Shot record depth migration of georadar

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CREWES

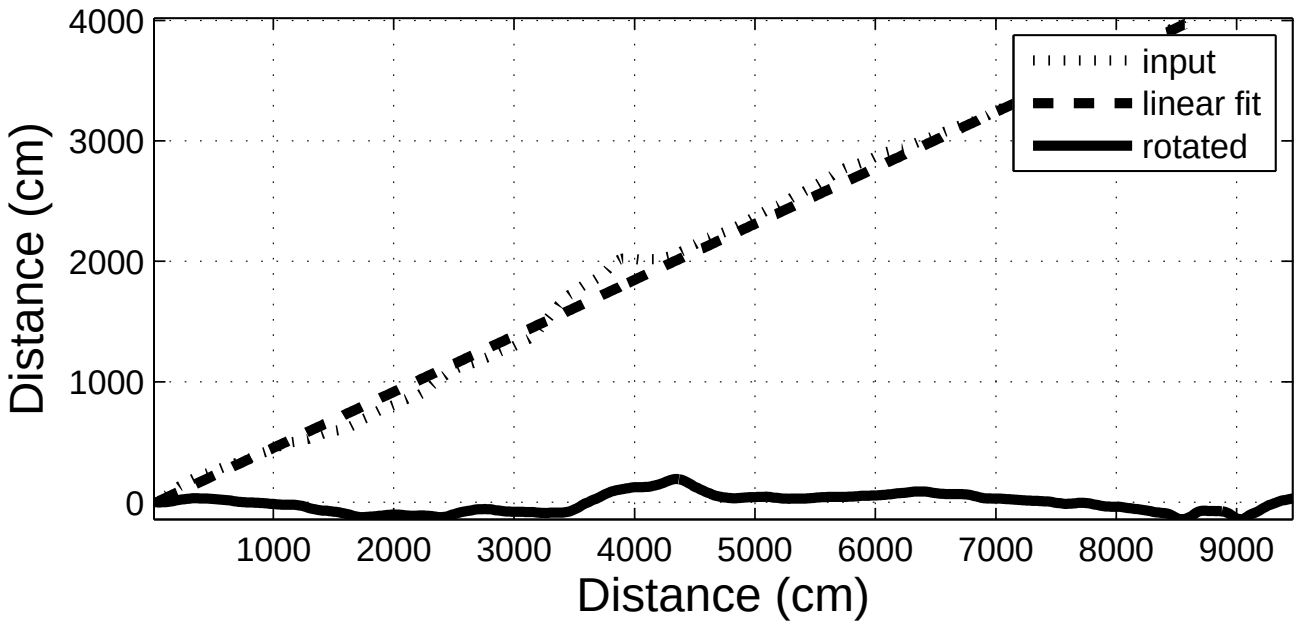
Introduction

- Low dielectric permittivity in basalt causes strong electromagnetic reflections.
- Low conductivity of basalt allows a great depth of penetration.
- A large basalt flood at Craters of the Moon, Idaho contains a plumbing system of volcanic conduits.
- Conduits are metres in height and circumference — need sub-decimetre trace spacings.

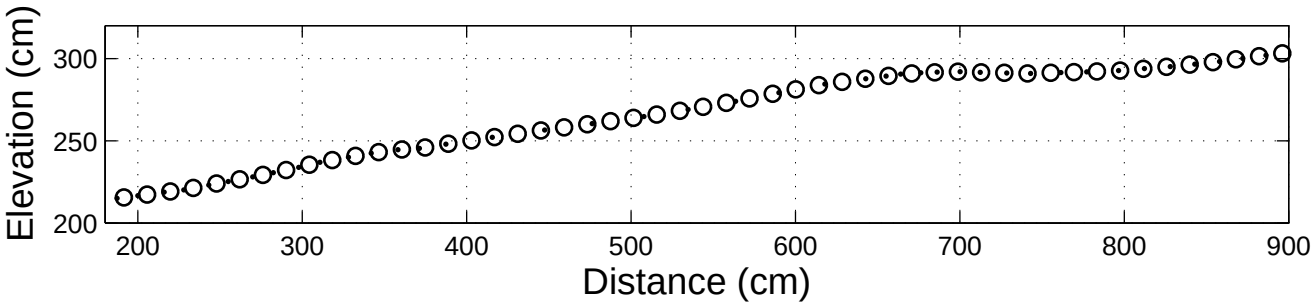
Data preparation

- Survey normalization and rotation.
- Survey regularization.
- Trace regularization.

