

CO₂ monitoring at the CaMI Field Research Station - update



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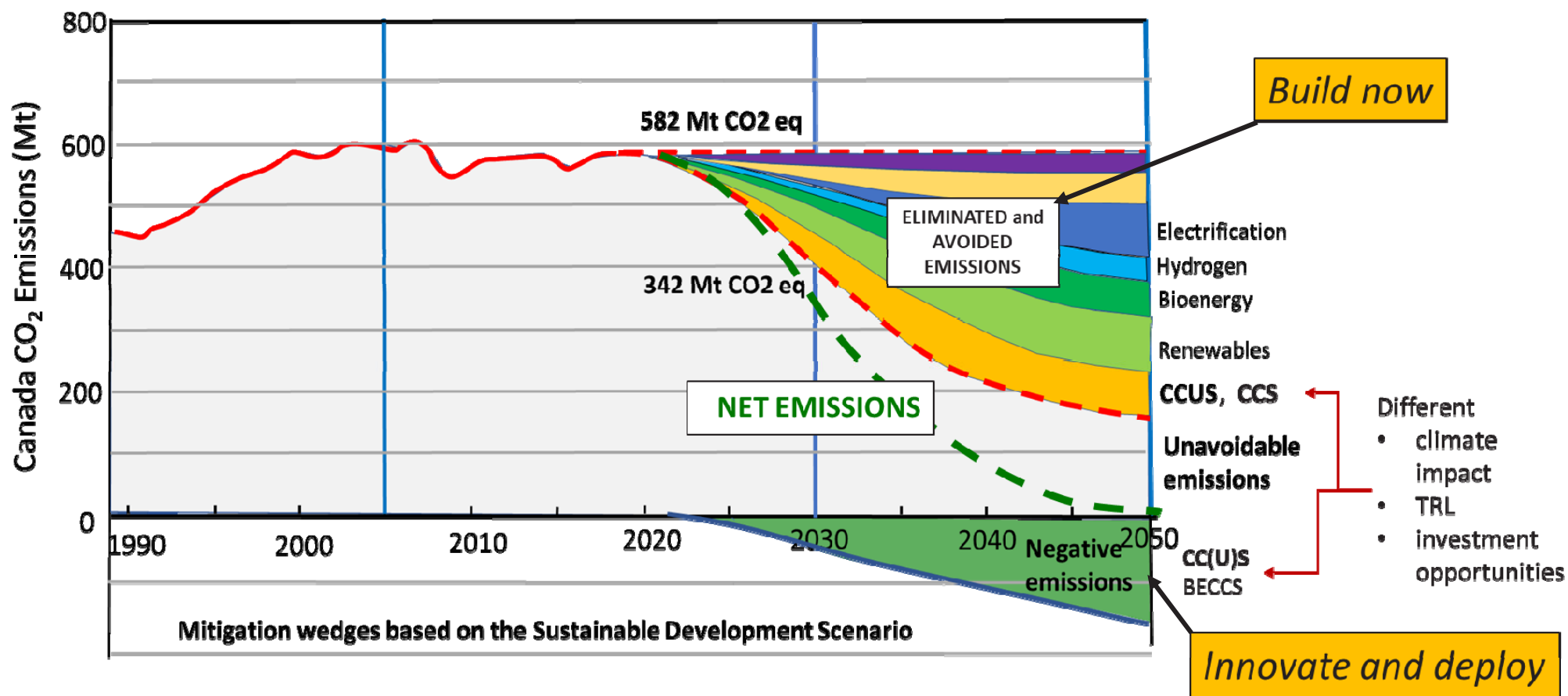
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³Explor, ⁴STRYDE



