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Distributed Sensing in Offshore Fields: Seismic and Flow Monitoring for Reservoir Characterization

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Seismic2019

Outline

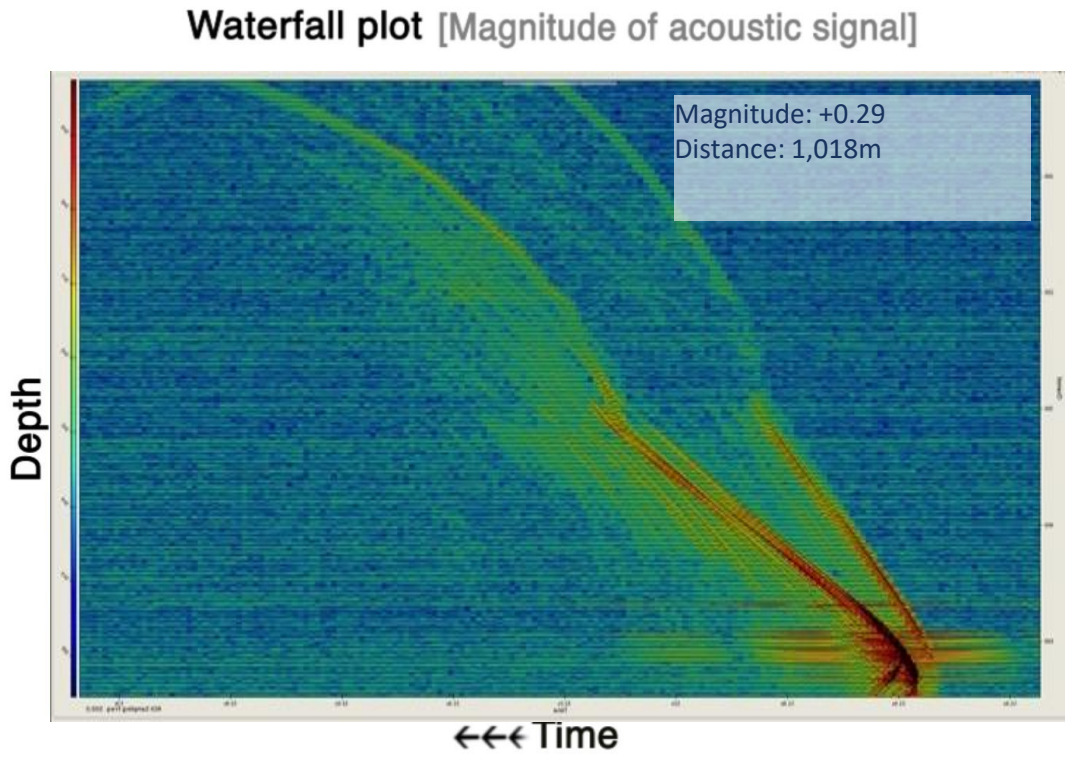
- Introduction
- DAS Seismic Measurements and 4D
- Seismic Acquisition during Production monitoring
- Conclusions

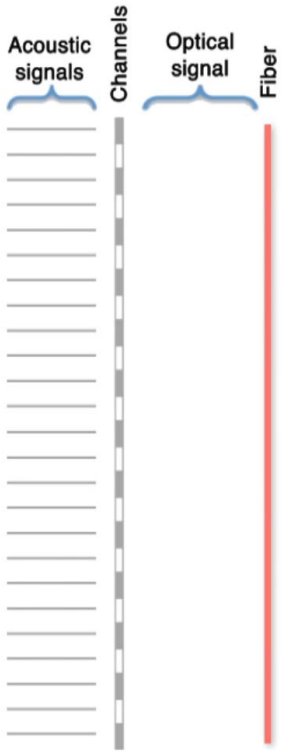
Why Use Distributed Acoustic Sensing Offshore?

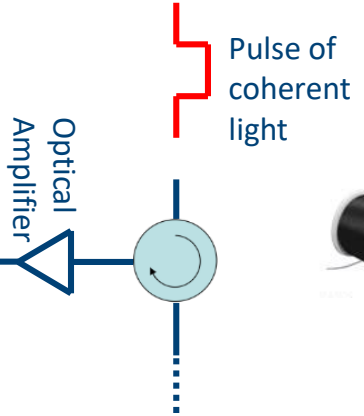
- More Fiber Optic is being deployed in complex wells i.e. smart well monitoring, deep water
- FO is deployed to lower the number of interventions in wells
- FO being deployed as part of life of well monitoring
- DAS measurements can either be used by reservoir/petroleum engineers or geoscientists
- Geoscience applications are seen as an add-on while monitoring wells → Lower intervention costs compared to conventional tools

