

EAGE



Digital arrays optimization for efficient land seismic exploration

Pavel Golikov¹, Van Do², George Barnes³, Eamonn Murray³, Amine Ourabah³

1 - Upstream Advanced Research Center Saudi Aramco

2 - Geophysical Imaging Department Saudi Aramco

3 - STRYDE

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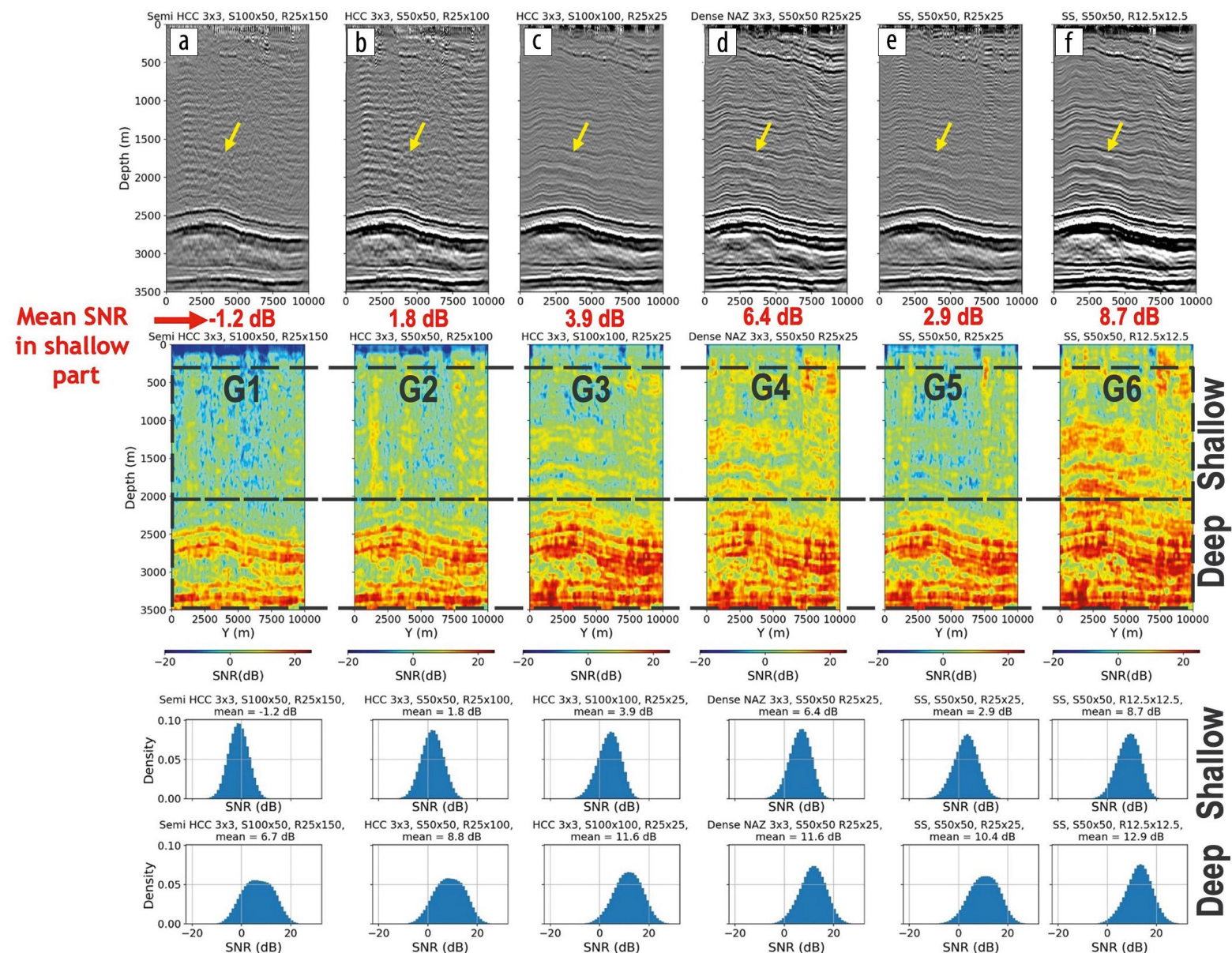
3 - STRYDE

Outline

- Optimal arrays: data quality vs cost
- Survey design and DGF geometries
- DGF9 vs geophone array
- DGF comparison
- PSTM comparison
- Conclusions and way forward



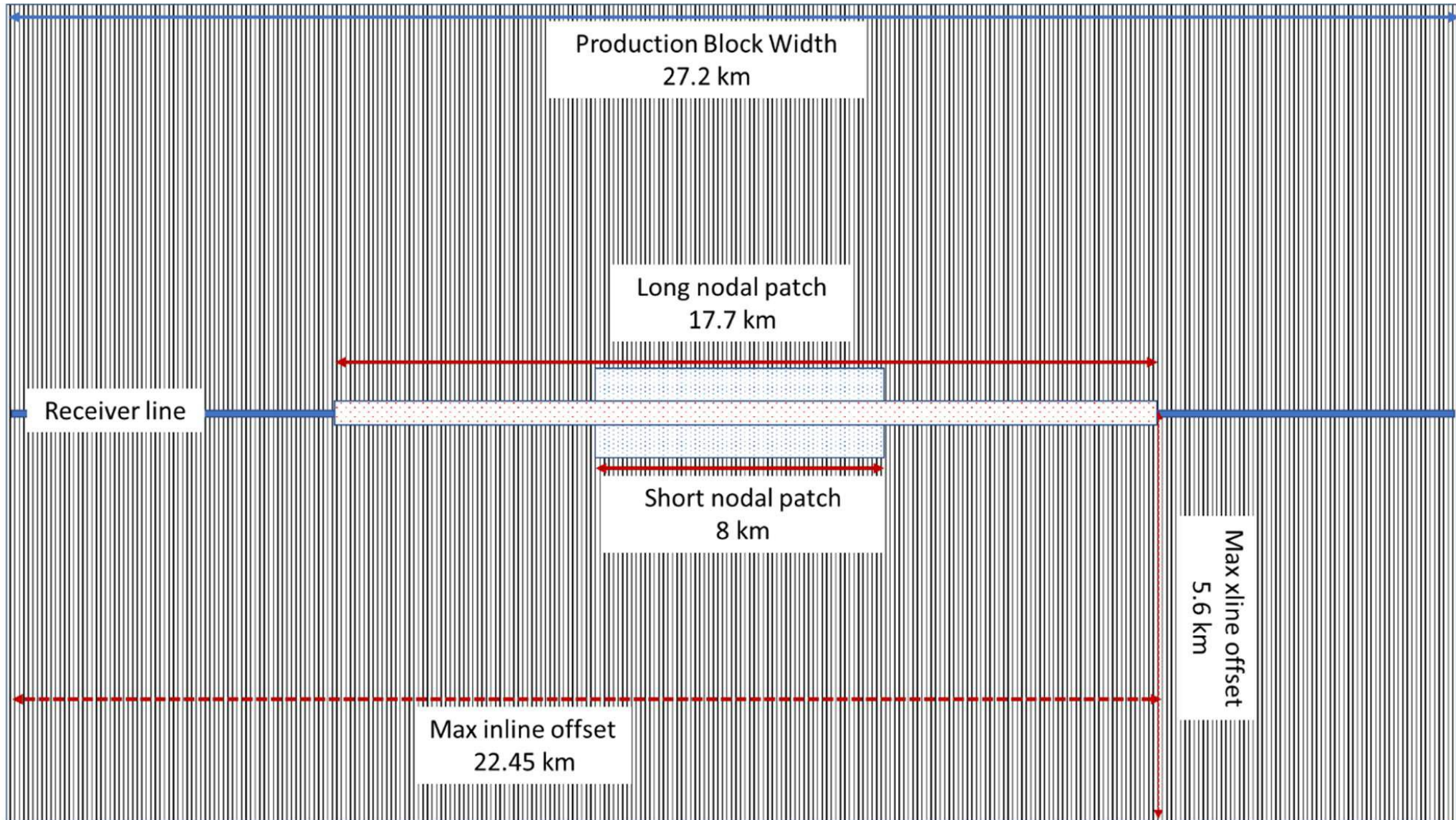
Dense nodal carpet vs sparse arrays - where is the optimum?



Survey design and DGF geometries

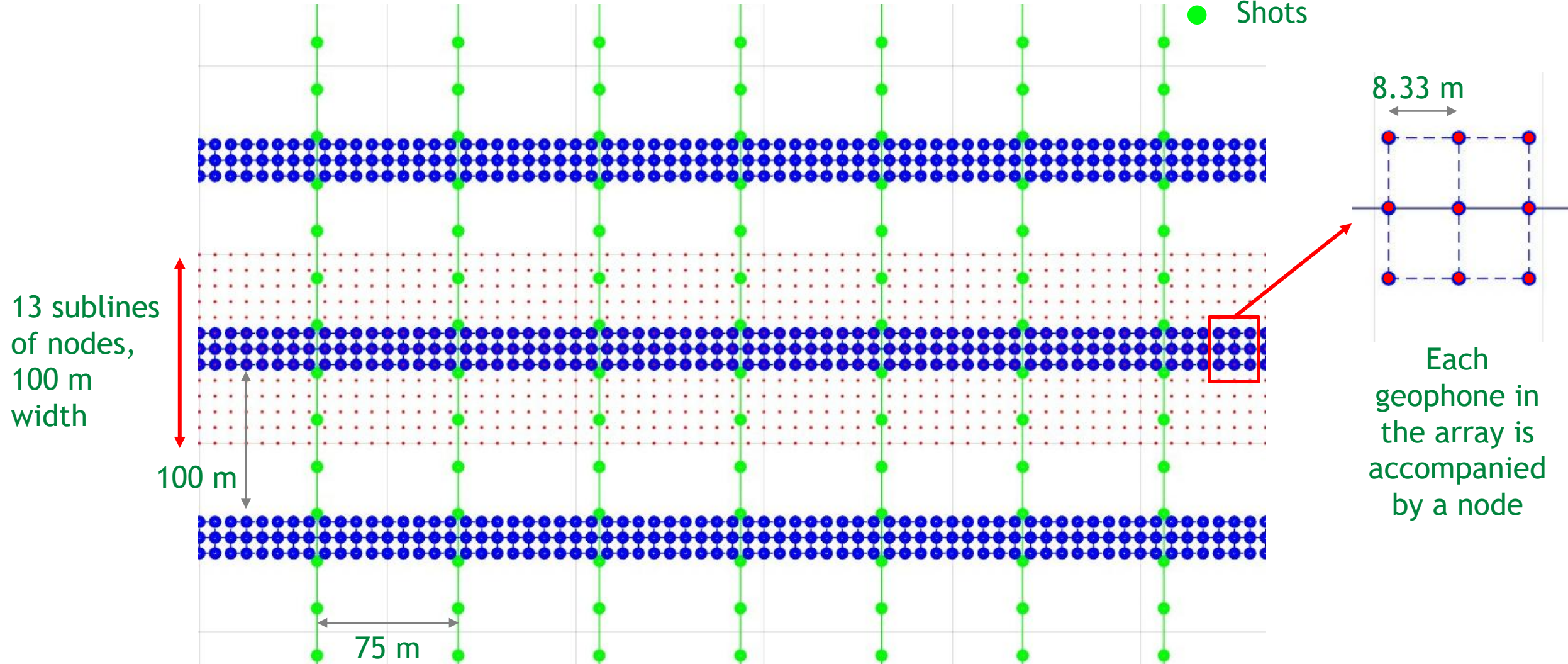


Survey Geometry: general overview



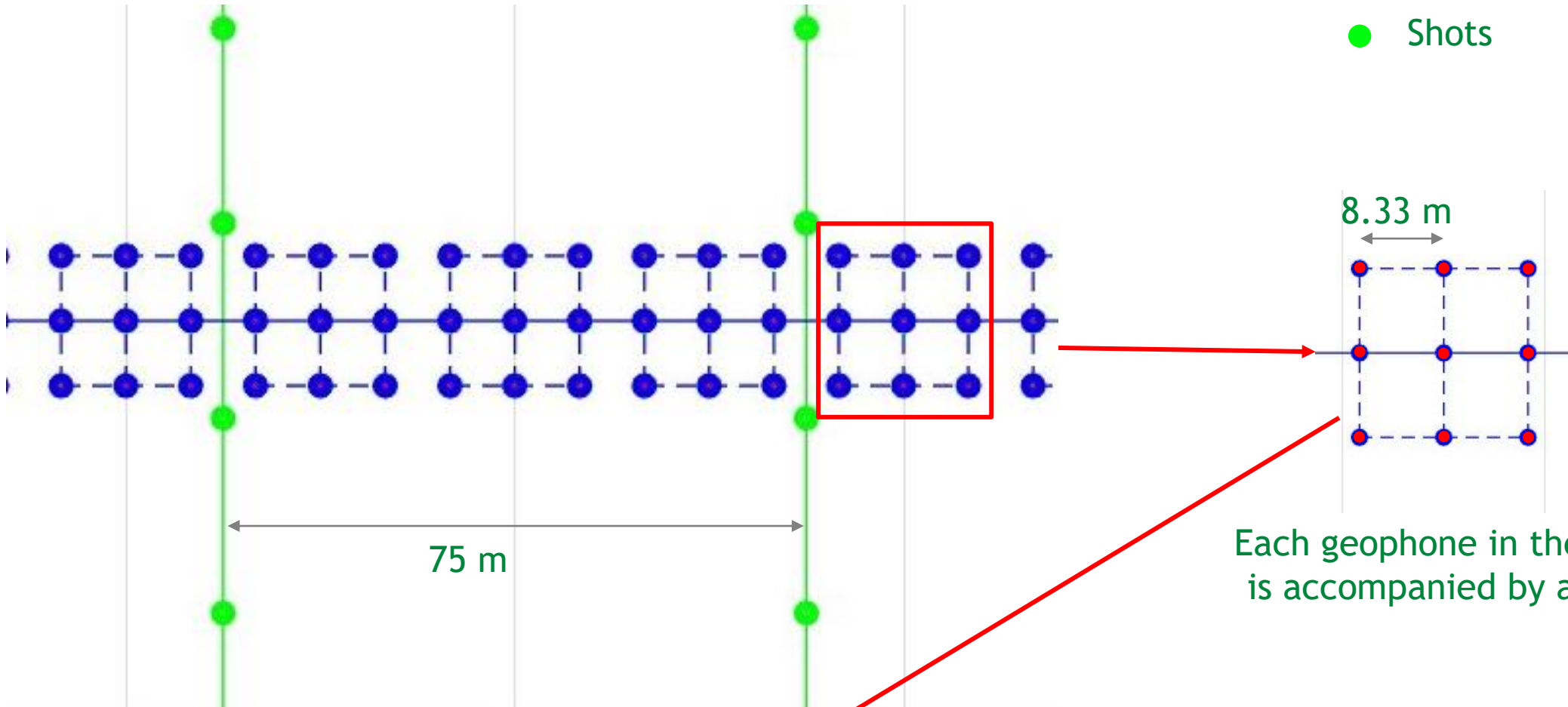
Survey Geometry: sensor placement

- Geophone arrays
- Nodes
- Shots



Survey Geometry: DGF definition

- Geophone arrays
- Nodes
- Shots



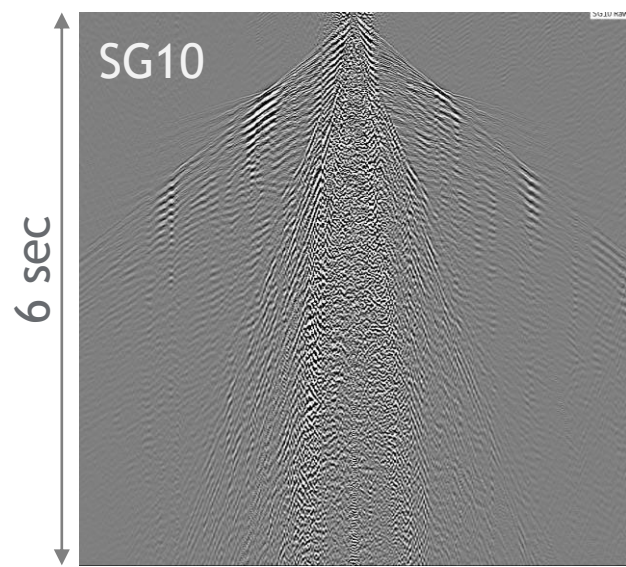
Each geophone in the array is accompanied by a node