UNIVERSITY OF CALGARY
Global Research Initiative
in Energy Research

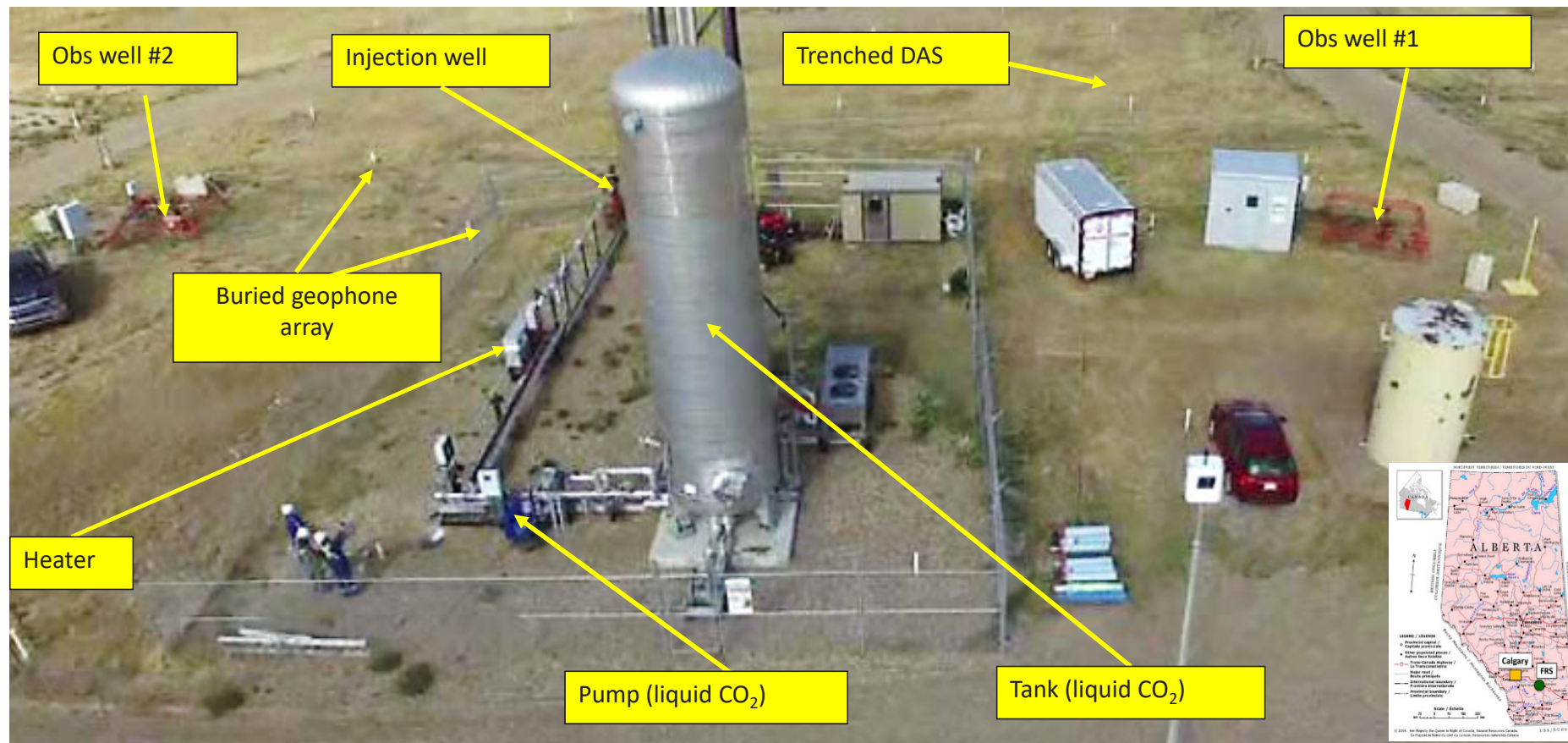
Pathways to a net zero carbon economy



Don Lawton & Steven Bryant



CMC CaMI Field Research Station

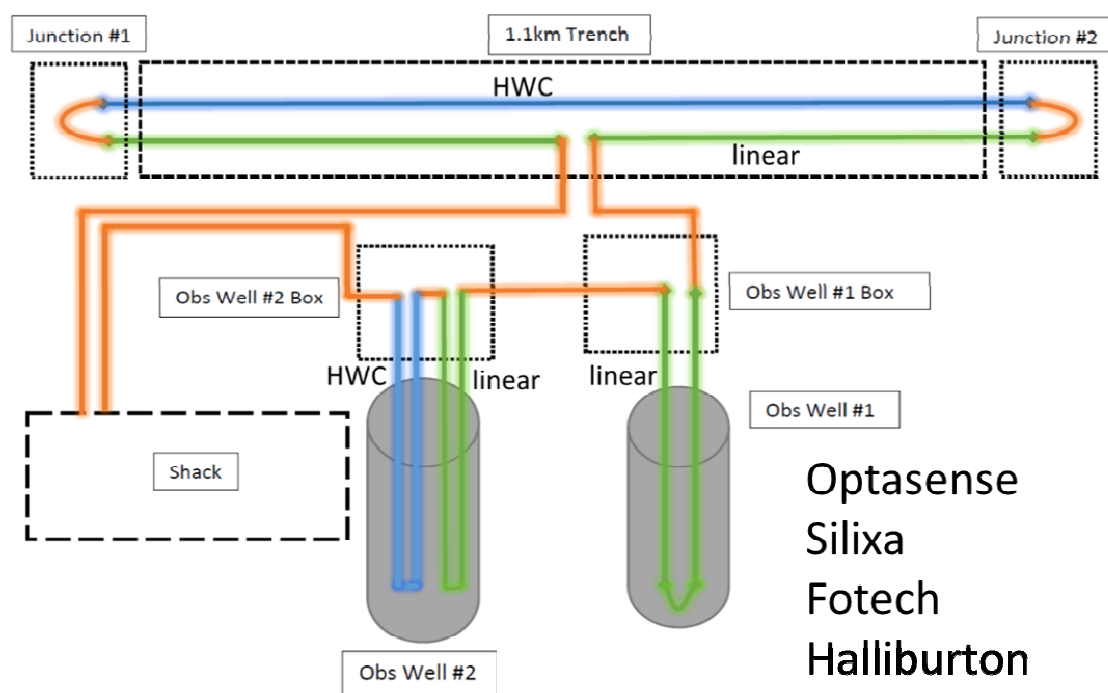






Seismic monitoring innovation

Optical fibre (DAS)