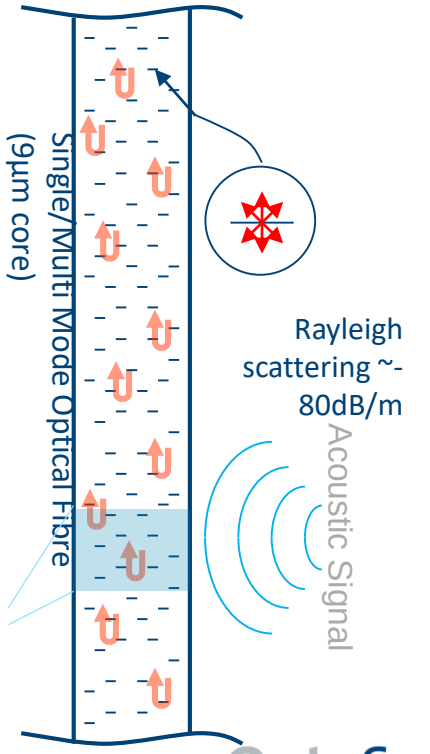
Distributed Sensing 101

- How DAS Data Is Converted Into Waterfall Visualizations









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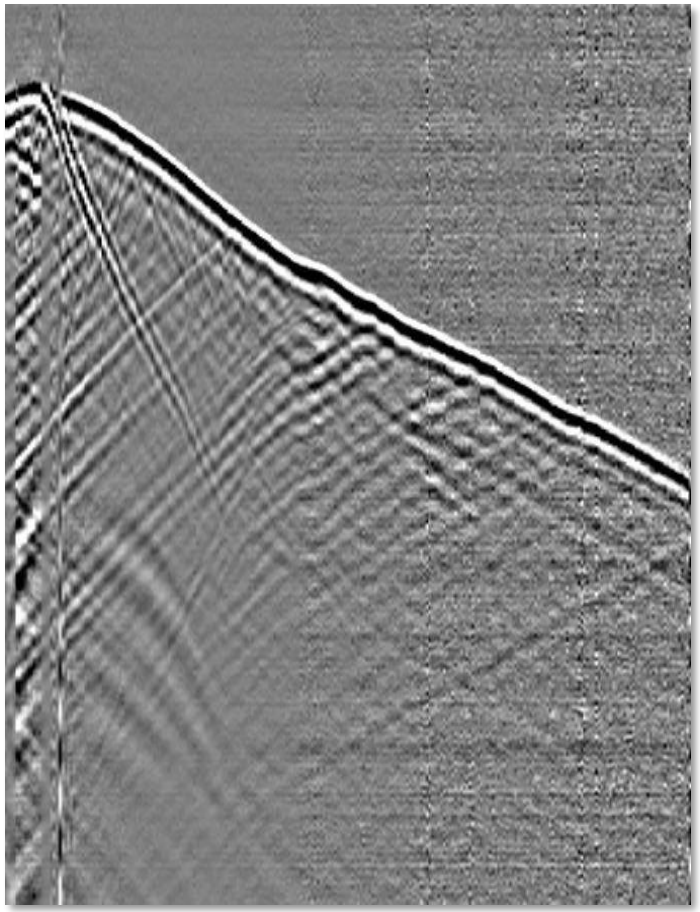
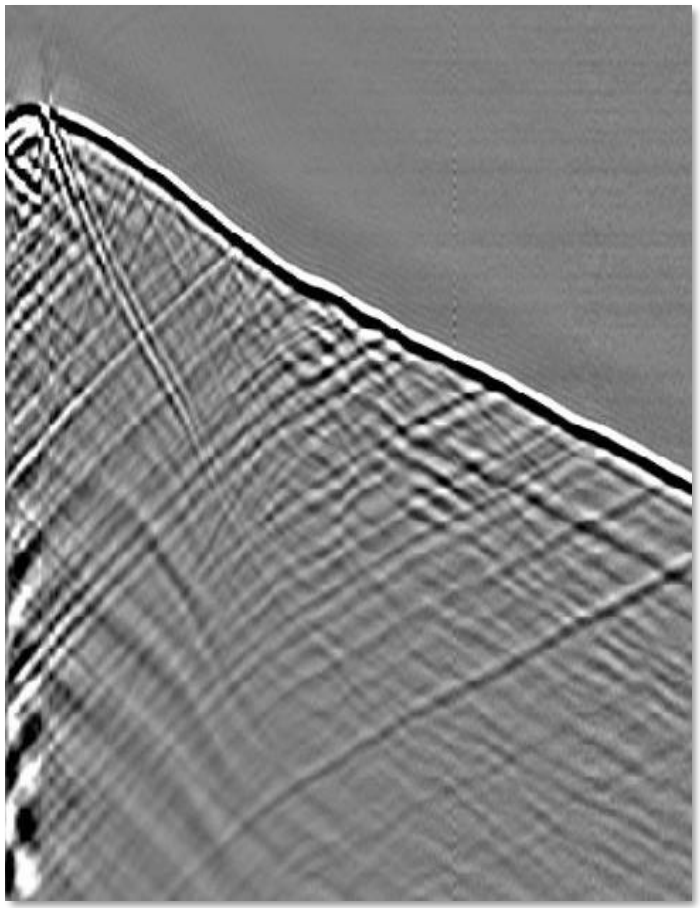
Advances in Interrogator Technology are yielding higher SNR