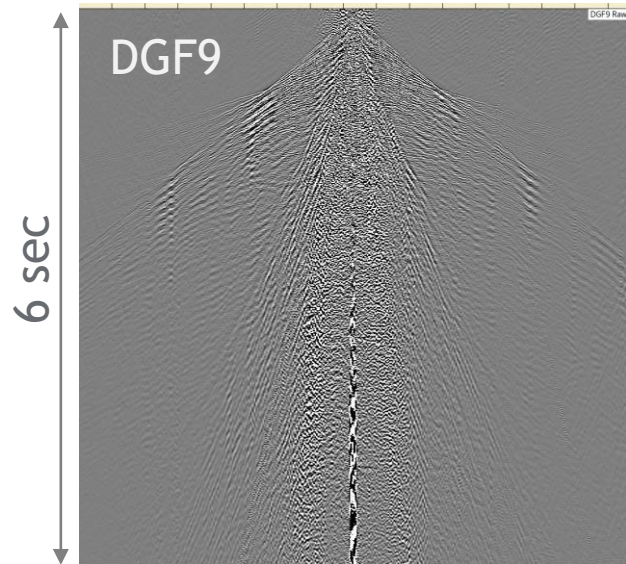
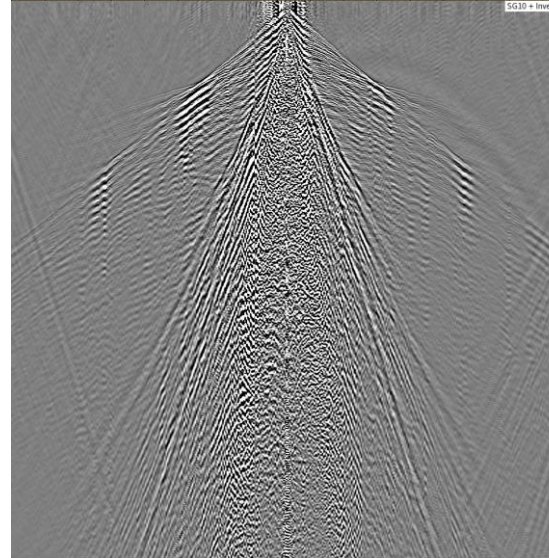
DGF9 vs geophone array



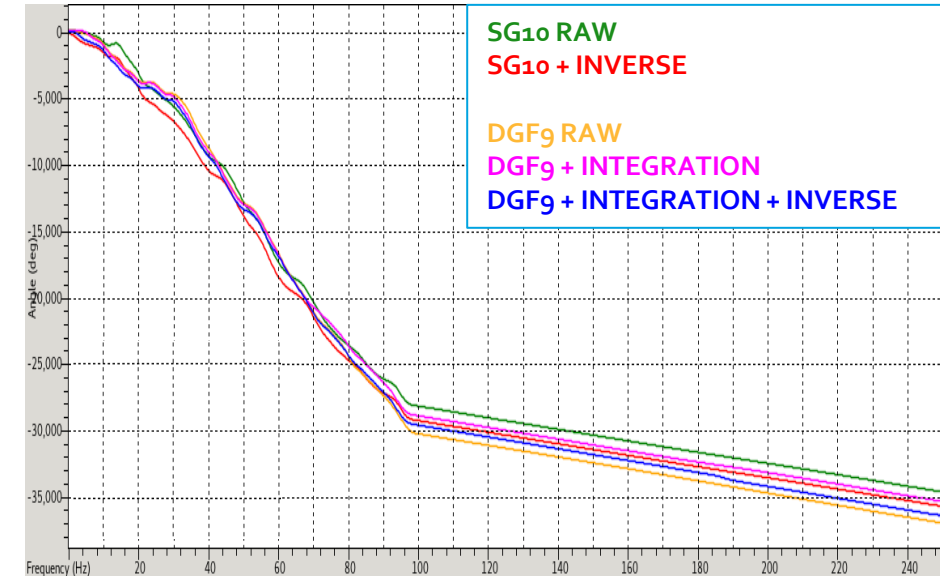
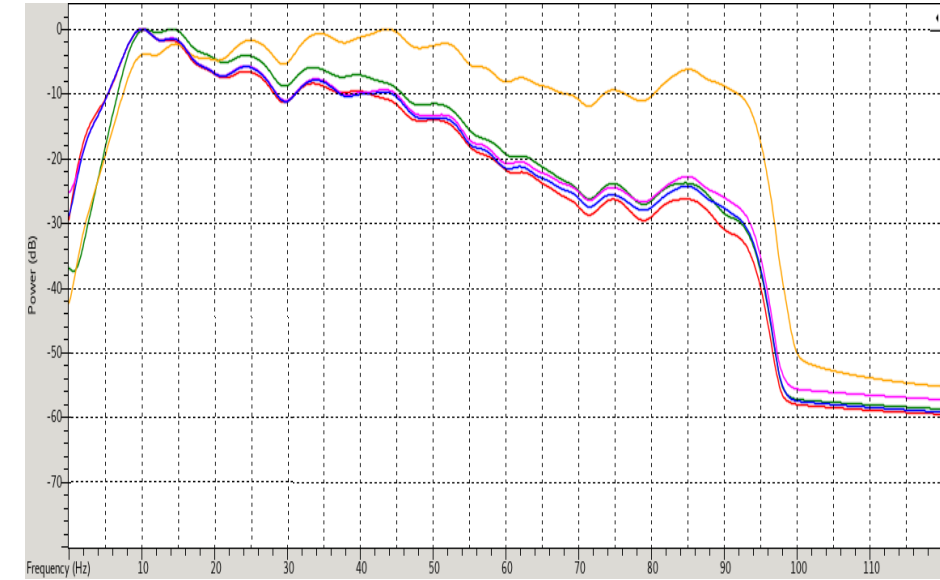
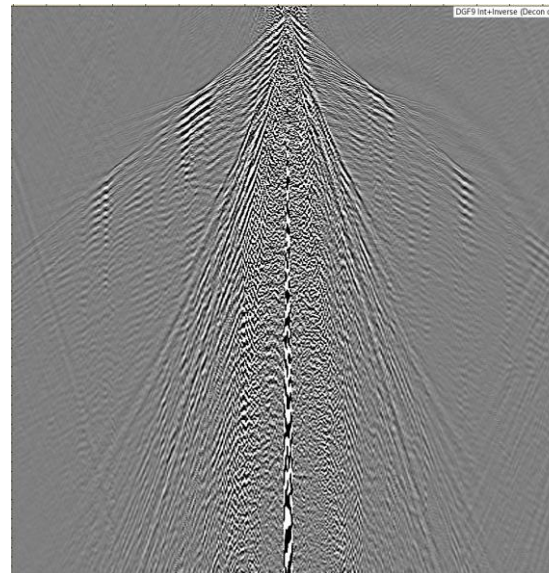
Instrument response correction



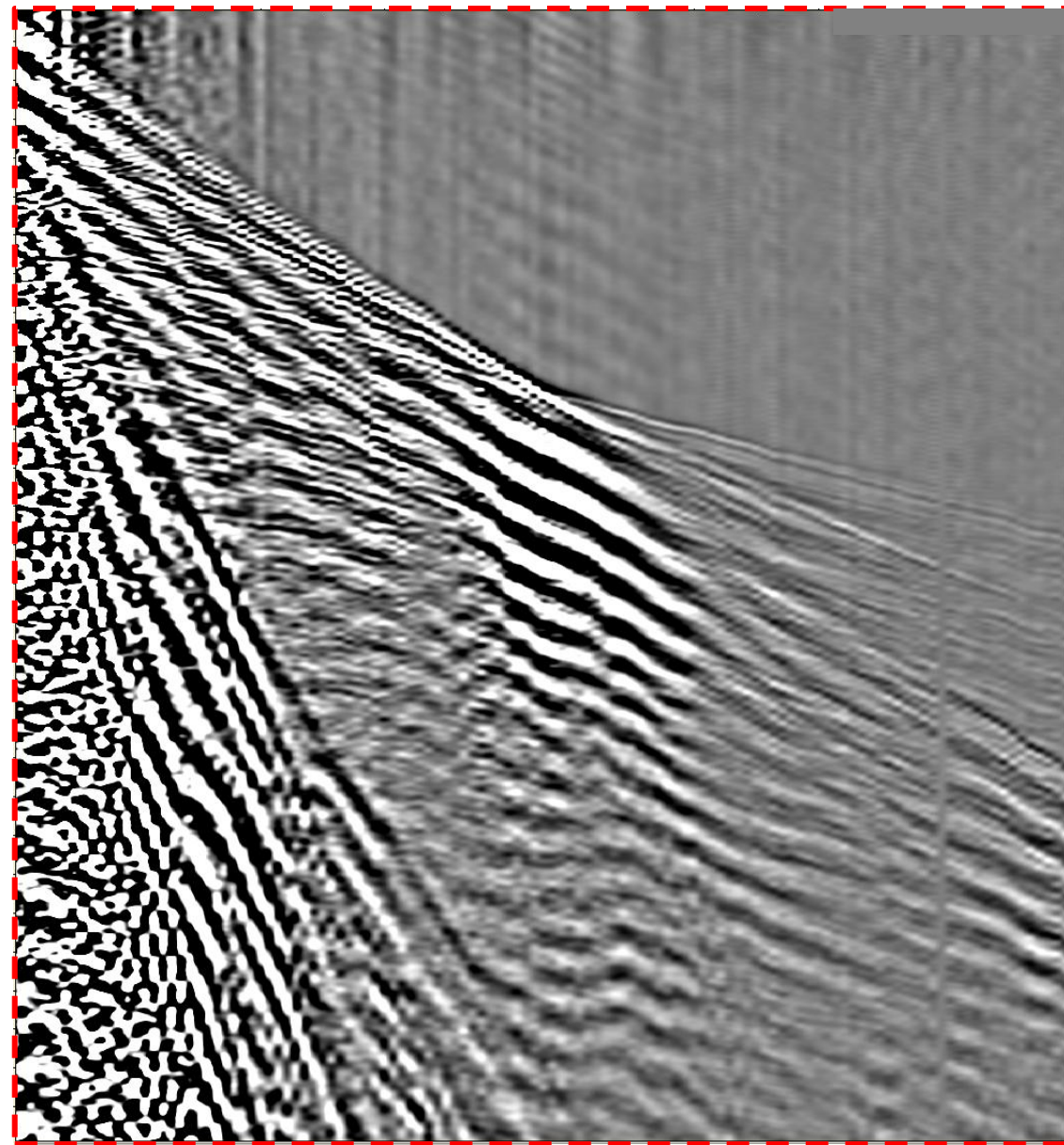
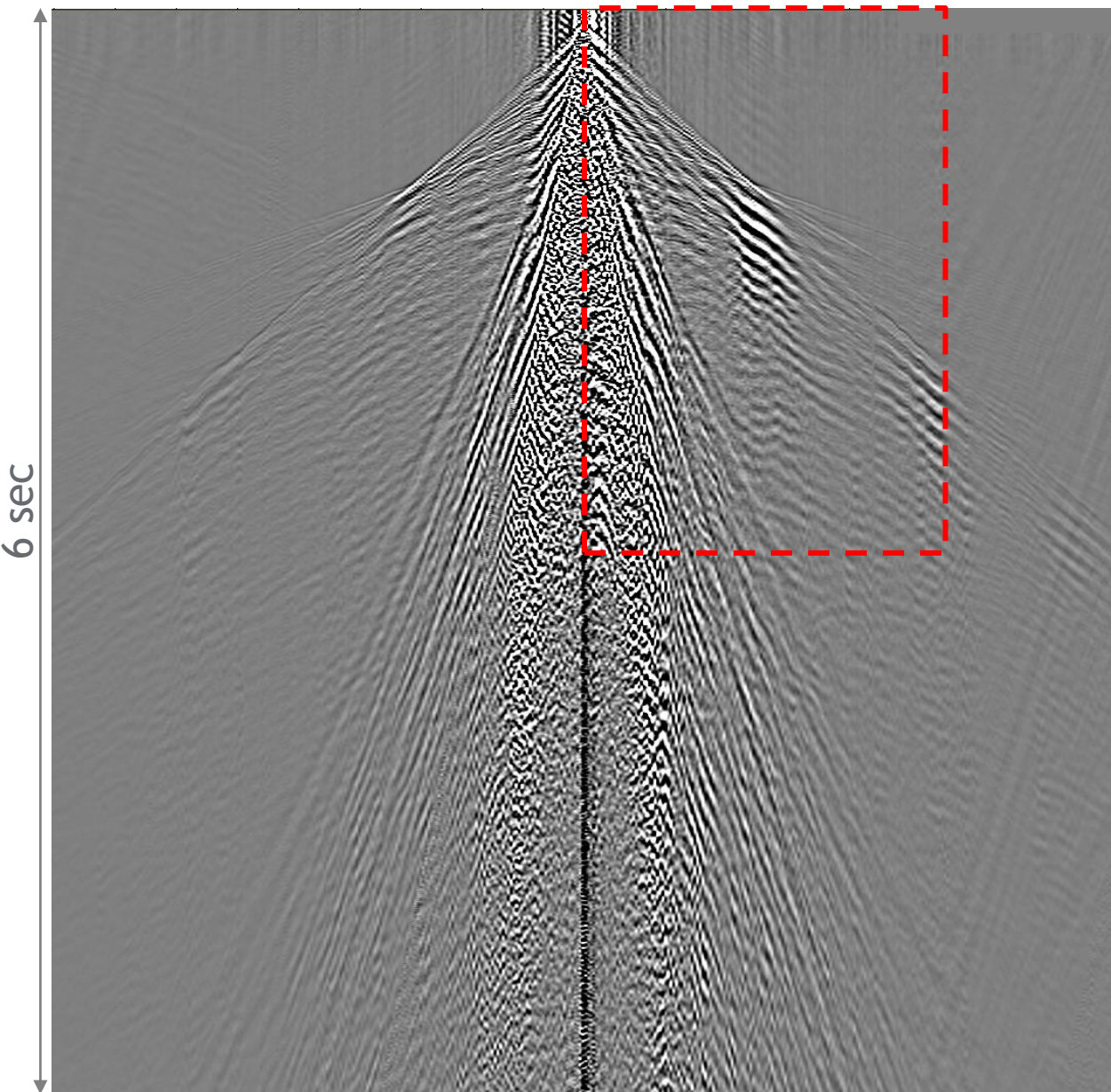
Instrument
Inverse filter



