Characterizing Microseisms Induced by Hydraulic Fracturing with Hybrid Borehole DAS and Three-Component Geophone Data

Zhendong Zhang

Postdoctoral Associate, ERL

In collaboration with Nori Nakata (PI),

Malcolm C. A. White, Tong Bai

& Hongrui Qiu

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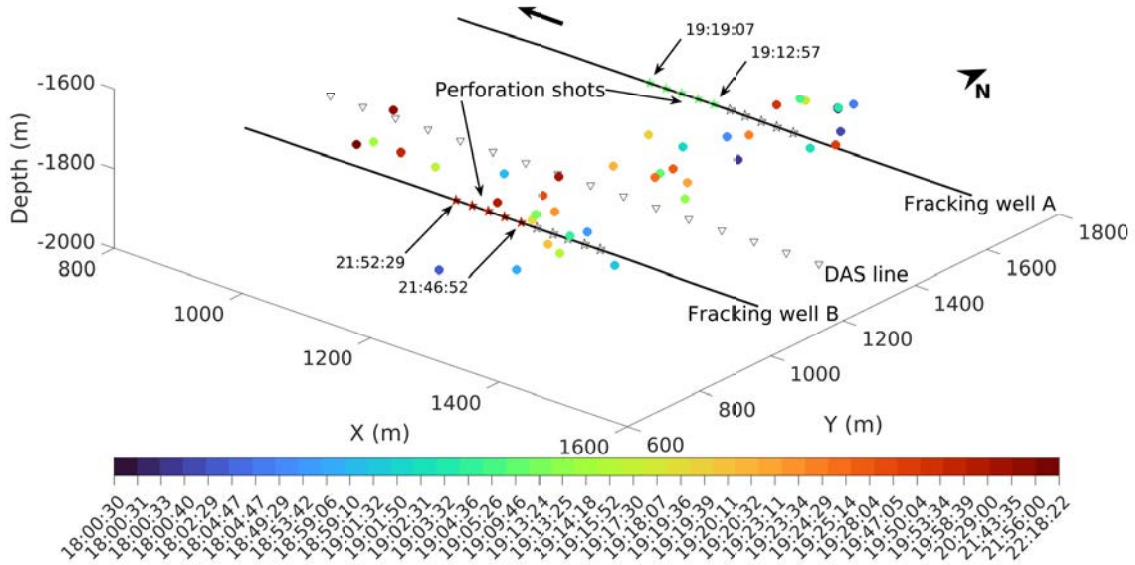
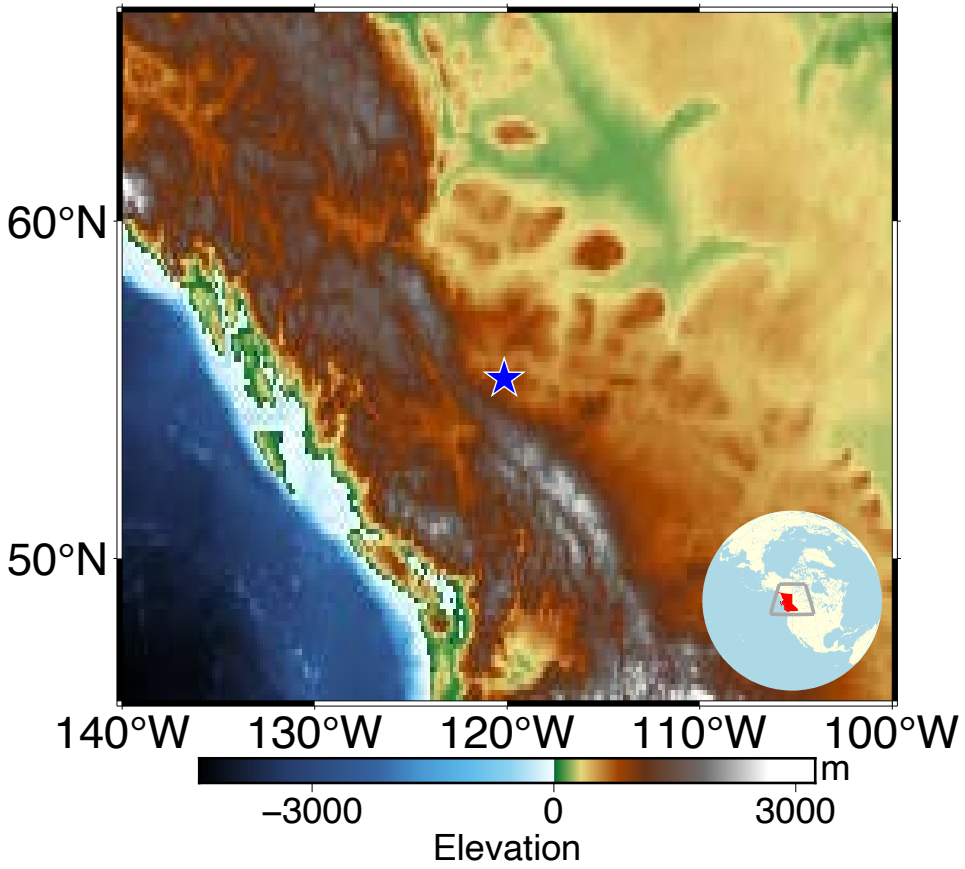
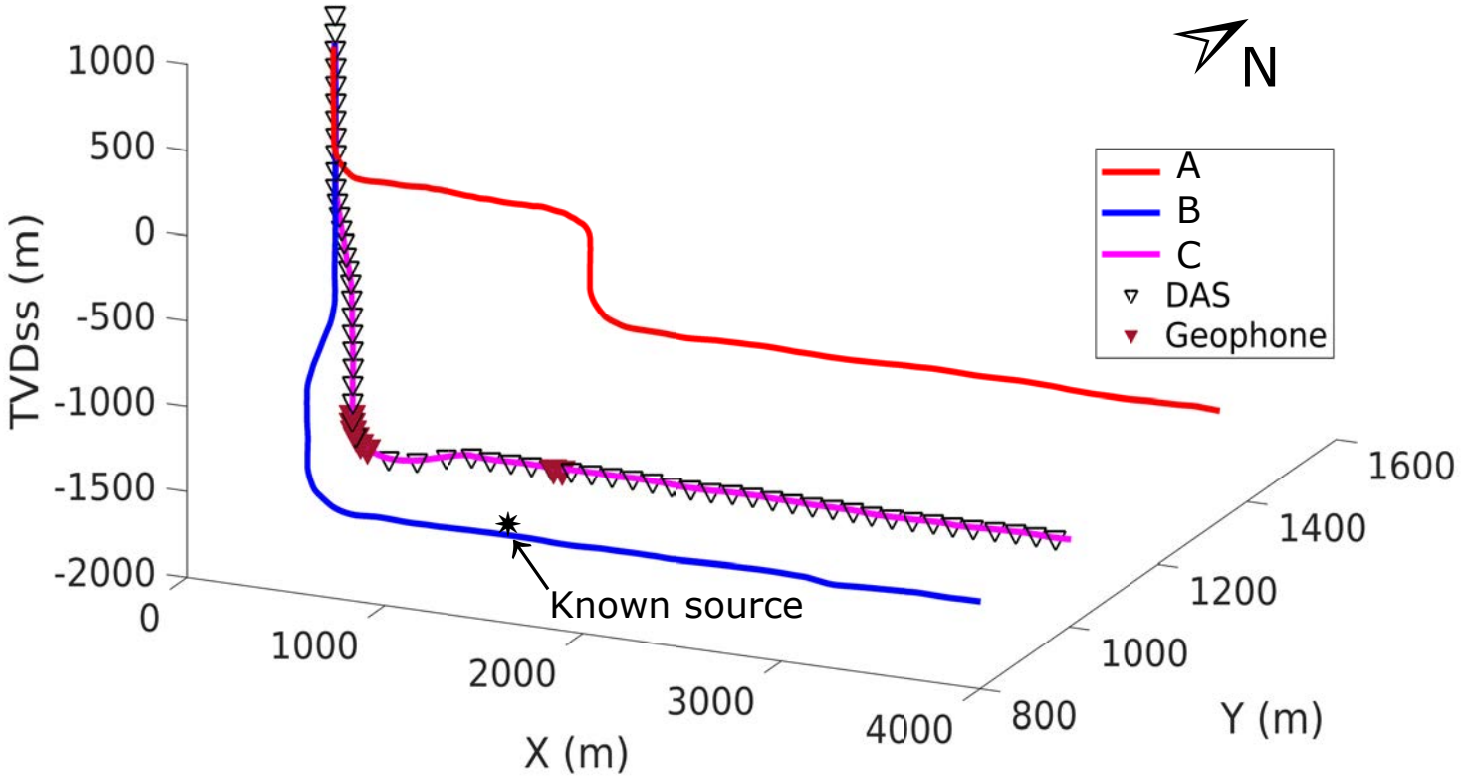


