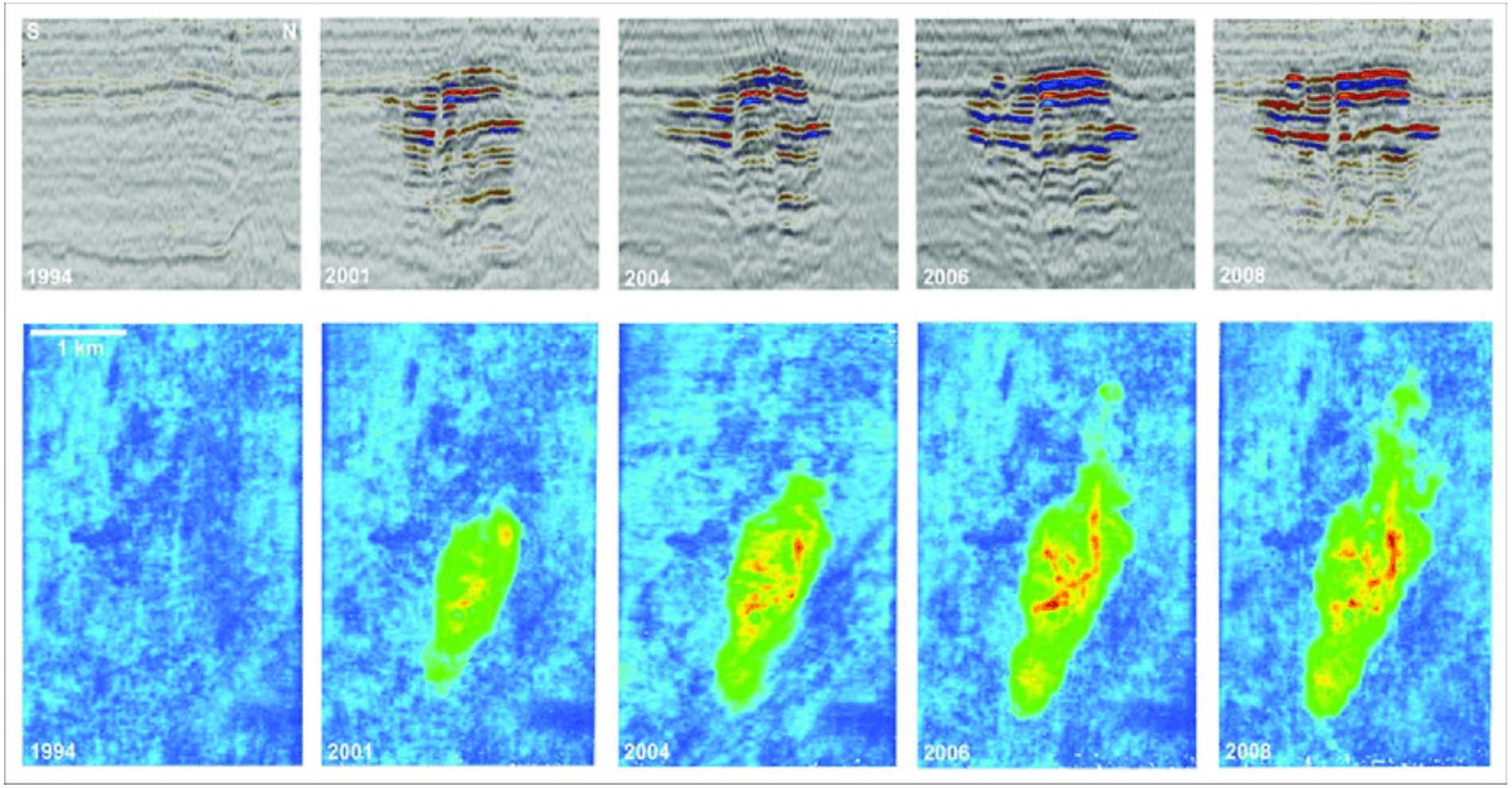
A comparative study of different DAS vendors data

Jorge Monsegny, Daniel Trad, Don Lawton

Calgary, Canada
December 3 2020

NSERC CRSNG
UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
Department of Geoscience
CMC Containment & Monitoring Institute

Motivation



Time-lapse seismic images of the Sleipner CO_2 plume. From Chadwick, 2010

Things that change with time in time-lapse seismic

Reservoir properties:

1. Pore pressure
2. Pore fluids
3. Temperature
4. *Compaction*
5. *Porosity*
6. *Density*
7. *Overburden stress*
8. *Fractures*
9. *Chemical changes*

Seismic observables:

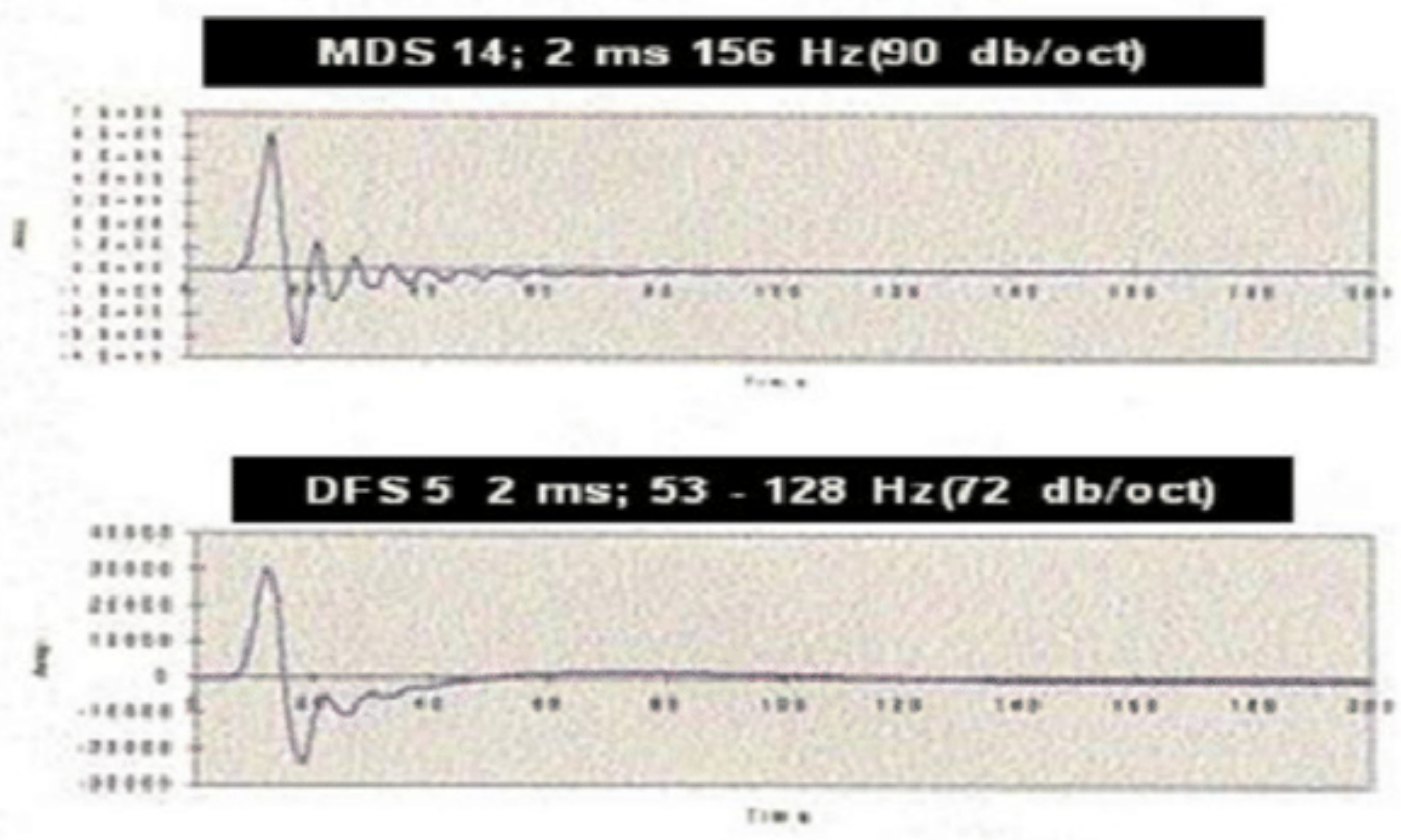
1. Times
2. Amplitudes
3. Velocities
4. Frequencies and phases

Undesirables:

1. Ambient noise
2. Environment changes
3. Near surface velocities and effects
4. **Recording equipment characteristics**
5. **Acquisition parameters**
6. Processing parameters
7. Processing software

Motivation

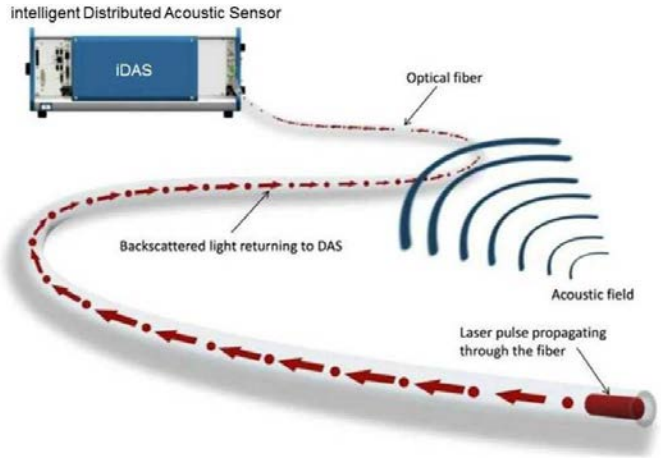
- Each recording instrument have its own different impulse response.
- The different equipment responses should be considered with a view to apply filters to equalize them.



From Jack, 1997

Motivation

- Positioning systems
- Source arrays
- Source depths
- Vibroseis parameters
- Charge size
- Receiver arrays
- Number of detectors
- Receiver channel spacing
- Shot spacing

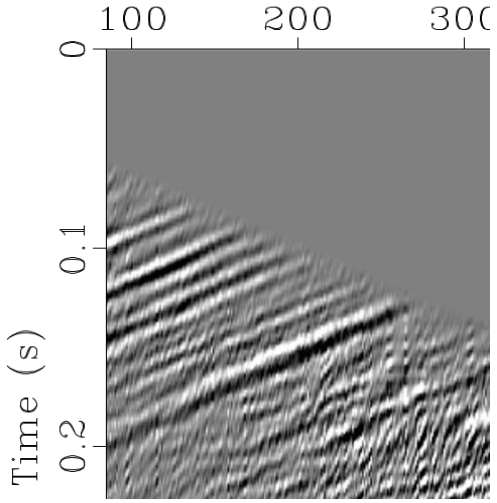


Motivation

Interrogator
Vendor 1

Sensing fibre

Permanently installed

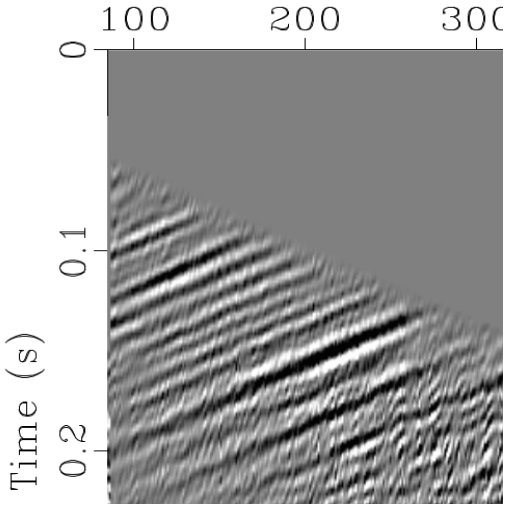


= or ≠ ?