Single Laser IU

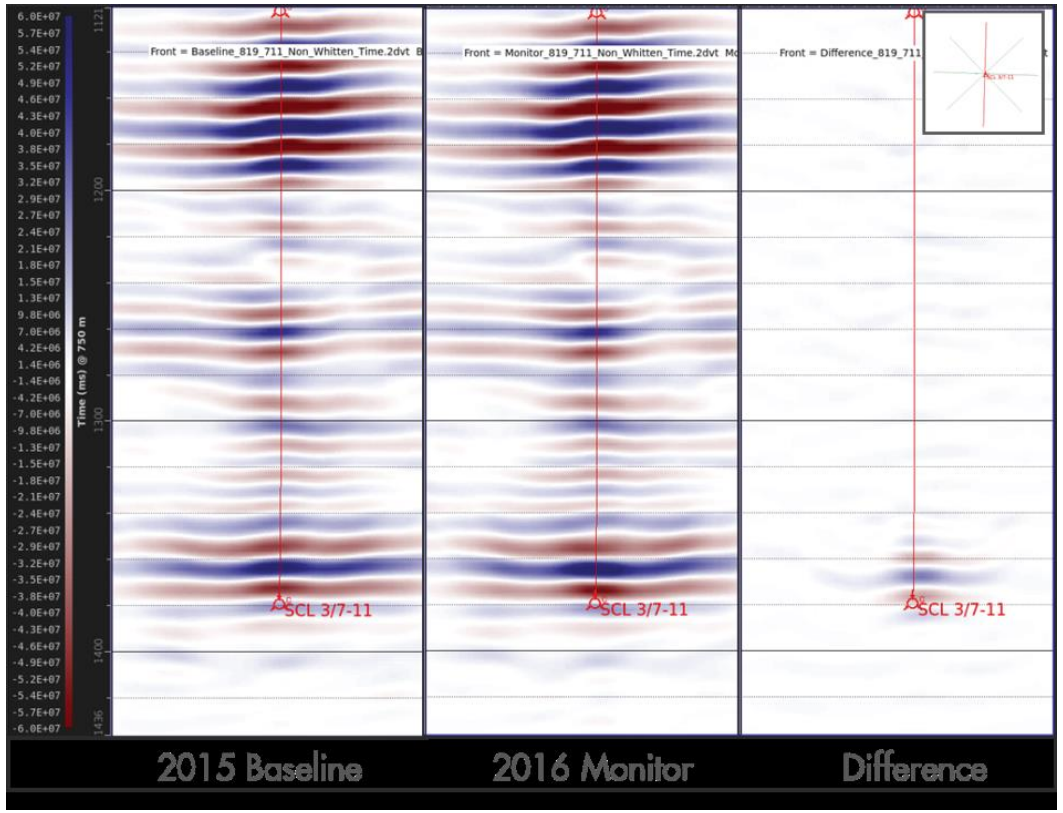


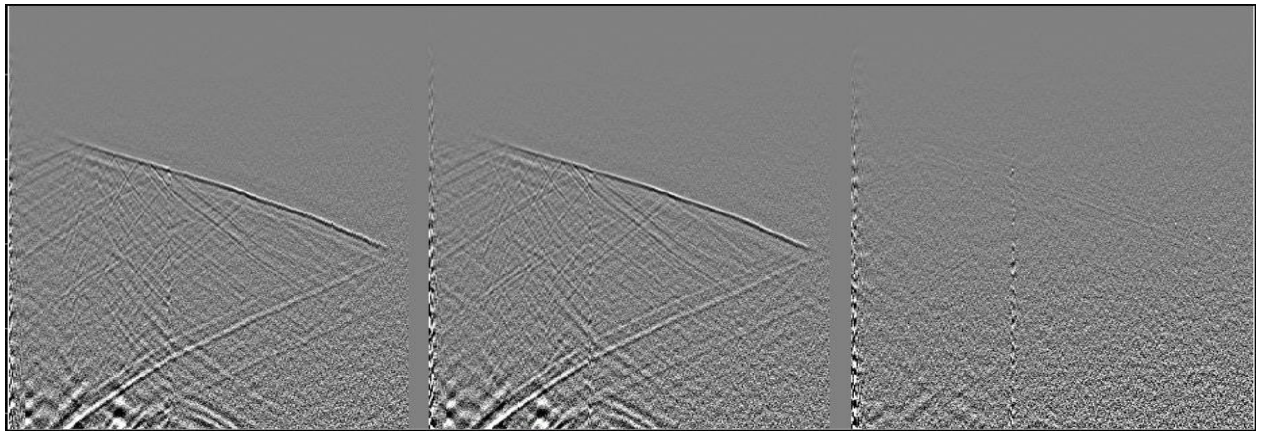
Multi Laser IU

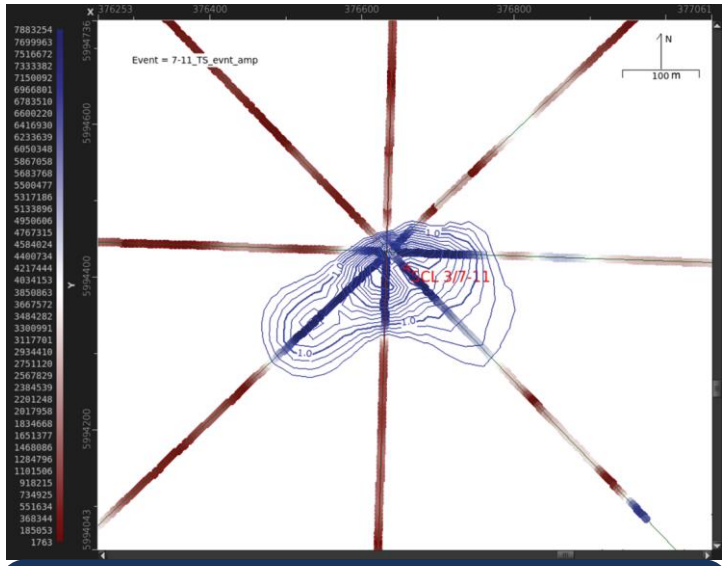


Repeatability in DAS and CO2 Plume Tracking with TimeLapse VSP

Repeatable DAS Surveys capture subtle amplitude anomalies from CO2







