

Low-frequency virtual-shot gathers by correlating OBC noise recordings

Sjoerd de Ridder

SEP sponsor meeting 2011

June 8, 2011



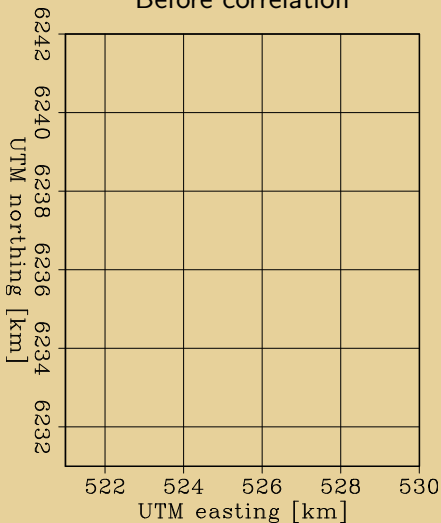
De Ridder and Dellinger: SEP143 p.221-236.

With contributions from and special thanks to

Joe Dellinger and Jianhua Yu

Seismic noise interferometry: sources from noise

Before correlation



After correlation

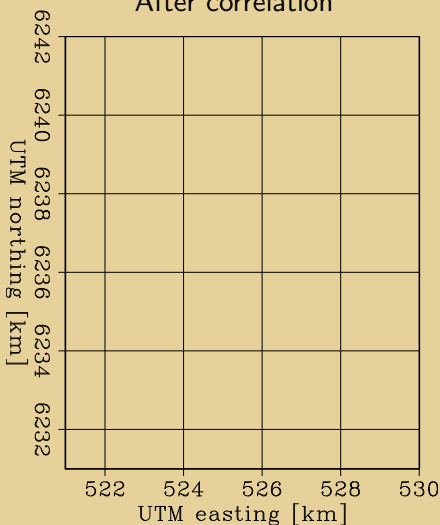


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- 4 Virtual-sources

Seismic noise interferometry in global seismology

Global seismology community

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Benefits of seismic noise interferometry

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- Locating virtual-sources where real sources are undesirable (marine life, infrastructure, deep water).
- Time-lapse with permanent arrays is straightforward.
- Potential near-surface starting models for higher frequency velocity-model building (proven in next presentation).

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Give up? No application of seismic interferometry for reservoir imaging?

Some early pioneers

Using broad-band sensors

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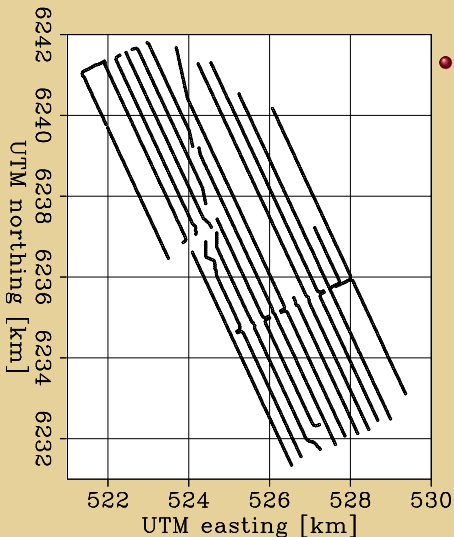
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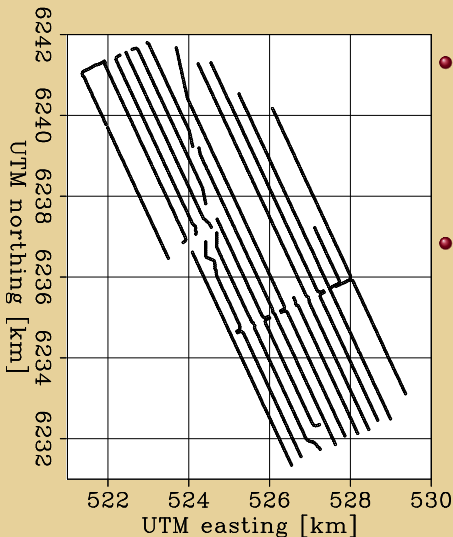
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Valhall OBC noise recordings