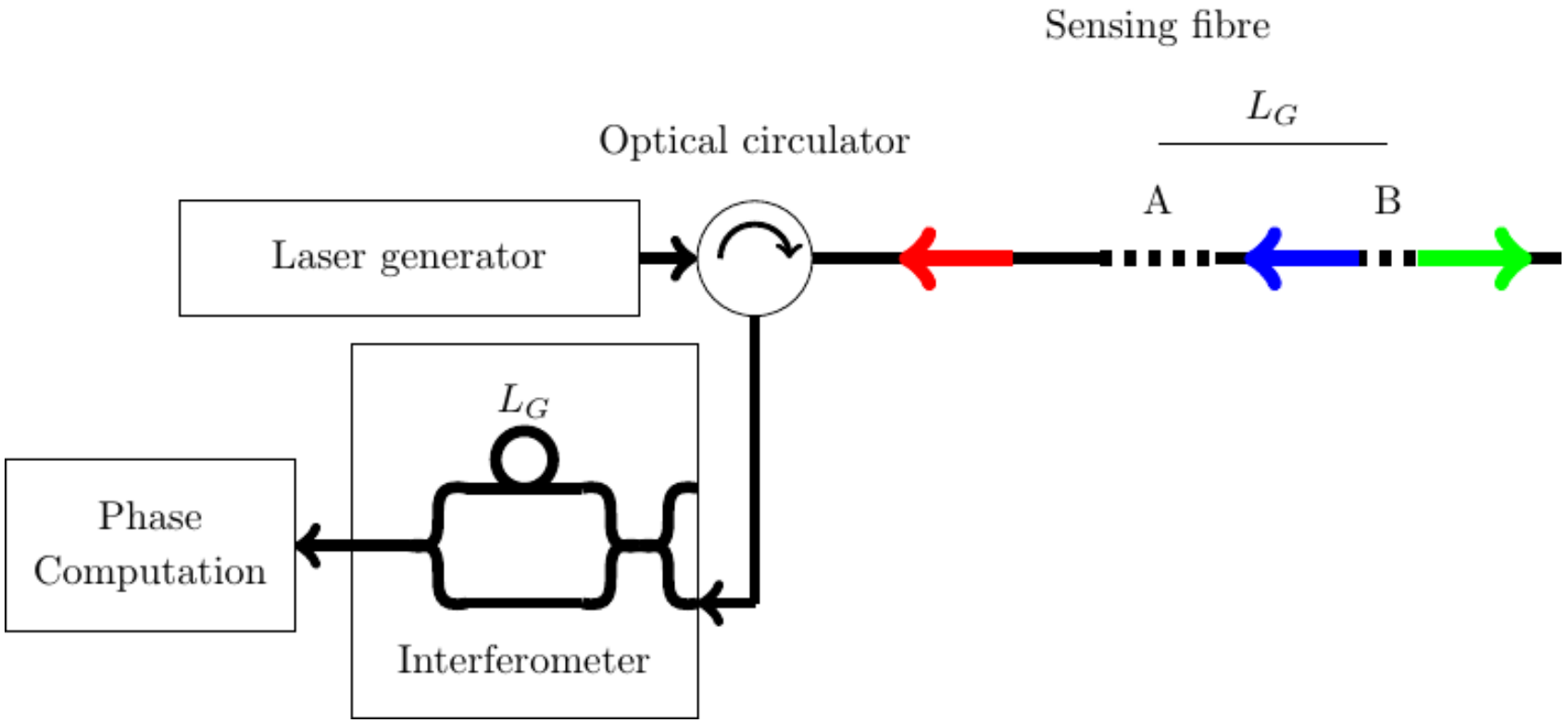
Interrogator
Vendor 2

Sensing fibre

Permanently installed

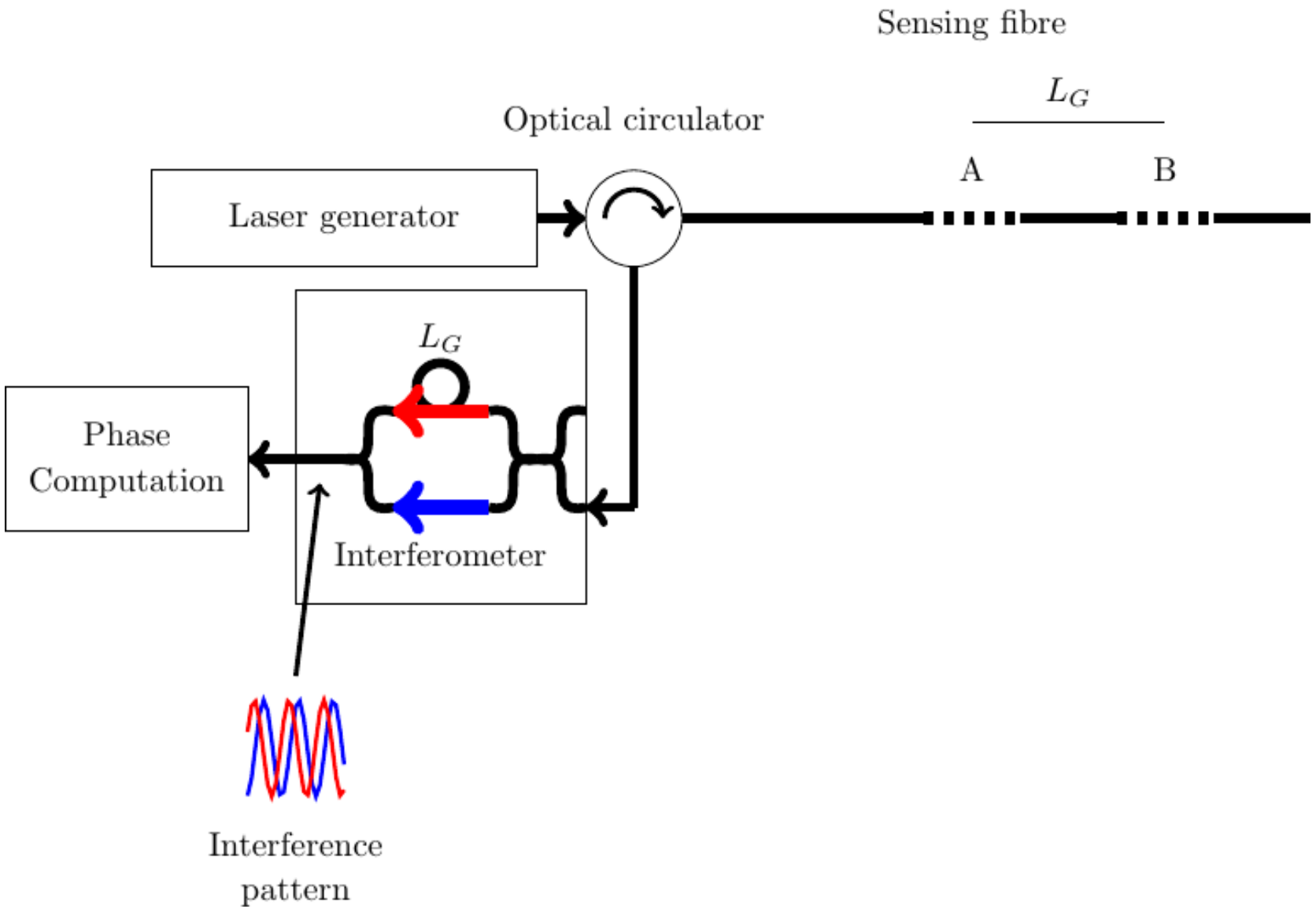


DAS principles



(Modified from Posey et Al., 2000)

DAS principles



(Modified from Posey et Al., 2000)

DAS principles

Interference pattern dynamic phase:

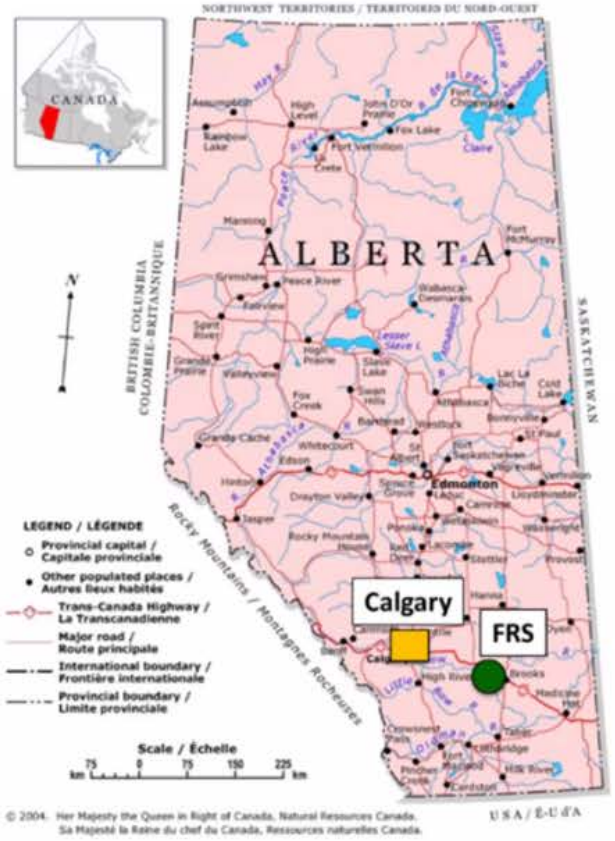
$$\Phi_A - \Phi_B + \frac{4\pi n \xi \delta l}{\lambda}$$

Strain from measured fibre length change:

$$\epsilon_f(s) = \frac{\delta l}{L_G}$$

- Correction to strain-optical effect:
  $\xi = 1 - \frac{n^2}{2}(P_{12} - \nu(P_{11} + P_{12}))$
- Refraction index:
  $n : 1.456$
- Strain-optic tensor:
  $P_{11} : 0.121$
  $P_{12} : 0.270$
- Optical fibre Poisson's ratio:
  $\nu : 0.17$

