

Microseismic and seismic while drilling in the physical modelling lab

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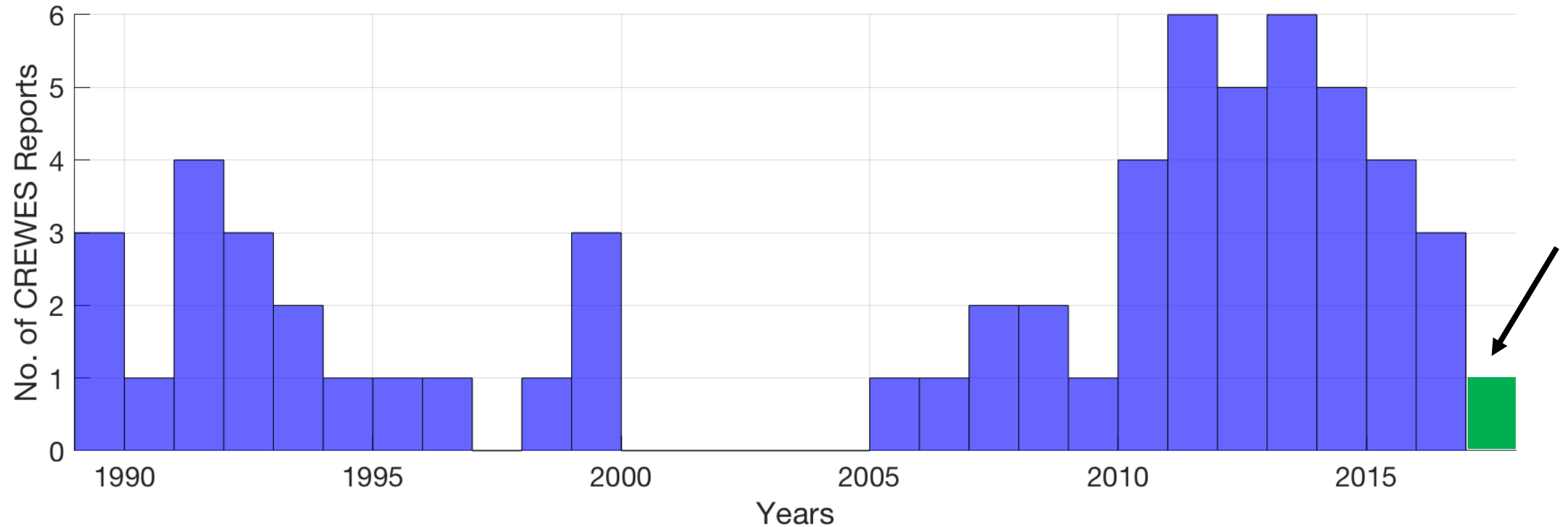


Outline

- Review of physical modelling
- Upgrades to lab
- Microseismic experiment
- Preliminary results
- Future work

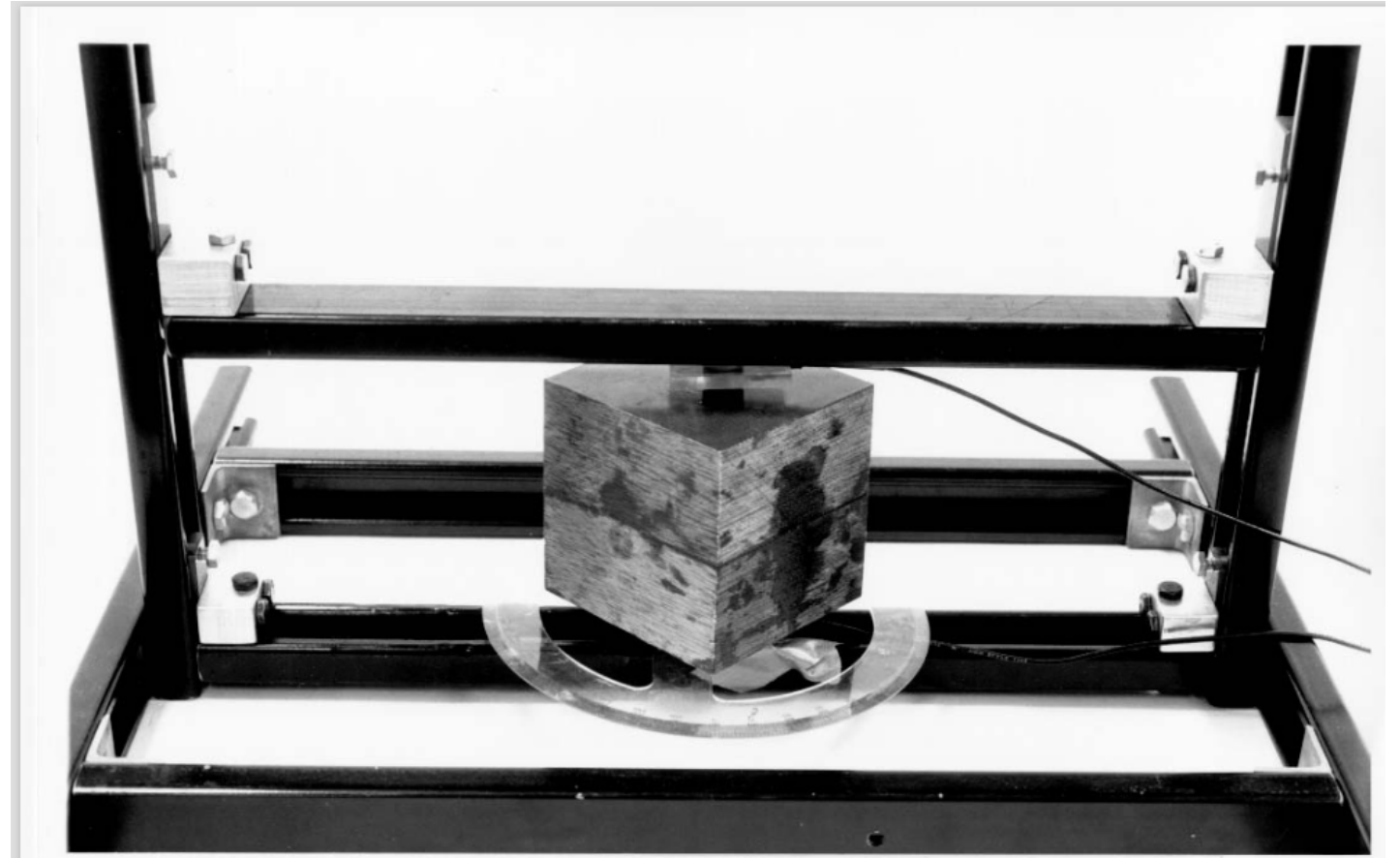


Over the last 30 years, there has been a lot of variability with the amount of work done on physical modelling each year