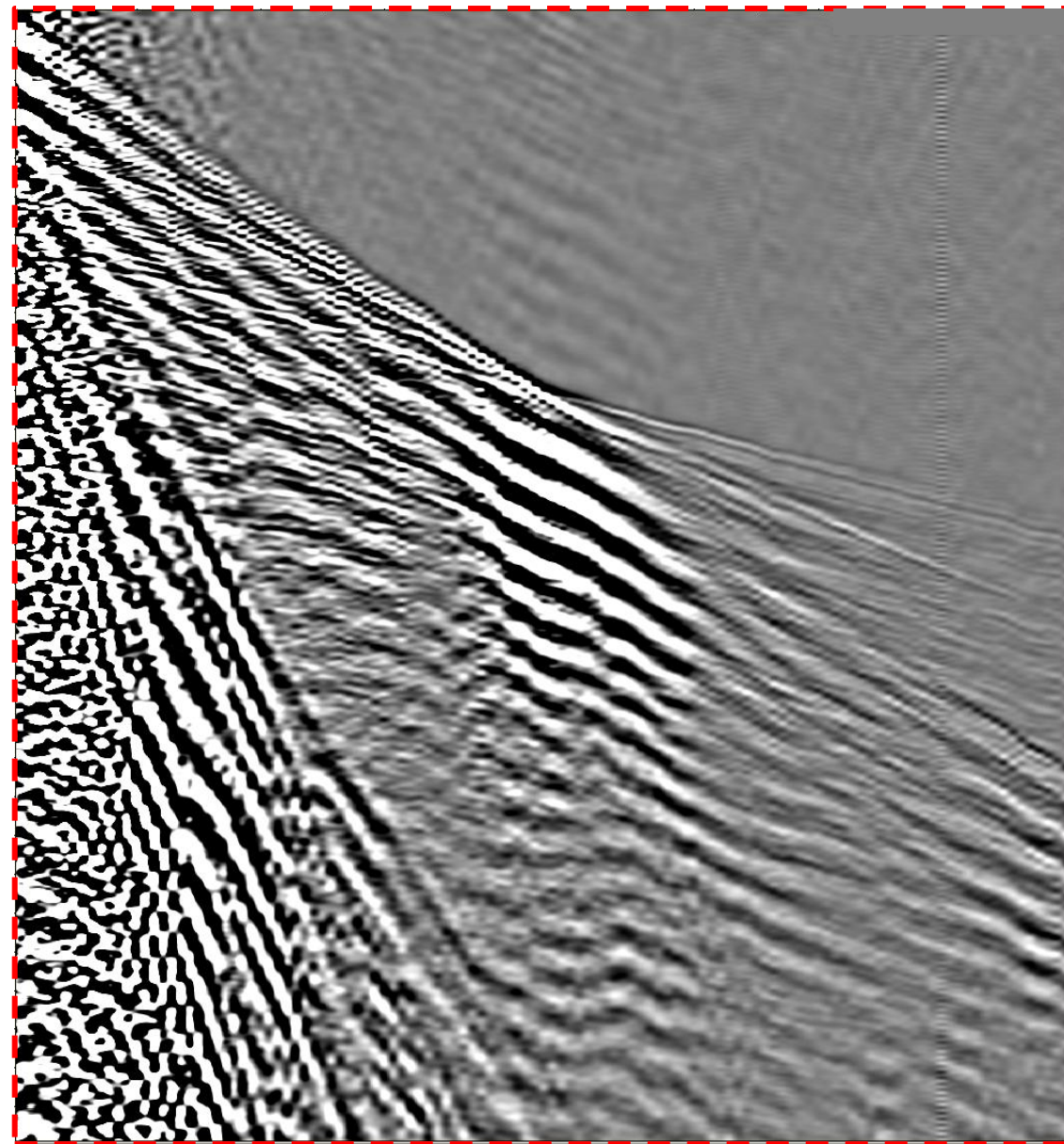
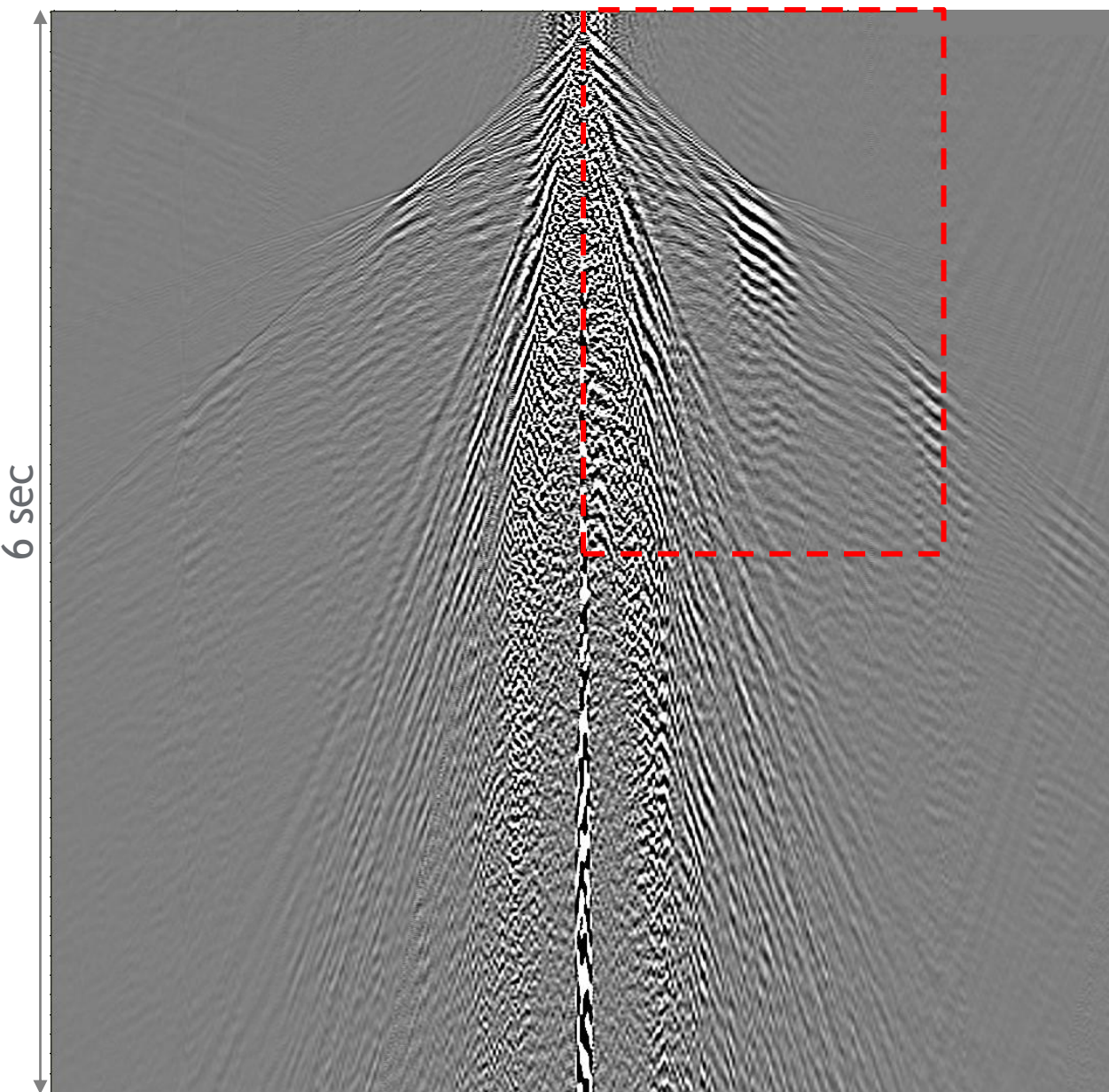
$\int$ + Instrument
Inverse filter



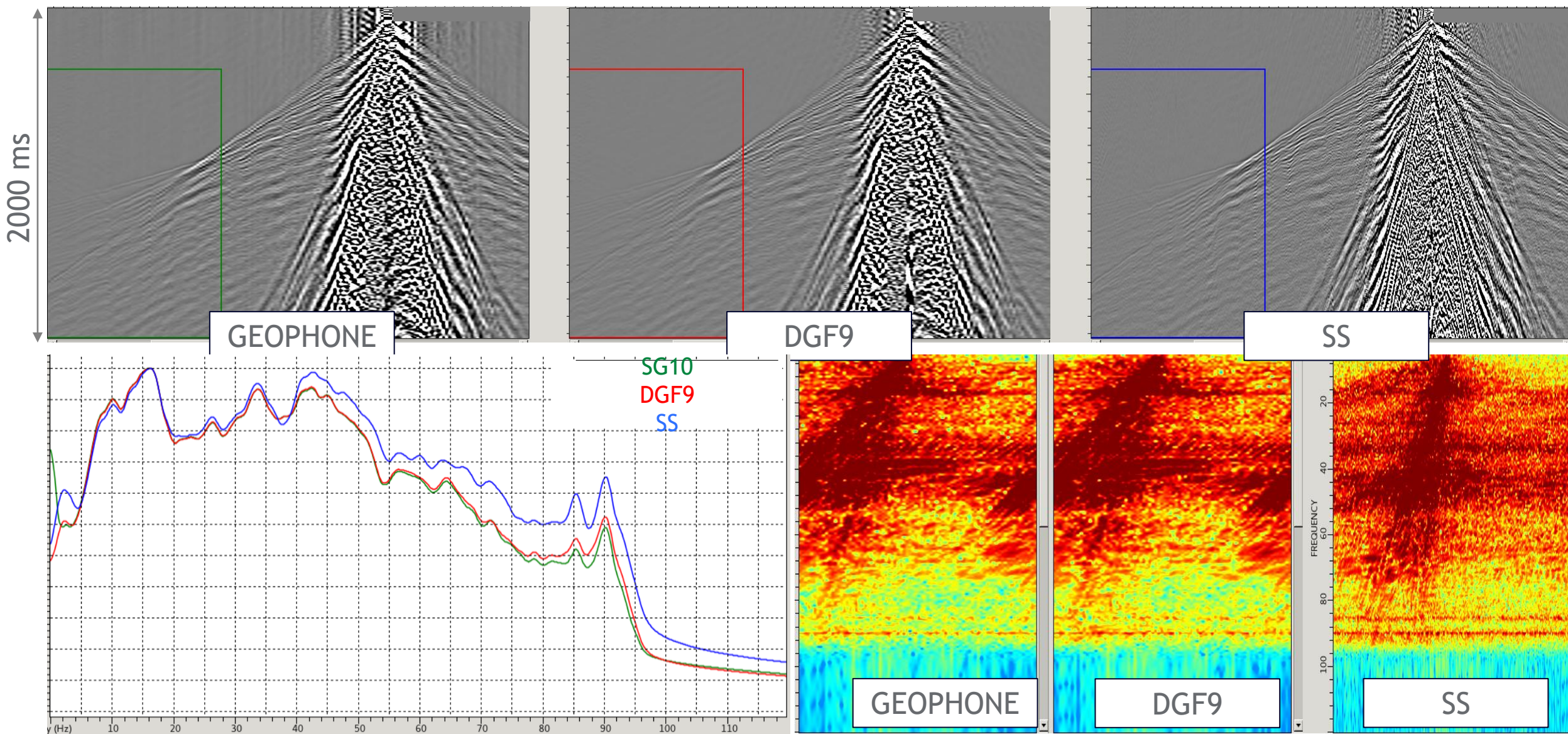
9-Geophone array: Shot after G-resp inv. Filter



