

# Physical modelling: complex source experiments

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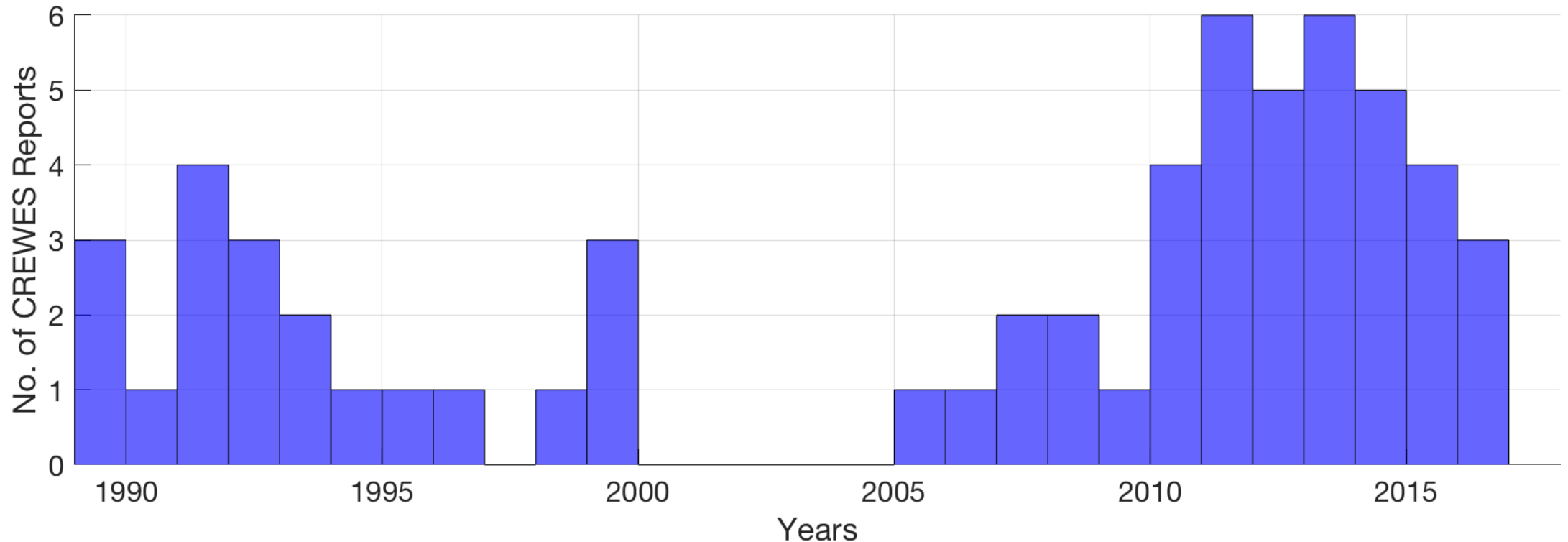
November 2, 2018

# Outline

- Review of physical modelling
- Upgrades to lab
- Seismic while drilling (SWD)
- Microseismic
- Future work

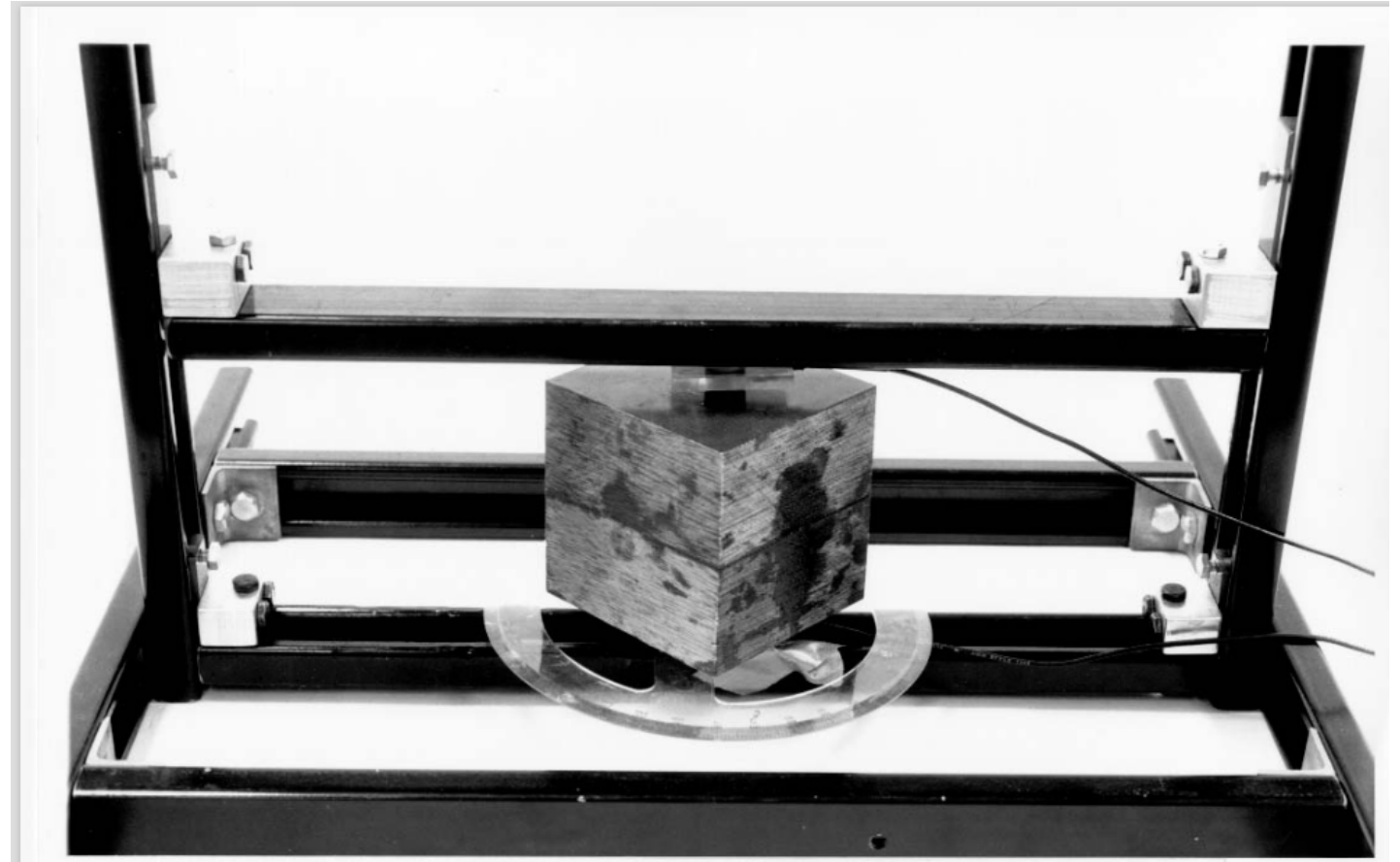
# Timeline

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



# Review of physical modelling

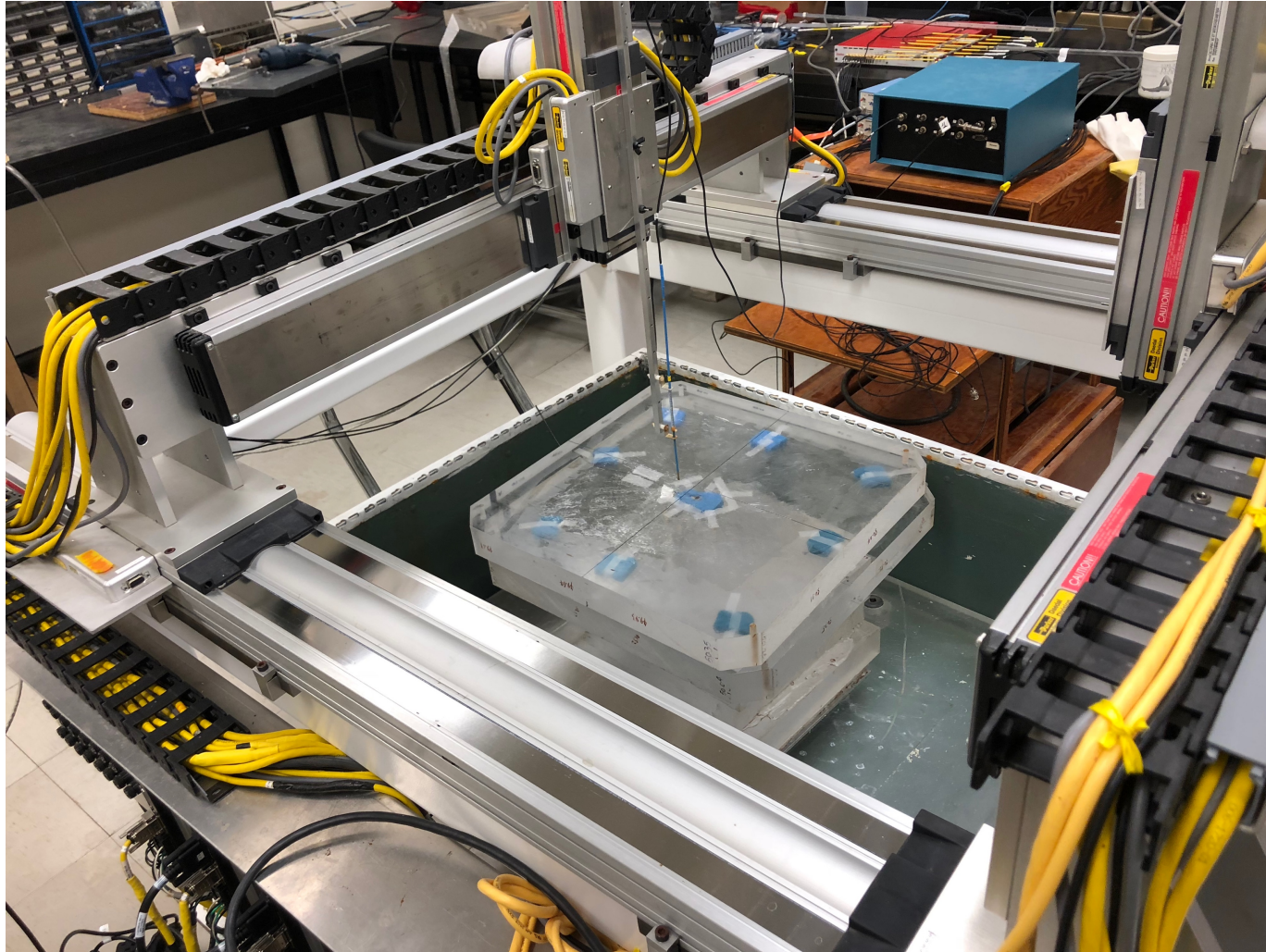
- It started with...
- Cube of phenolic to measure orthorhombic symmetry (anisotropy)