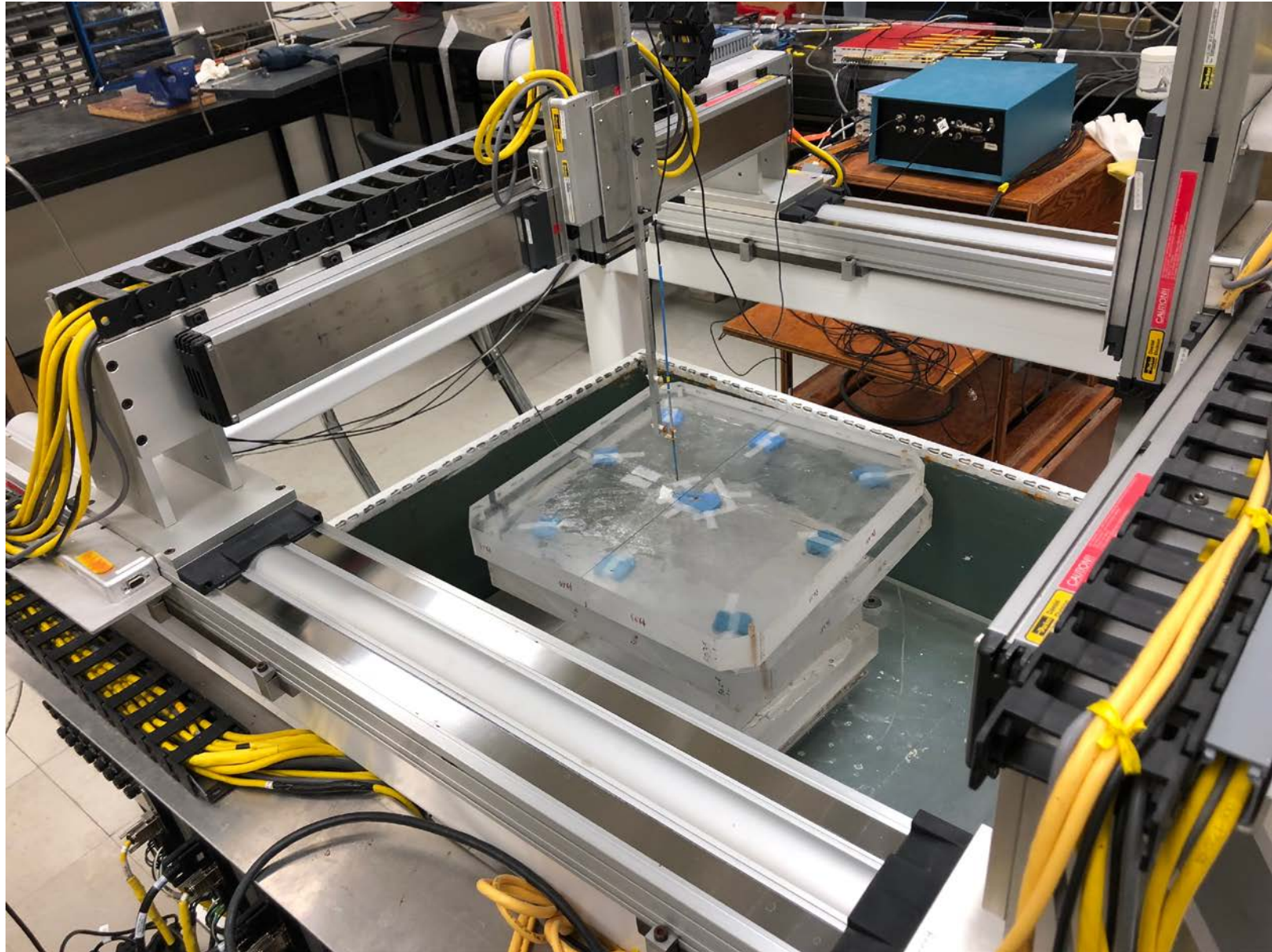


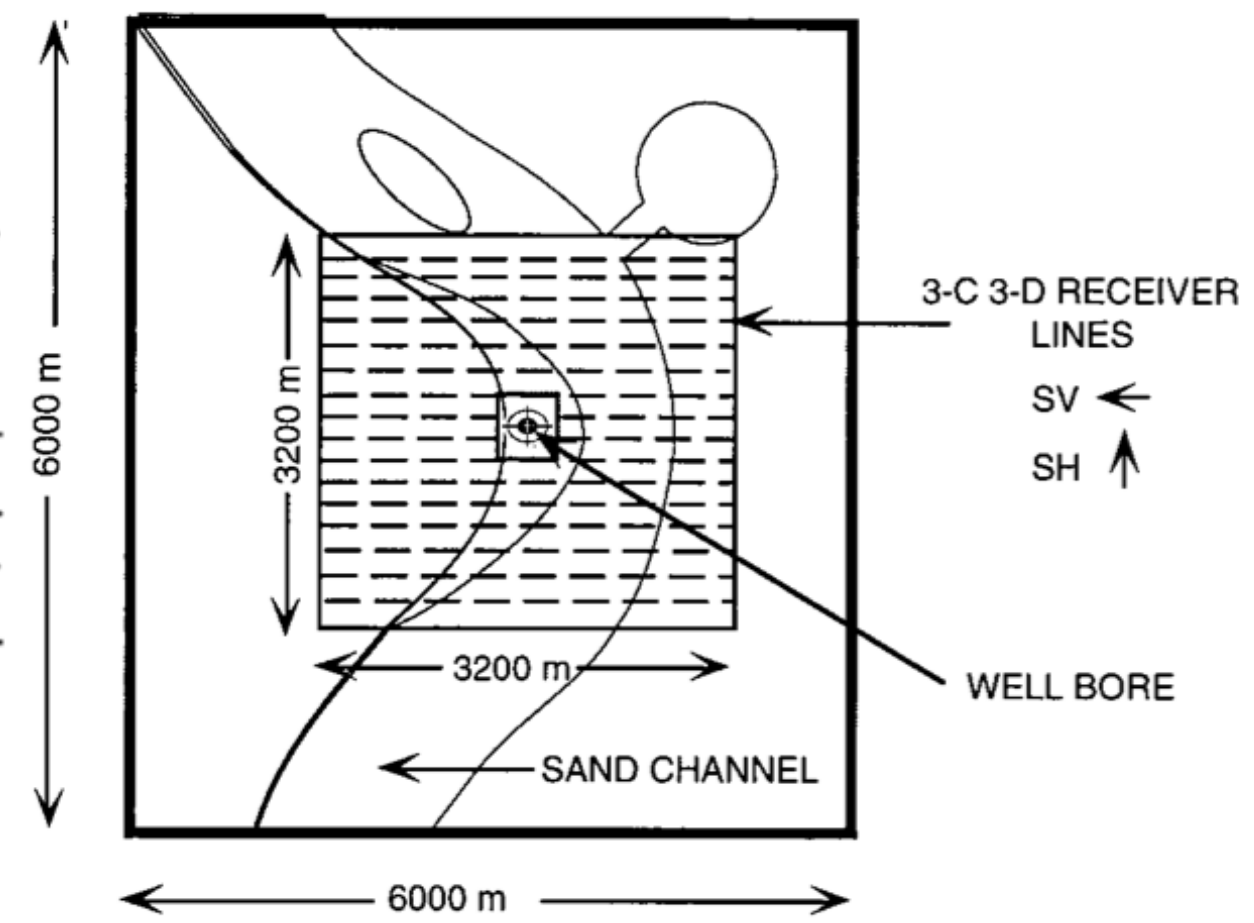
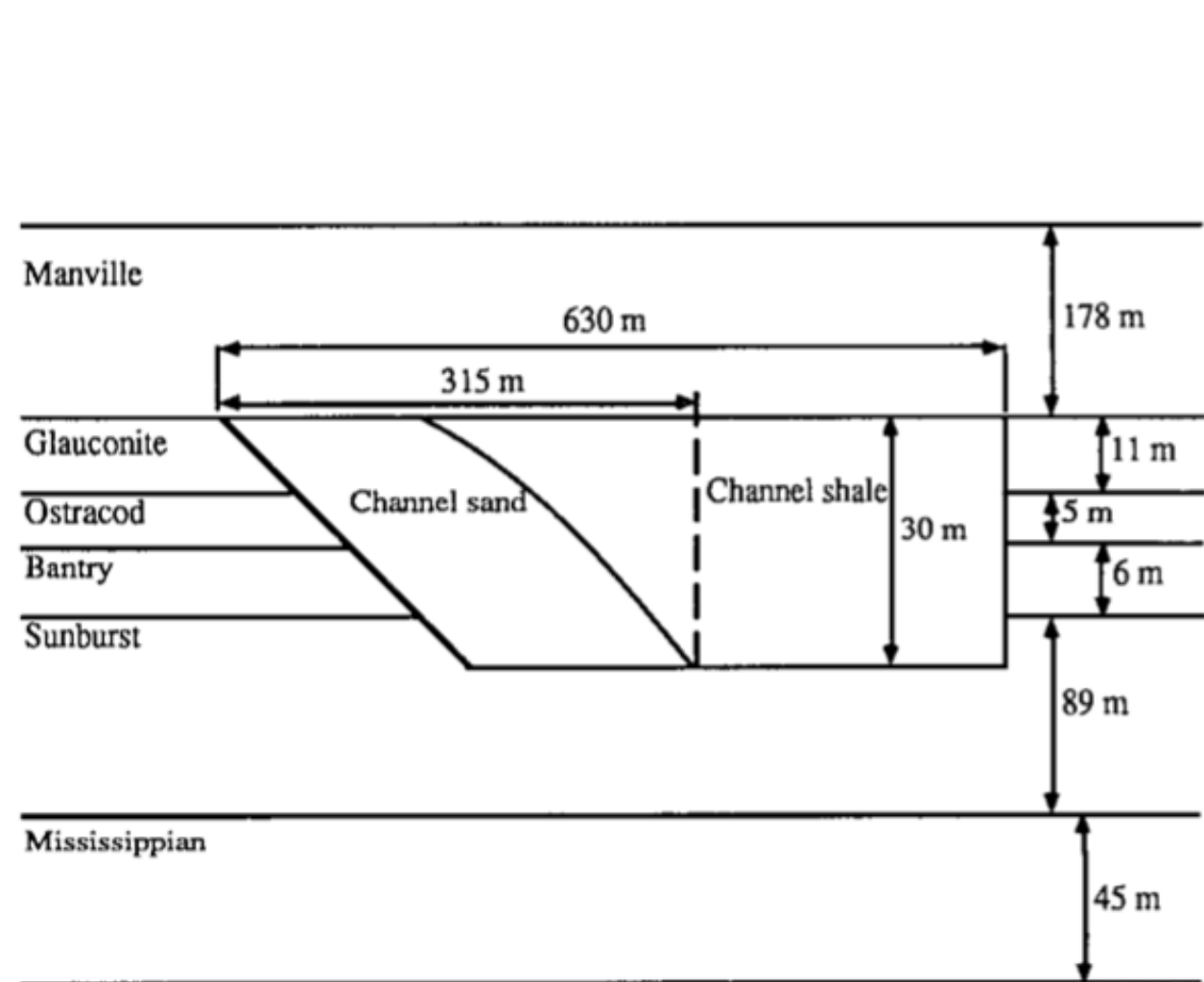
It started with...

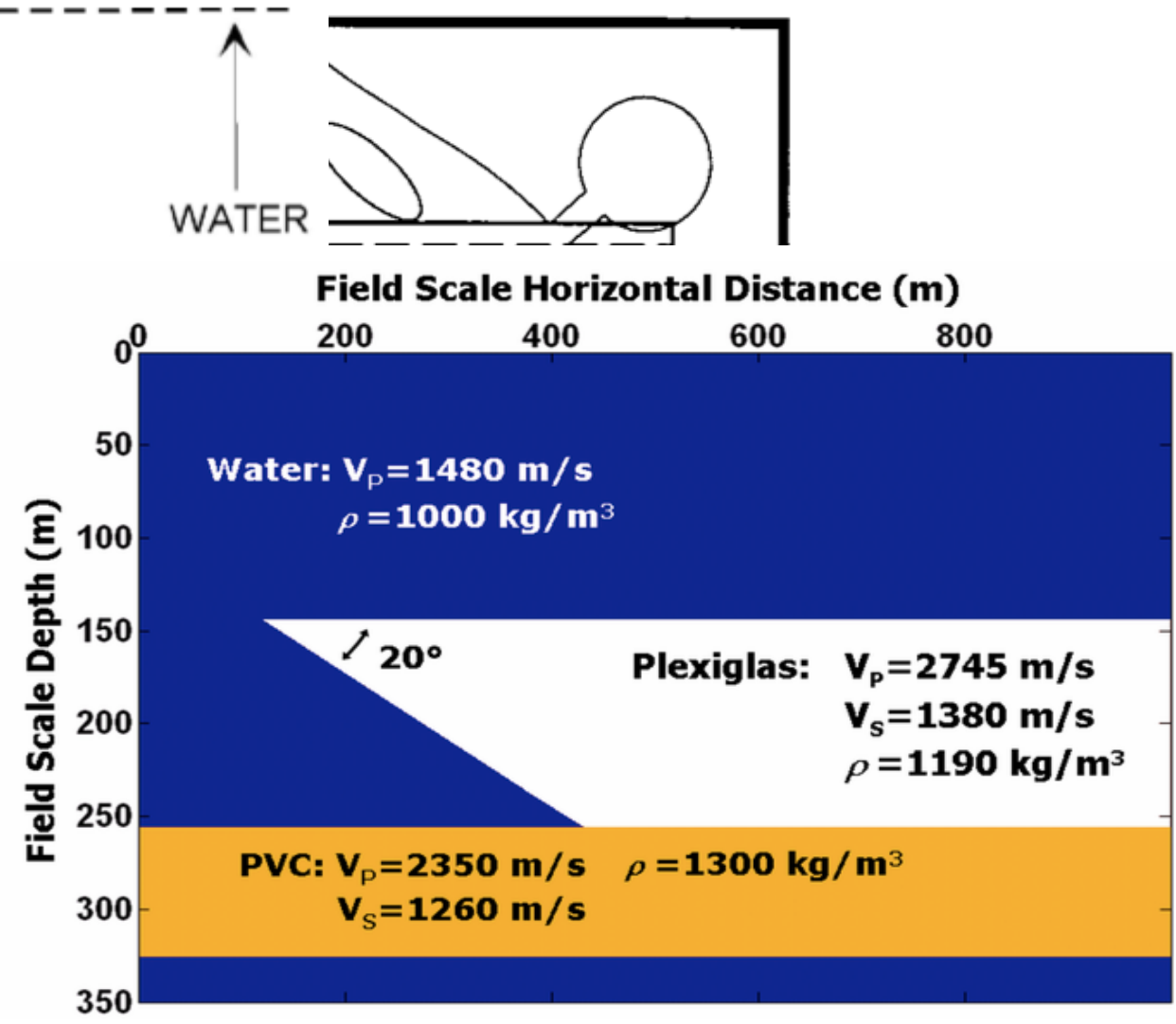
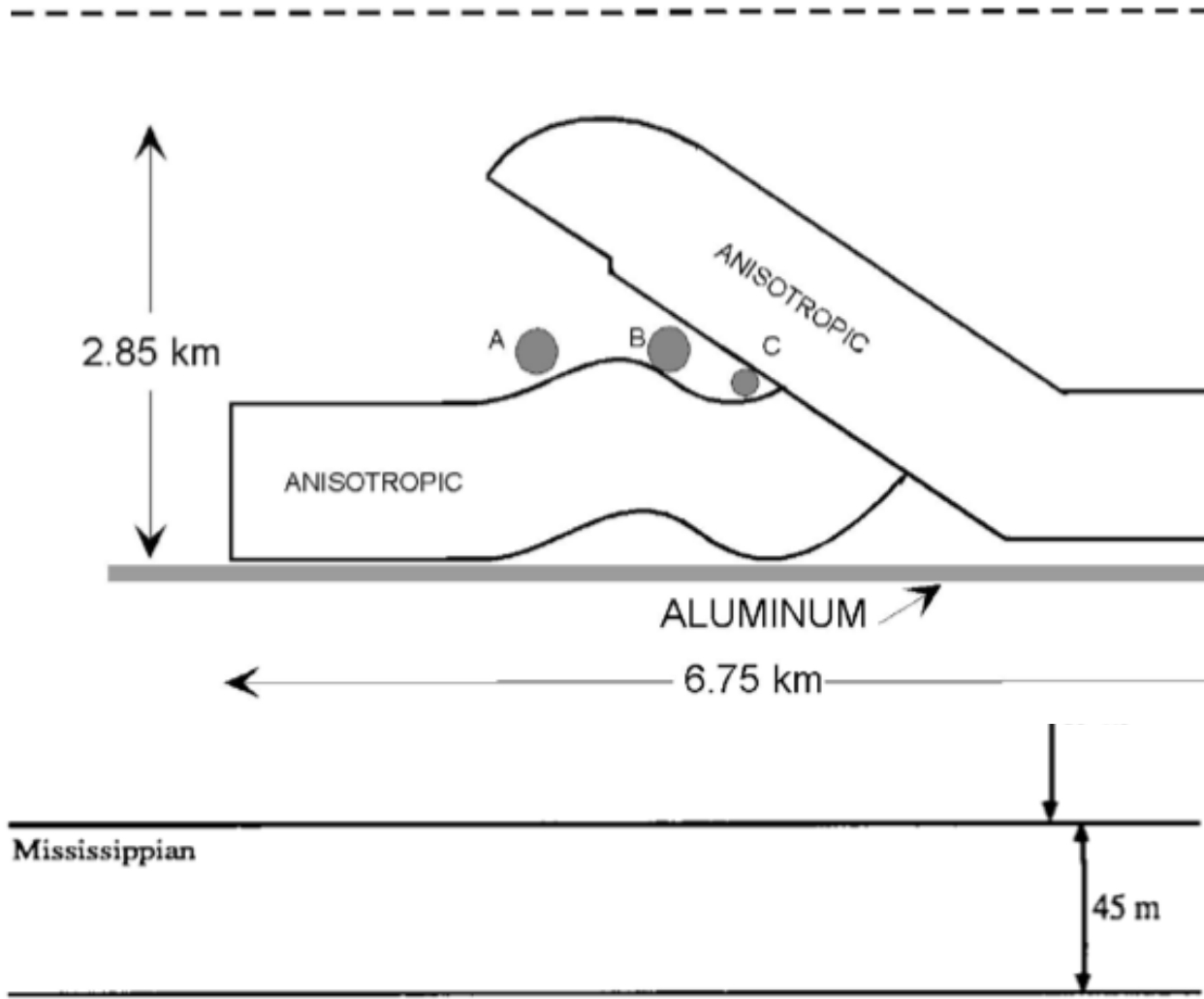
Cube of phenolic to measure
orthorhombic symmetry
(anisotropy)