Study site

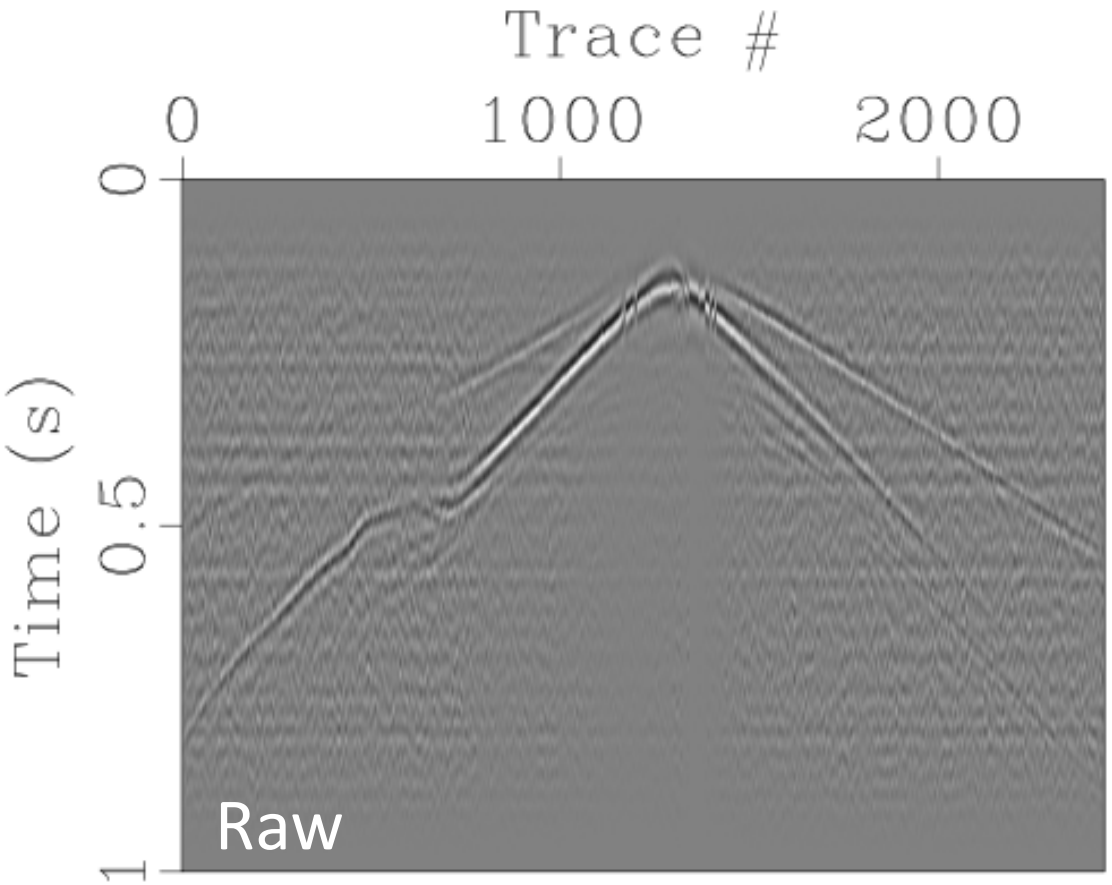
- The Montney Formation

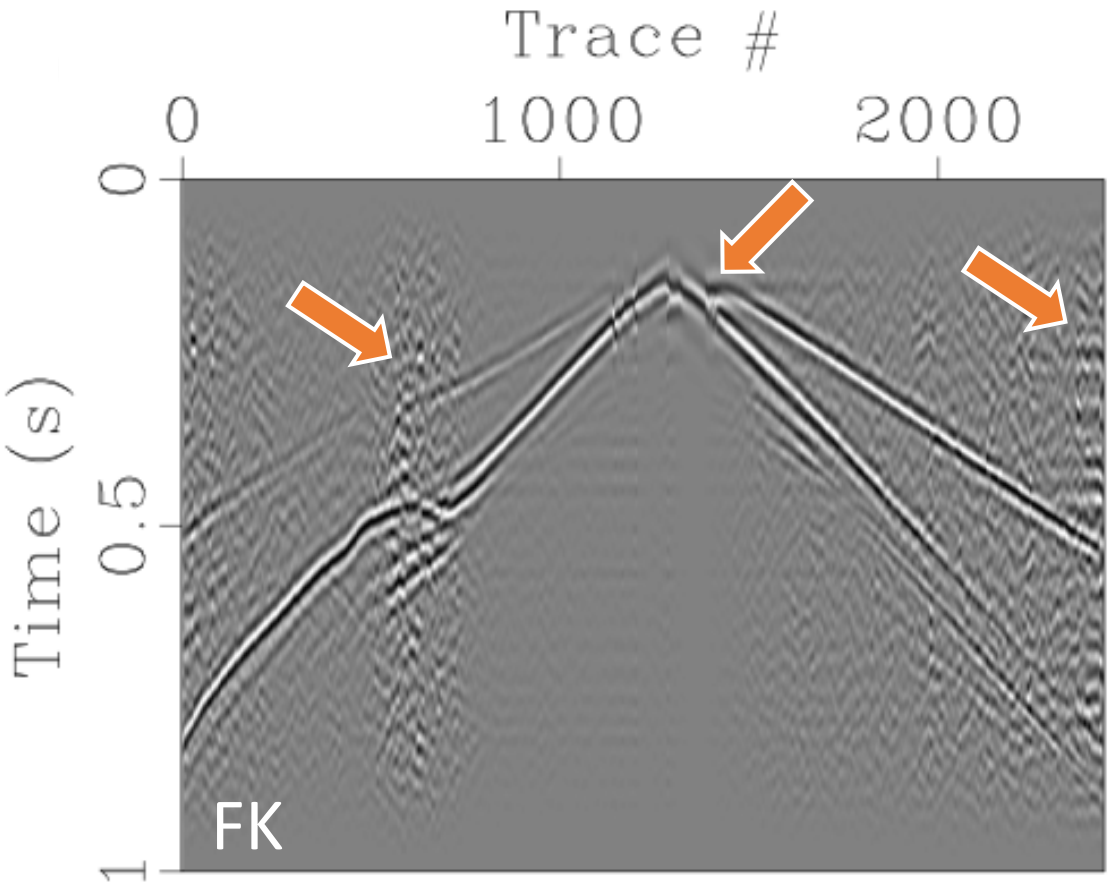




Data processing

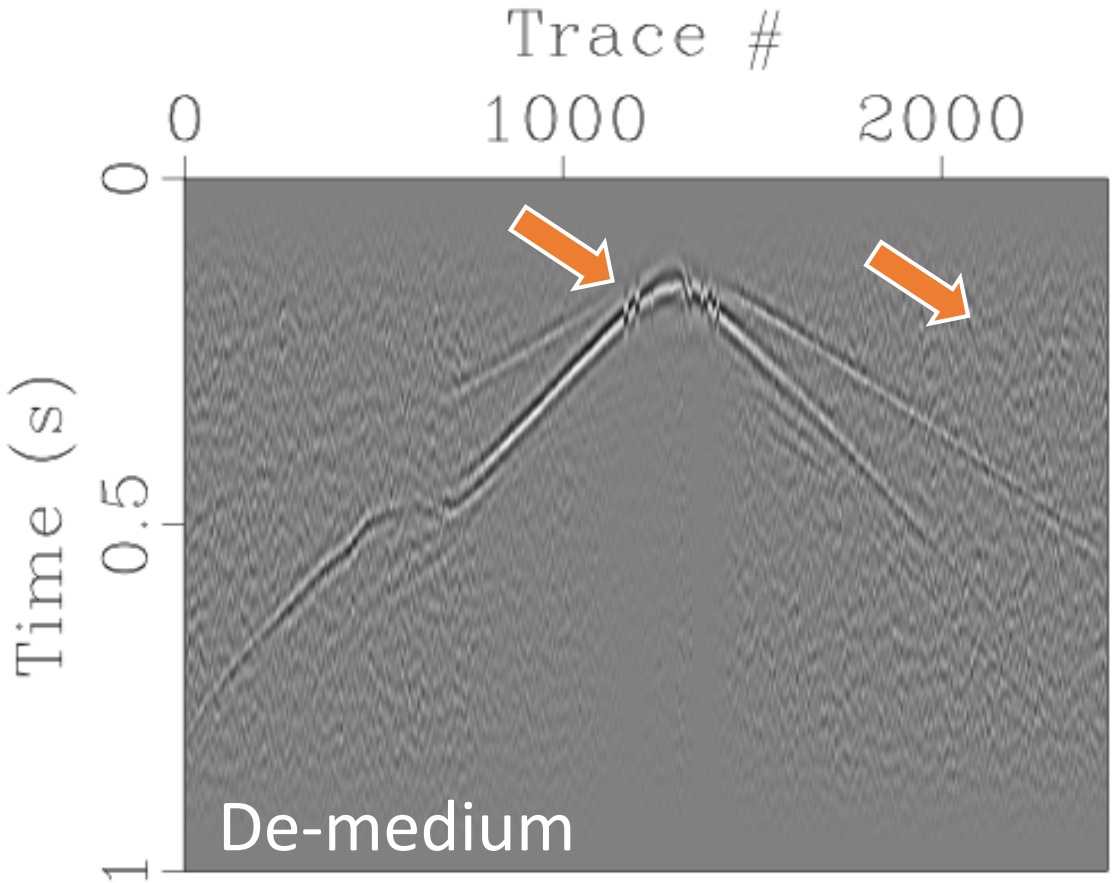
- FK filtering

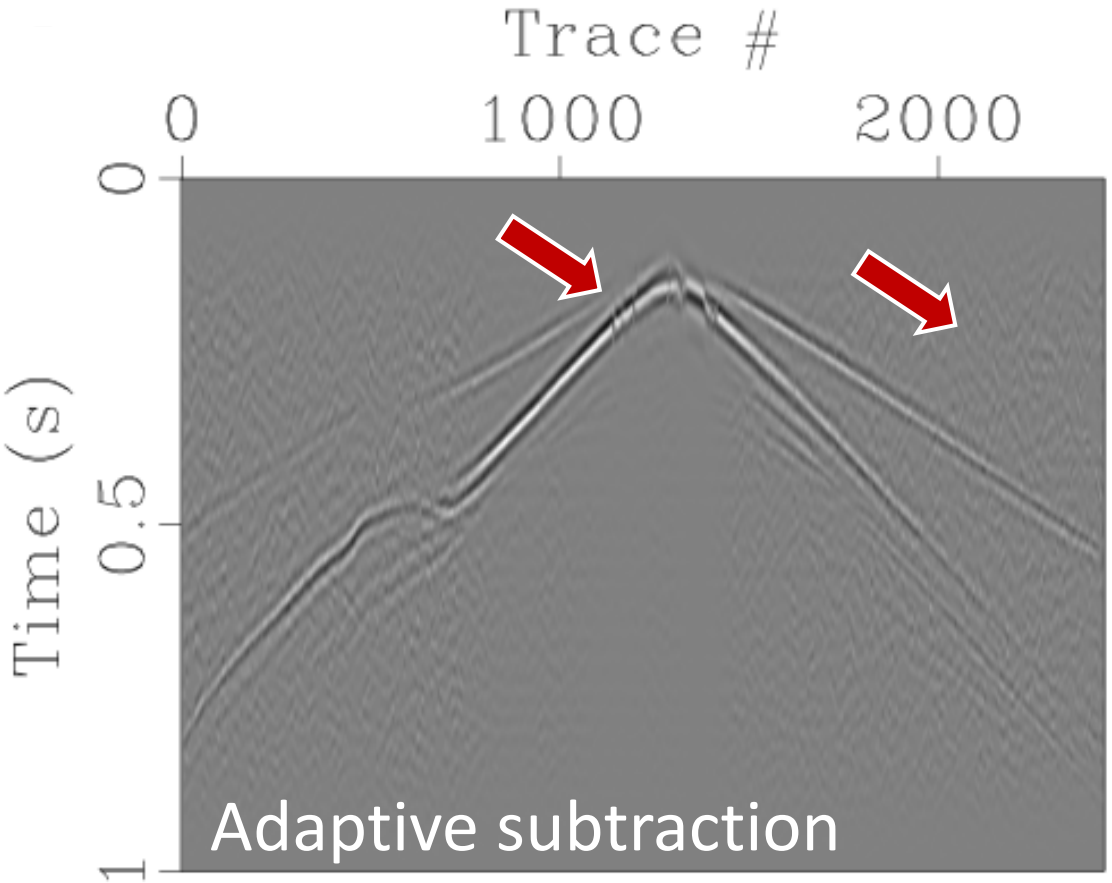




Data processing