- MultiWAW source geometry is low cost and suitable for aerial tracking of plumes

Oropeza-Bacci et al. CSEG 2017

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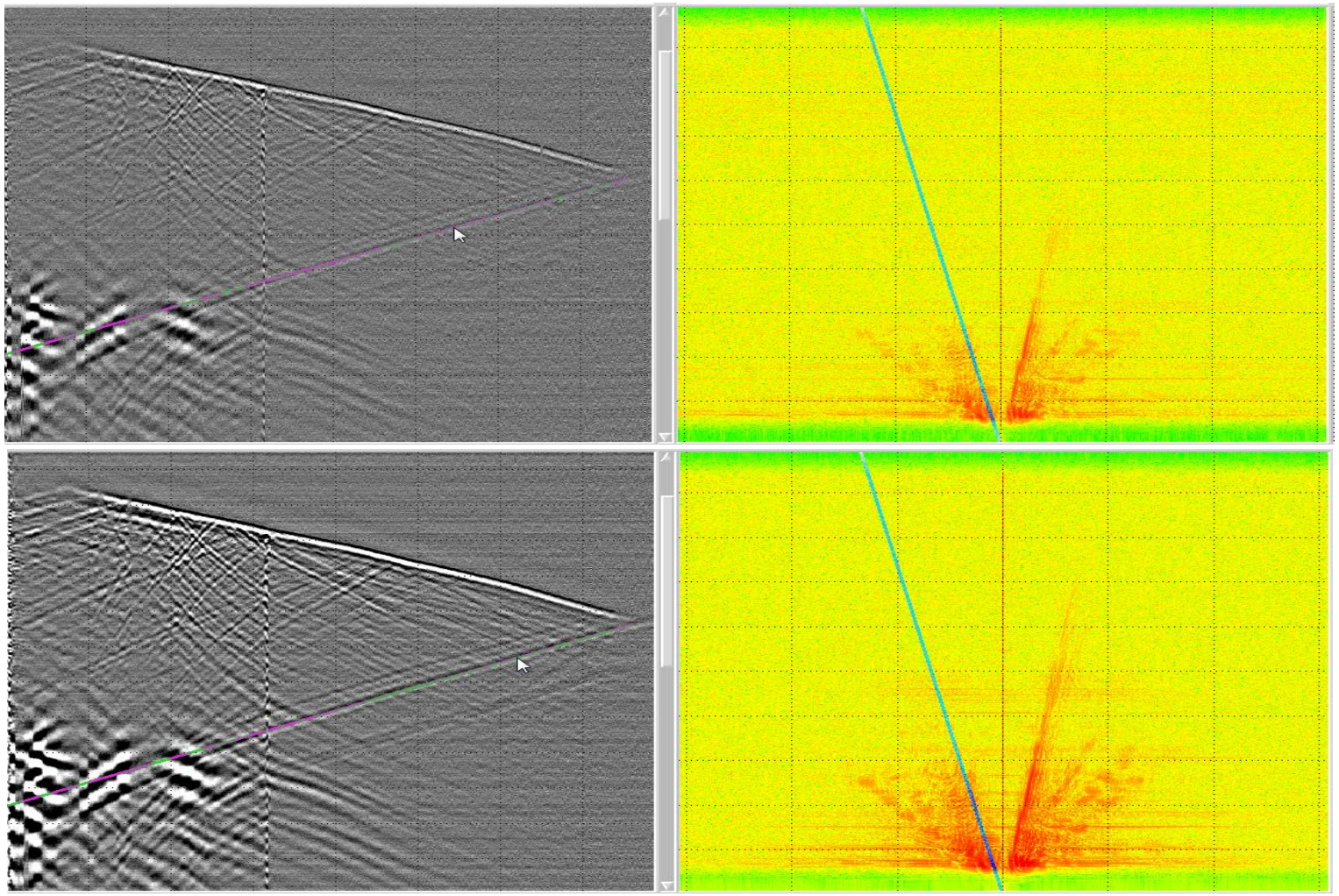
Field QC - Gauge length impact on SNR