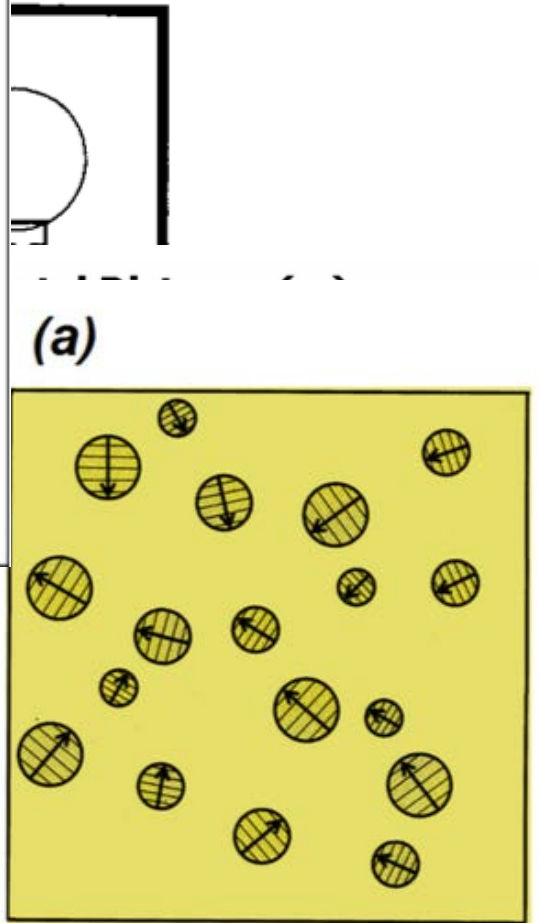
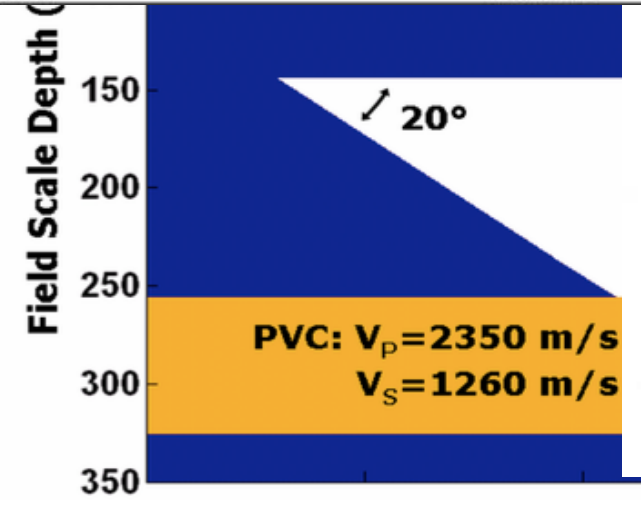
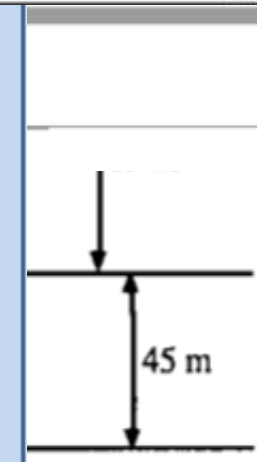
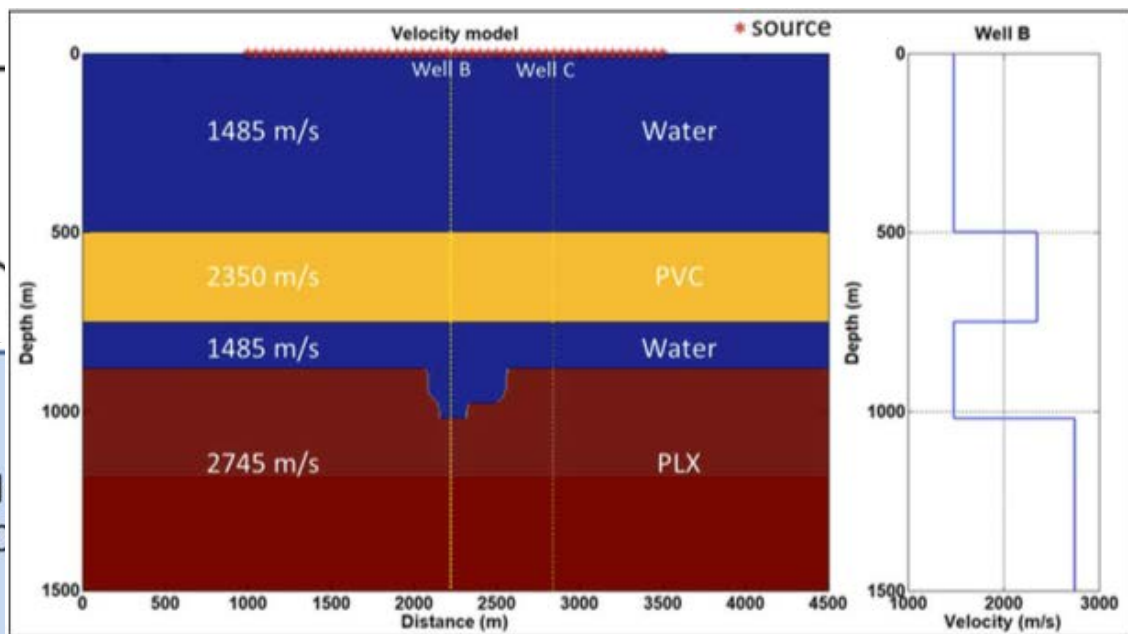
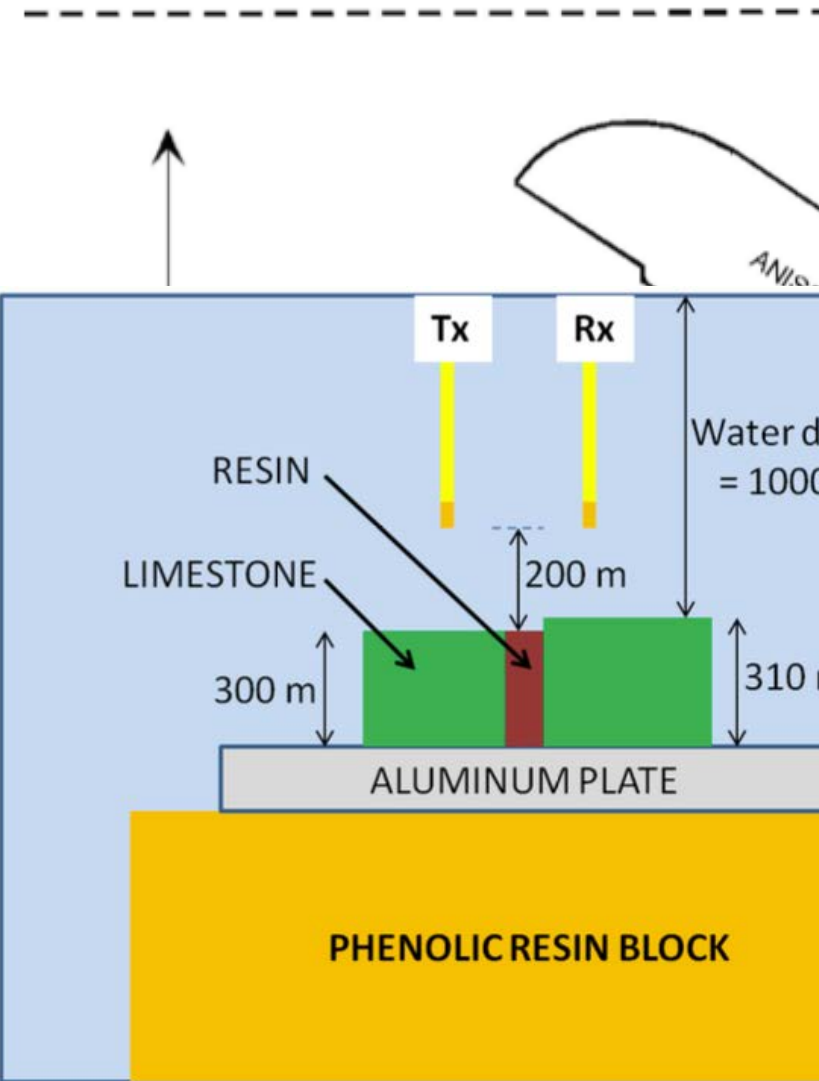
Today:







Review of physical modelling

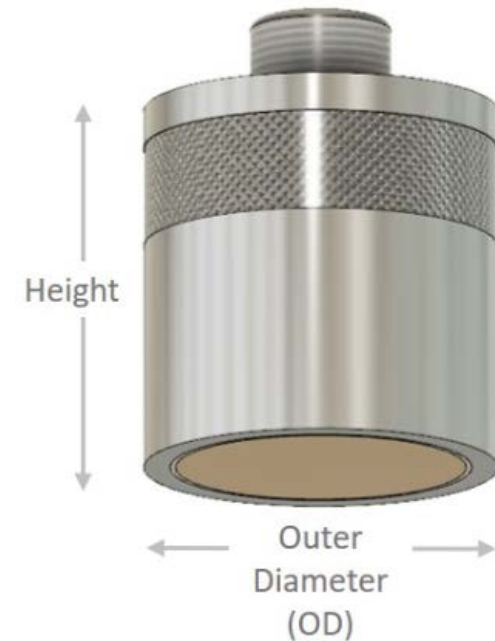


Topics covered:

- Anisotropy
- Multiple removal
- Migration
- Deblending
- AVO
- FWI
- Material and acquisition optimization

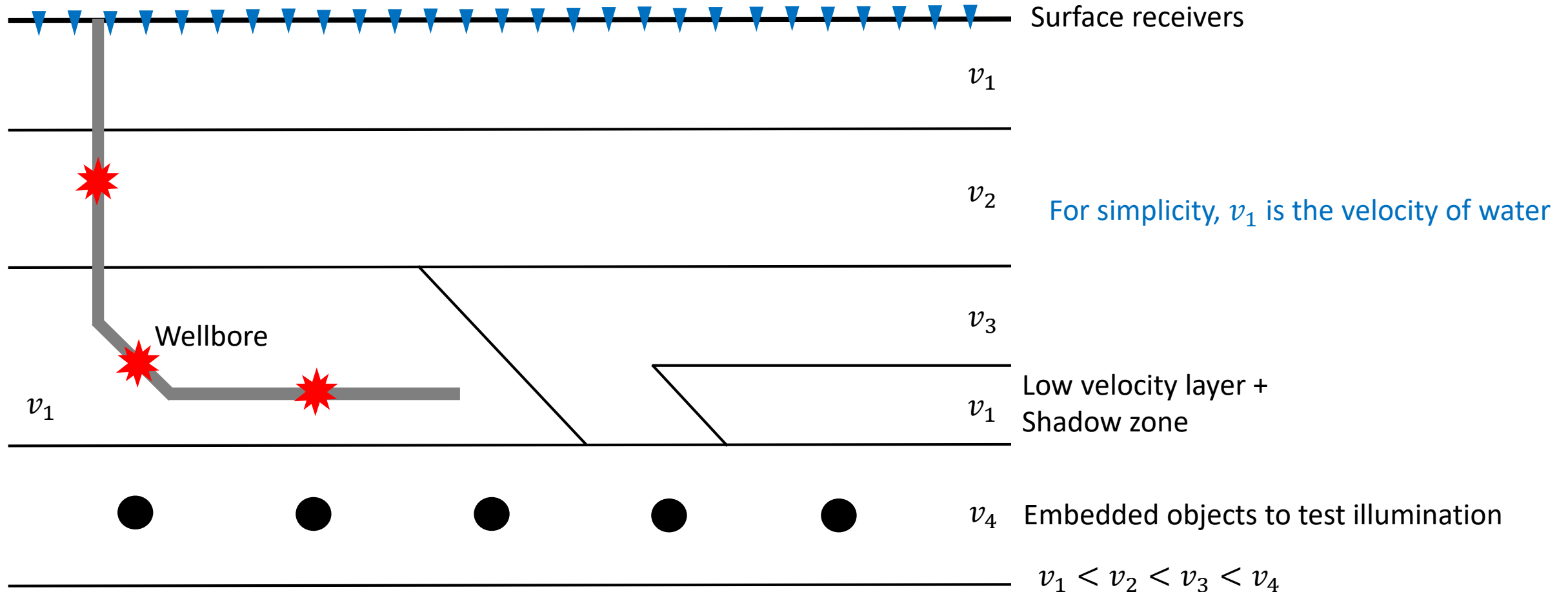
Upgrades and new equipment

- Digitizers to allow for 24 channel acquisition
- Piezoelectric transducers of various sizes and frequencies.
 - P and S wave types