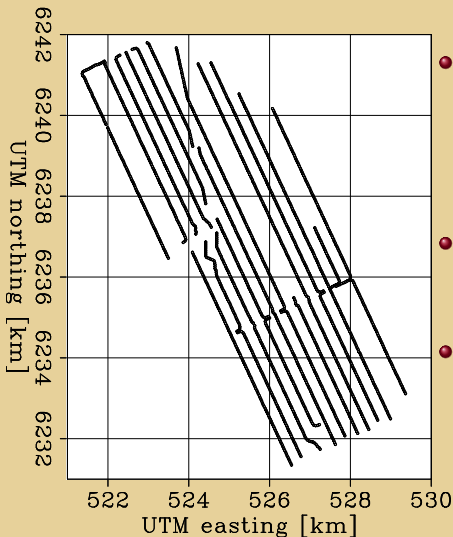
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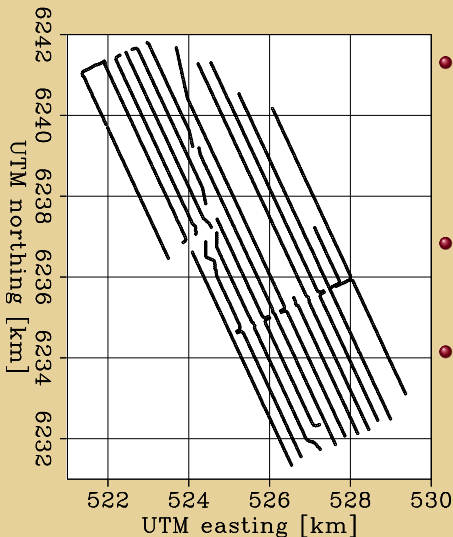
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→ Excellent test-location for passive seismic data study.

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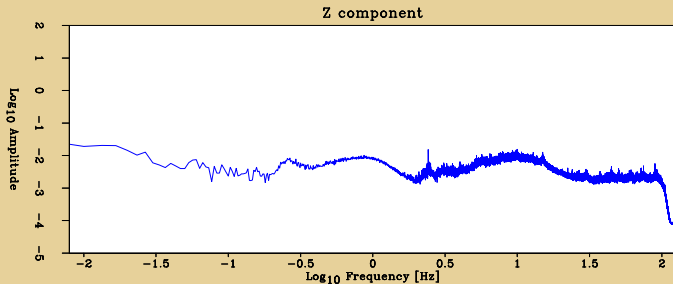
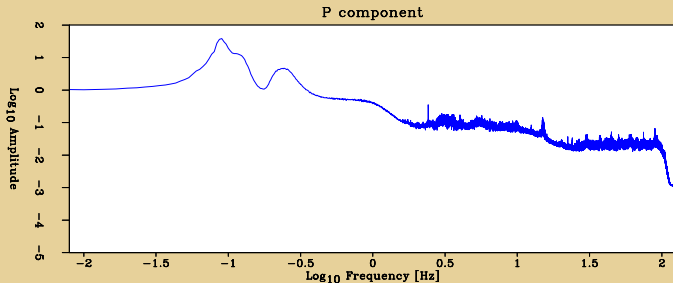
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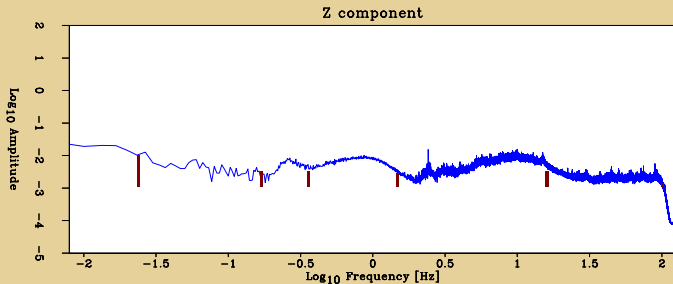
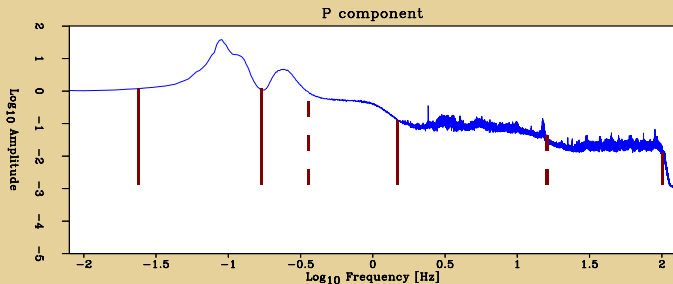
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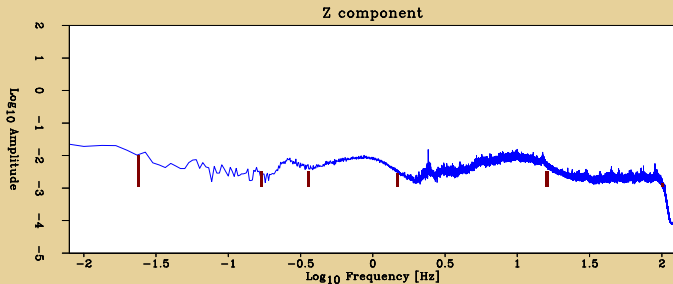
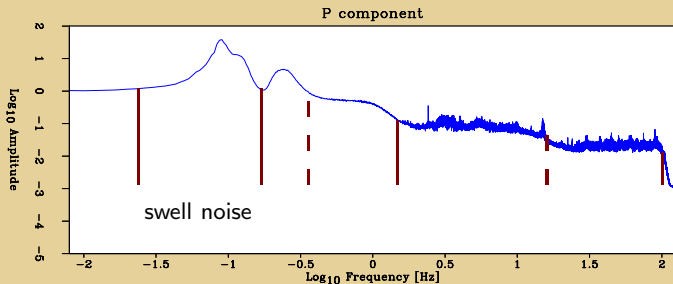
Frequency spectra of ambient seismic noise