Containment and Monitoring Field Research Station CaMI-FRS



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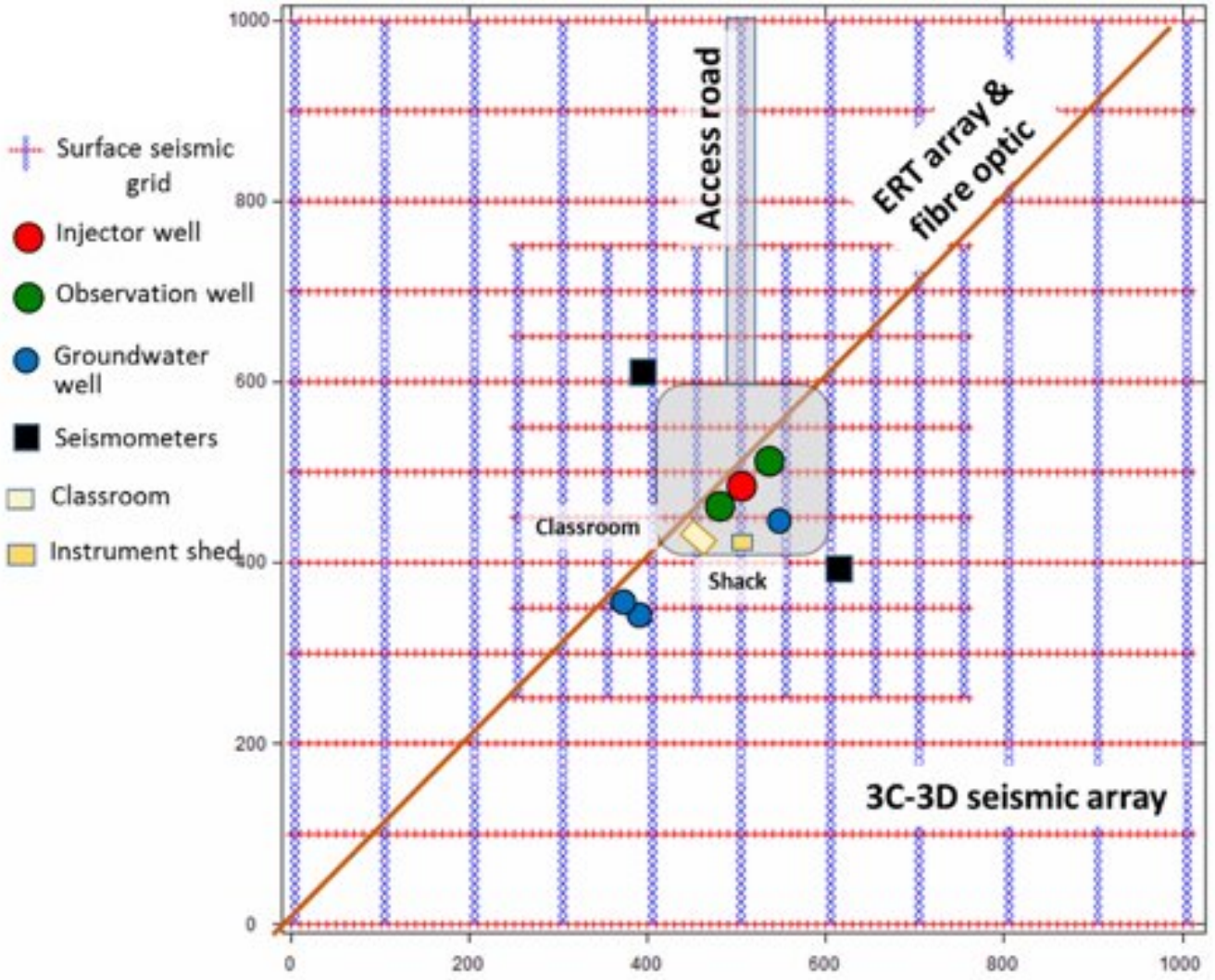

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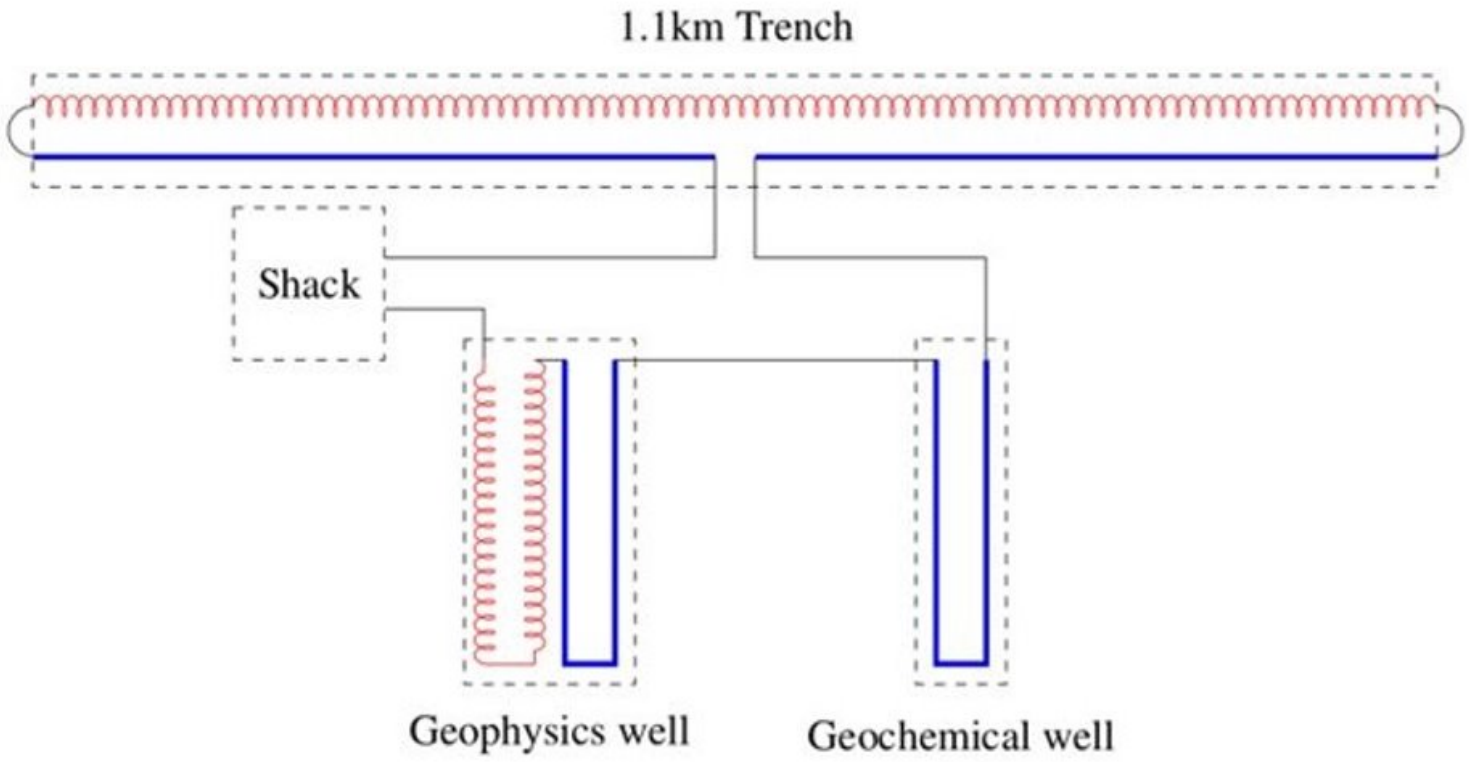


Summary

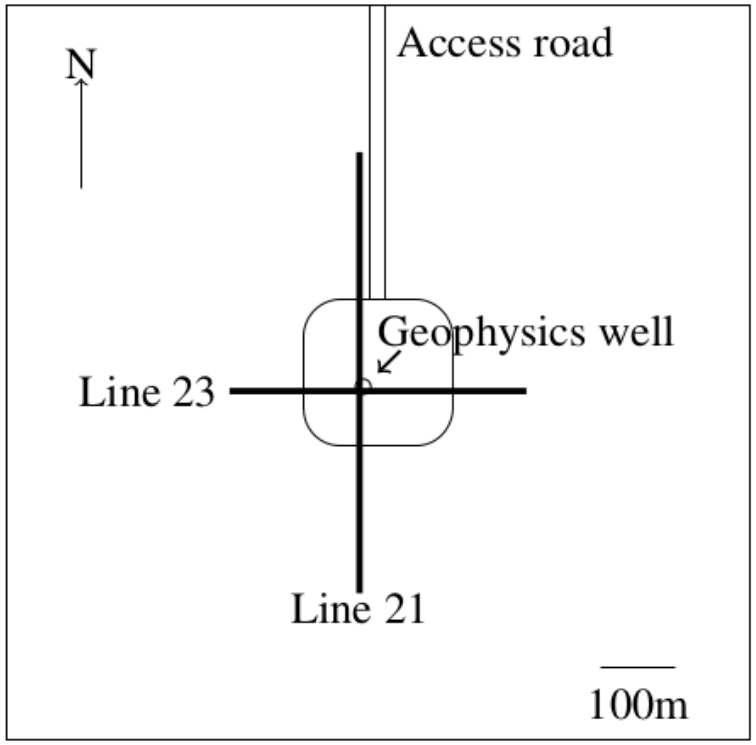
- The three vendors DAS data showed a checkerboard low frequency noise, maybe related to the surface operations.
- Data from one vendor was the opposite polarity than the others.
- After applying a basic data conditioning, the three vendors DAS data showed similarities in the early times, but differences in phase at later times.
- The phases differences vary slowly from trace to trace, this could be a registration issue related to the traces separation.

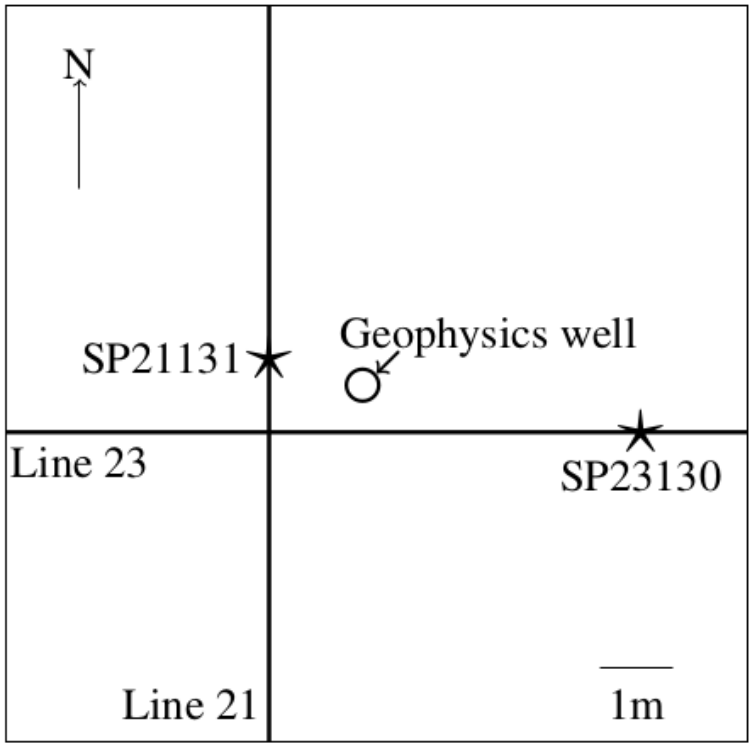
Plan

1. Describe the datasets
2. Show the raw shot gathers
3. Perform some data conditioning.
4. Show the conditioned gathers
5. Compare some individual traces.