Optasense
Silixa
Fotech
Halliburton
Onyx

NEW ENERGY CCUS / Seismic and Exploration

STRYDE, Explor And Carbon Management Canada Say Record Set In Seismic Imaging

Wednesday, June 2, 2021, 12:57 PM MDT

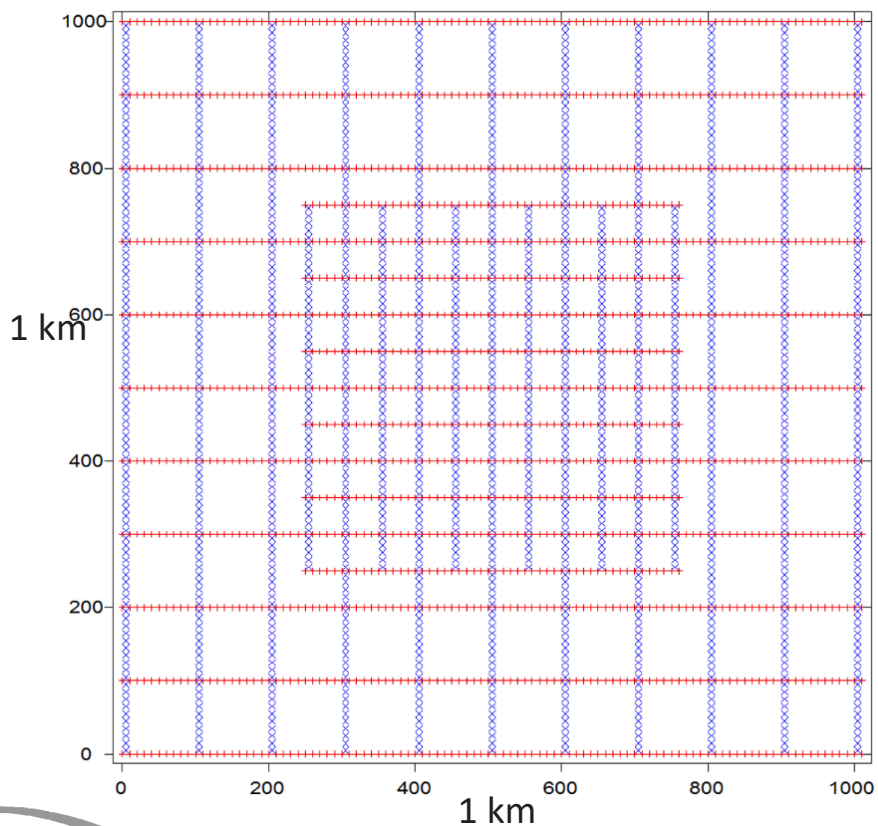


DOB June 2, 2021



Ultra-high-density 3D surface seismic survey

2014 baseline legacy survey



2021 UD3D



Explor. STRYDE, CMC

Al Châtenay, Explor

Receivers for UHD3D surface seismic survey



STRYDE nodes

- Total of 19,872 nodes laid out over 1 km x 1 km area.
- 4 person location marking, no surveying
- Nodes laid out on a 7.5 m x 7.5 m grid
- 2 lines of 3C nodes included

Sources for UHD3D surface seismic survey



Ultra-Light Seismic Source System

- ▶ Impulsive chemical seismic source
- ▶ Tool weighs less than 1 kg, less than 10 kg total
- ▶ Integrated RTK GNSS positioning
- ▶ Variable energy levels, sizes, characteristics
- ▶ Modular, adaptable to different conditions

9,041
shots



Al Châtenay, Explor

UofC Envirovibe
3,910 VPs





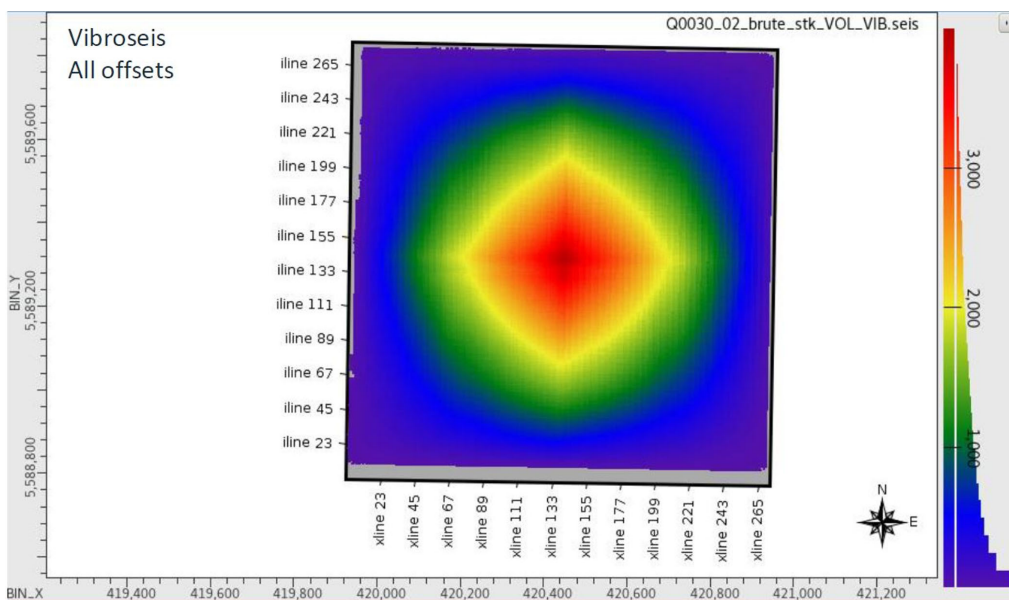
UHD3D surface seismic survey summary

Receivers	Source #1	Source #2
STRYDE nodes	PinPoint	Envirovibe (10-120 Hz) over 10 seconds
135 receiver lines	134 shot lines	34 shot lines
7.5 m x 7.5 m grid	3 x interleaved 15 m x 15 m grids (nominal)	30 m line x 7.5 m shot.
19,872 nodes	9,041 shots	3,910 shots
Binning: 3.75 m x 3.75 m	Binning: 3.75 m x 3.75 m	Binning: 3.75 m x 3.75 m