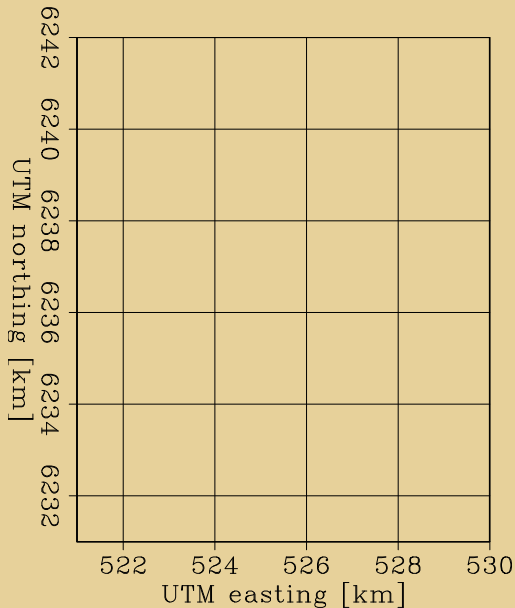
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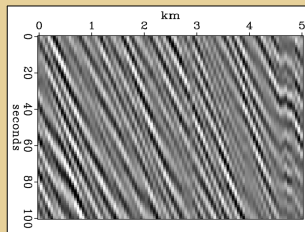
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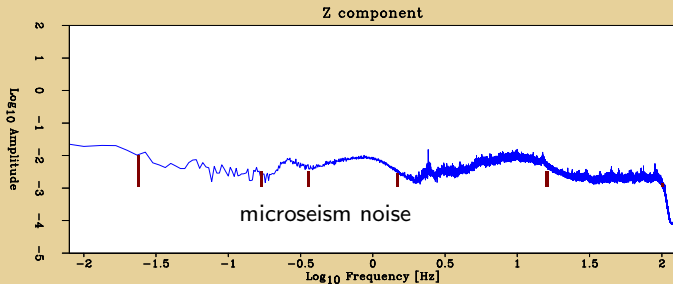
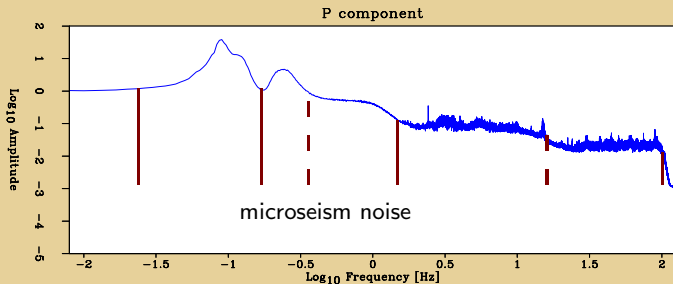
Swell noise (< 0.18 Hz)