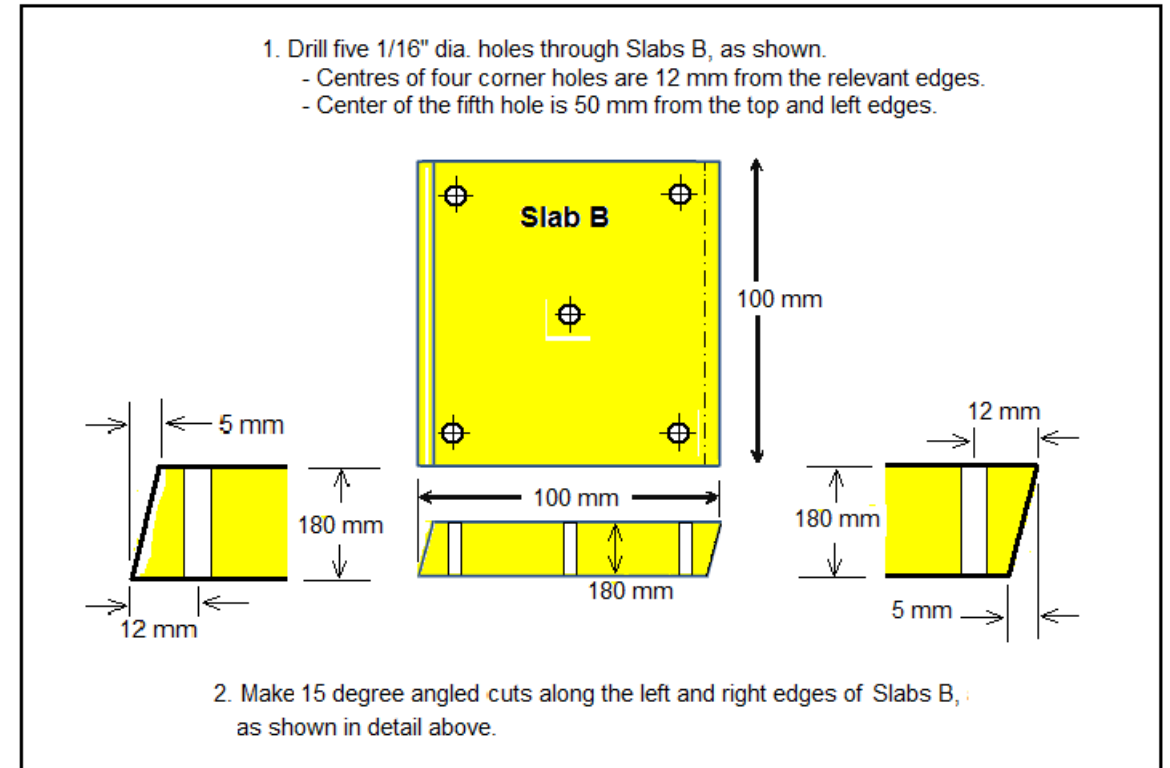
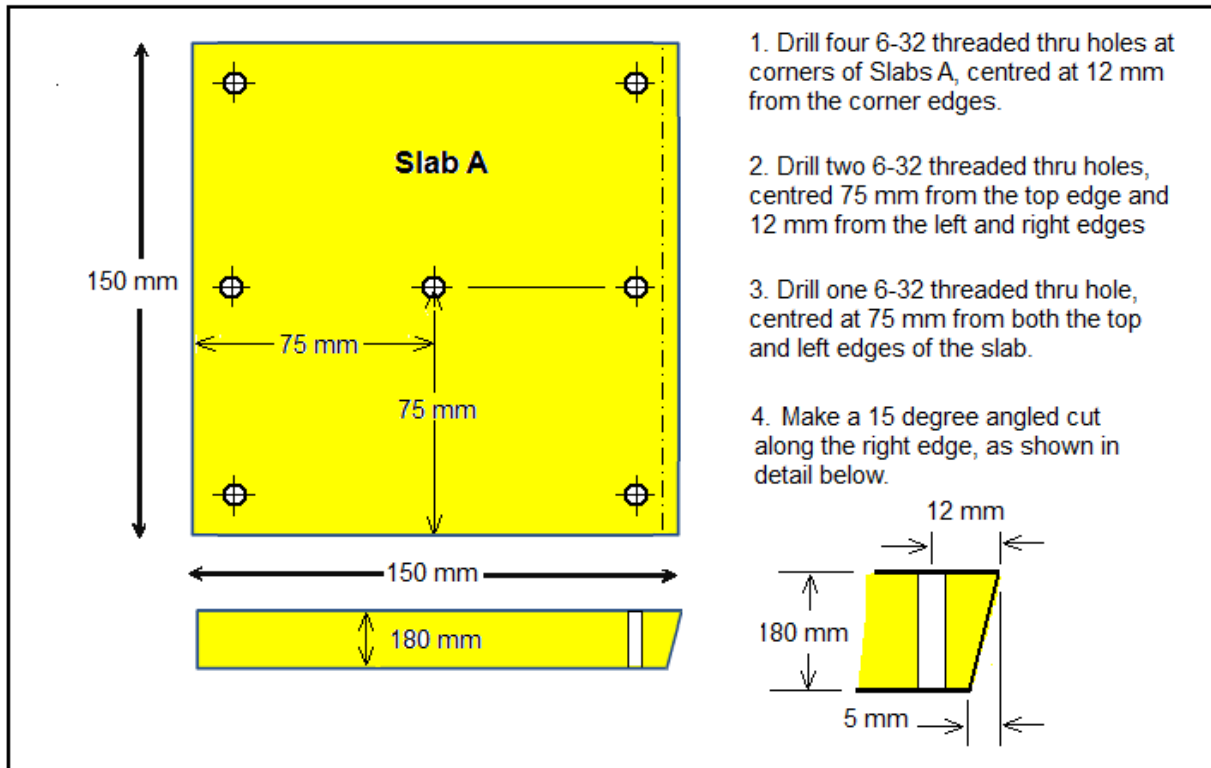
Motivation: building a model that has illumination problems in order to test effect of enhancing illumination with subsurface sources





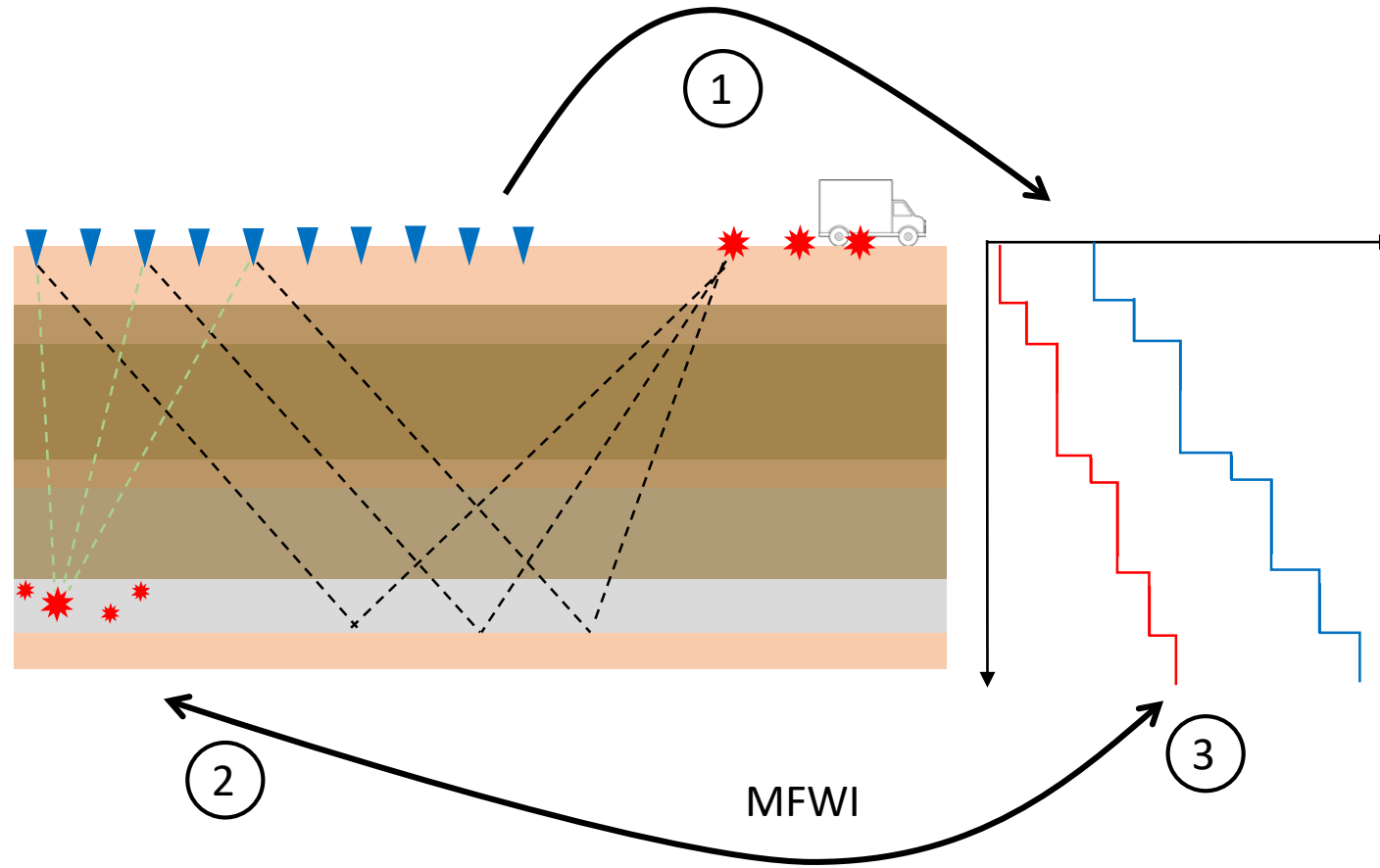
Building the model requires sending a request to the Science Workshop at the U of C

Example schematics for model specifications:





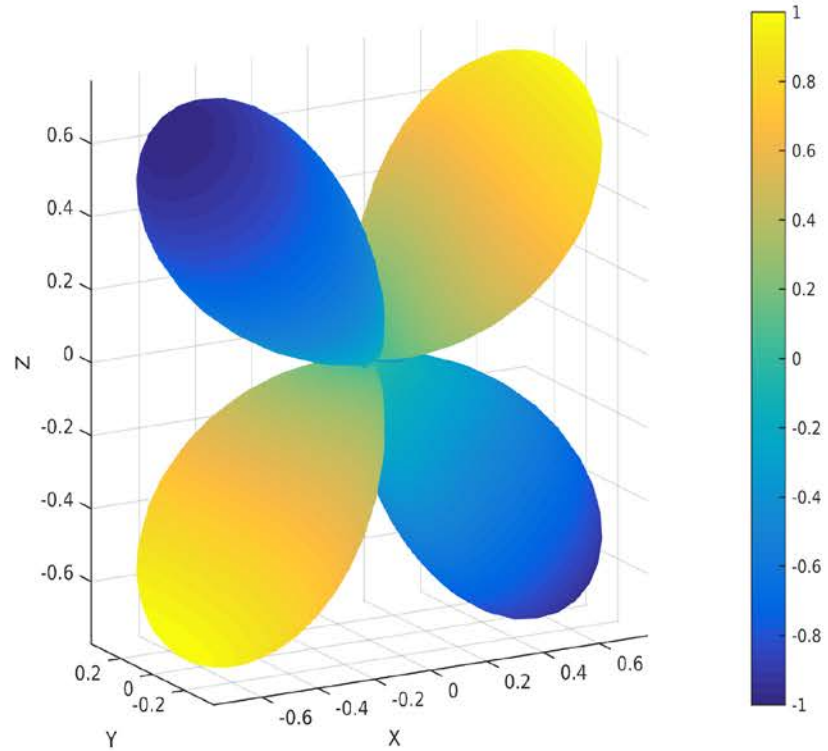
Physical modelling dataset to be used for testing microseismic full waveform inversion (MFWI) → Simultaneous updates of source location and velocity model



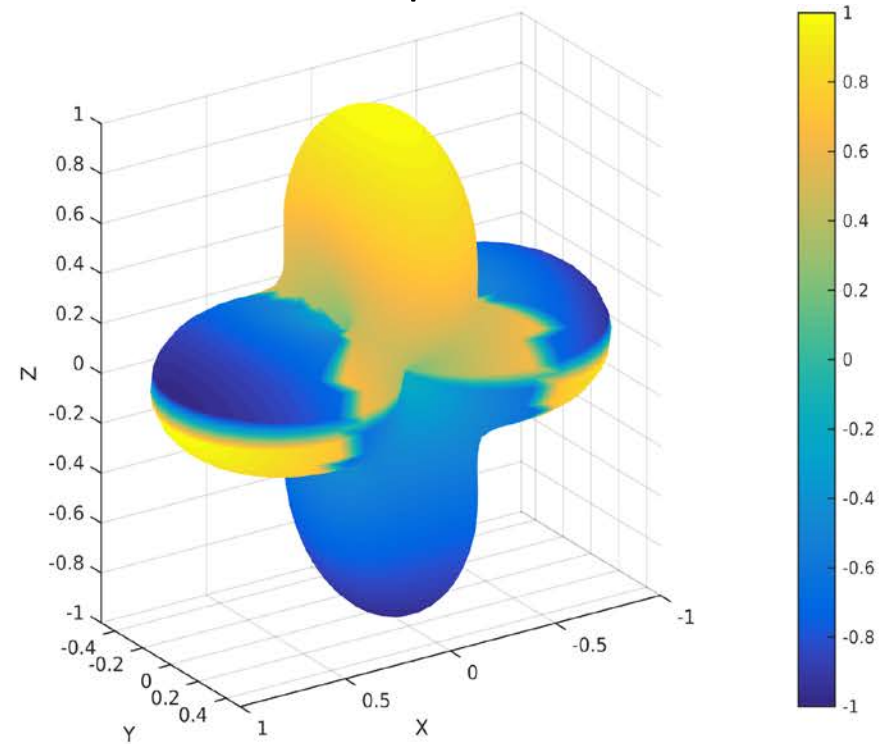


Requires a source that can represent microseismic radiation patterns

P-wave radiation pattern



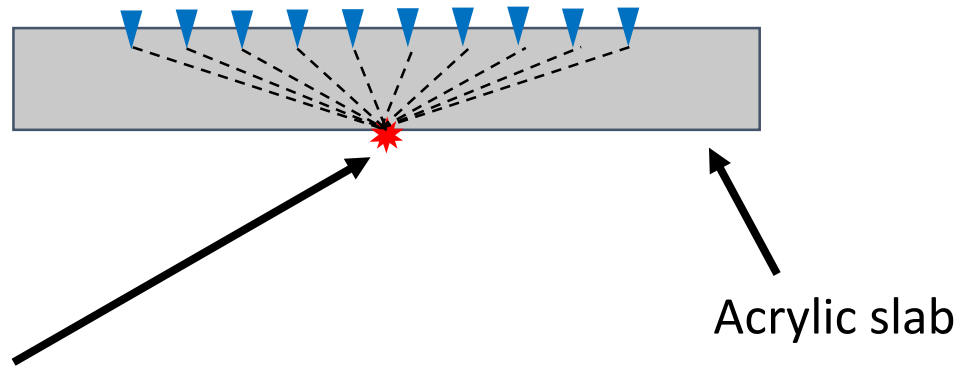
S-wave radiation pattern





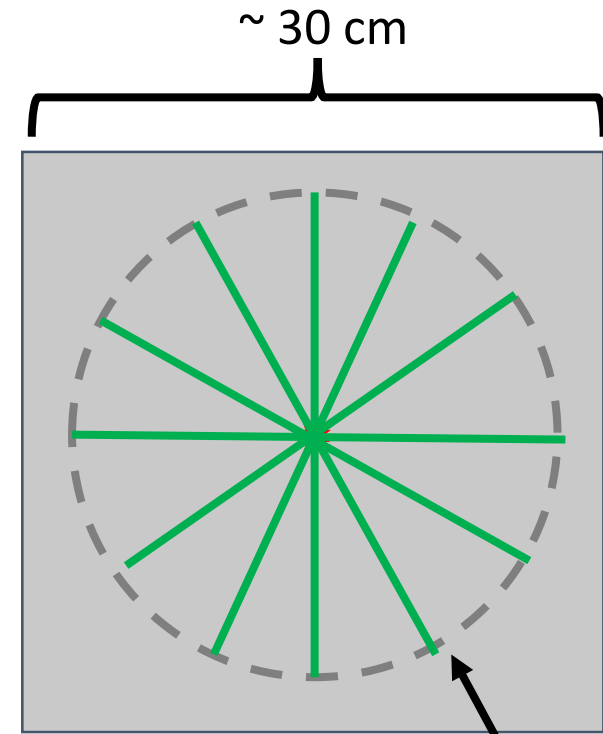
To study the source radiation pattern of the P-wave transducers, the following set-up was used:

Side view:

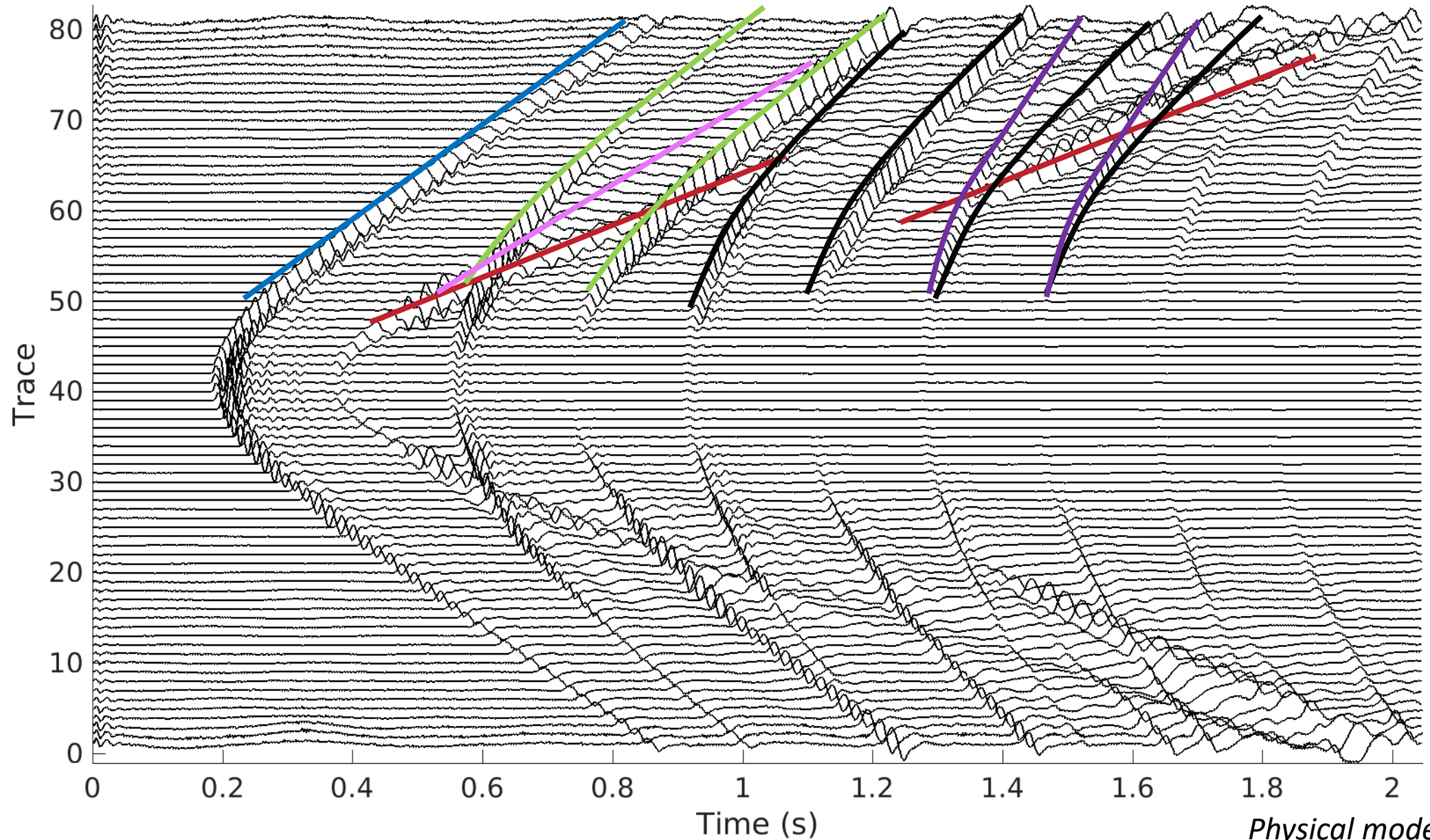


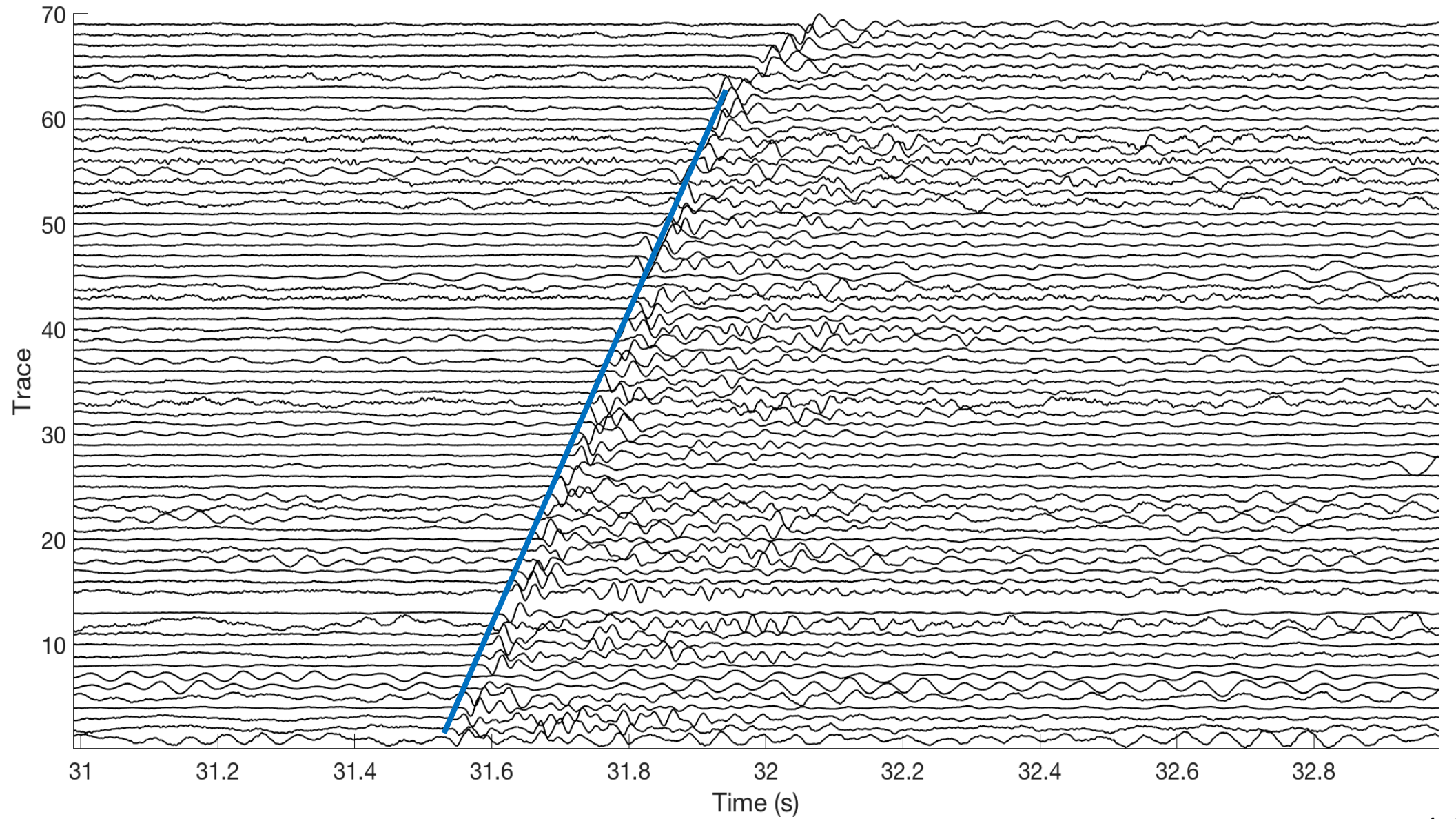
Source: P-wave transducer

Map view:



Receiver lines at 14 degree increments

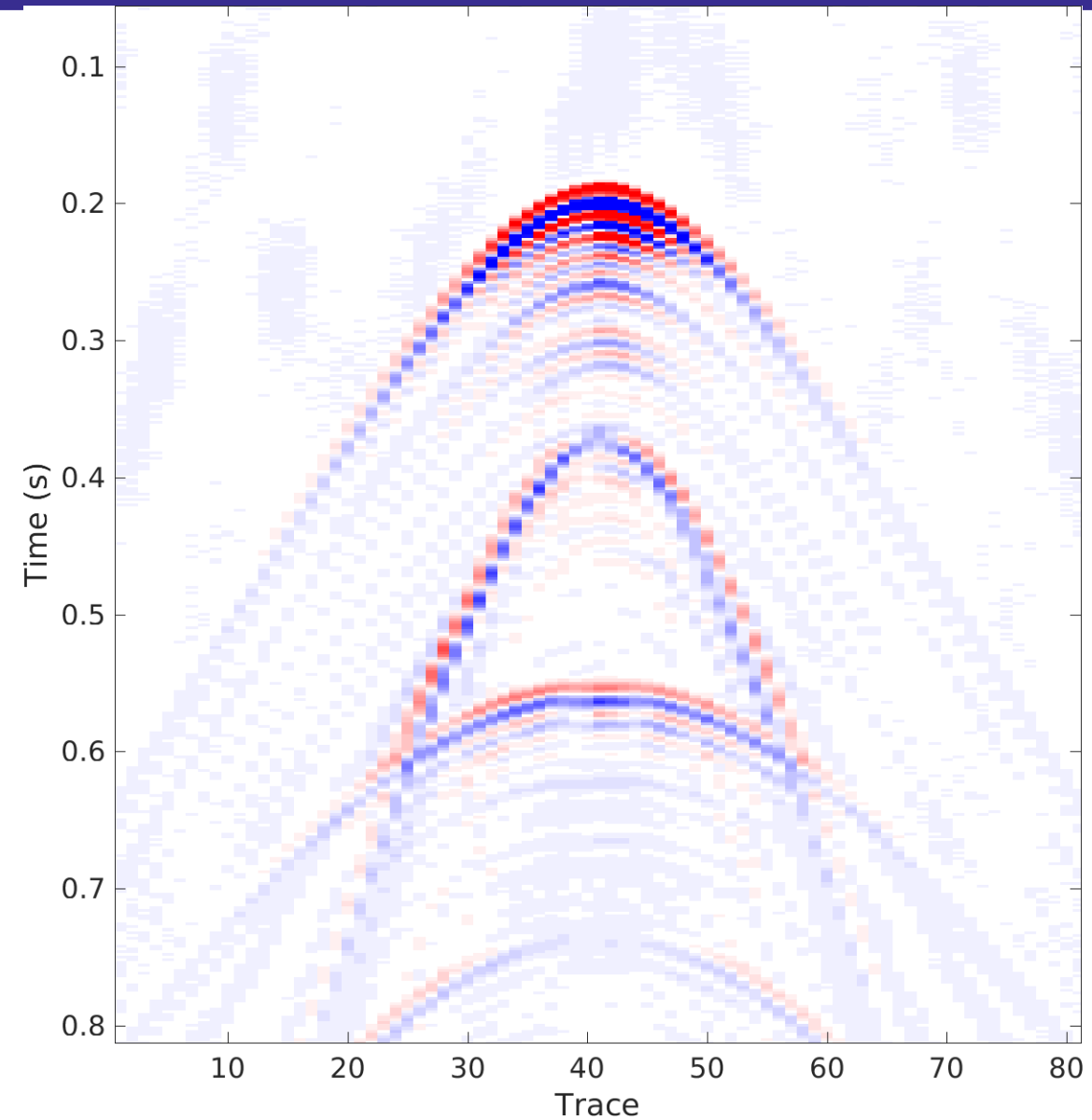






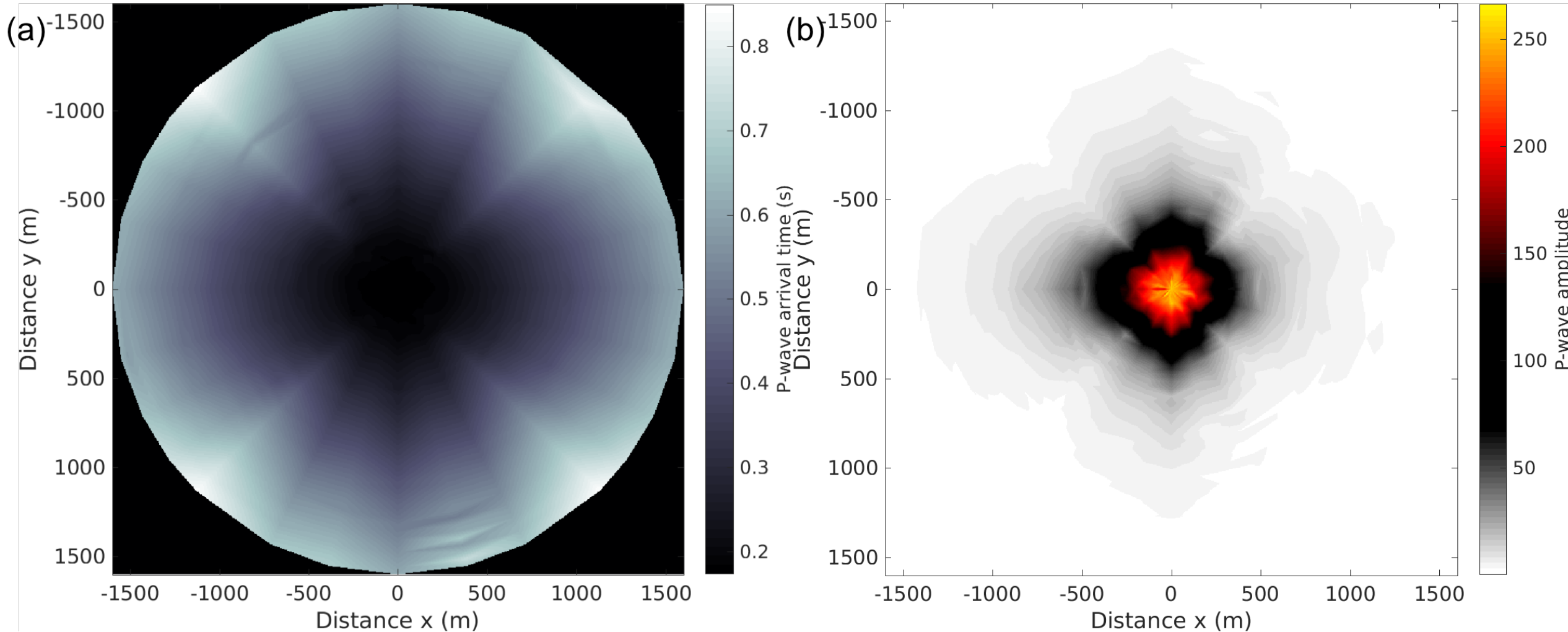
Raw data from experiment:

Polarities do not change across the array, with the exception of the S-wave at the zero offset

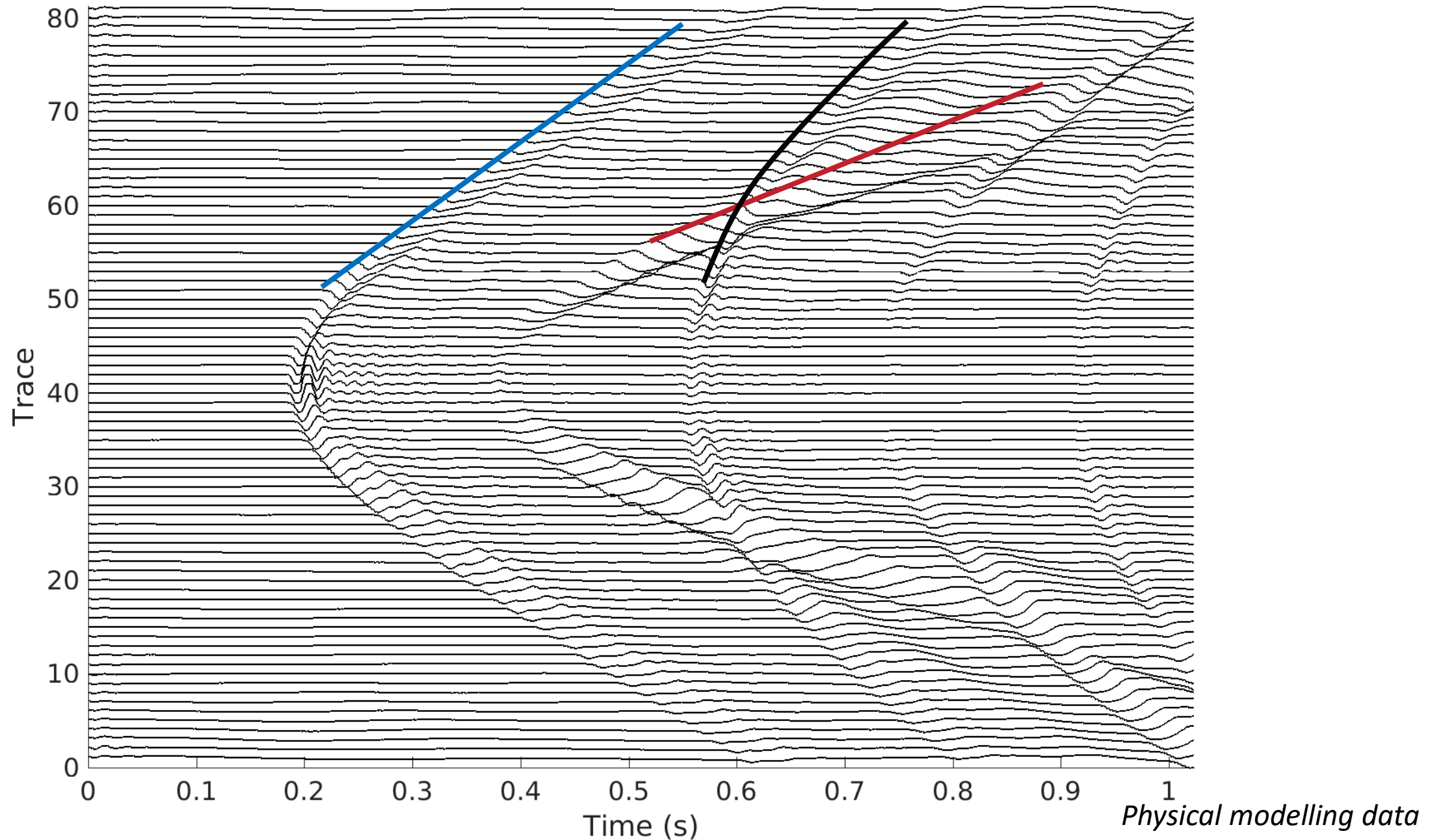




Map view of P-wave arrival times (left) and amplitudes (right)

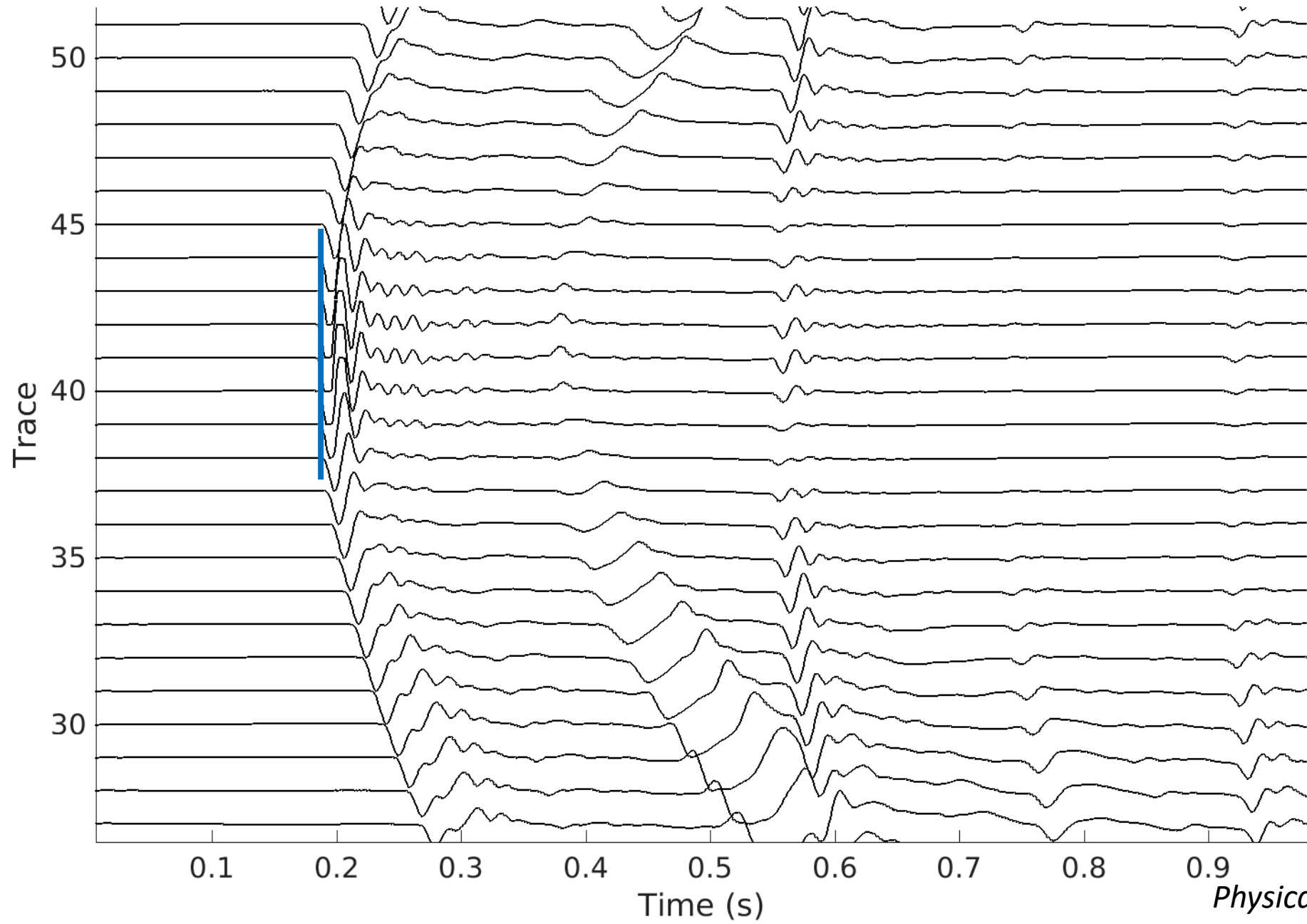


Units: *scaled* distance (1:10000)