256 million raw traces collected

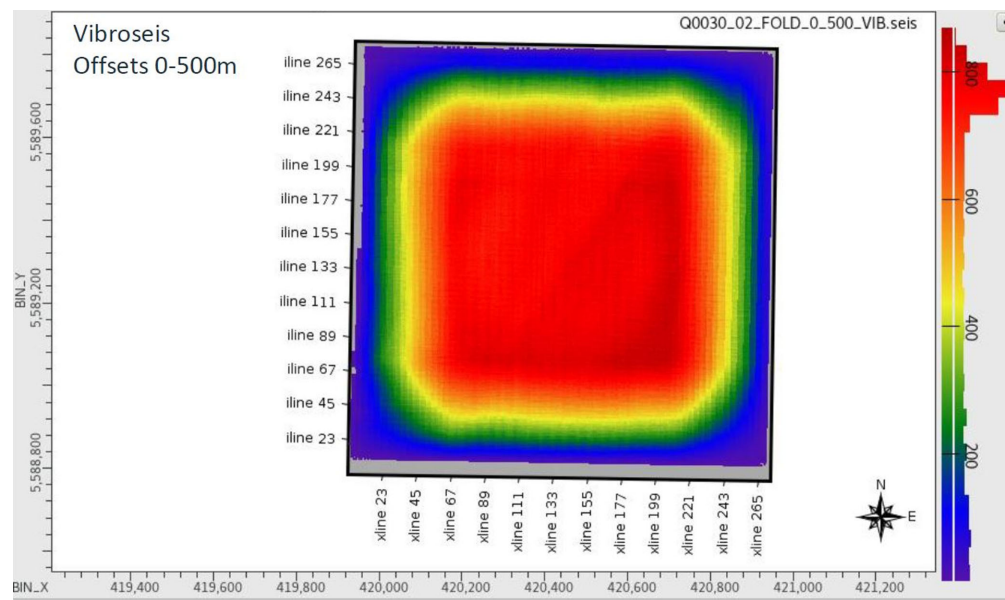
Fold for Envirovibe survey

All offsets (max 1.43 km)



Max fold = ~4,000

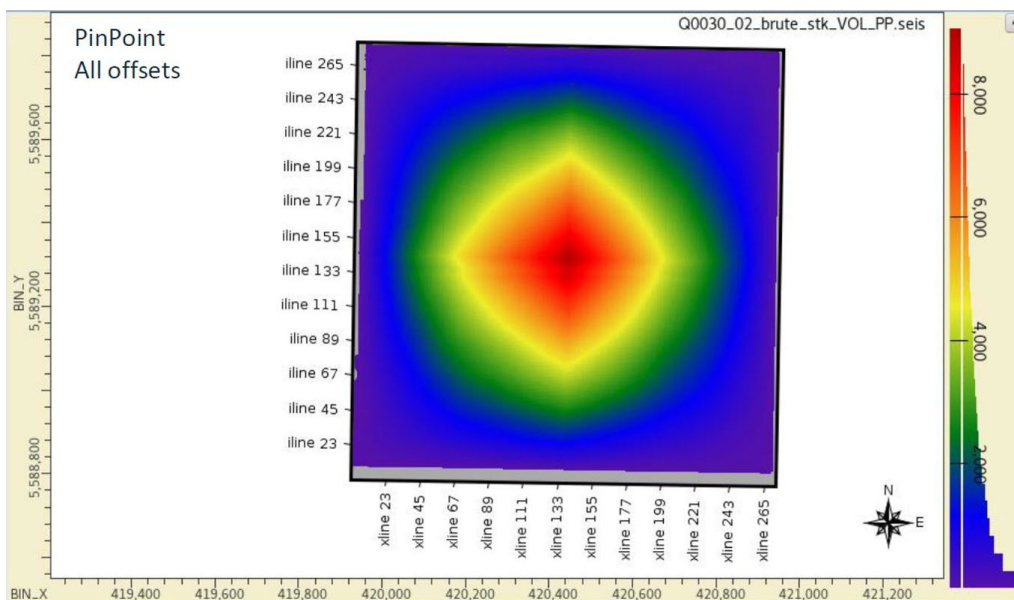
Offsets 0 – 500 m



Max fold = ~830

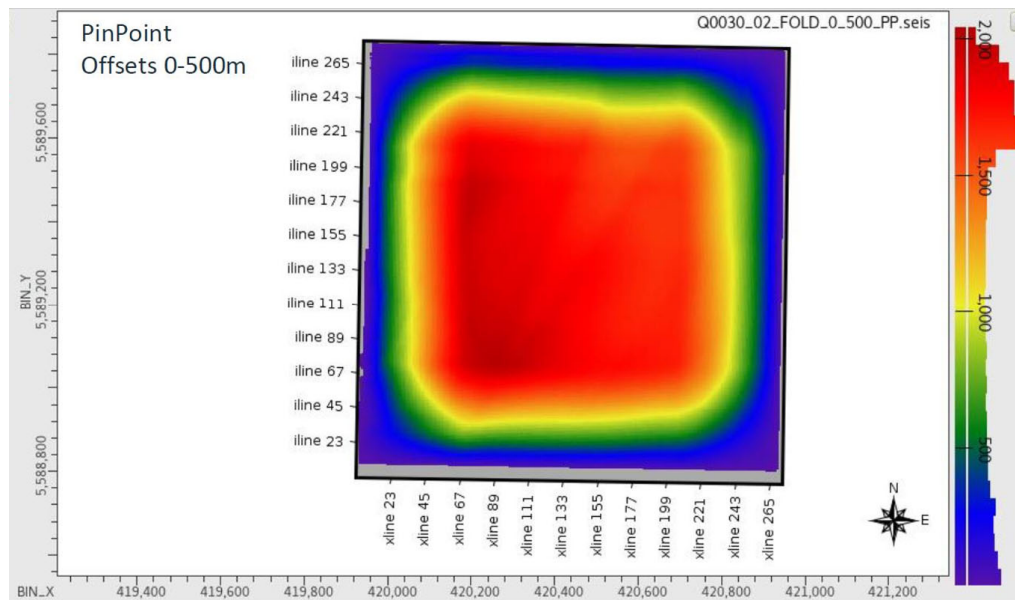
Fold for PinPoint survey

All offsets (max 1.43 km)