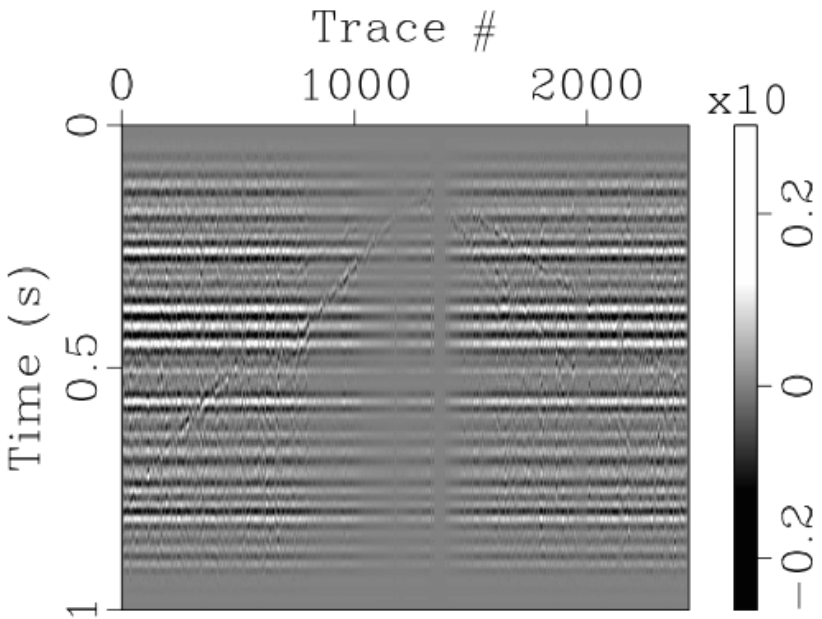
- De-medium and adaptive subtraction



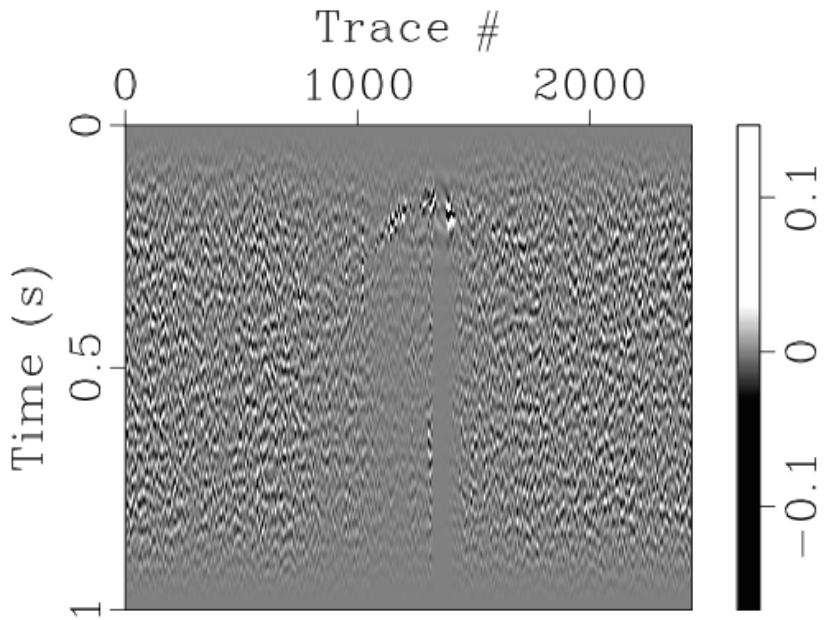


Data processing

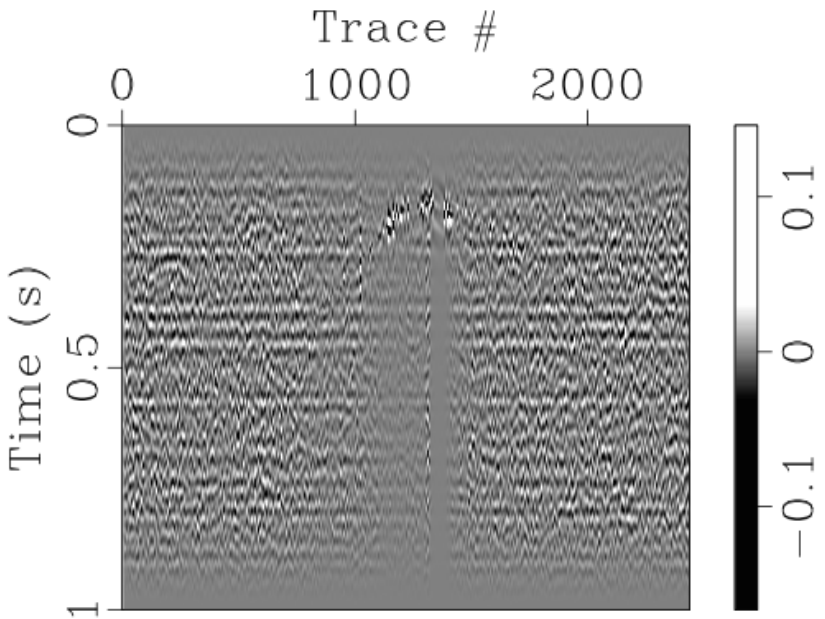
- Removed data



De-medium



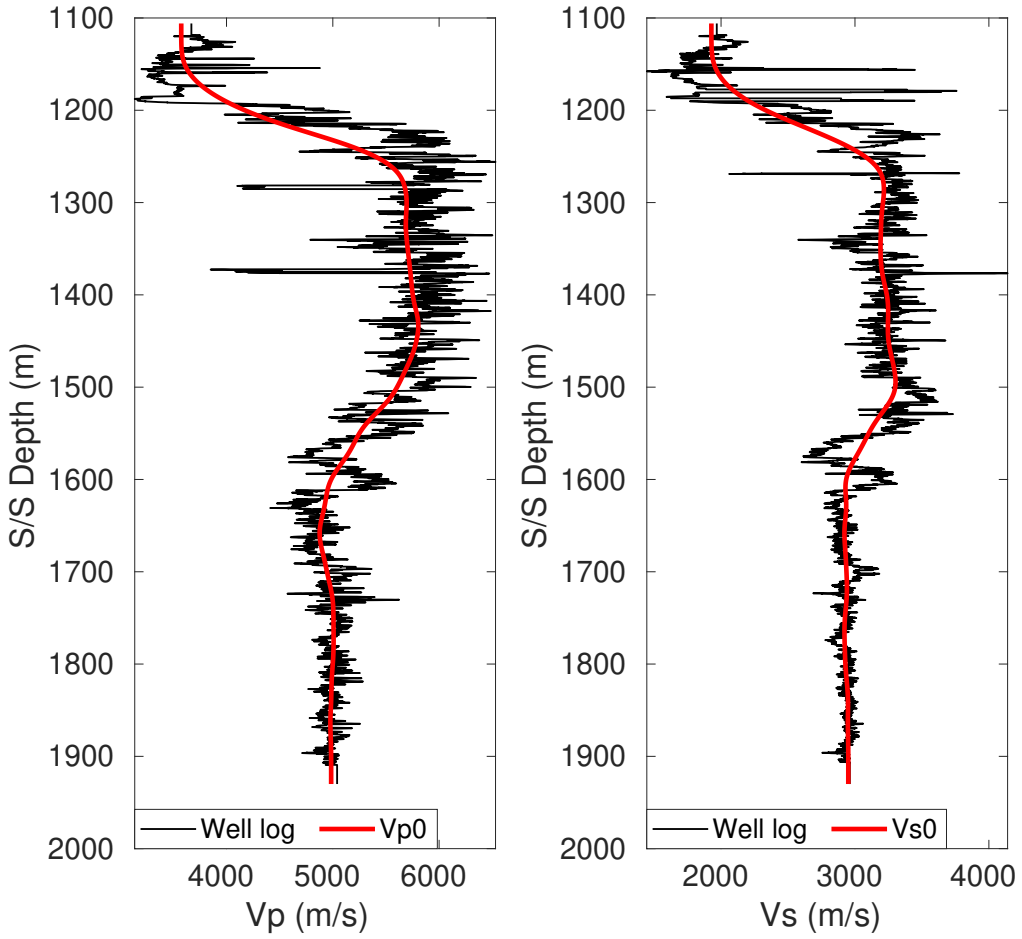
Adp. sub.