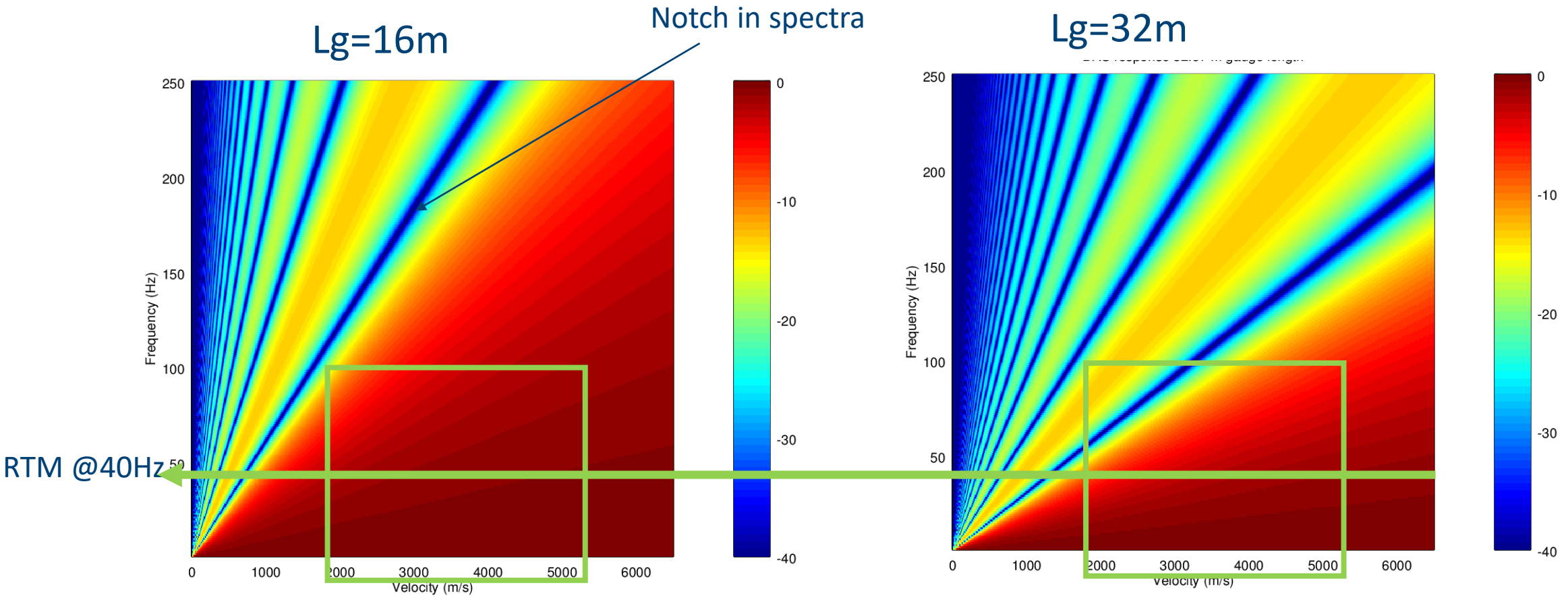
Change Interrogator Settings in Real Time to ensure best quality Signals