CRR1989-18

# Review of physical modelling

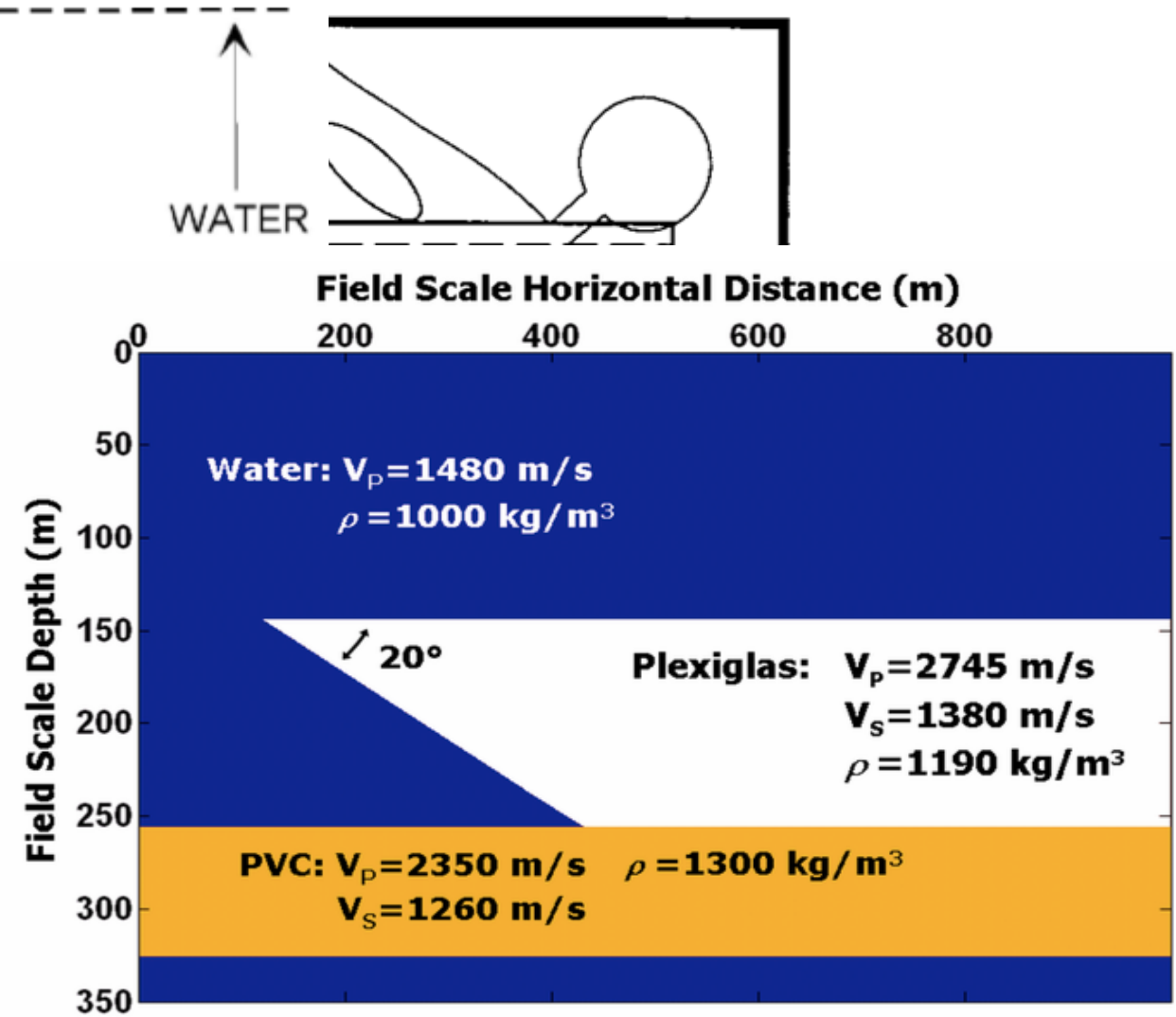
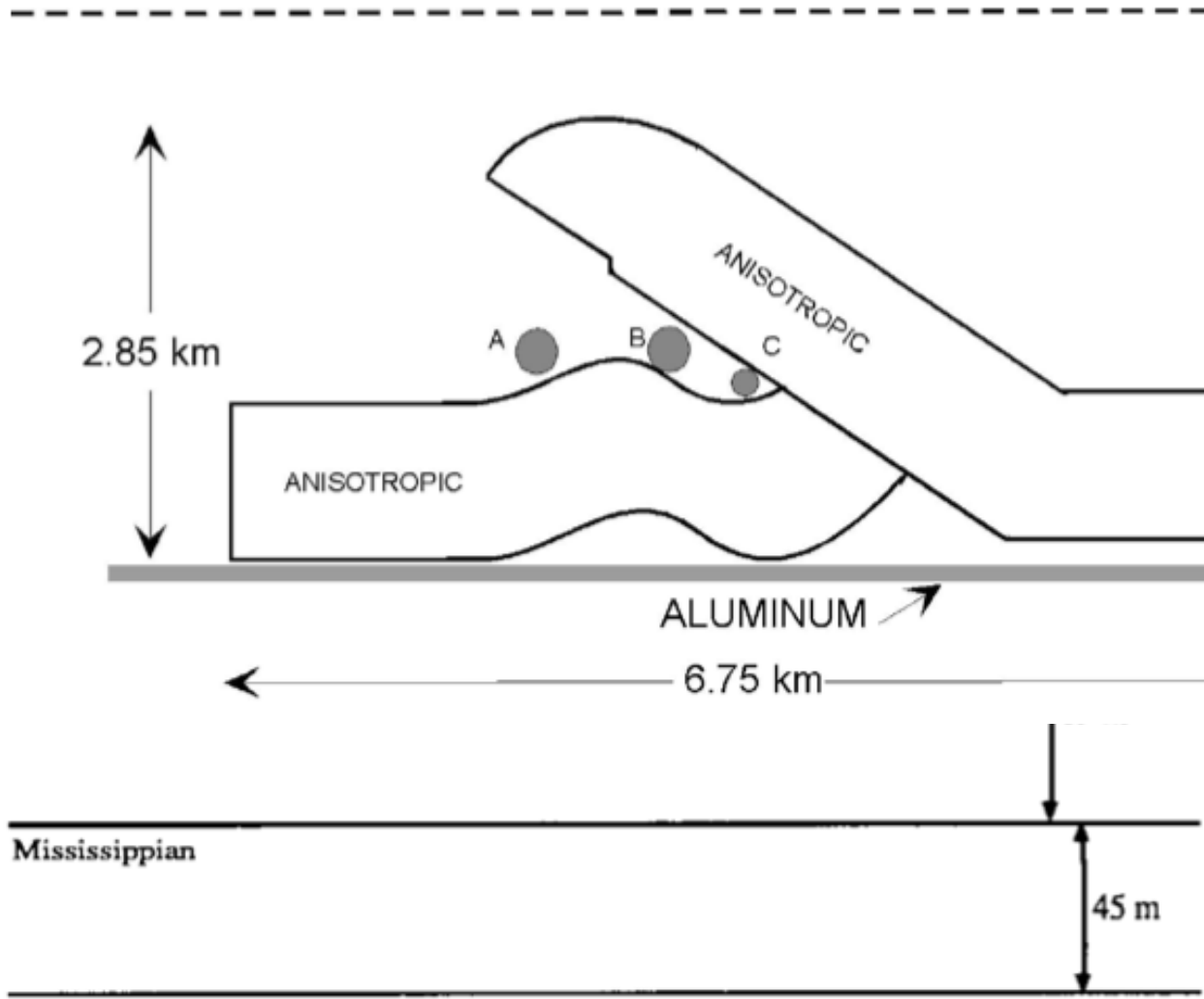
- Today:



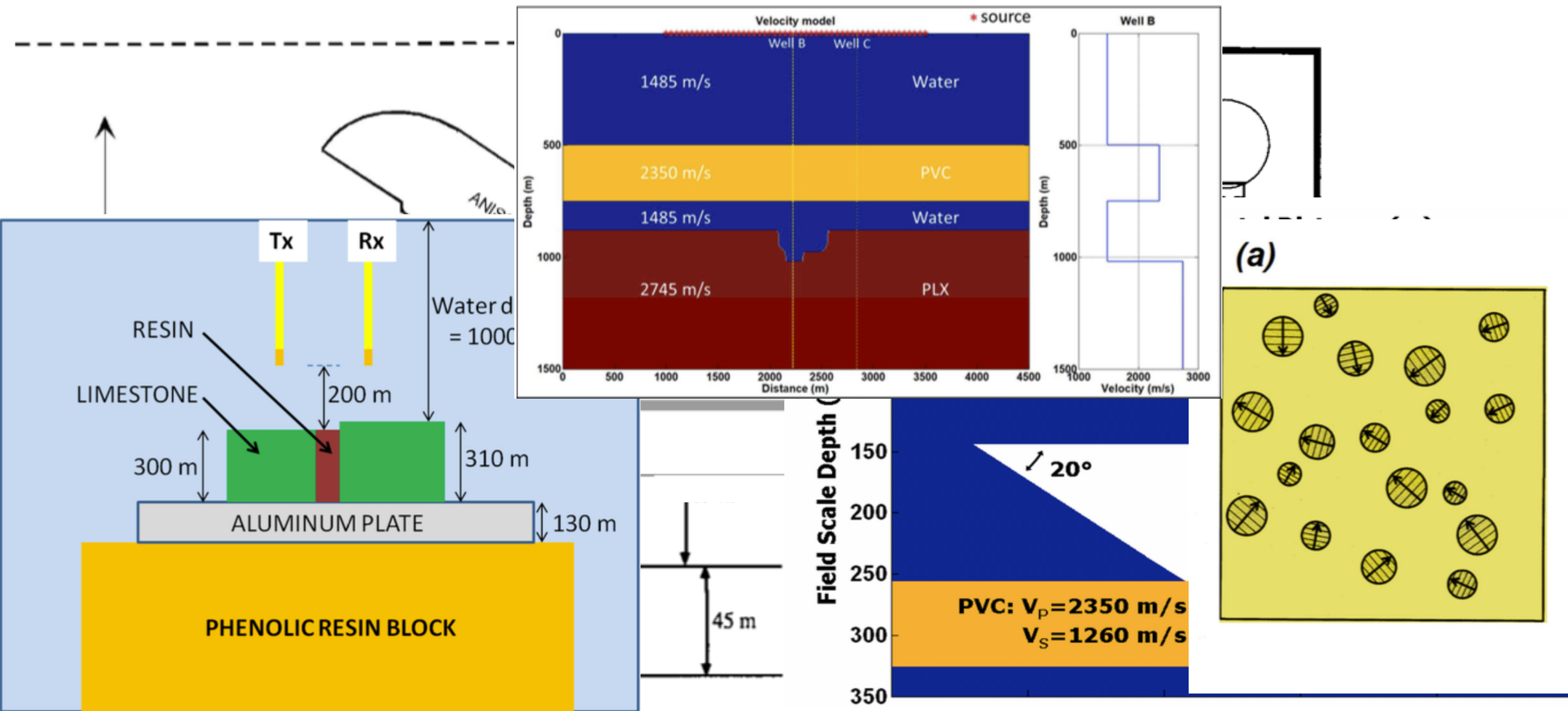




# Review of physical modelling



# Review of physical modelling



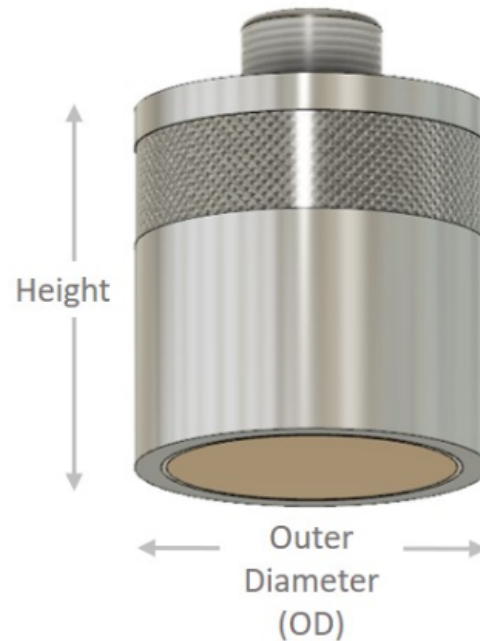


# Review of physical modelling

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

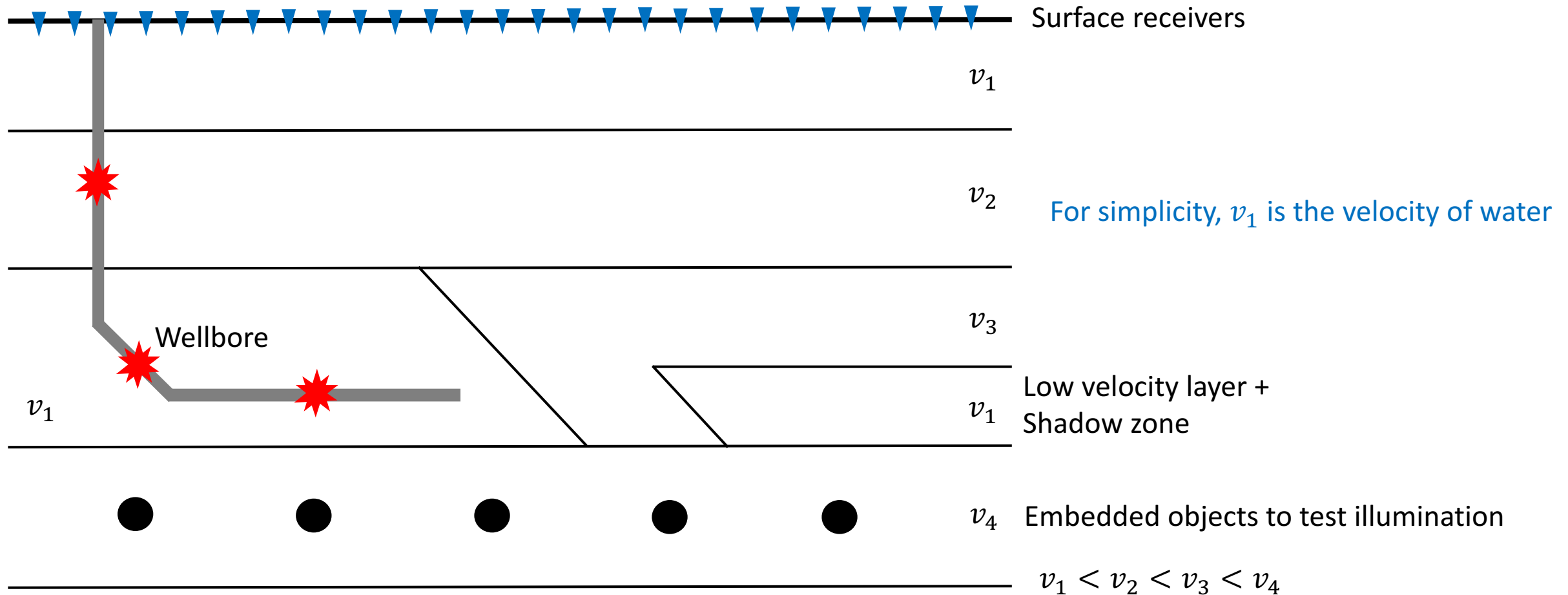
# Upgrades and new equipment

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



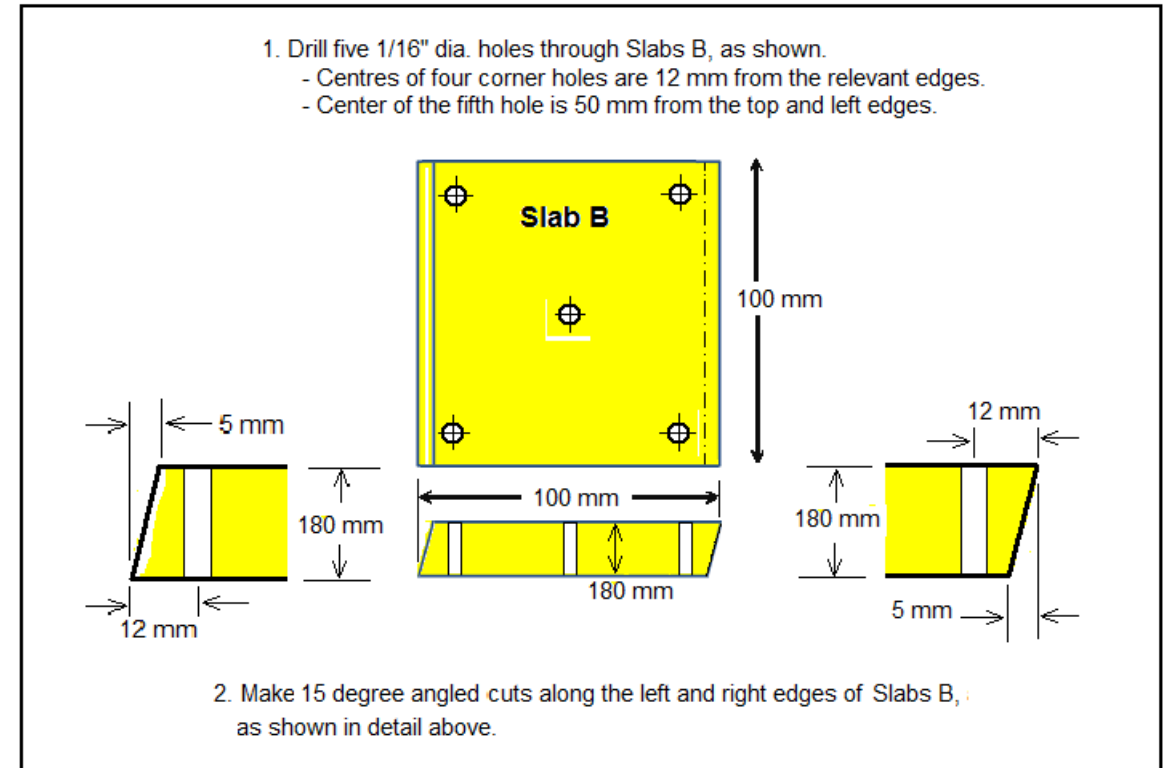
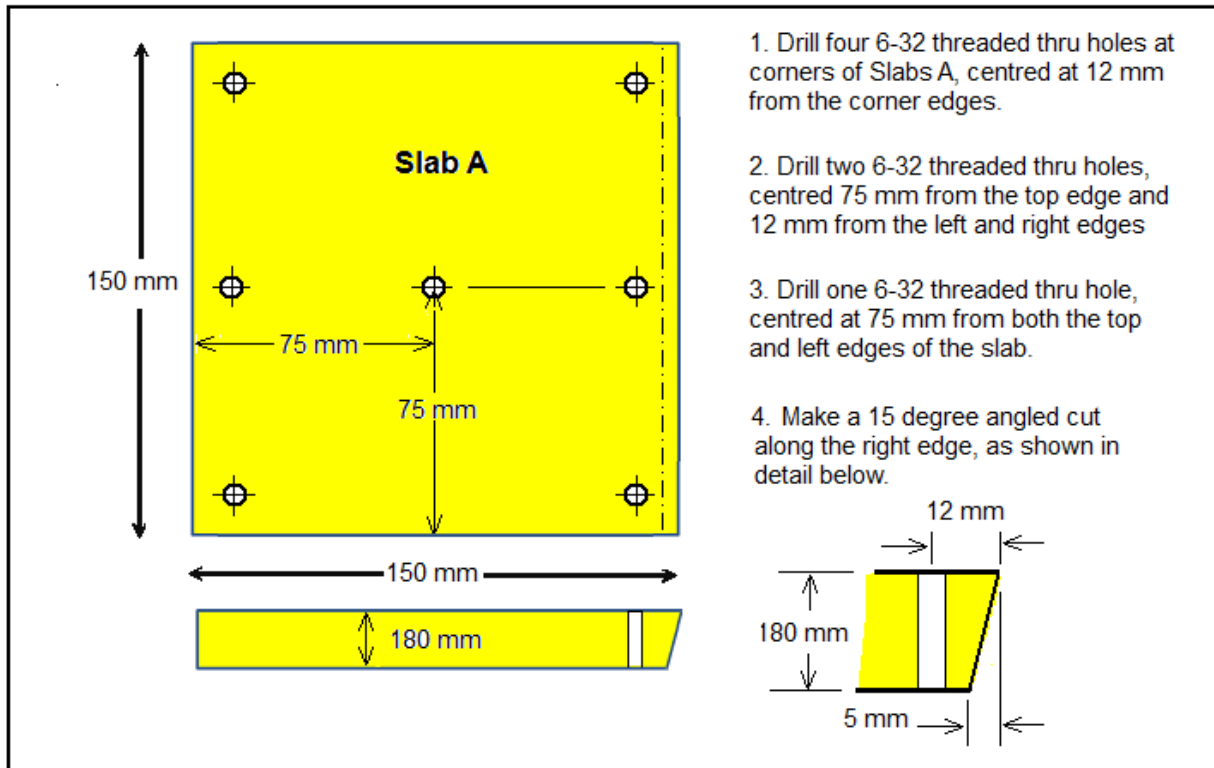
# Model