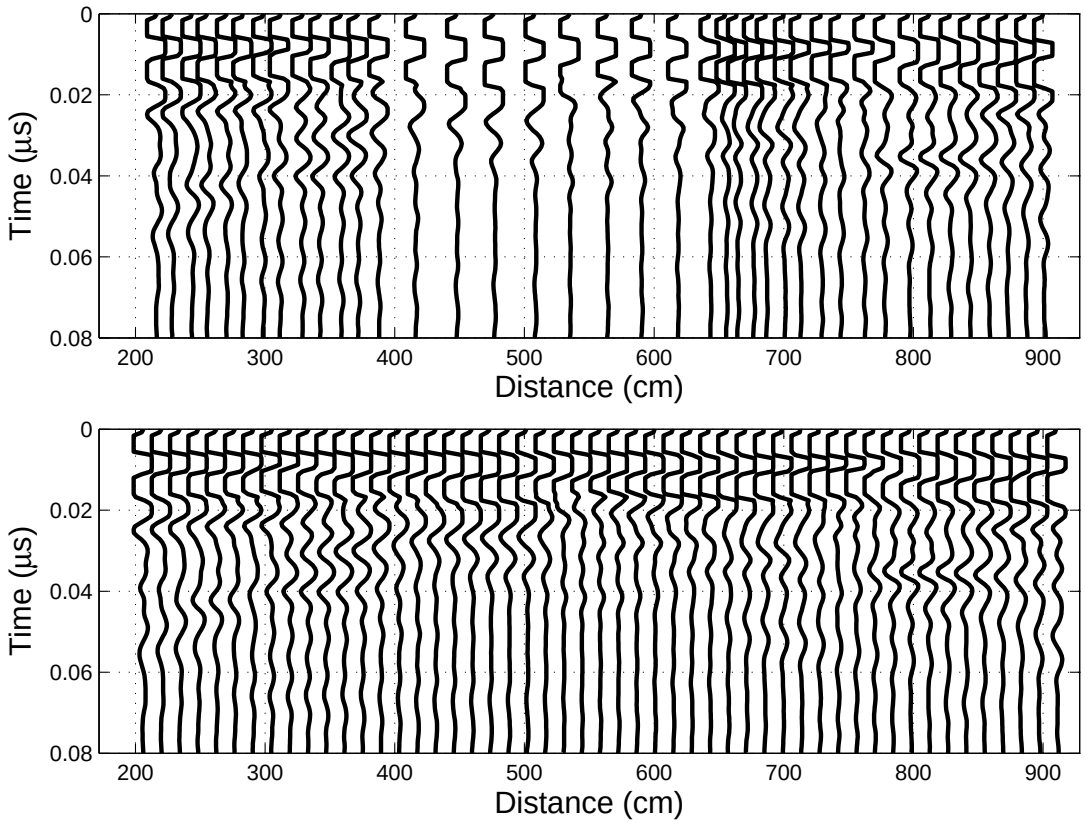
Survey


4000
3000
2000
1000
0
Distance (cm)
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)
input
linear fit
rotated