Selected DAS VSP shot gathers

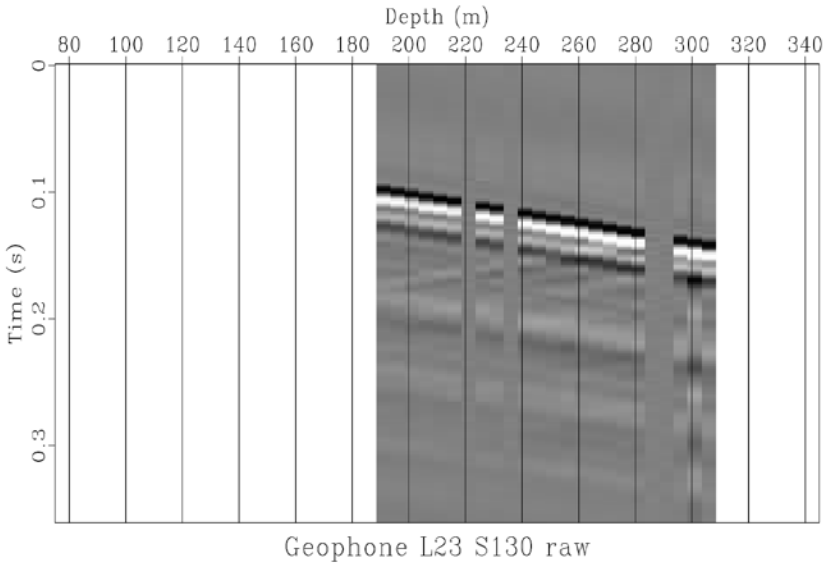
Vendor	Line	Acquisition time	Shot Point
Geophone	23	October 2017	130
Vendor 1	23	October 2017	130
Vendor 2	23	October 2017	130
Geophone	21	October 2017	131
Vendor 1	21	October 2017	131
Vendor 3	21	February 2018	131