- 7m Gauge
- 16m Gauge



Gauge Length Modeling i.e. Deep Targets

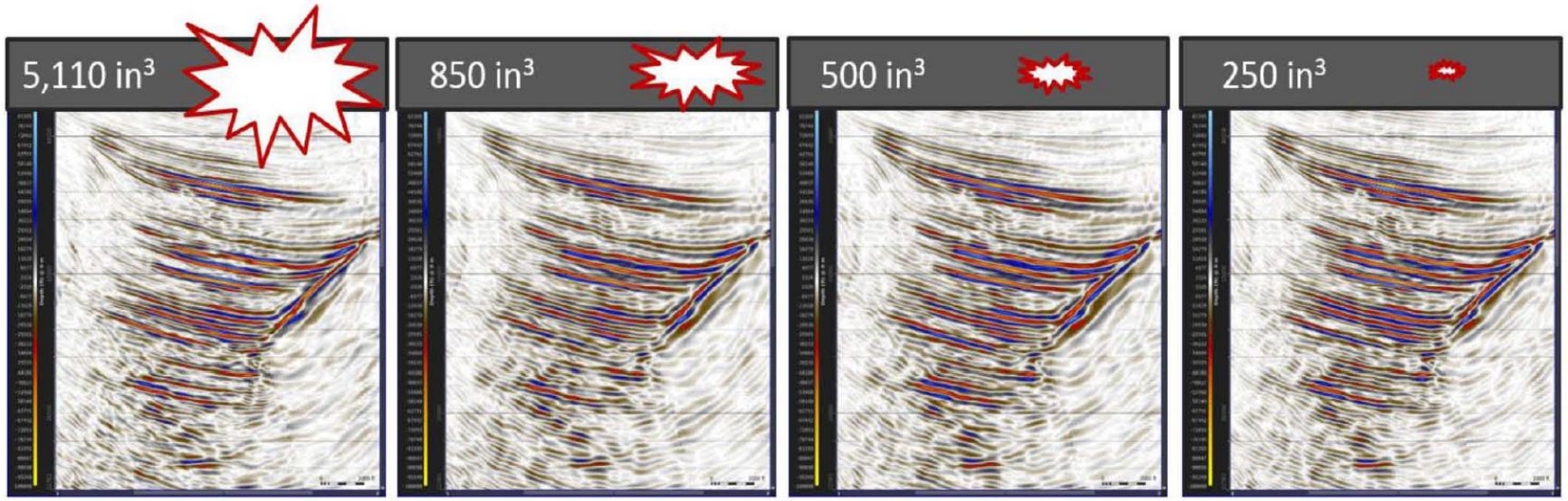
i.e. estimate the longest Lg without introducing a notch in the spectra



Smaller Boat – Lower Costs → Same Quality Image

32m Gauge Length

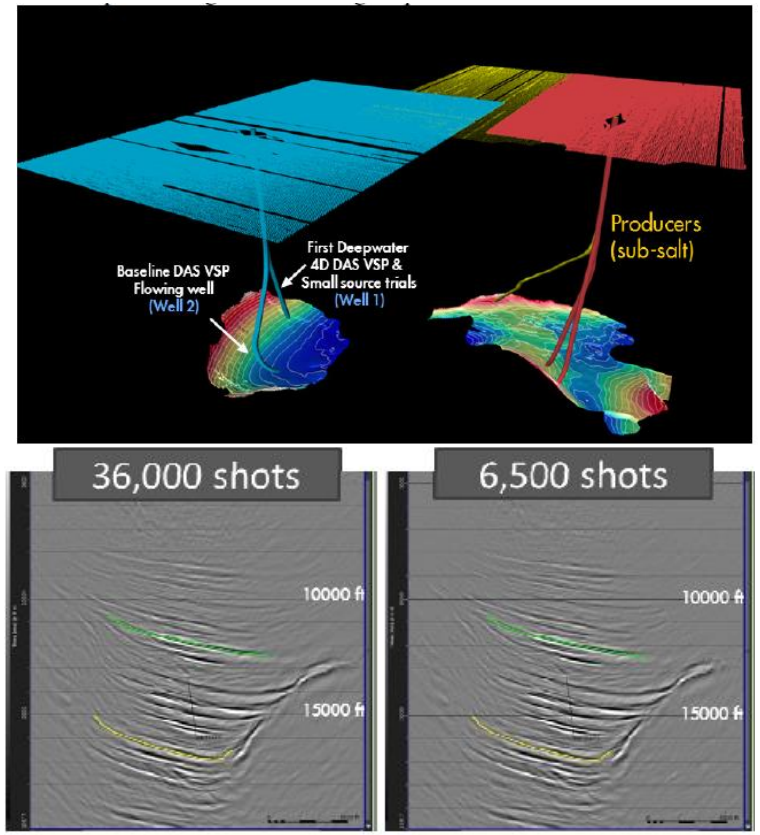
Decreasing Airgun Size →



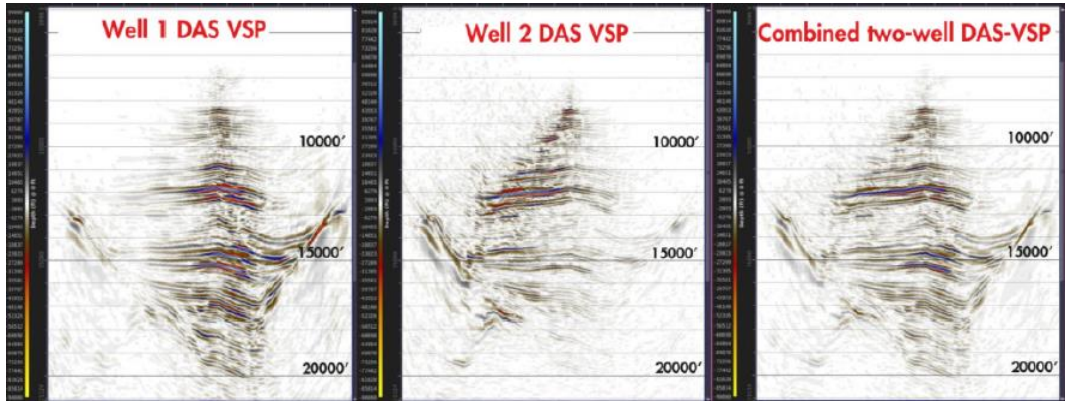
Wang et al. 2017

Reduced Source Size and Coverage for Low-Cost Reservoir Monitoring

Targeted source footprints and smaller boat size



Multi-Well Acquisition on producing and shut-in wells provide complementing views of the reservoir