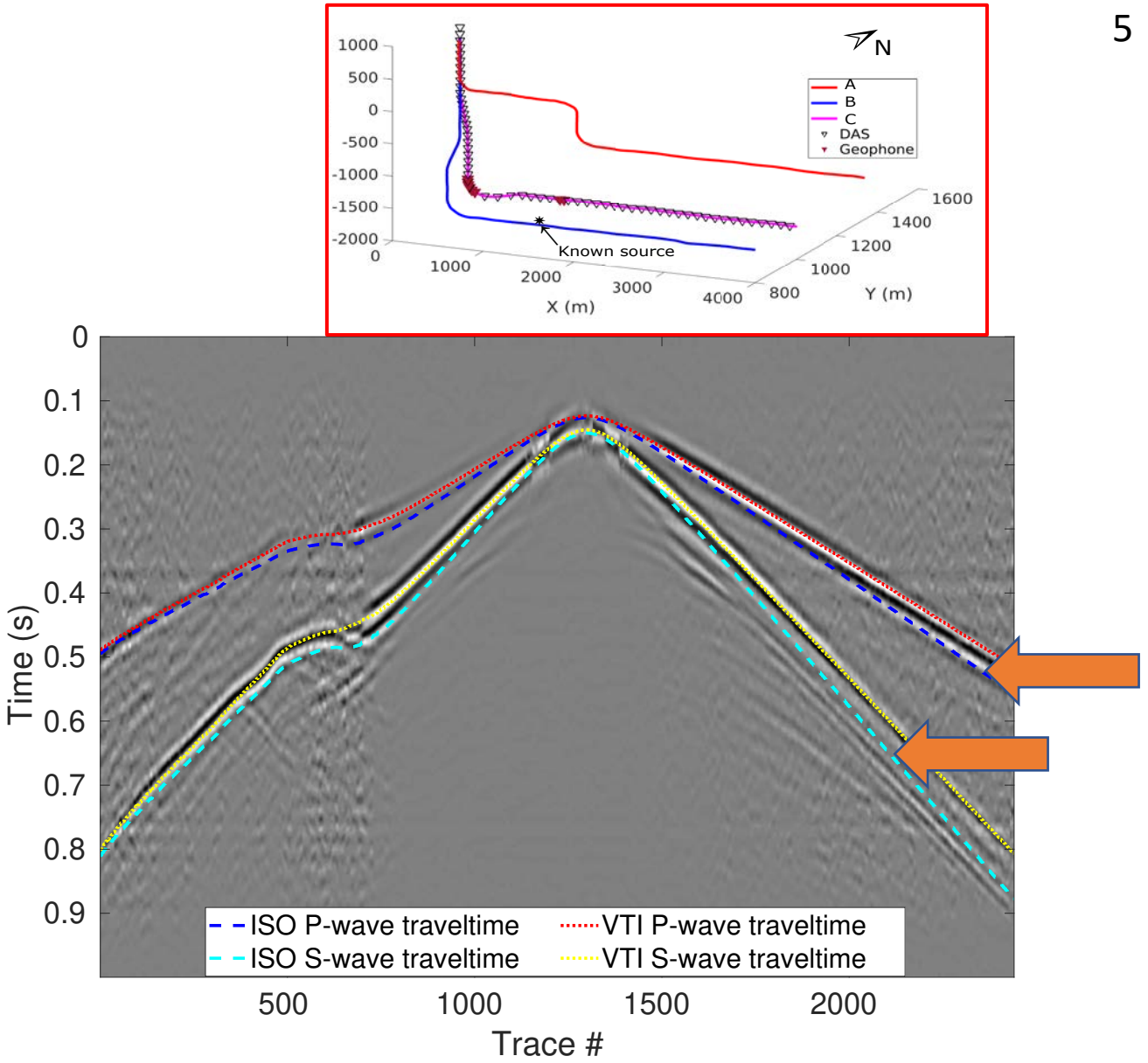


In total

Velocity model

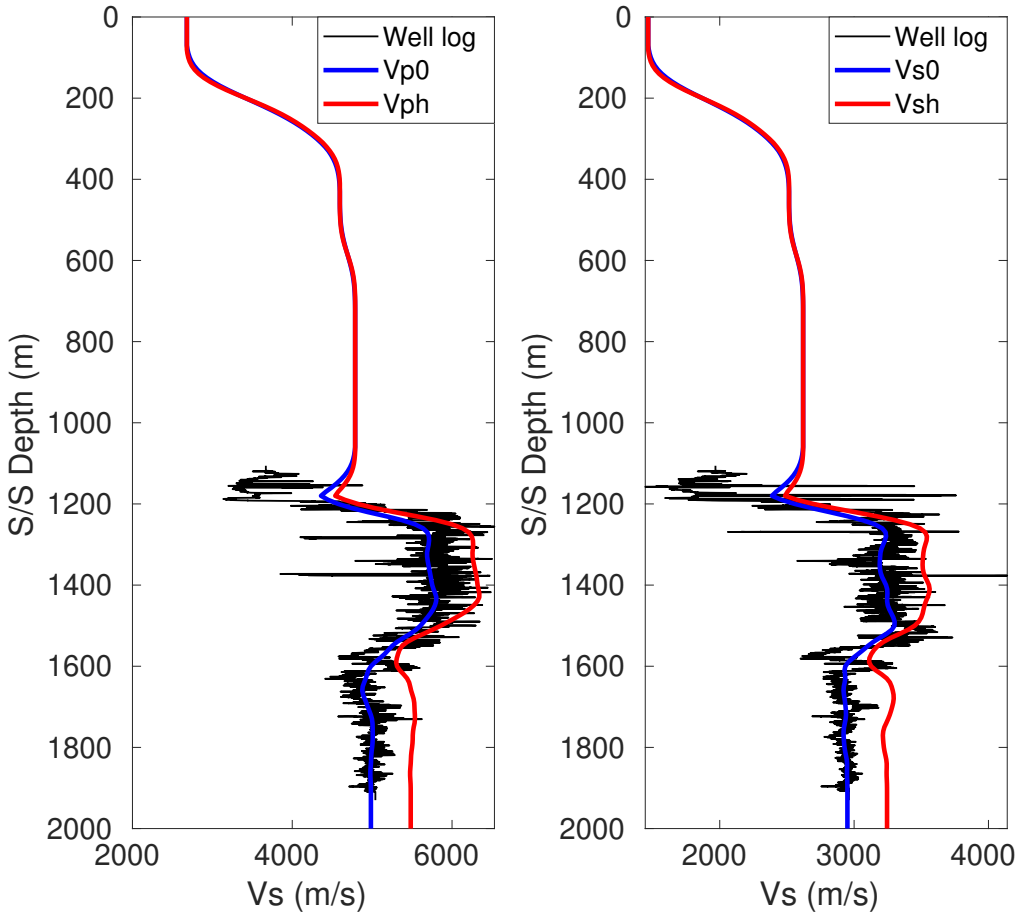
- Backus averaging

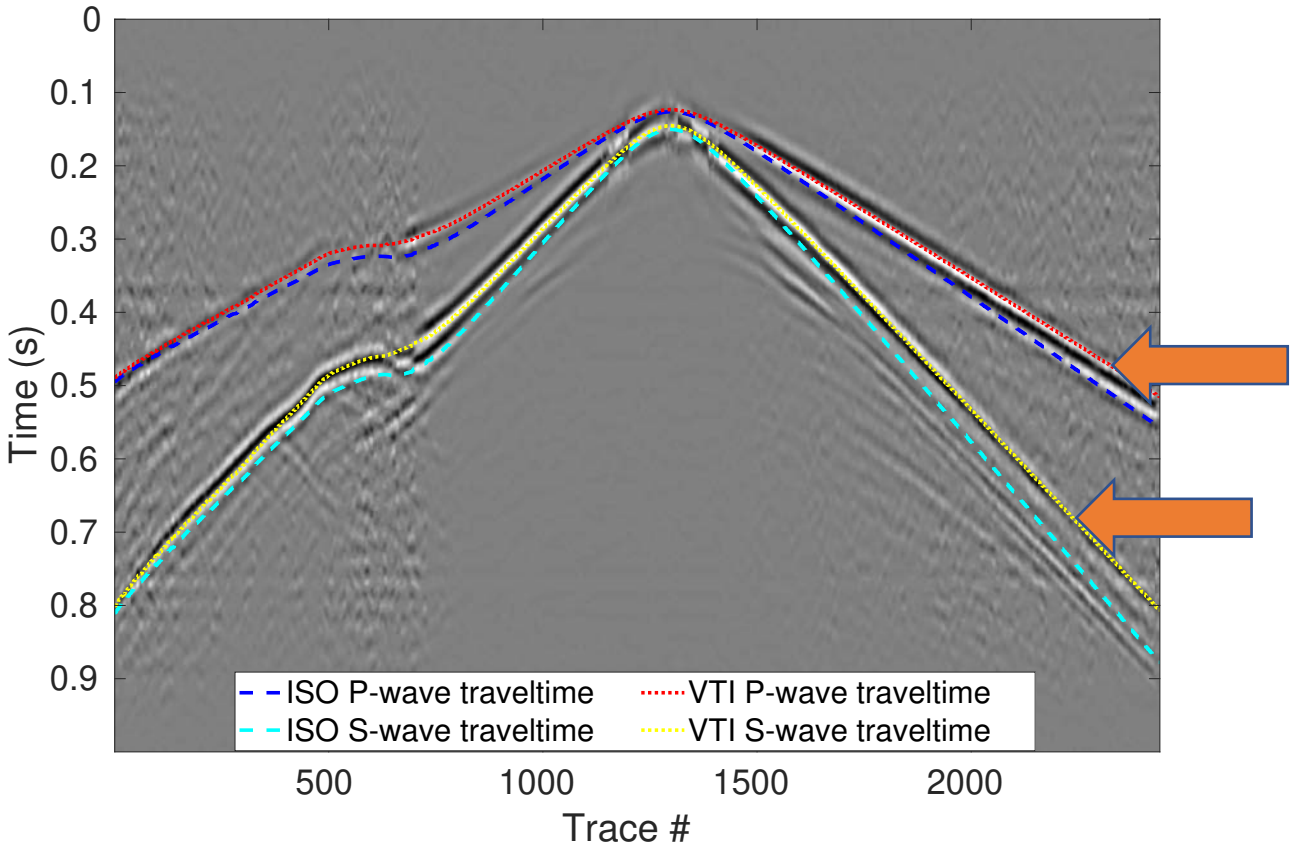




Velocity model

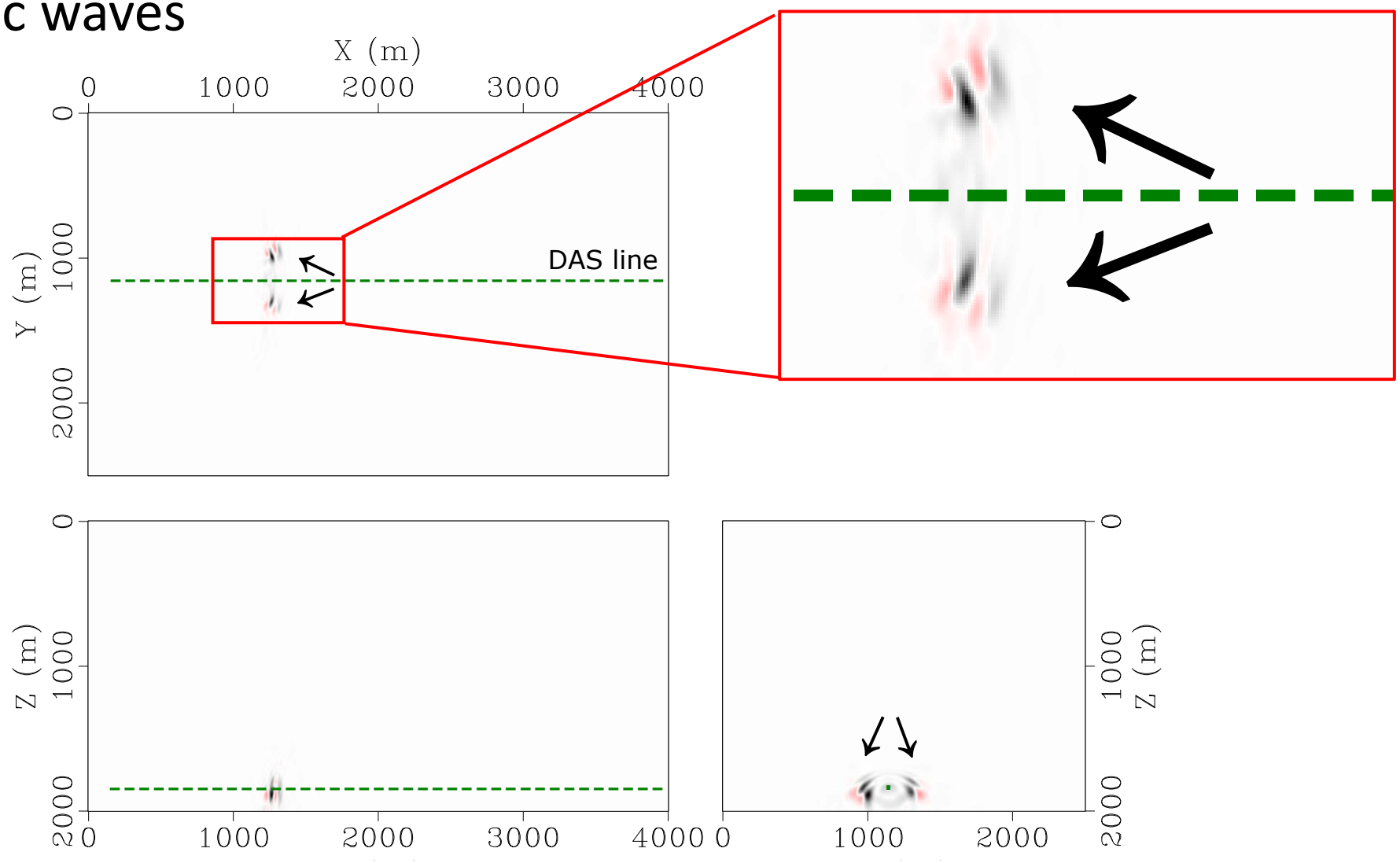
- VTI model to match the wavefronts





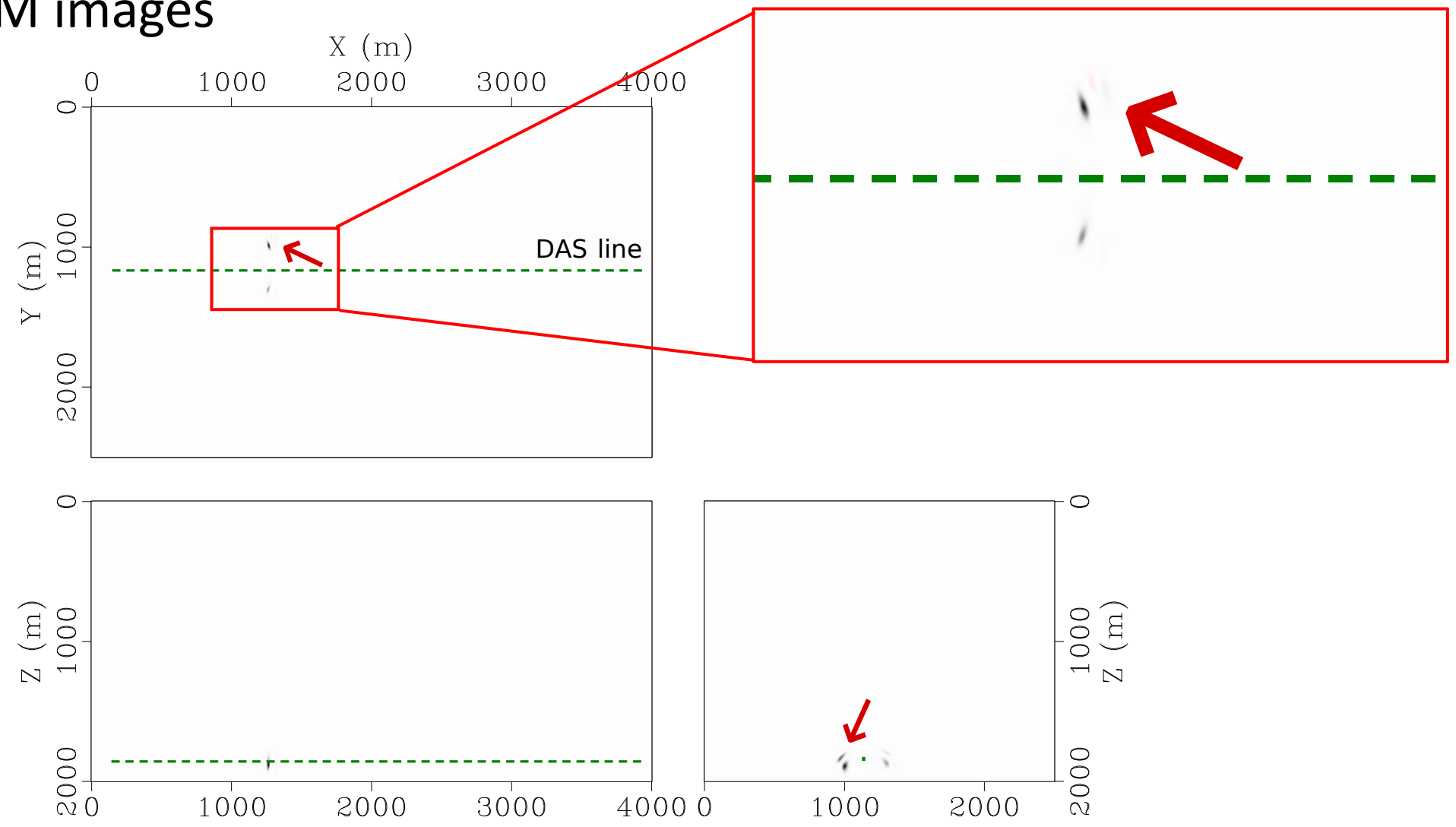
Relocation

- GmRTM for elastic waves



