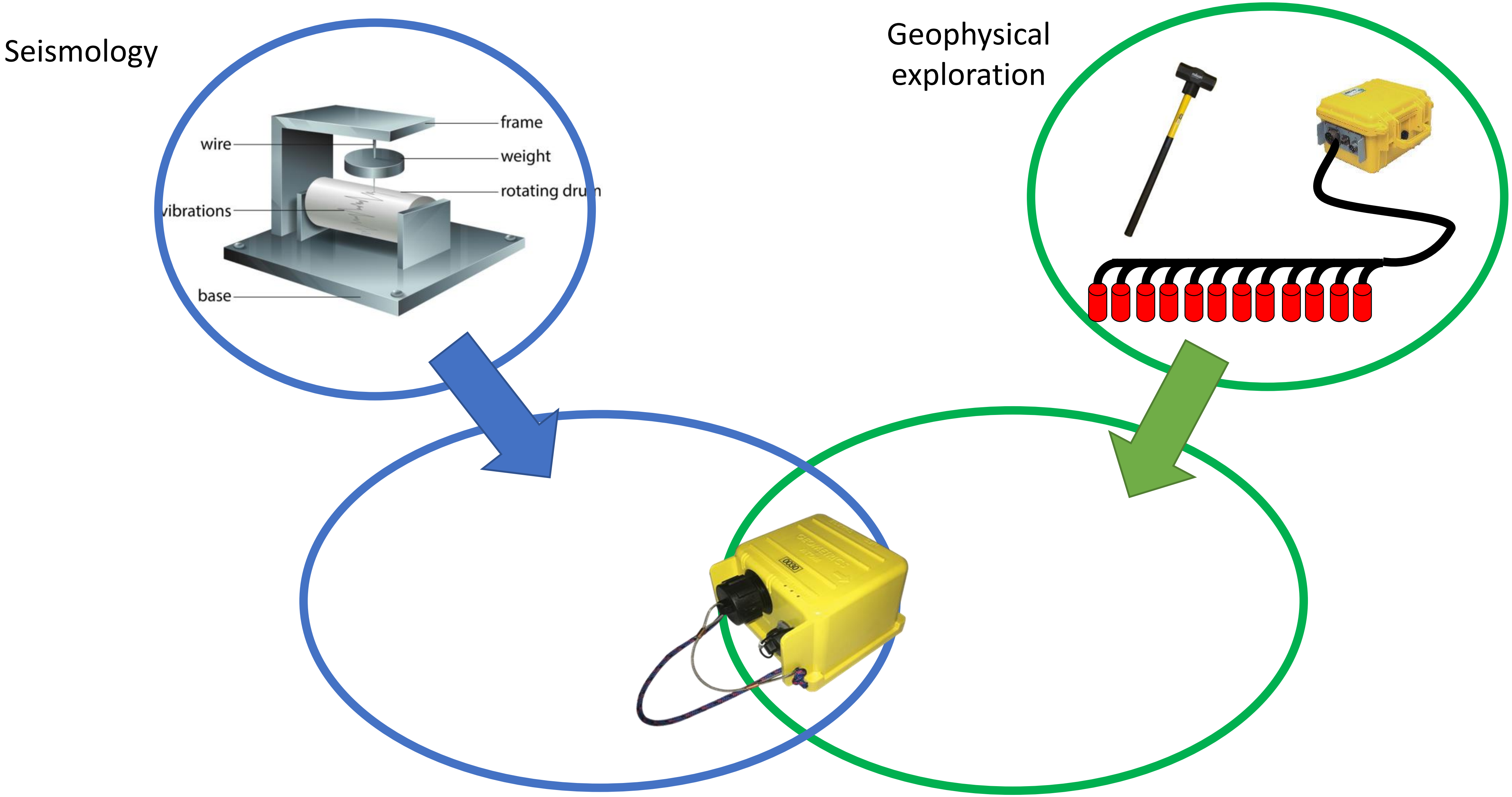
SeisImager/SW

Application examples of active and passive surface wave methods and ambient noise tomography

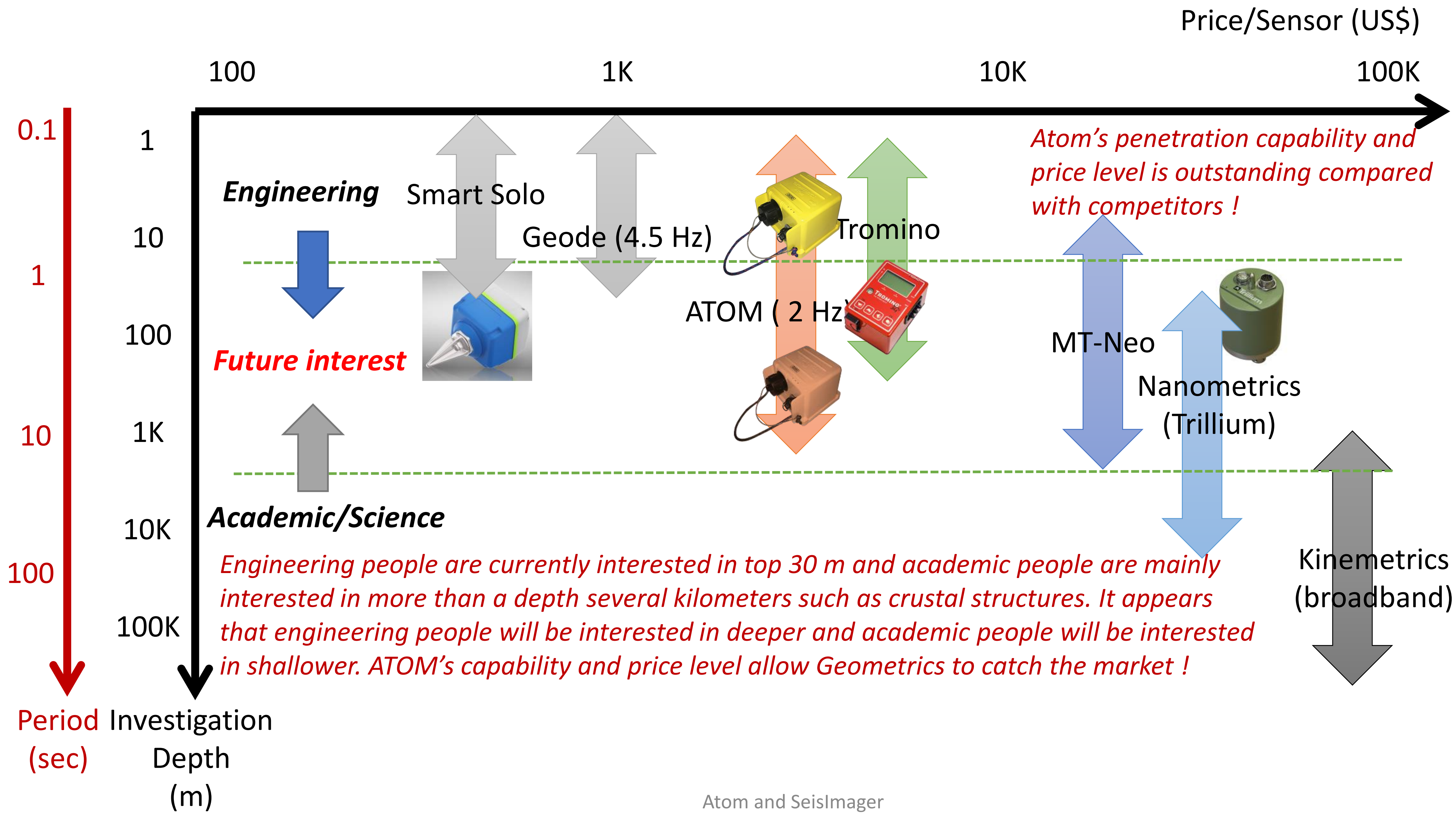
6/4/2019

GEOMETRICS
Simplify your search

Seismographs for seismology and exploration



Investigation Depth Vs. Price/Sensor



Atom fits everything !

Fast sampling rate

Easy download

Conventional seismic refraction, reflection

Shot box

Large scale seismic refraction

Fast sampling rate

Active (MASW) and passive (SPAC) surface wave method

VS30

Deep passive surface wave method

2D/3D ambient noise tomography

Monitoring

Solar battery

Sensor correction

mseed export

Communicati on interface

Application examples

- Active fault investigation at Beijing, China (3D)
- Bedrock investigation at the granite hills (3D)
- Major fault investigation (2D)
- Levee safety evaluation (2D)
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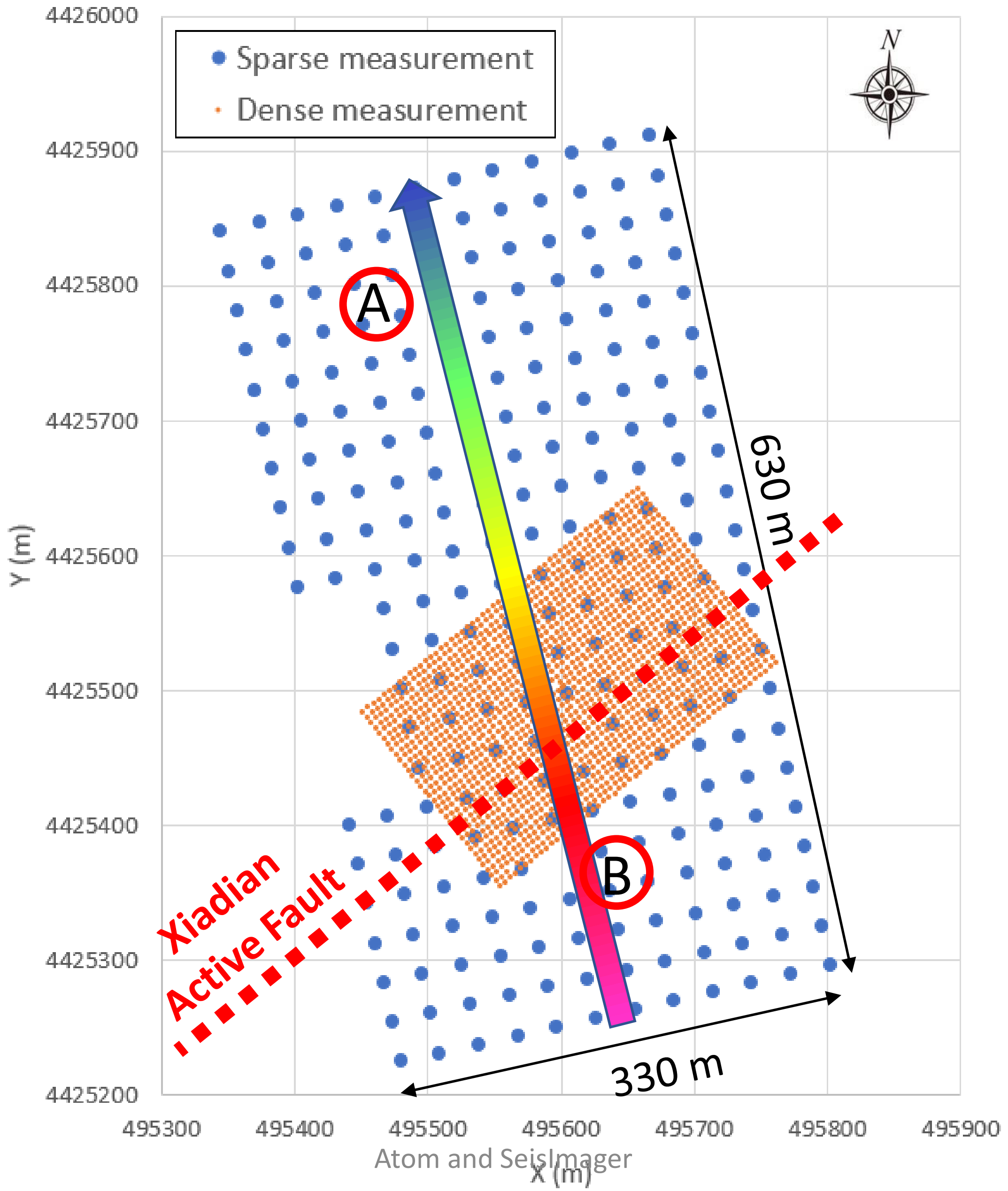
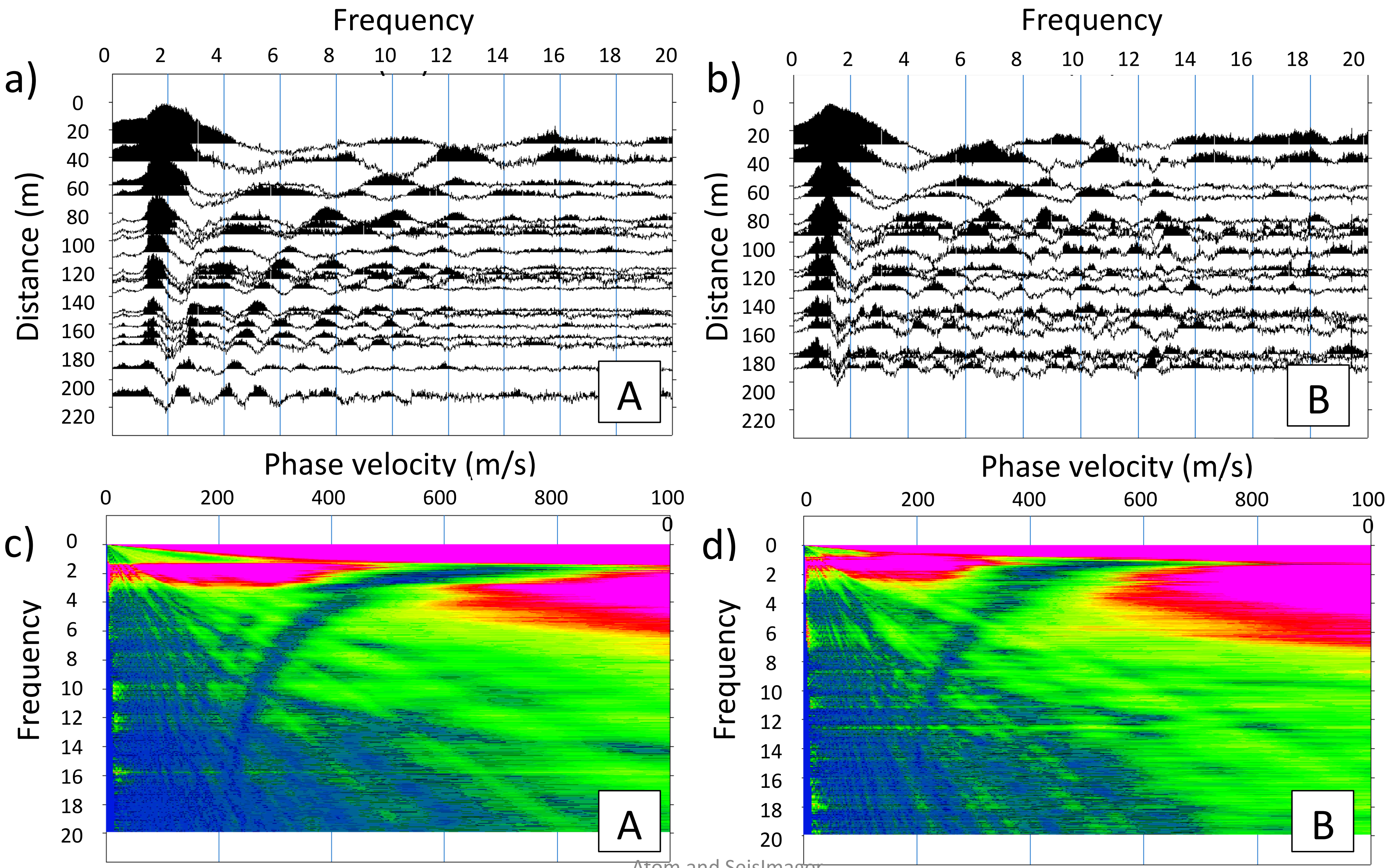
Active fault investigation at Beijing, China


Beijing Capital International Airport
Investigation site
Xiadian Active Fault
Downtown Beijing

Acquisition geometry

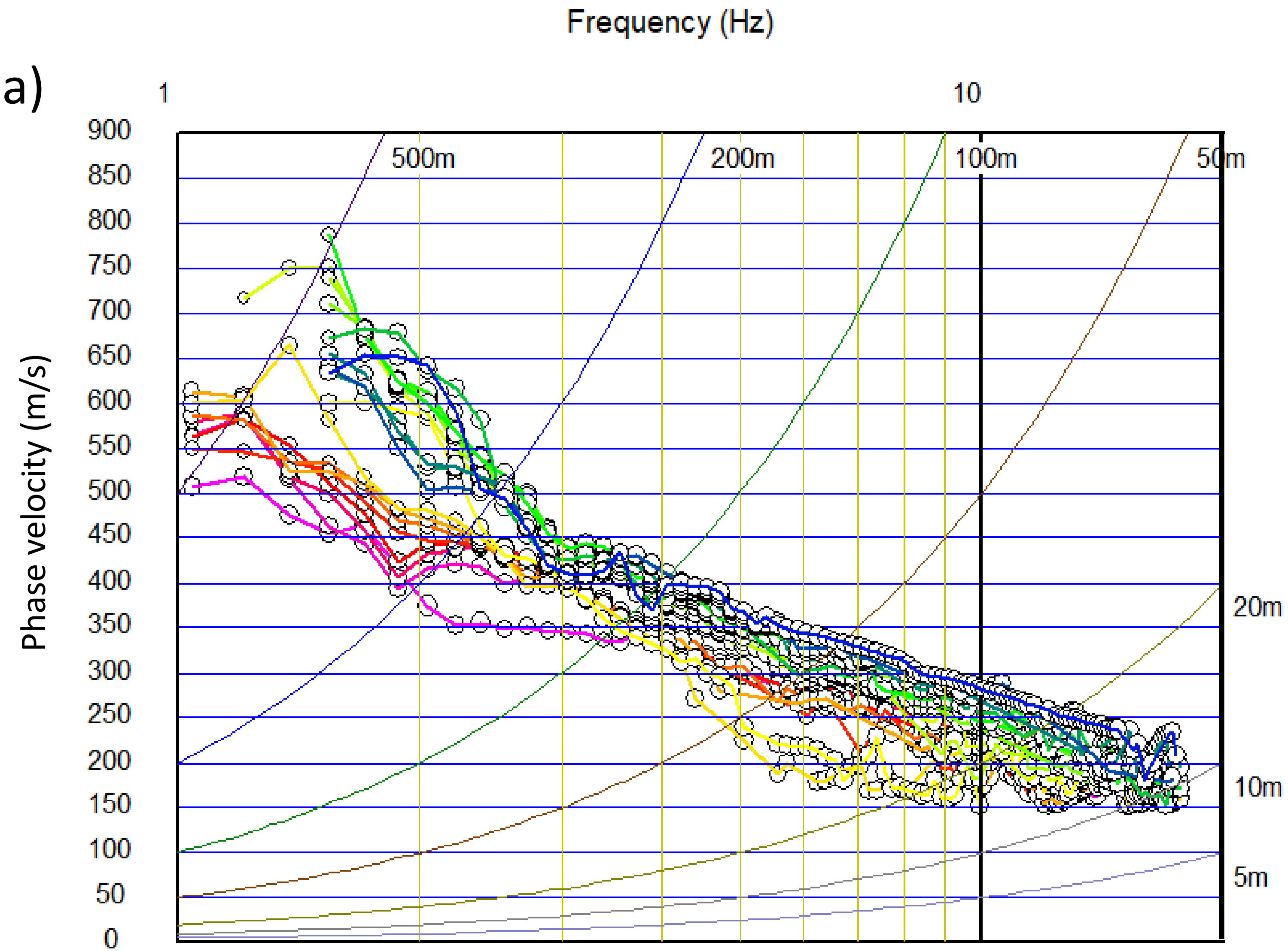


Coherencies and phase velocity images in frequency domain

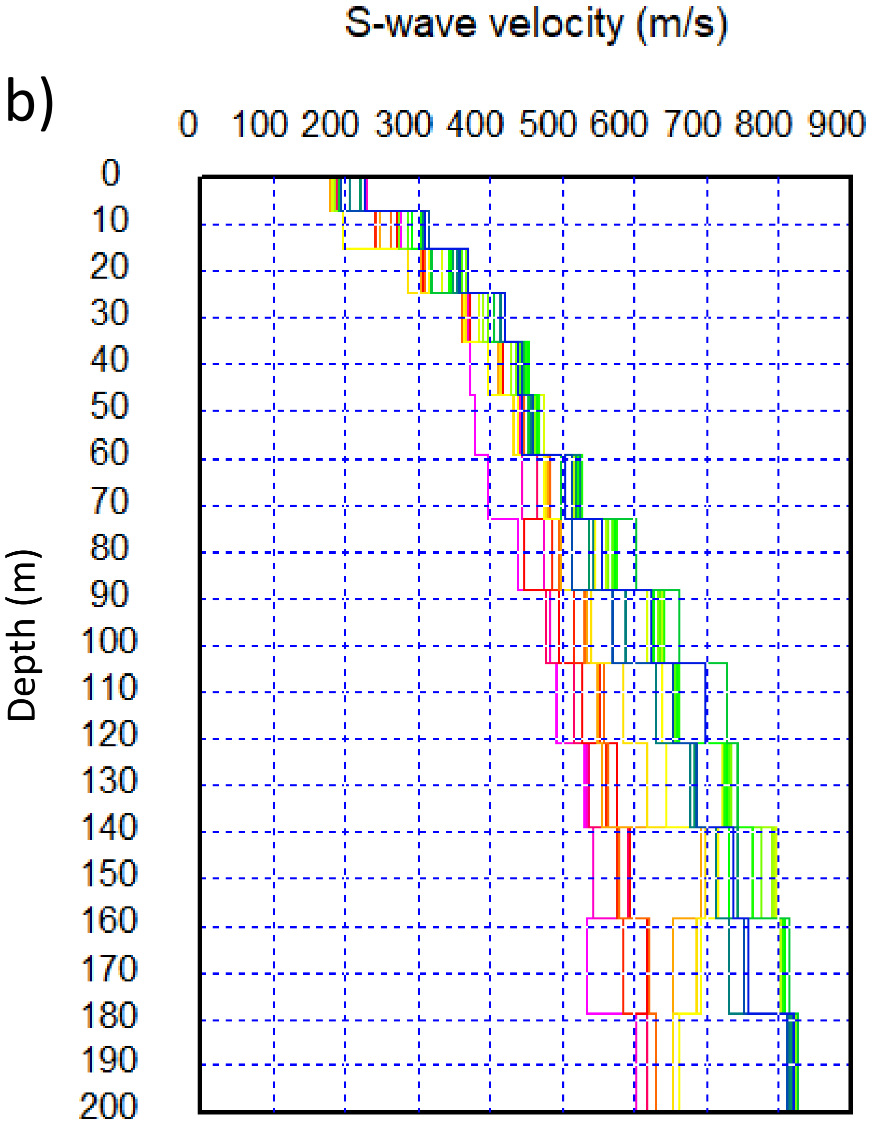


Dispersion curves and S-wave velocity models

a)

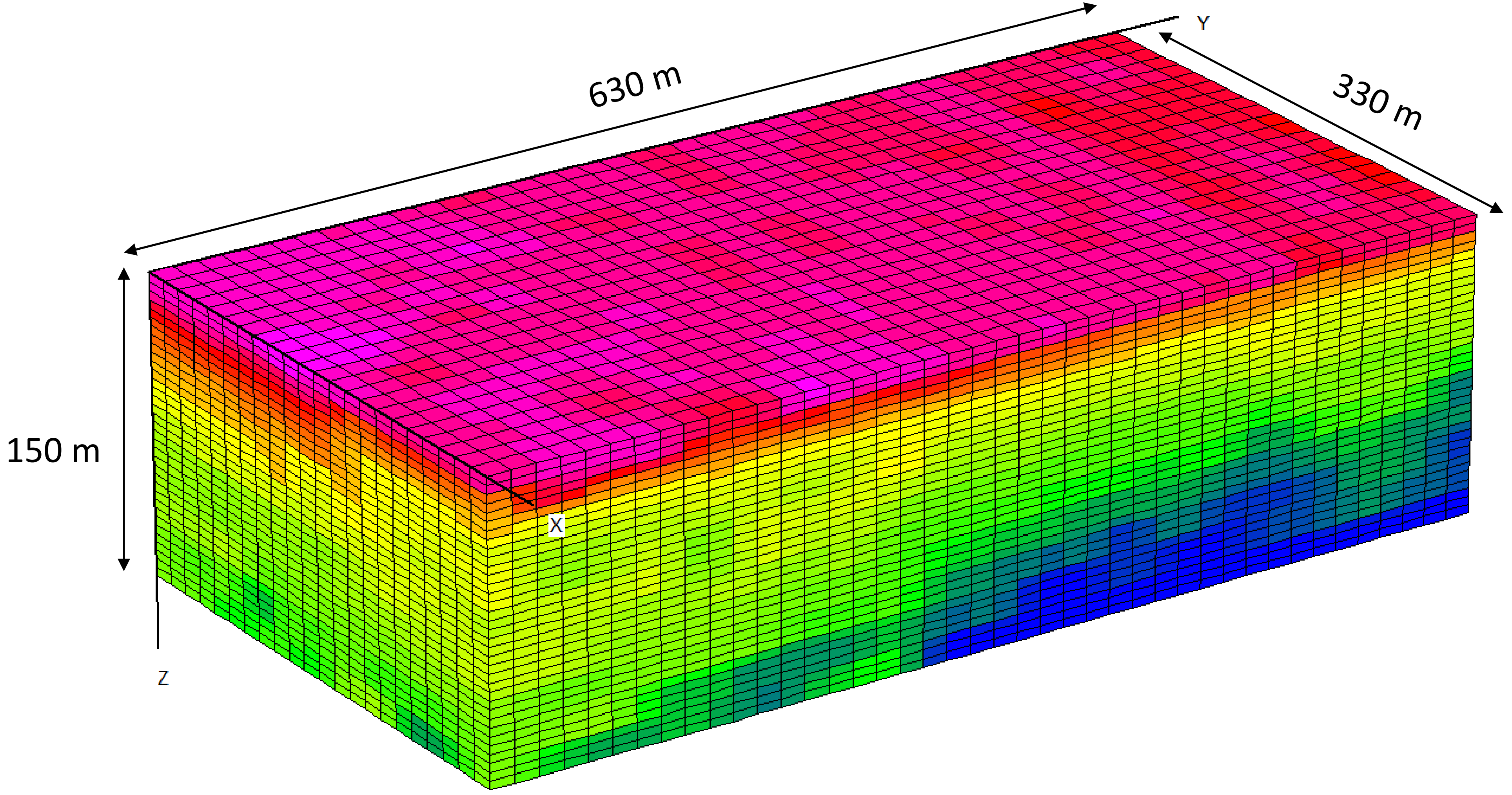


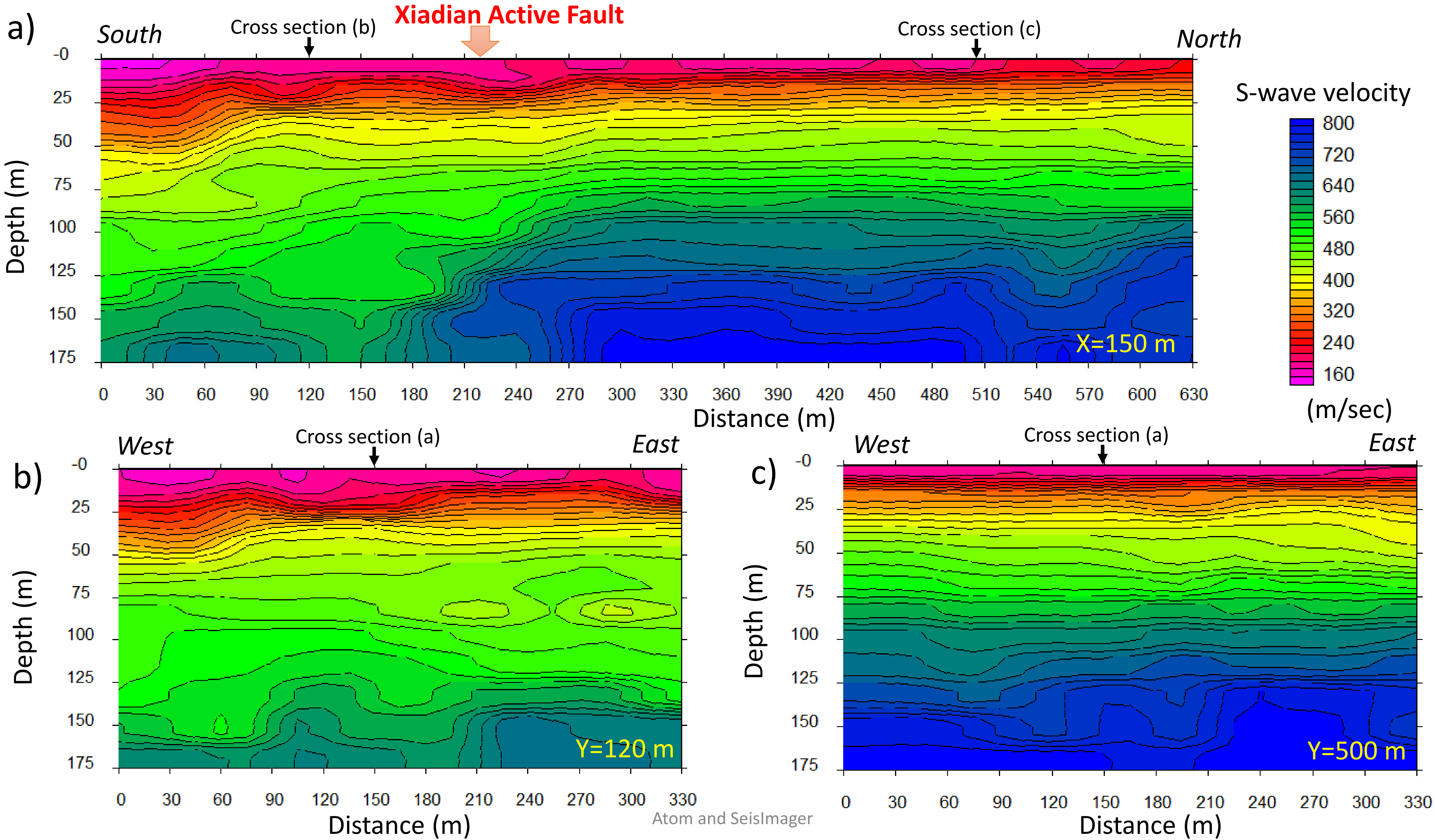
b)



Atom and SeisImager

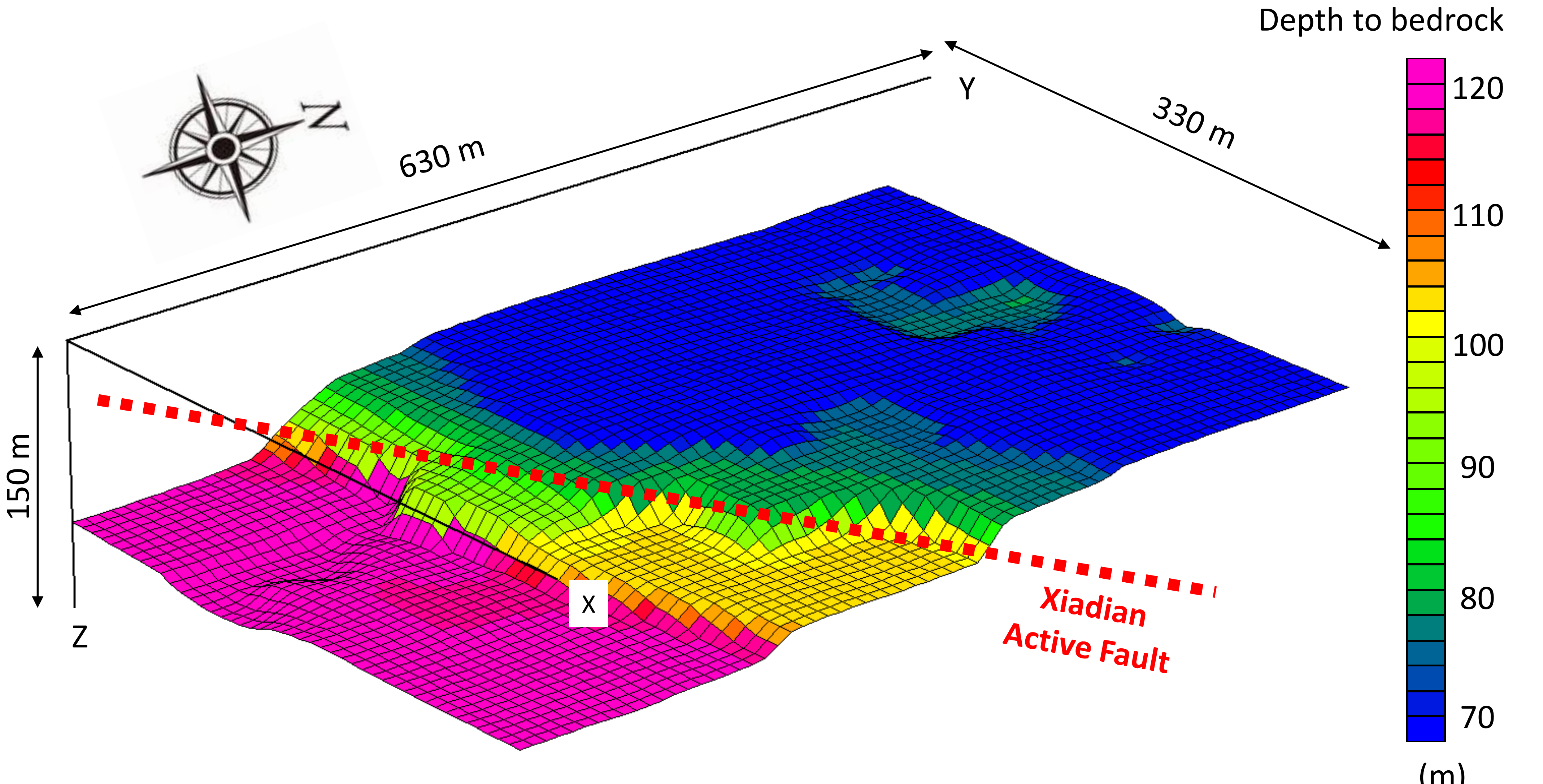
Active fault investigation at Beijing , China