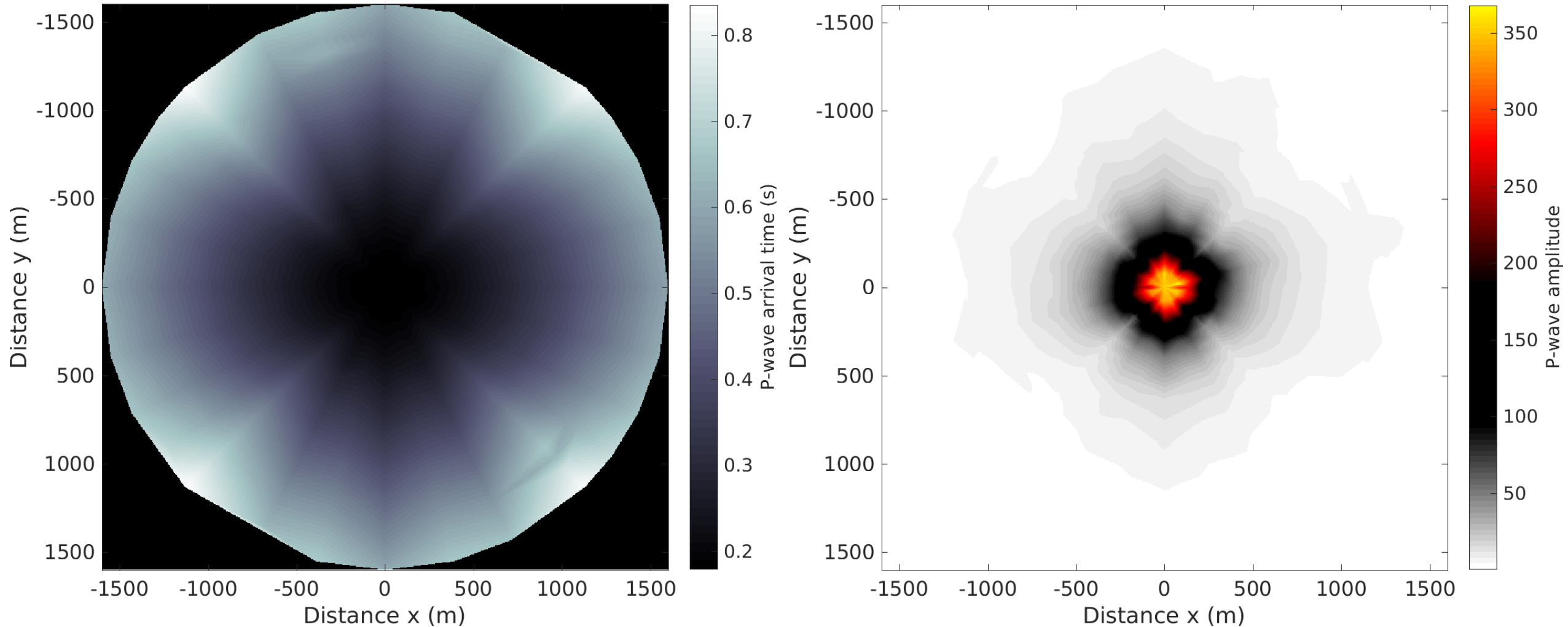


Flat spot due to
transducer size





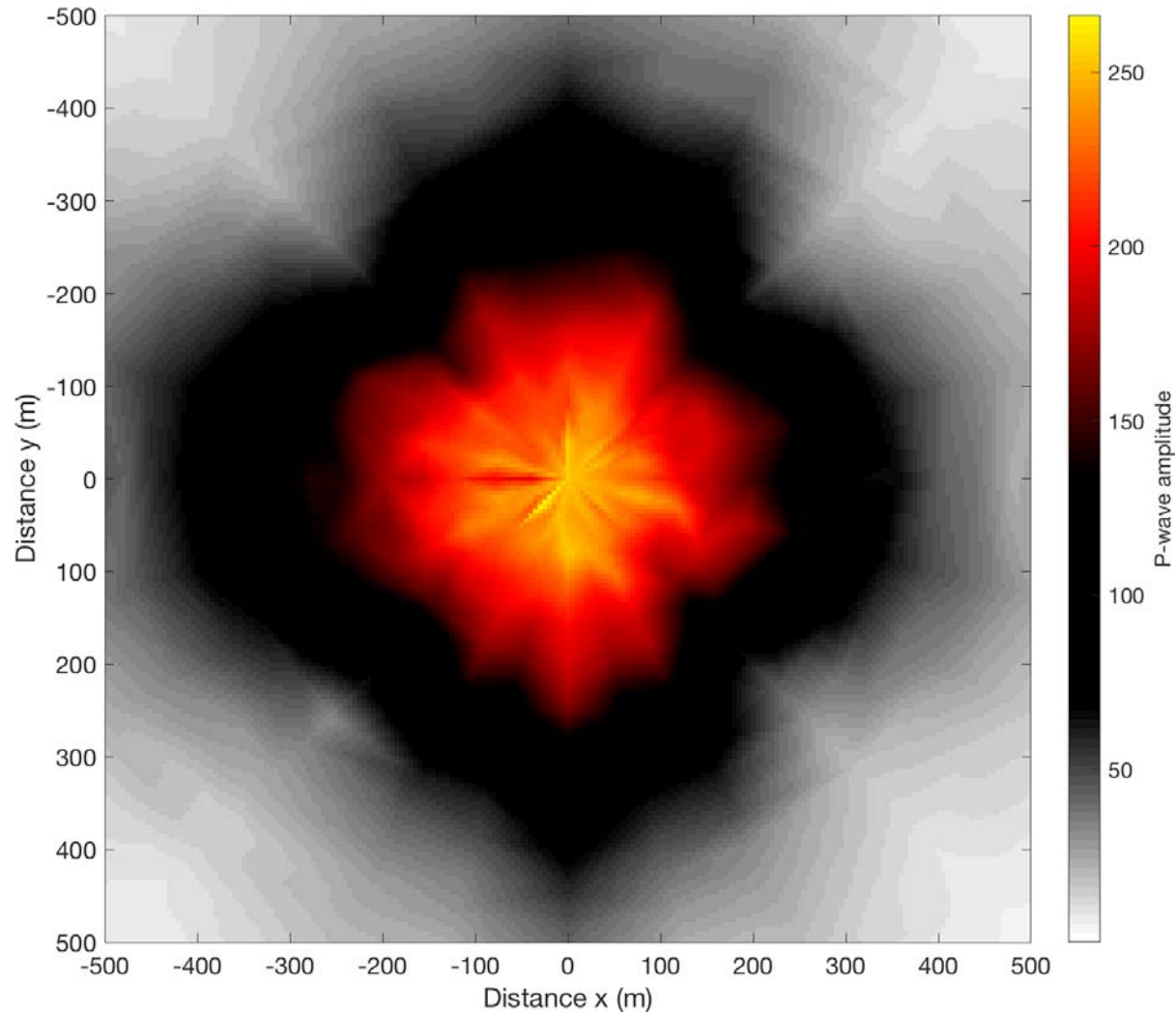
Map view of P-wave arrival times (left) and amplitudes (right)



Units: *scaled* distance (1:10000)

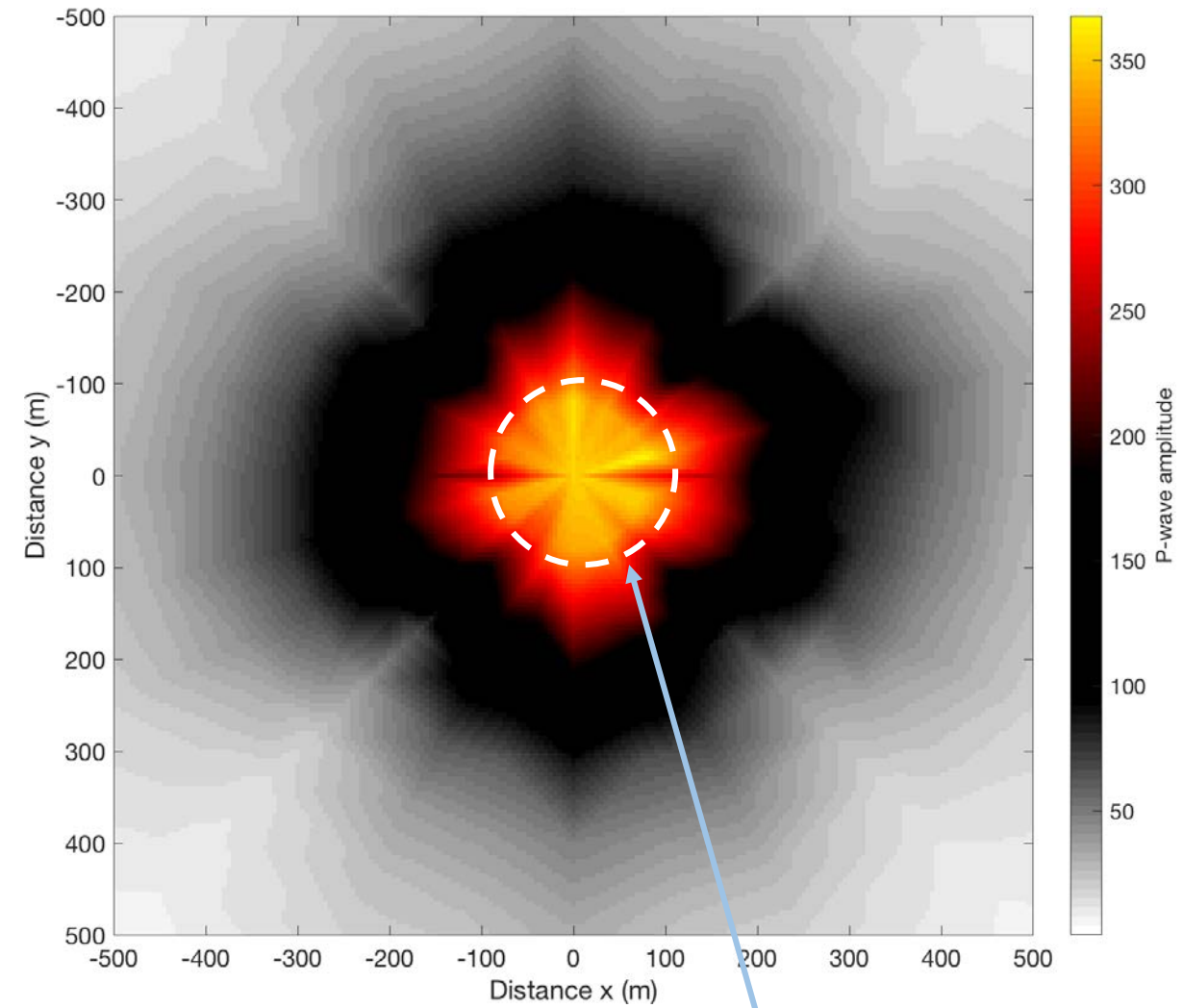


Small transducer



Units: *scaled* distance (1:10000)

Large transducer



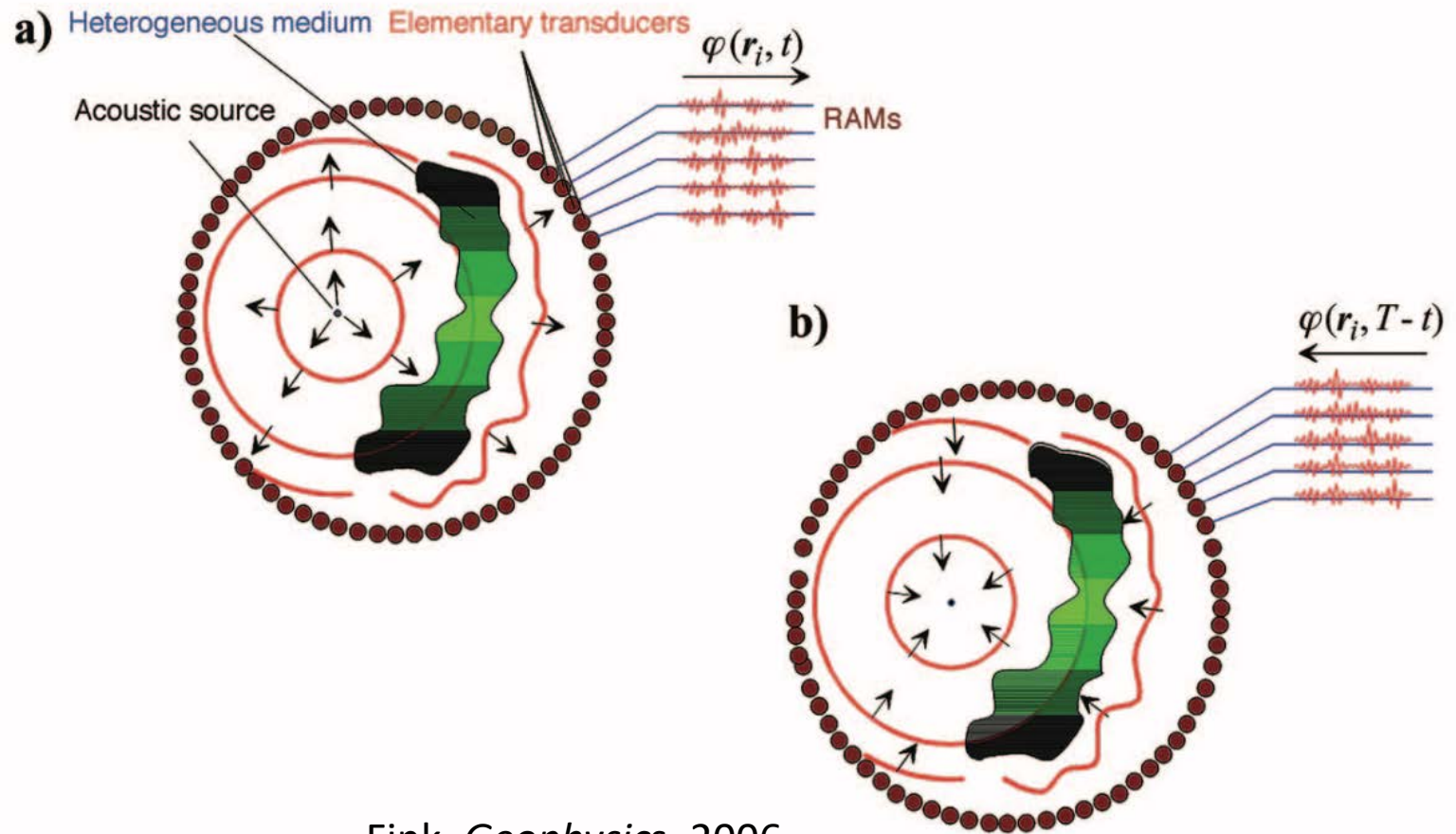
Large footprint partially due to clipping