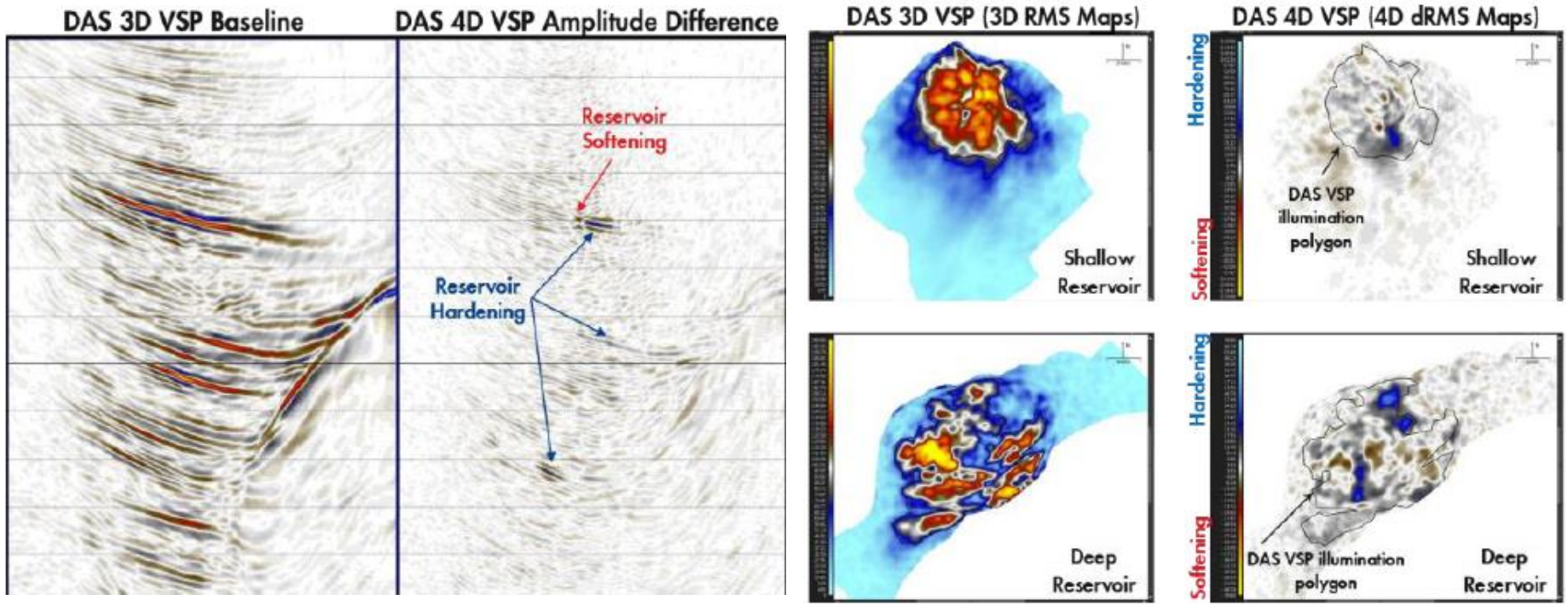
Tatanova et al. 2017

GOM: 4D Reservoir hardening and softening

Multiwell 4DVSP: Water Injector, Gaslift producer(s) and Inactive

NRMS 7%

Smaller Faster Surveys: 36000 shots ~ 6000 shots; 5110in3 – 500in3

