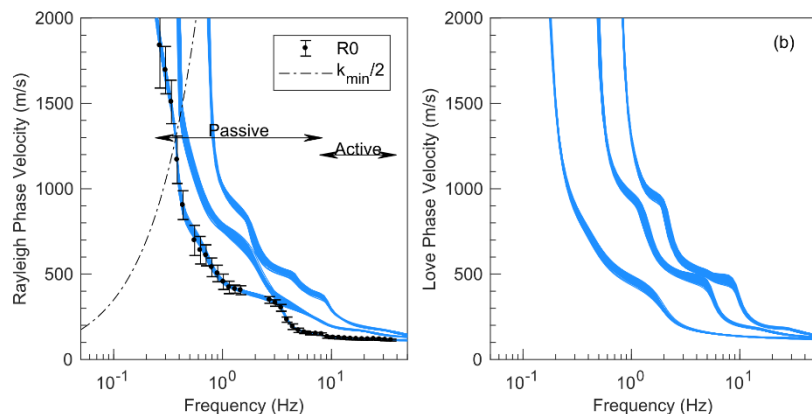


Rotokauri Dispersion Curves



- ▽ HFK C500 m - Data
- I HFK C500 m - Binned
- ▽ HFK C150 m - Data
- I HFK C150 m - Binned
- ▽ HFK C50 m - Data
- I HFK C50 m - Binned
- Active 5 m - Data
- Active 10 m - Data
- ◇ Active 20 m - Data
- Active -5 m - Data
- Active -10 m - Data
- ◇ Active -20 m - Data
- I Active - Binned
- △ MSPAC T1500 m - Data Ring 1
- △ MSPAC T1500 m - Data Ring 2
- I MSPAC T1500 m - Binned
- △ MSPAC C500 m - Data Ring 1
- △ MSPAC C500 m - Data Ring 2
- I MSPAC C500 m - Binned
- △ MSPAC C150 m - Data Ring 1
- △ MSPAC C150 m - Data Ring 2
- △ MSPAC C150 m - Data Ring 3
- I MSPAC C150 m - Binned
- △ MSPAC C50 m - Data Ring 1
- △ MSPAC C50 m - Data Ring 2
- △ MSPAC C50 m - Data Ring 3
- I MSPAC C50 m - Binned