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



# Model

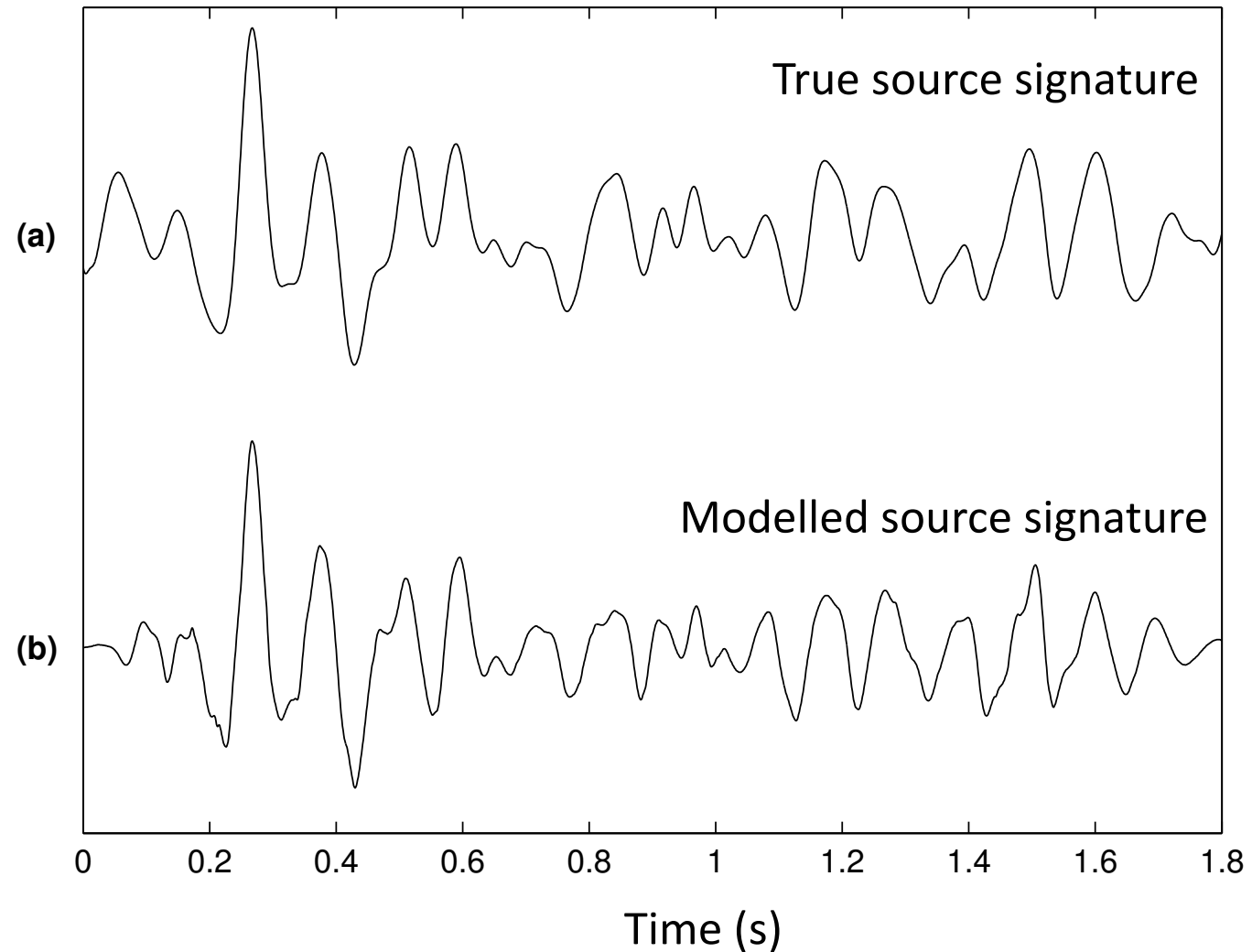
- Building the model requires sending a request to the Science Workshop at the U of C
- Example schematics for model specifications:



# Seismic while drilling (SWD)

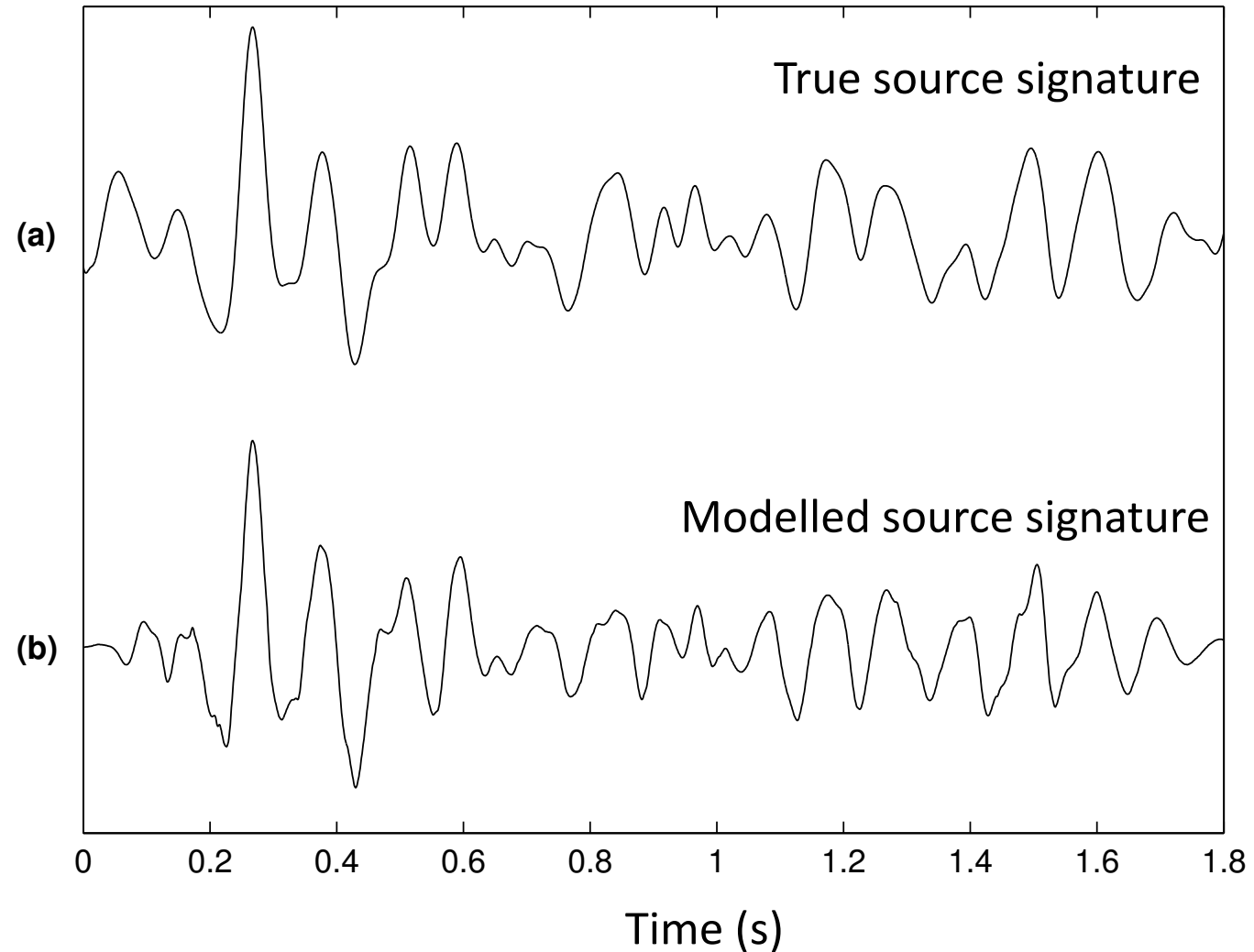
- Source wavelet of a drill can be approximately modelled and reproduced analytically

...but can this be reproduced in the lab?