Max fold = ~8,800

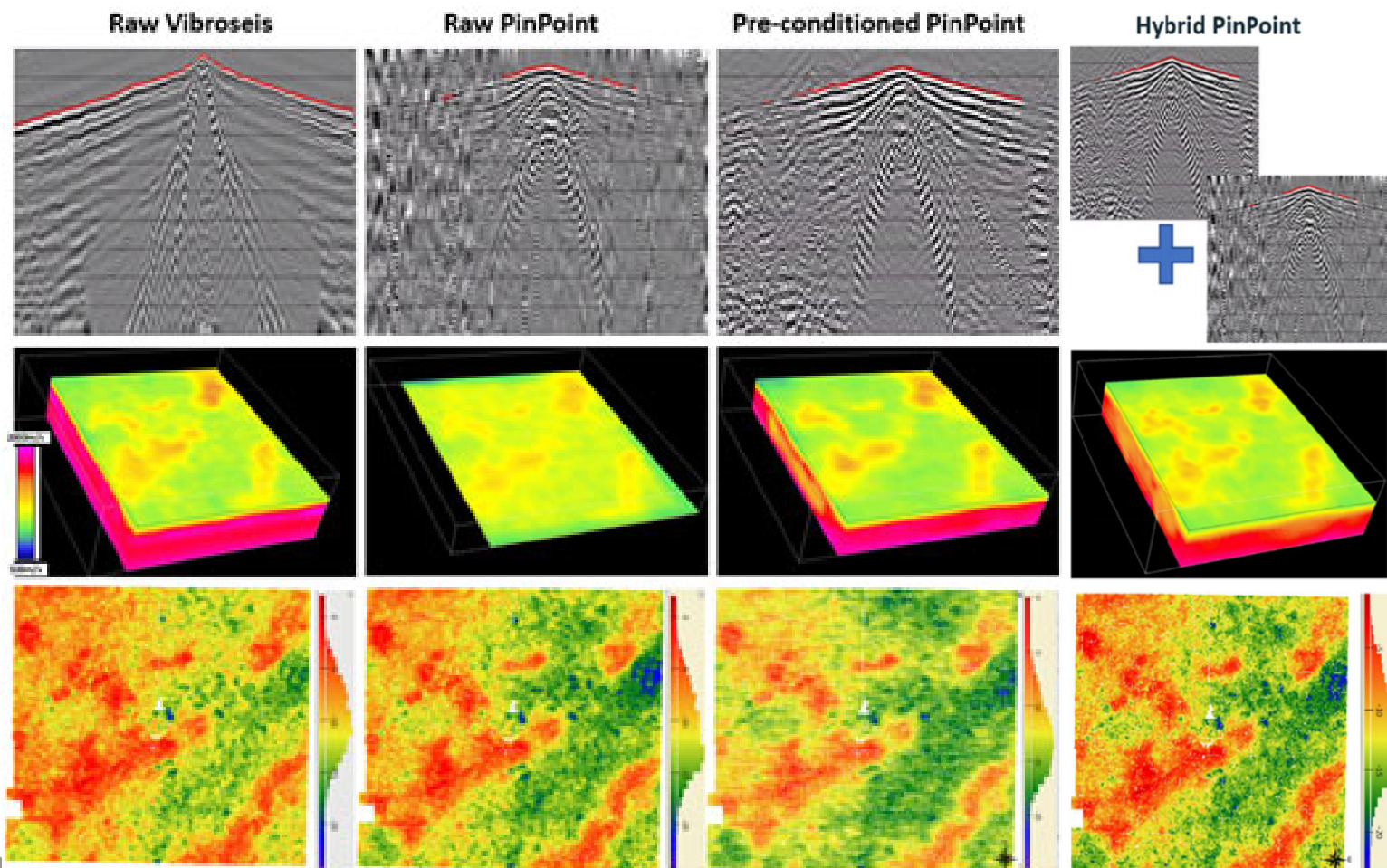
Offsets 0 – 500 m



Max fold = ~2,020

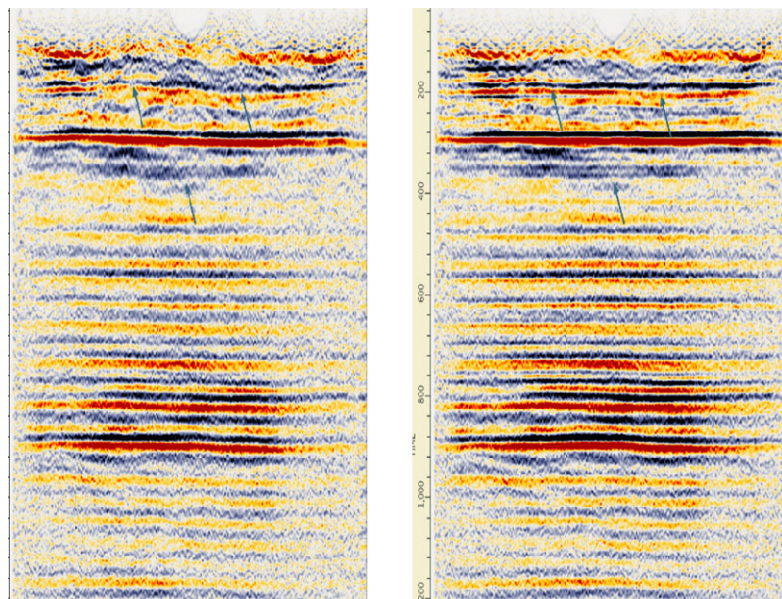


Near-surface model and statics



Tomo-statics & brute stacks

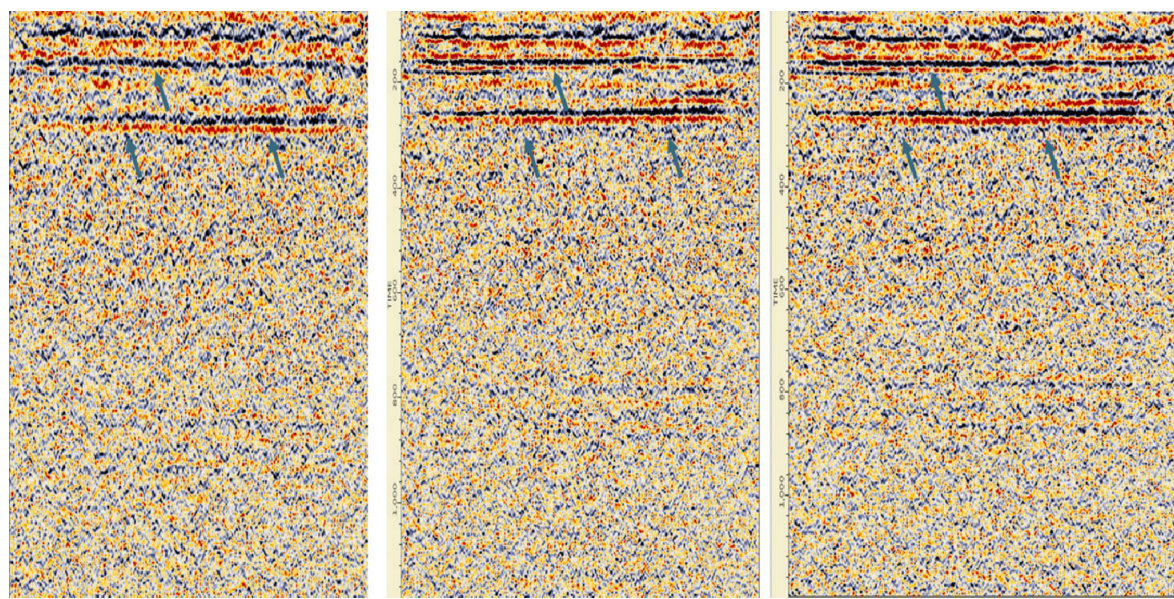