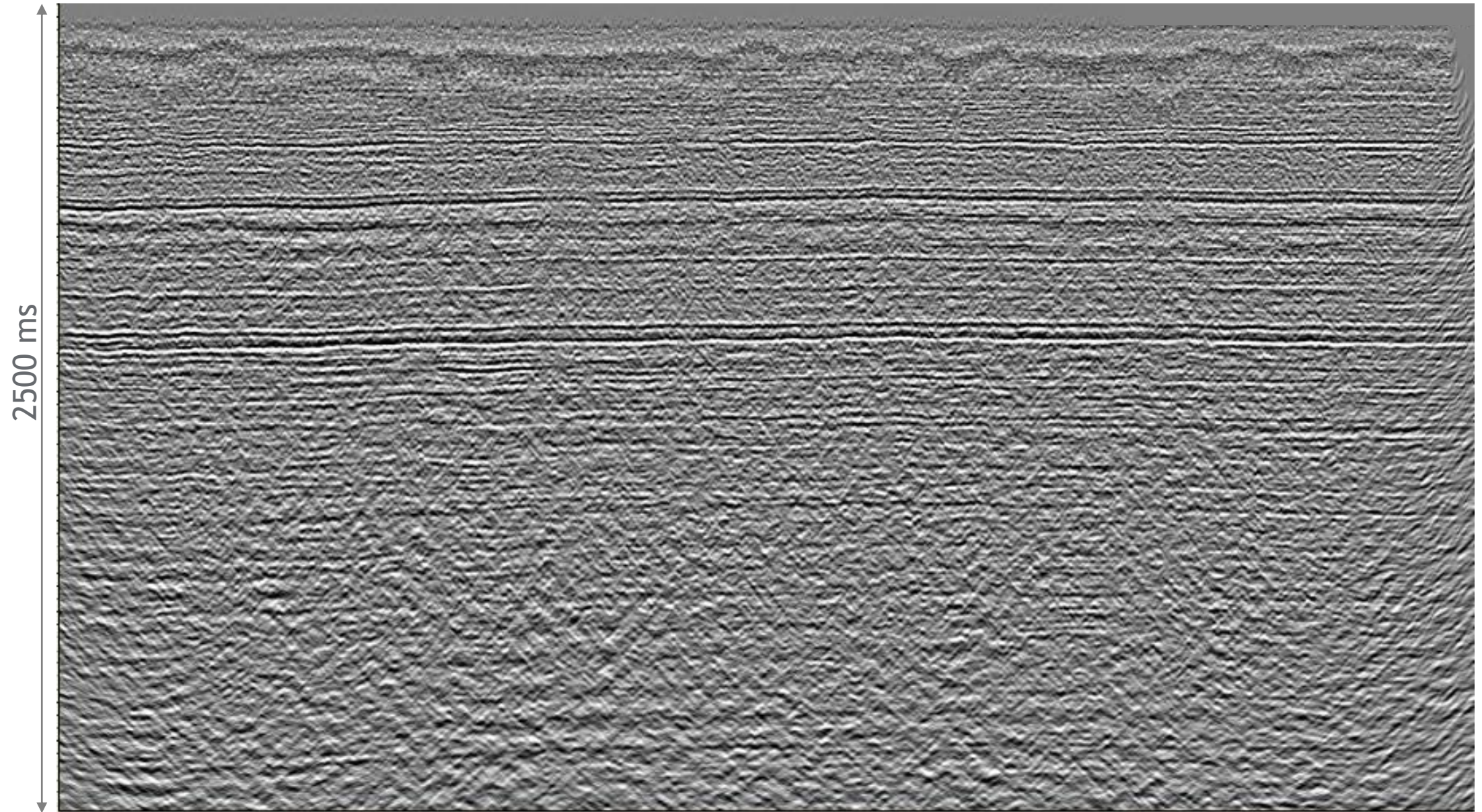
DGF9: Shot after Node Inverse Filter



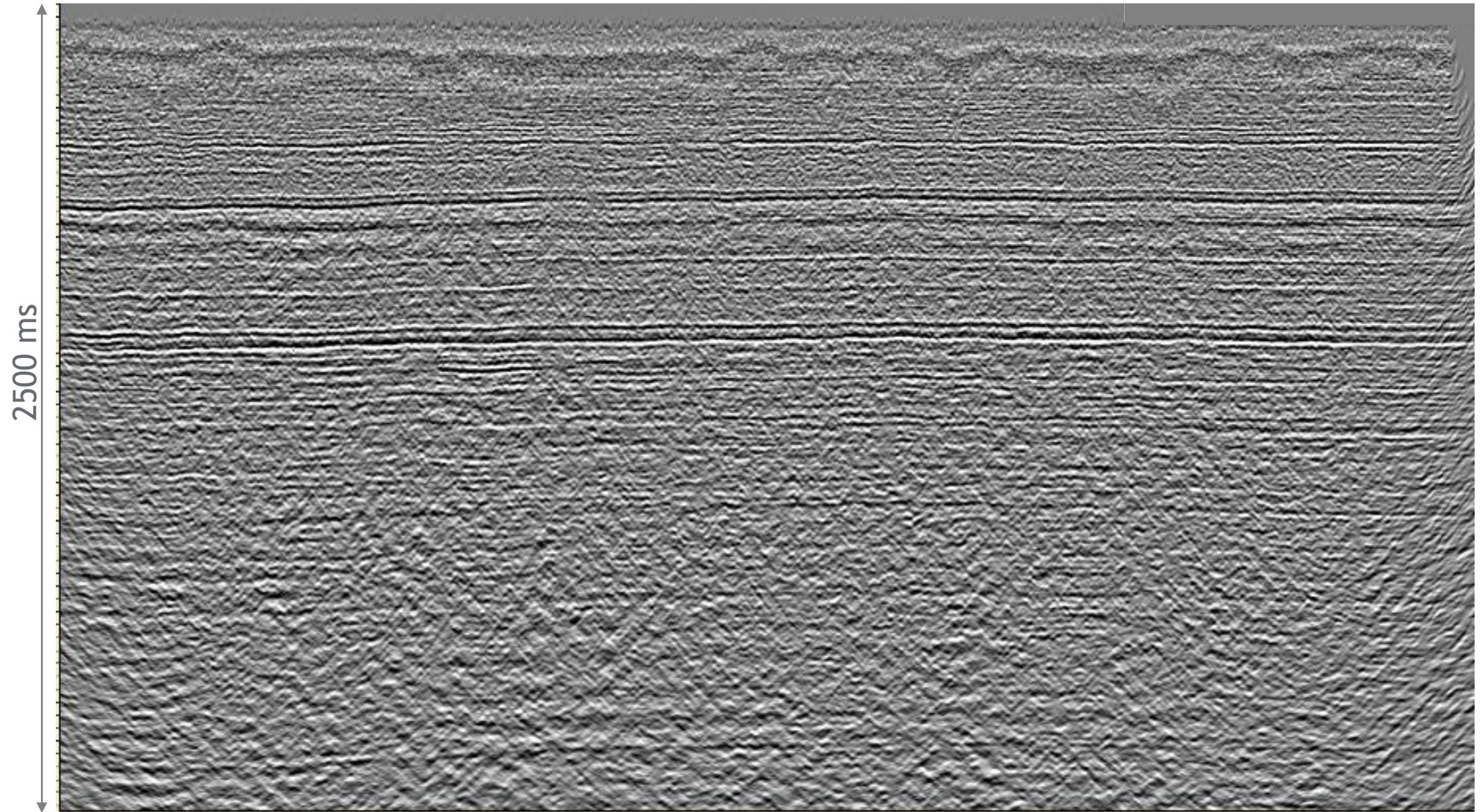
Geophone array vs DGF9 vs SS



PSTM: SG10 array - 1 source / 1 receiver line



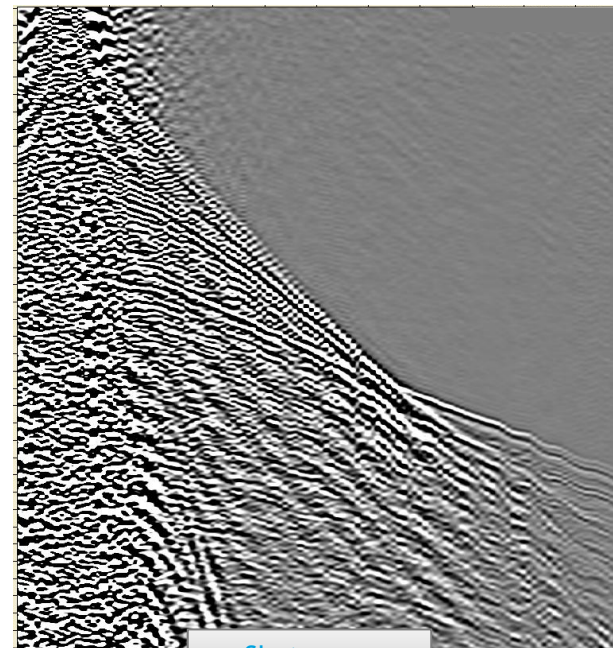
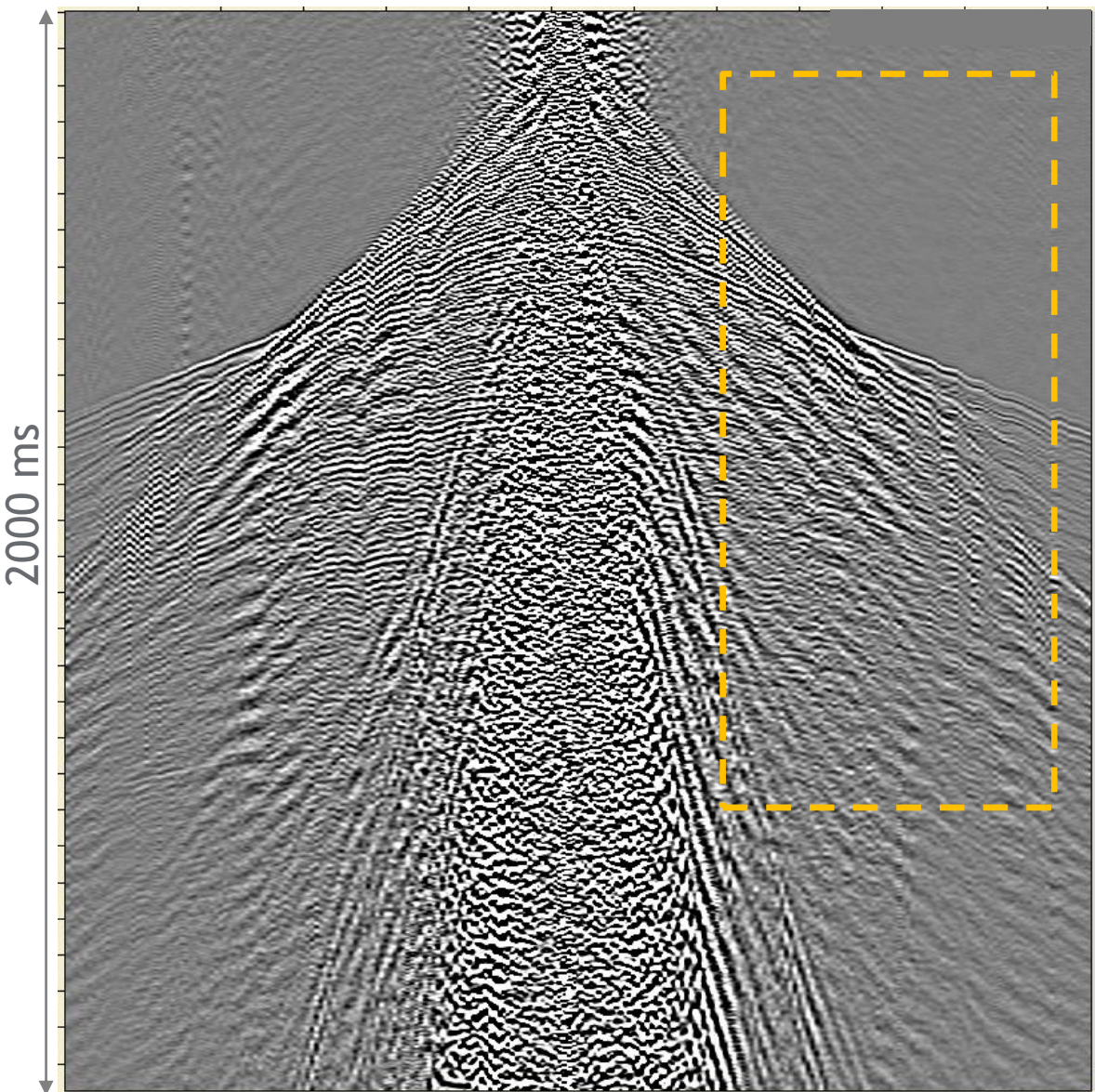
PSTM: DGF9 - 1 source / 1 receiver line



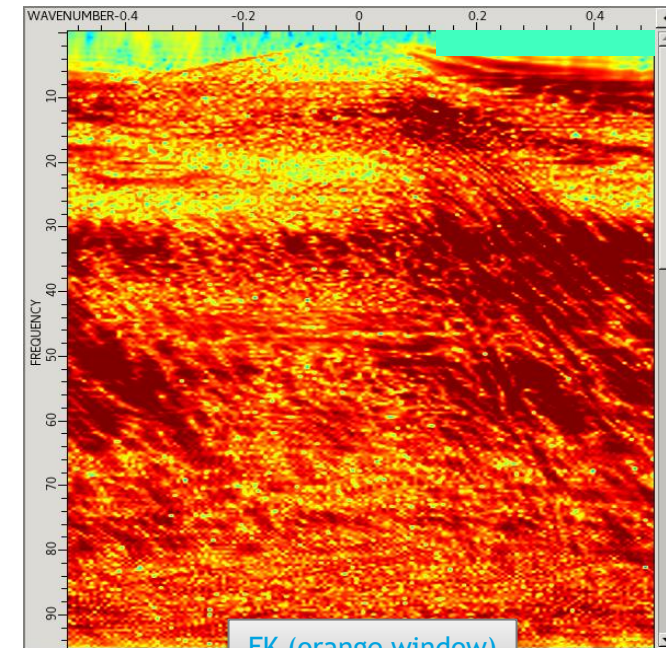
Comparison of DGFs



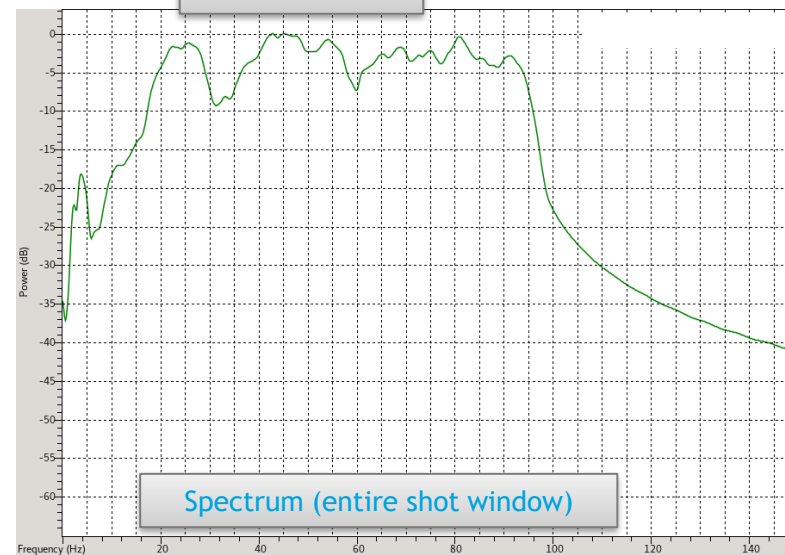
DGF9 (production reference)