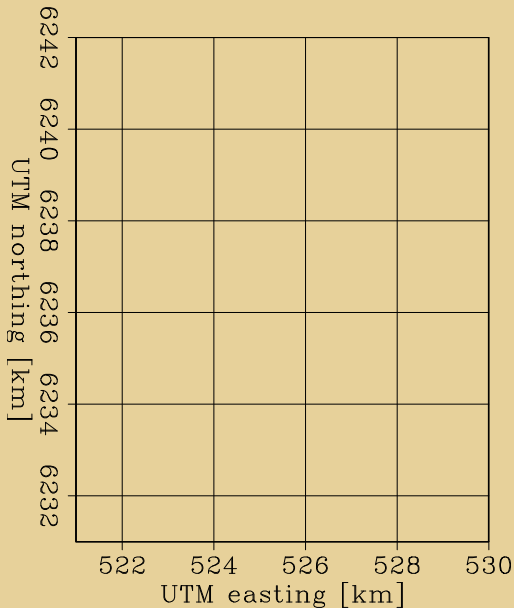
Ocean swells dominate the pressure component.



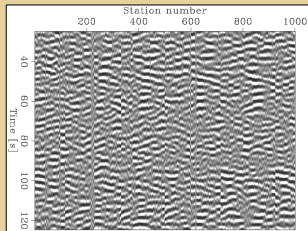
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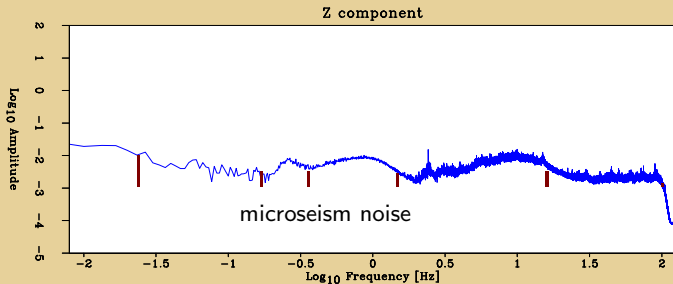
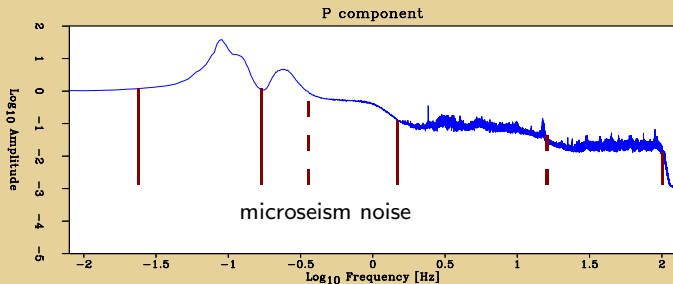
Microseism noise (0.18 – 0.40 Hz)



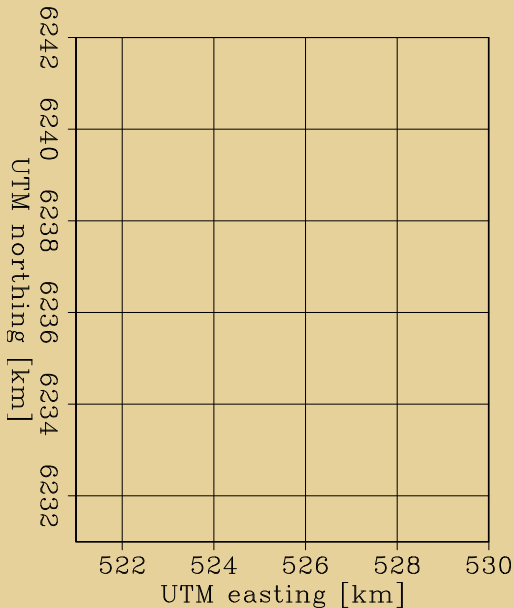
Long wavelength microseisms dominate the vertical component.