Rotokauri Initial Results



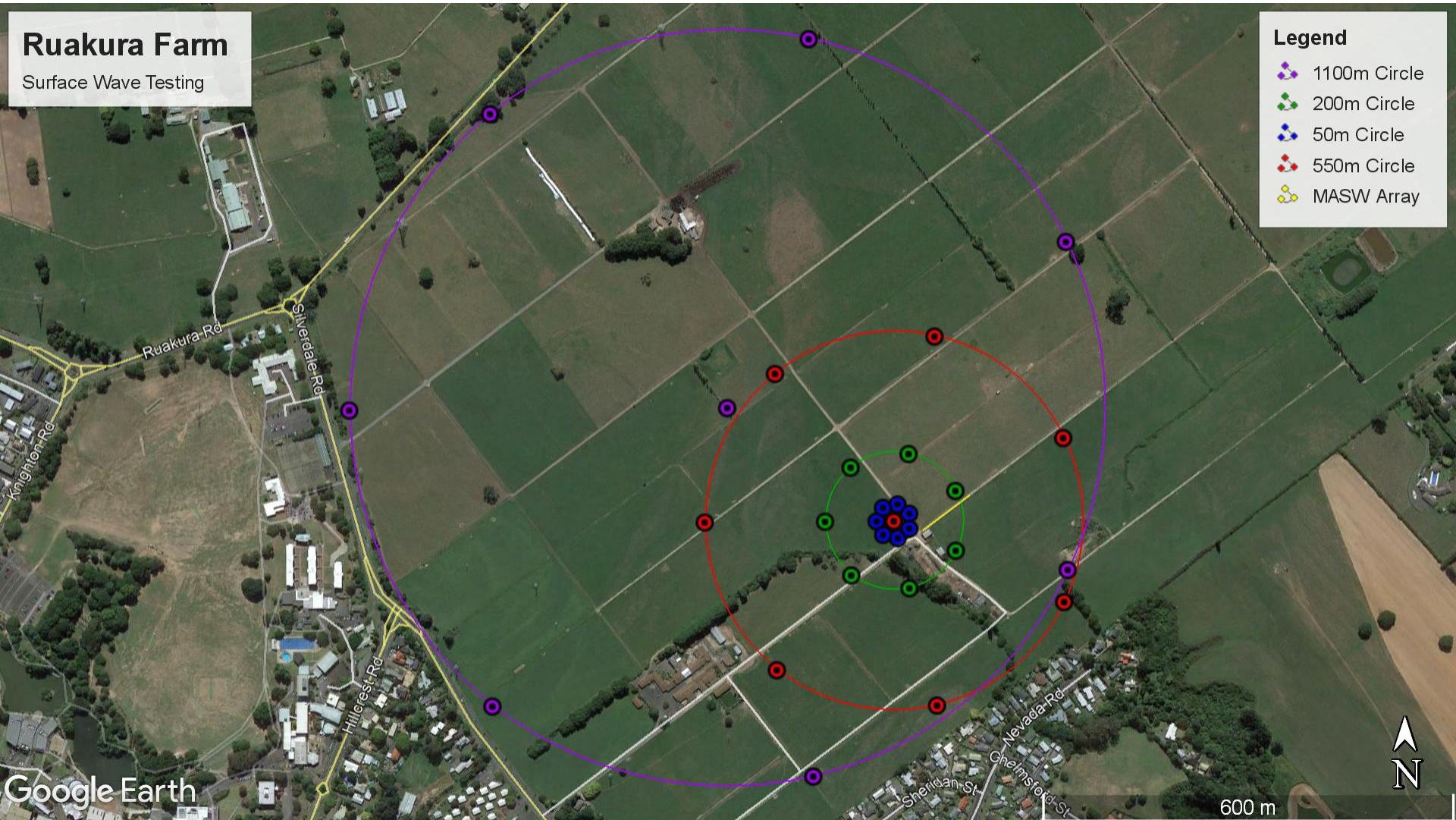
- Inversion Targets
 - R0 DC ($w=0.7$)
 - Ellipticity Peak 0.18 Hz ($w=0.3$)
- Layering Ratios:
 - Cox and Teague 2016
 - 1.5, 2.0, 2.5, 3.0, 3.5, **4.0**, 5.0, and 7.0
- Inversions
 - Software: Dinver
 - Neighbourhood Algorithm (Wathelet et al. 2004)
 - For each LR:
 - 310,000 trial profiles
 - Keep 1,000 best profiles
 - 100 profiles shown here

Ruakura Site

- Active Testing (MASW)
 - 24x Vertical 4.5 Hz geophones
 - 2-m geophone spacing
 - Source Offsets:
 - Both ends of the array
 - 5 m, 10 m, and 20 m
- Passive Testing (MAM)
 - Nanometrics Broadband Seismometers
 - Circular Arrays:
 - 50 m, 200 m, 550 m, 1100 m diameters