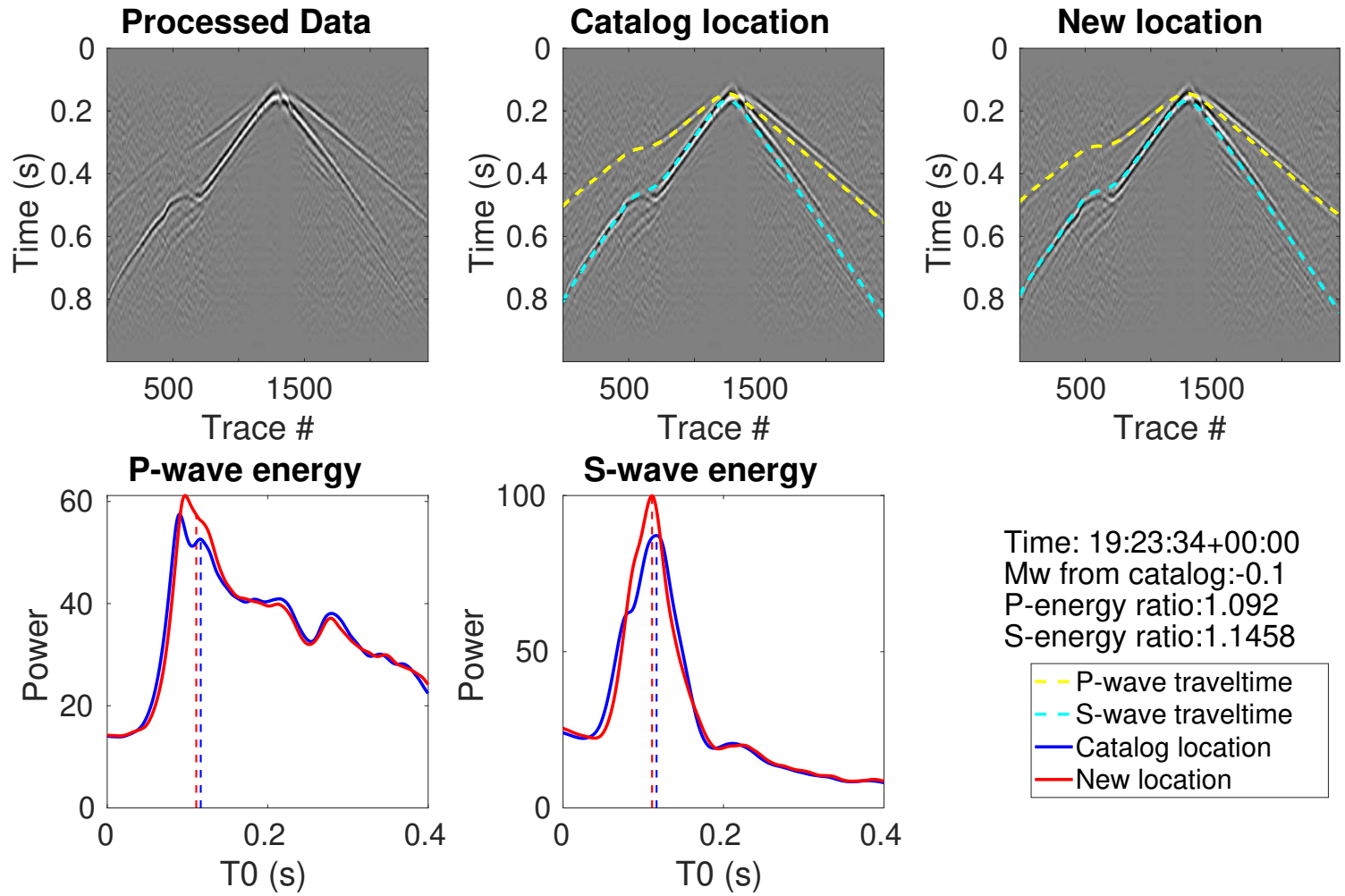
Relocation

- Processed GmRTM images



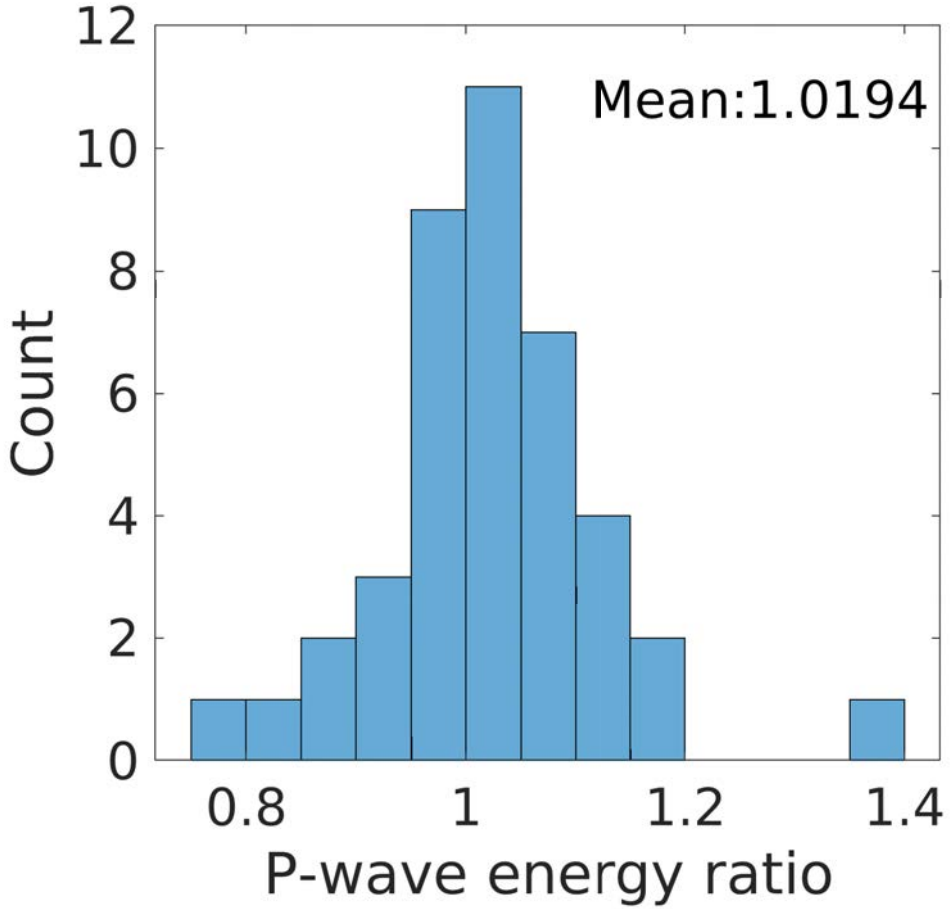
Comparison to cataloged location

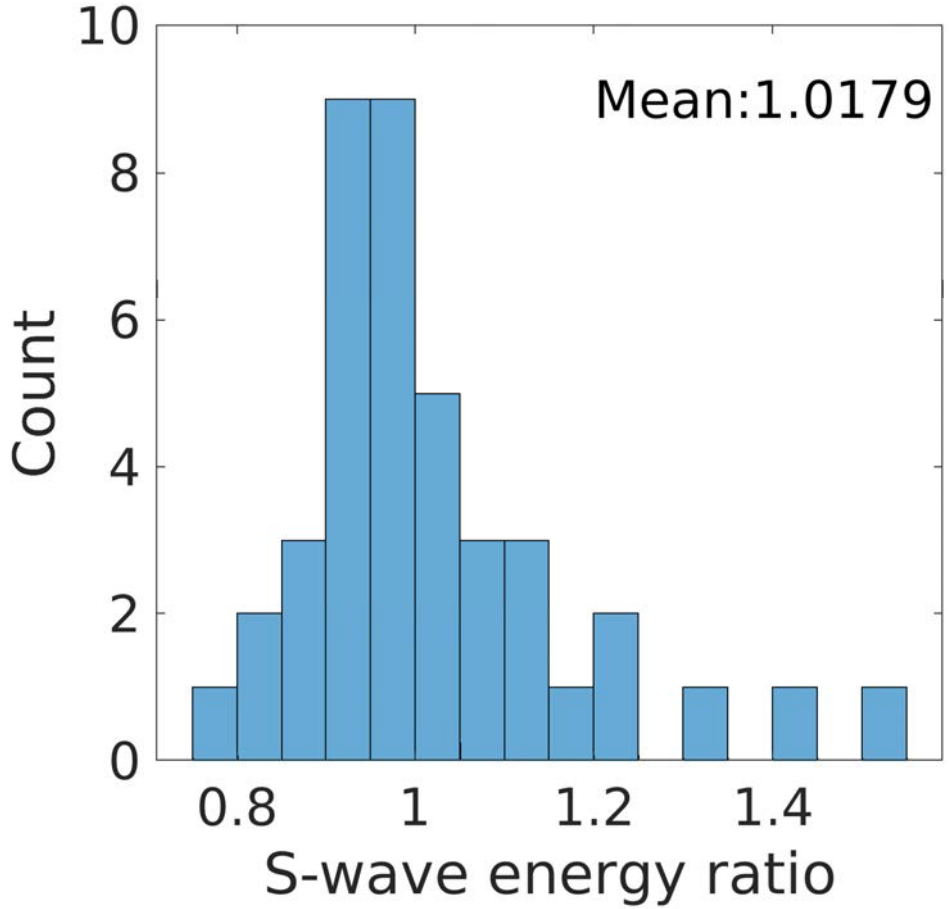
- Collected energies along predicted TT.



Validation

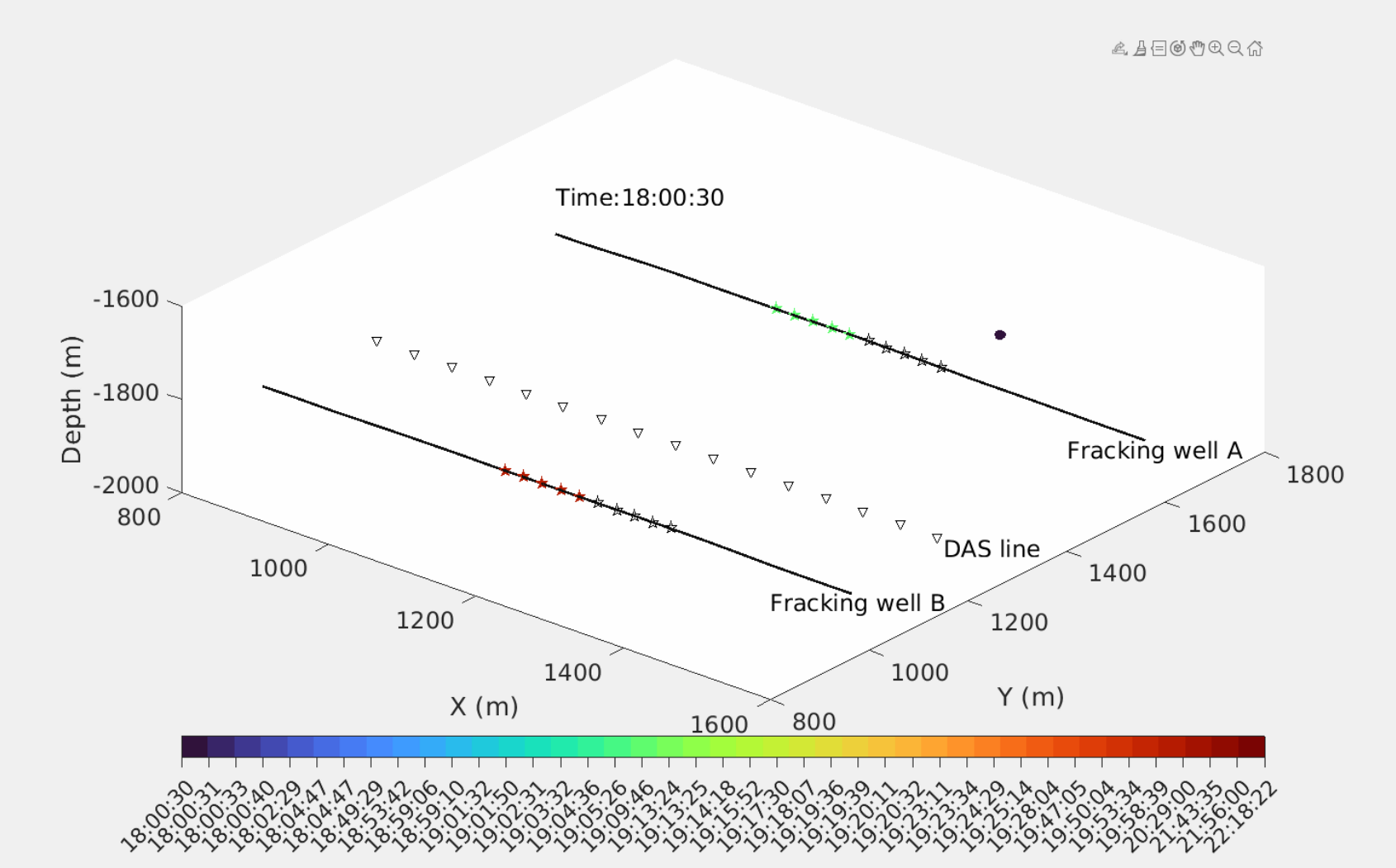
- Histograms of the energy ratio for 41 events