Atom and SeisImager

Depth to bedrock



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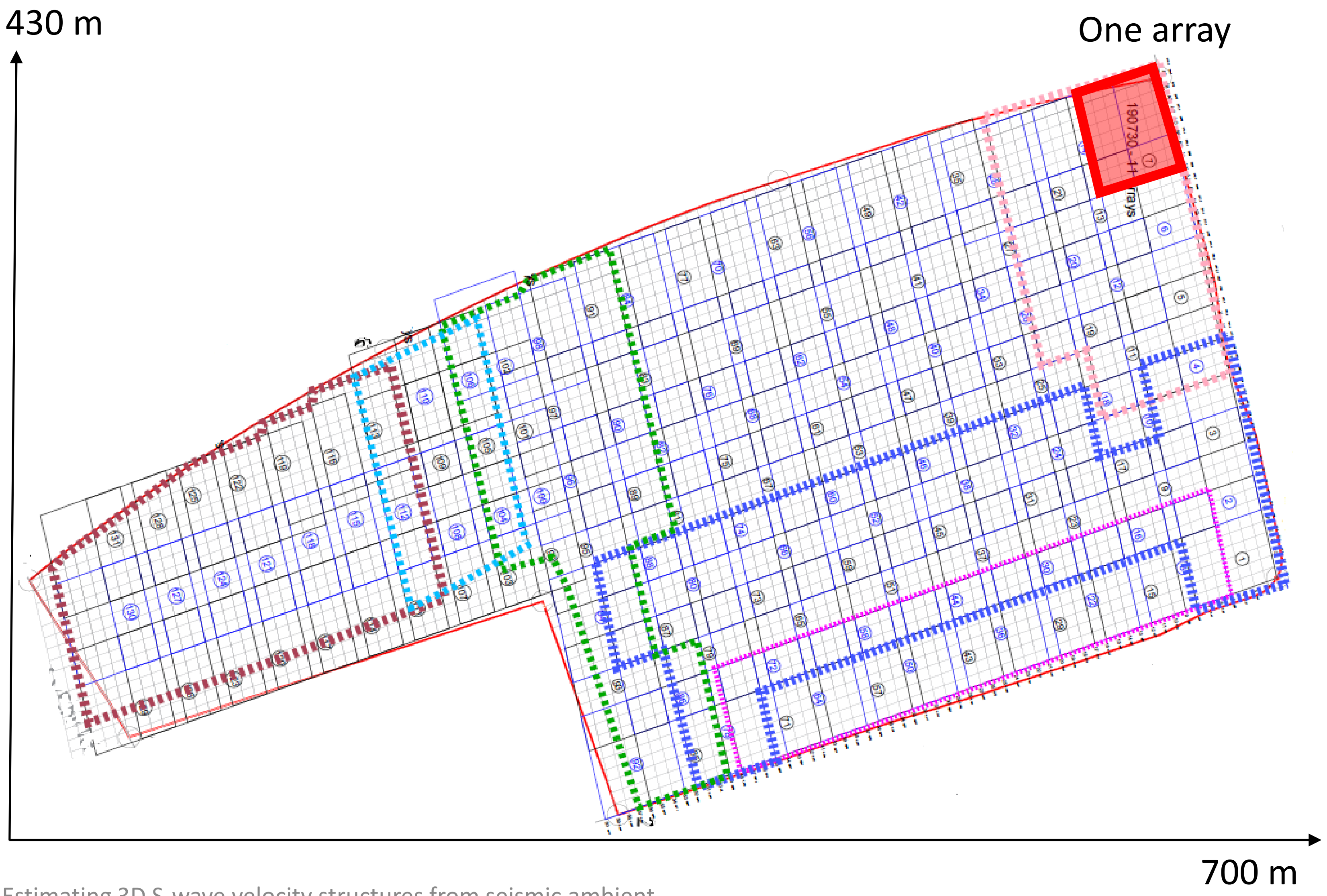
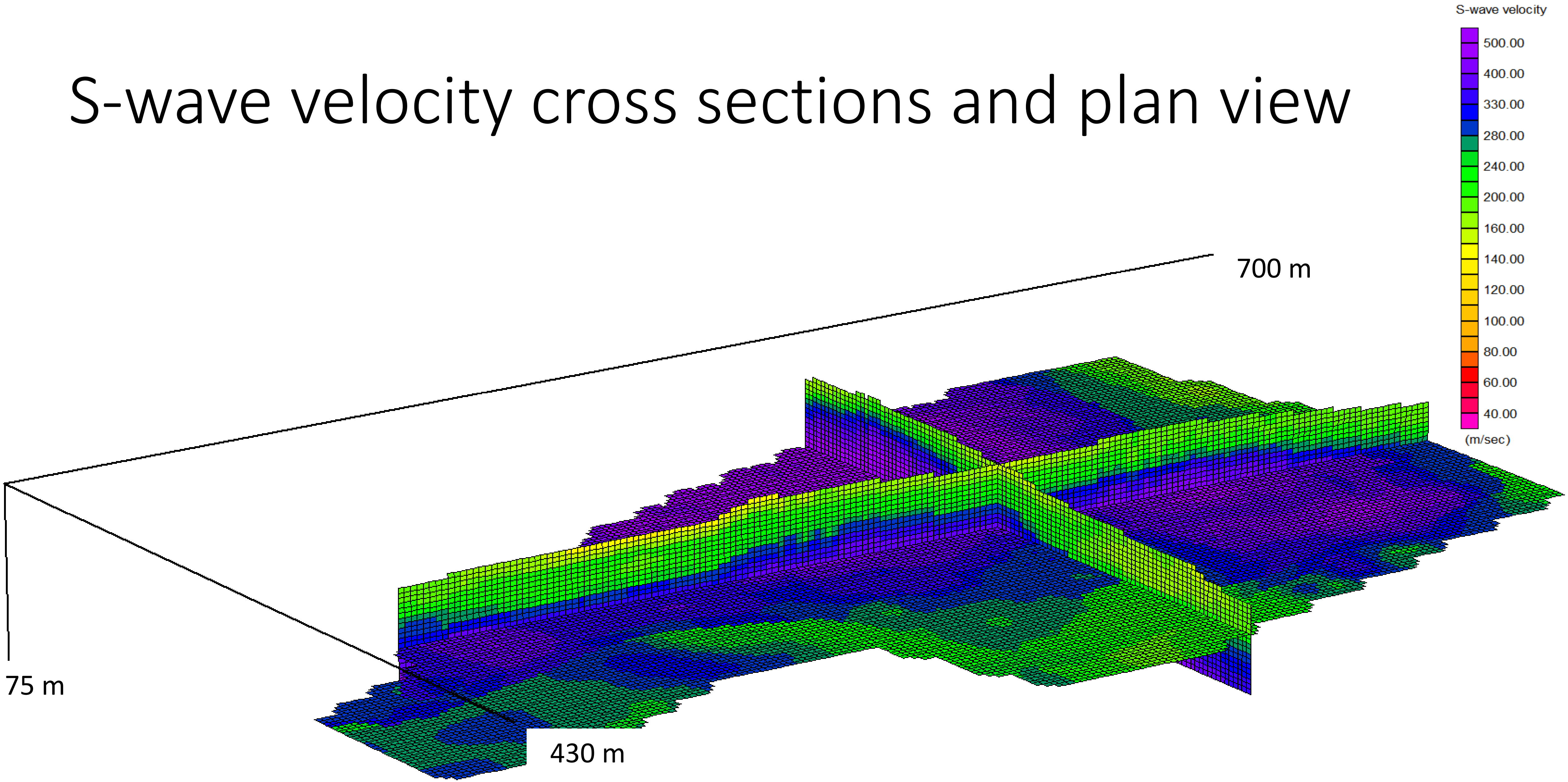
Bedrock investigation at the granite hills

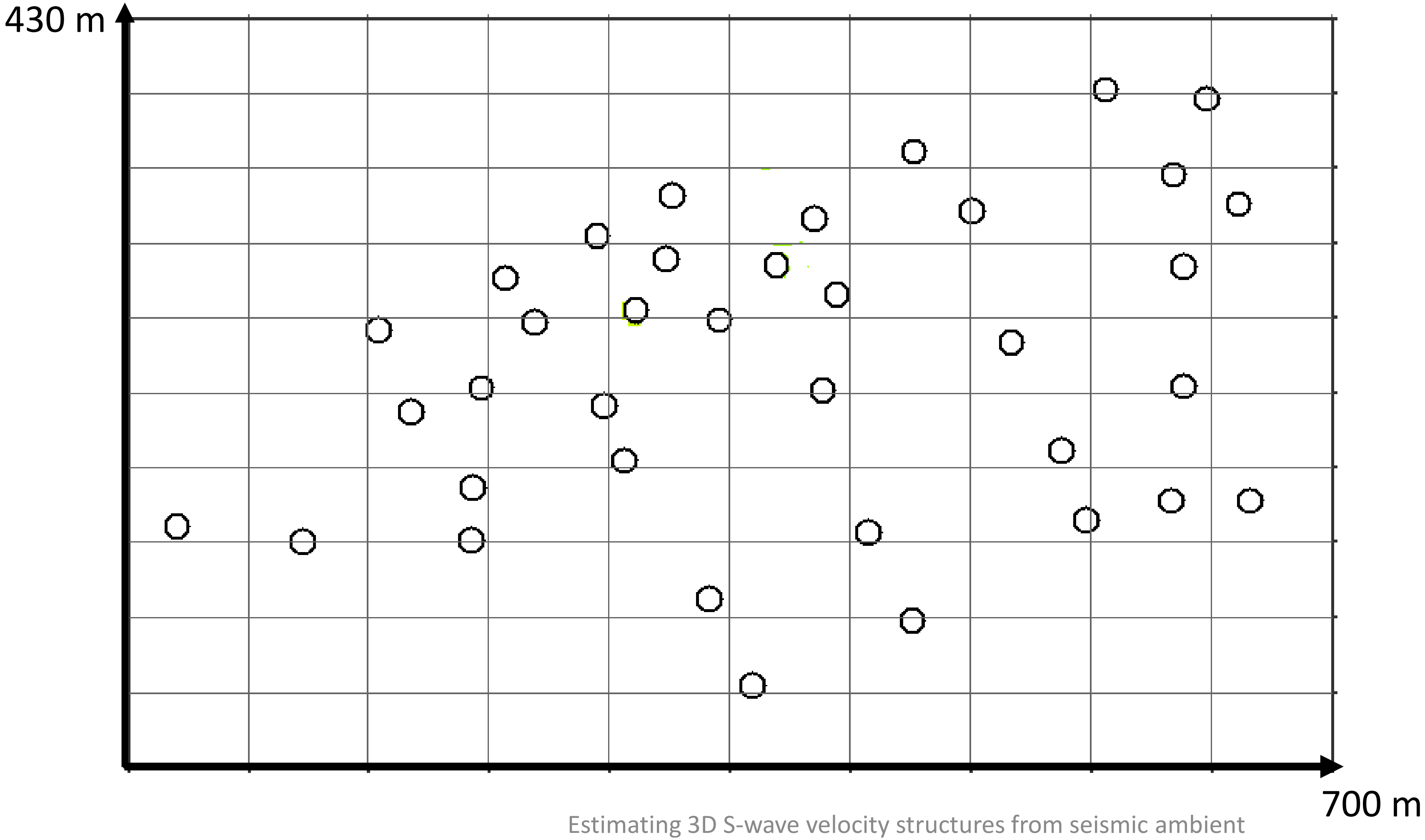
- In order to delineate depth to a bedrock (GII), ambient noise tomography (passive surface wave method) was carried out.
- Investigation area is 700 X 430 m.
- 70 sensors were deployed with 7 m spacing.
- 133 arrays with overlap were measured and total sensor location is approximately 2300.



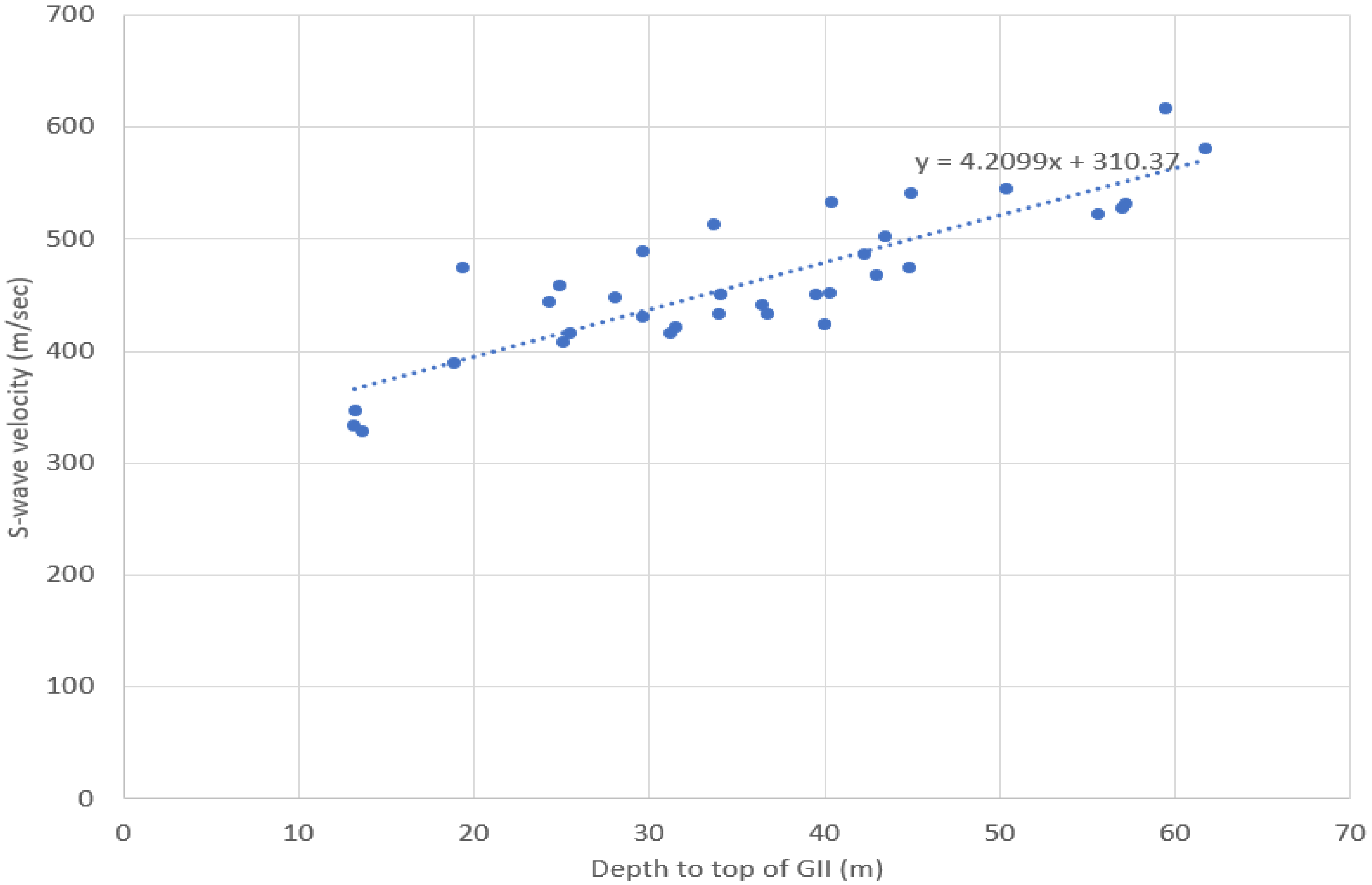
S-wave velocity cross sections and plan view



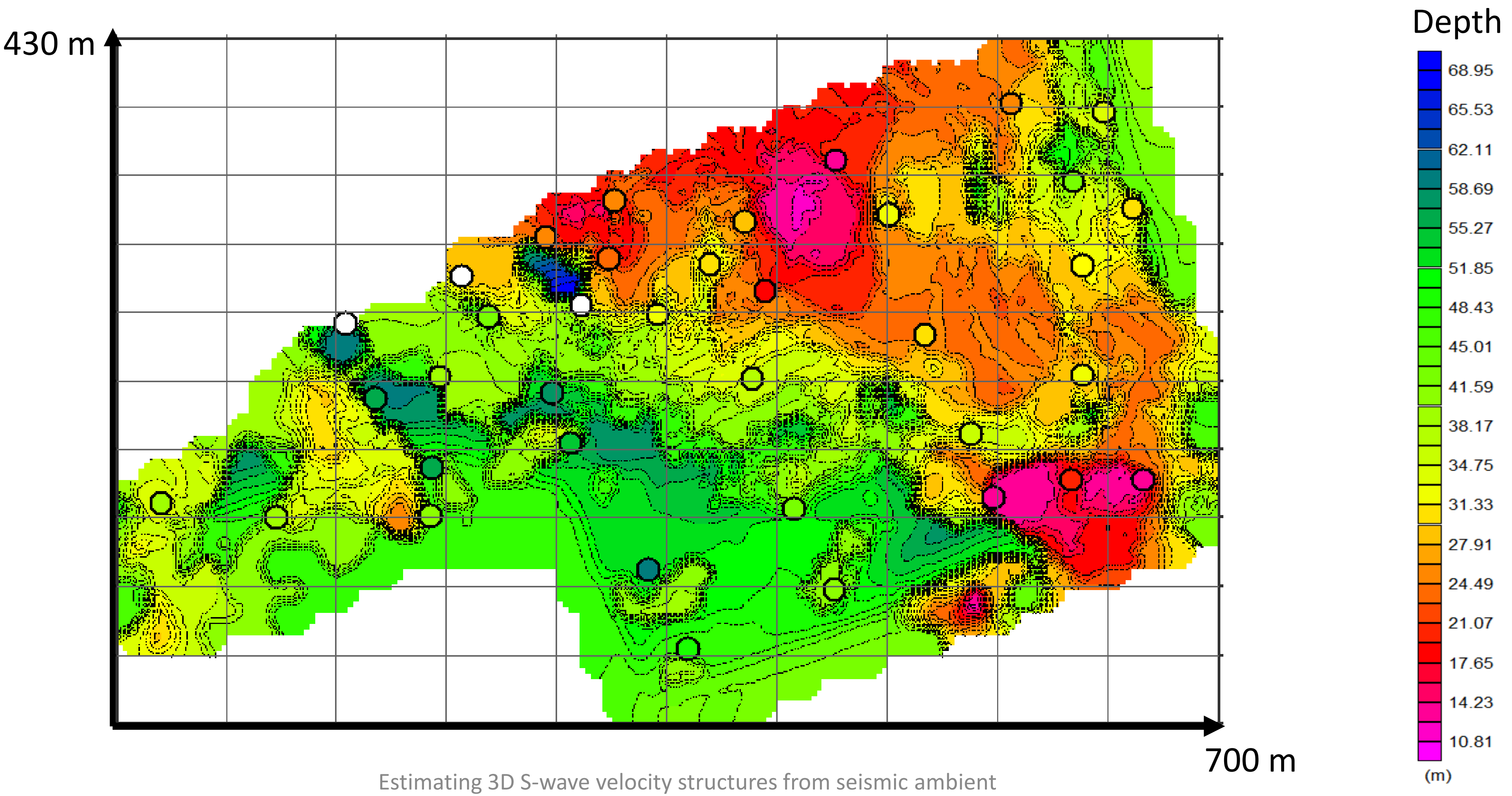
37 borehole at the site



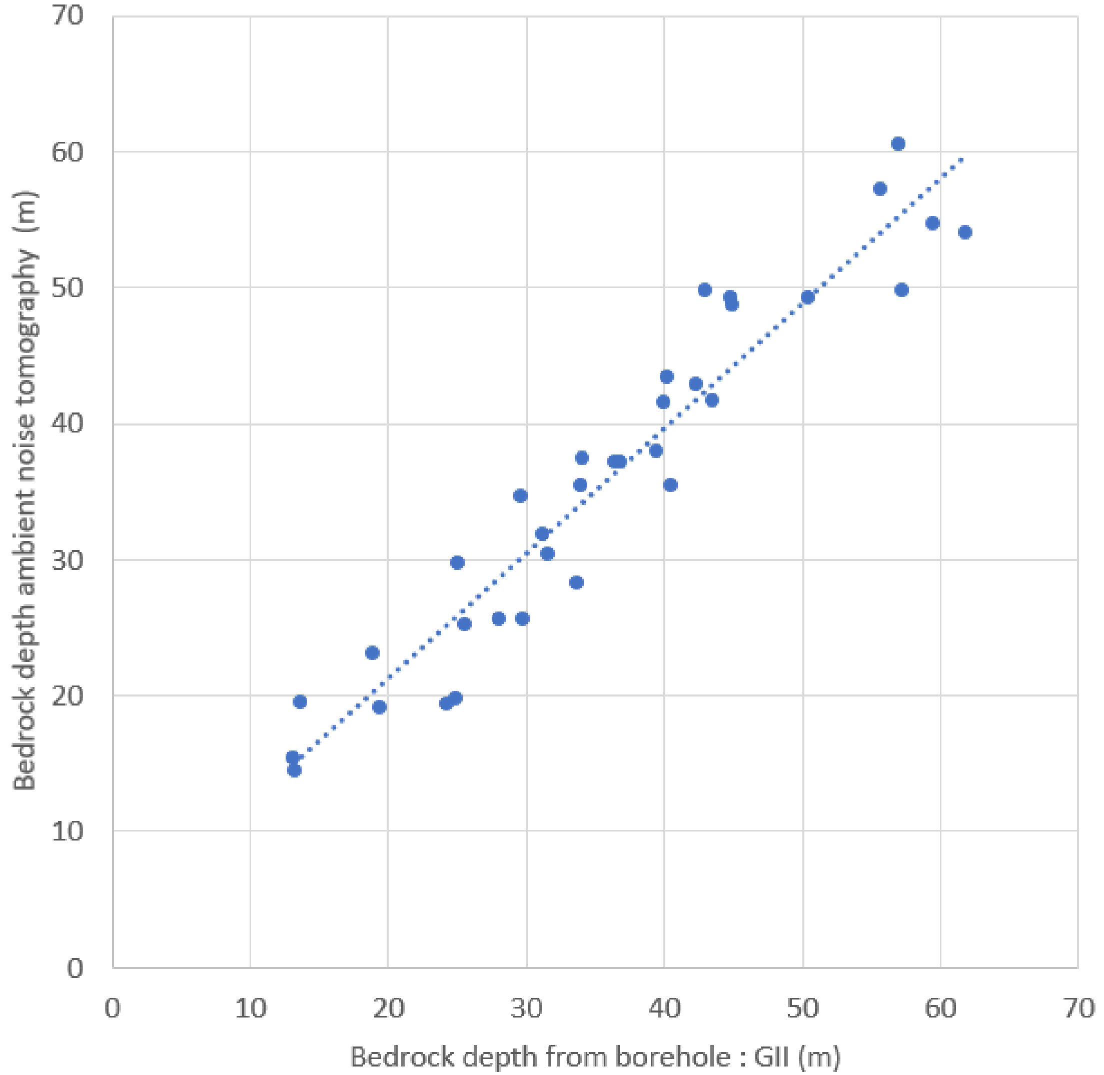
S-wave velocity at GII confirmed by boring



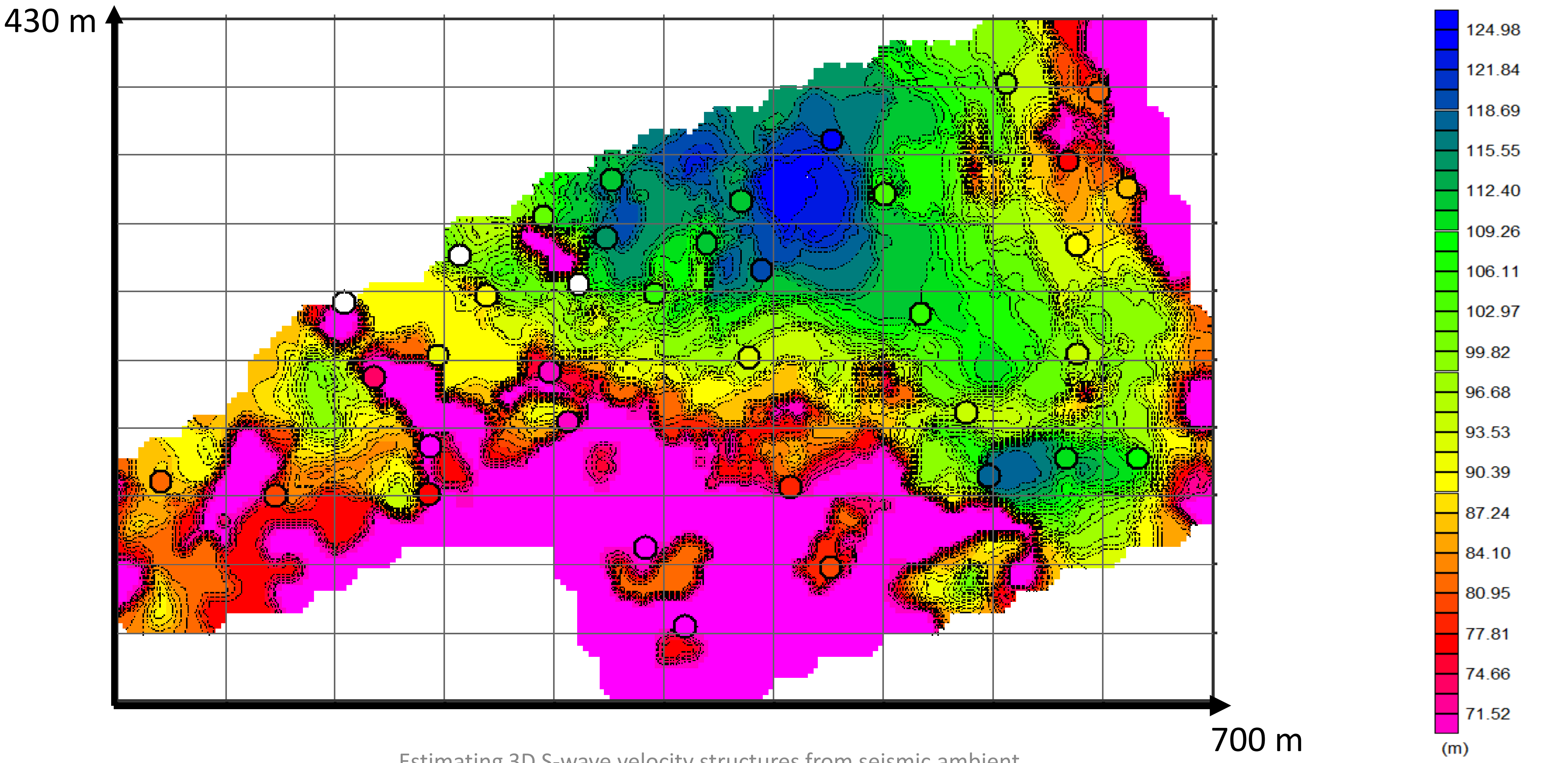
Depth to bedrock (GII)



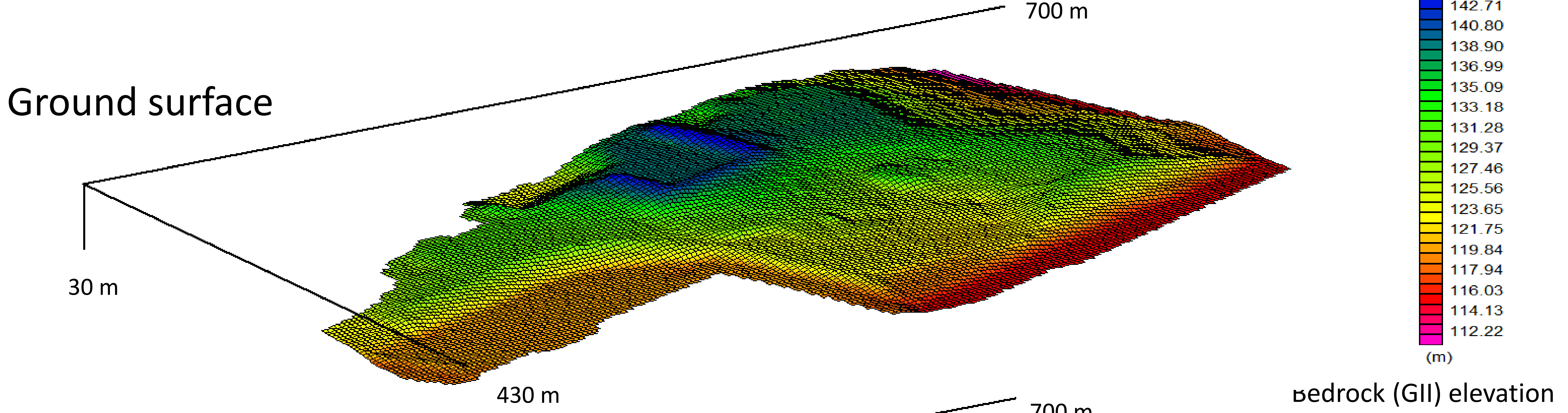
Comparison of bedrock (GII) depth estimated by ambient noise tomography and boring