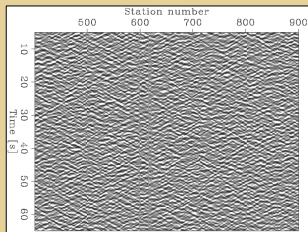
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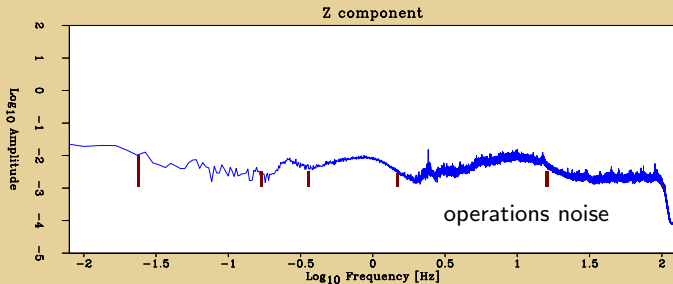
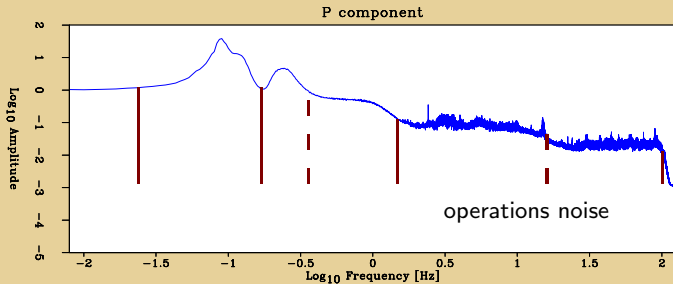
Microseism noise (0.40 – 2.00 Hz)



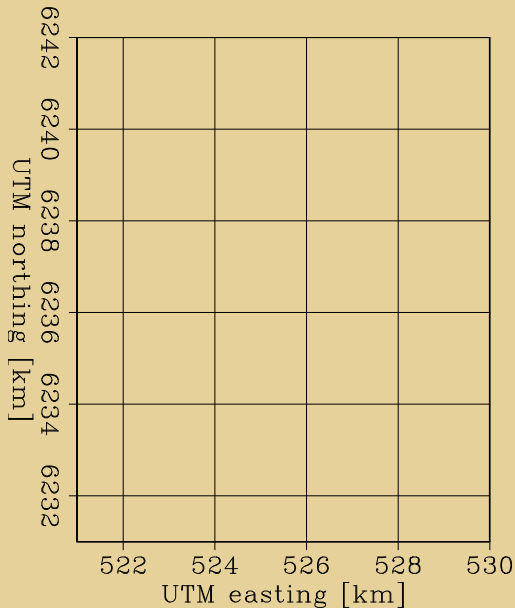
Short wavelength microseisms dominate the vertical component.



Frequency spectra of ambient seismic noise



Field-operations noise (> 2 Hz)



Operations noise,
boat noise,
seismic survey noise.

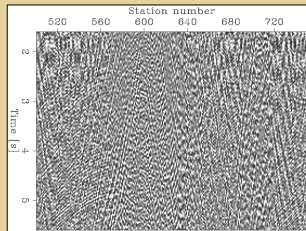


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Too good to be true?

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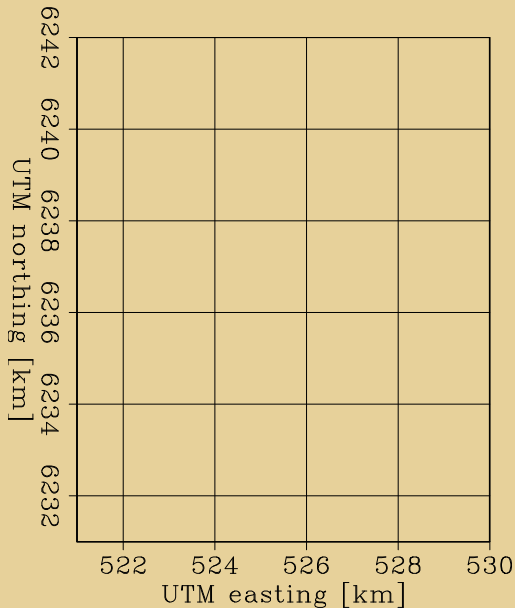
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(Vasconcelos and Snieder, 2008)
- White spatial spectrum: multi-dimensional deconvolution.
(Wapenaar et al., 2008)