Spatial-time evolution

- New locations: corridor between two fracking wells



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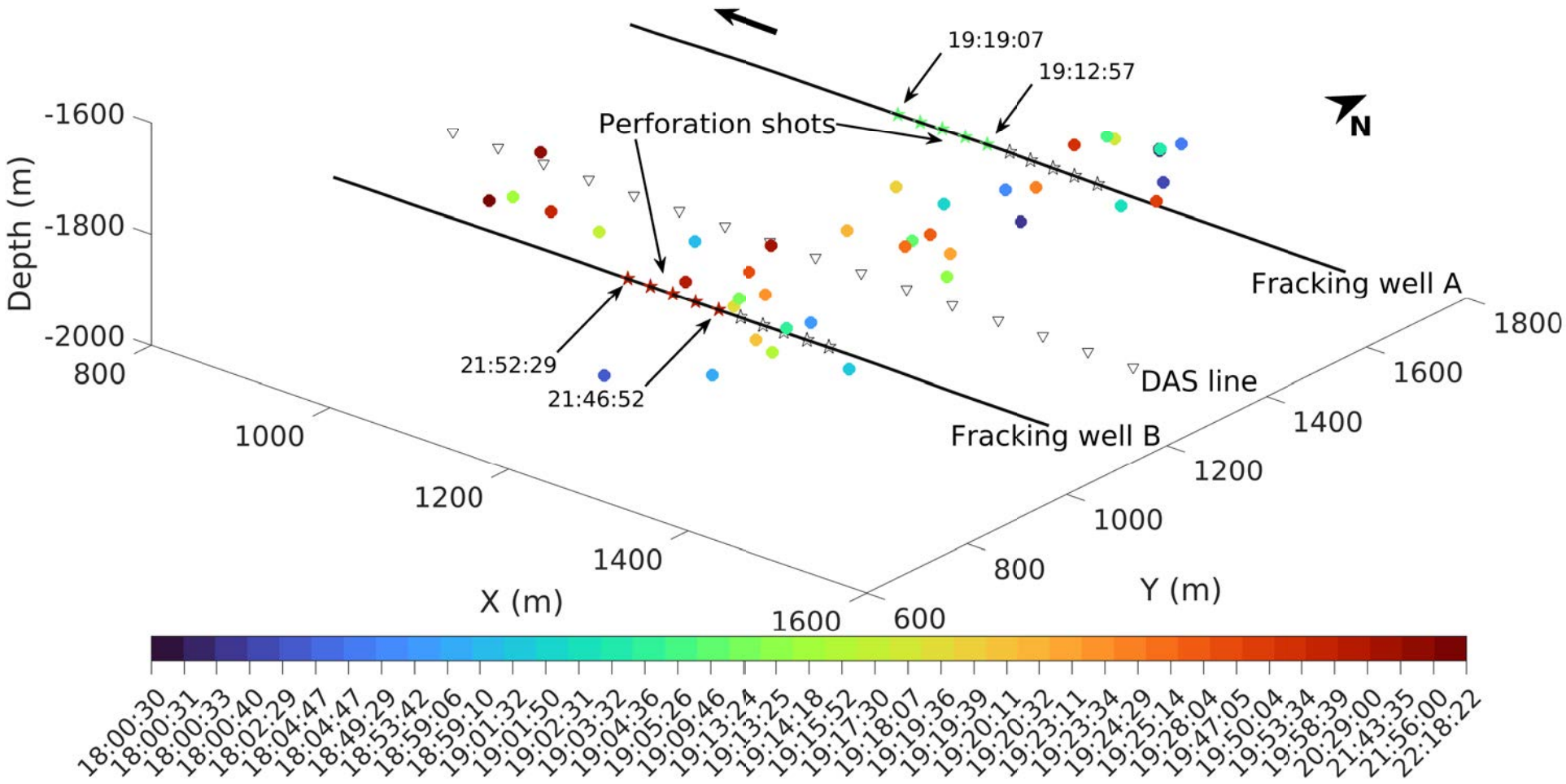
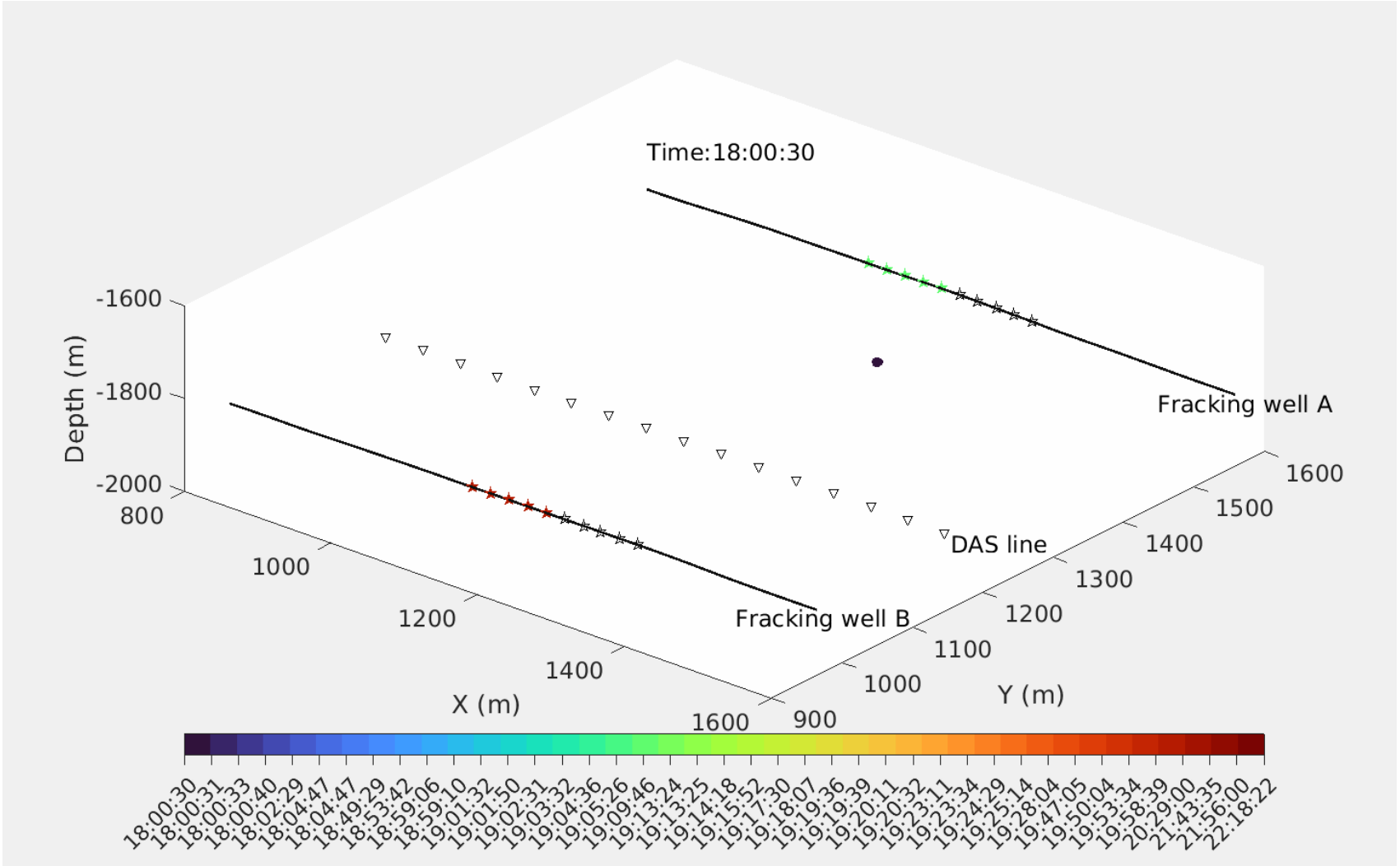