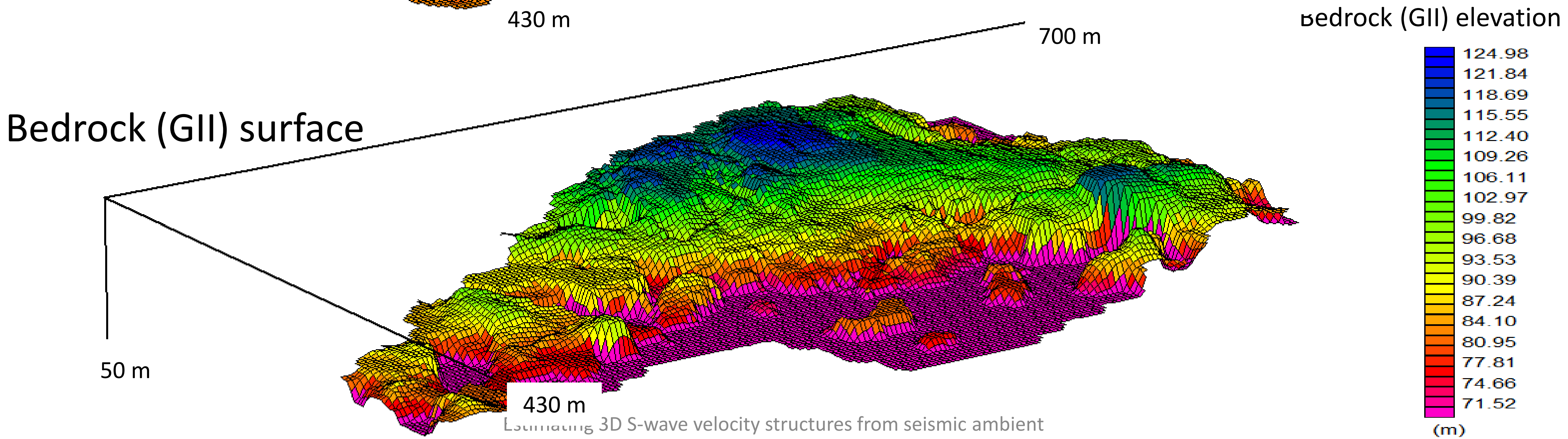


Bedrock (GII) elevation



Surface and bedrock topography





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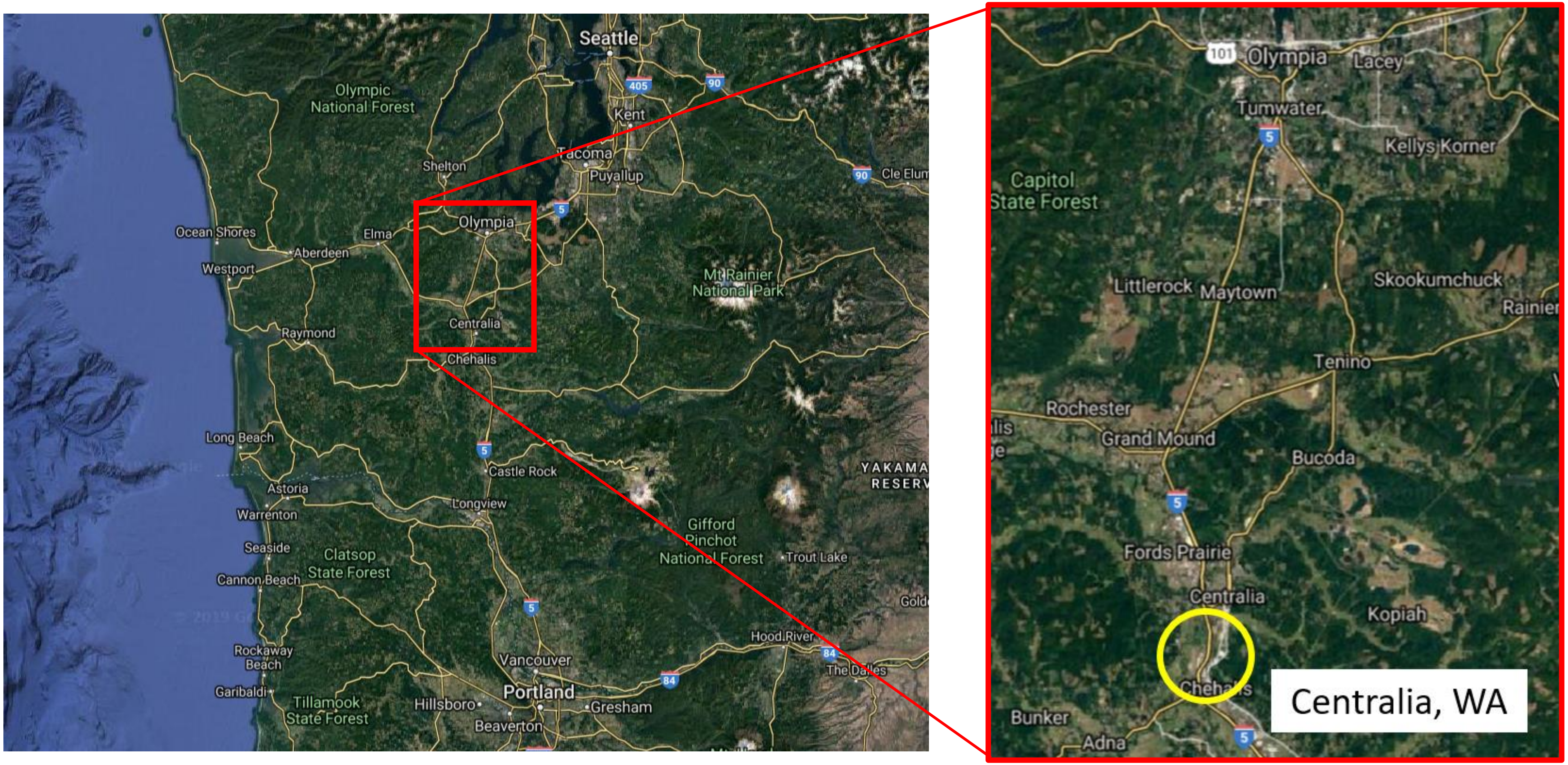
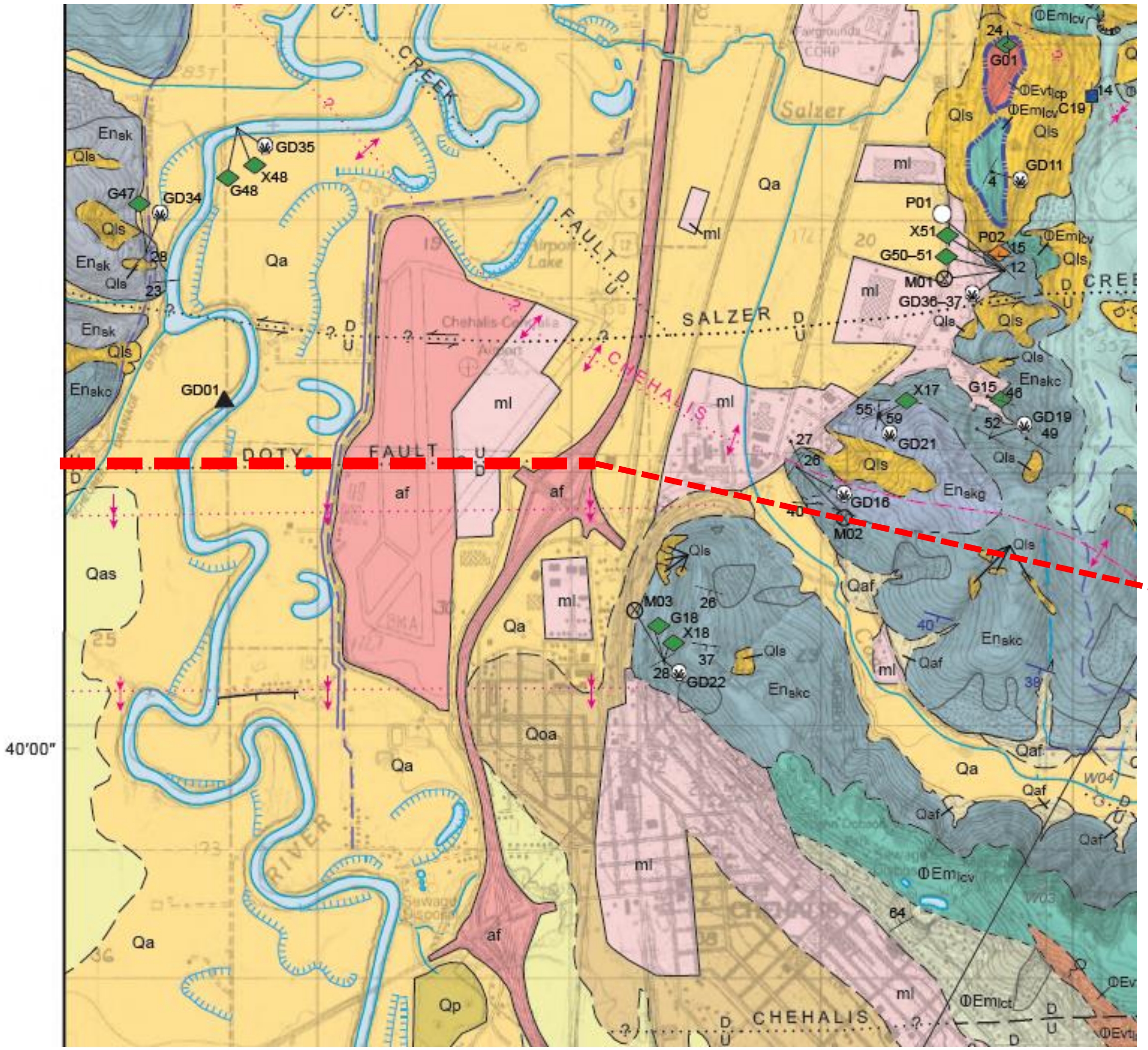
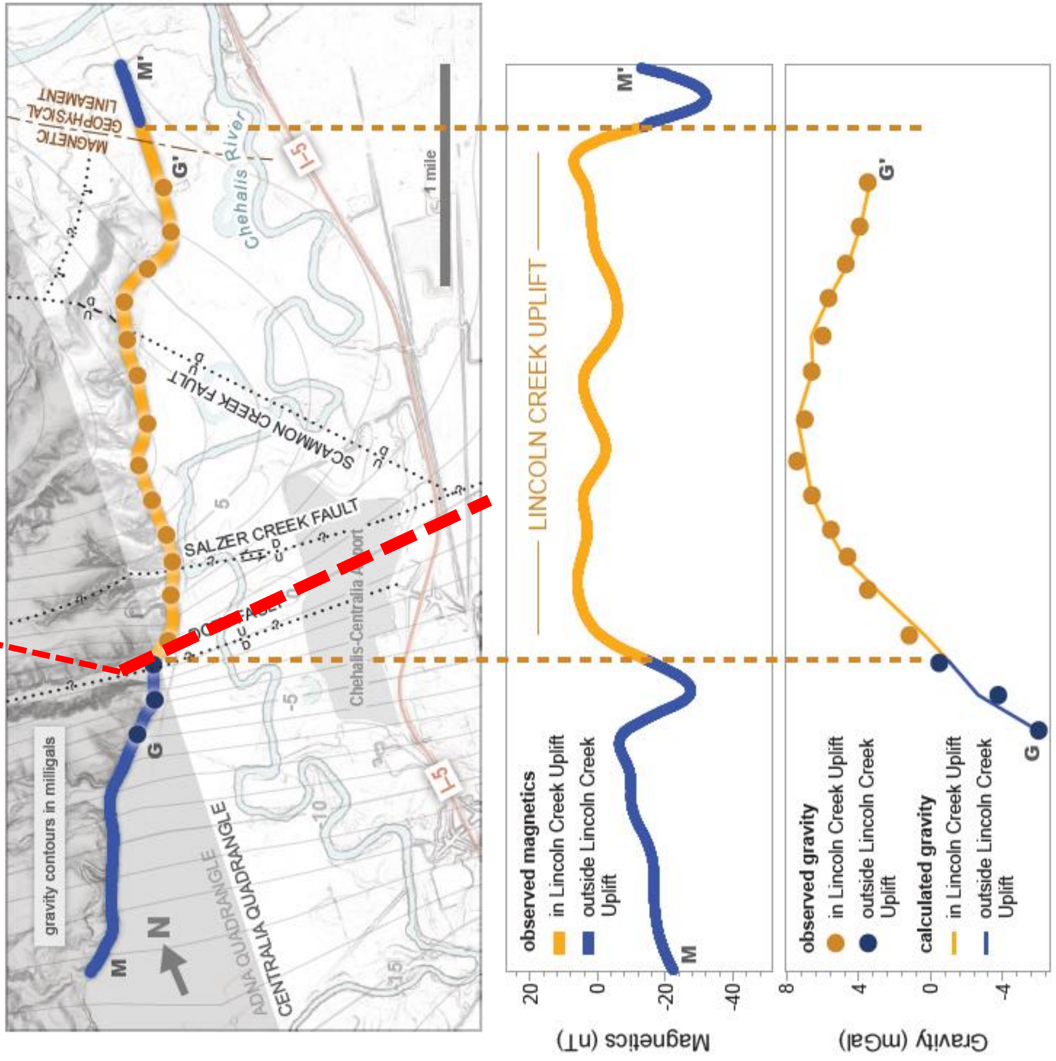
Investigation site

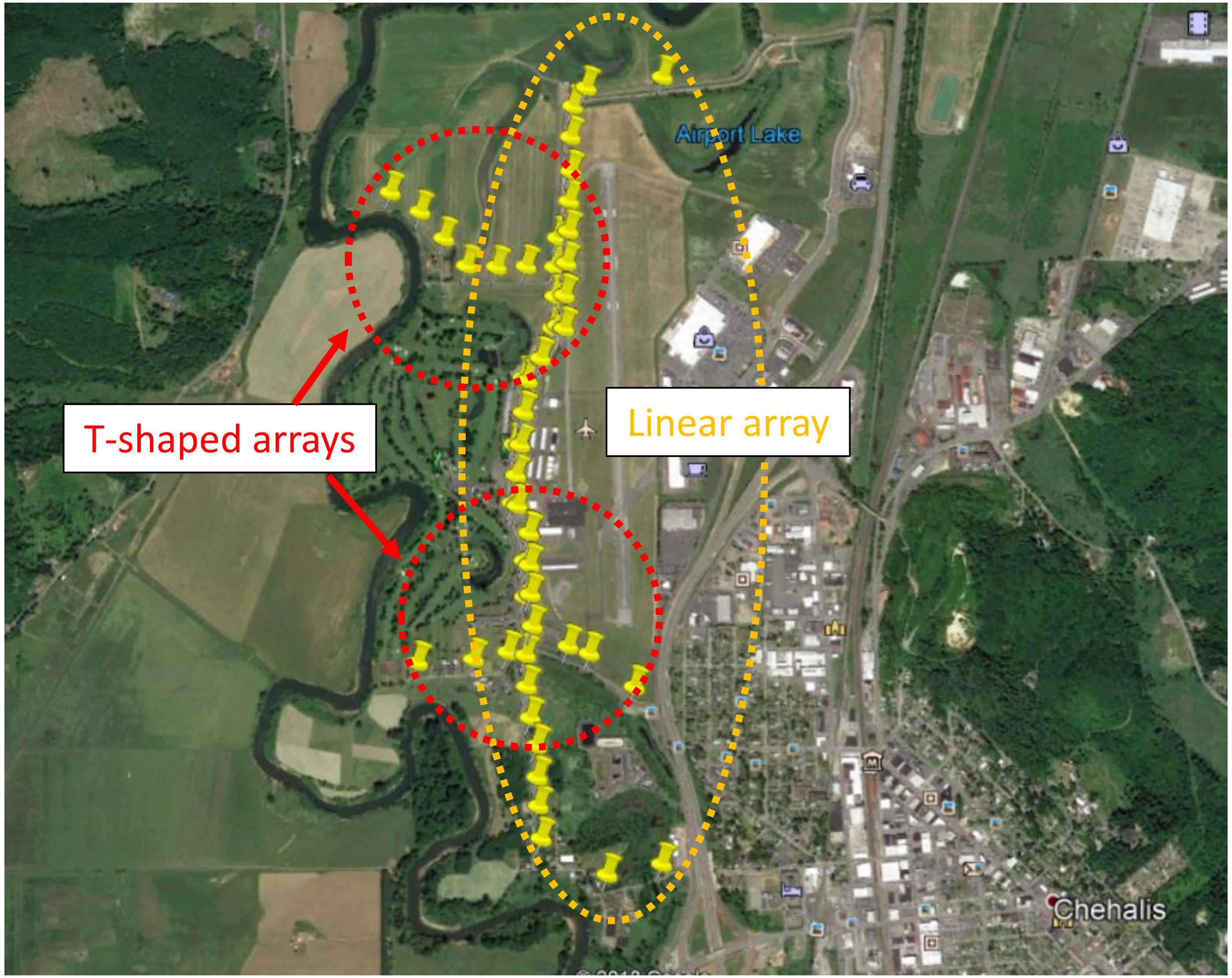


Geology of the site





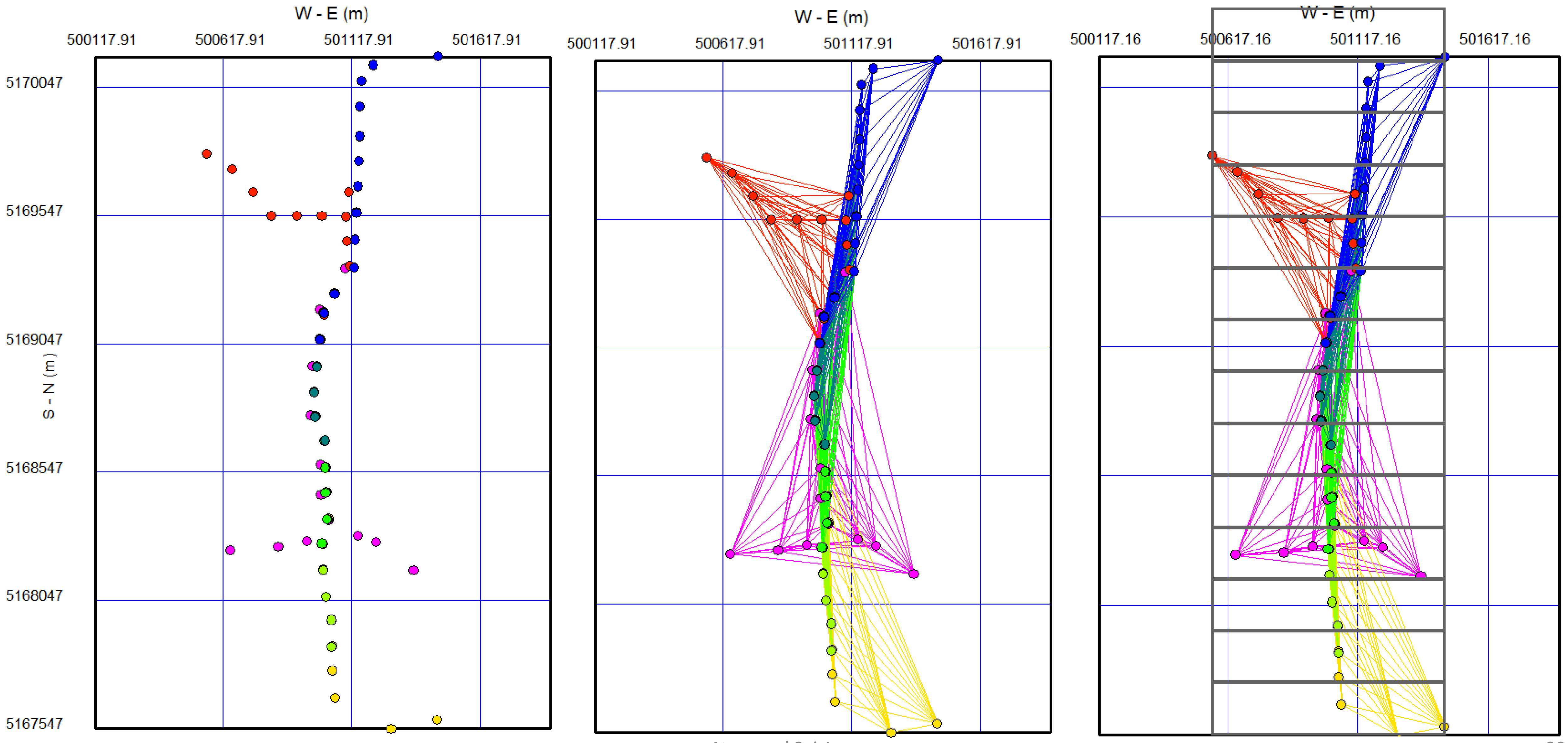
Acquisition geometry



Data acquisition

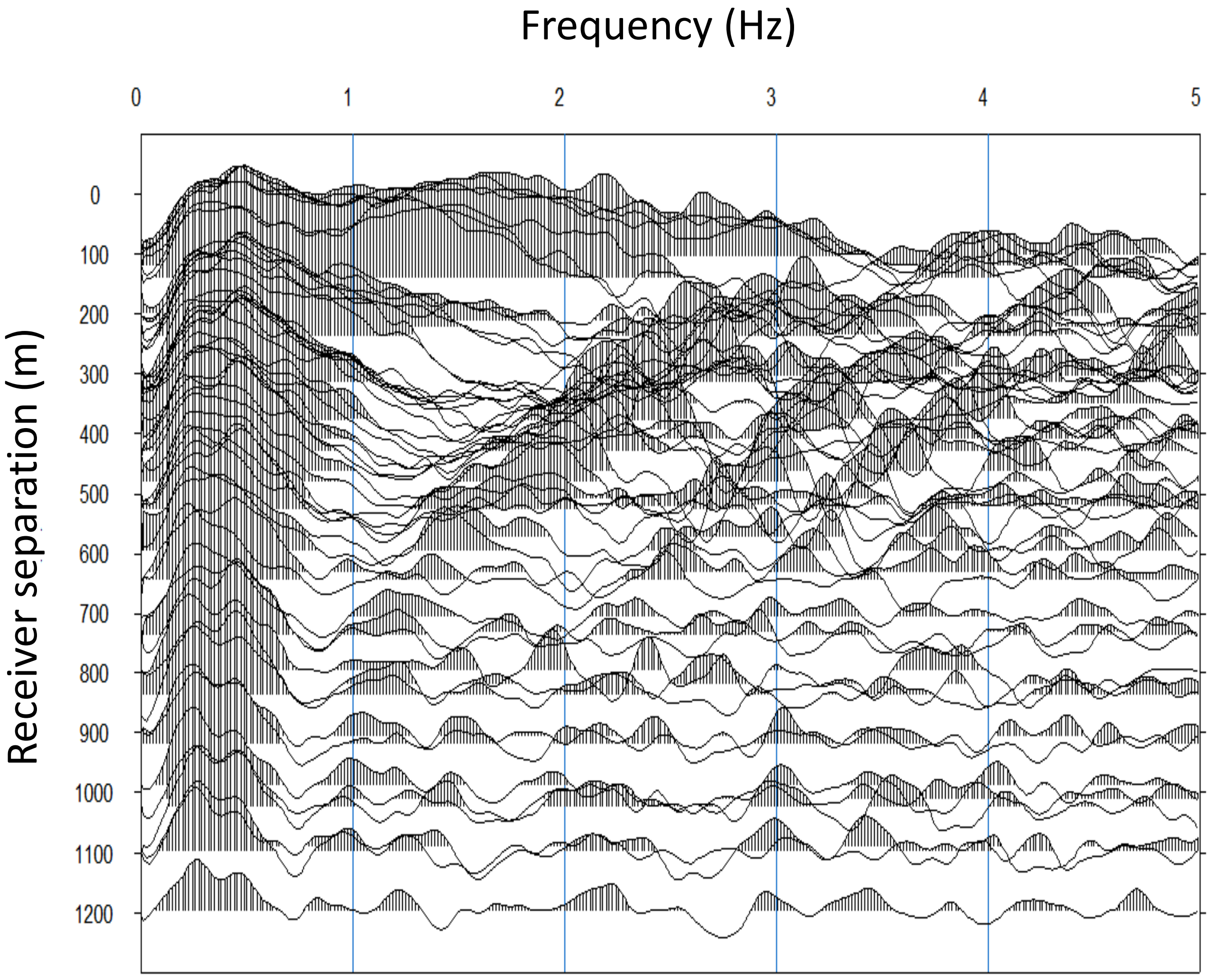
Data acquisition

Acquisition geometry, SPAC pairs, and CMP bins

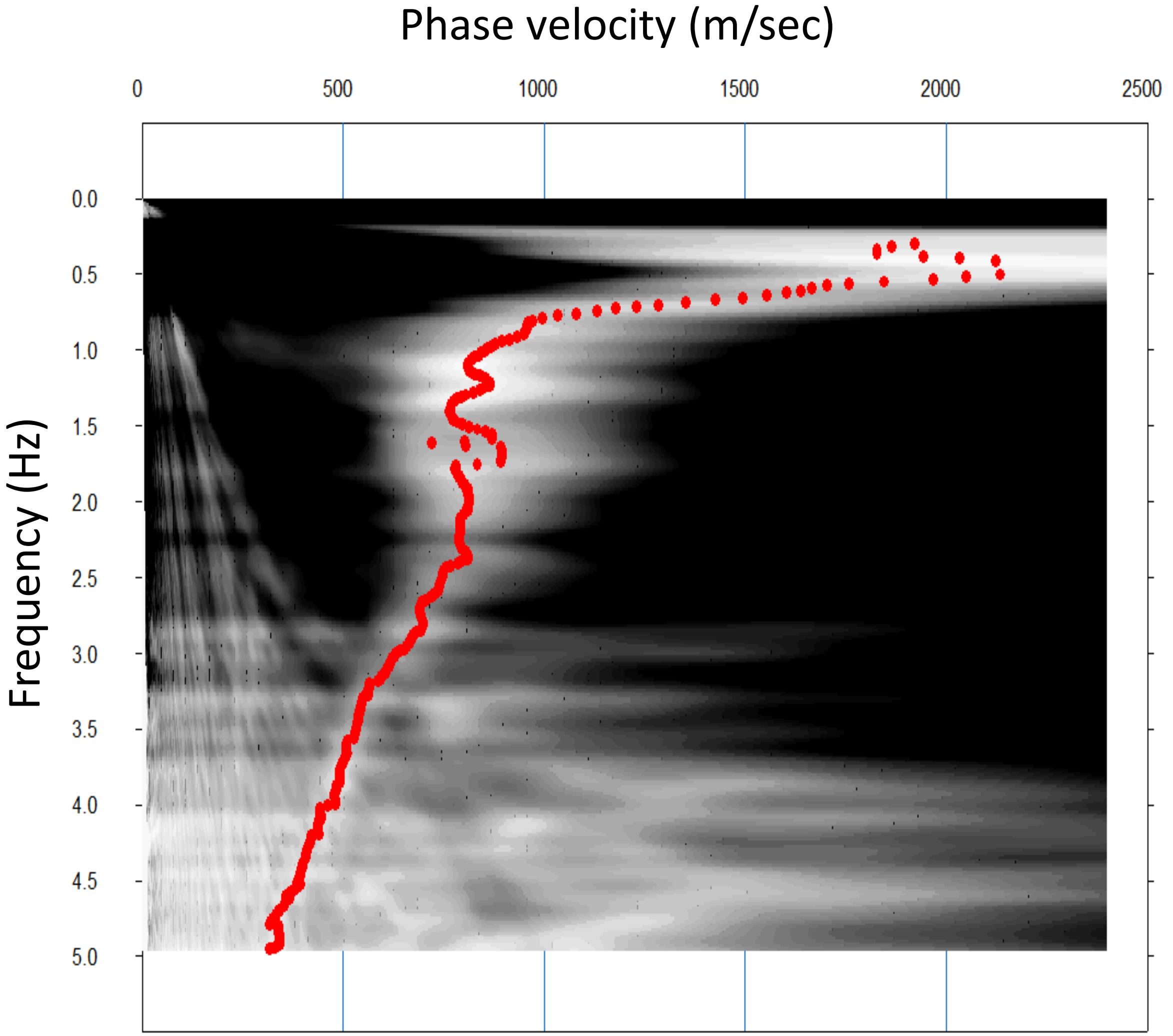


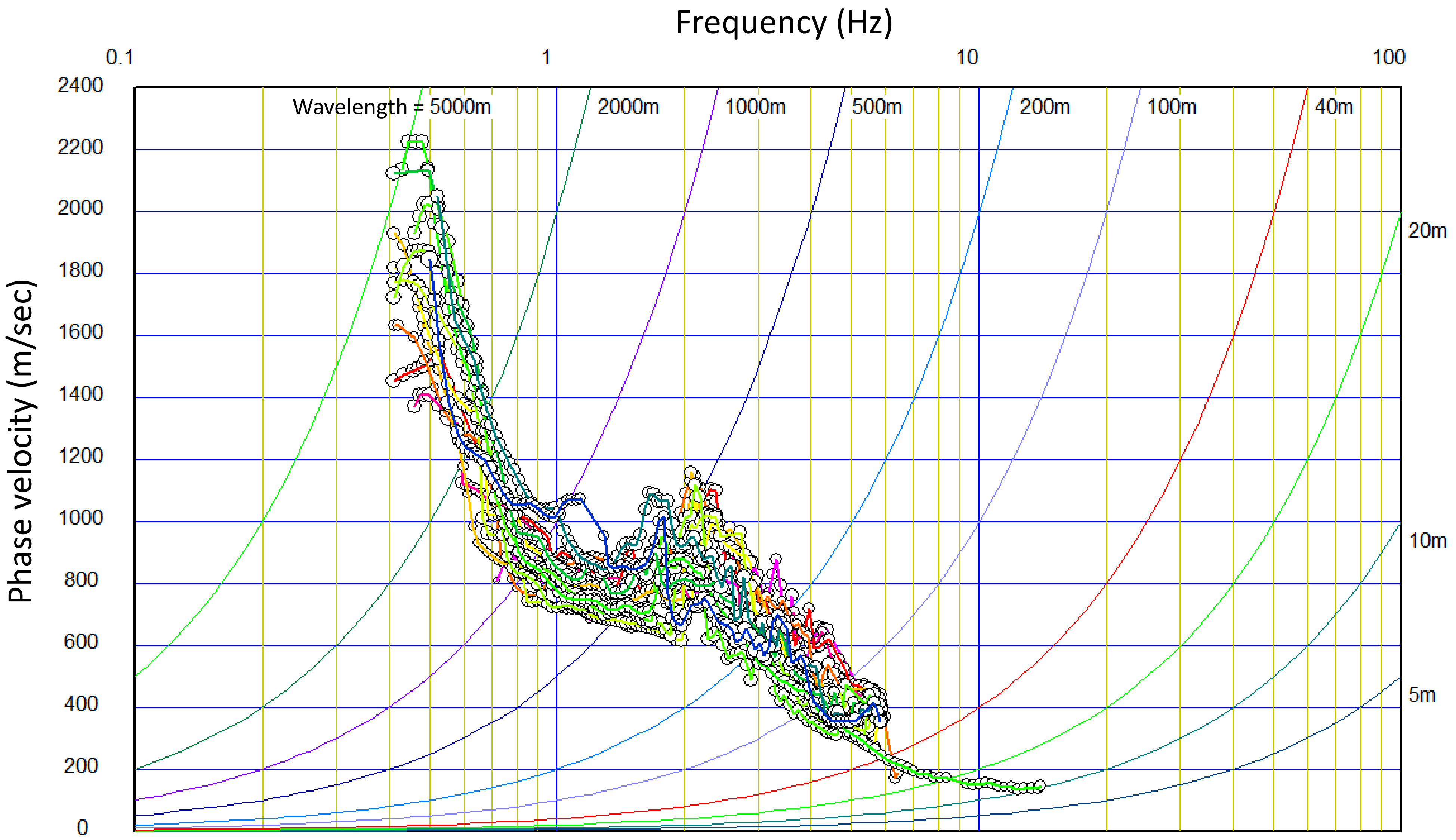
Example of CMP-SPAC and phase velocity image

CMP-SPAC



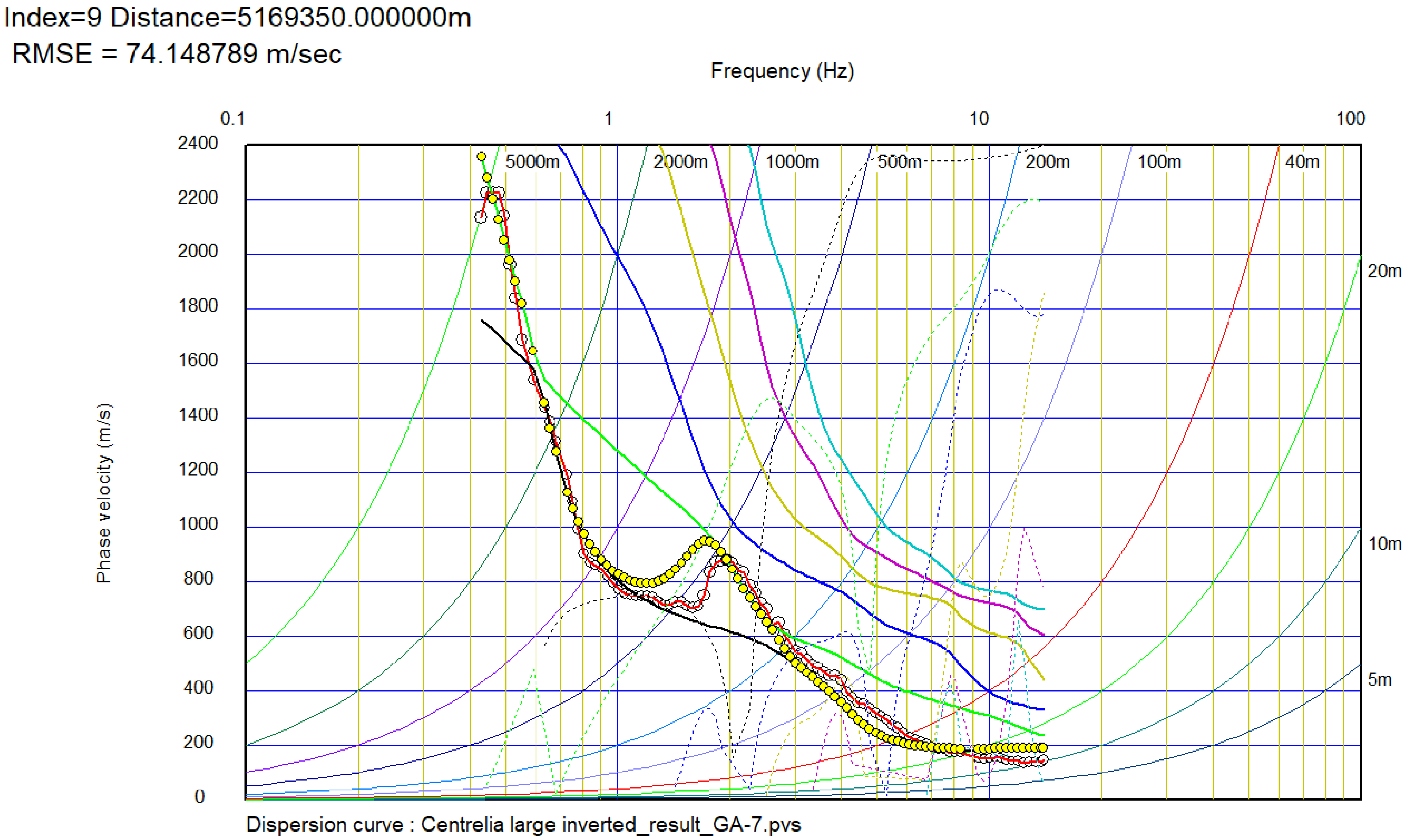
Phase velocity image in frequency domain