Survey regularization



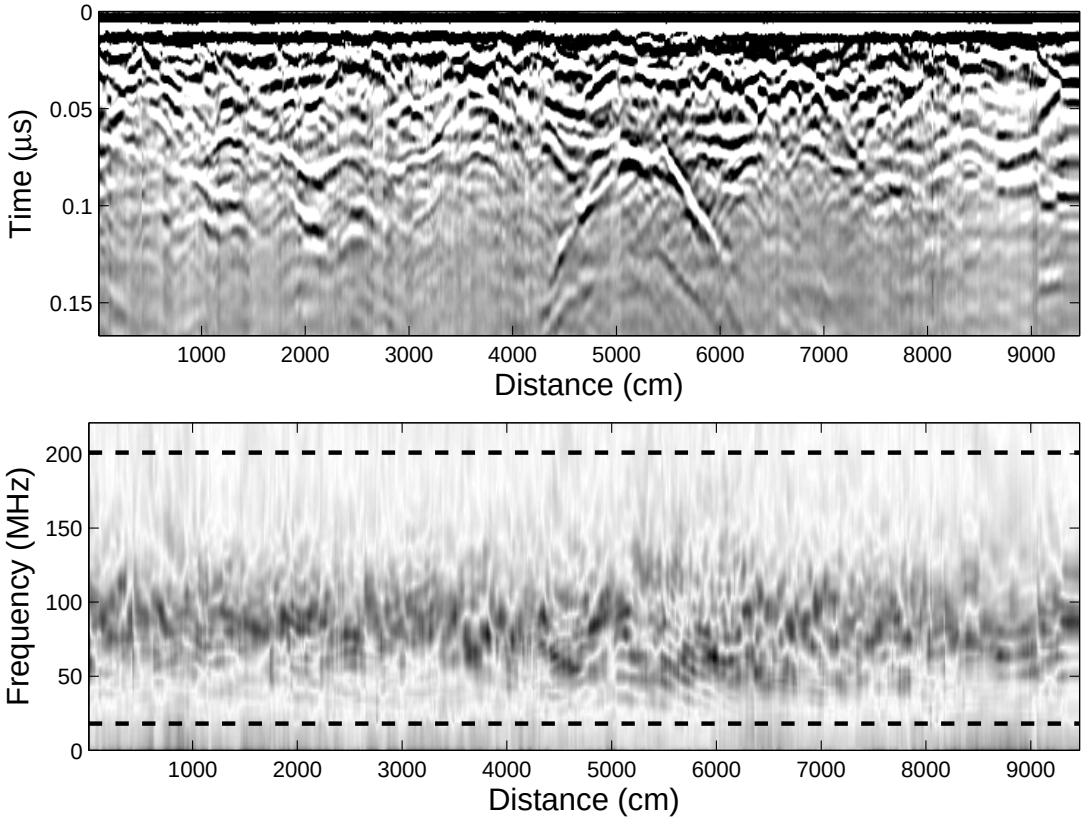
Trace regularization



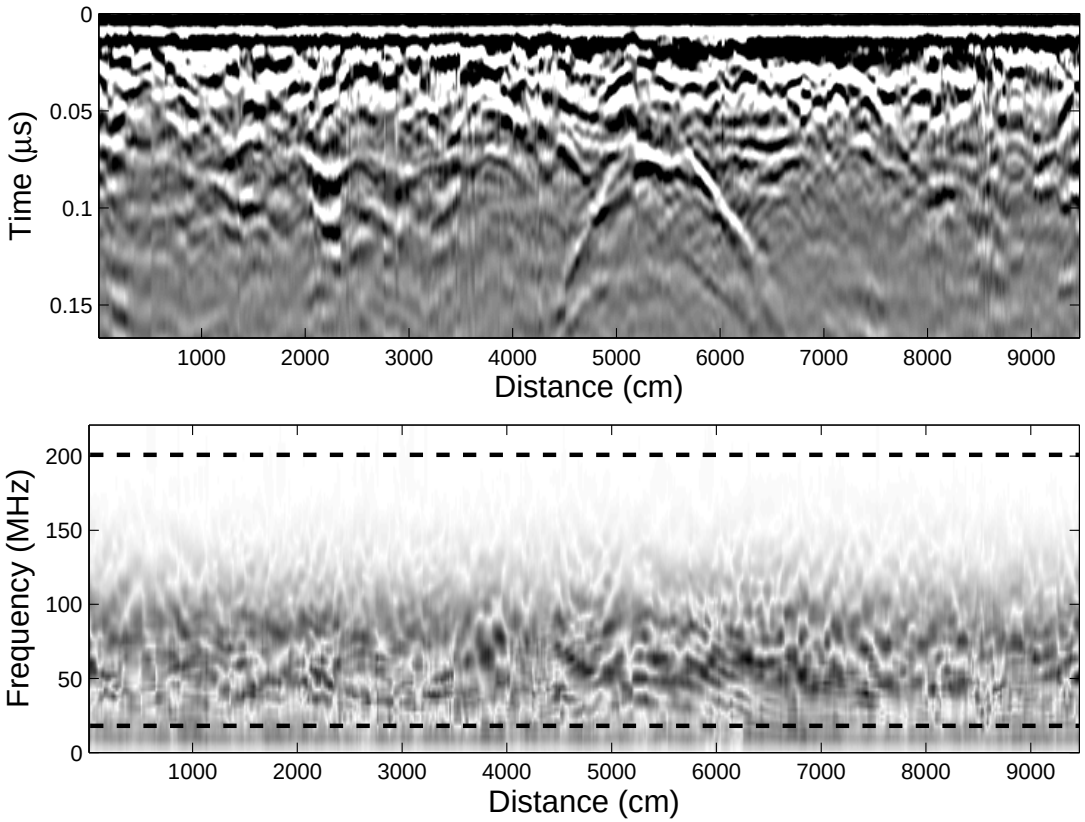
Data processing

- Determine frequency range.
- Spiking deconvolution.
- Gabor deconvolution.