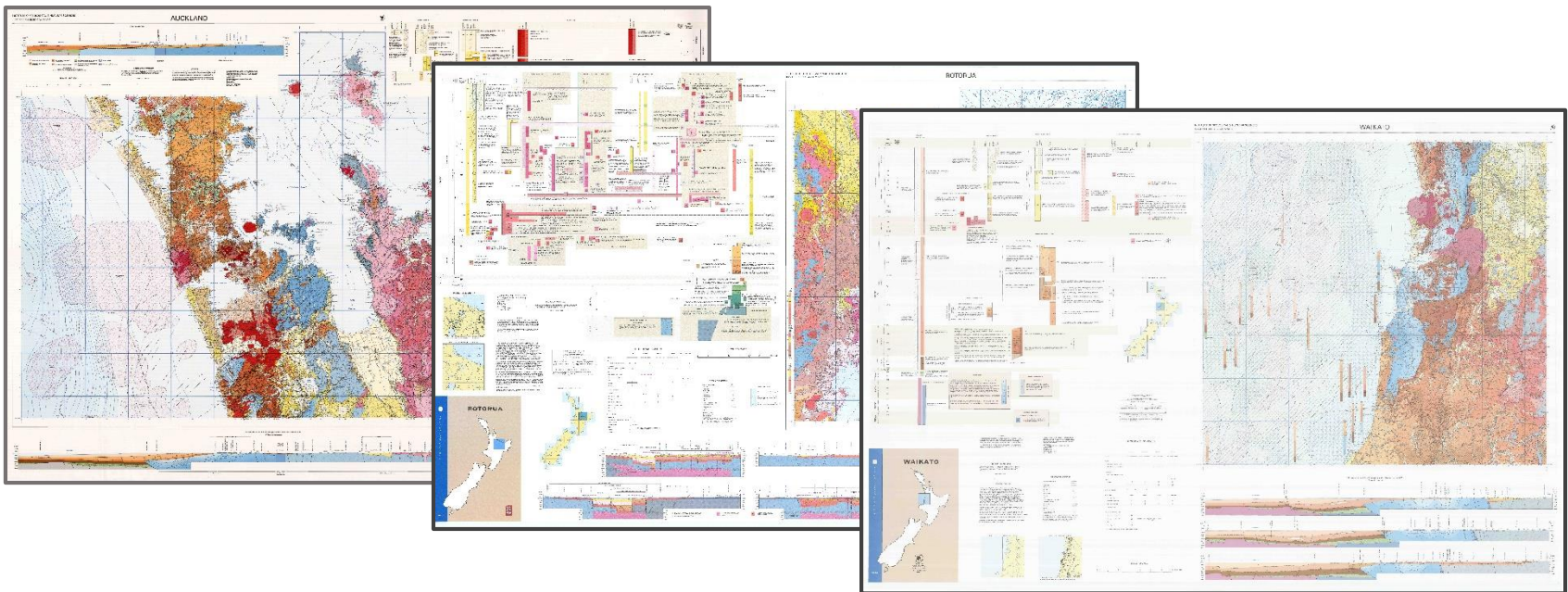


Ruakura Site



Building Type 1 Basin Models

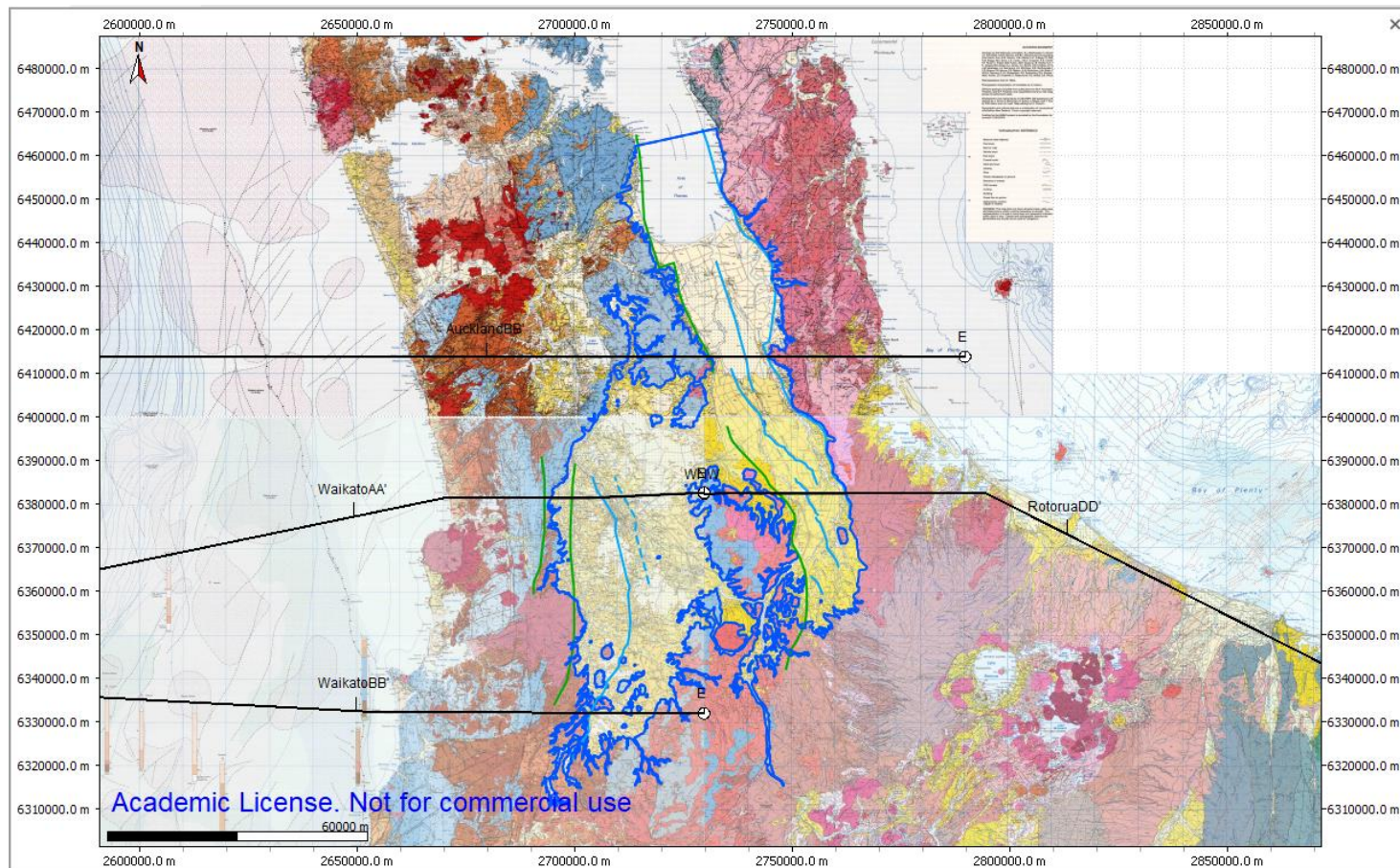
- Auckland, Rotorua, and Waikato Geological Maps
 - Use Quaternary Sedimentary deposits to bound basin edge
 - Constrain rock/soil interface geometry with cross sections