Envirovibe



No statics

Tomo statics applied

PinPoint



No statics

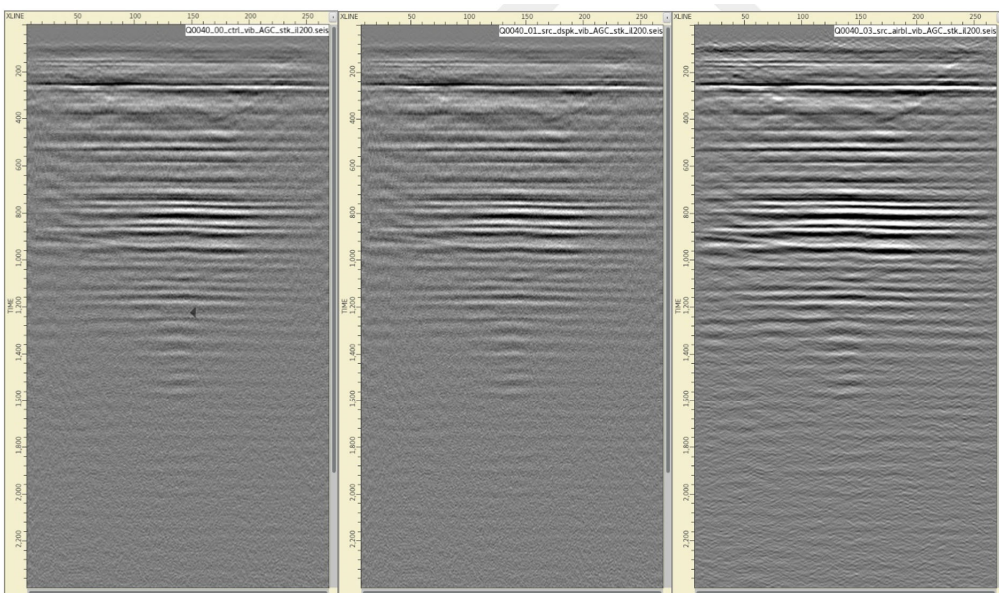
Tomo statics applied

Tomo statics applied
after preconditioning



Noise reduction processing