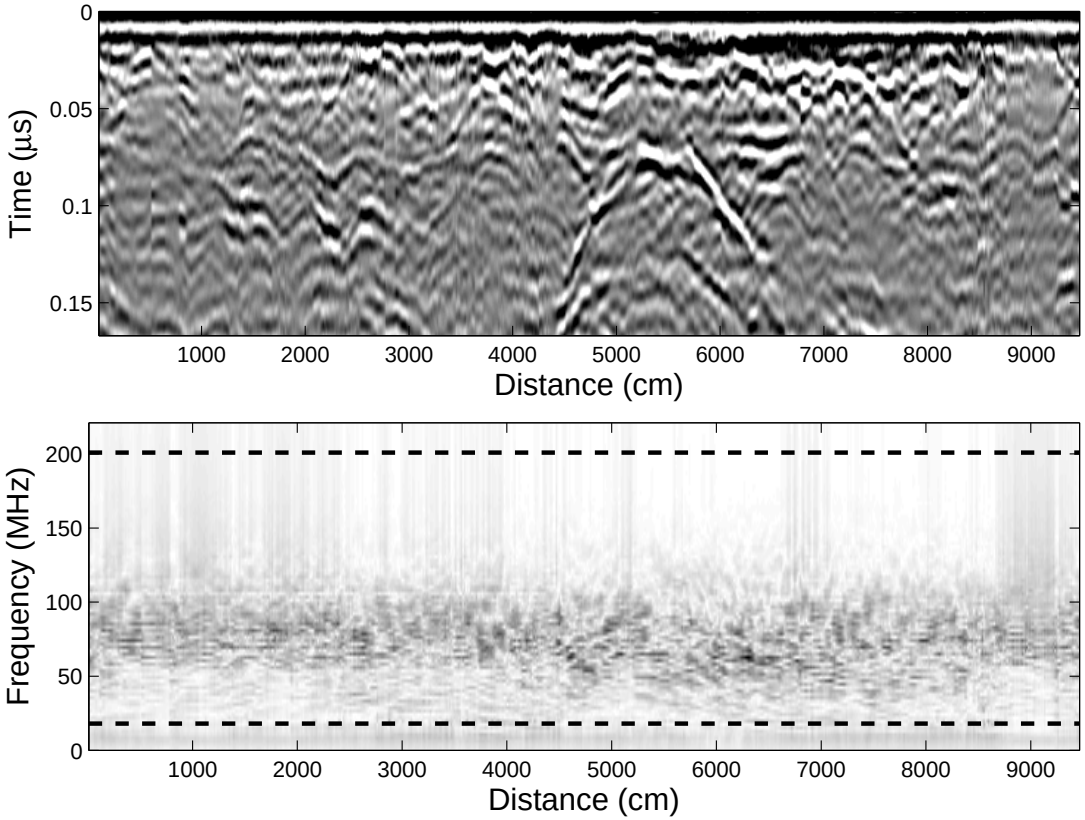
Raw data


Time (μs)
0
0.05
0.1
0.15
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)
Frequency (MHz)
200
150
100
50
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)