- DEM from Shuttle Radar Topography Mission
 - Define ground surface elevation
 - Infer slope of rock/soil interface from topography (e.g., mountains)
- Midland Valley Move 2018.1

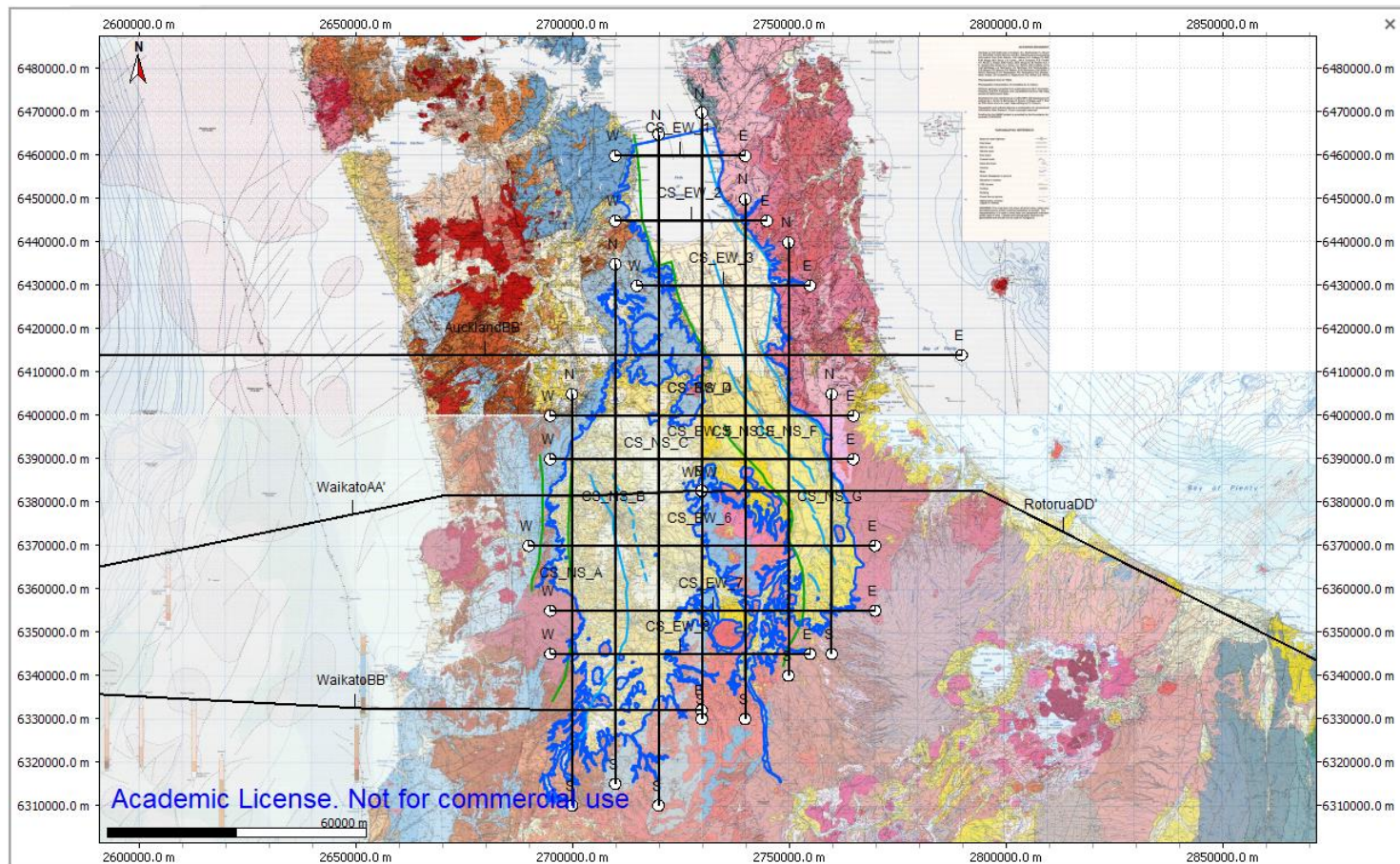
Building Type 1 Basin Models

Pull Maps, Cross sections, DEM together in 3D