# Seismic while drilling (SWD)

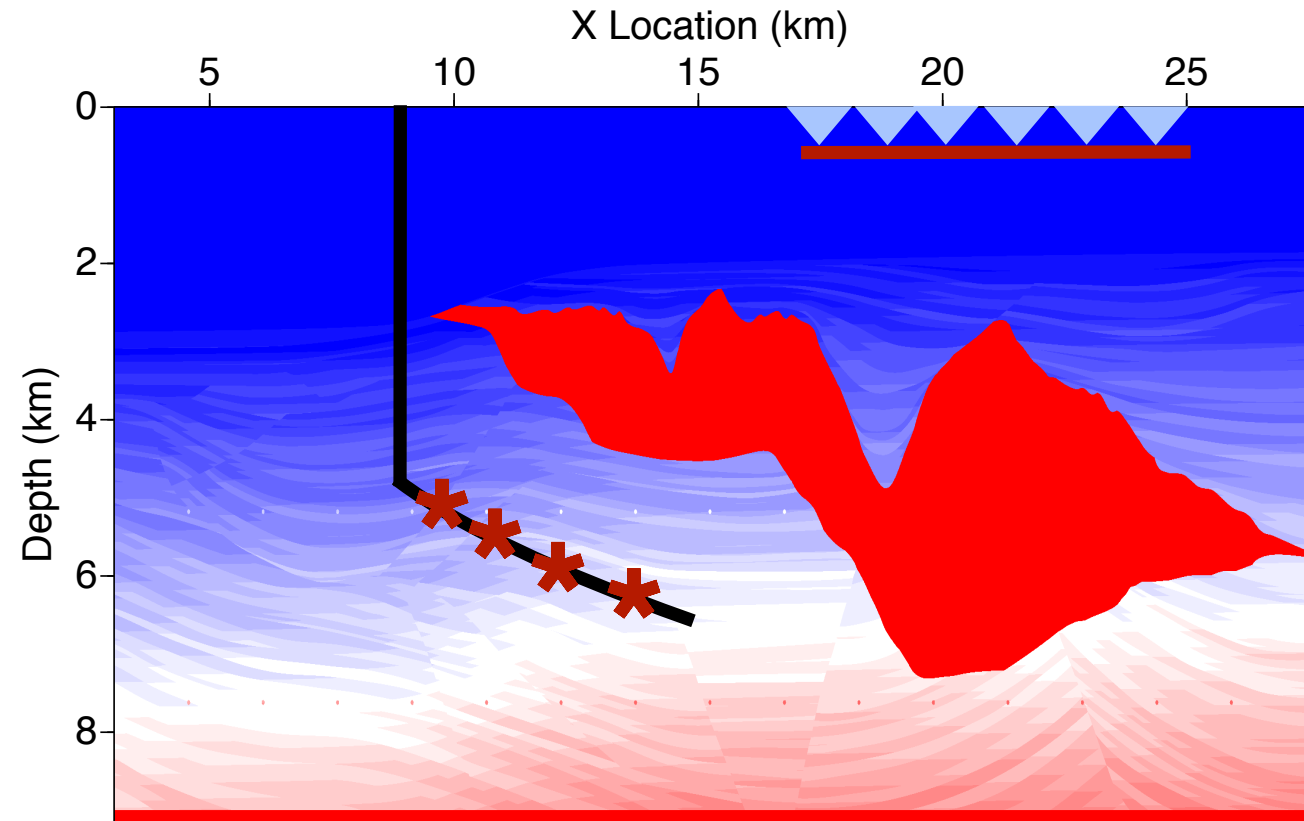
- Currently? No.
- Instead, using convolution to get the desired signal (post acquisition)
- In the future: working on building a flexible source using a microcontroller and a high-voltage amplifier





# Seismic while drilling (SWD)

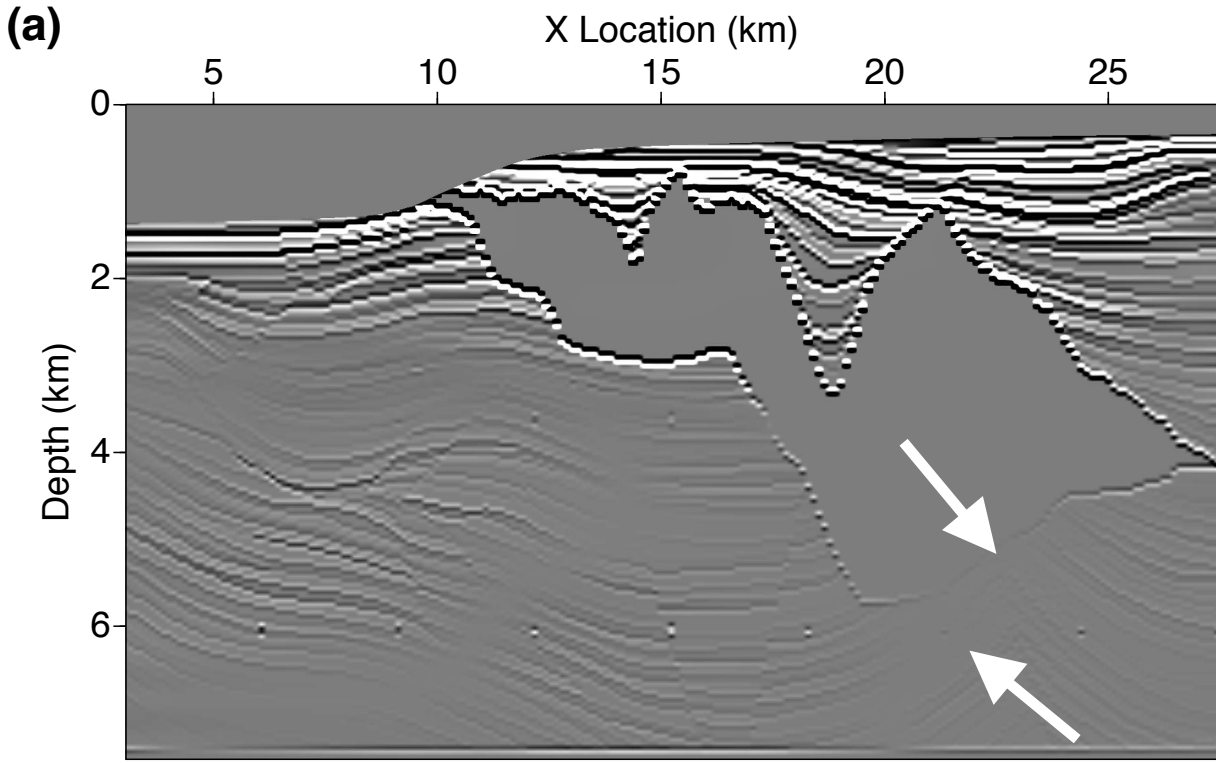
- Synthetic example:  
consider a salt body with a  
drilling target below one of  
the flanks
- Can we use the SWD  
signals to enhance the  
imaging of this salt body?



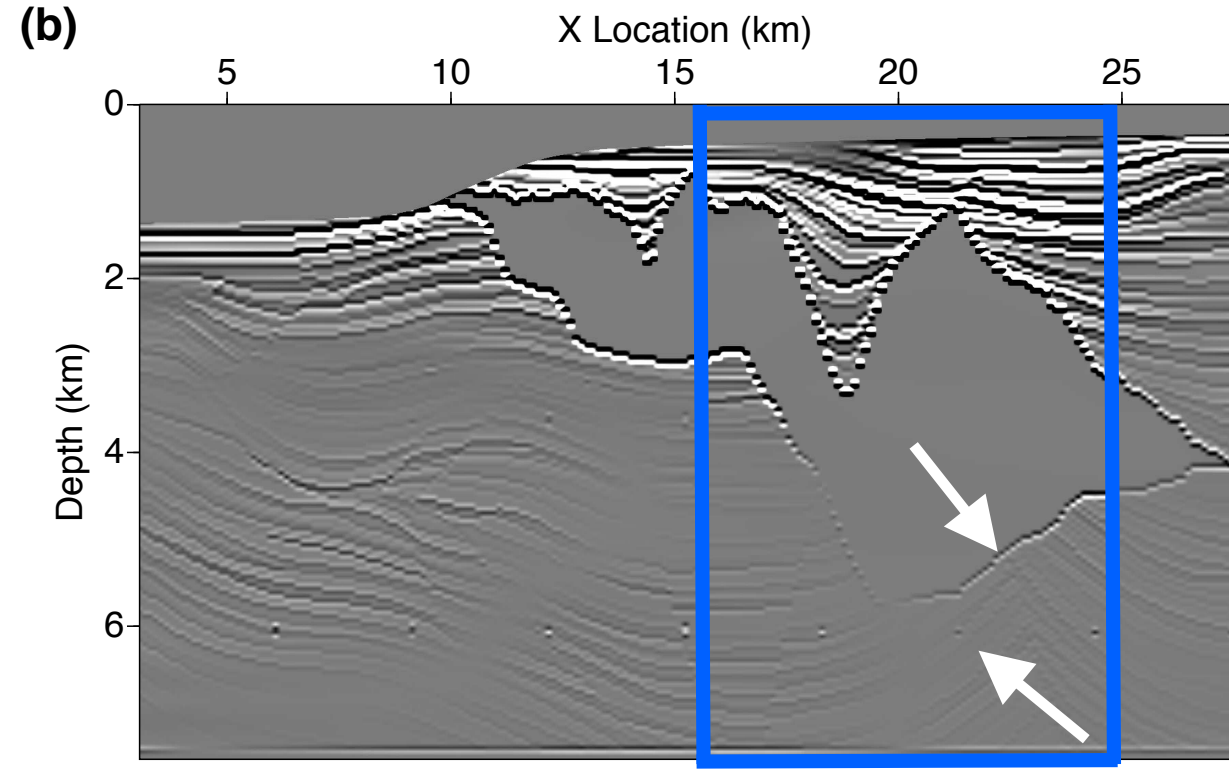
# Seismic while drilling (SWD)