Time reversal imaging

Step 1: recording

Step 2: sending recording back into medium from position of receivers




Fink, *Geophysics*, 2006

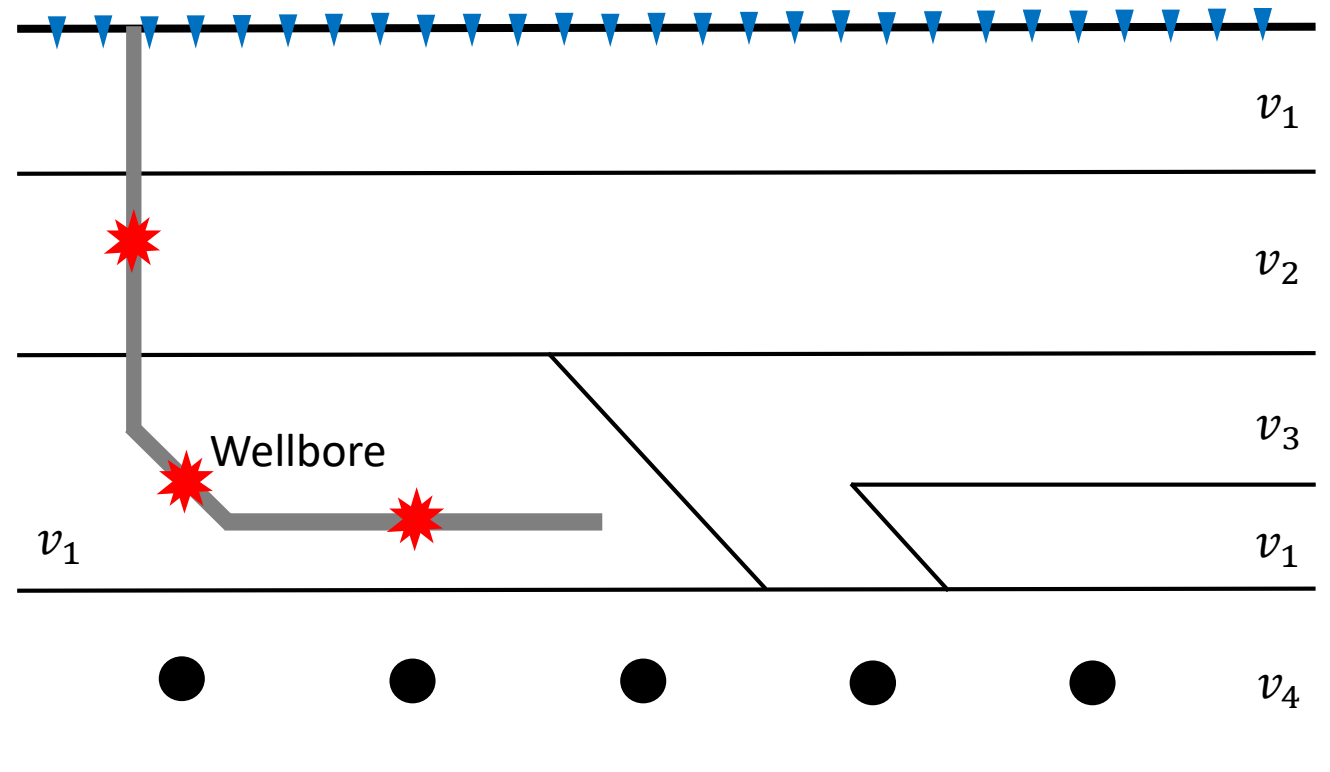


Future work

- Acoustic data acquisition to start with → testing MFWI and SWD
- Moving toward elastic data acquisition
- Using S-wave sources and receivers
- Experiments with time reversal imaging



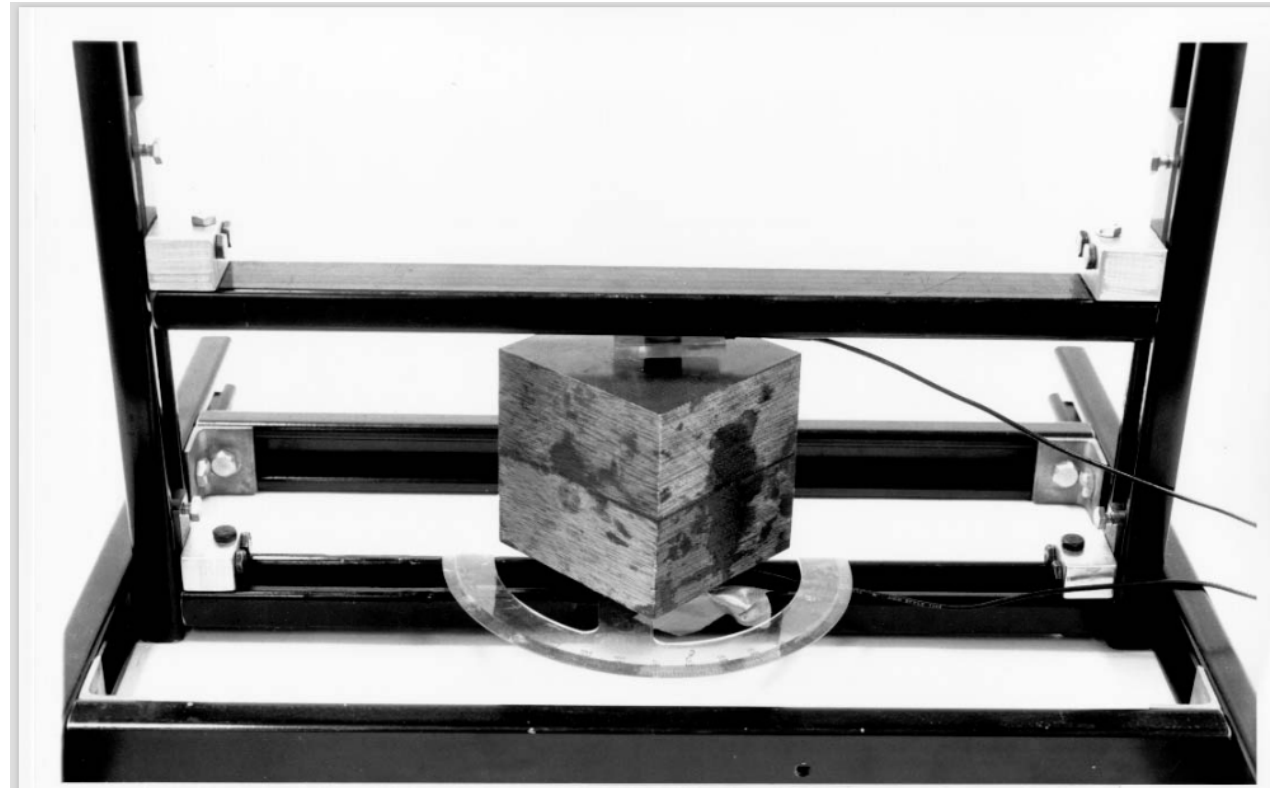
| Transducer Dimensions (in inches) | | |
|--------------------------------------|------|------|
| Nominal Element Size | (A) | (B) |
| 1.00 | 1.25 | 0.63 |
| 0.75 | 1.00 | 0.63 |
| 0.50 | 0.70 | 0.63 |
| 0.375 | 0.53 | 0.50 |
| 0.25 | 0.35 | 0.42 |
| 0.125 | 0.25 | 0.38 |





Conclusions

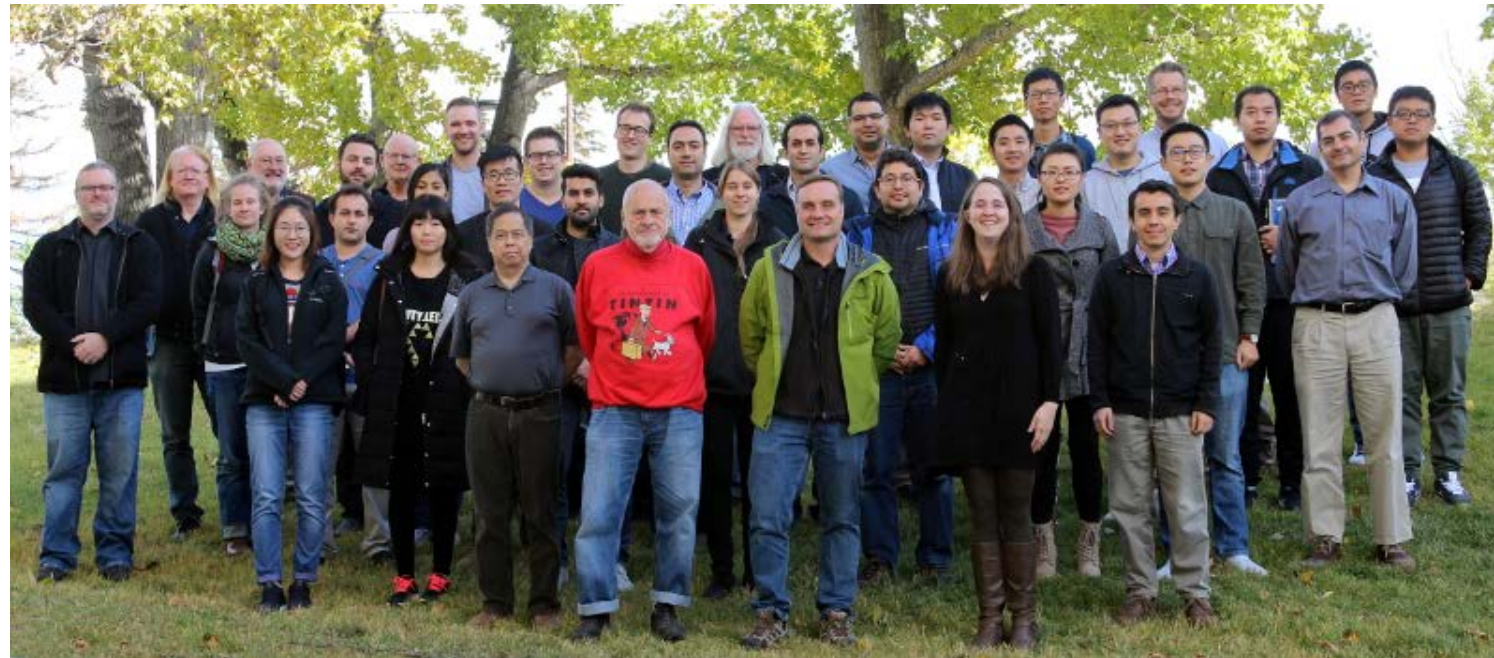
- The physical modelling lab is in the process of being upgraded
- Increasingly complex experiments involving SWD, microseismic, and time reversal imaging are going to be carried out
- The radiation patterns of the P-wave transducers can be approximated as exploding sources

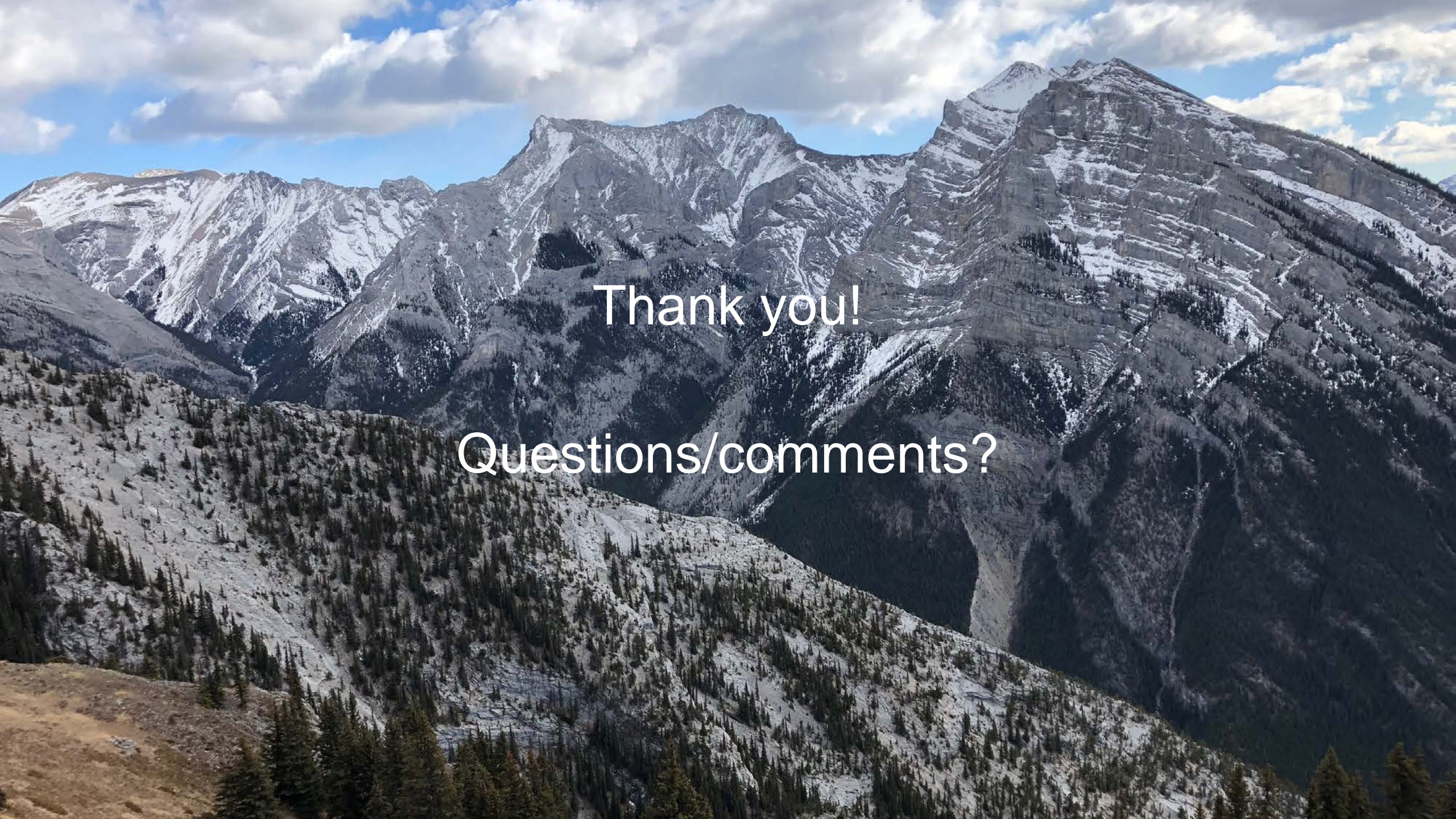




Acknowledgements

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- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Society of Exploration Geophysicists (SEG)





Thank you!

Questions/comments?