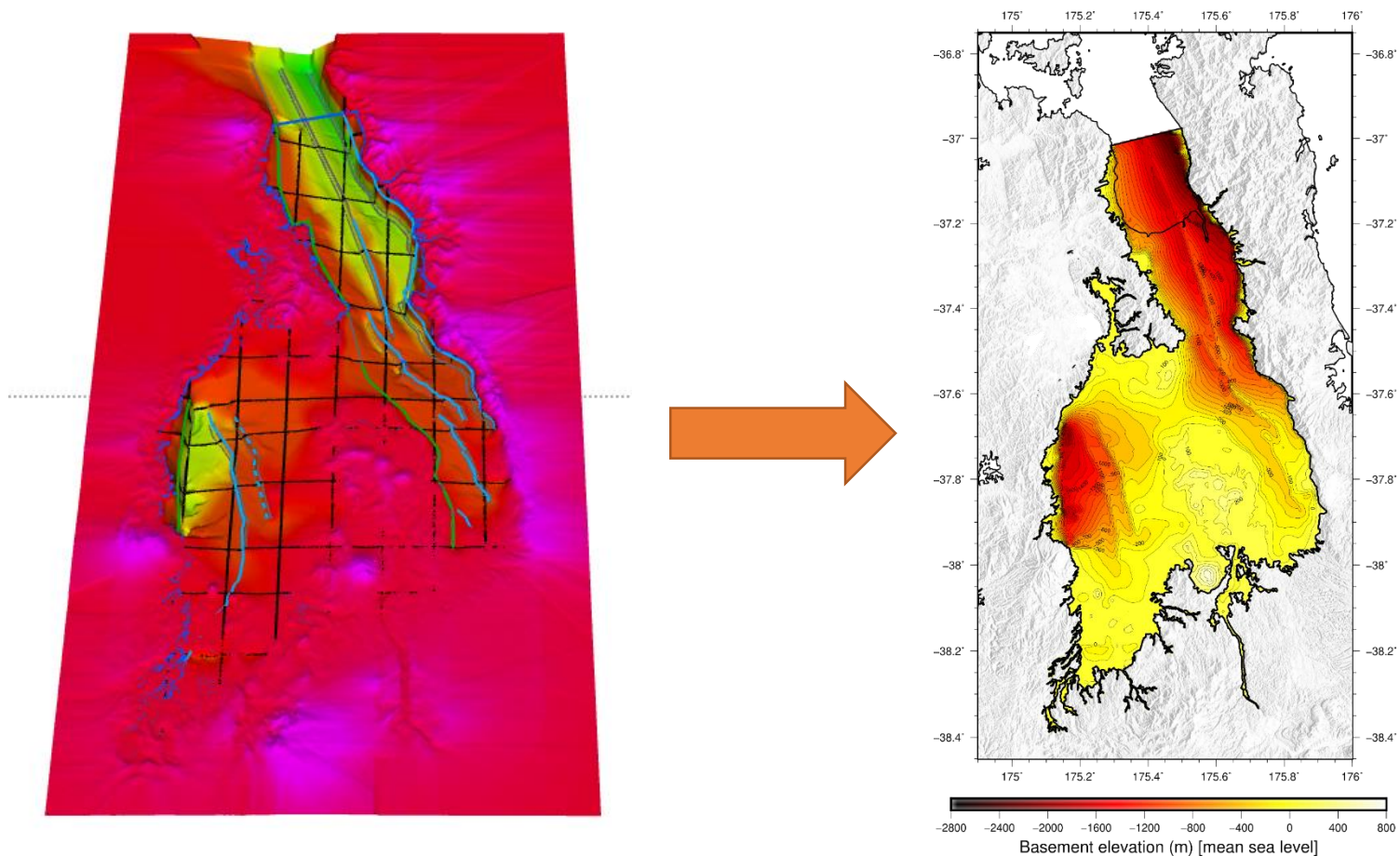
Building Type 1 Basin Models

Create additional cross sections to constrain basin



Building Type 1 Basin Models

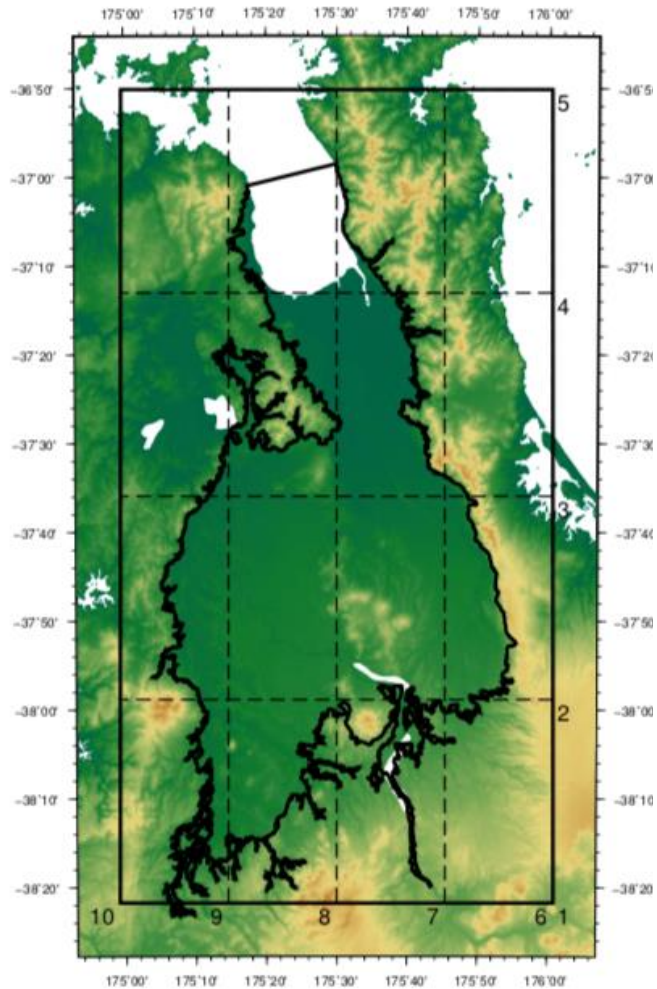
Kriging (500m grid) to develop 3D basement surface for NZVM