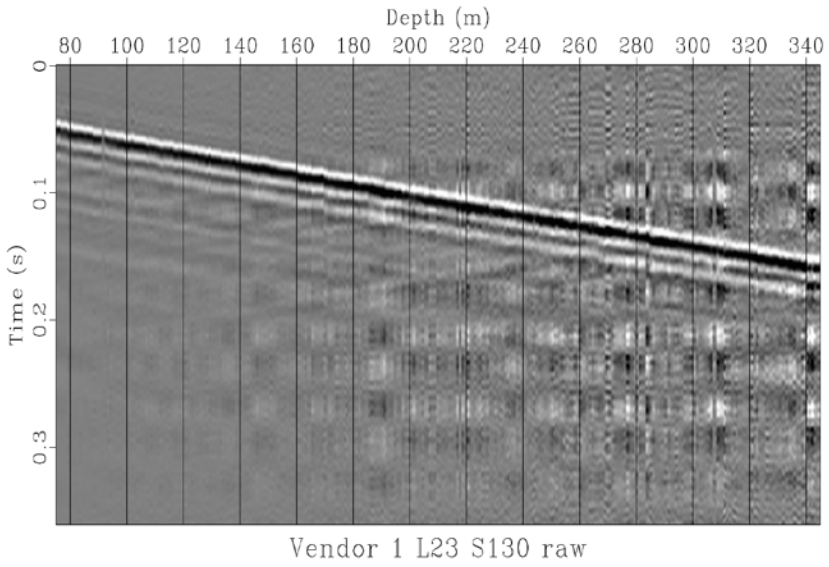


The source was always an Envirovibe with a 20s linear sweep from 10 to 150Hz

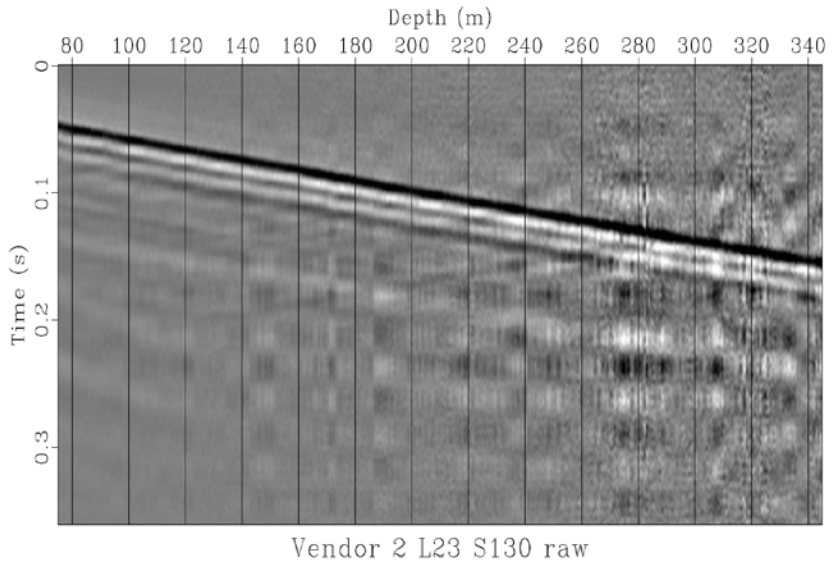
Raw DAS VSP shot gathers



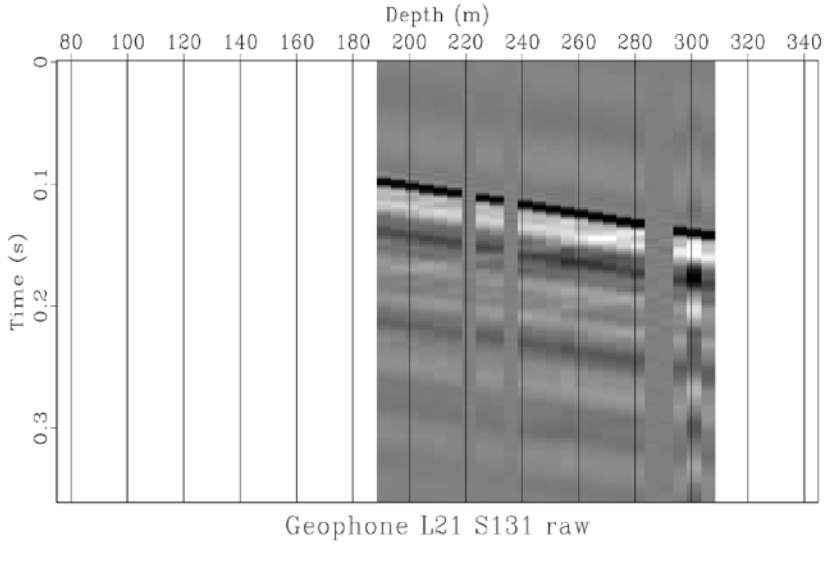
Geophone L23 S130 raw



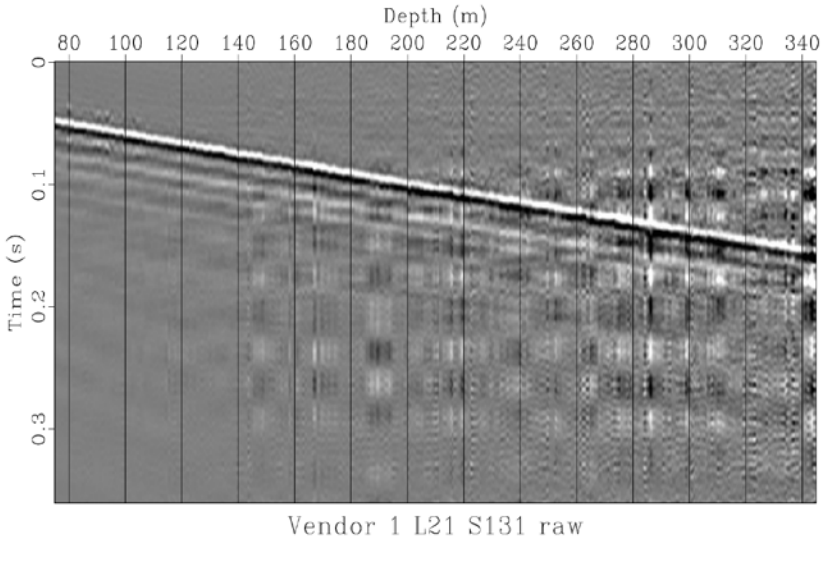
Vendor 1 L23 S130 raw



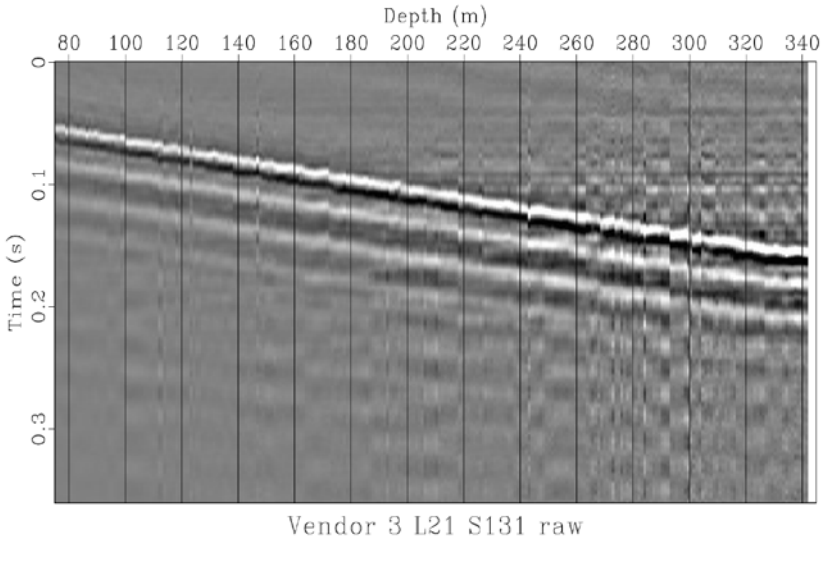
Vendor 2 L23 S130 raw



Geophone L21 S131 raw

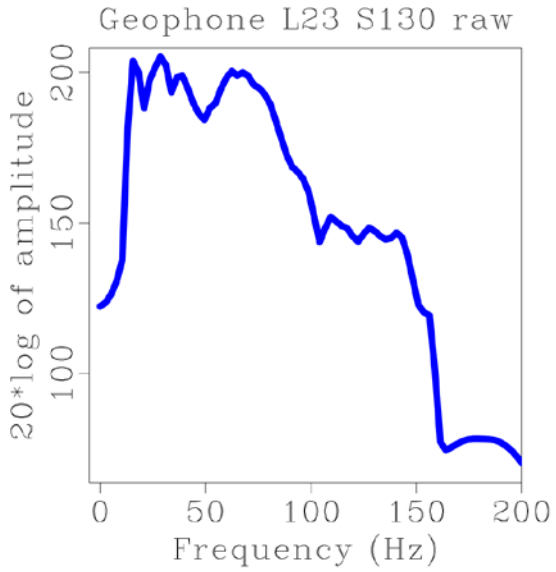


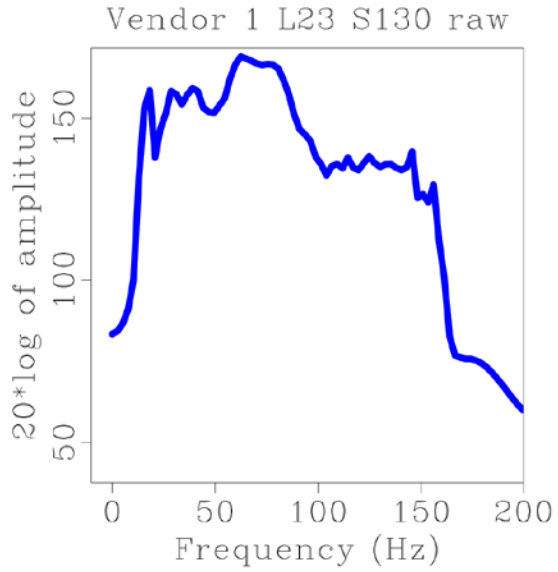
Vendor 1 L21 S131 raw

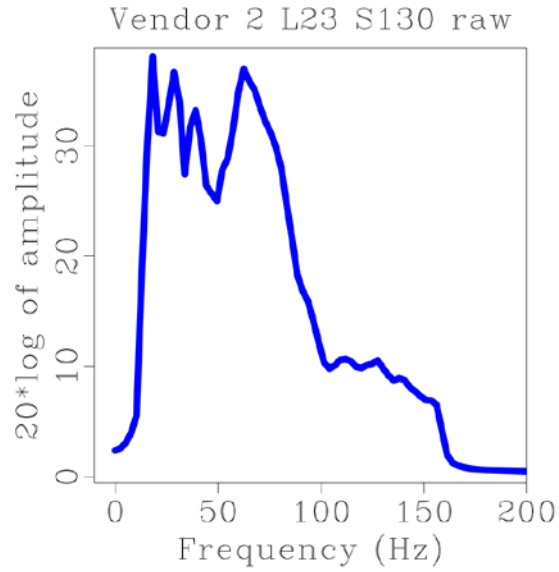


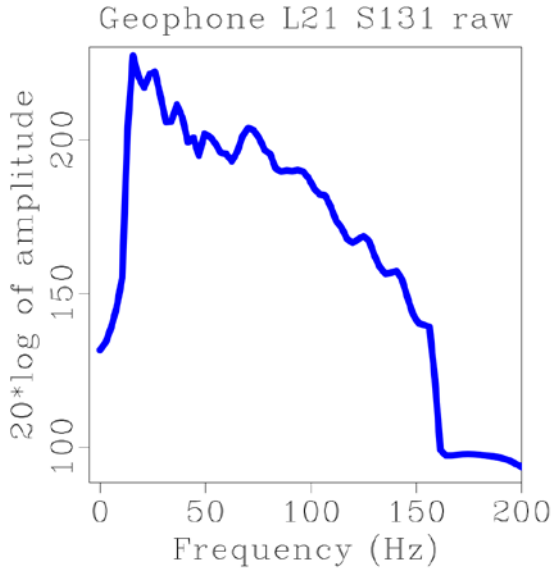
Vendor 3 L21 S131 raw