Shot zoom



FK (orange window)

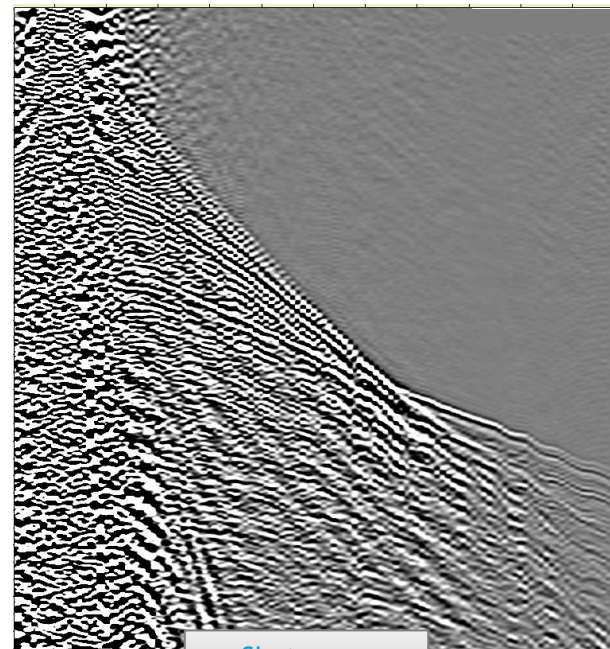
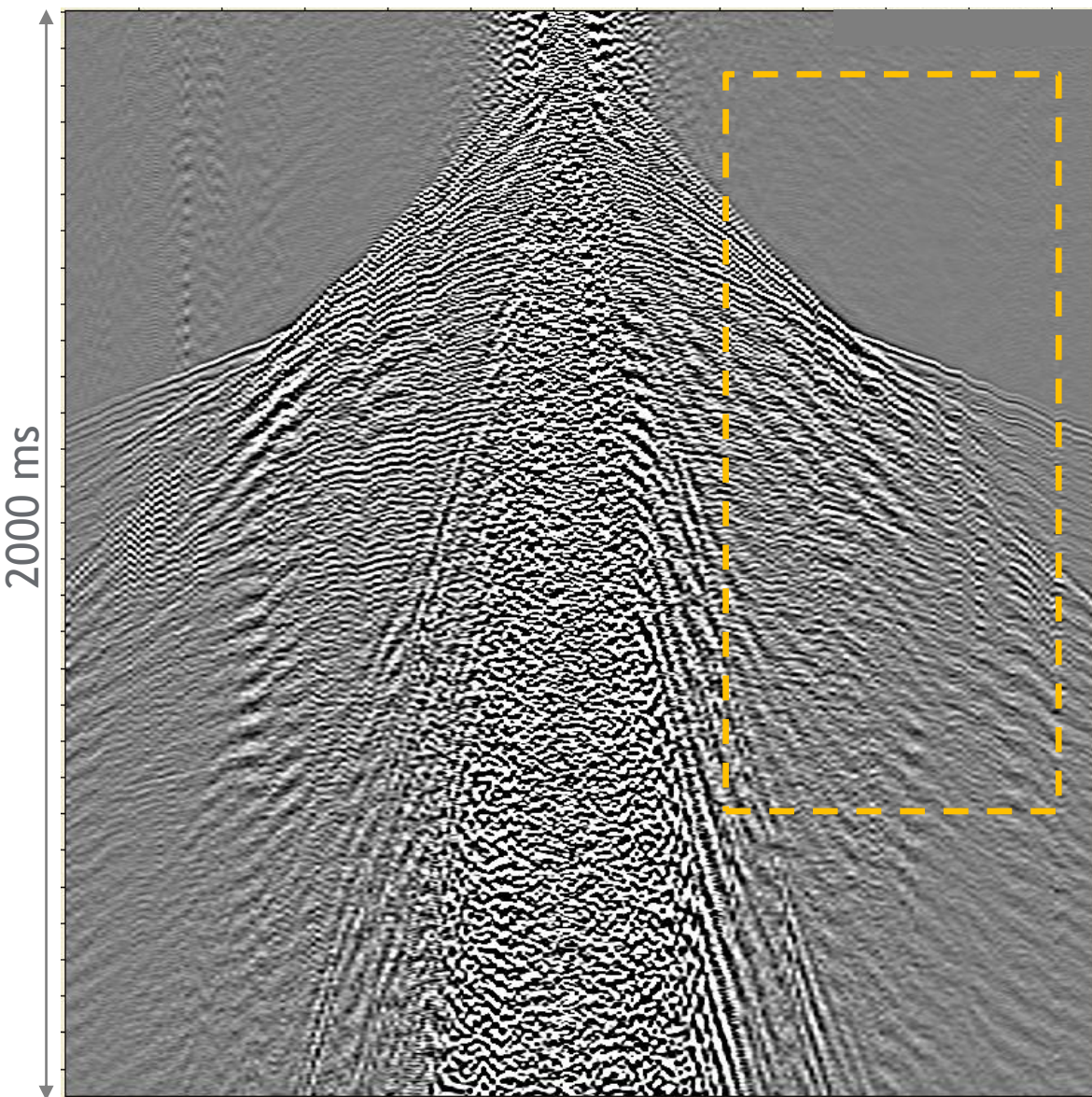


Spectrum (entire shot window)

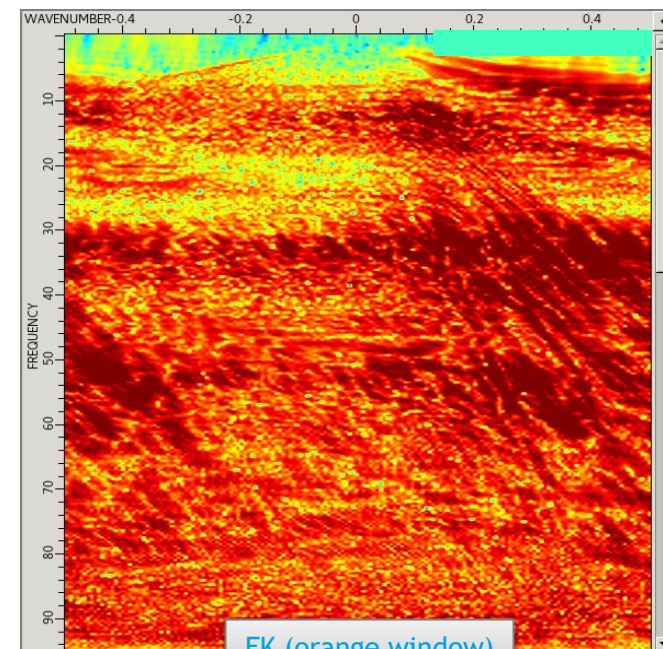


Traces in DGF

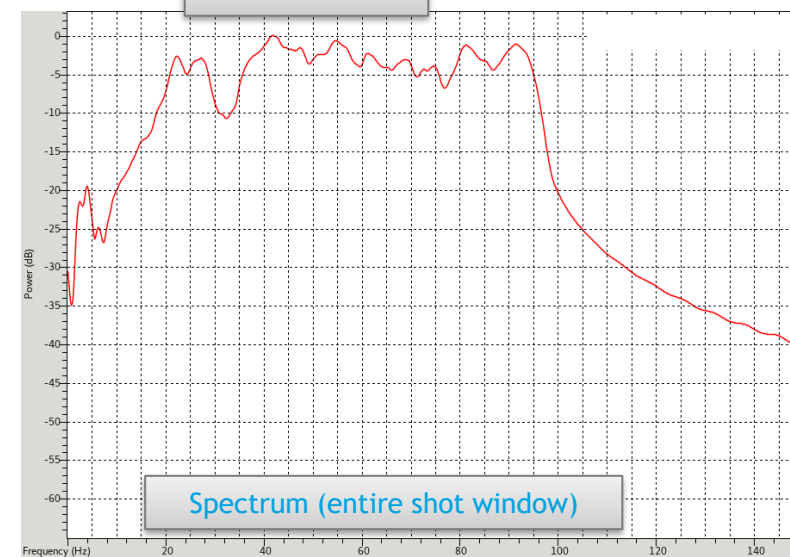
DGF6



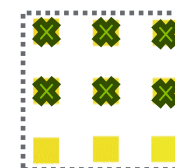
Shot zoom



FK (orange window)

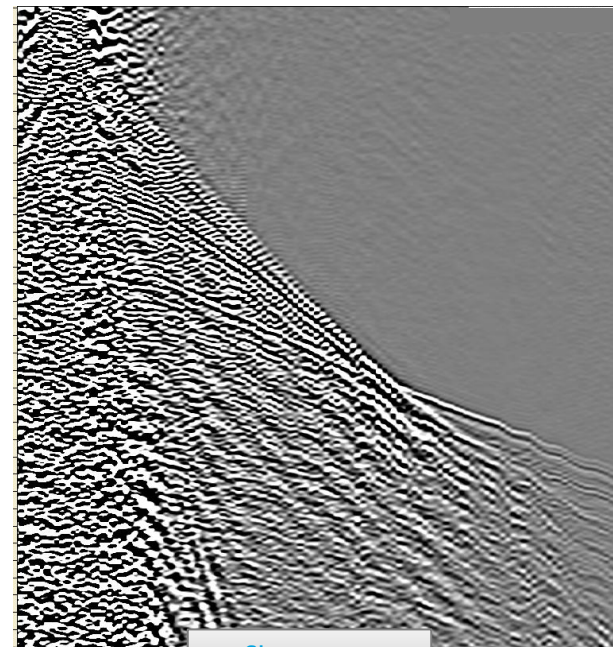
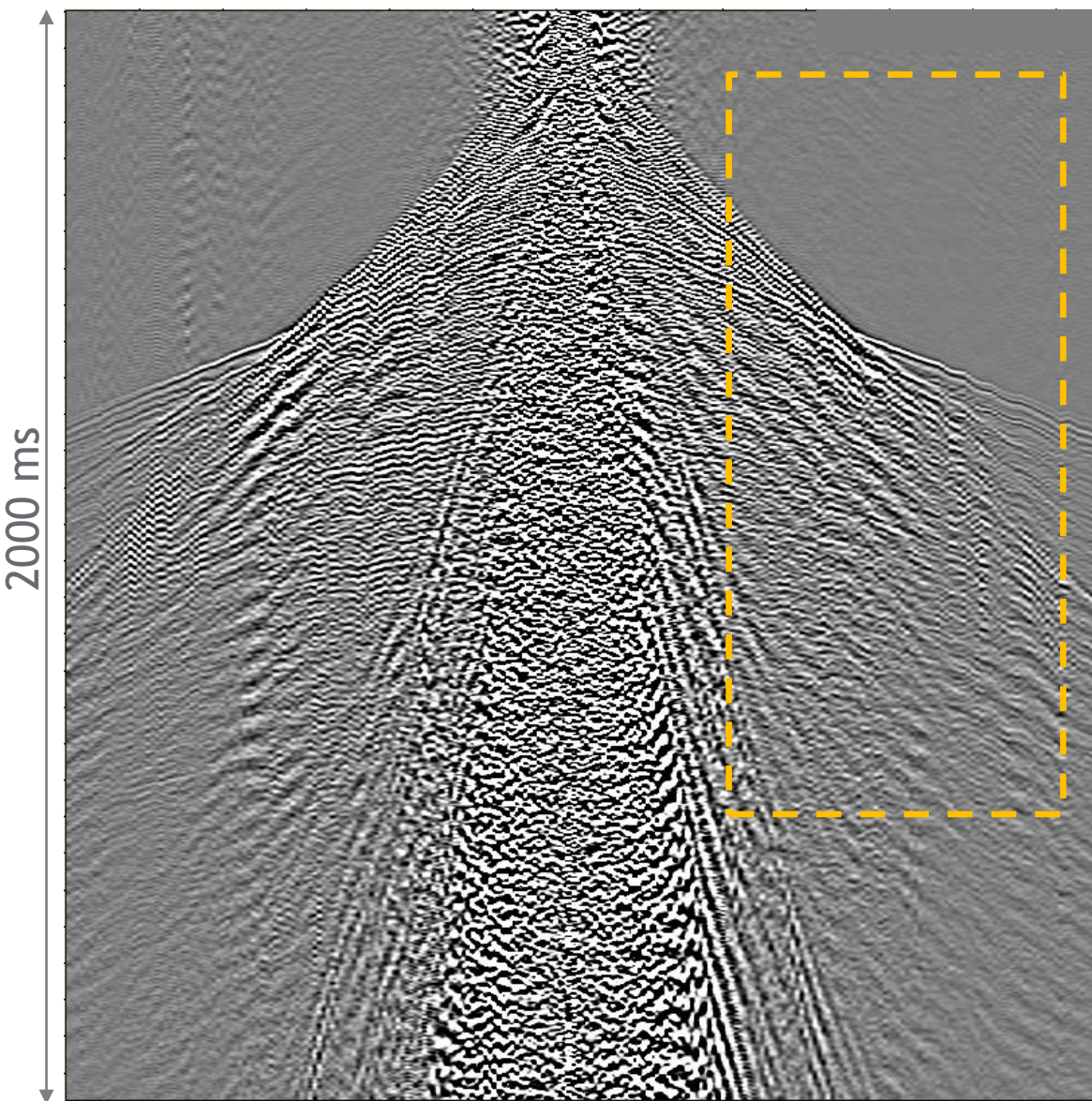


Spectrum (entire shot window)