- Enhanced imaging of steeper side of the salt body

Surface acquisition only

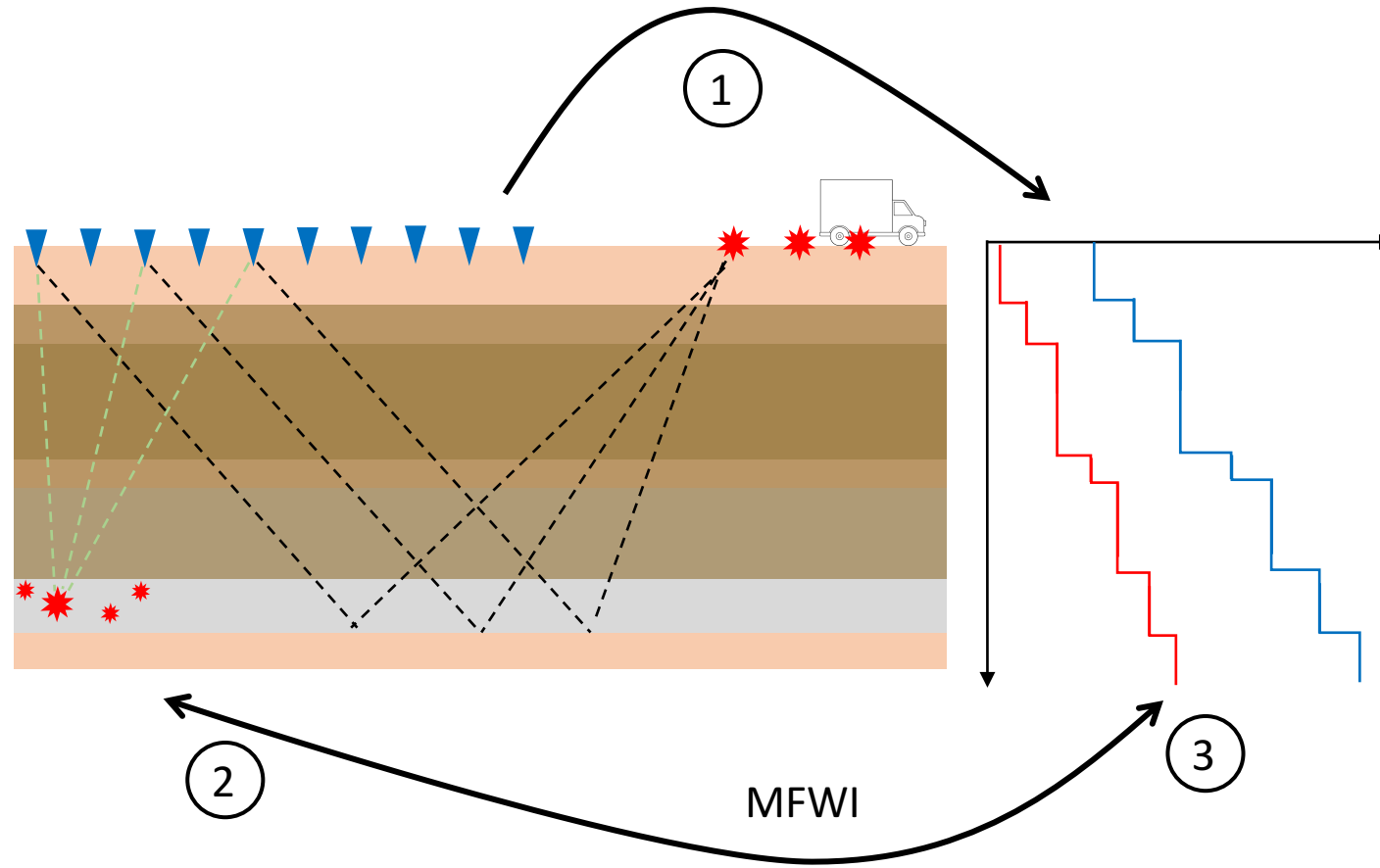


Combined SWD and surface imaging



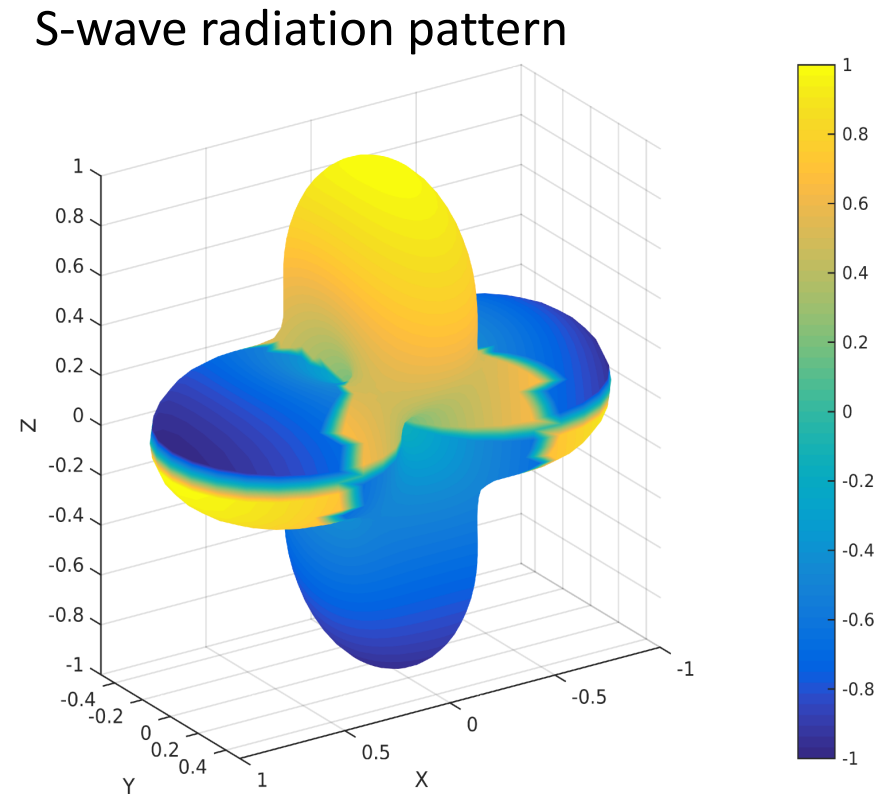
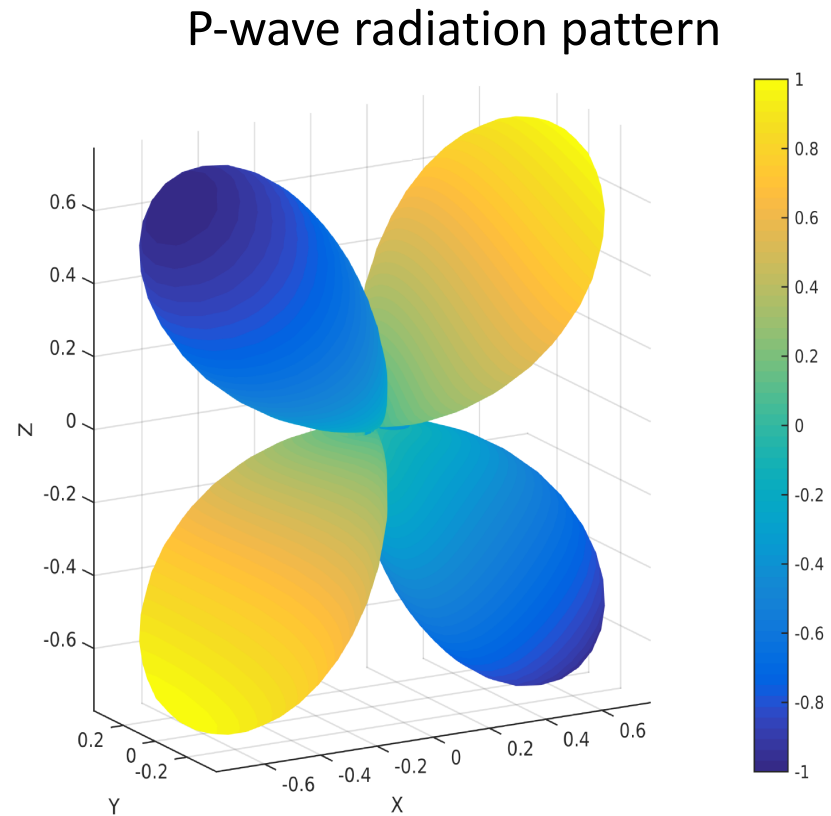
# Microseismic

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



# Microseismic

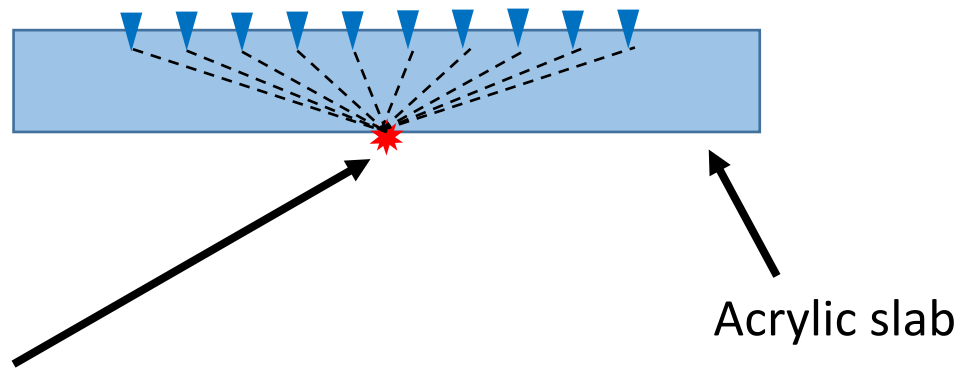
- Requires a source that can represent microseismic radiation patterns



# Microseismic

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

Side view:

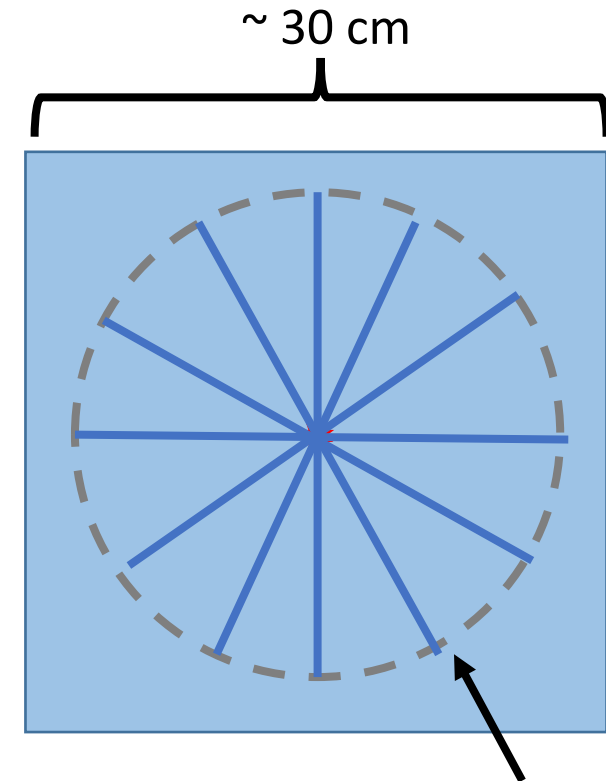


Source: P-wave transducer

Acrylic slab

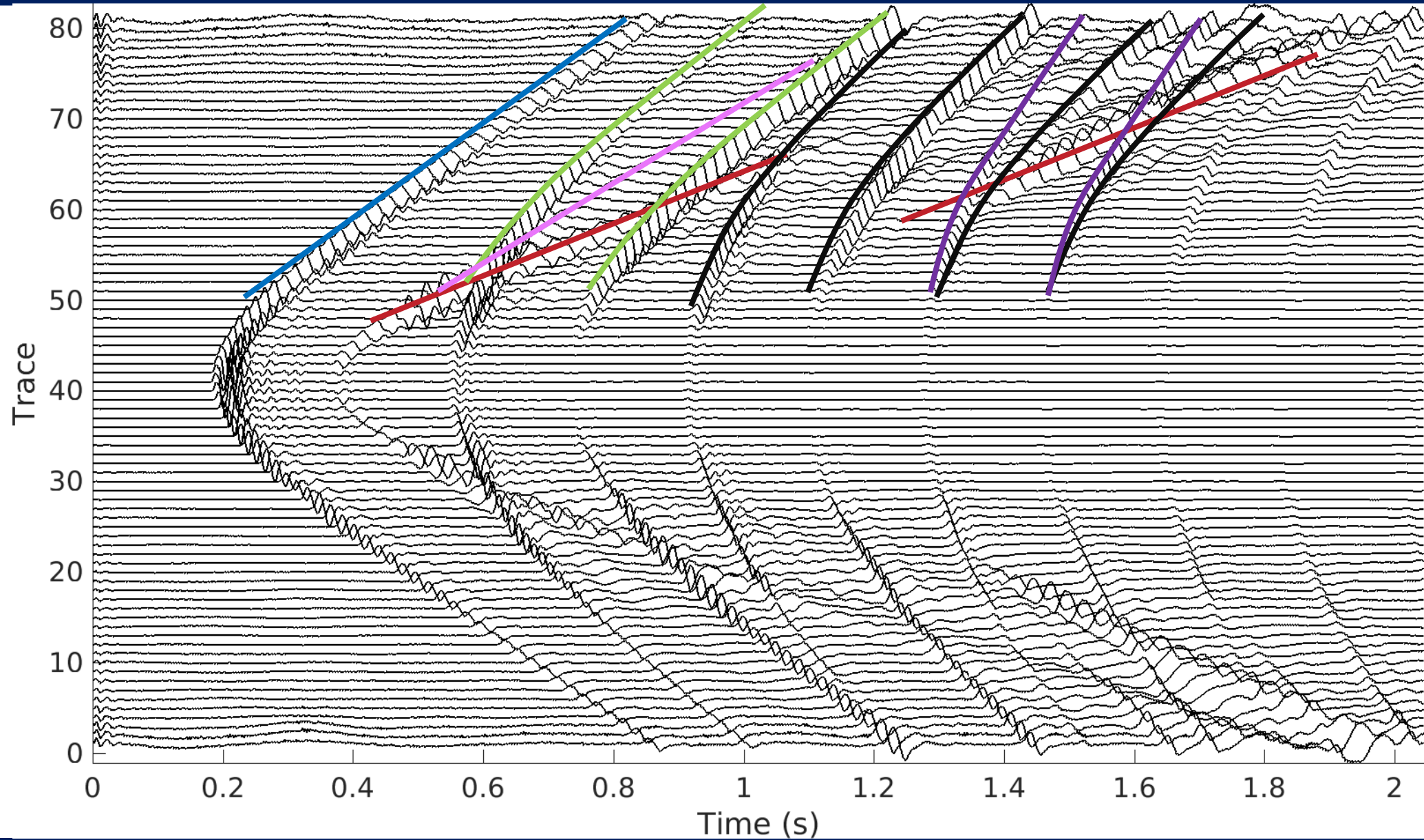
Can also repeat this with a S-wave transducer

Map view:



Receiver lines at 14  
degree increments

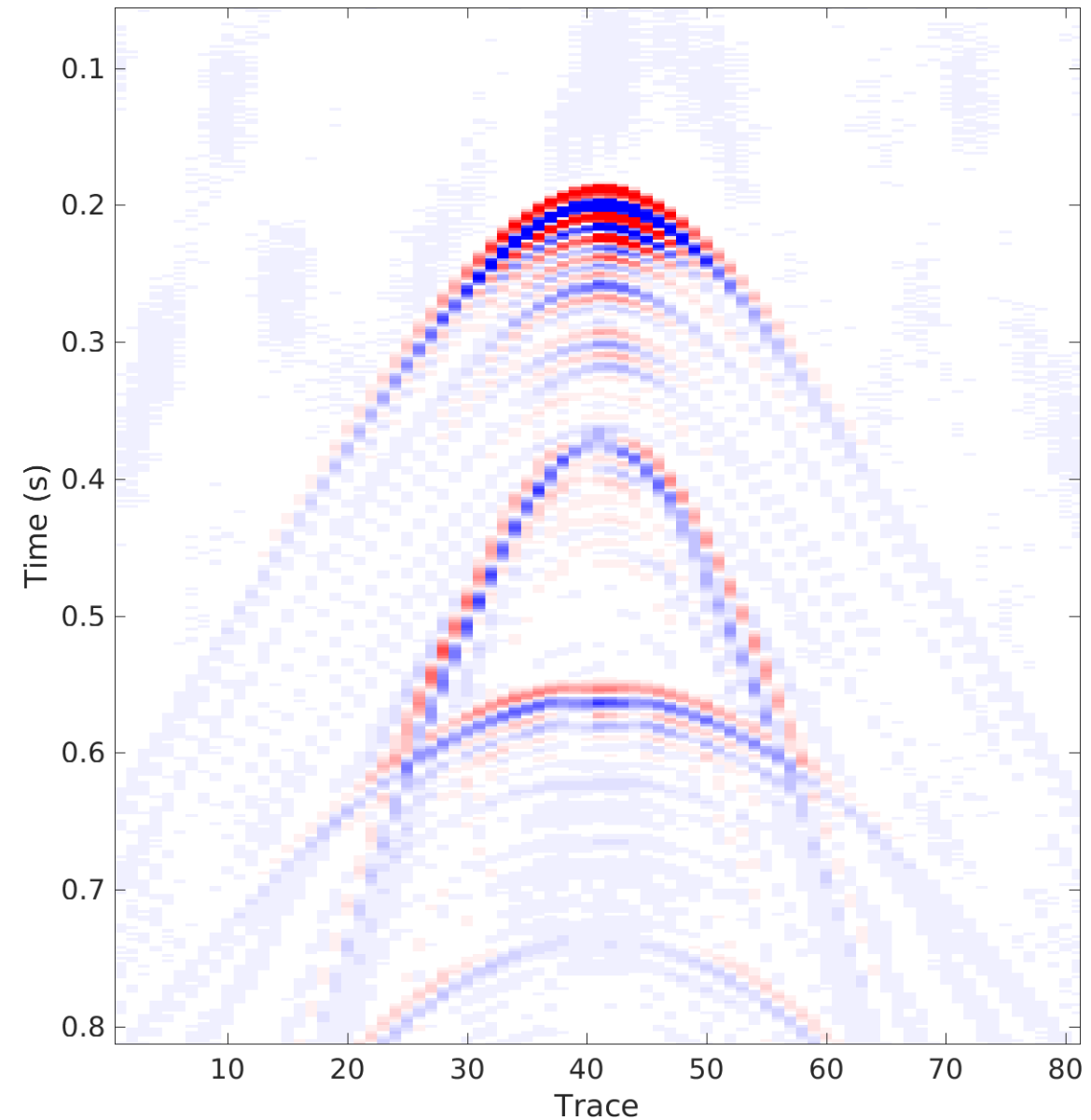
# Microseismic





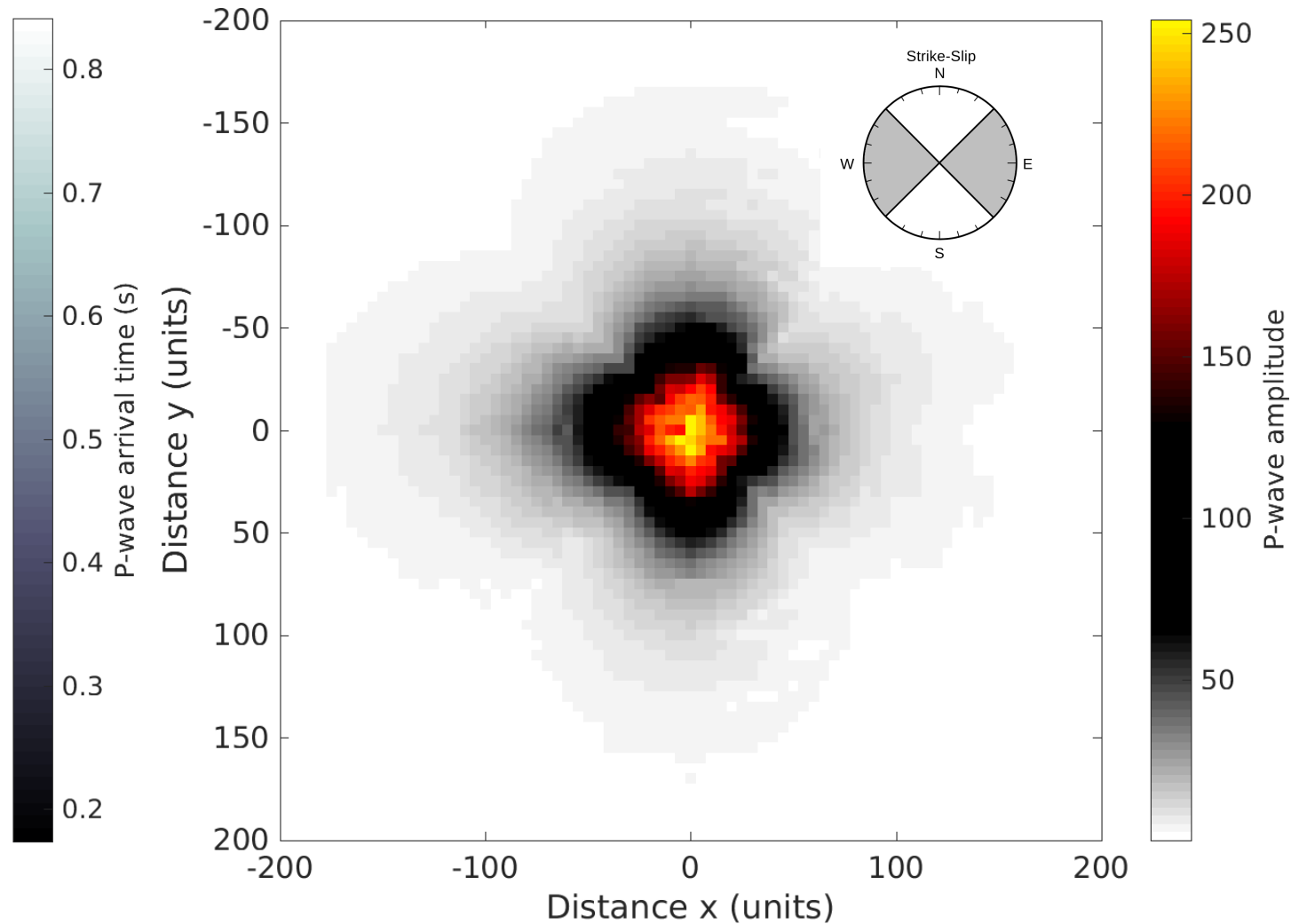
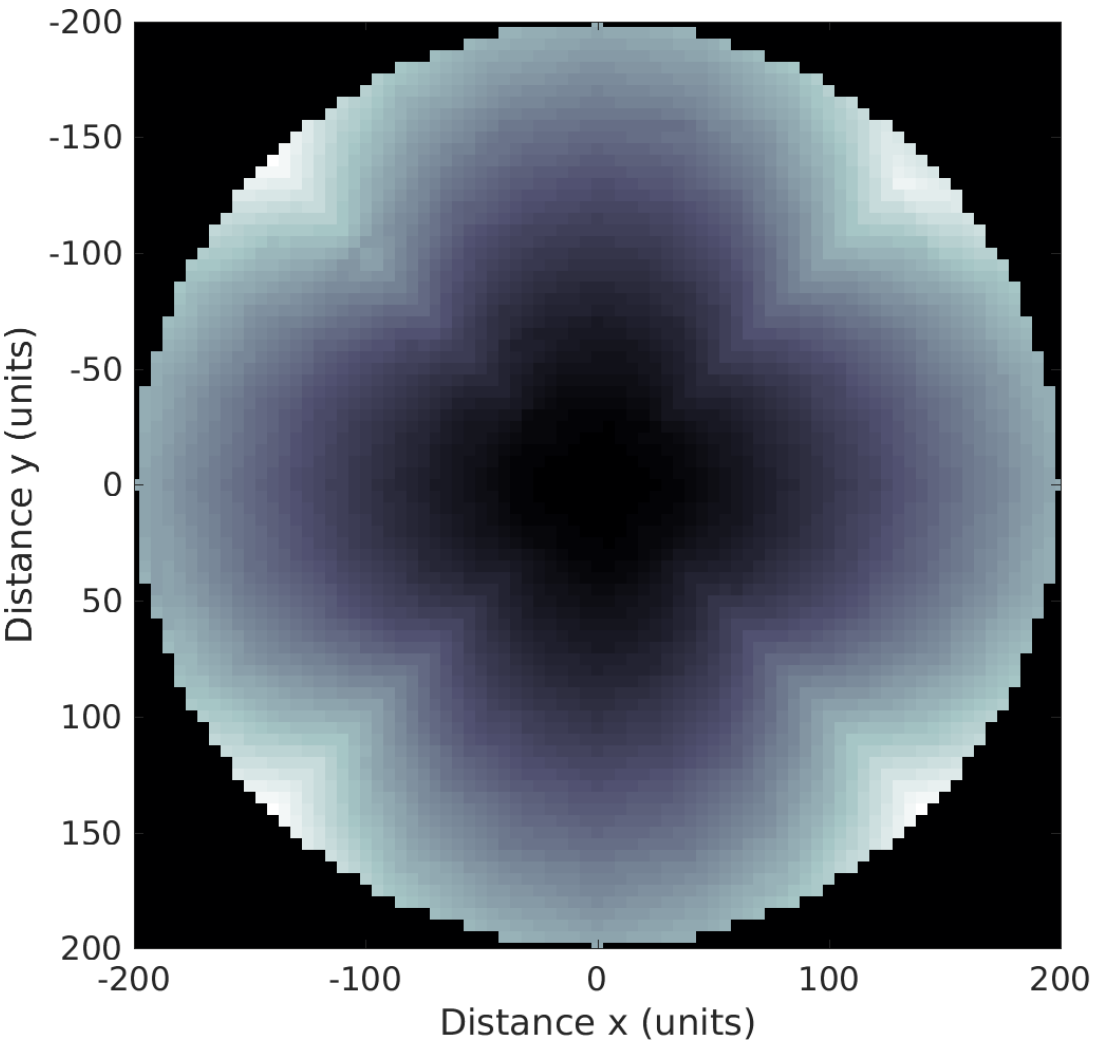
# Microseismic

- Raw data from experiment:
- Polarities do not change across the array



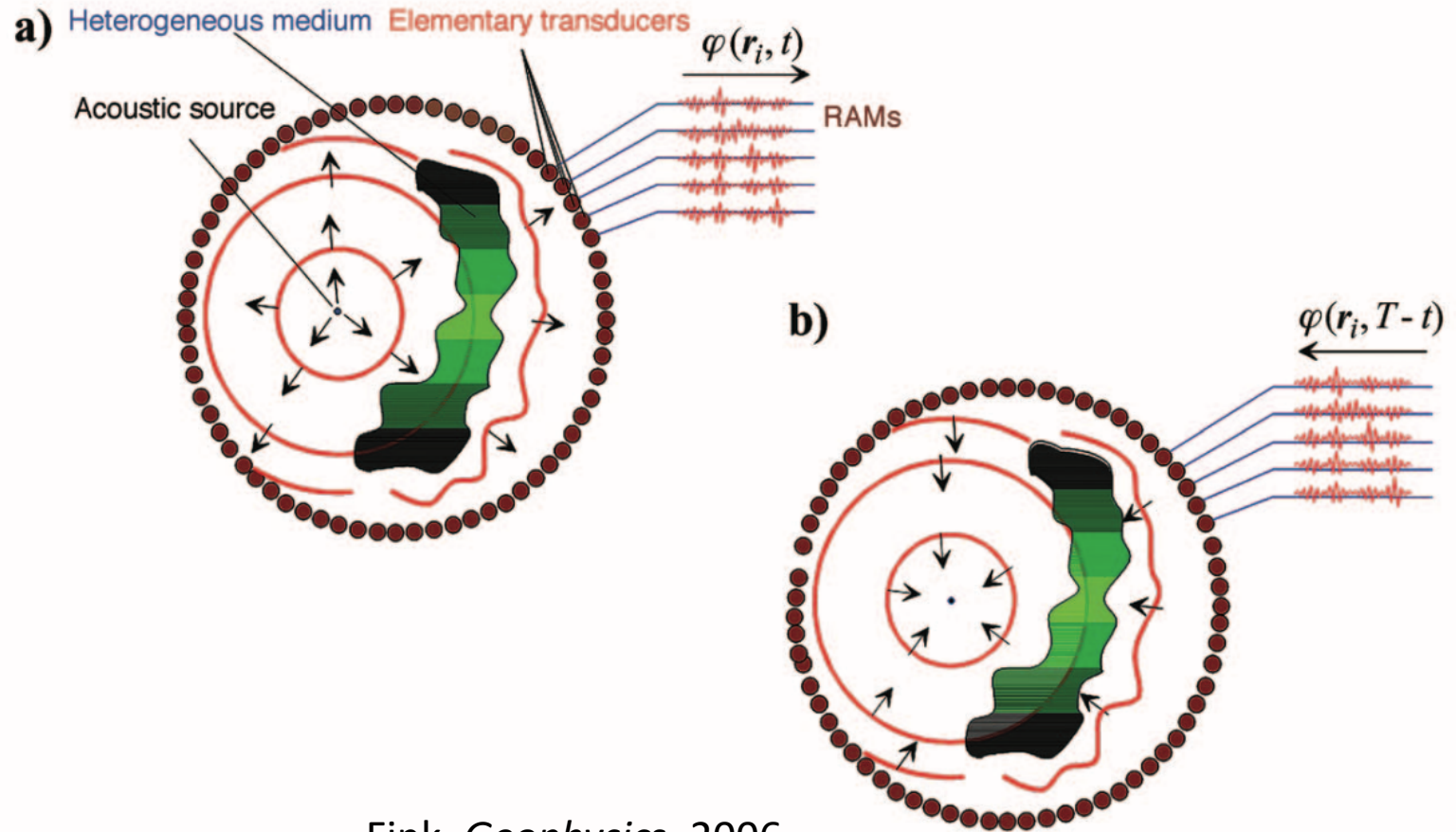
# Microseismic

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



# 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

# Conclusions

- The physical modelling lab is in the process of being upgraded
- Increasingly complex experiments involving SWD and microseismic are going to be carried out
- Lots of future work!

# Acknowledgements

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# Thank you!

## Questions/comments?



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