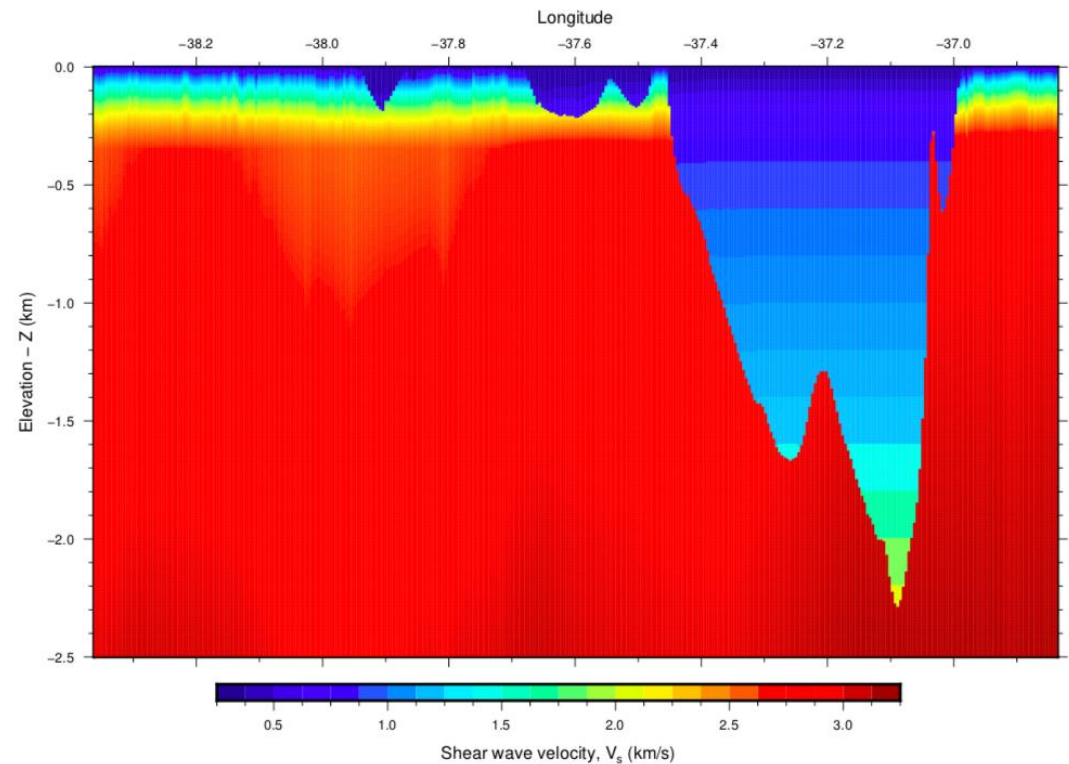
Waikato/Hauraki Basin in NZVM



QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū



Slice 8 Vs

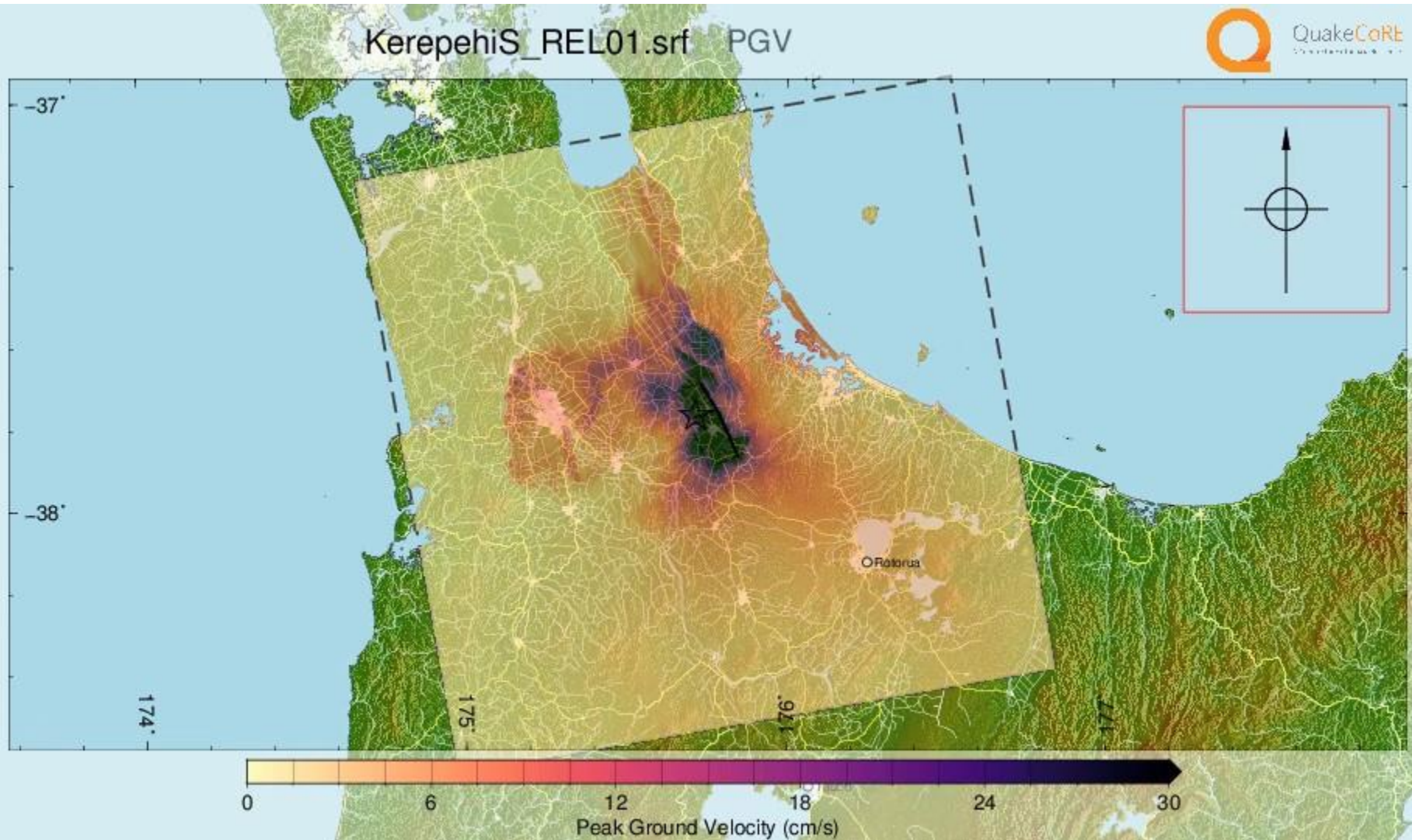


Karepehi Fault Rupture Simulation

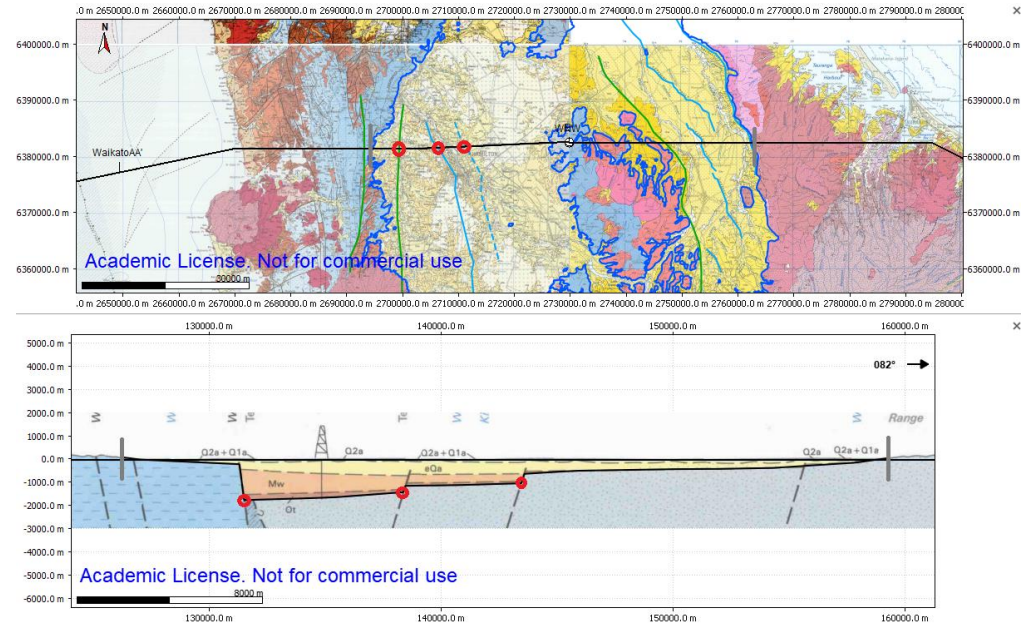
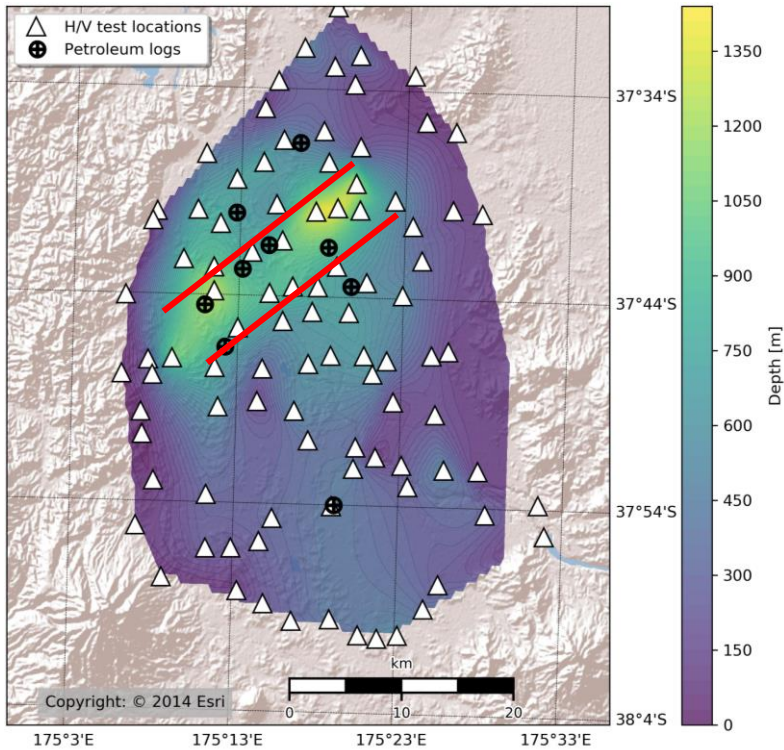
- Karepehi Fault in the middle of the Hauraki Plains
- 100-m grid
- Low Frequency Only

- Show animation from QC Software Team

Karepehi Fault Rupture Simulation



Update for Type 2 Model





QuakeCoRE

NZ Centre for Earthquake Resilience
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Thank you!

www.quakecore.nz