Cataloged locations

- More concentrated to fracking locations



Cataloged locations

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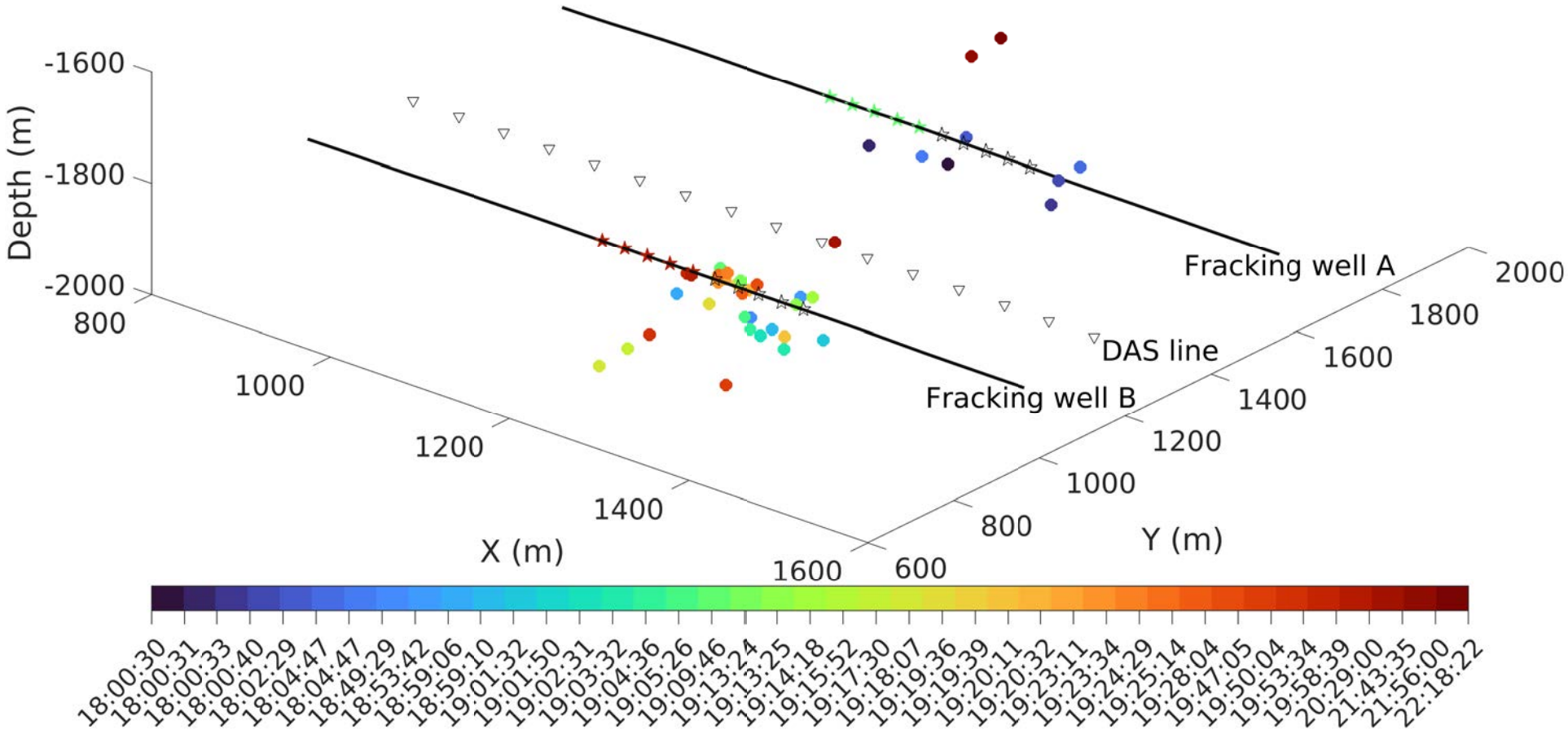
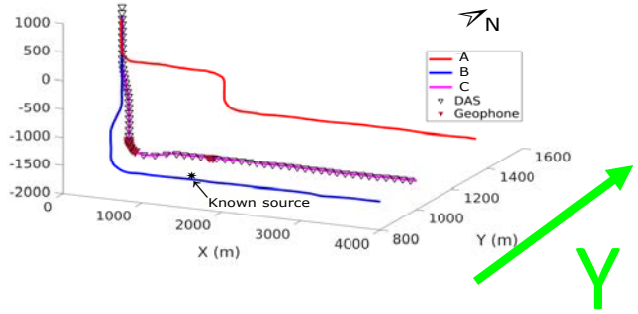
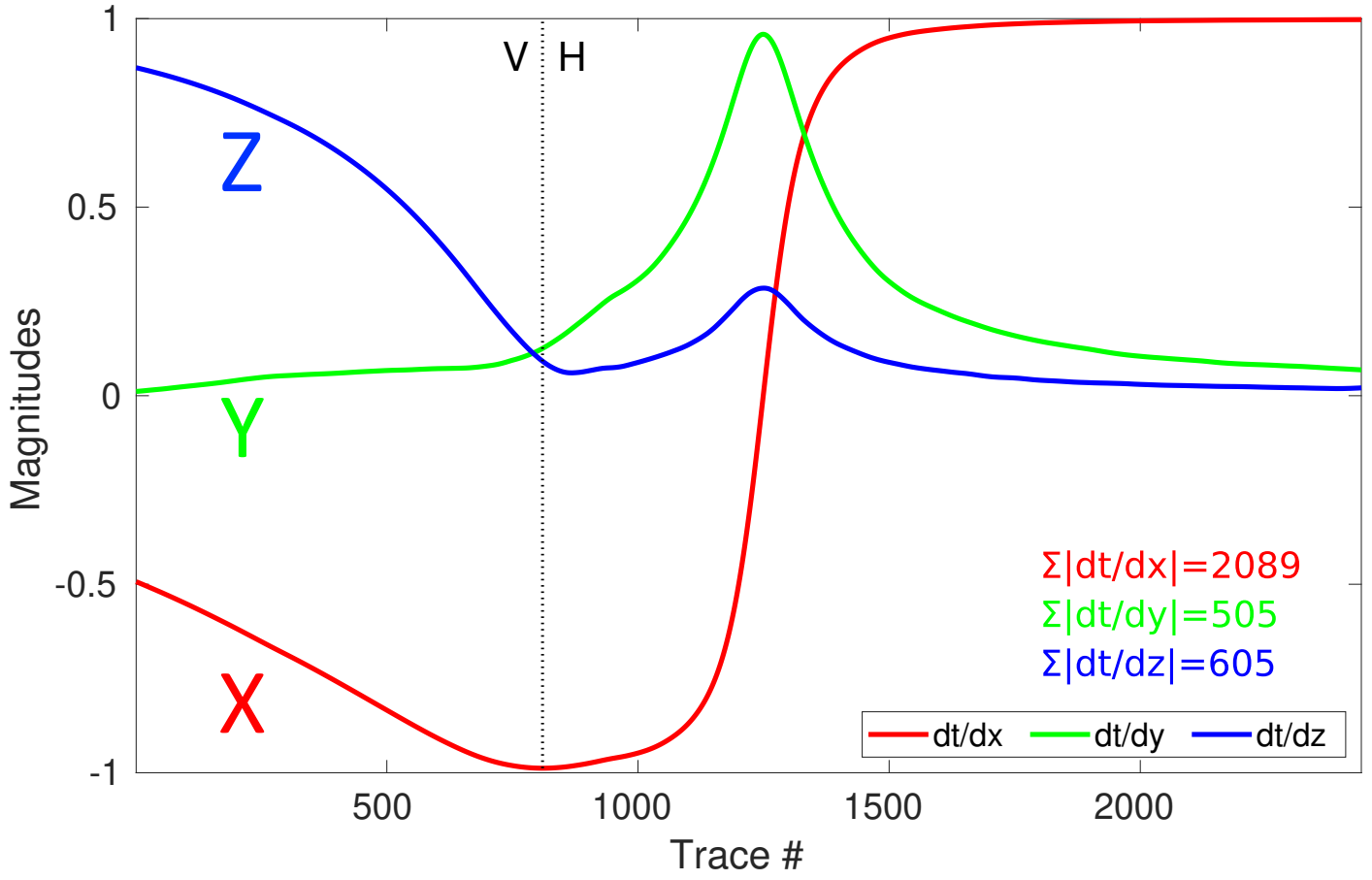


Uncertainty analysis

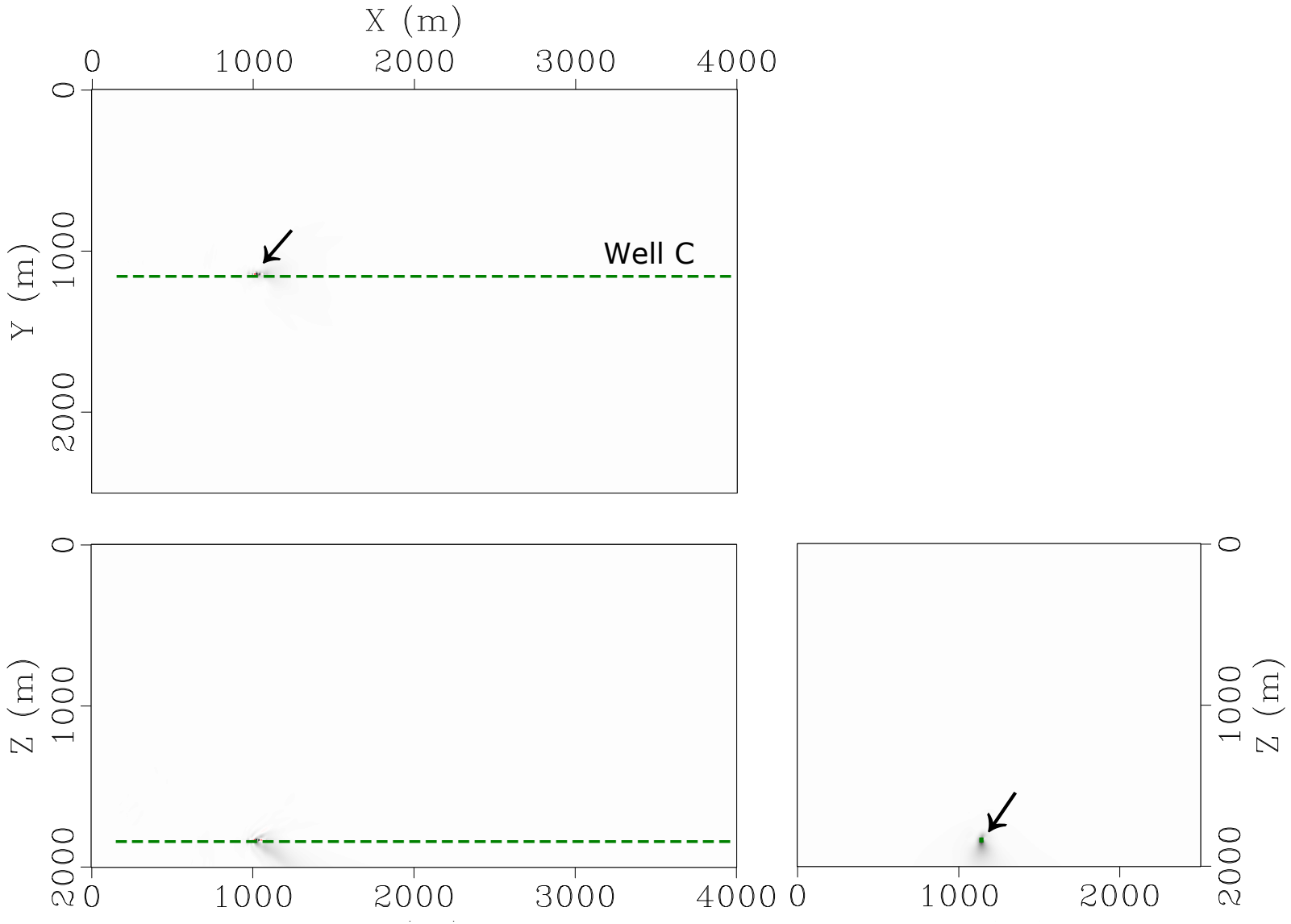
- $\frac{\partial T}{\partial x}$, X > Z > Y