Envirovibe

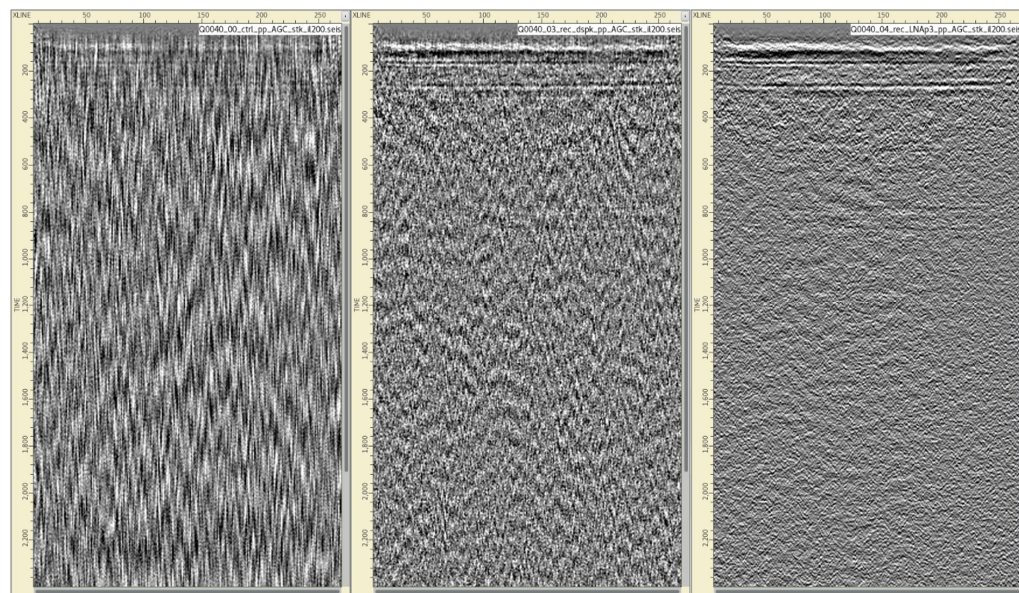


Control stack

Despike

LNA + RNA

PinPoint



Control stack

Despike

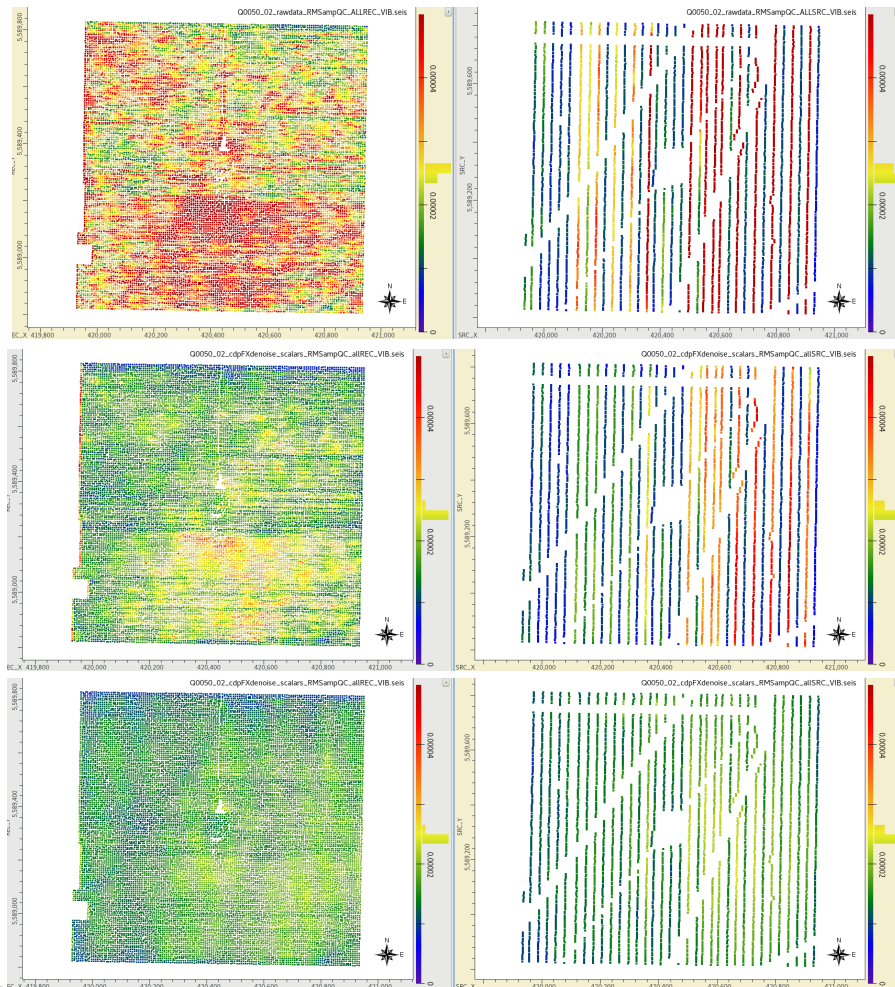
LNA + RNA



Surface consistent amplitude scaling (SCAMP)