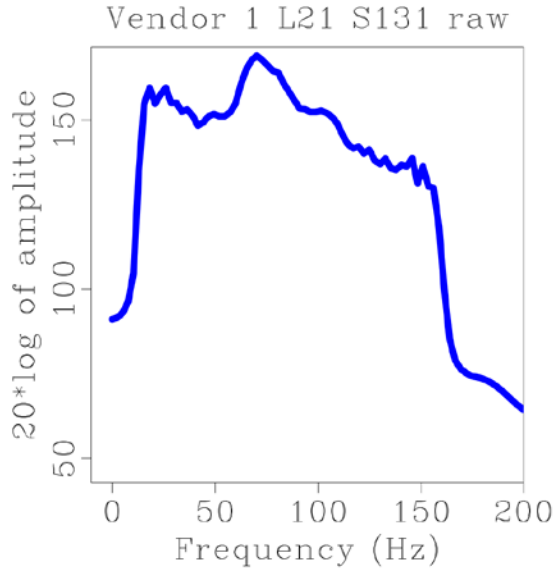
Raw average frequency spectra

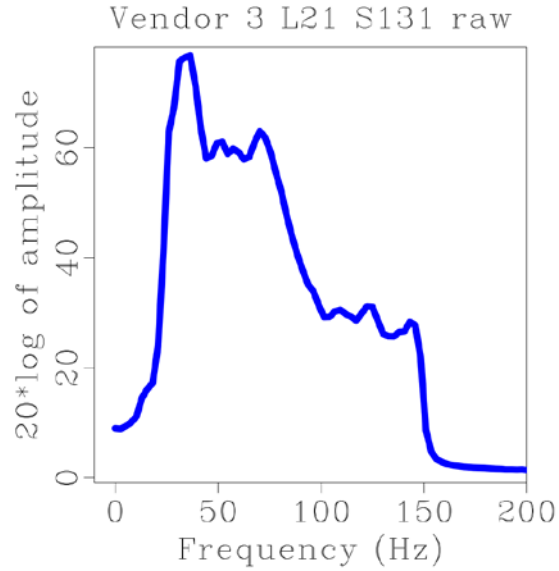




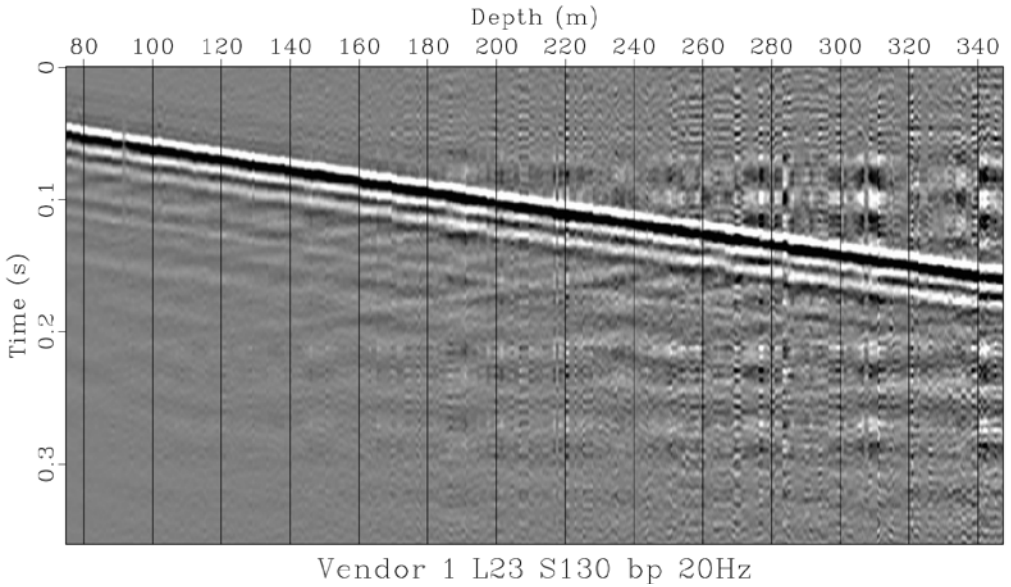




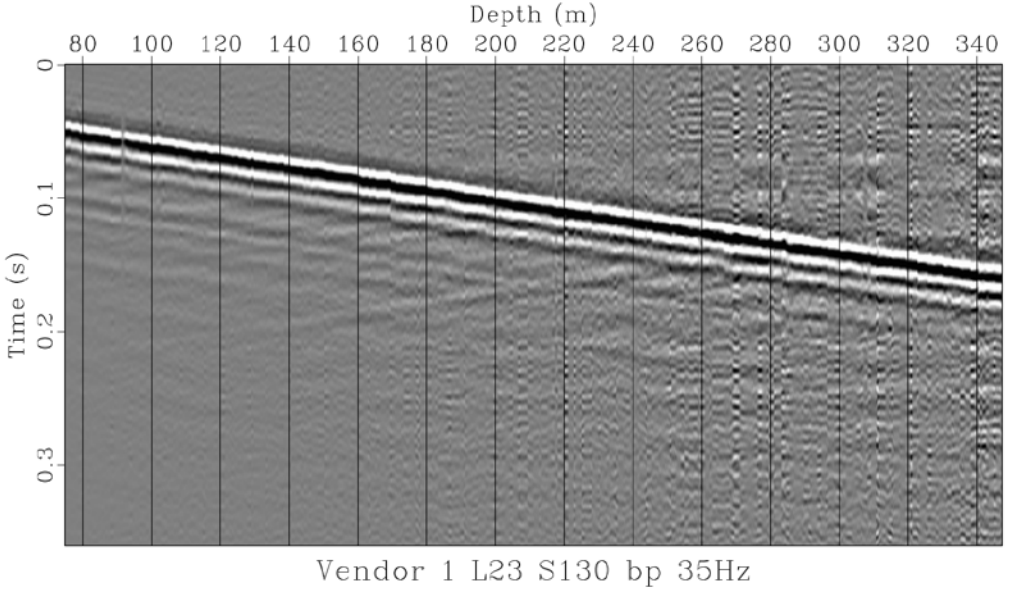




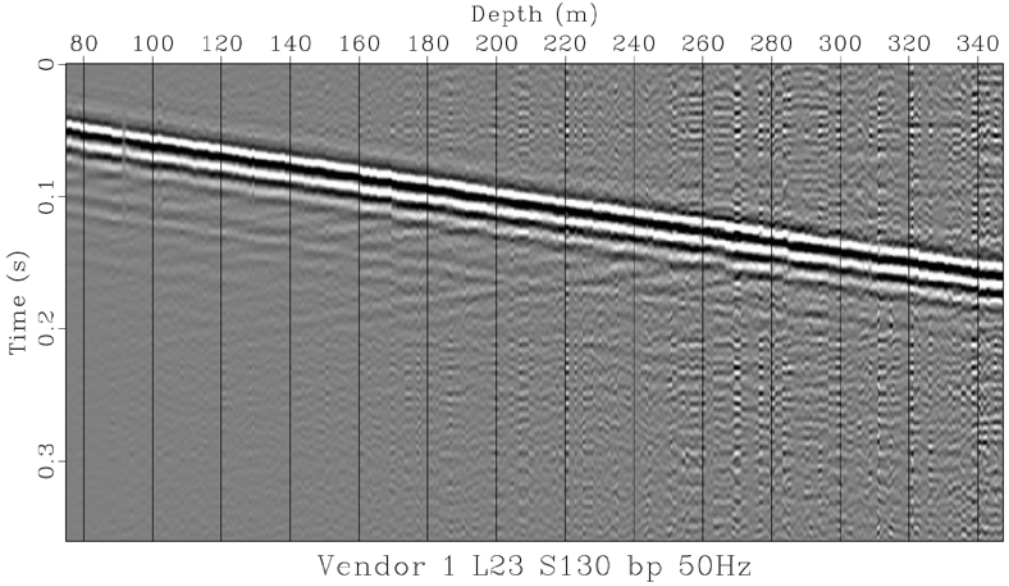
Checkerboard noise supression



Vendor 1 L23 S130 bp 20Hz

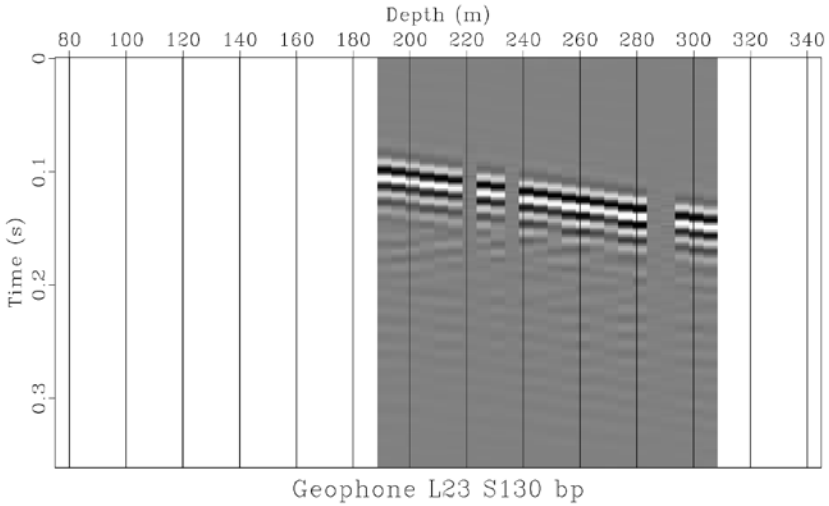


Vendor 1 L23 S130 bp 35Hz

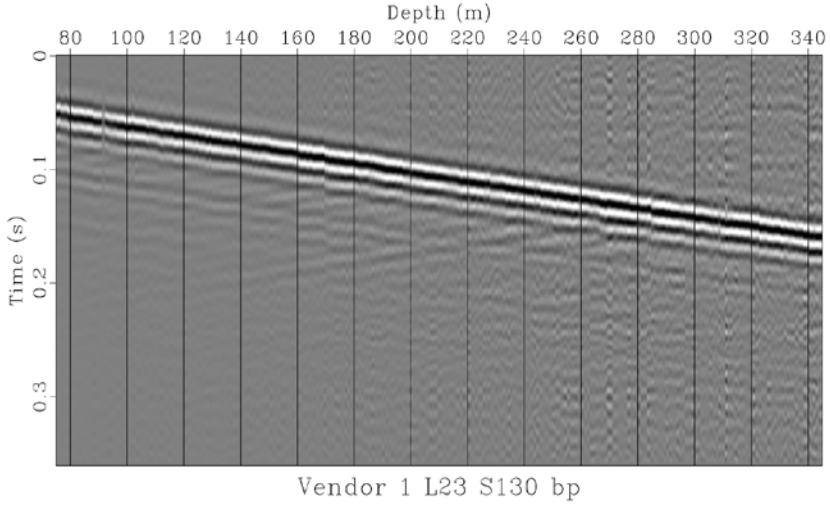


Vendor 1 L23 S130 bp 50Hz

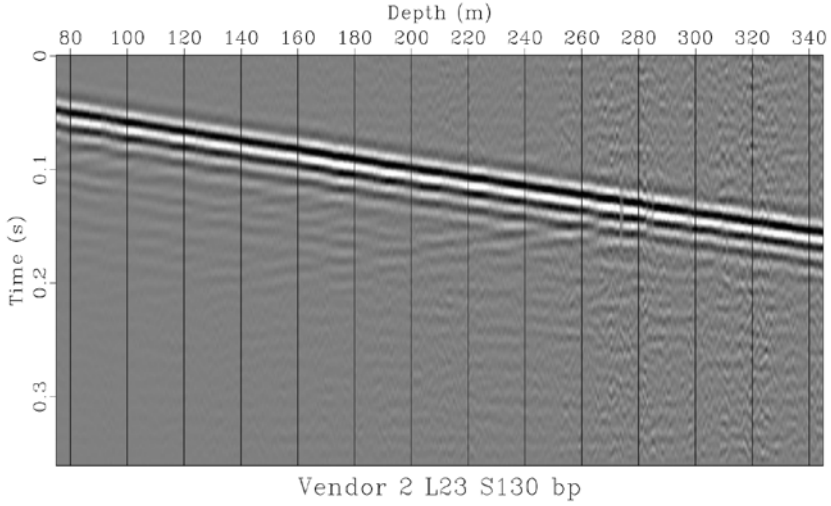
Filtered DAS VSP shot gathers



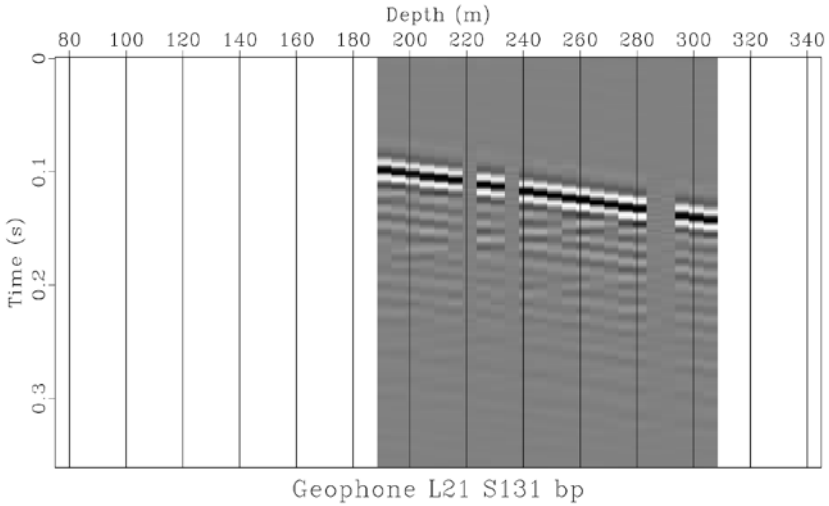
Geophone L23 S130 bp



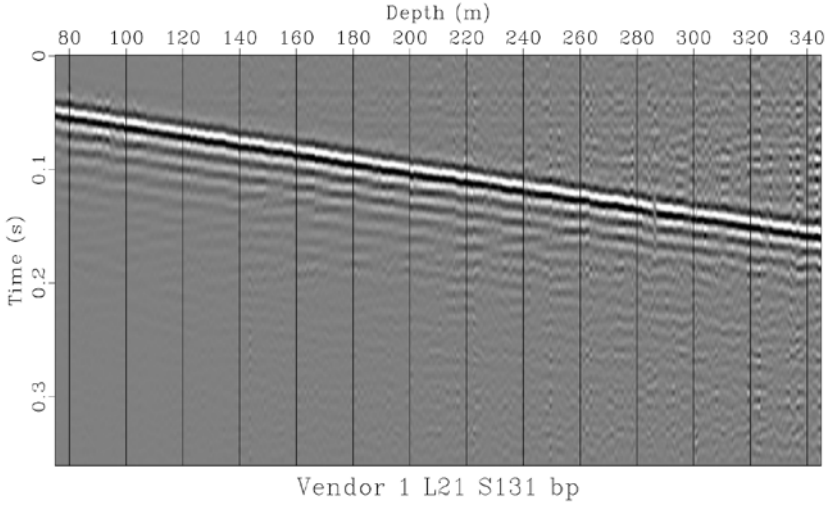
Vendor 1 L23 S130 bp