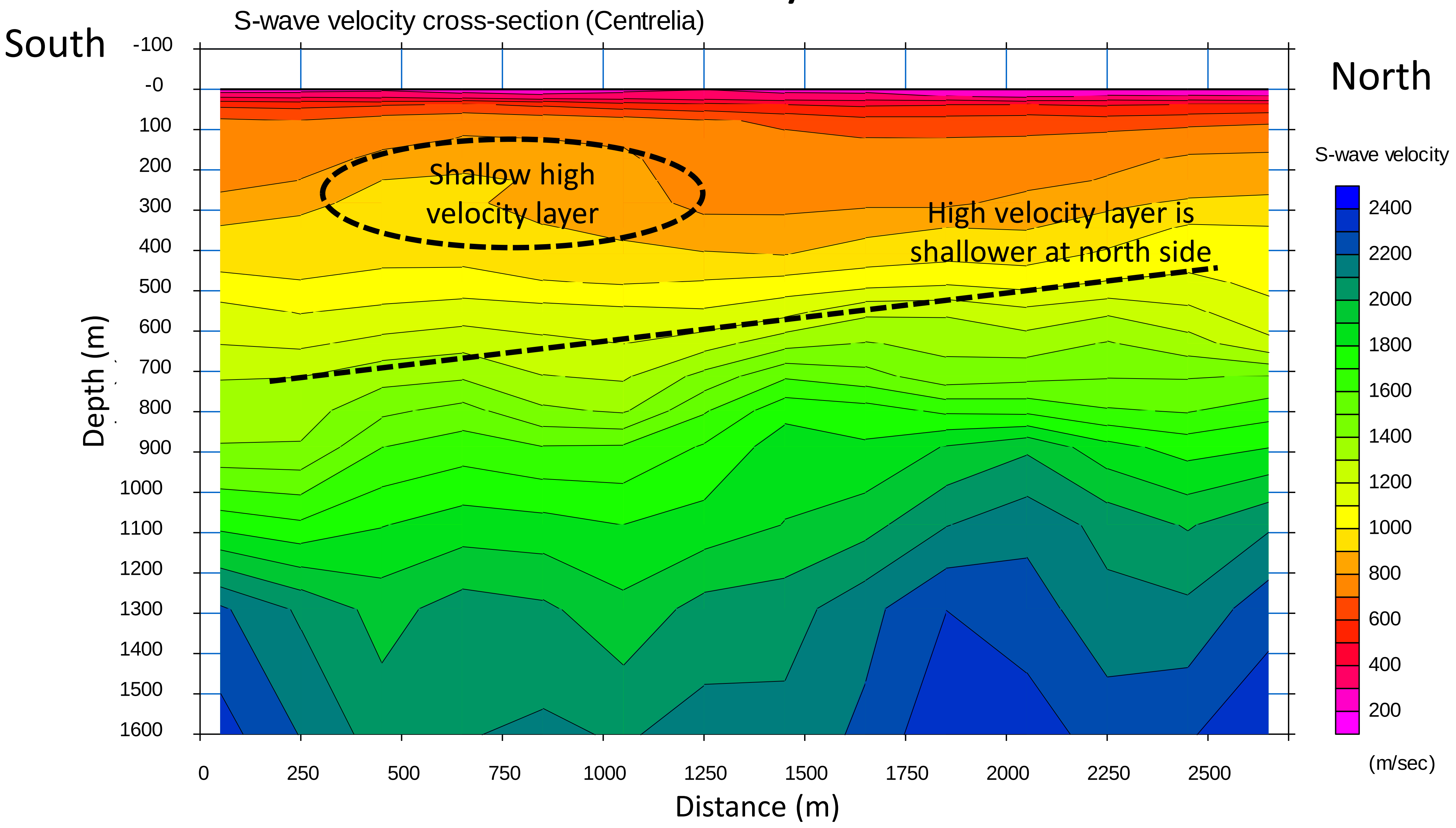


Frequency (Hz)
0.1
1
10
100
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Phase velocity (m/sec)
Wavelength = 5000m
2000m
1000m
500m
200m
100m
40m
20m
10m
5m

Comparison of observed and theoretical dispersion curves



Resultant S-wave velocity cross section



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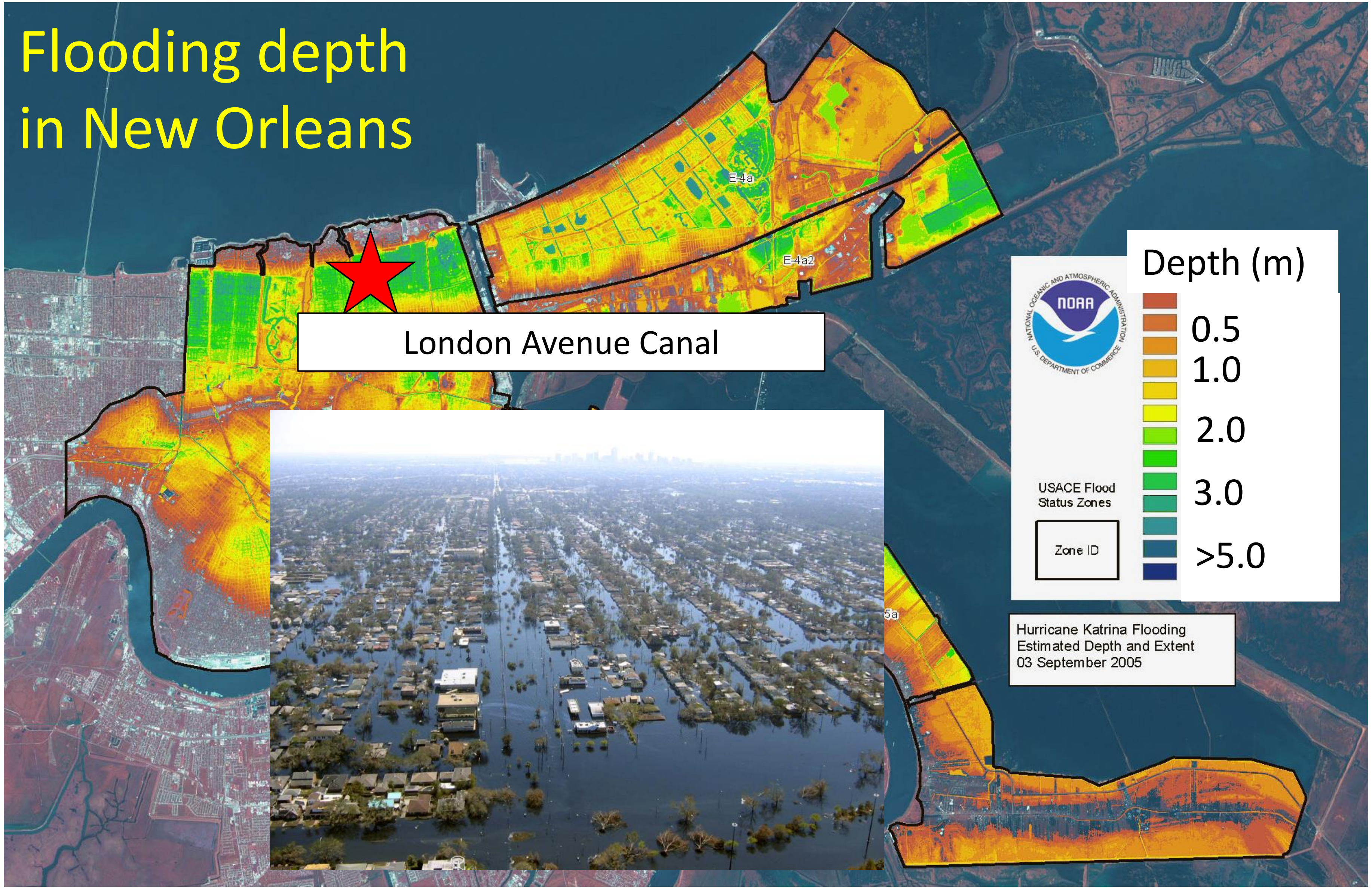
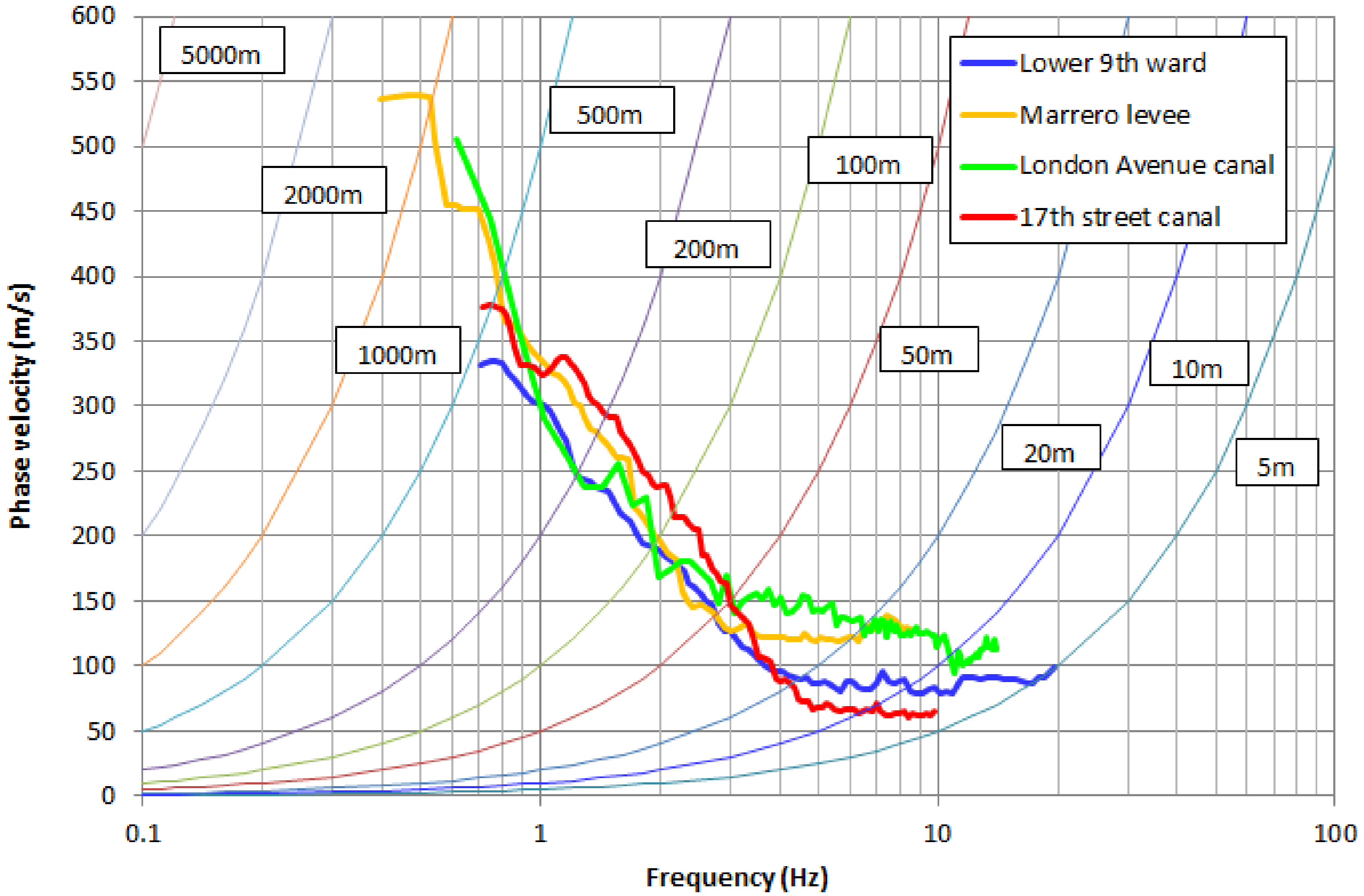
Hurricane Katrina (2005)



Sites of Investigation

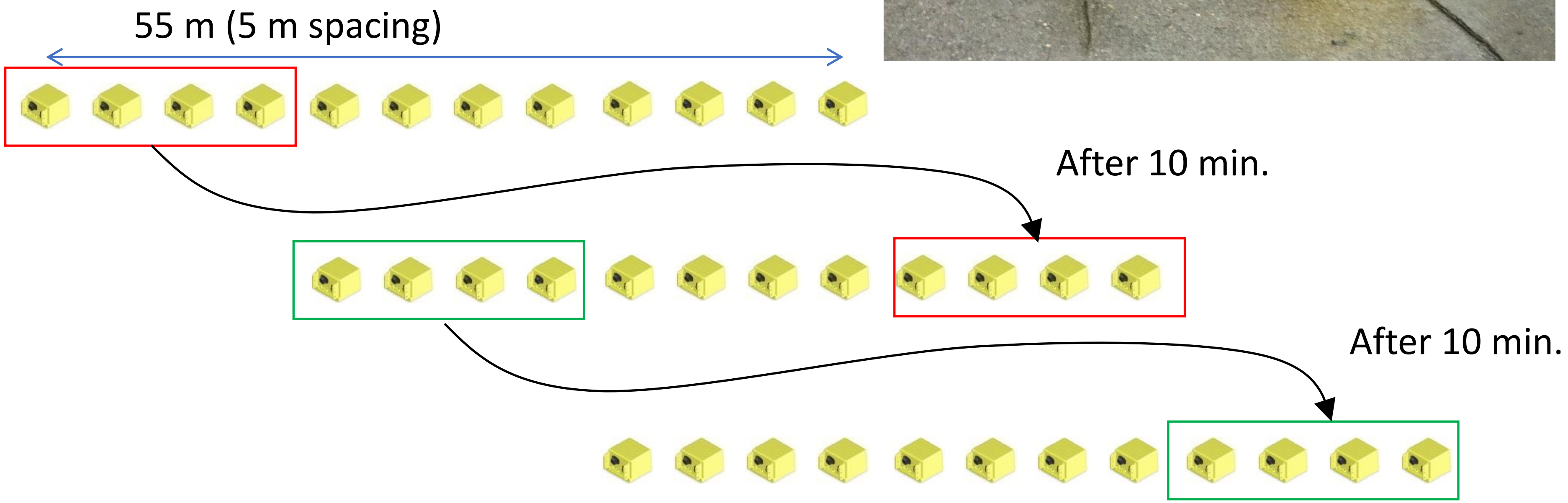
Deep investigation (2016)

Deep investigation (2016)
Comparison of dispersion curves

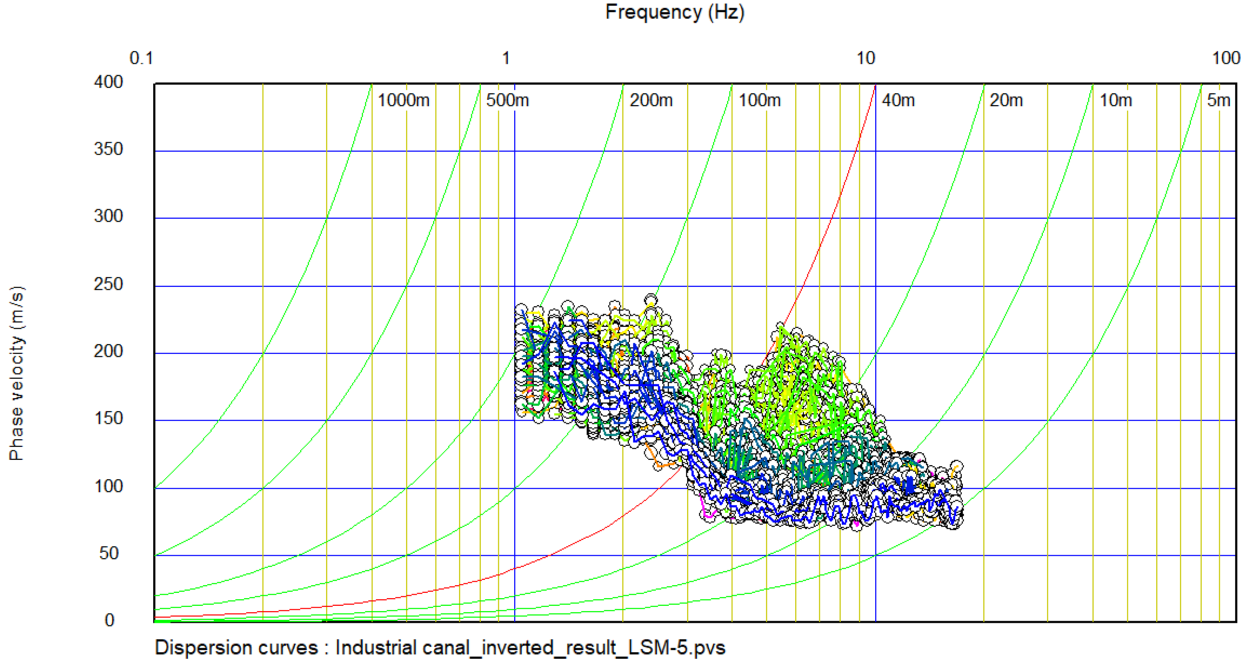


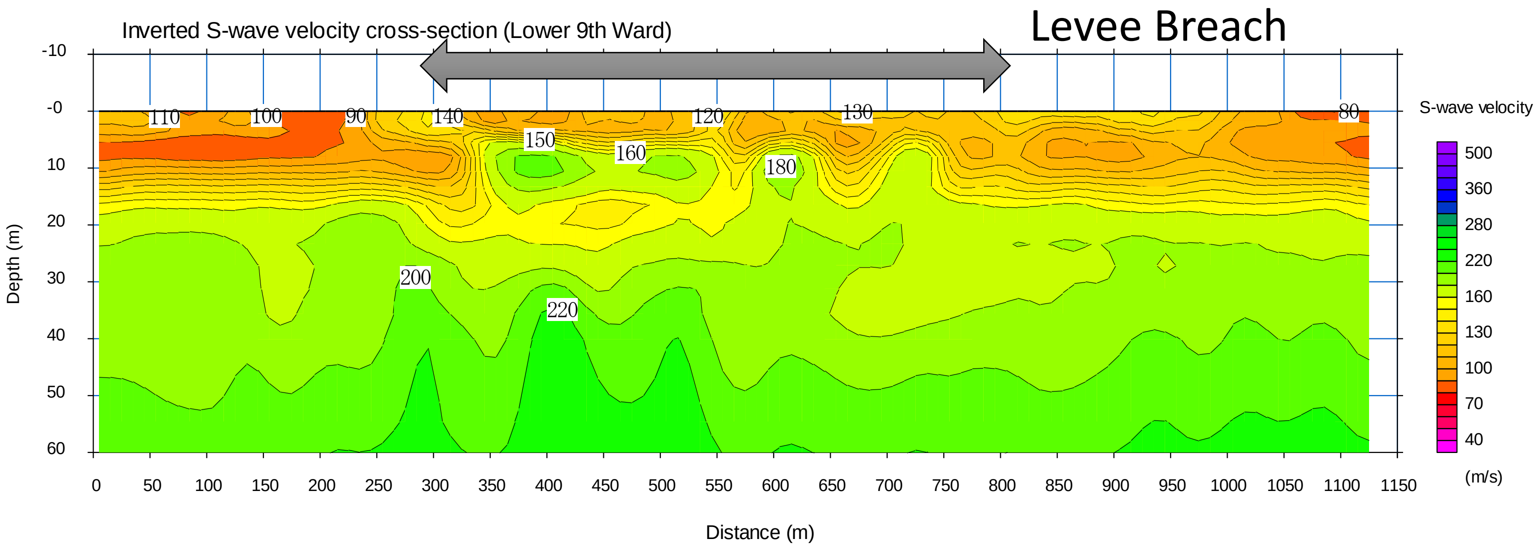
2D MAM : Industrial Canal

2D Ambient Noise Tomography with Linear Array



2D MAM : Industrial canal





2D MAM : London Avenue Canal

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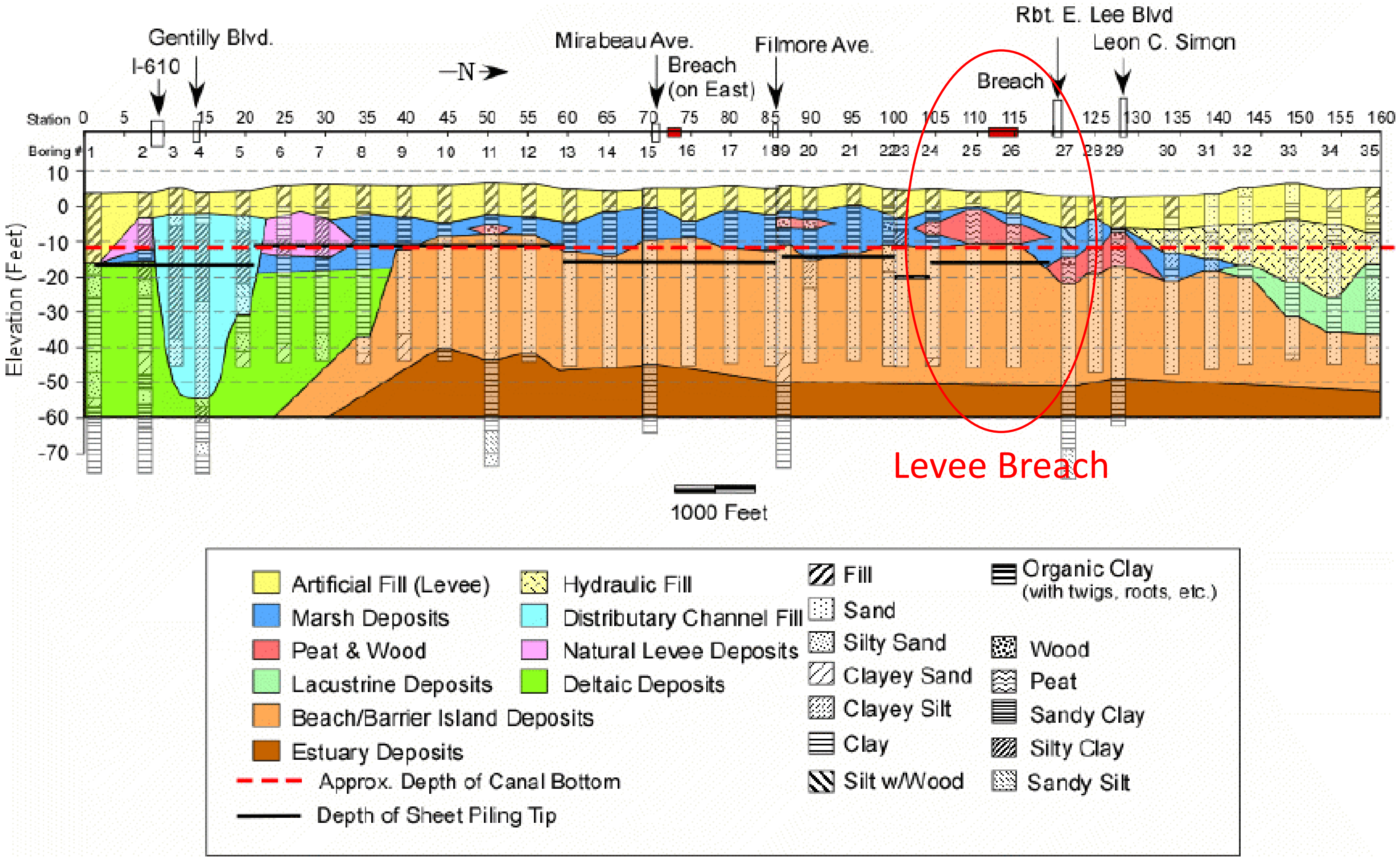
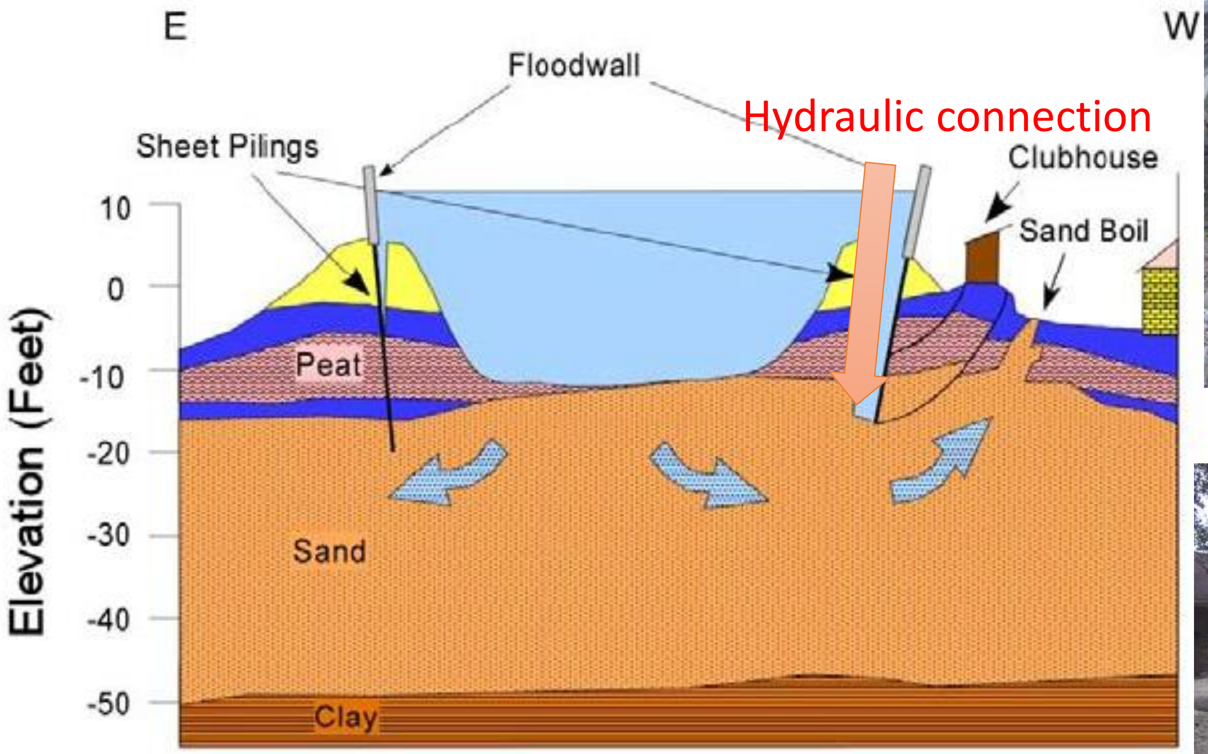
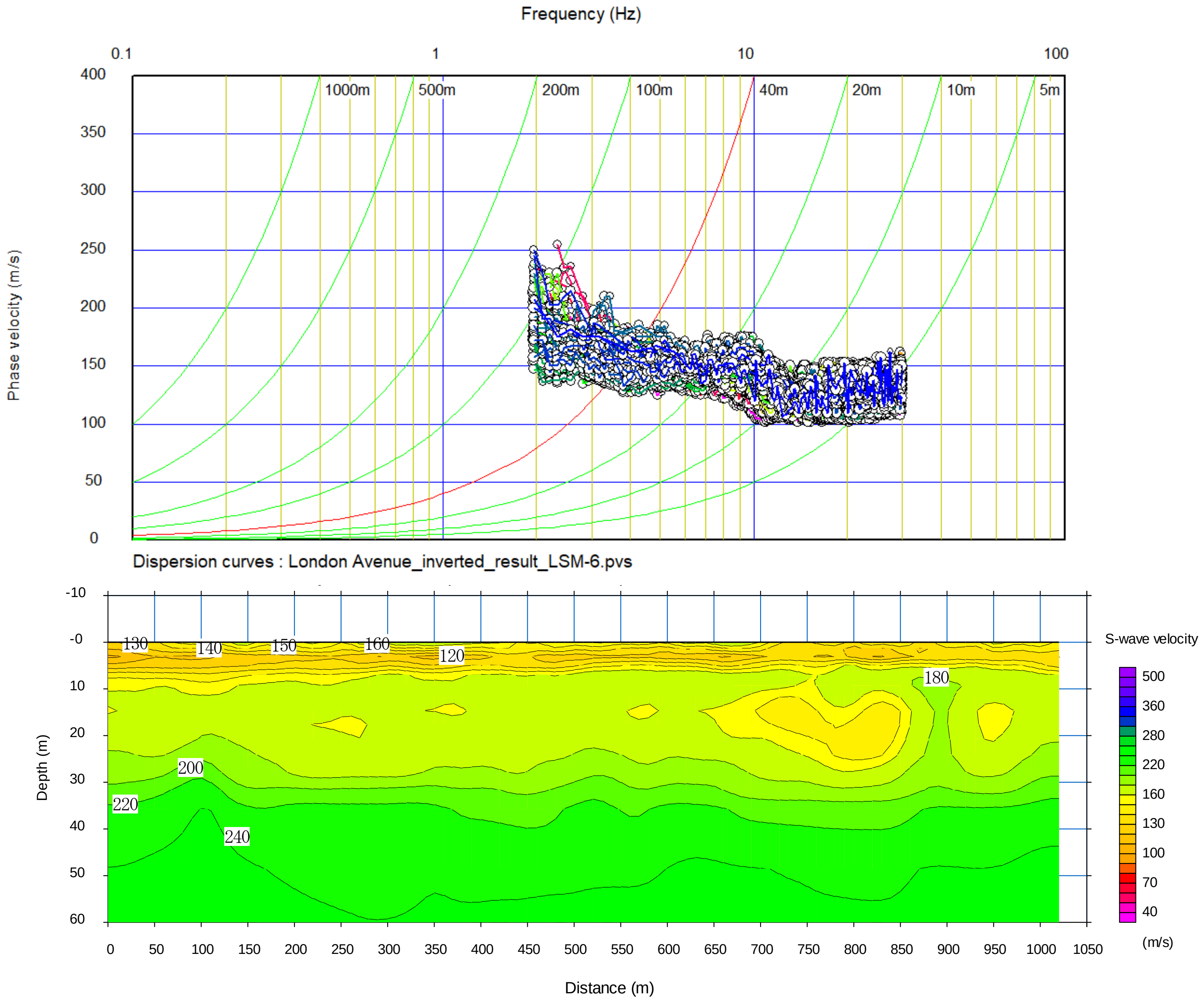


Sand boil at London Avenue Canal



London avenue canal



London Avenue Canal

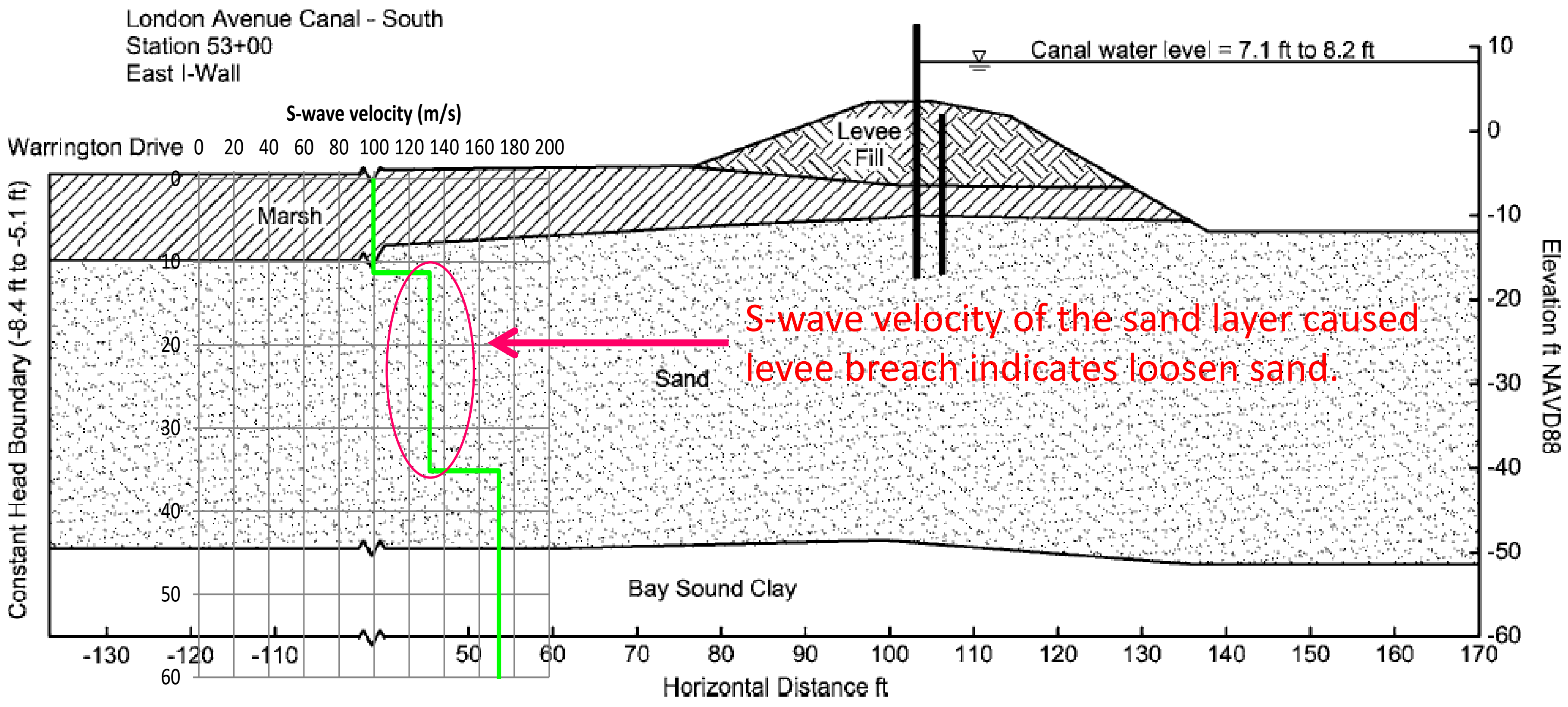
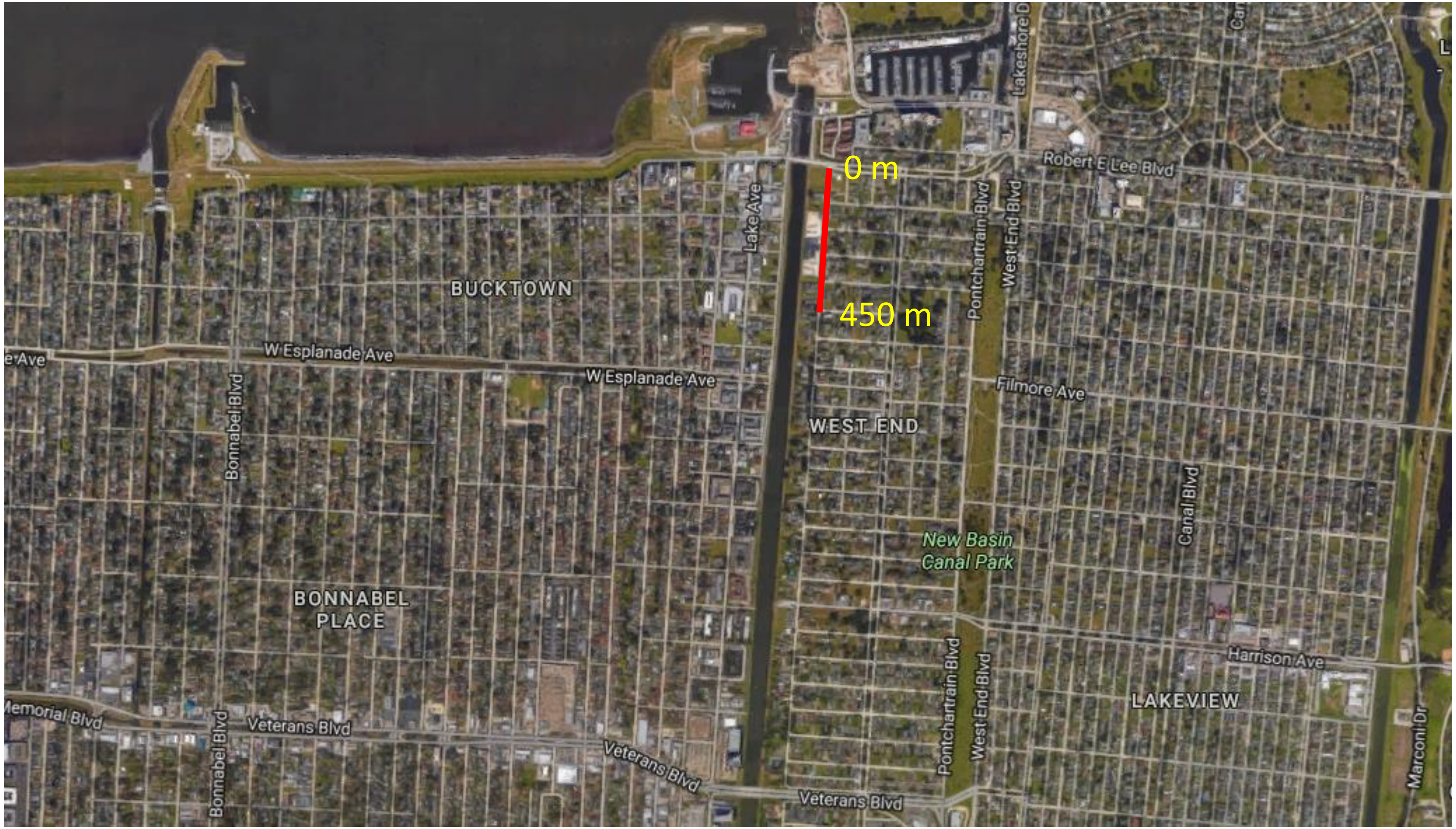