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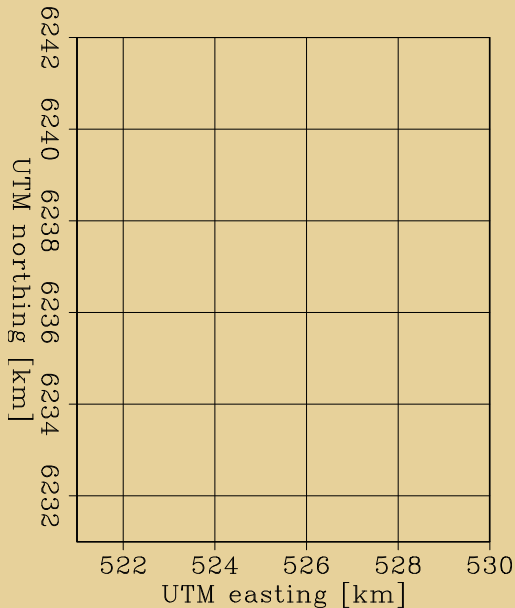
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Virtual-source (0.18 – 0.40 Hz)



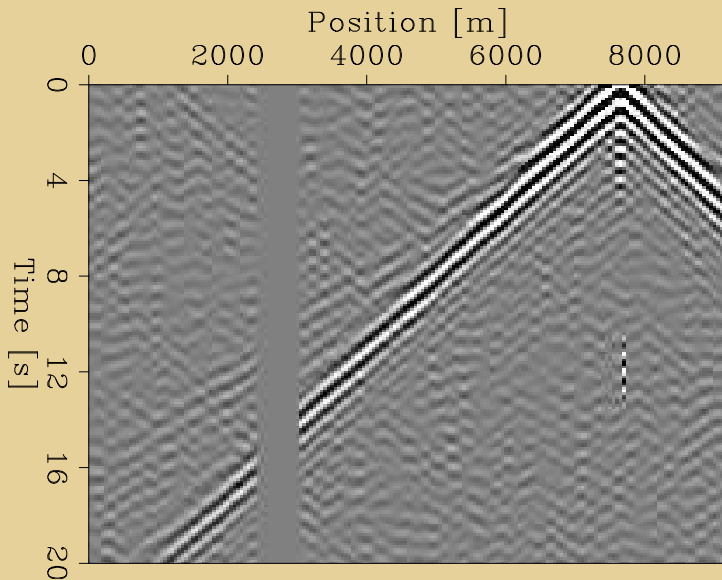
point source
omnidirectional?
4 km wavelength

Virtual-source (0.40 – 2.00 Hz)



point source
omnidirectional
300 m wavelength

Virtual-source gathers



Background

Valhall OBC noise

Seismic interferometry

Virtual-sources

Sjoerd de Ridder

Correlating OBC noise recordings

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- Very-low frequencies → Holy Grail for FWI or the wrong wave-mode?

Acknowledgements

Joe Dellinger and Jianhua Yu for scouting Valhall noise correlations before me and allowing me to continue.

Ray Abma, Olav Barkved, John Etgen and Phuong Vu for helpful discussions and suggestions.

BP and the partners of the Valhall Field (BP Norge and Hess Norge) for data permissions.

- Dellinger, J. and J. Yu, 2009, Low-frequency virtual point-source interferometry using conventional sensors: *71st EAGE Conference and Exhibition, Extended Abstracts*, X047.
- Dellinger, J., J. Yu and **S. de Ridder**, (2010). Virtual-source interferometry of 4C OBC data at Valhall without a low-cut recording filter: *SEG low-frequency workshop, Snowbird, Utah*.
- **De Ridder**, S., and J. Dellinger, (2011). Ambient seismic noise eikonal tomography for near-surface imaging at Valhall: *SEP-Report*, 143, 221-236.