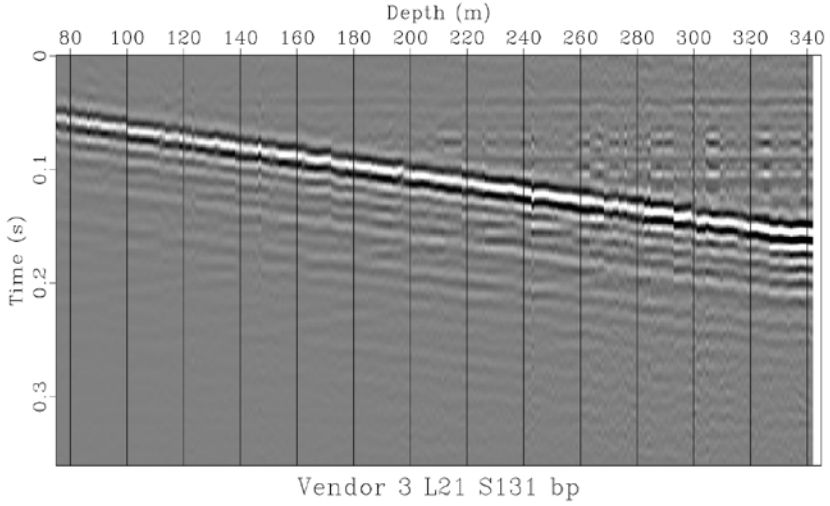
Vendor 2 L23 S130 bp



Geophone L21 S131 bp

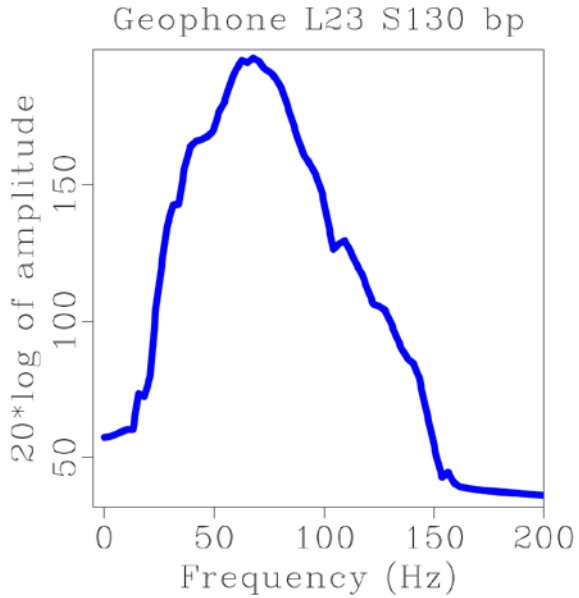


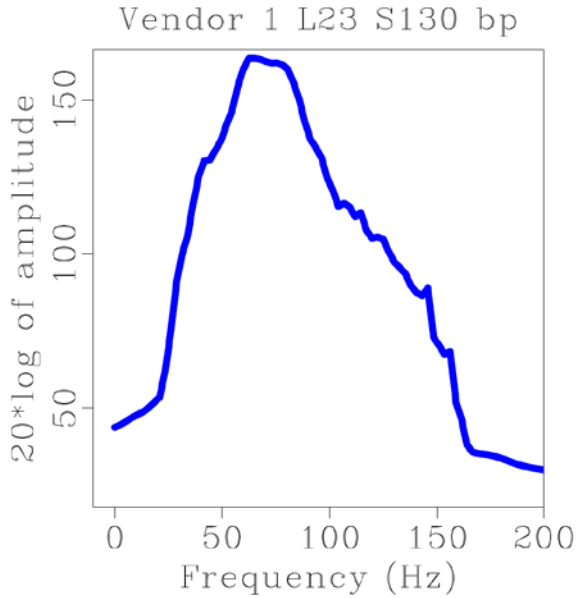
Vendor 1 L21 S131 bp

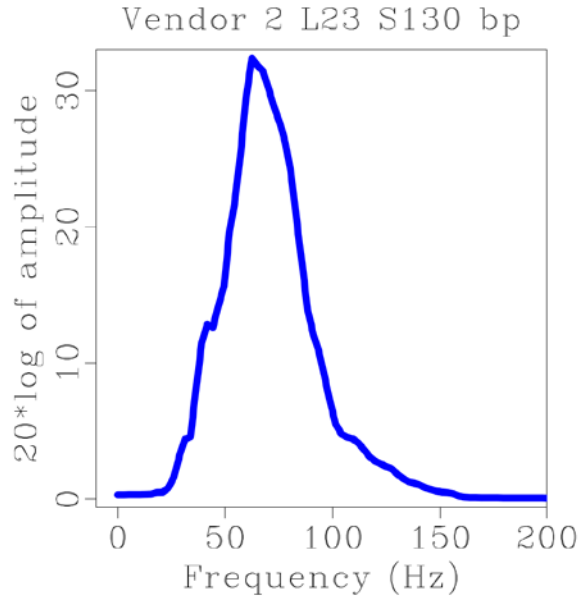


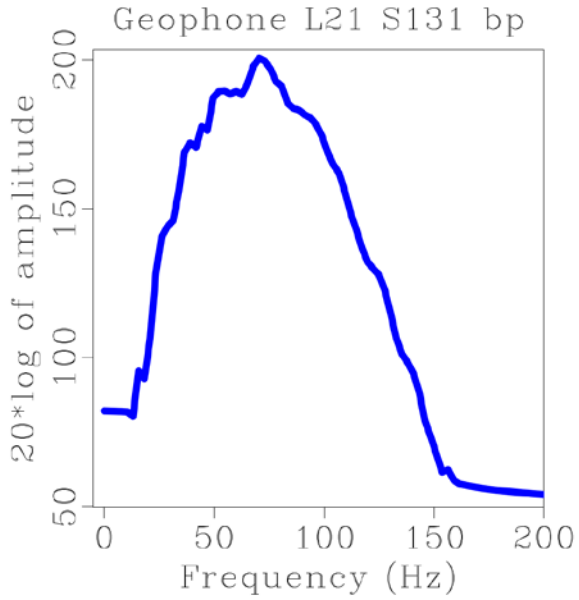
Vendor 3 L21 S131 bp

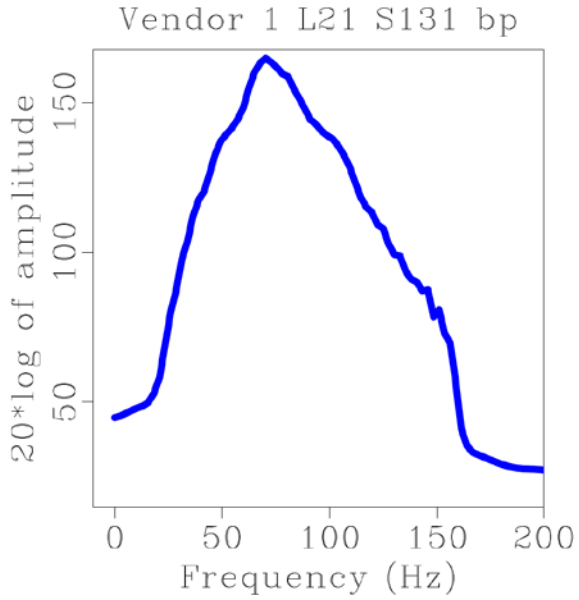
Filtered DAS VSP frequency spectra

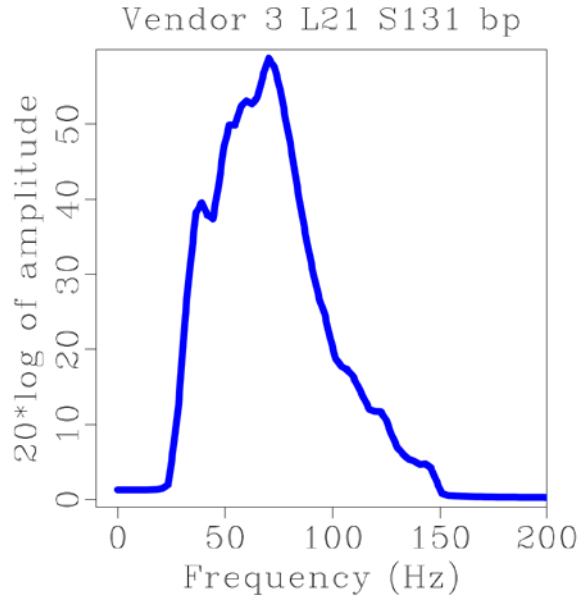




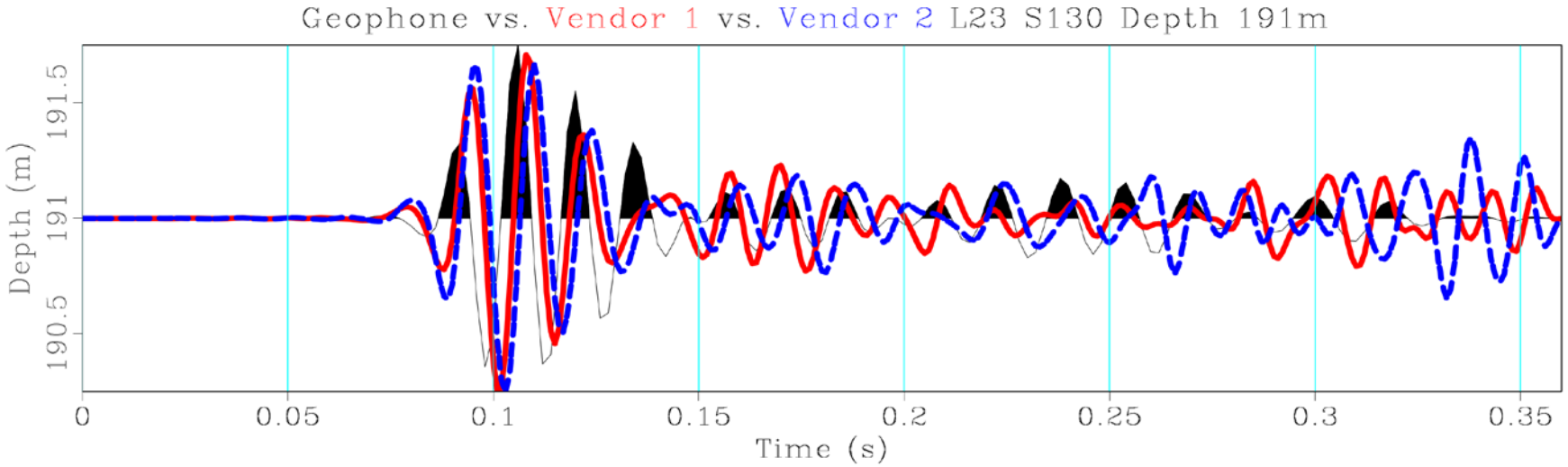


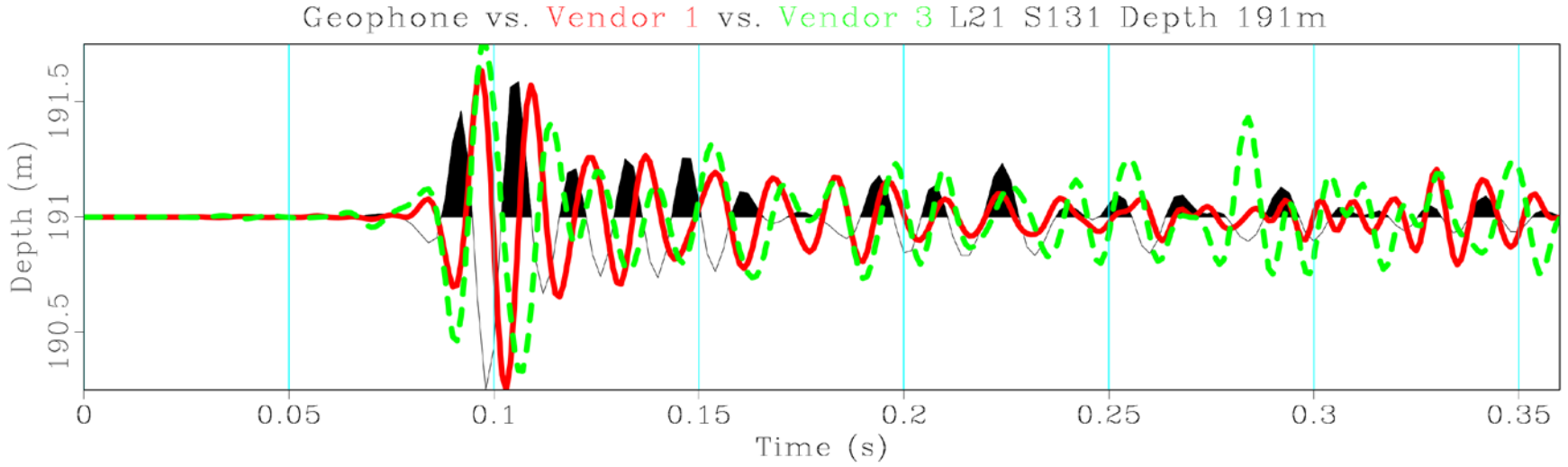






Individual traces comparison





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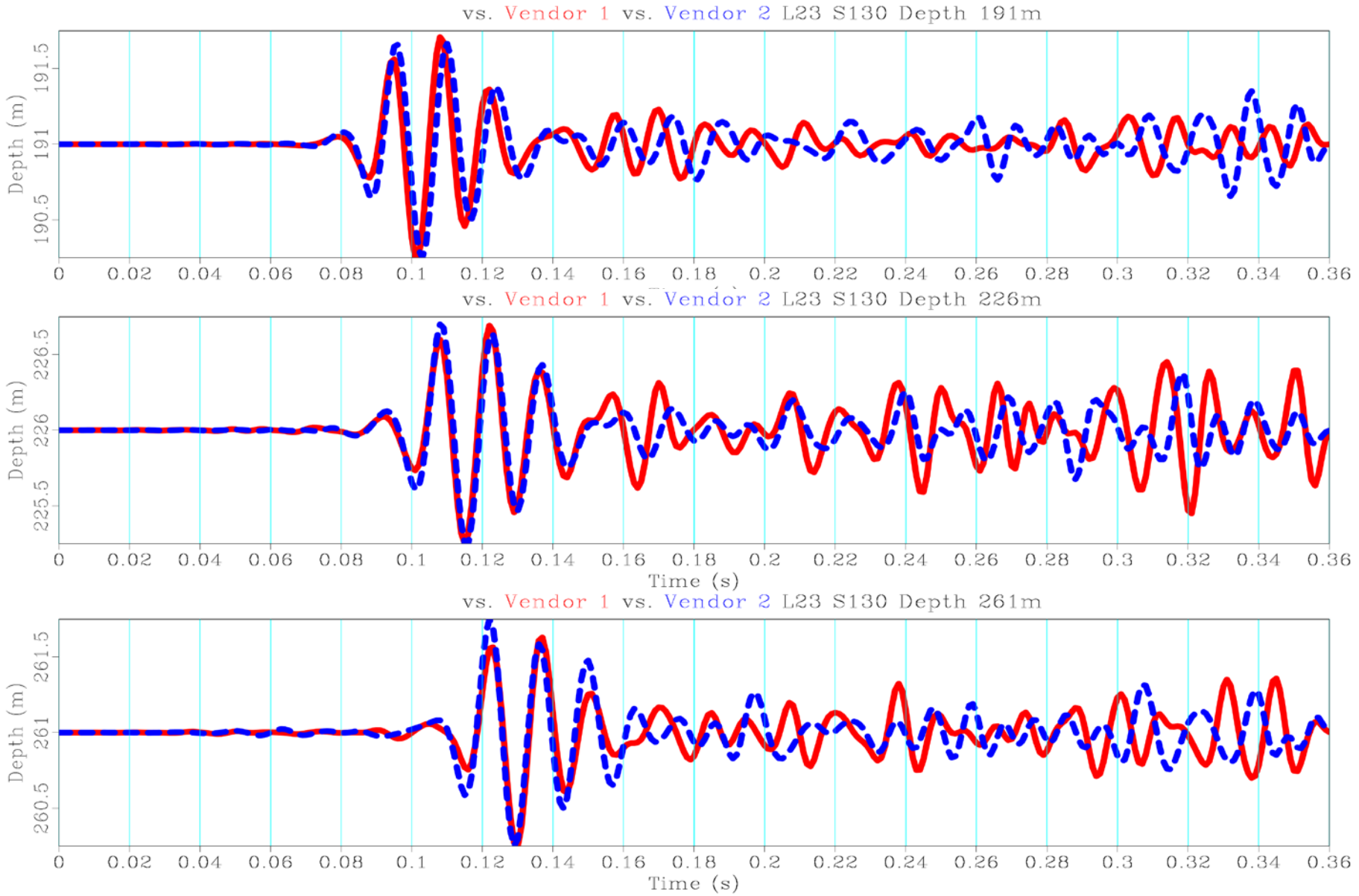