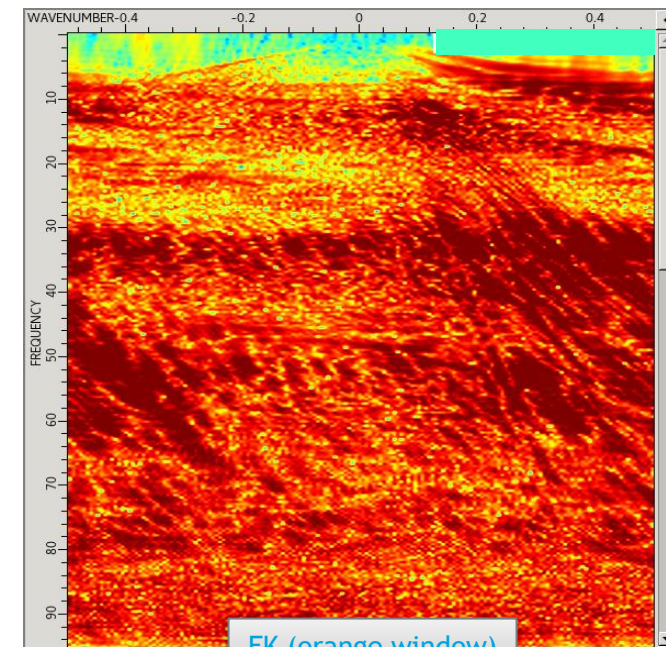


Traces in DGF

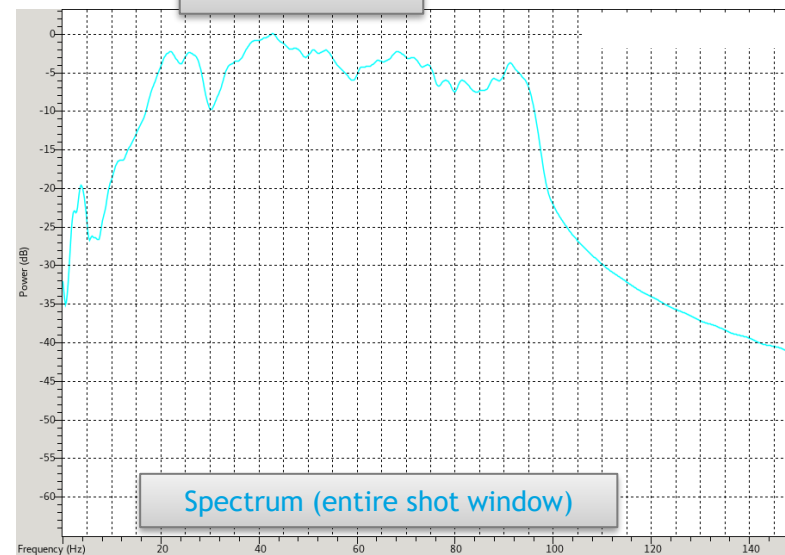
DGF5P



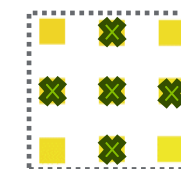
Shot zoom



FK (orange window)

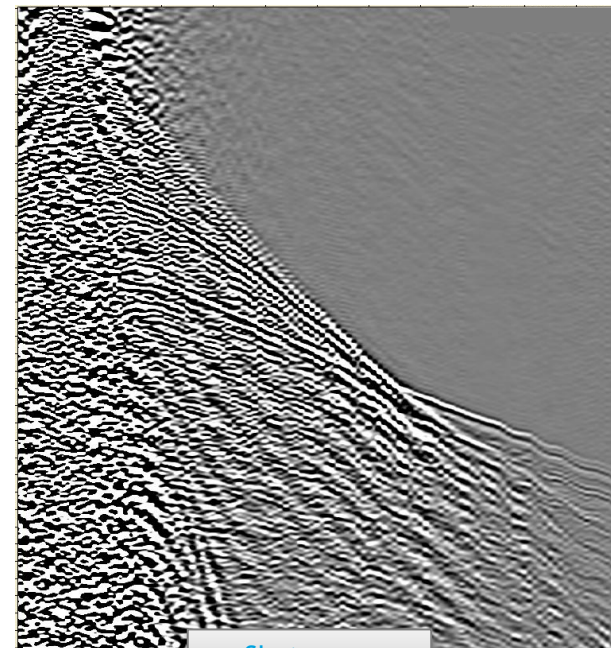
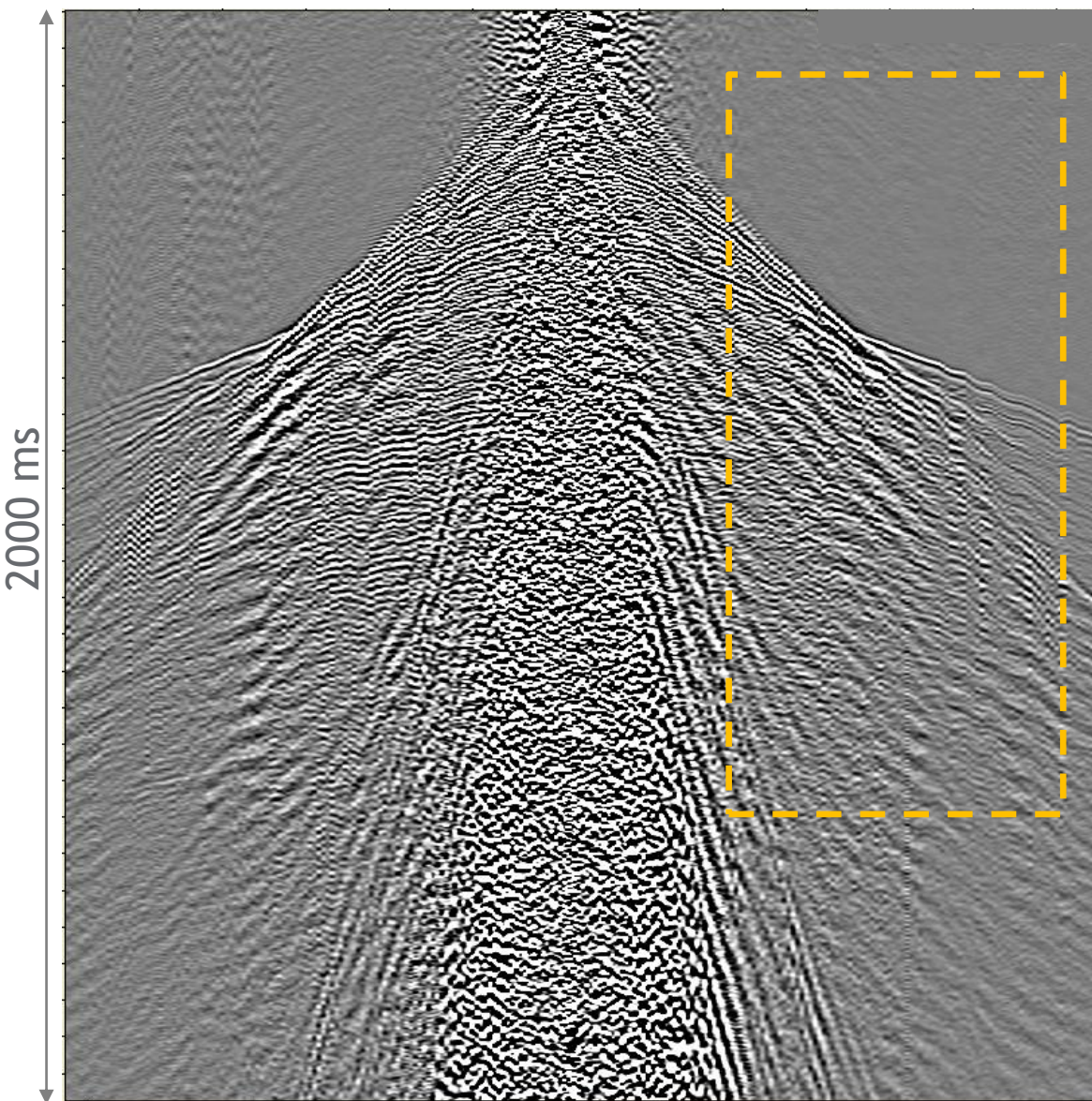


Spectrum (entire shot window)

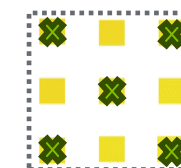
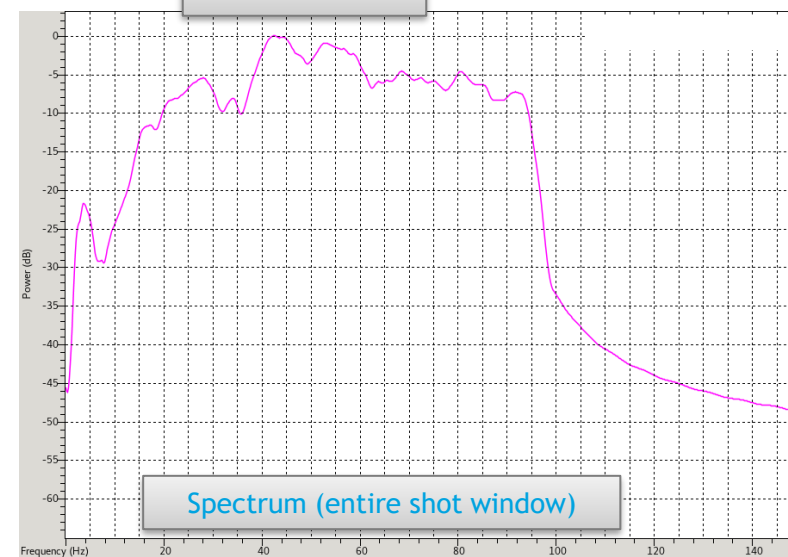
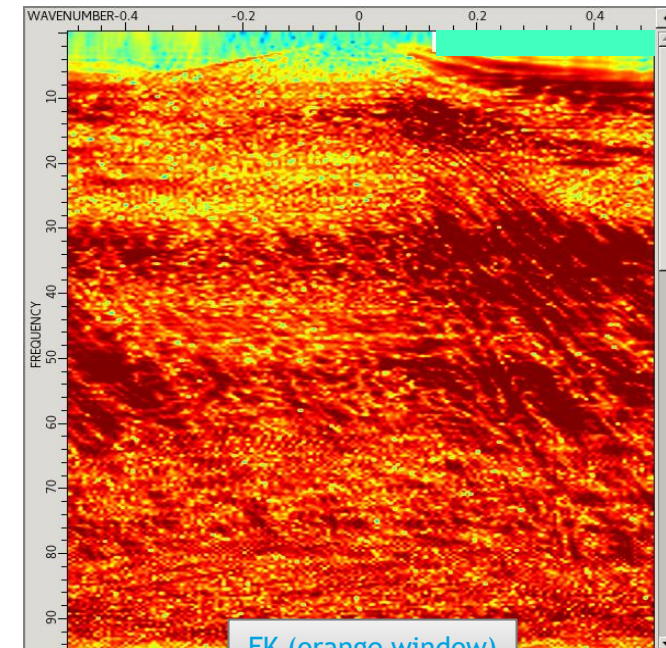


Traces in DGF

DGF5X

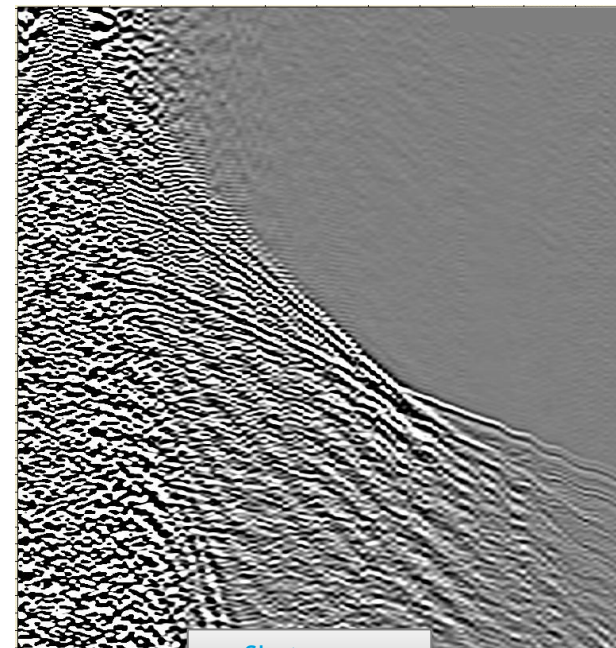
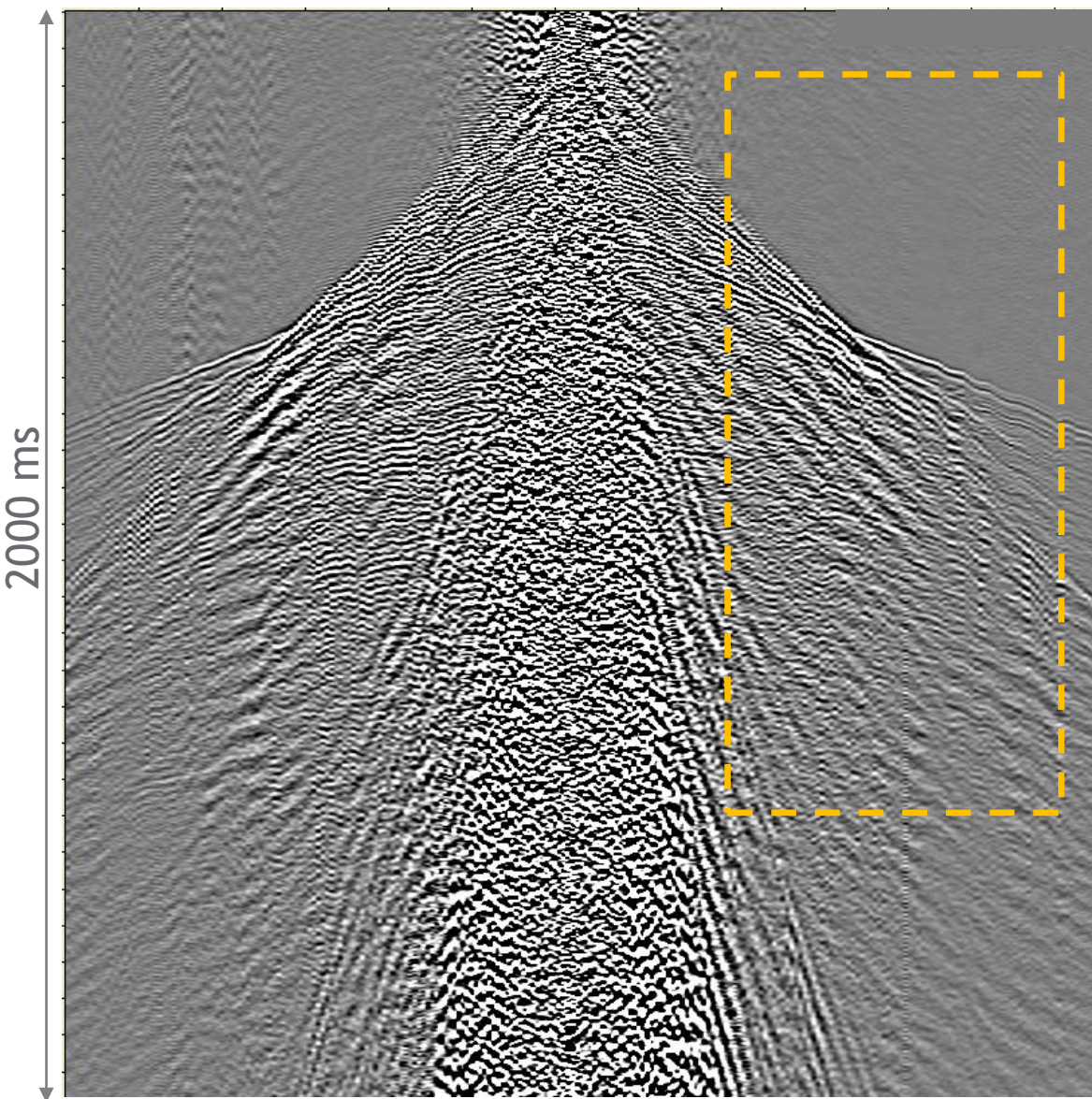