Spiking decon



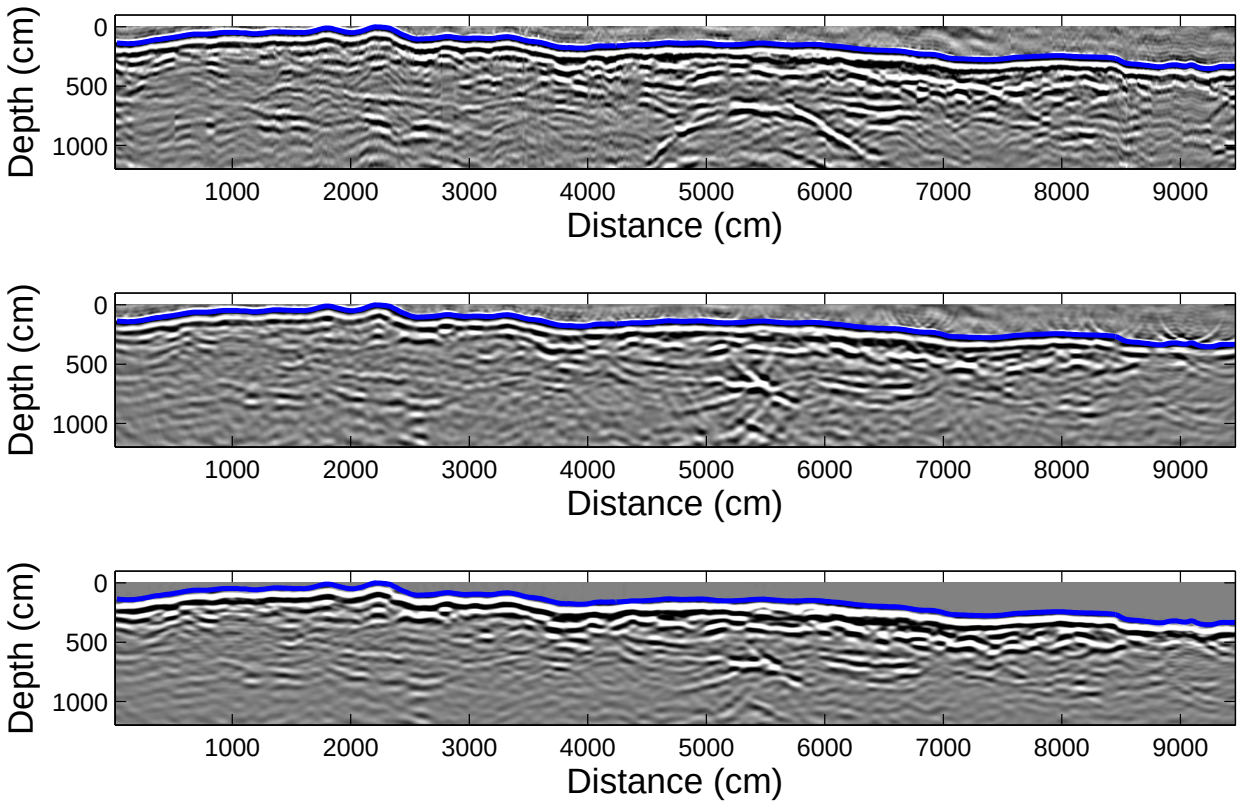
Gabor decon


Time (μs)
0
0.05
0.1
0.15
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)
Frequency (MHz)
200
150
100
50
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)