Fig. 10. Cross section of south breach area of London Avenue Canal

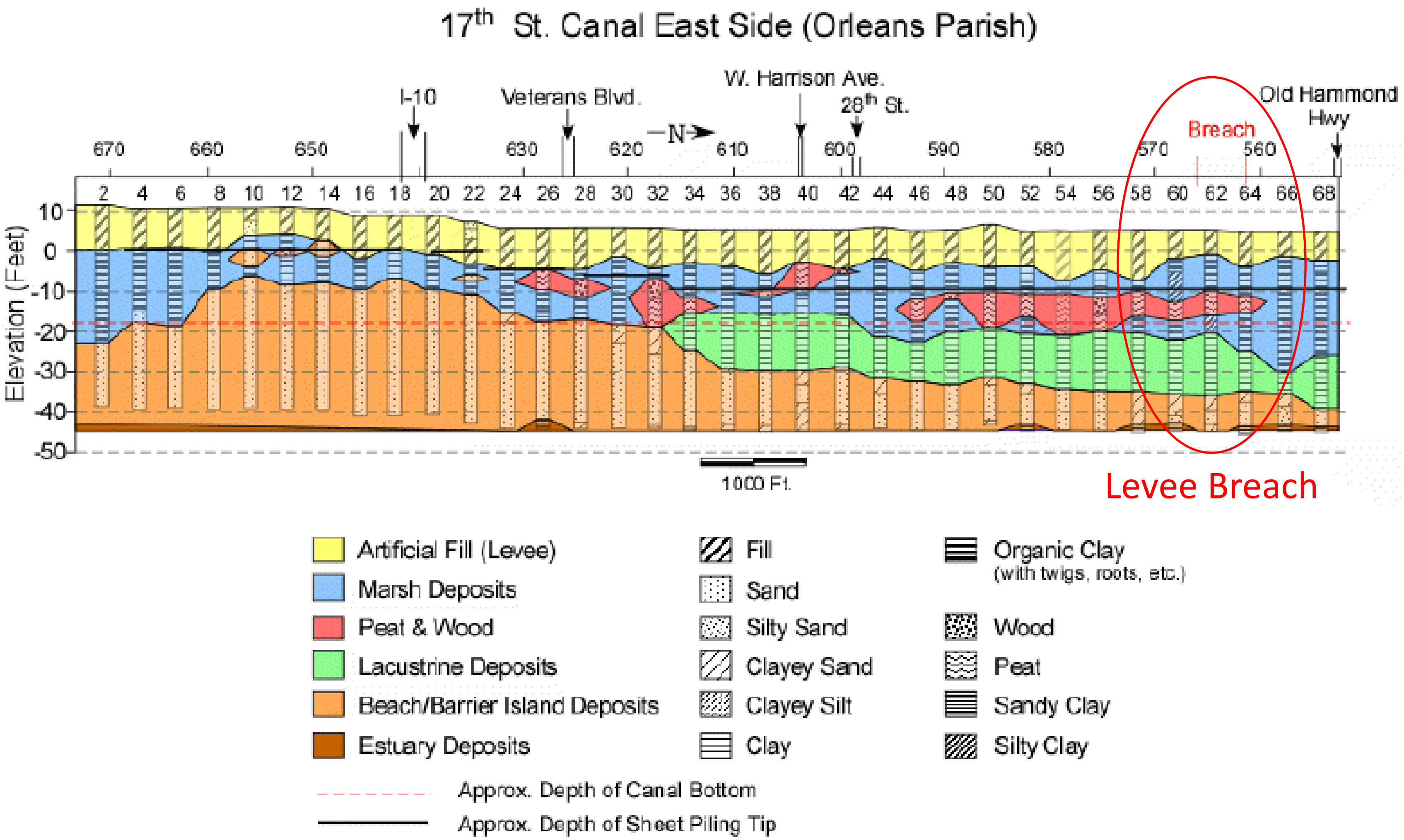
17th Street Canal

2D MAM : 17th Street Canal

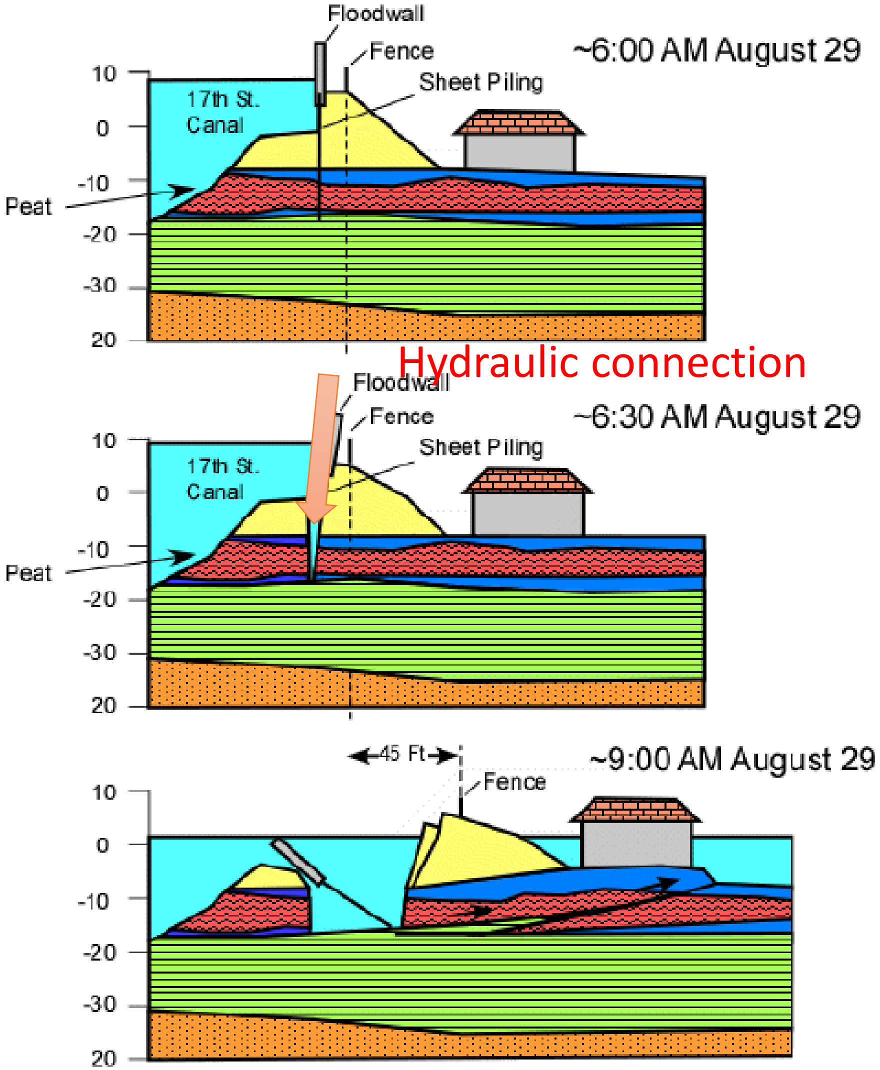


17th Street Canal

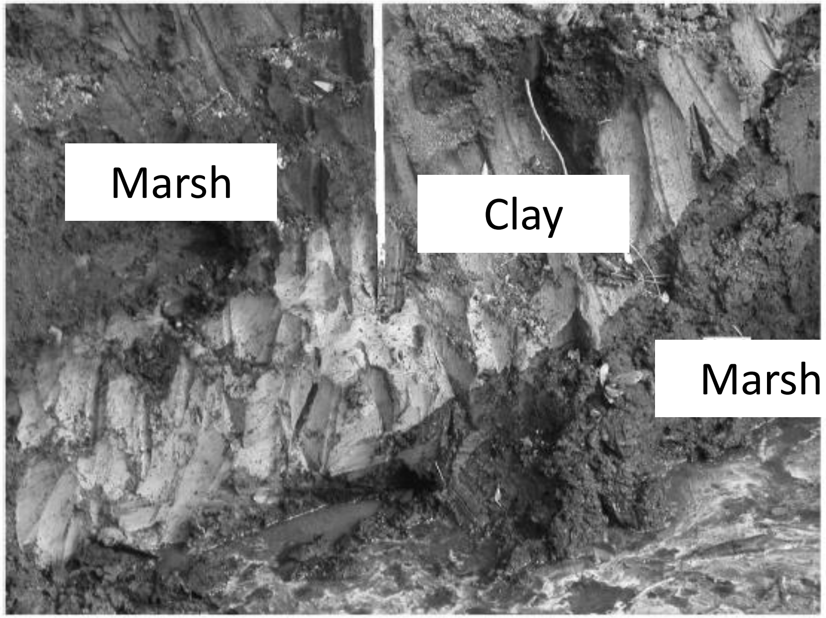
17th Street Canal



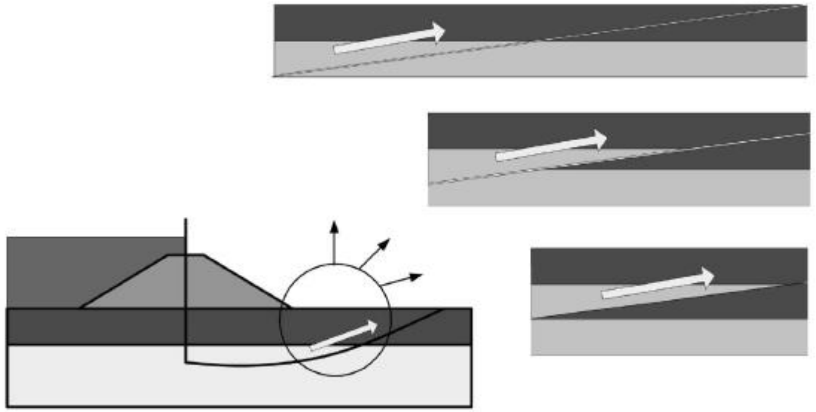
Shear failure at 17th Street Canal



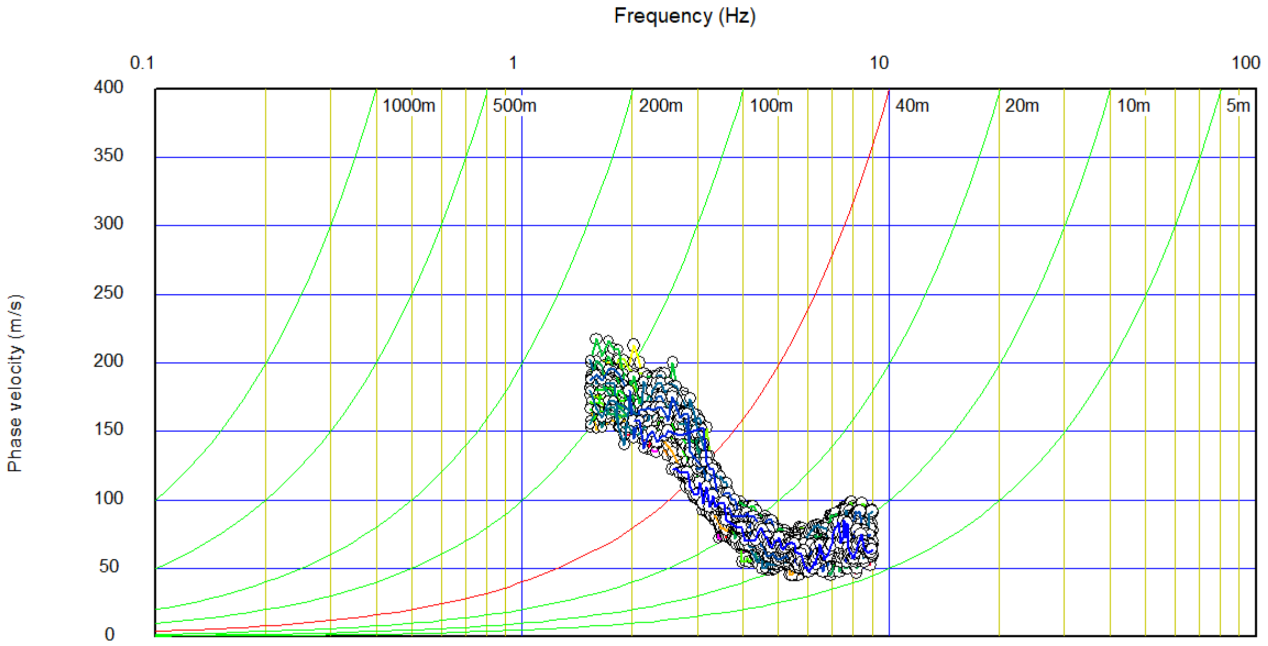
Failure of the 17th St. Canal Levee & Floodwall



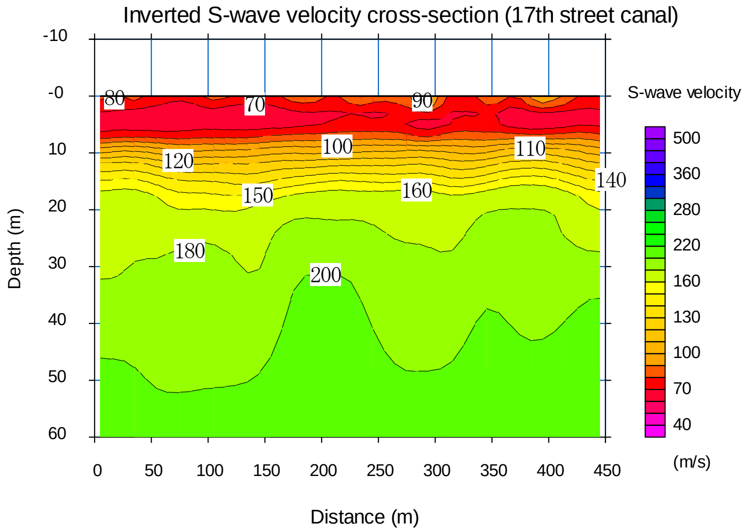
(a) Photograph of exploration trench showing clay layer above marsh layer.



2D MAM : 17th street canal



Dispersion curves : 17th street canal_inverted_result_LSM-4.pvs



17th Street Canal

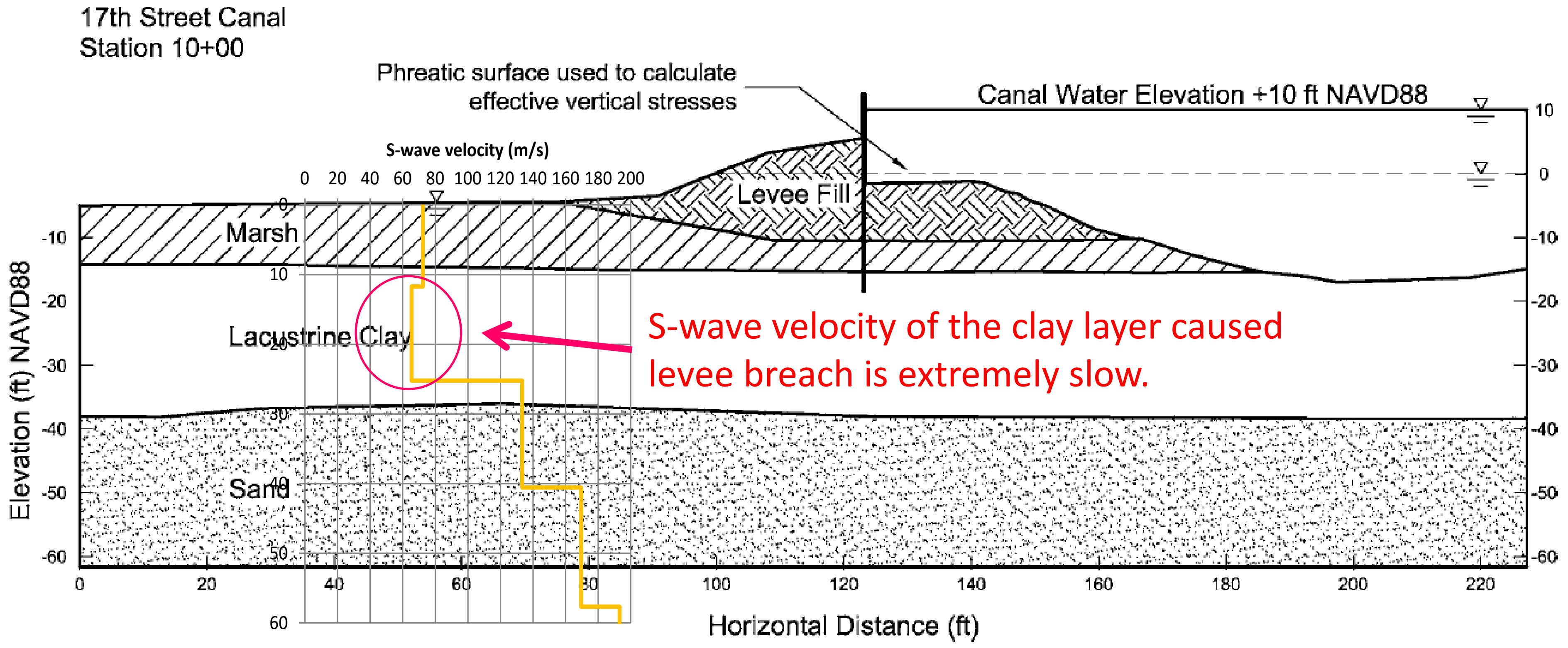
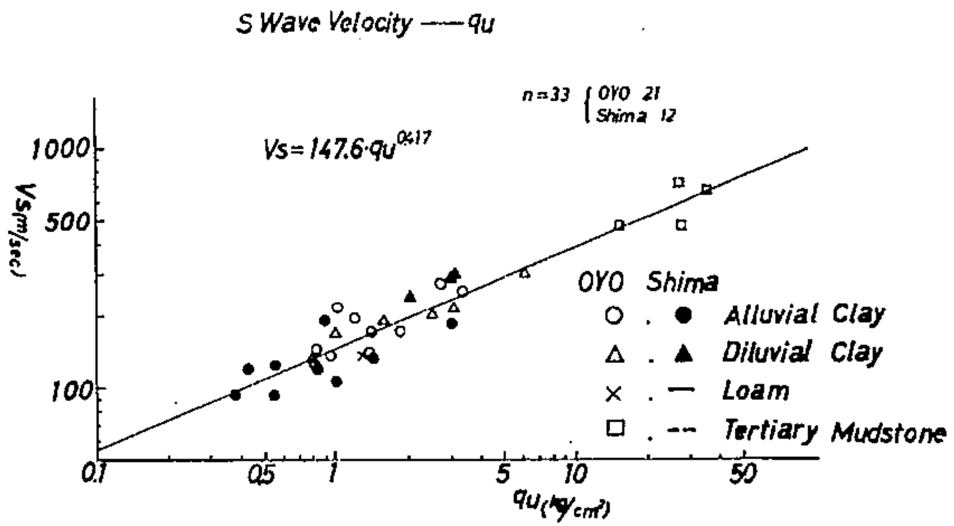


Fig. 4. Cross section of 17th Street Canal I-wall at Station 10+00

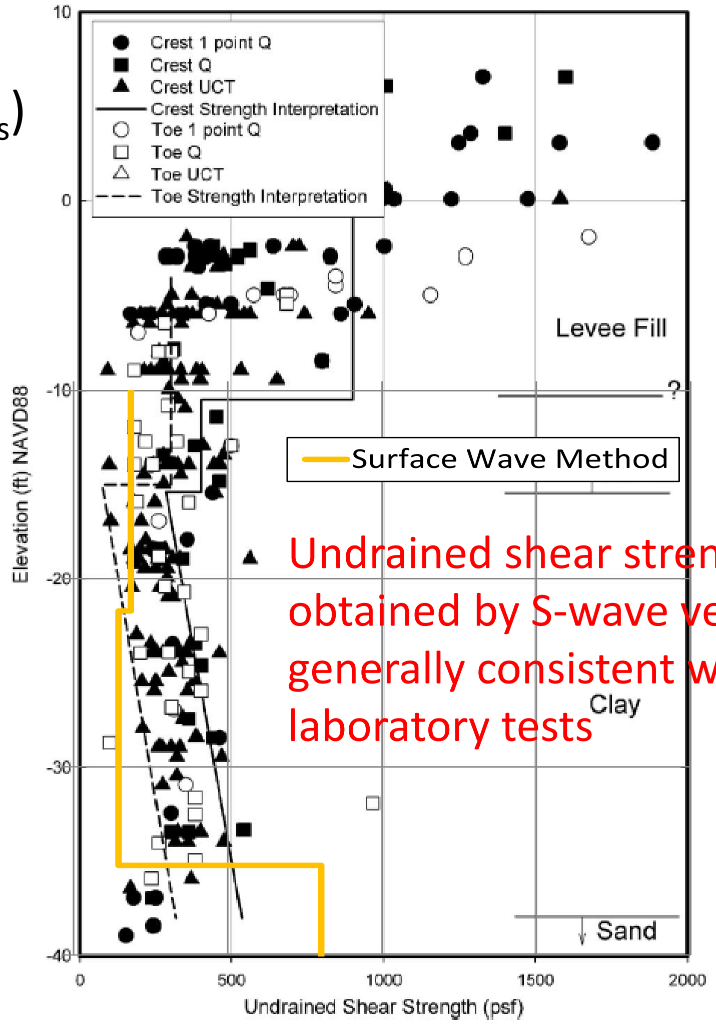
17^{th} Street Canal

Comparison of undrained shear strength (S_u) empirically calculated from S-wave velocity (V_s)



S-wave velocity (m/s) and unconfined compression strength (q_u(kg/cm^2))

$$V_S = 147.6 q_u^{0.417} \qquad S_u = \frac{q_u}{2}$$



Undrained shear strength obtained by S-wave velocity is generally consistent with the laboratory tests

Fig. 5. Laboratory undrained shear strength test results from crest and toe borings and strength interpretation for 17th Street Canal I-wall at Station 10+00

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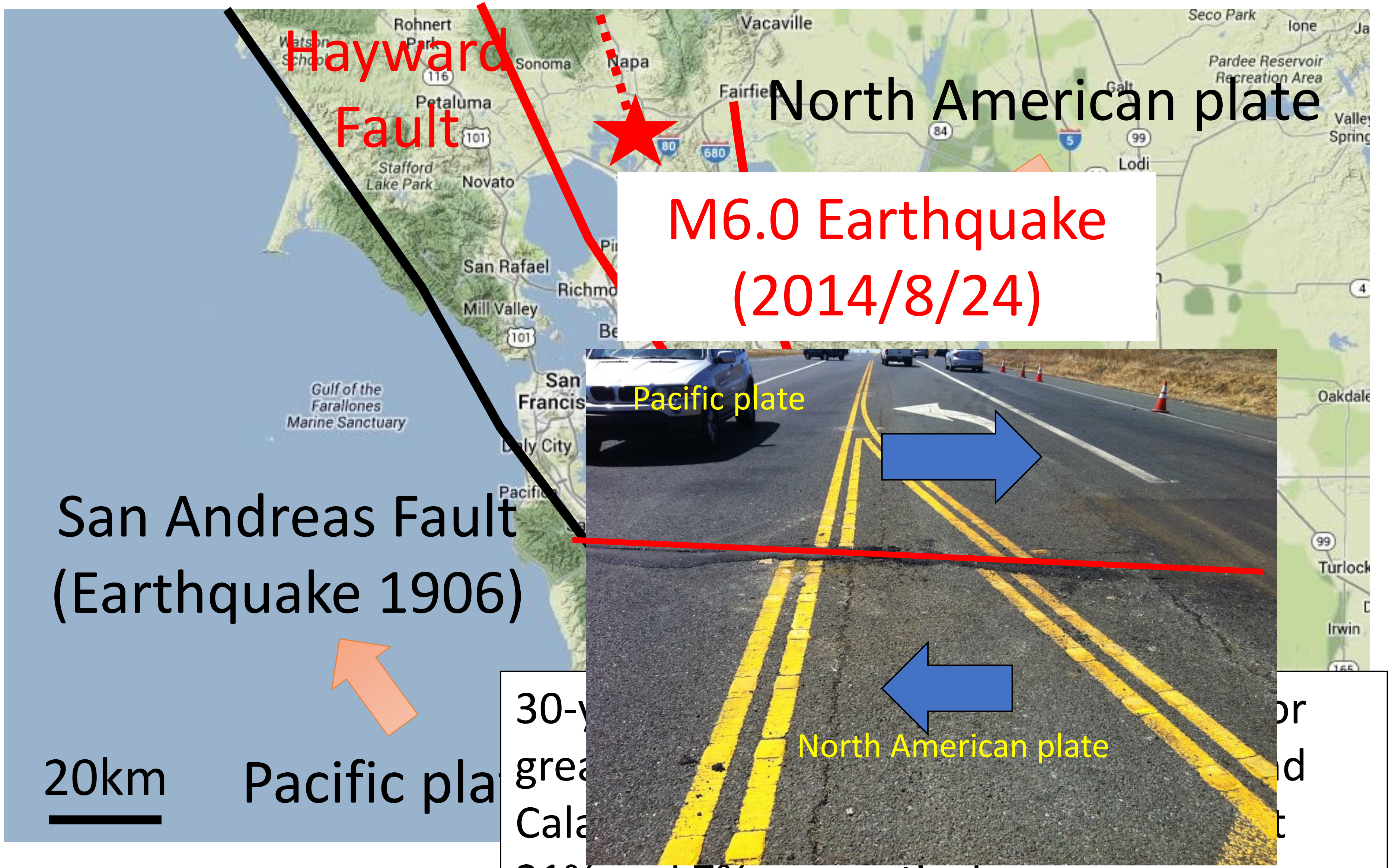
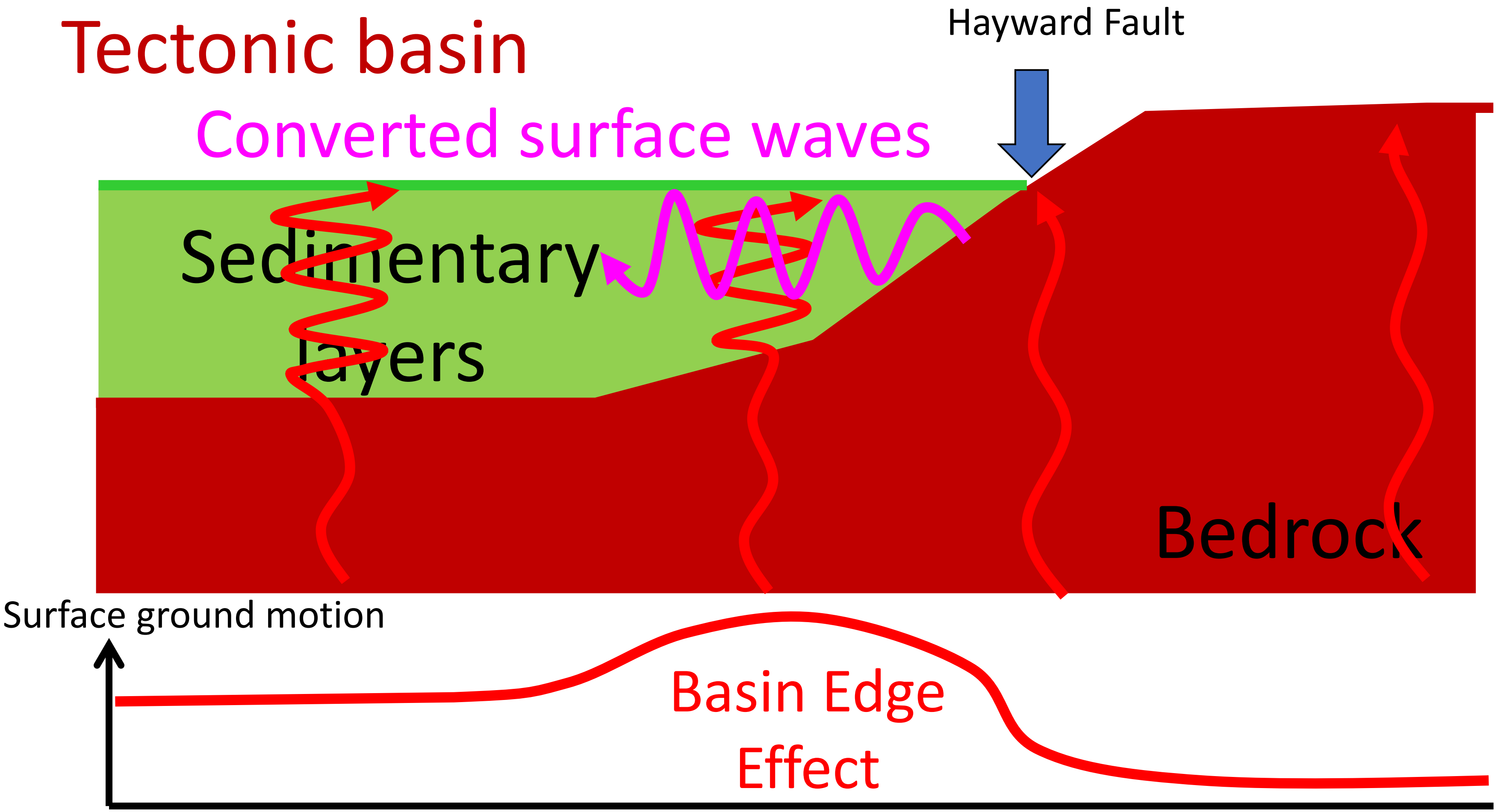
Local site amplification



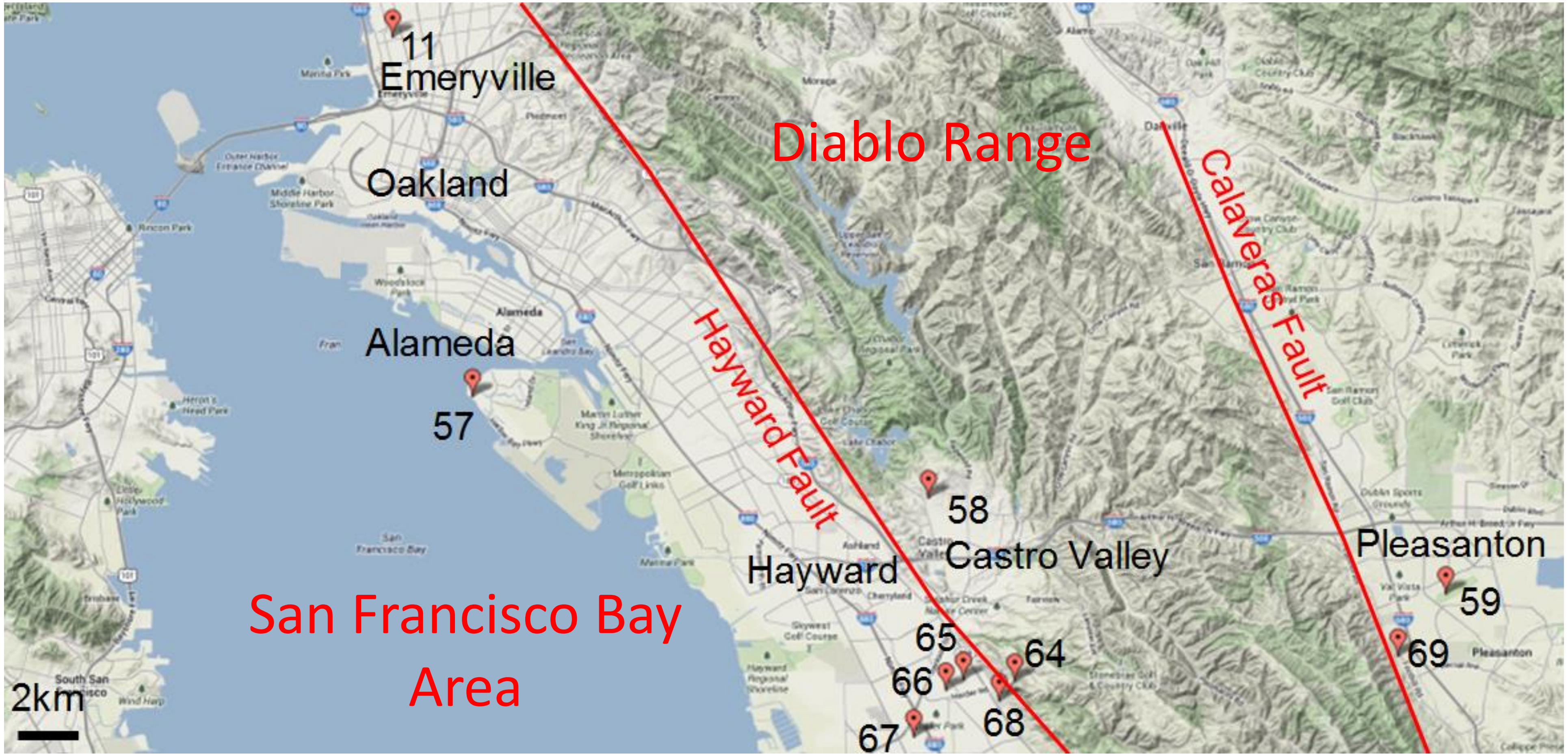
30-y … or
grea … nd
Cala … t
31% and 7%, respectively

Basin edge effect

Seismic ground motion can be locally amplified at the edge of a tectonic basin.