Shot zoom

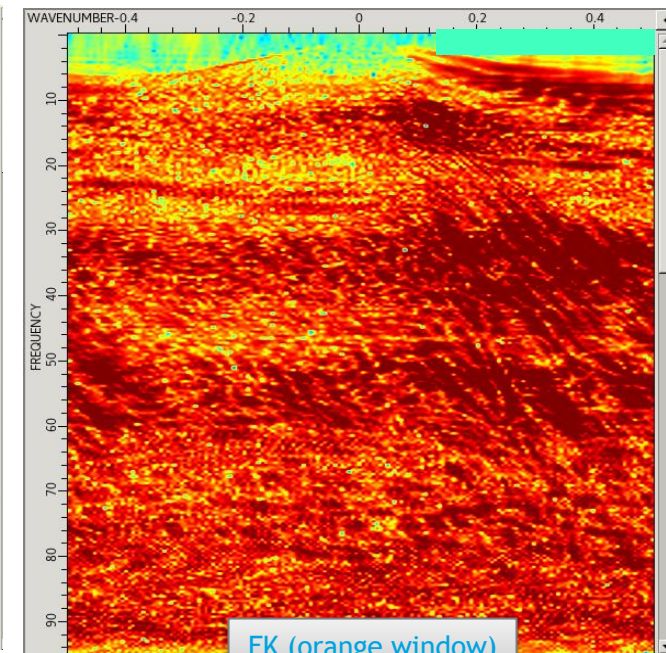


Traces in DGF

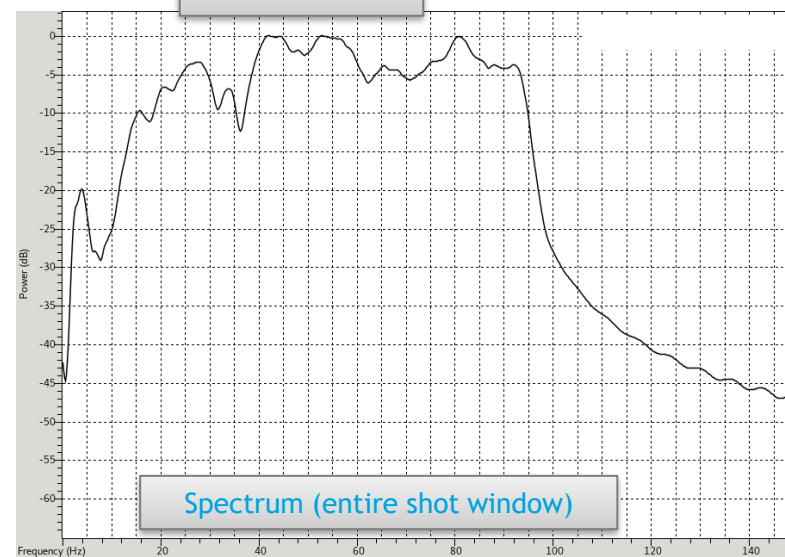
DGF4



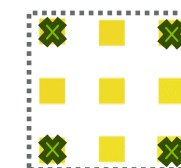
Shot zoom



FK (orange window)

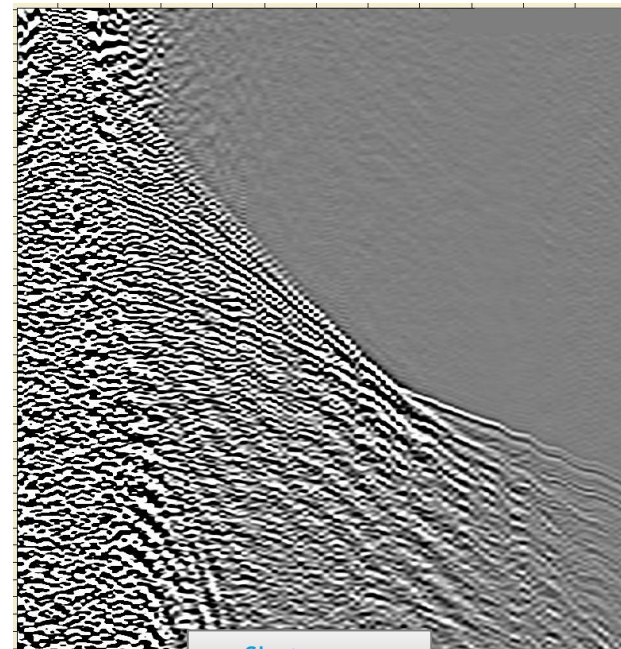
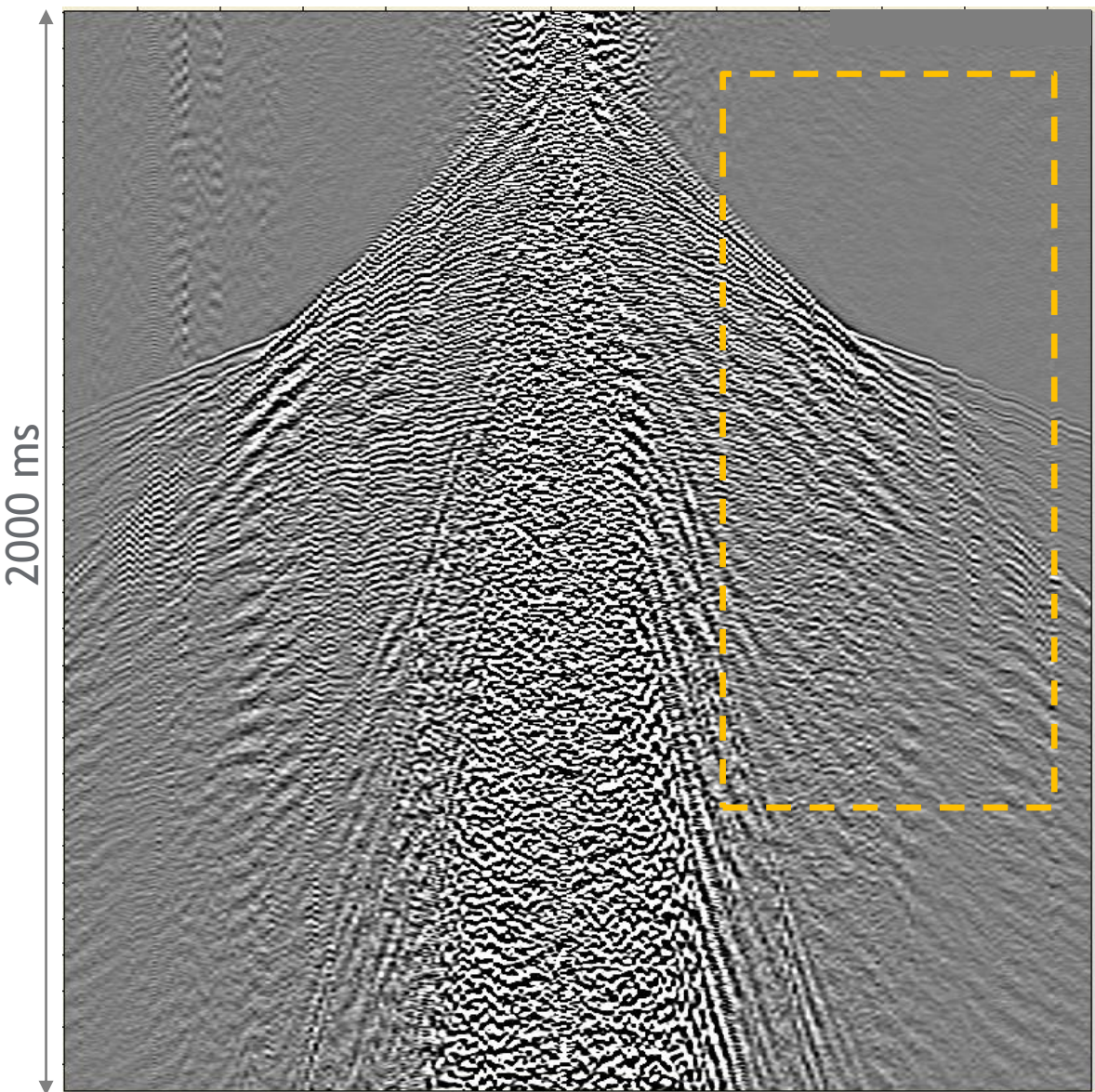


Spectrum (entire shot window)

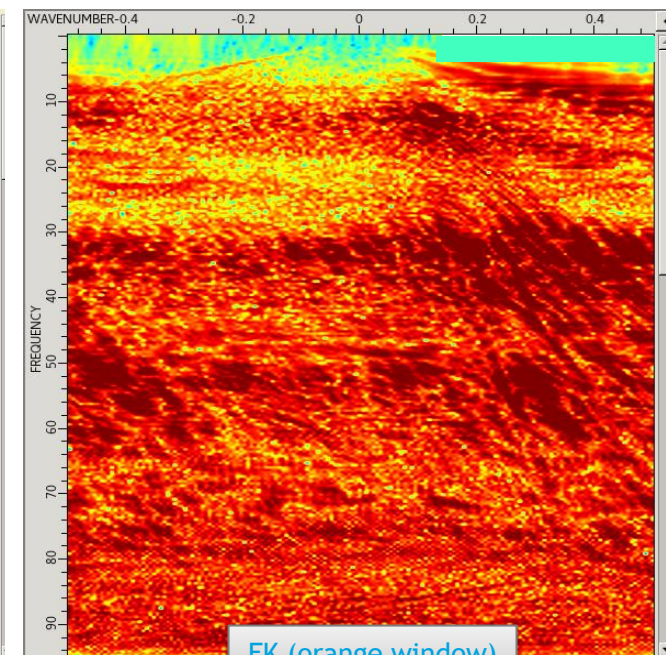


Traces in DGF

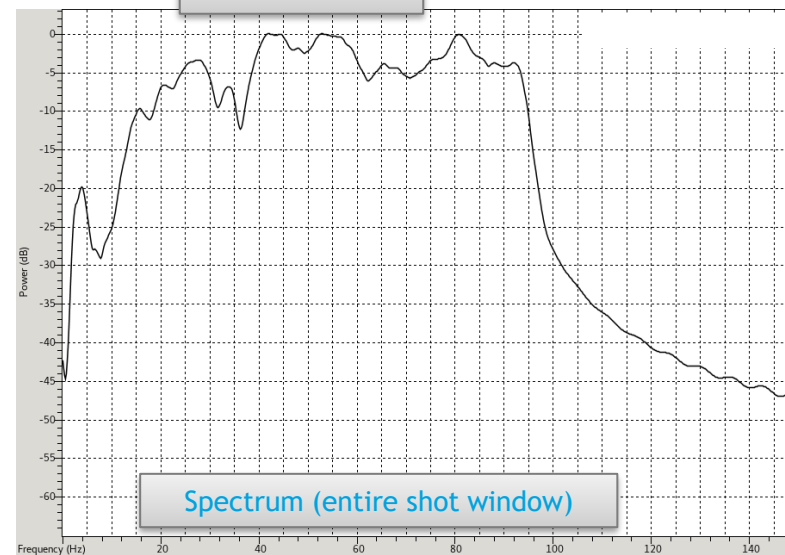
DGF3



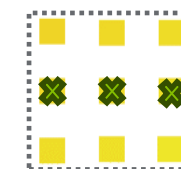
Shot zoom



FK (orange window)

