Zero offset VSP processing of fiber optic cable (DAS) and geophone array at the CaMI Field Research Station

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Outline

- Introduction
- Data set
- Processing
- Results
- Conclusions
- Future work
- Acknowledgments





















CaMI FRS



Southern Alberta

~ 200 Km SE of Calgary

Newell County















Animation obtained from: https://silixa.com/resources/what-is-distributed-sensing/

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New technologies



Distributed Acoustic Sensing (DAS)

Advantages

- Low-cost acquisition once installed
- Non-intrusive
- Full vertical coverage
- Ability to use preinstalled fiber optic cables for DAS measurements.

Limitations

- Upfront cost of the fiber optic cable deployment
- Lower signal-to-noise ratio (S/N) than geophones
- Uncertainty in the precise locations of the DAS channels along the well
- For straight fiber optic cables DAS is only sensitive to axial deformations







New technologies



Observation well 2:

Fiber optic cables (DAS and DTS) 24-level 3C geophone array









CO₂ injection site



- Process two zero-offset VSPs and an offset VSP from the surveys acquired in May and July 2017.
- Compare results of both data sets (DAS and geophone).

Survey Line Vibe Point Offset (m) Vertical Fold

May	13	159	6.39	3
July	21	132	9.18	16
July	21	139	79.10	10











Data set

Source

EnviroVibe: 10-160 Hz 16 s

Receivers

- Geophone array:
 194.9 m 309.9 m, 5 m
- DAS measurements: Channel spacing 0.25 m











DAS shot gather











DAS shot gather











Down loop and up loop calibration





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DAS depth calibration



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DAS depth calibration



First geophone trace	194.9	797
Last geophone trace	309.9	1253
Depth aperture	115	114







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First break times and velocity profiles

DAS











Wavefield separation

DAS

Downgoing wavefield

Geophone











After deconvolution

DAS

-10

-70

dB Value

Downgoing wavefield

Geophone



Upgoing wavefield after deconvolution











Corridor stack mute and corridor stack

5016

4816

SHOT

CHAN

TIME (ms)

100

150

200

250

300-

4016

DAS

4016

4216

4416

4616

SHOT

CHAN

TIME (ms)

200

250

300

Corridor stack mute

4416

4616

4816

5016

4216





Geophone







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Zero-offset vibe point 132 (July)











211

Zero-offset vibe point 159 (May)











Offset vibe point 139 (July)











- Two VSP surveys were acquired at the Field Research Station in May and July, 2017. A geophone array and a fiber optic (DAS) cable was deployed in the observation well 2.
- Two zero-offset VSPs and an 80 m source-well offset VSP were processed using a standard processing flow.
- DAS data set was calibrated with the geophone array to properly identify the corresponding depth of each trace. A difference between 0 to 3 m was calculated from the calibration.
- There is a good match between the corridor stack of the upgoing and downgoing fibre loop.







Future work

- Process the walk-away VSP surveys acquired in May and July 2017 for both data sets.
- DAS signal conversion in order to retrieve a more precise comparison between the signal recorded with the fiber optic cable and the geophone array.
- Process the helical-wound fiber optic data set and compare it with the geophone data set.









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