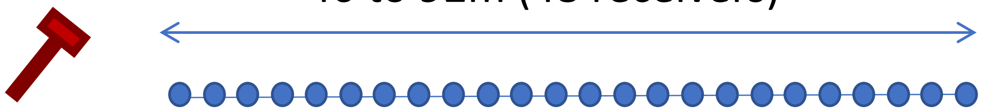


Site of investigation



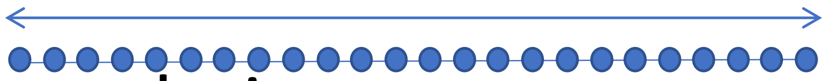
Surface wave methods

- Multichannel Analysis of Surface Waves (MASW)



Depth < 20m

- Passive Surface Wave Survey Using geophones in a Linear Array (Linear-MAM)

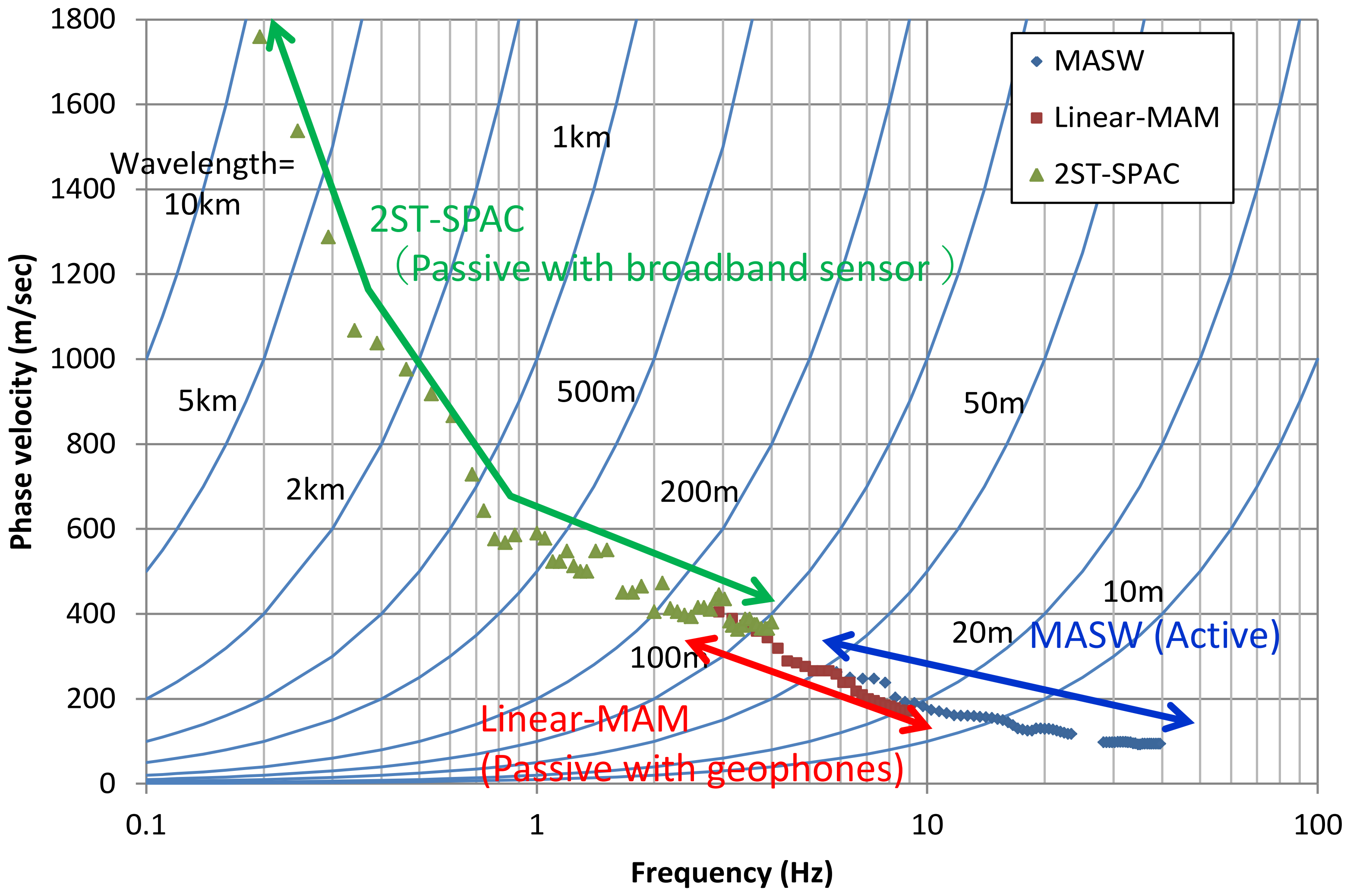


10m < Depth < 100m

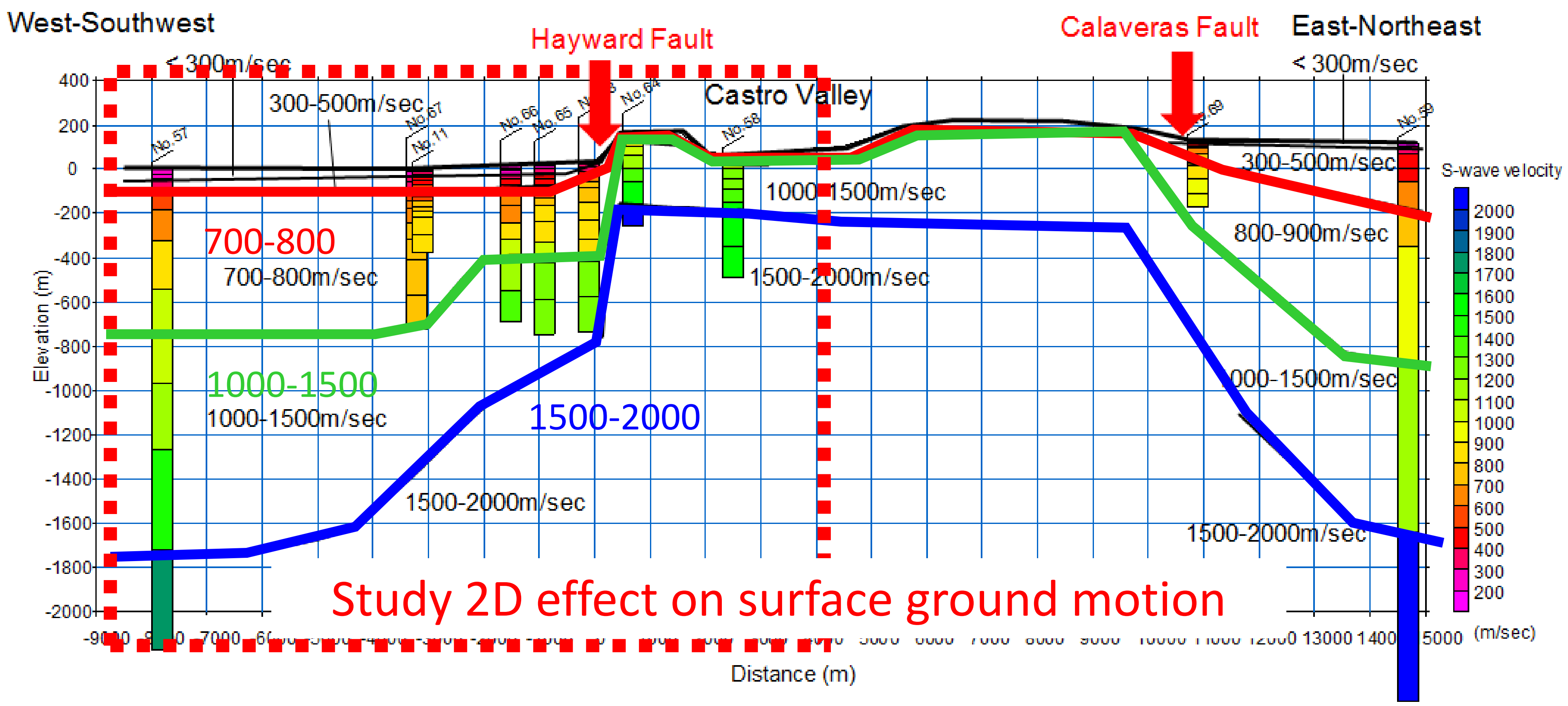
- Two-station Spatial Autocorrelation (2ST-SPAC)

50m < Depth < 2000m

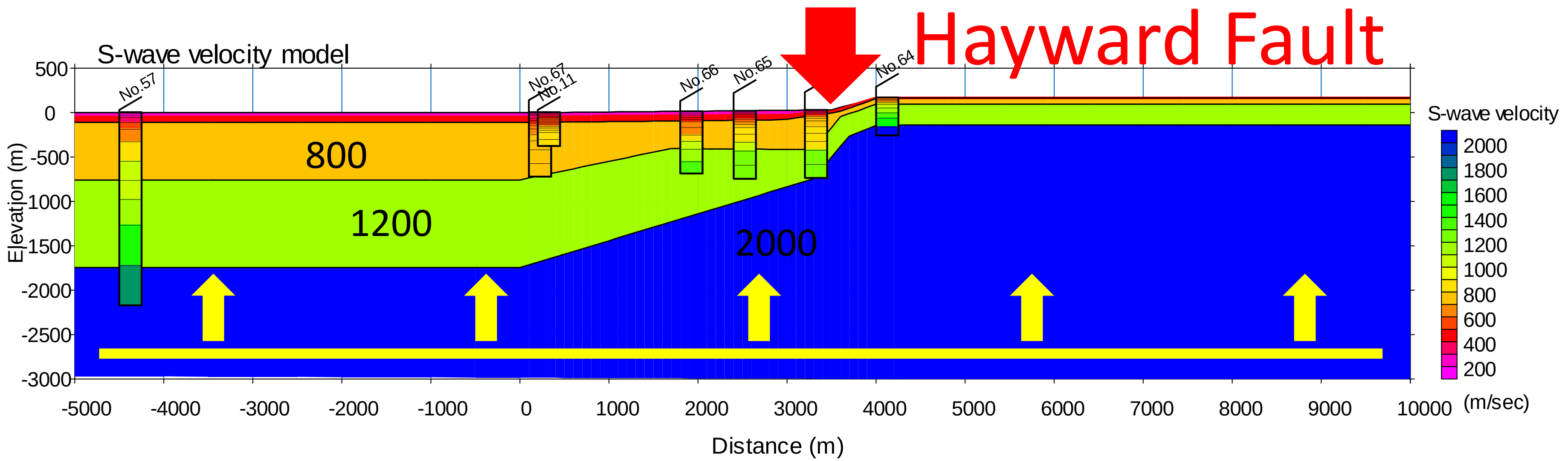
Comparison of dispersion curves



Schematic S-wave velocity model across the faults

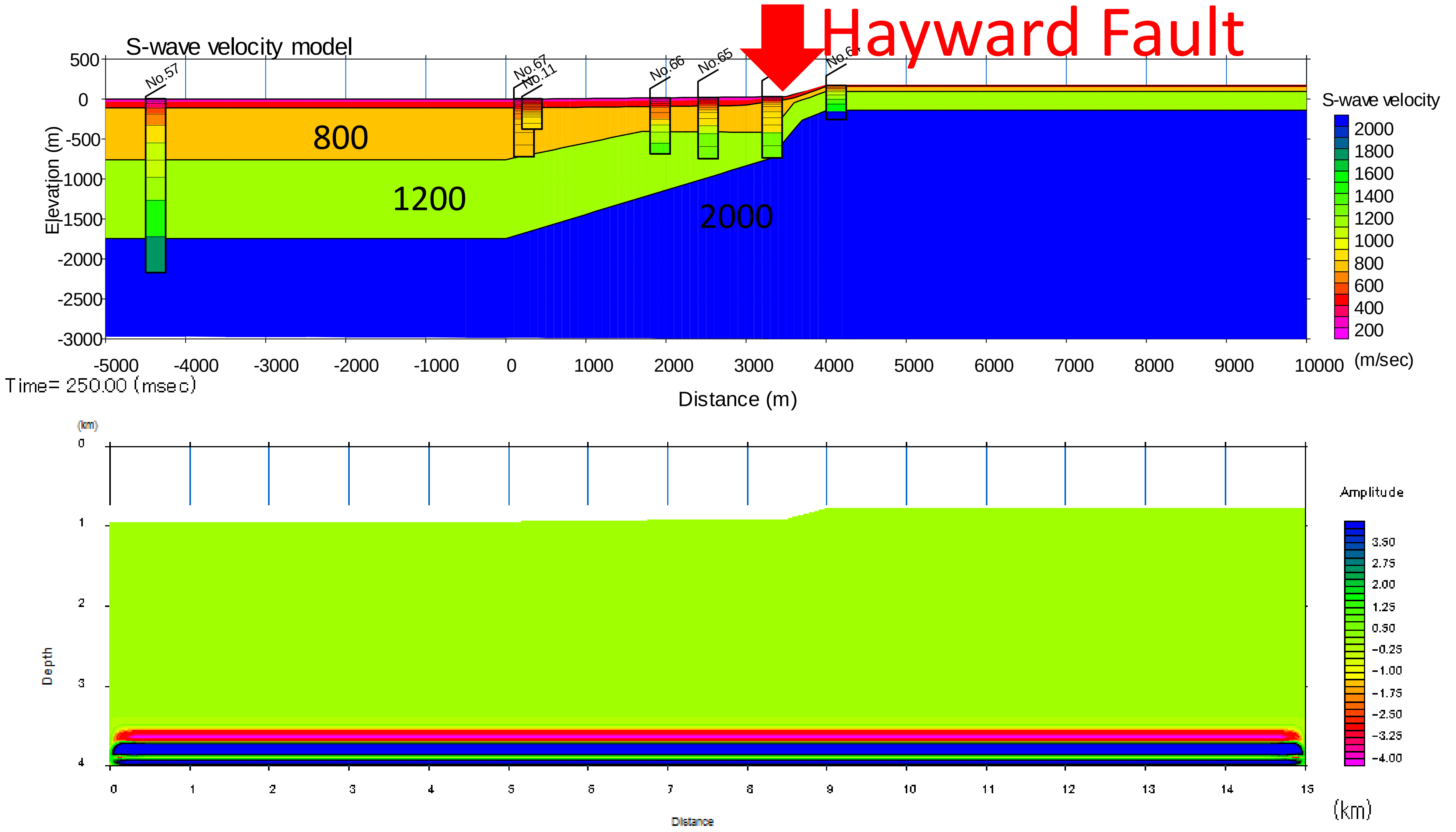


Effect of 2D structure on surface ground motion



Input plane SH wave at the bottom the model

Effect of 2D structure on surface ground motion



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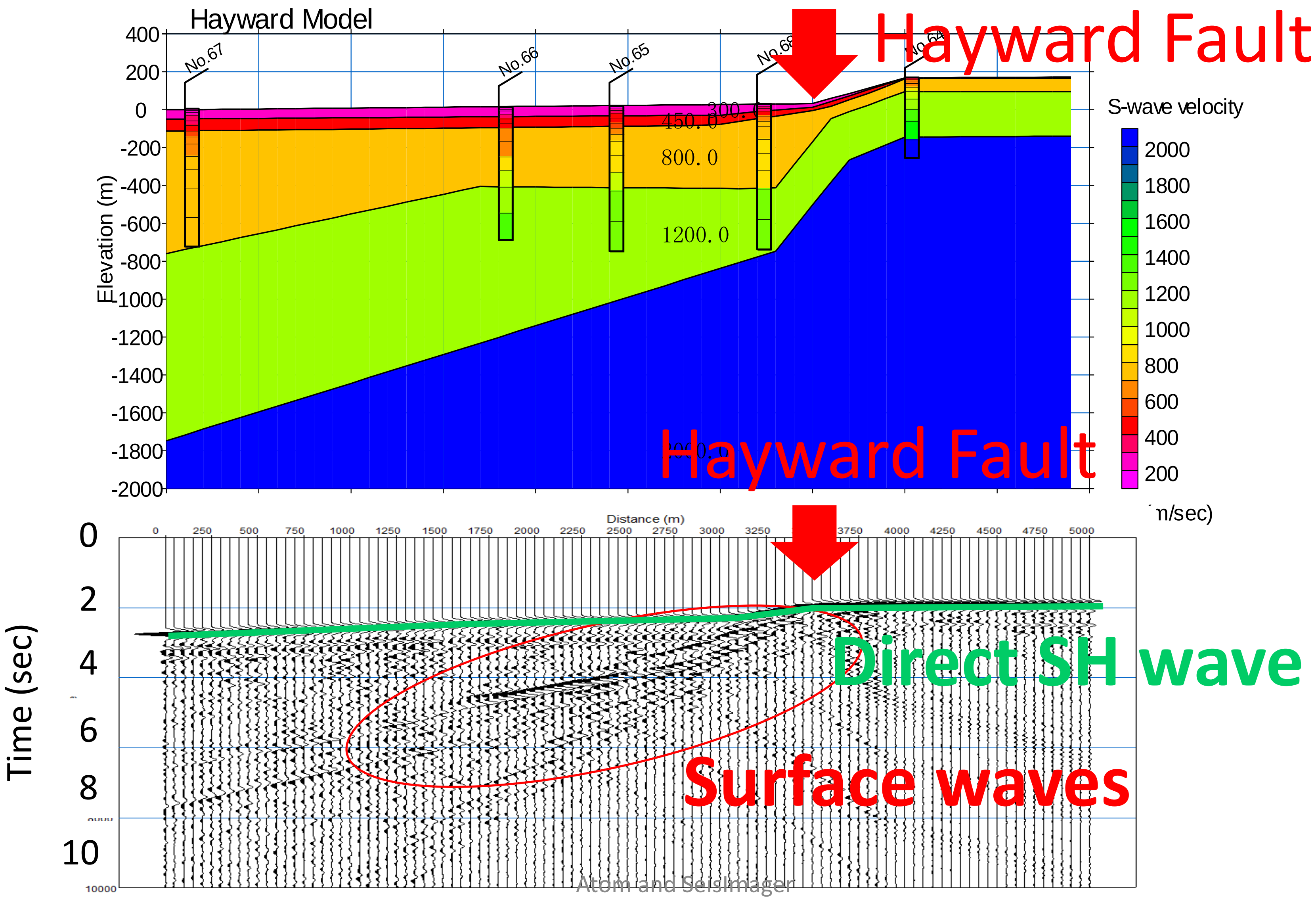

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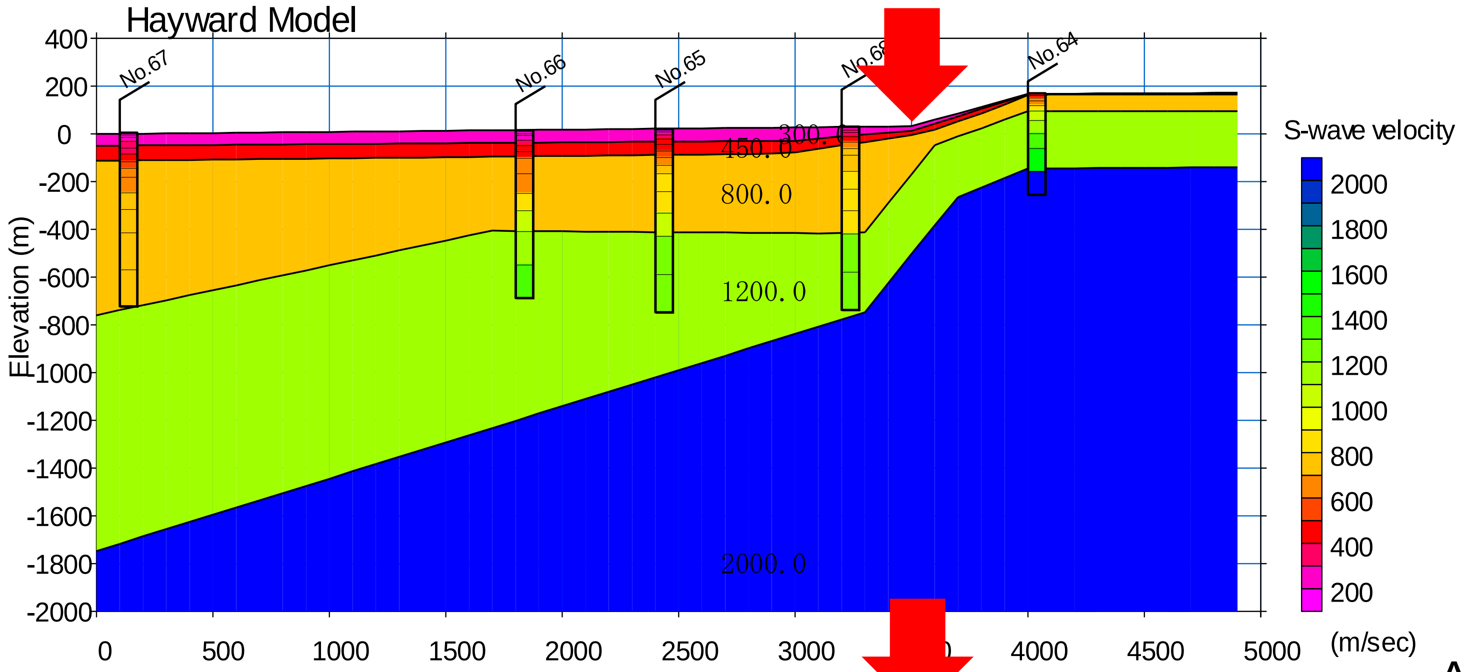
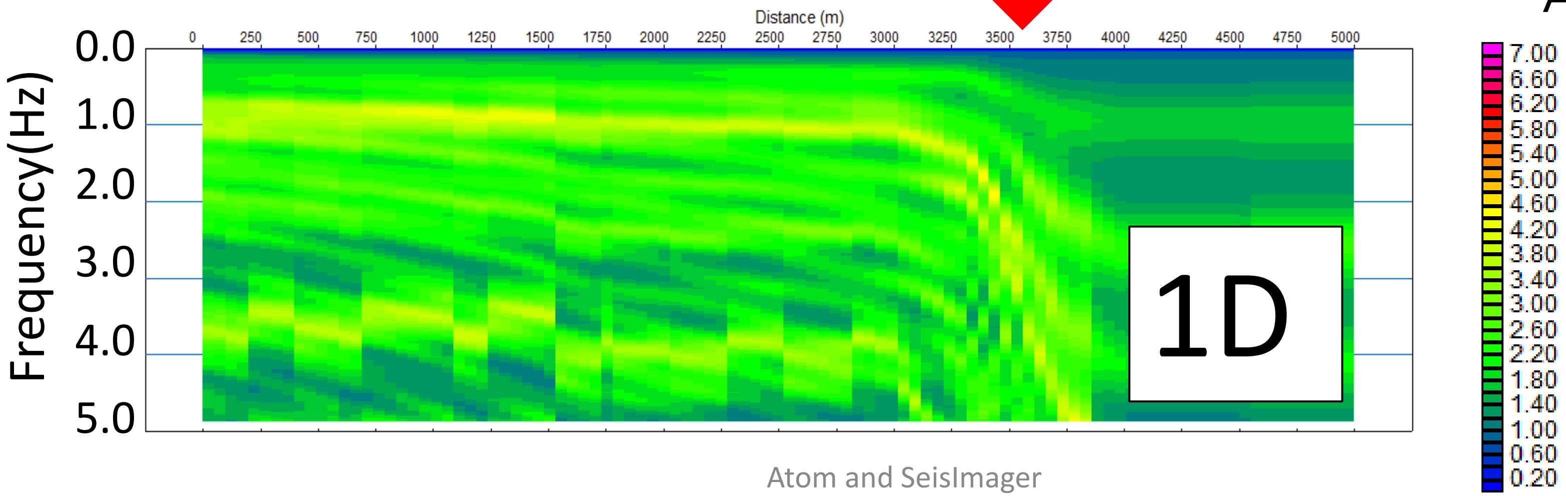
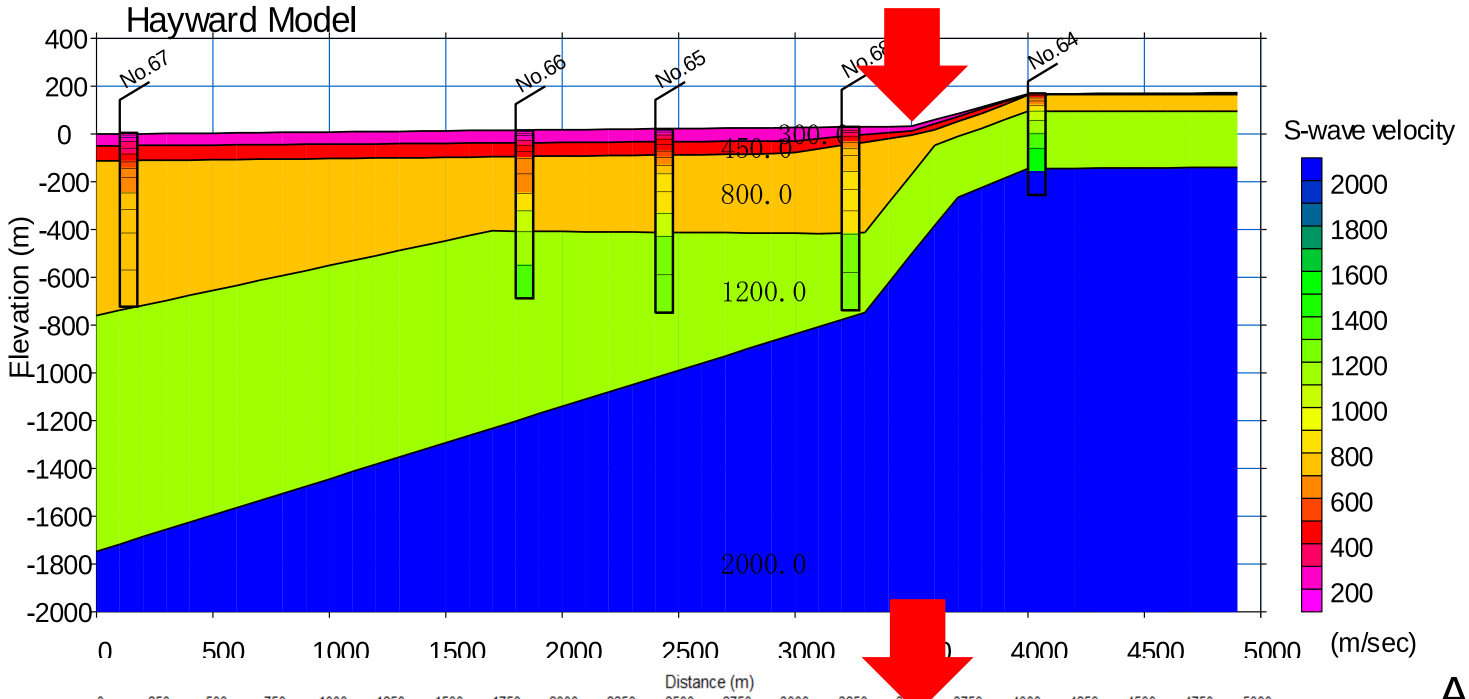
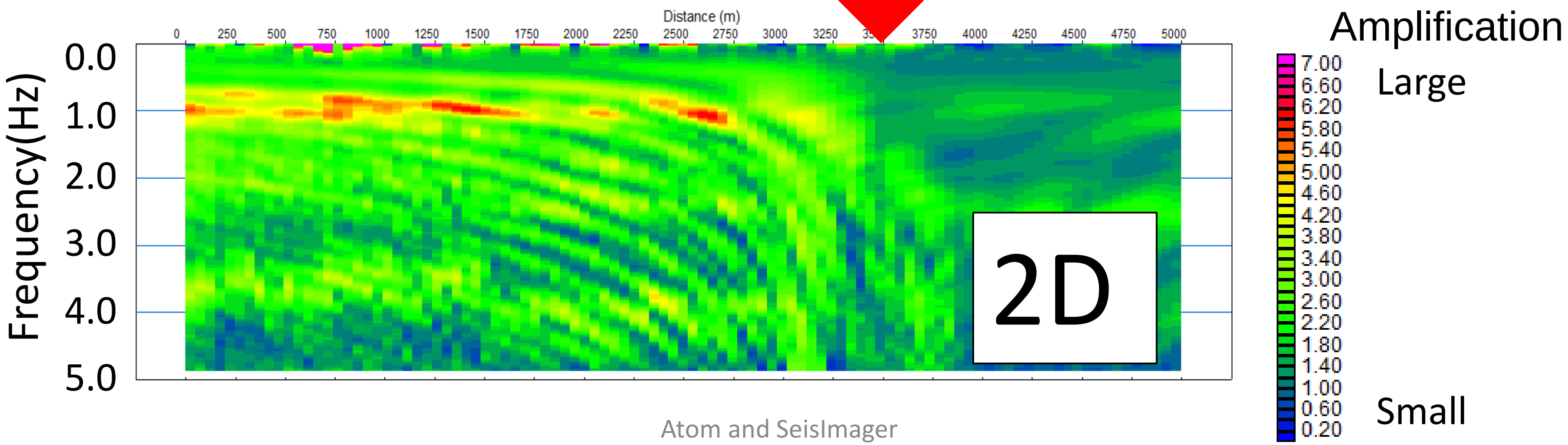
Surface ground motion without edge effect (1D)





Surface ground motion with edge effect (2D)

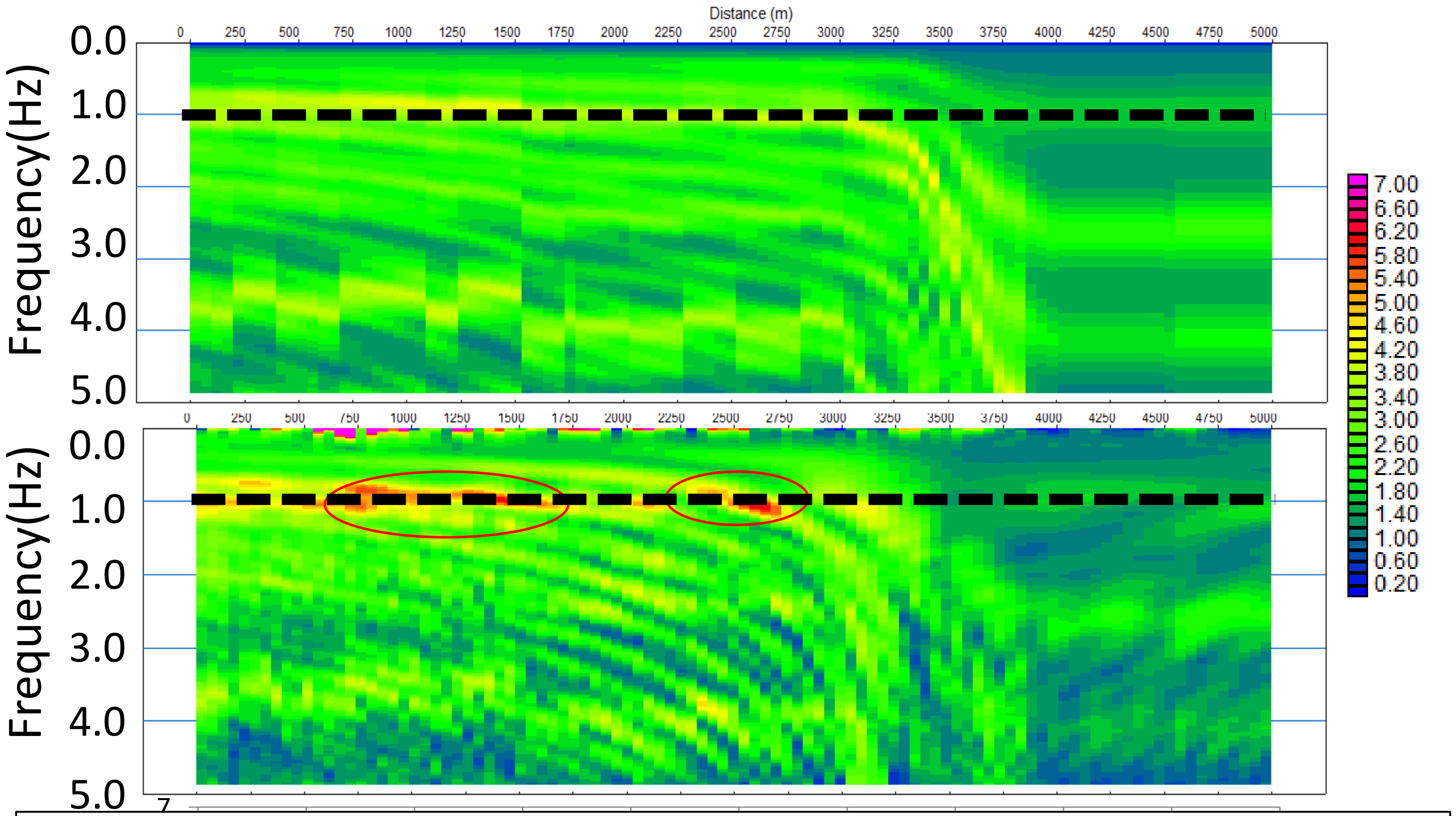




Comparison of 1D and 2D amplification

1D

Without Edge Effect



2D

With Edge Effect

Amplificati
at 1Hz

Bedrock depth changes at least 400m across the Hayward Fault, and it may cause large local amplification (4 to 6 times greater than bedrock). The impact of this so-called basin edge effect must be taken into account at least several kilometers away from the Hayward Fault.