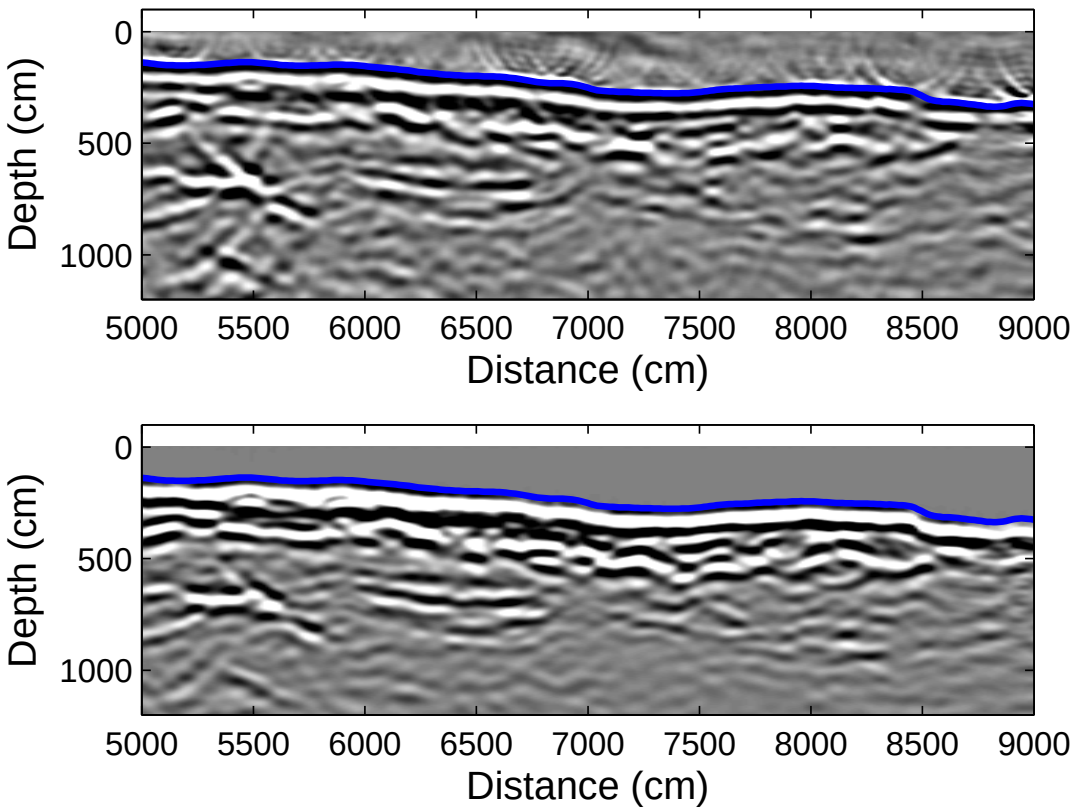
Imaging

- ZOM vs. PSDM.
- ZOM: Gabor + elevation statics $\longrightarrow$ ZOM.
- PSDM: Gabor $\longrightarrow$ PSDM.

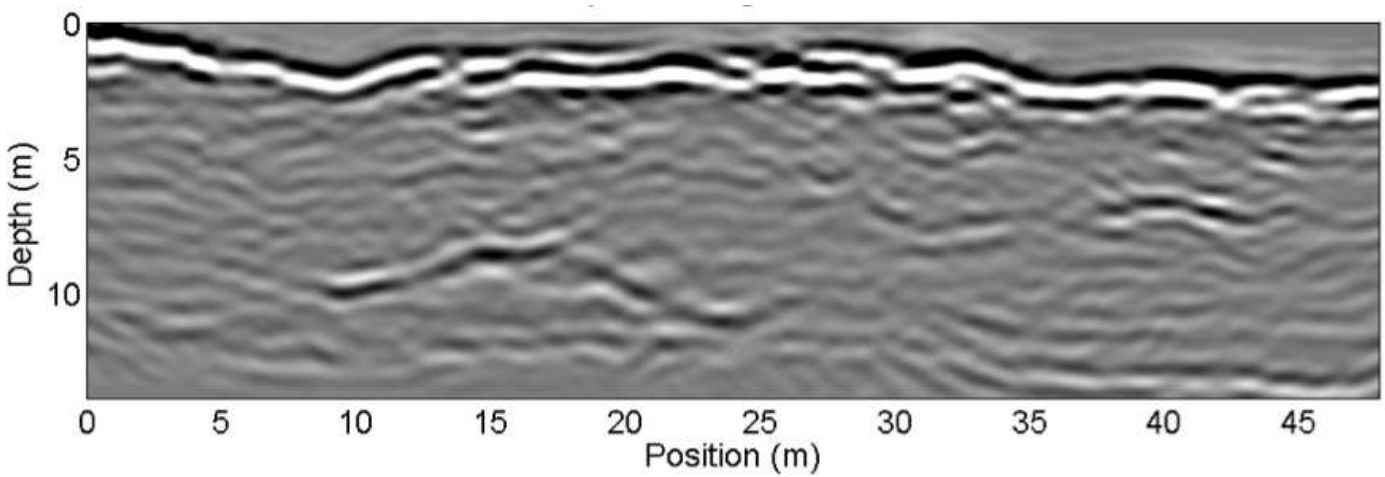
Migration


Depth (cm)
0
500
1000
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)
Depth (cm)
0
500
1000
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)
Depth (cm)
0
500
1000
1000
2000
3000
4000
5000
6000
7000
8000
9000
Distance (cm)