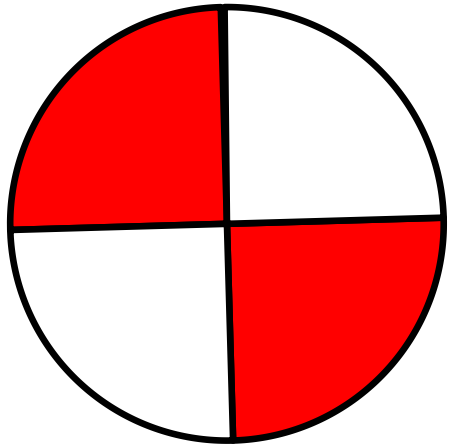
Role of 3C geophone data

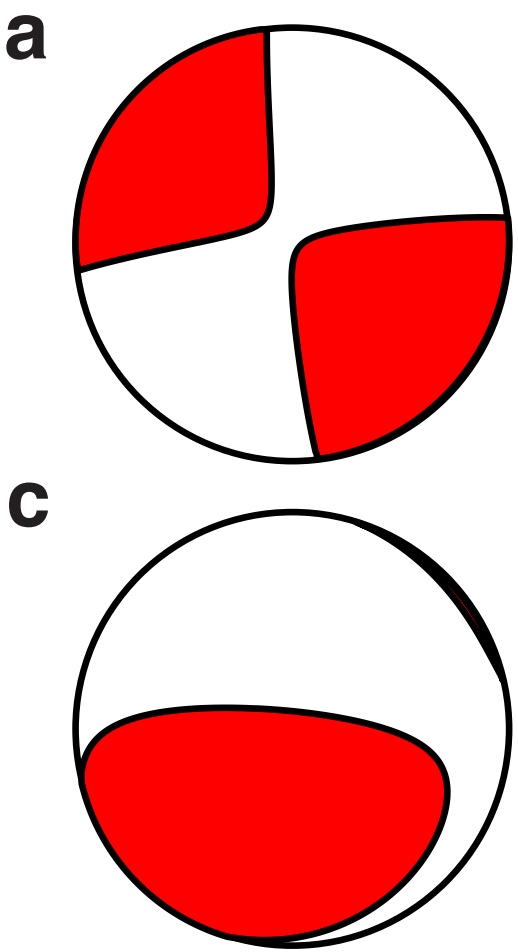
- ~~Relocation~~

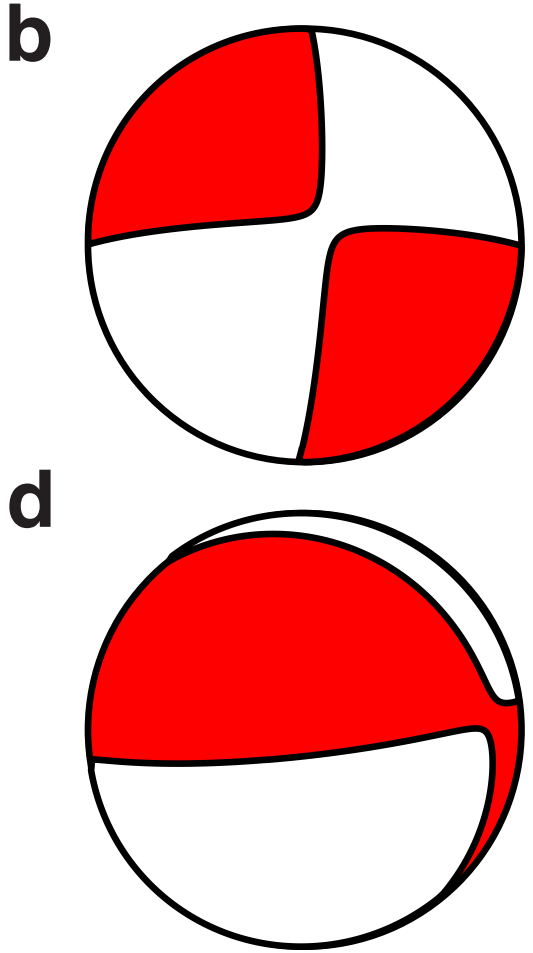


Role of 3C geophone data

- Focal mechanism estimation







a: Perfect Azi. 3C

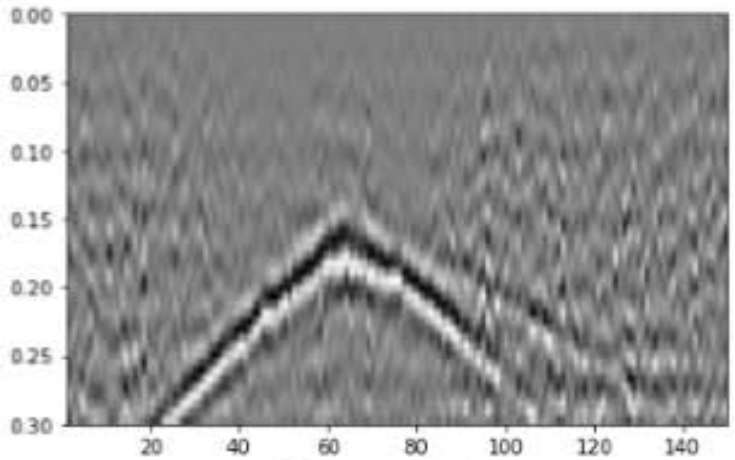
b: Real geom. 3C

c: Real geom. 1C

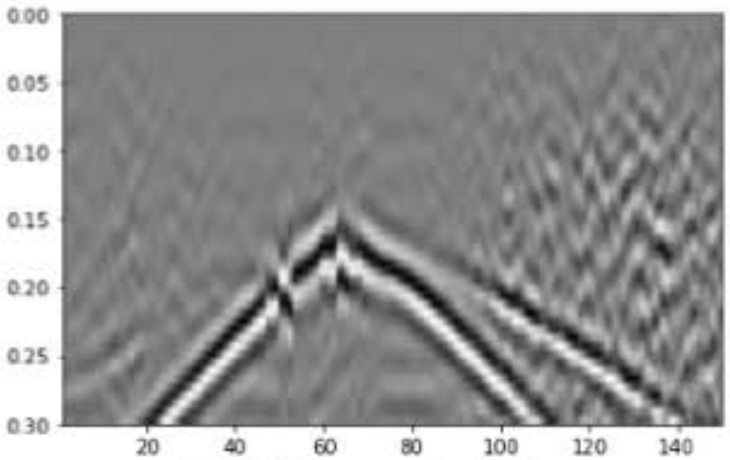
d: DAS geom. 1C

Outlook: Machine learning applications

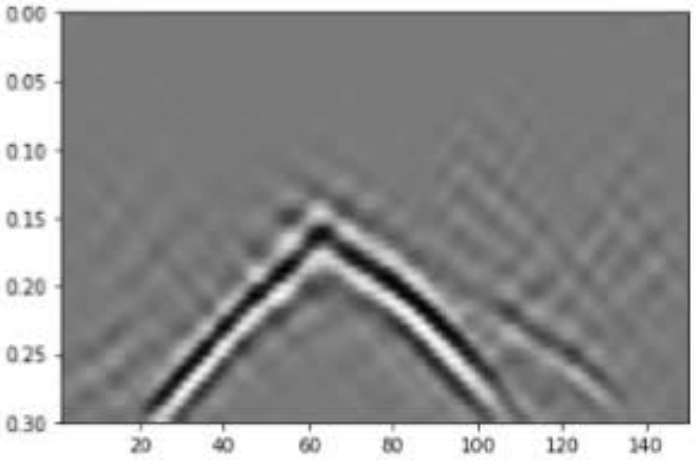
- Denoising



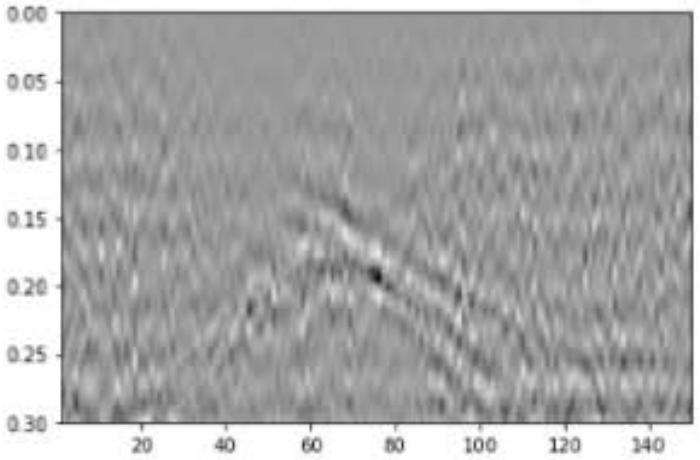
Raw data



FK filtered data



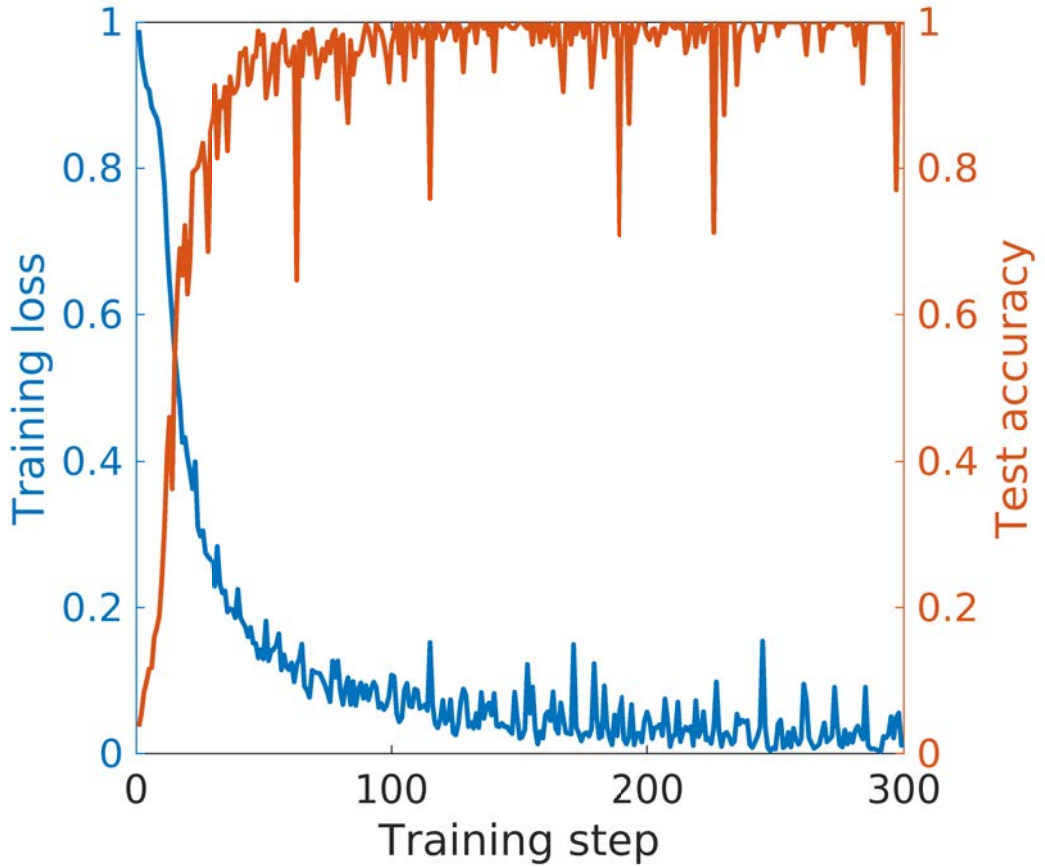
ML-denoised data

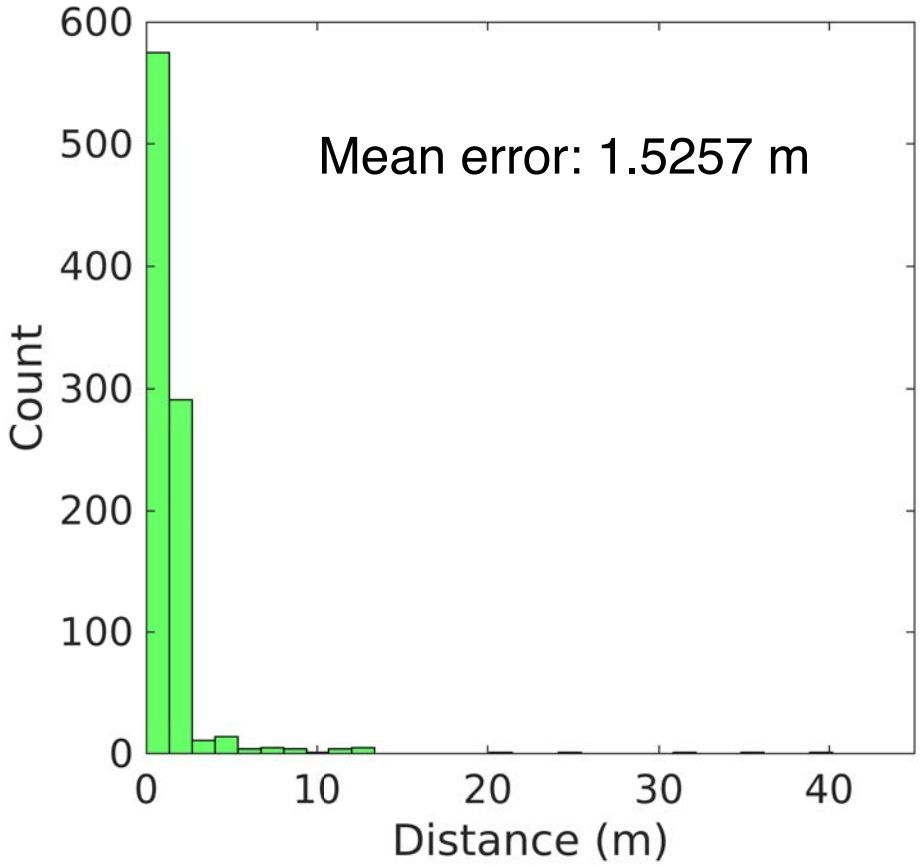


Noise removed by ML

Outlook: Machine learning applications

- Rapid relocation





Conclusions

- Using DAS data for relocation [Step 1]
- Using 3C geophone data for focal mechanism estimation [Step 2]
- A good sensor coverage is needed for accurate relocation
- Geophysical and ML approaches have their own pros and cons

Acknowledgements

- JOGMEC for providing the data

- OU and KAUST for providing computational resources