Application examples

- Active fault investigation at Beijing, China (3D)
- Bedrock investigation at the granite hills (3D)
- Major fault investigation (2D)
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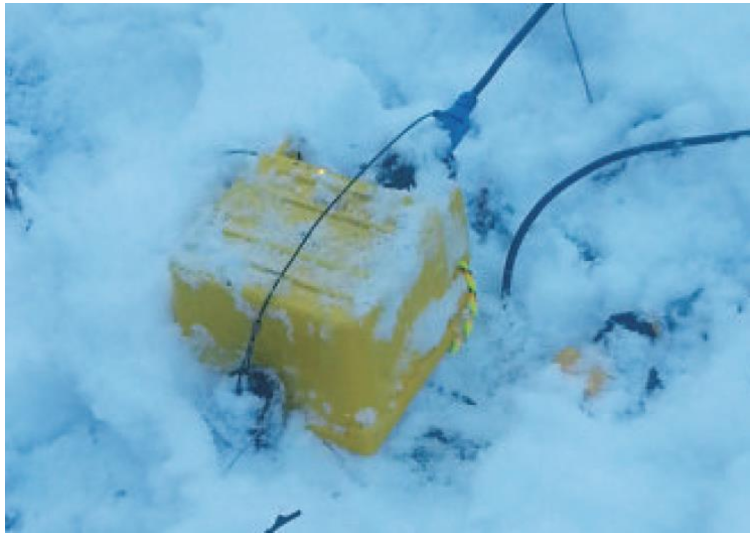
Large scale seismic refraction
– Data acquisition

Investigation site

Atom in snowy mountain

Preparation of Atom

Atom in snowy mountain

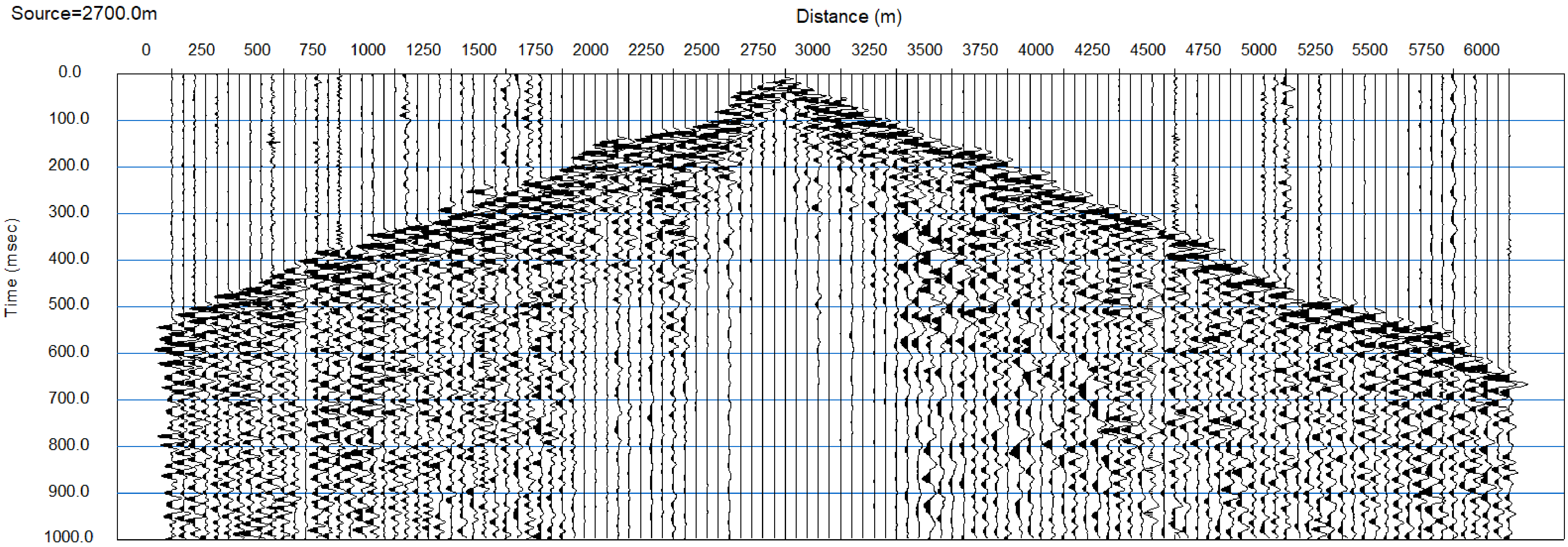


Large scale seismic refraction – Explosion

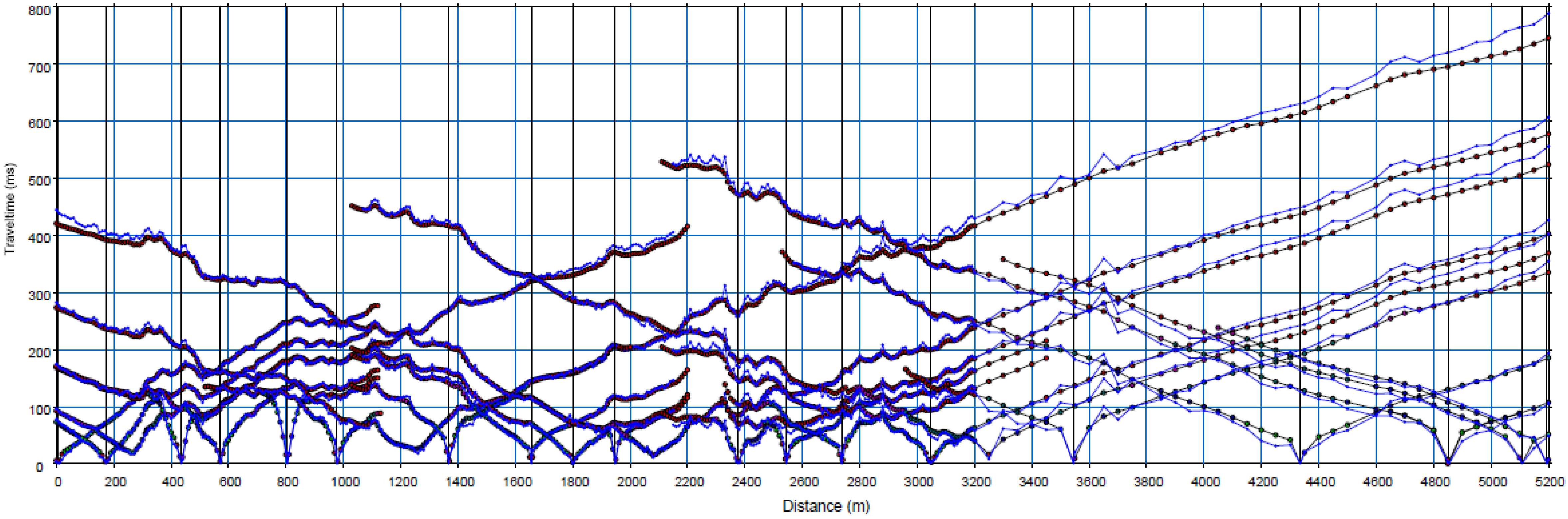
Preparation of explosion

Explosion

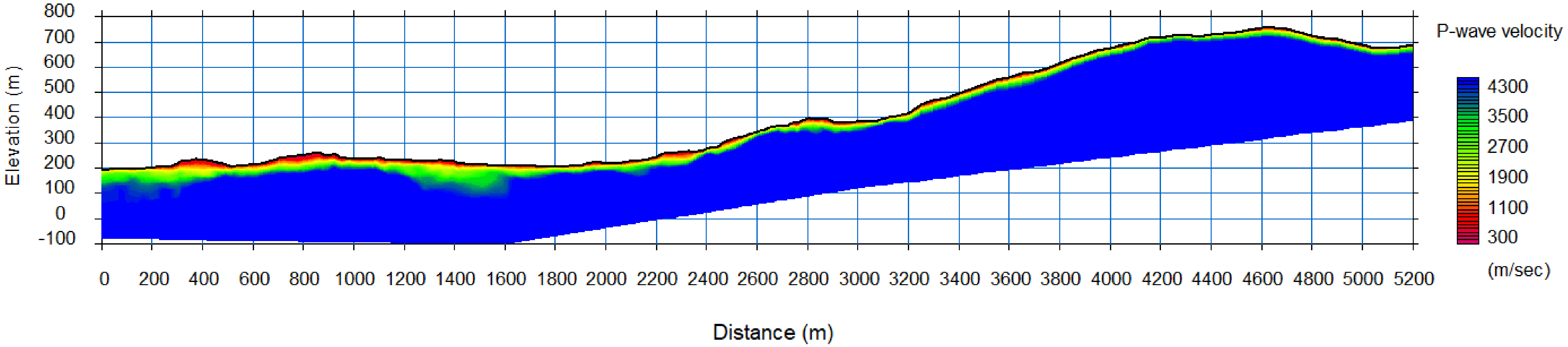
Large scale seismic refraction – Shot gather



Large scale seismic refraction – Traveltime curves



Large scale seismic refraction – Resultant velocity model



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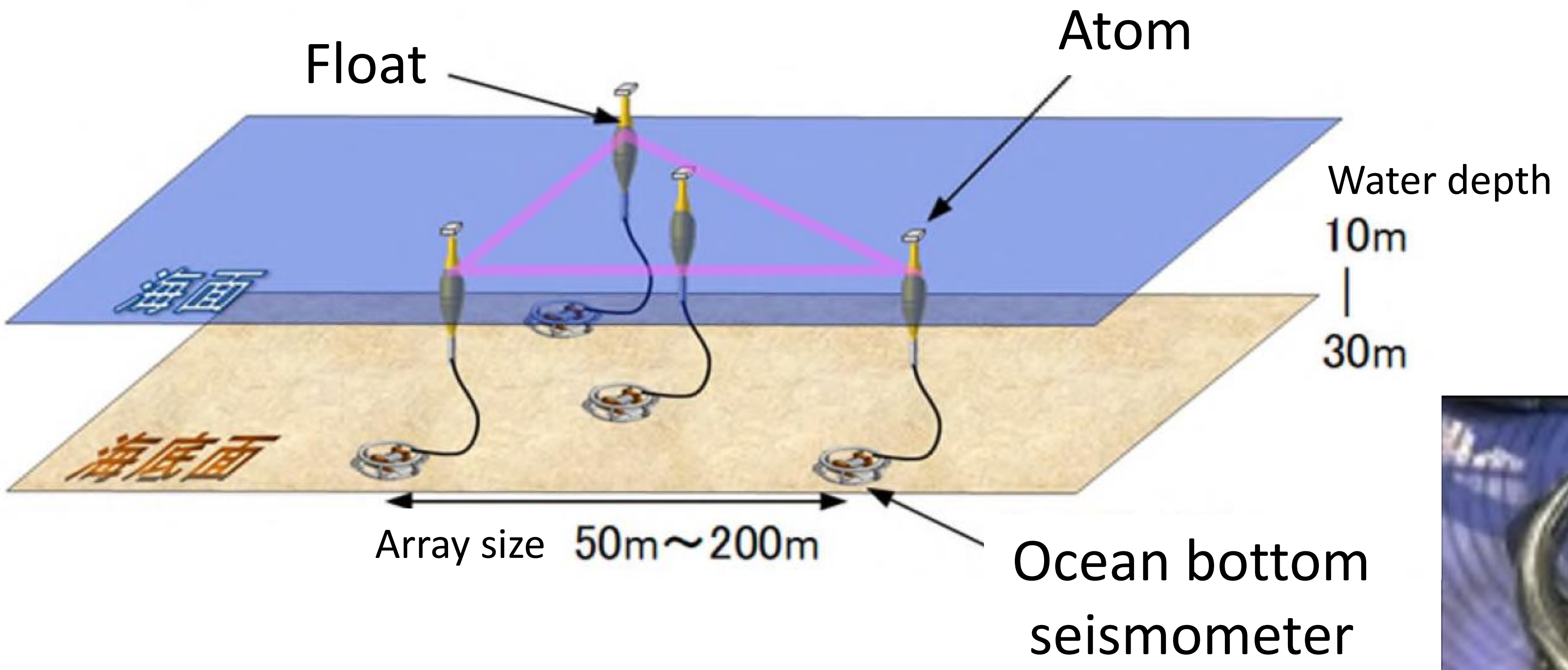
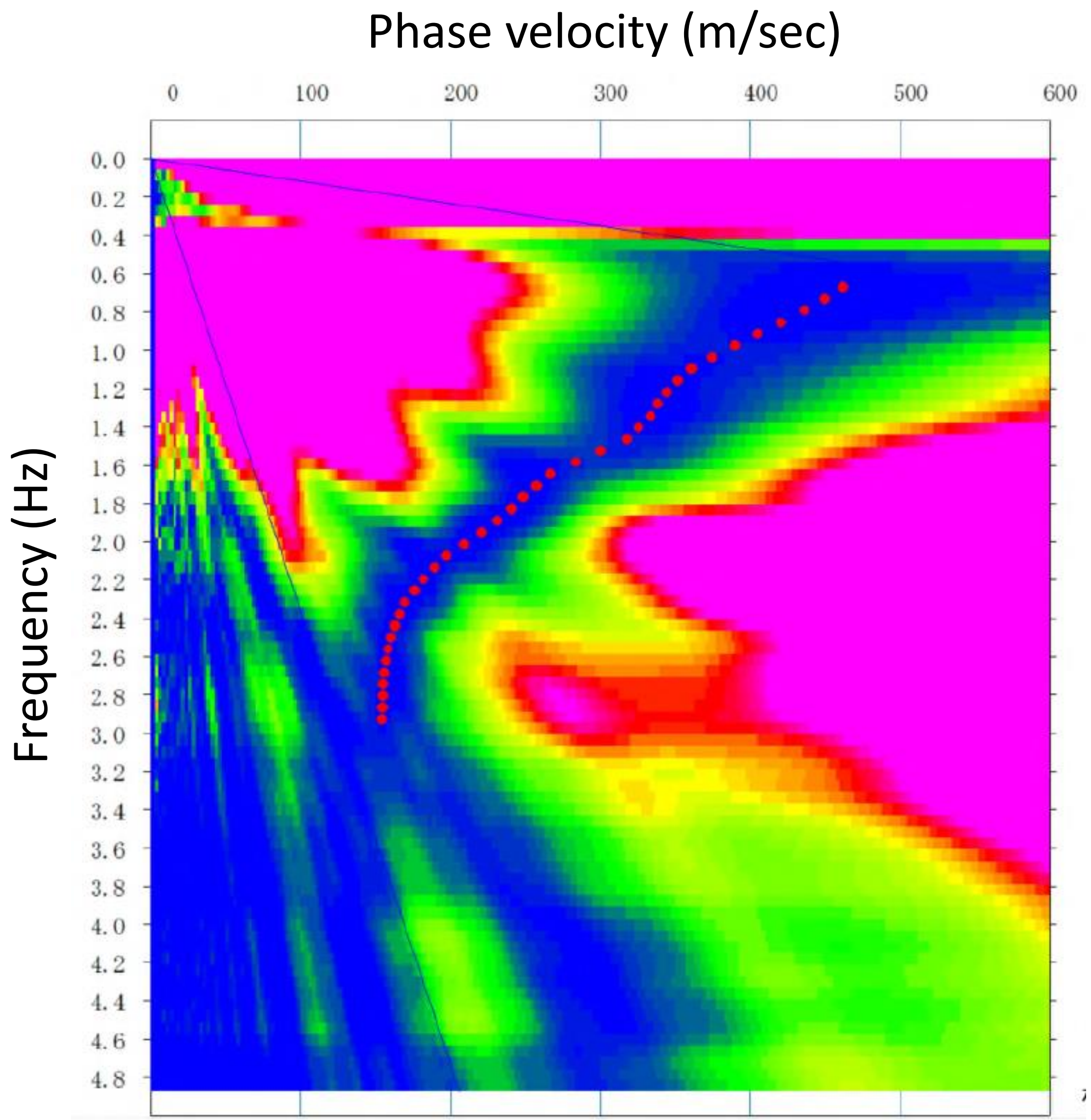
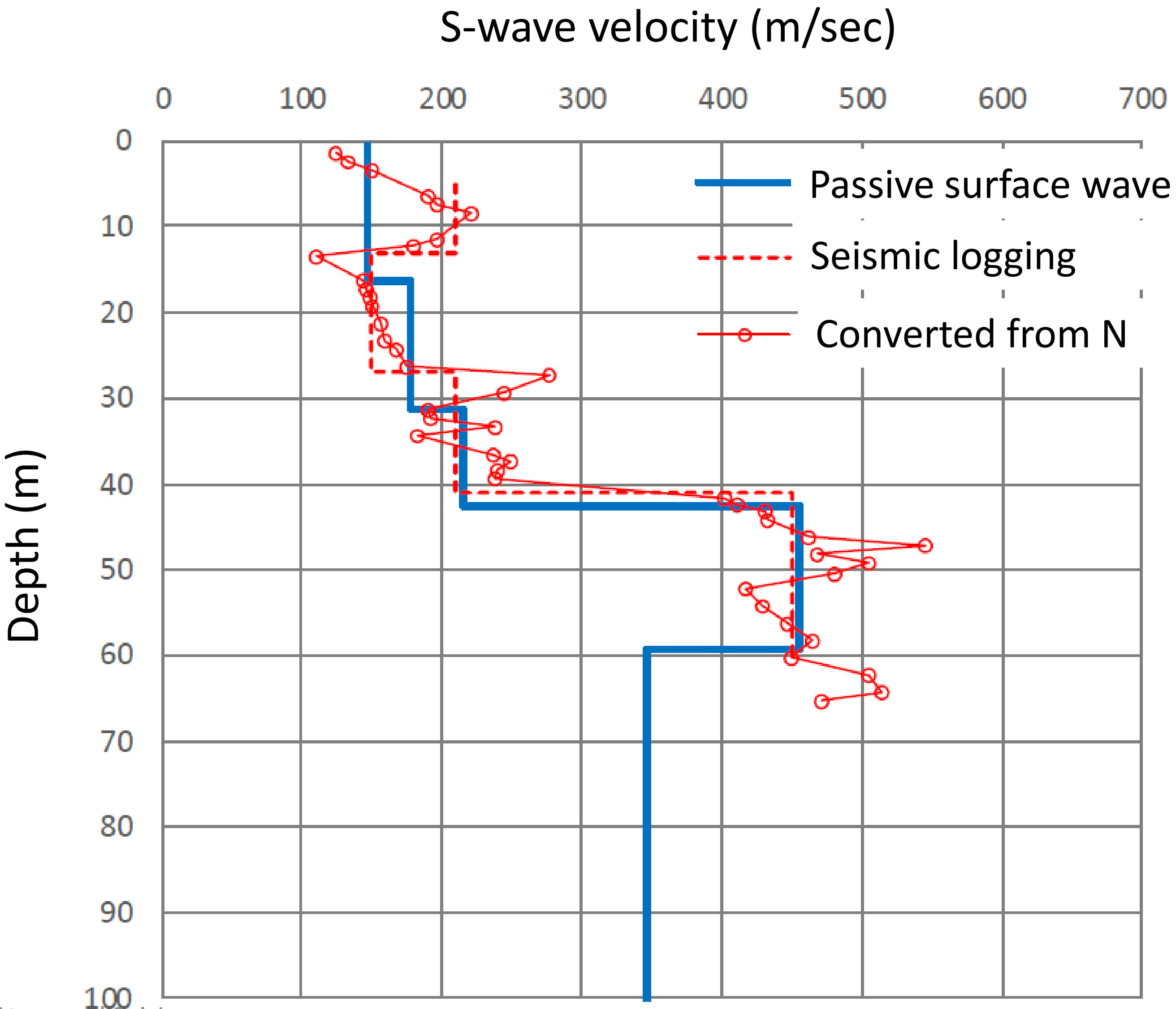
Ocean bottom passive surface wave method



Ocean bottom passive surface wave method





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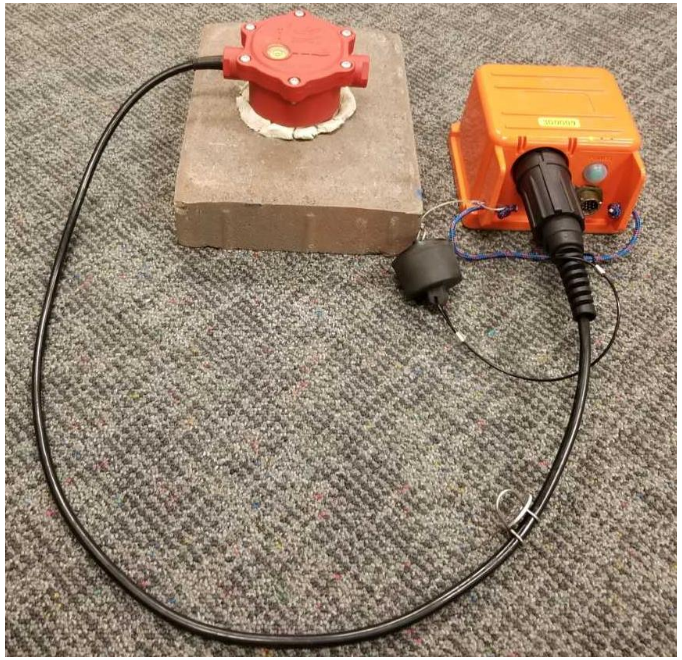
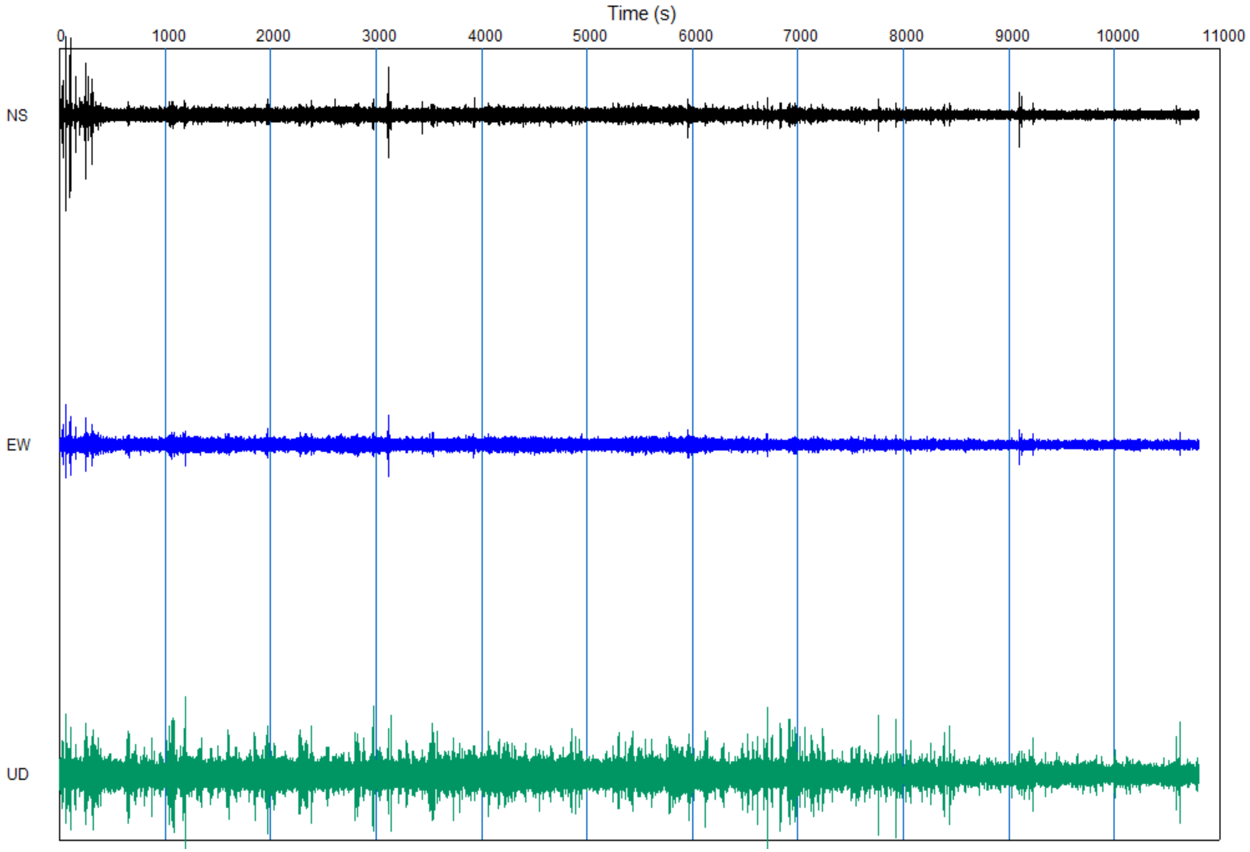
Atom records tele-seismic event – M7.7 Earthquake at Aleutian Islands (7/17/2017)

3C Atom and 3C 2Hz geophone at Geometrics office, San Jose, CA, U.S.

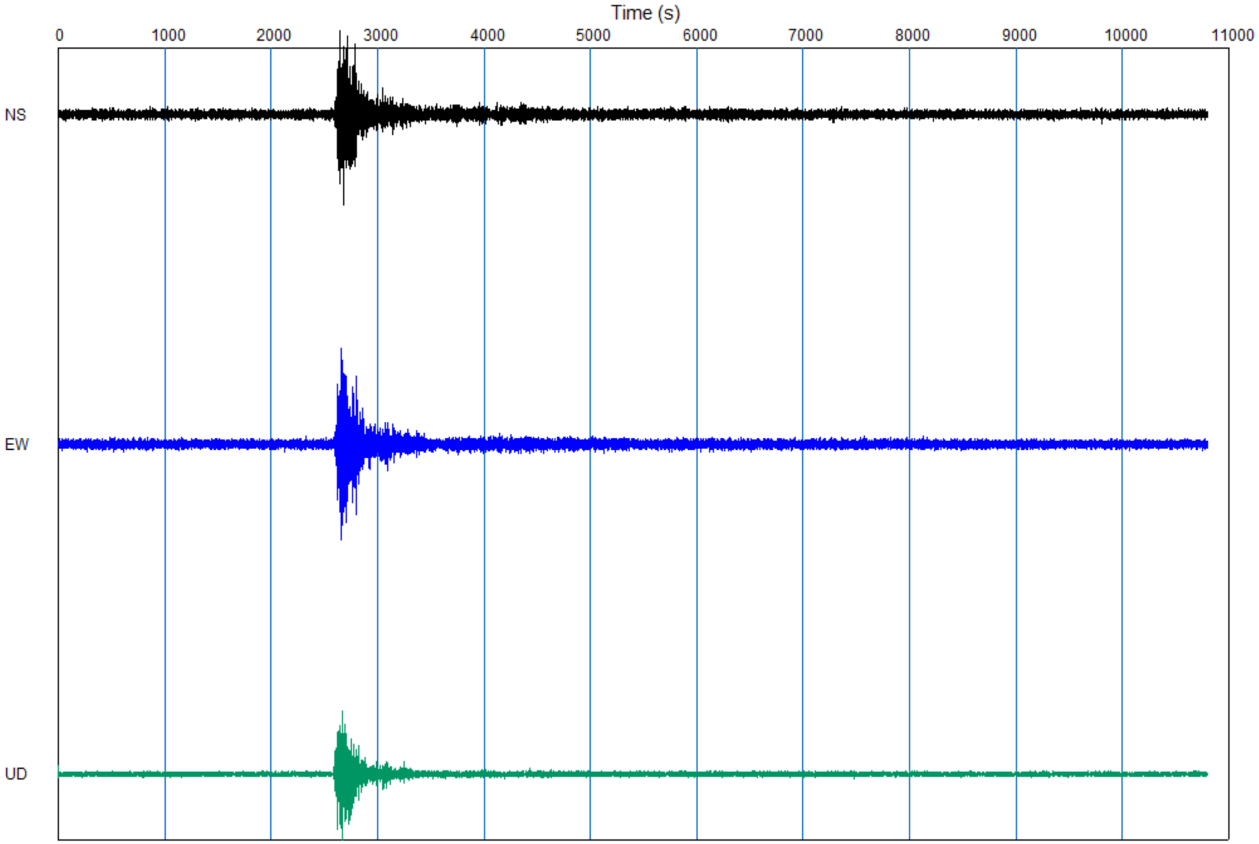


Atom records tele-seismic event
– M7.7 Earthquake at Aleutian Islands (7/17/2017)