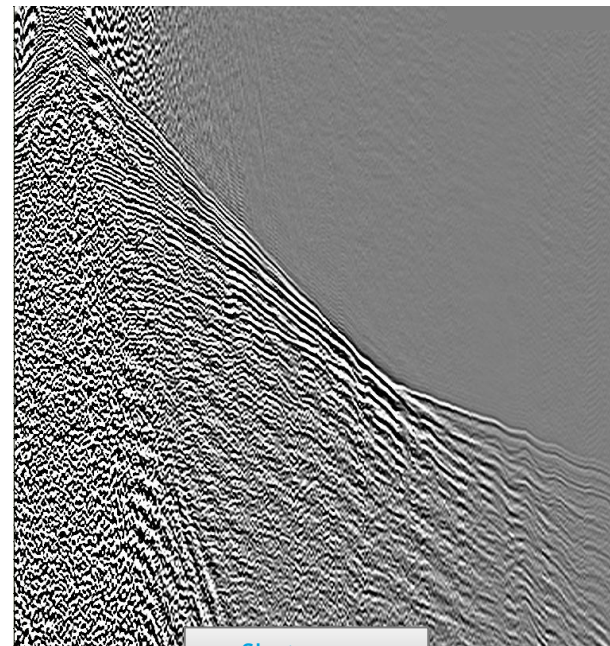
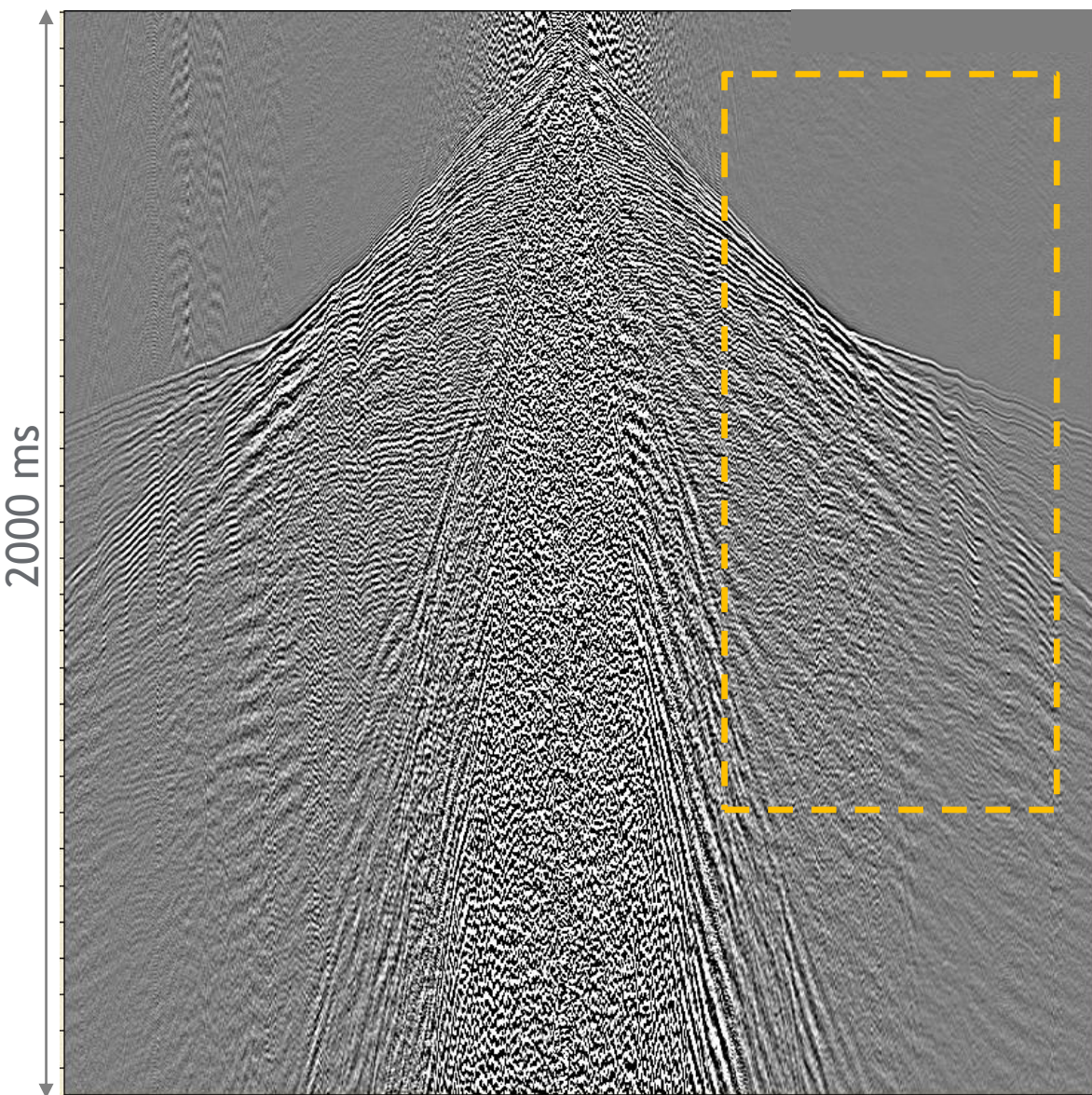


Spectrum (entire shot window)

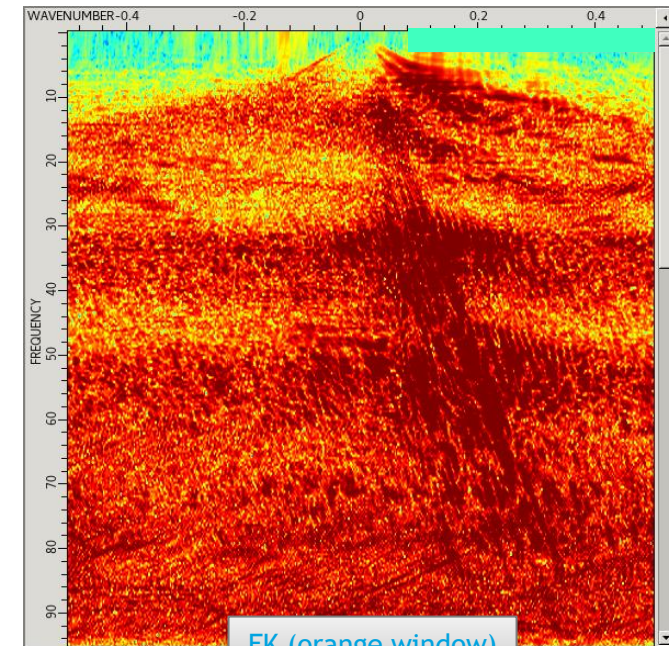


Traces in DGF

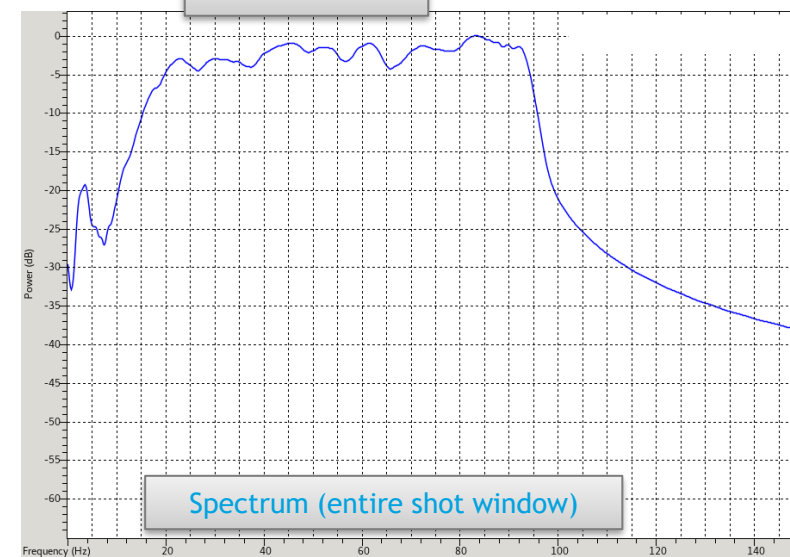
Single Sensor



Shot zoom

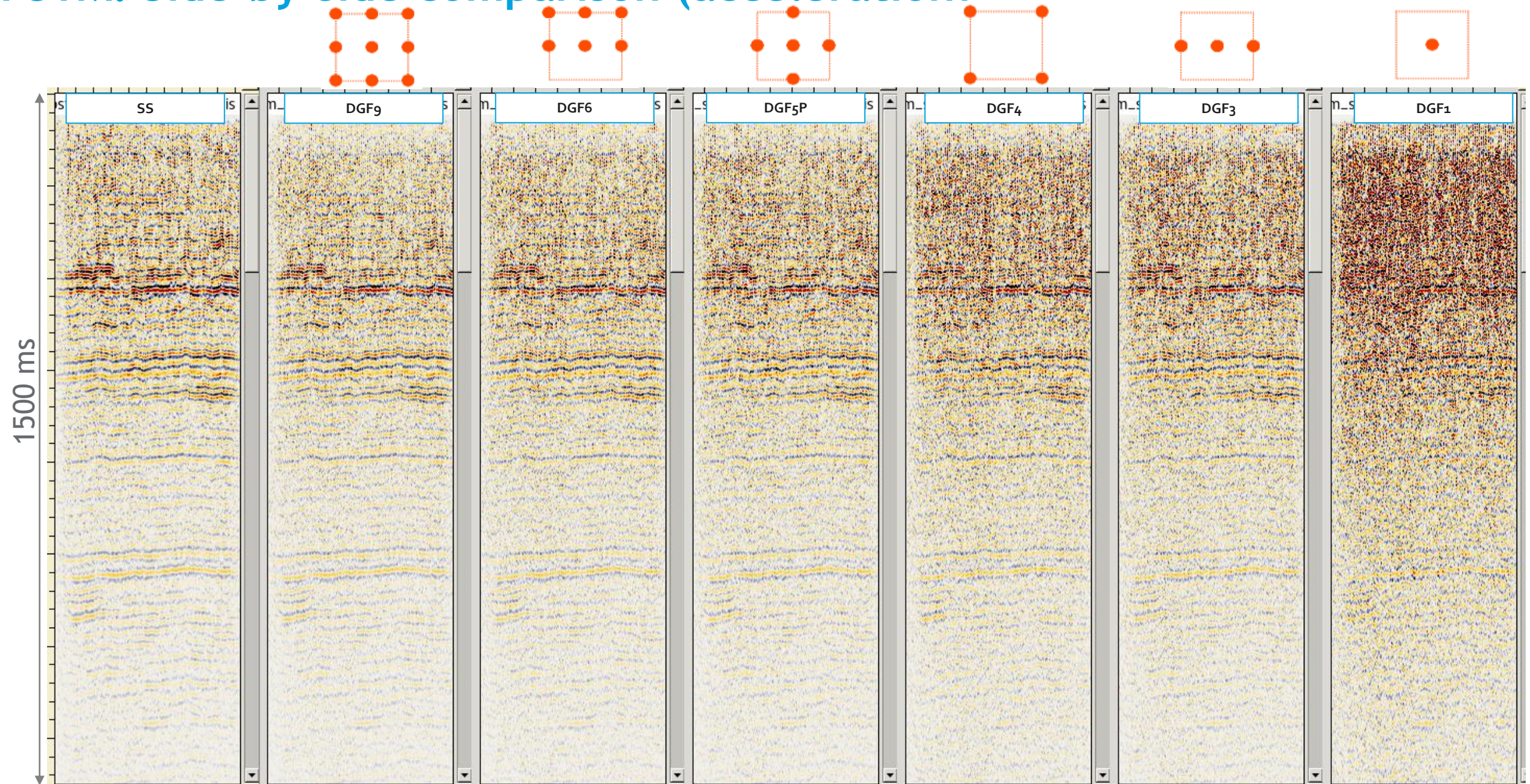


FK (orange window)

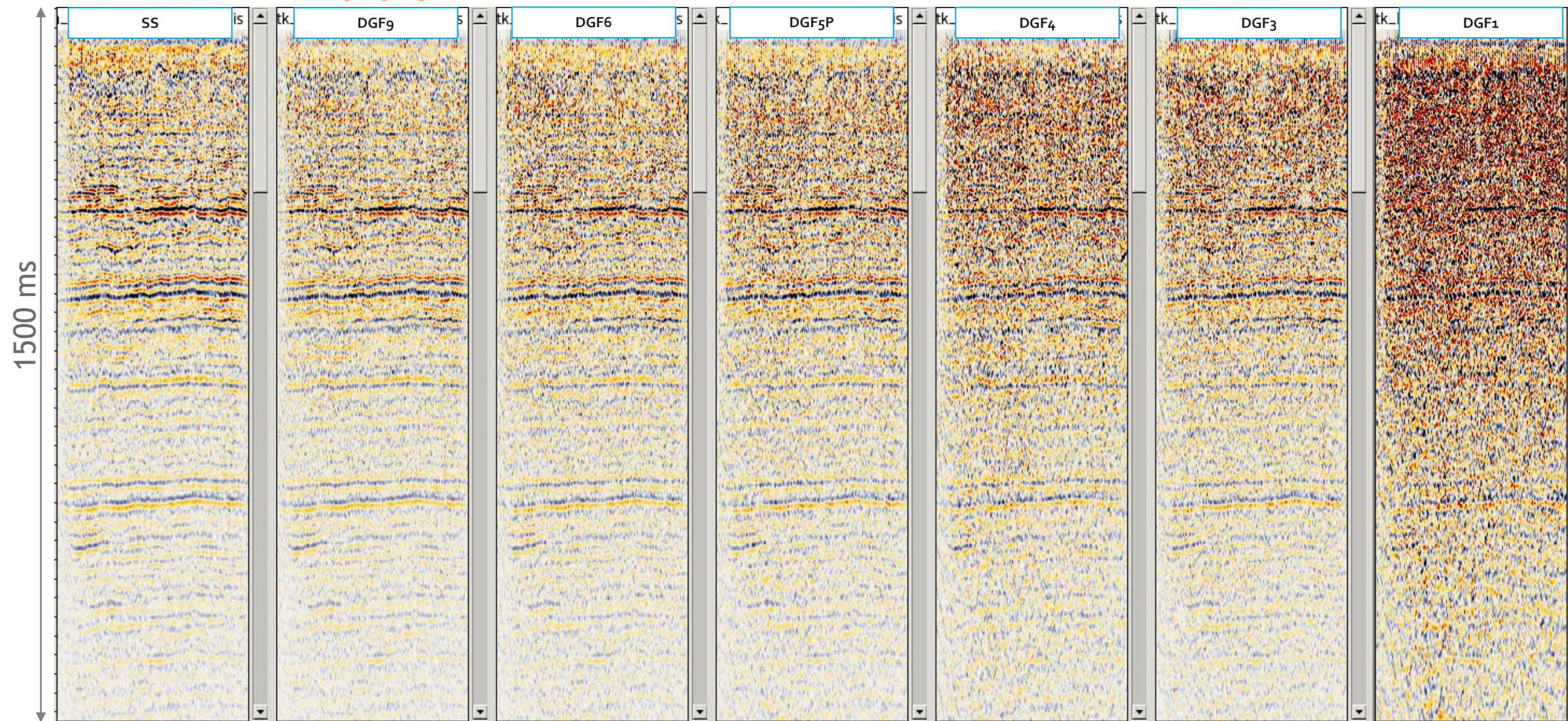


Spectrum (entire shot window)

PSTM: Side-by-side comparison (acceleration)



PSTM: Side-by-side comparison (velocity)



Conclusions

- Compact, autonomous, single-sensor nodes with digital group forming can **augment or replace cabled array** systems, offering a solution for challenging terrain and offset limitations.
- Digital group forming (DGF) produces data deliverables **identical to geophone arrays**, allowing for seamless integration with conventional acquisition methods.
- Pre-processing techniques like trace editing and filtering can **improve raw data quality**, and should be routinely applied to enhance data quality.
- DGF designs with fewer elements (e.g. DGF-6, DGF-4) can deliver **comparable image quality to larger arrays**, making them suitable for special acquisition scenarios where equipment cost and deployment speed are prioritized.
- The single-sensor data from nodal acquisition is a valuable asset, enabling **targeted high-resolution processing**, improved statics and noise attenuation, and high-resolution near-surface characterization, and can be accessed and utilized in the future as computational technologies advance.





Thank you for your attention!

For questions and enquires please contact Pavel Golikov:
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