Receivers

Shots



RMS amplitudes, no CMP denoise

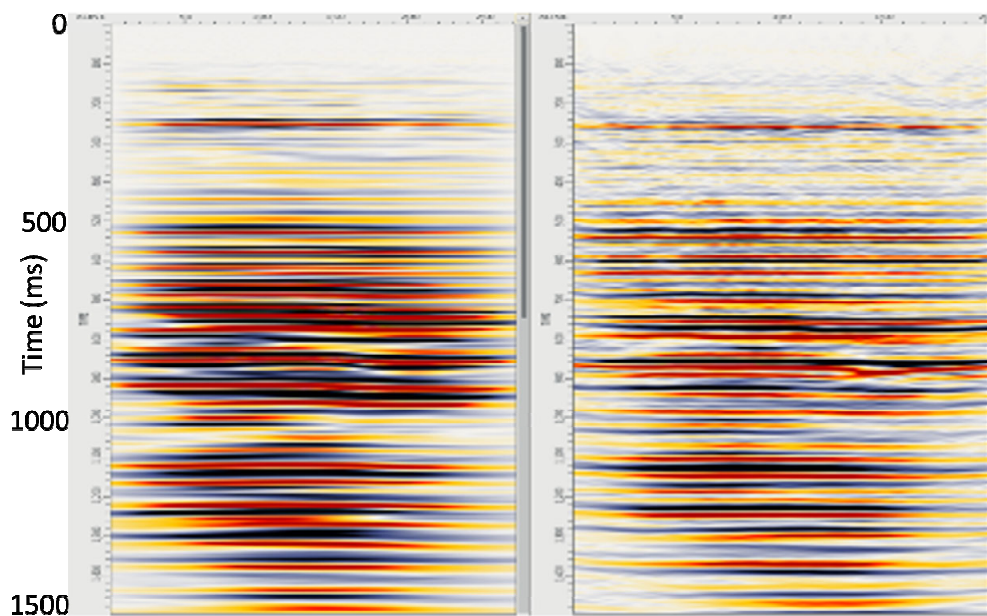
RMS amplitudes, with CMP denoise

RMS amplitudes, with CMP denoise and
SCAMP

Initial post-stack time migrated sections

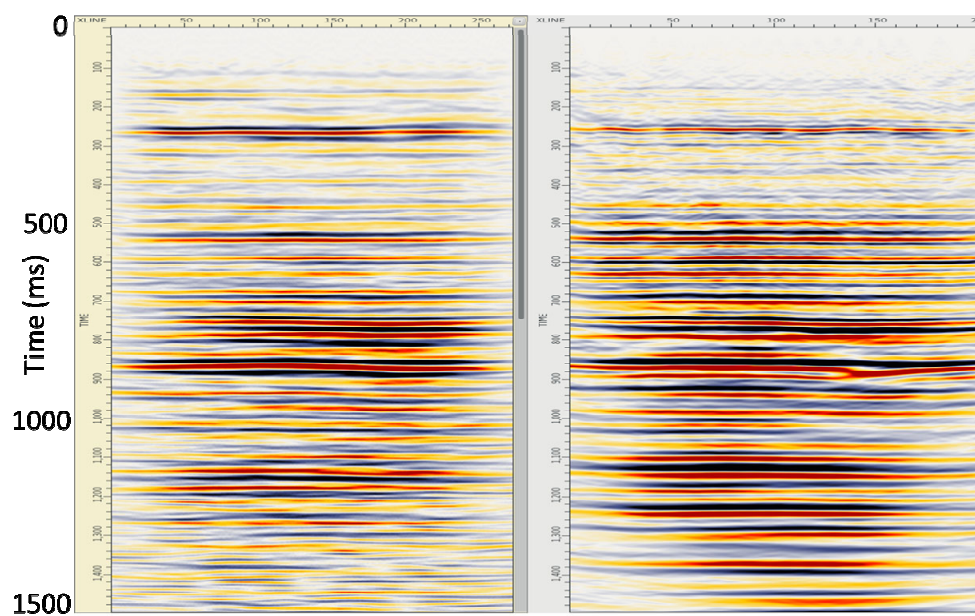
Envirovibe

Baseline

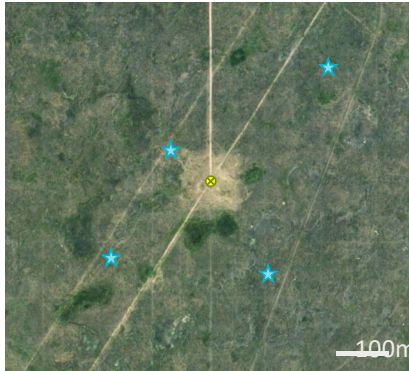


PinPoint

Baseline



SADAR® passive seismic monitoring



Four SADAR arrays are deployed at CaMI at different distances from the injection well and of different array designs in order to refine performance understanding.

SADAR is a compact, phased array that maximizes:

Signal to noise

- This benefits signal detection by increasing the range or distance to source

Frequency

- Frequency fidelity not only improves source classification but also aids in noise cancellation

Azimuth

- Three-dimensional direction finding improves source location and clutter rejection

SADAR's Network comprises multiple arrays to determine source location and identification

Reduced footprint of sensors

- Environmental and land-owner benefits, no deep boreholes

Flexible array locations

- Accommodate cultural and natural impediments

SADAR's Processing Pipeline is a reductive process of signal and information analytics

Real-time and Automatic

- Persistence with purpose to deliver actionable information

Detect, Associate, Locate, and Identify

Leverage time, frequency, and spatial processing to deliver results

Mike Dahl, Mark Tinker, Caroline Kempf (Geospace and Quantum)



Conclusions and continuing research

- UHD3D survey successful in imaging to PreCambrian basement
- High spatial sampling provided very detailed near-surface model and static corrections
- Processing effort focussed on noise reduction
- CO₂ injection horizon at 300 m depth is well-characterized
- Next steps – pre-stack migrated volumes and time-lapse analysis
- Passive seismic monitoring for CO₂ injection and storage also gaining interest

Acknowledgements

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- Explor
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- Geospace
- Quantum