Raw data

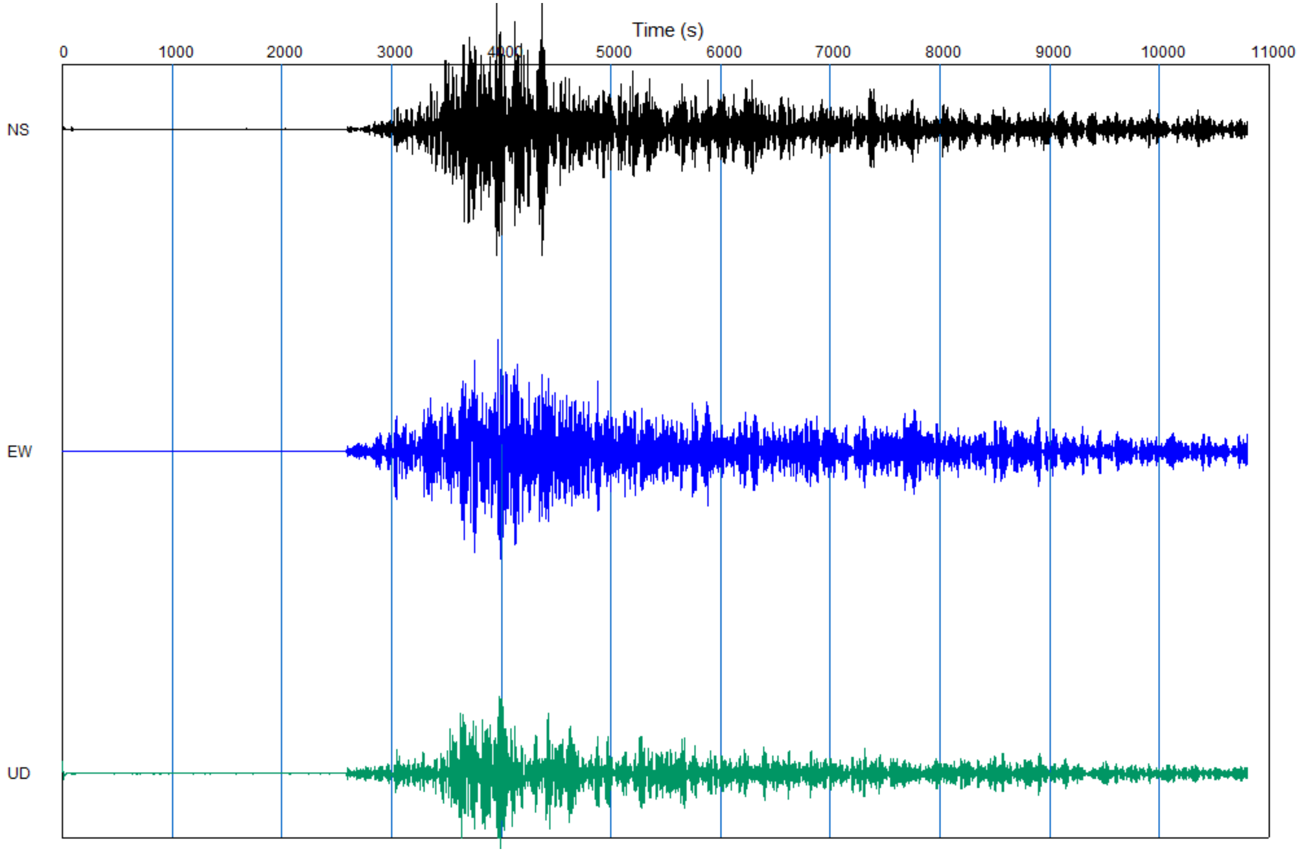


LPF 1 sec

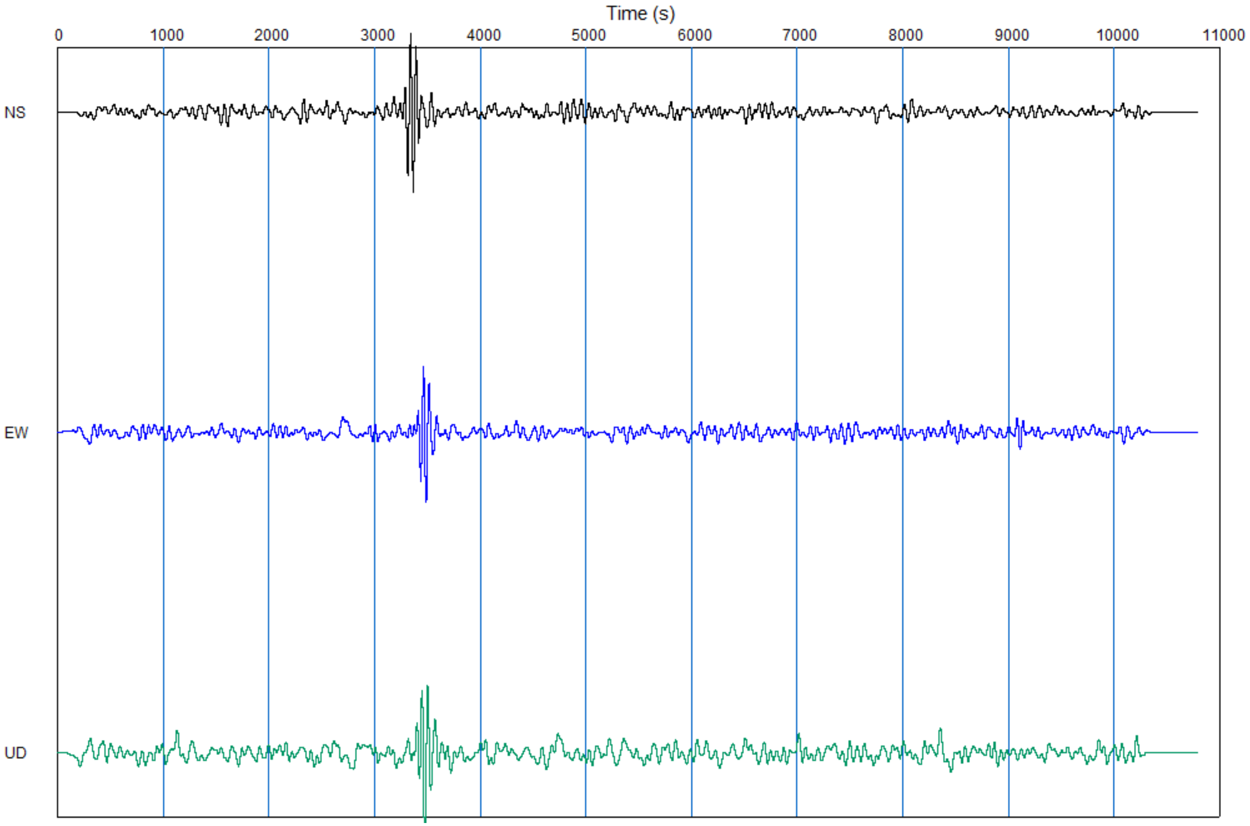


Atom records tele-seismic event – M7.7 Earthquake at Aleutian Islands (7/17/2017)

LPF 10 sec



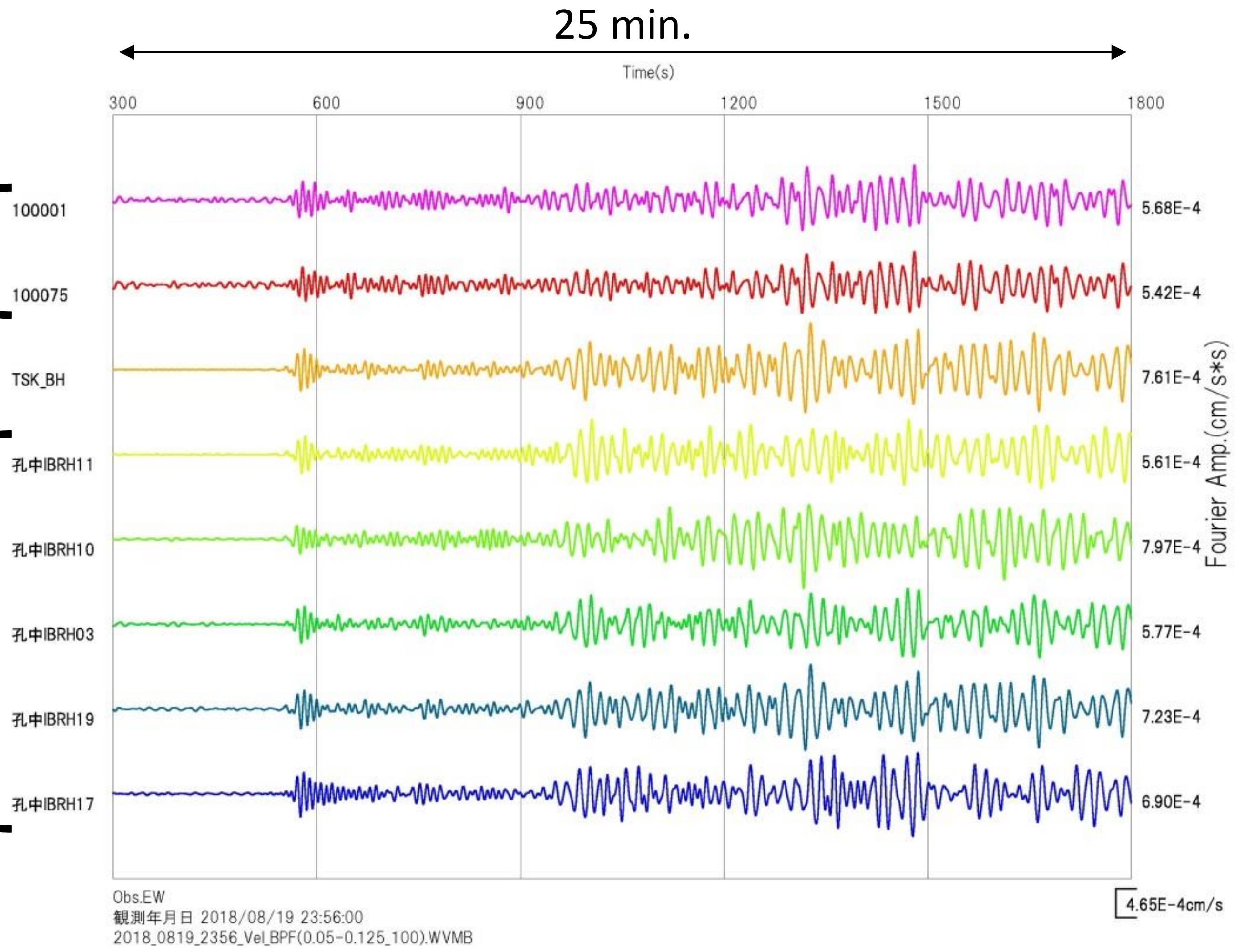
LPF 50 sec

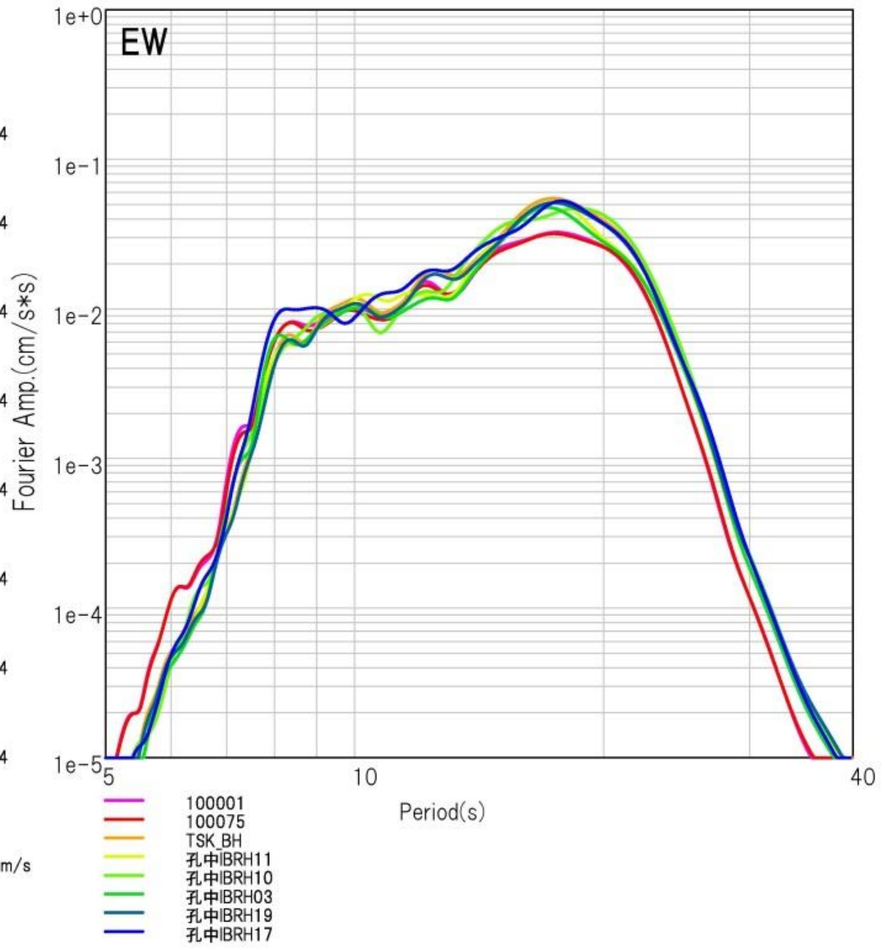


Comparison with broadband sensor (earthquake)

Atom with 2 Hz sensor

Borehole broad band sensor (Hi-net)





Application examples

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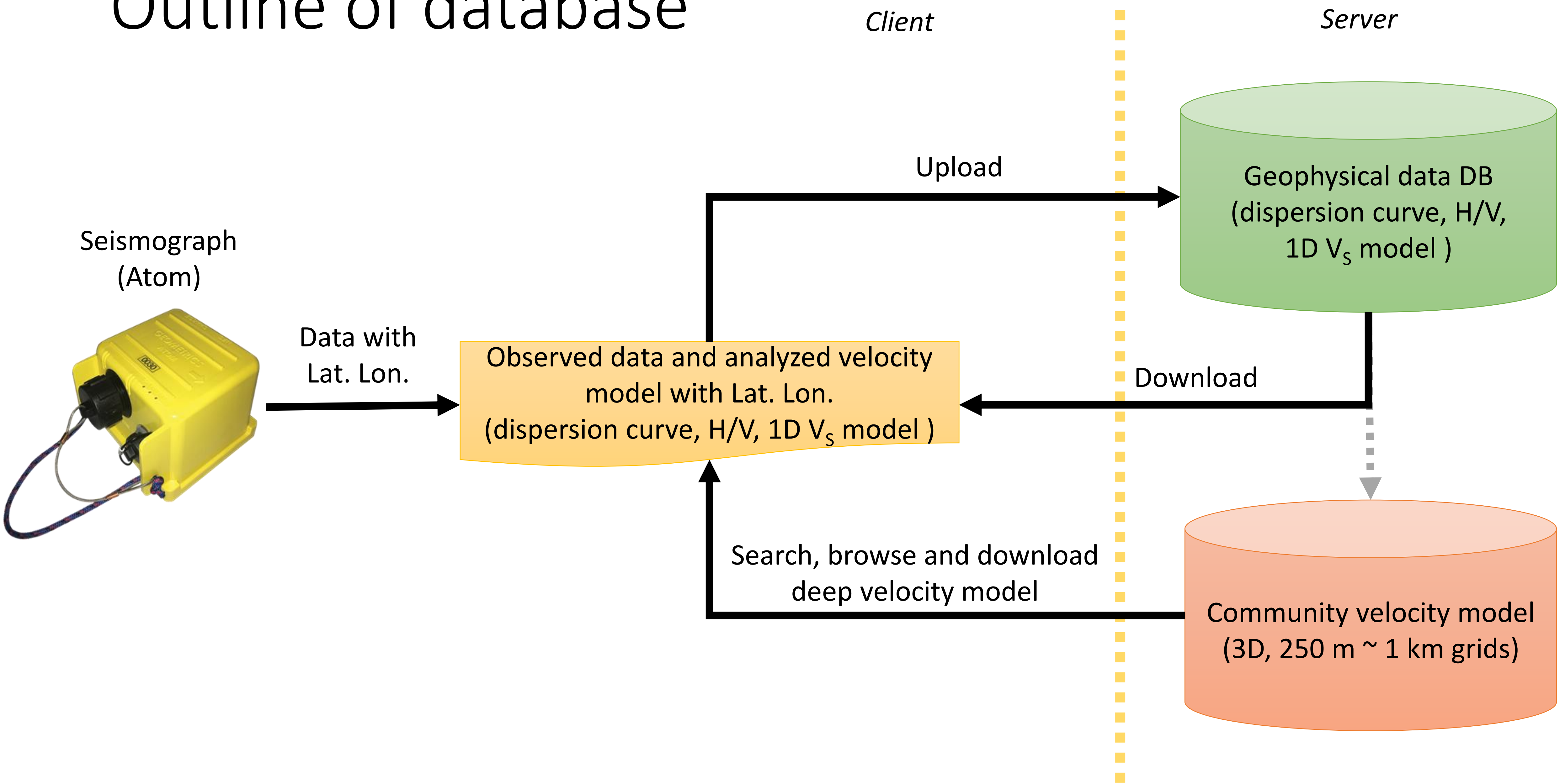
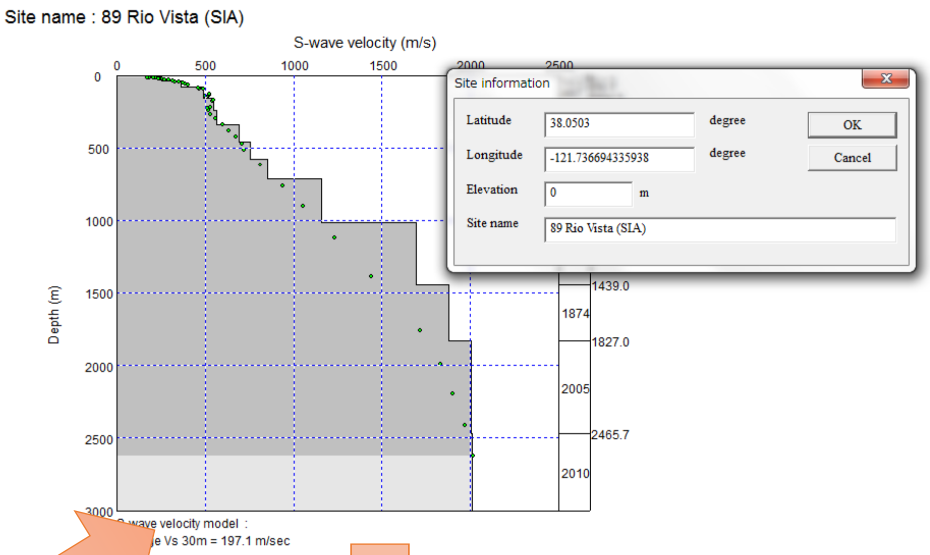
Outline of database

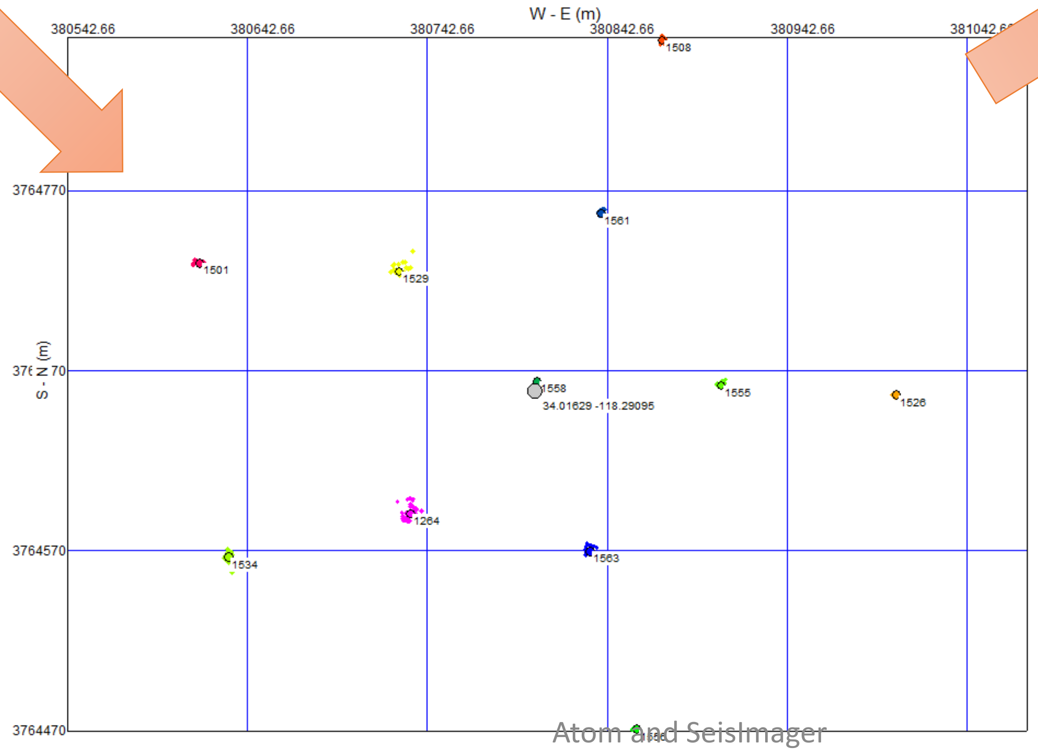


Data acquisition and processing

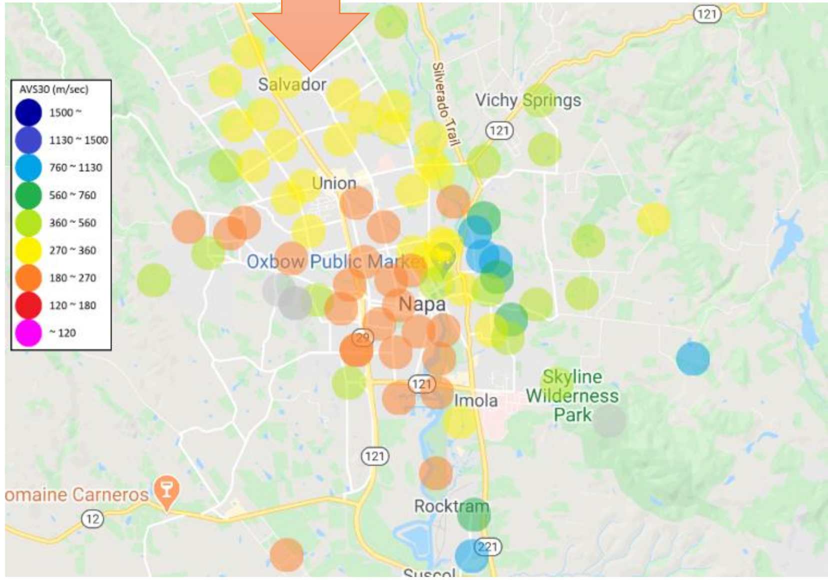
Processing results



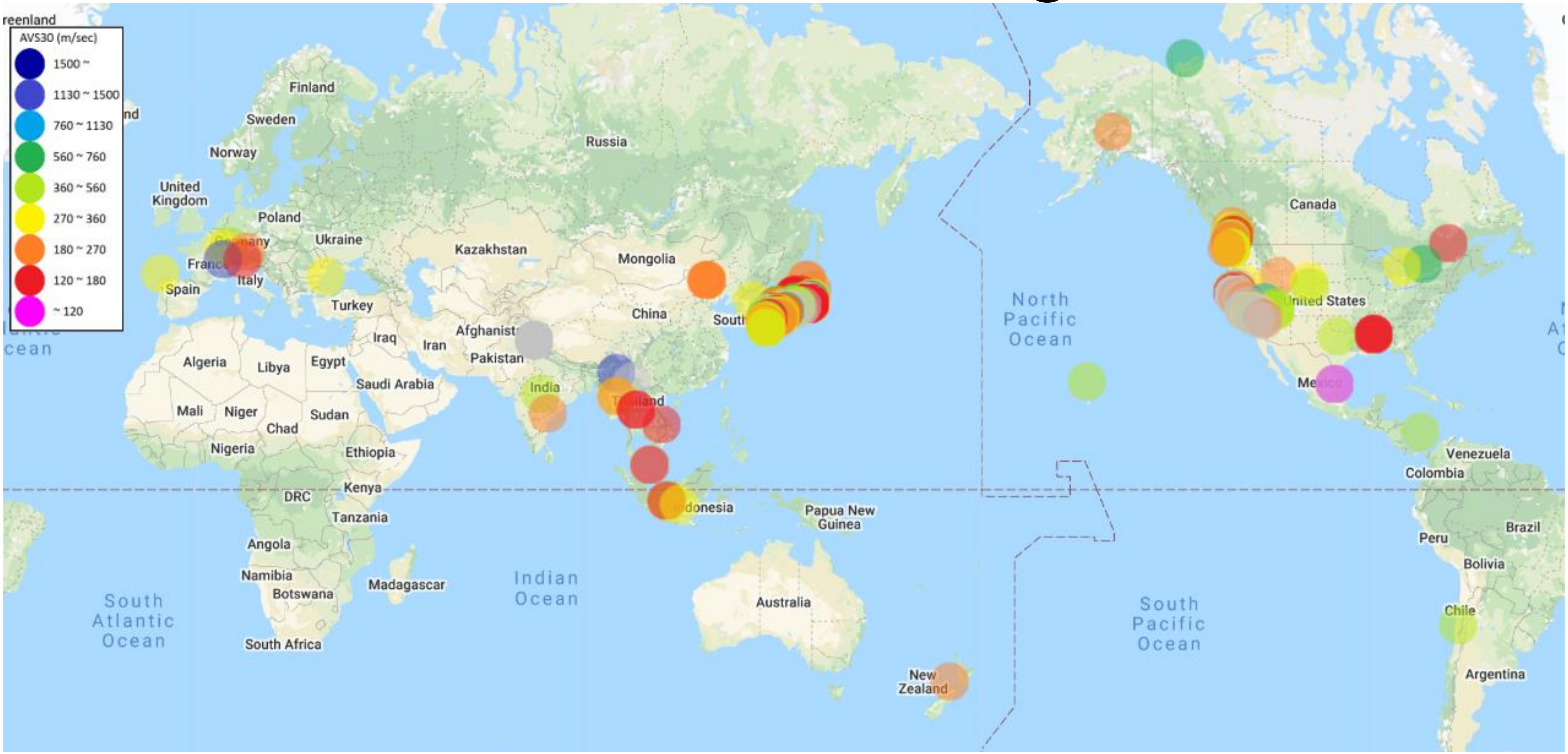
Sensor locations from GPS



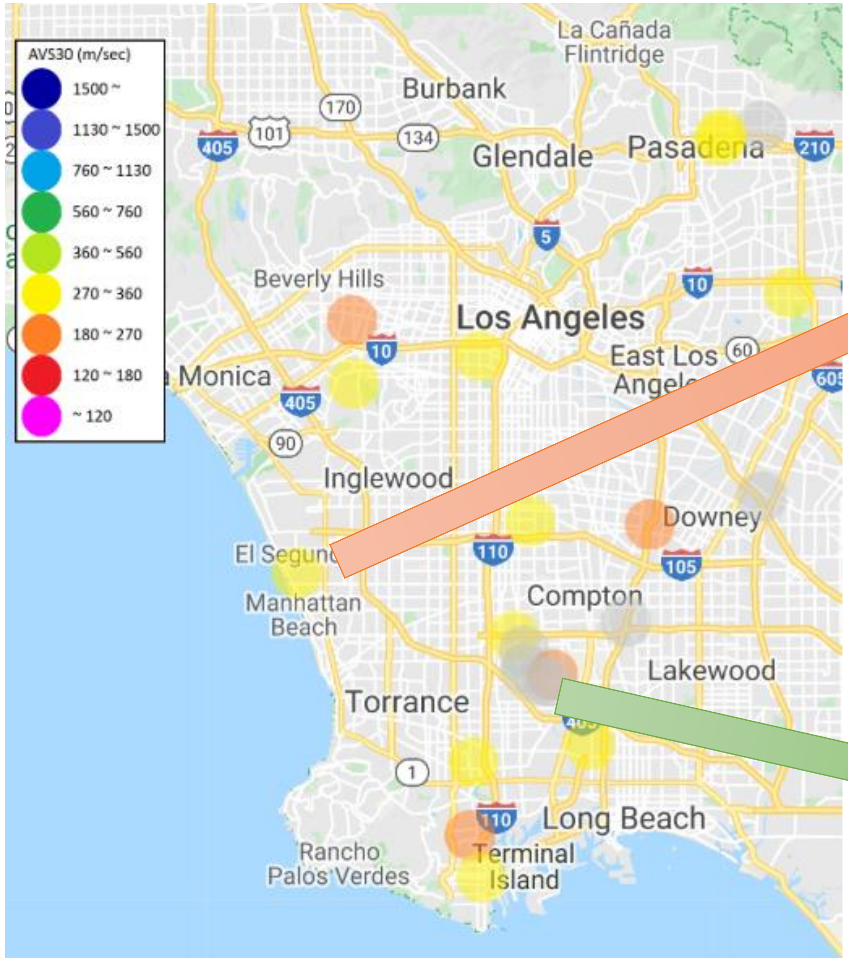
Upload data to database



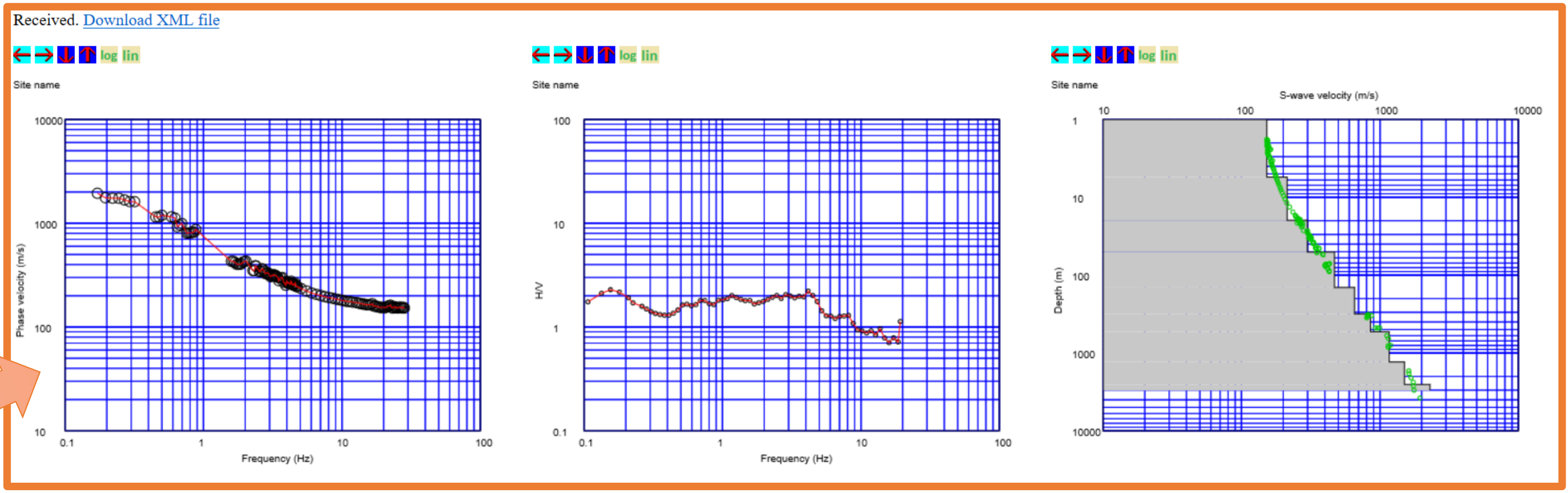
Finding dispersion curve, H/V and velocity model from database : SeisImager.com



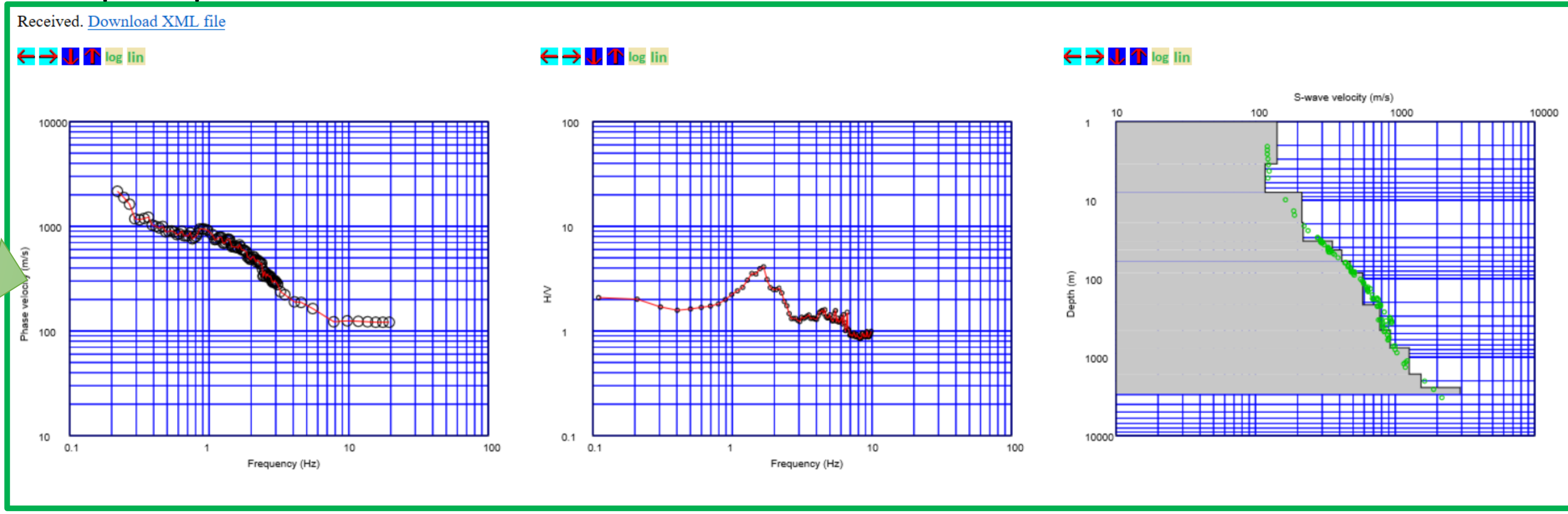
Data in Los Angeles area



Manhattan Beach



Dolphin park



Finding community velocity model from database
seisimager.esy.es/GeophysicalDatabase

Microtremor Array Measurements Database

All Microtremor Array Measurements Data

Find Velocity Model in Japan or U.S. (California)

Show Velocity Model at Current Position (Japan or U.S. (California))

Exam e data

Enter latitude and longitude

Latitude: 34.068850
Longitude: -118.442976

- ○ CAO, Japanese Geovernment (2017, all Japan, Reference)
- ○ J-SHIS (all Japan, Reference)
- ○ HERP (2017, Kanto. Japan, Reference)
- ○ USGS San Francisco Bay Are ... 8.3.0, Reference)
- ● 3D Velocity ... California SCEC Unified Velocity Model (4.0, Reference)

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Received.

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