Zoom

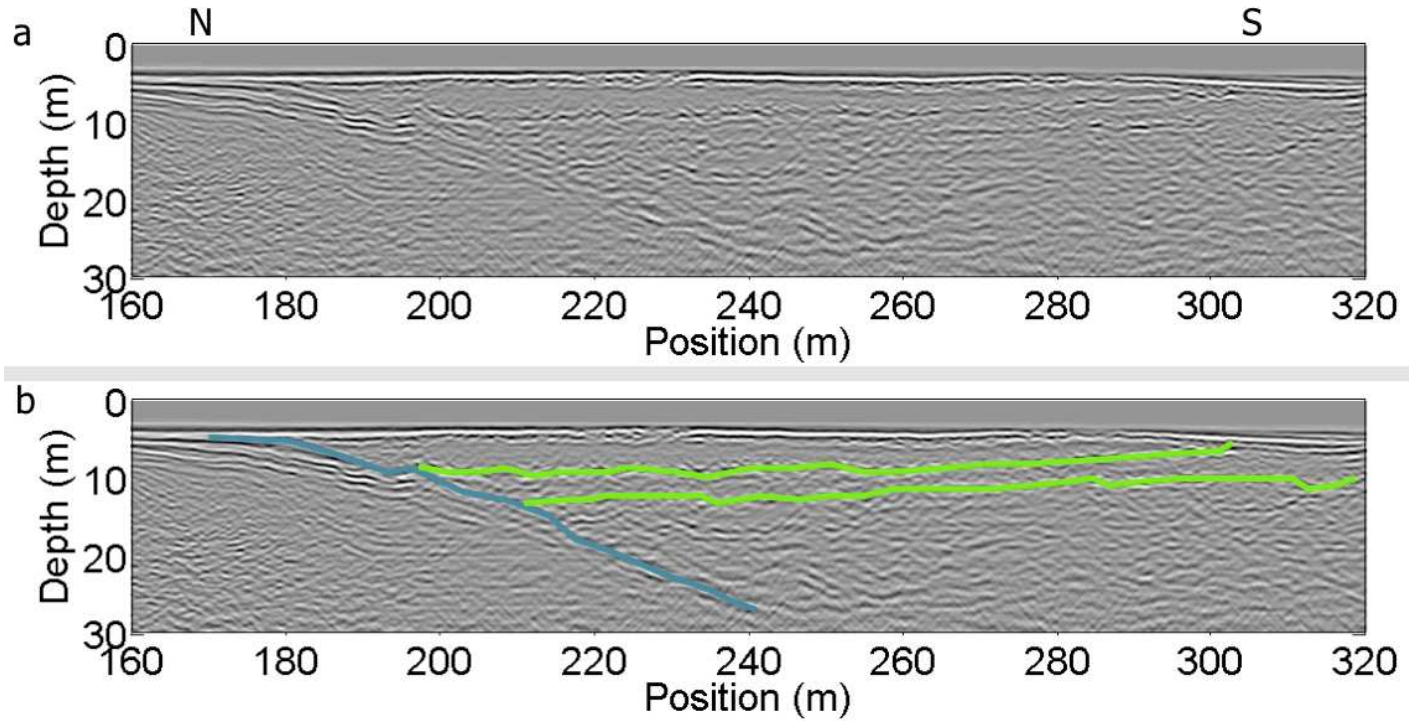

0
500
1000
Depth (cm)
5000
5500
6000
6500
7000
7500
8000
8500
9000
Distance (cm)
0
500
1000
Depth (cm)
5000
5500
6000
6500
7000
7500
8000
8500
9000
Distance (cm)

Beauty cave



From Rowell et al, 2010, *Characterization of lava tubes using ground penetrating radar at Craters of the Moon National Monument, USA*: CREWES Research Report.

Stratified flows



From Rowell et al, 2010, *Characterization of lava tubes using ground penetrating radar at Craters of the Moon National Monument, USA*: CREWES Research Report.

Conclusions

- Sub-decimetre georadar acquisition is migrate-able.
- Deconvolution works: Gabor deconvolution pulls out deep reflections.
- PSDM is superior to elevation statics + ZOM.

Future work

- Velocity analysis.
- Longer traces.
- Tighter line spacing.
- Real 3D over an interesting target.

Acknowledgements

- CREWES sponsors and NSERC.
- Dr. James D. Irving, School of Engineering, University of Guelph.
- Kevin W. Hall.