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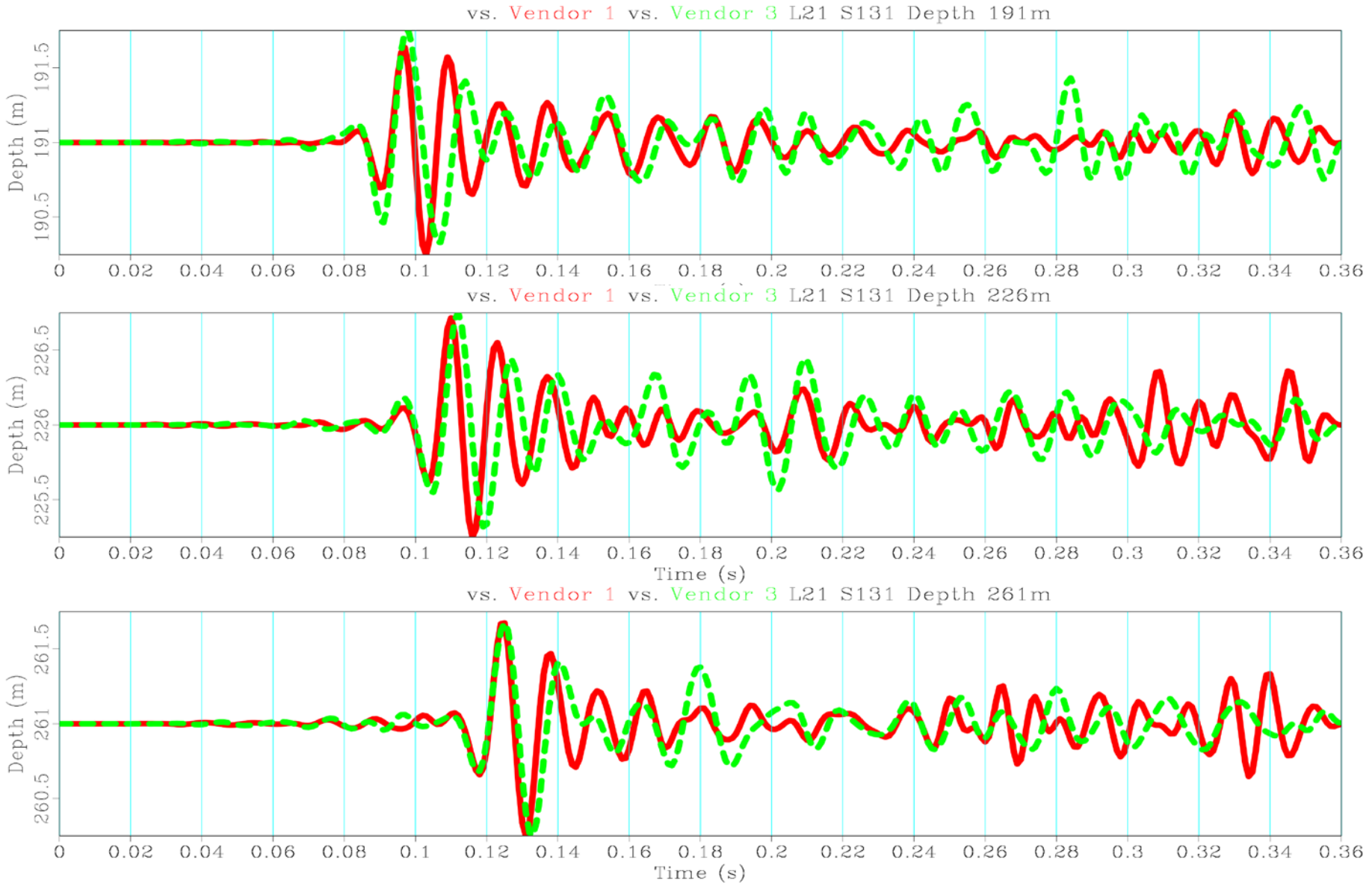

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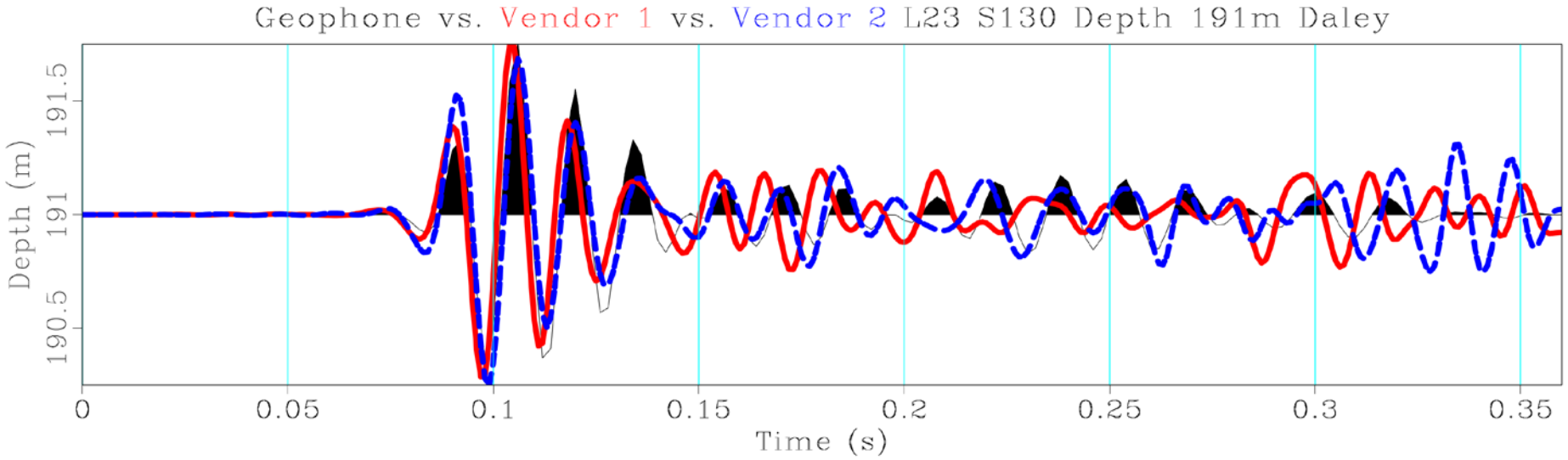

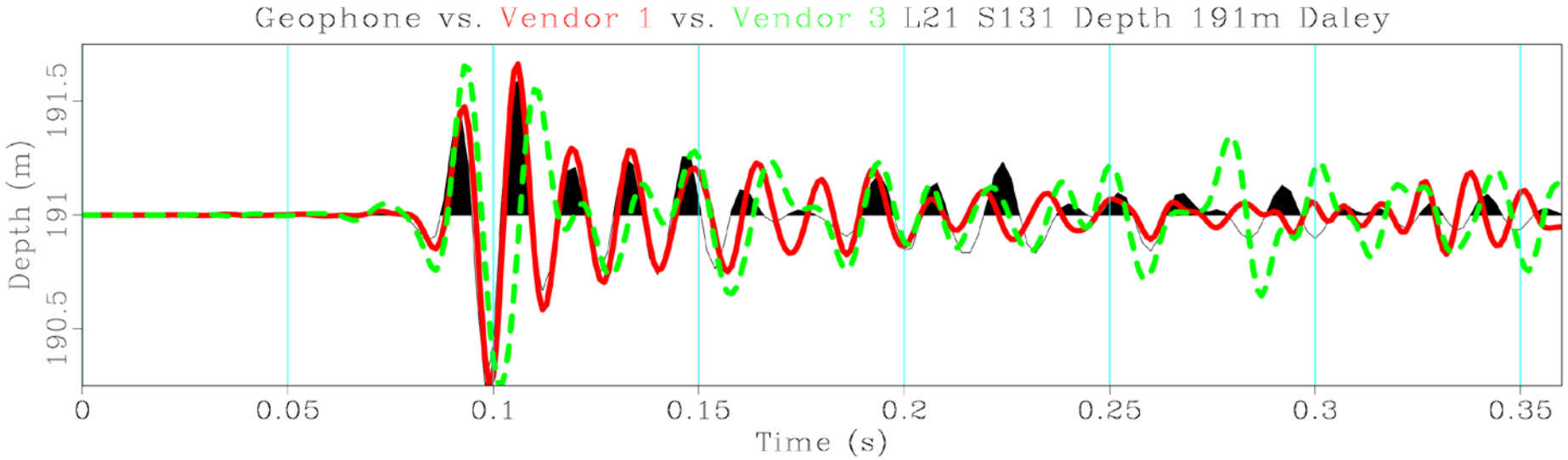

Summary

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Acknowledgements

UNIVERSITY OF CALGARY
Global Research Initiative
in Energy Research

This research was undertaken thanks in part to funding from the Canada First Research Excellence Fund

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Containment &
Monitoring Institute

CREWES

Any questions or comments?

You can find me at:

Jorge.monsegnyparra@ucalgary.ca