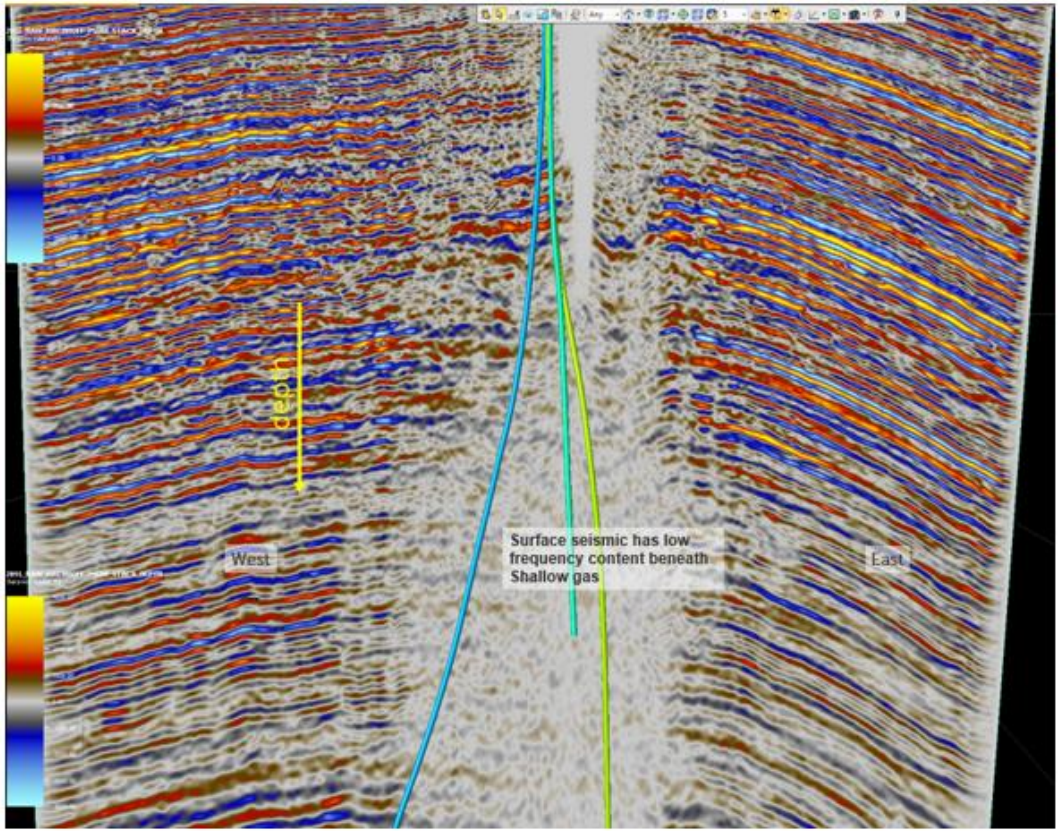


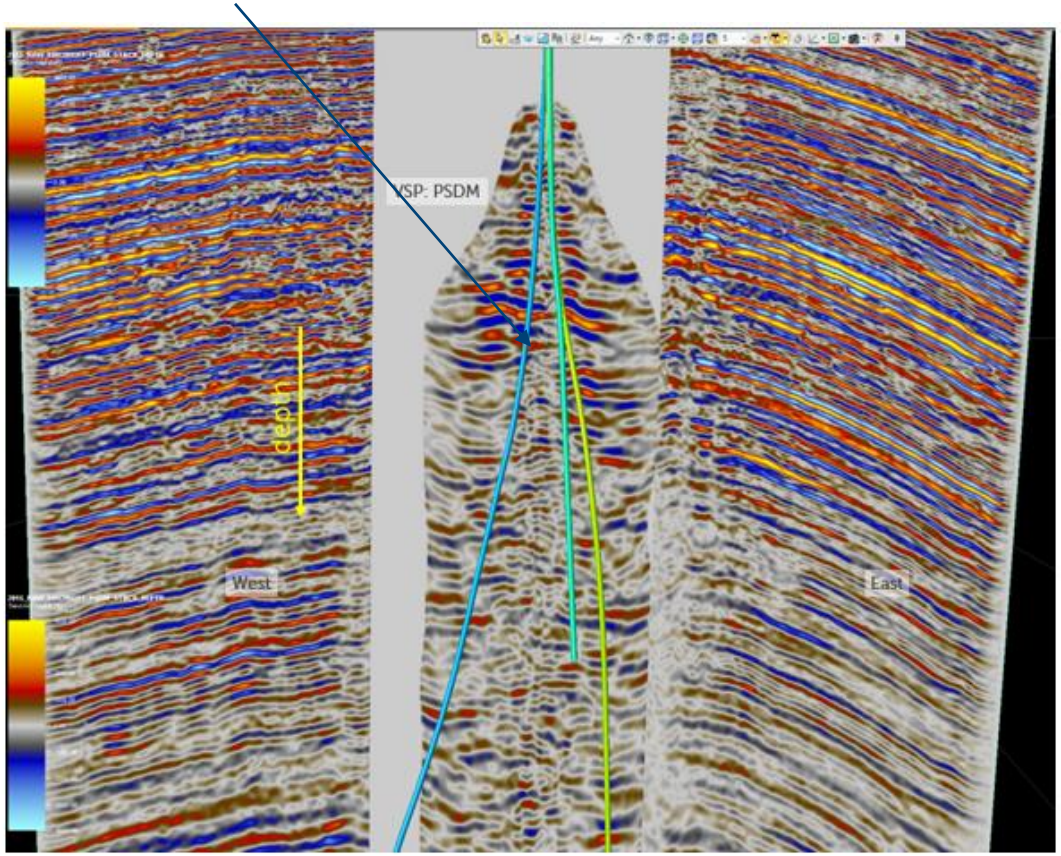
Zwartjes et al. 2017

Blow Gas Cloud - Offshore SE Asia

55000 Shots; Three Highly Deviated and Producing Wells

Reflections are images below gas cloud with DAS receiver sensors

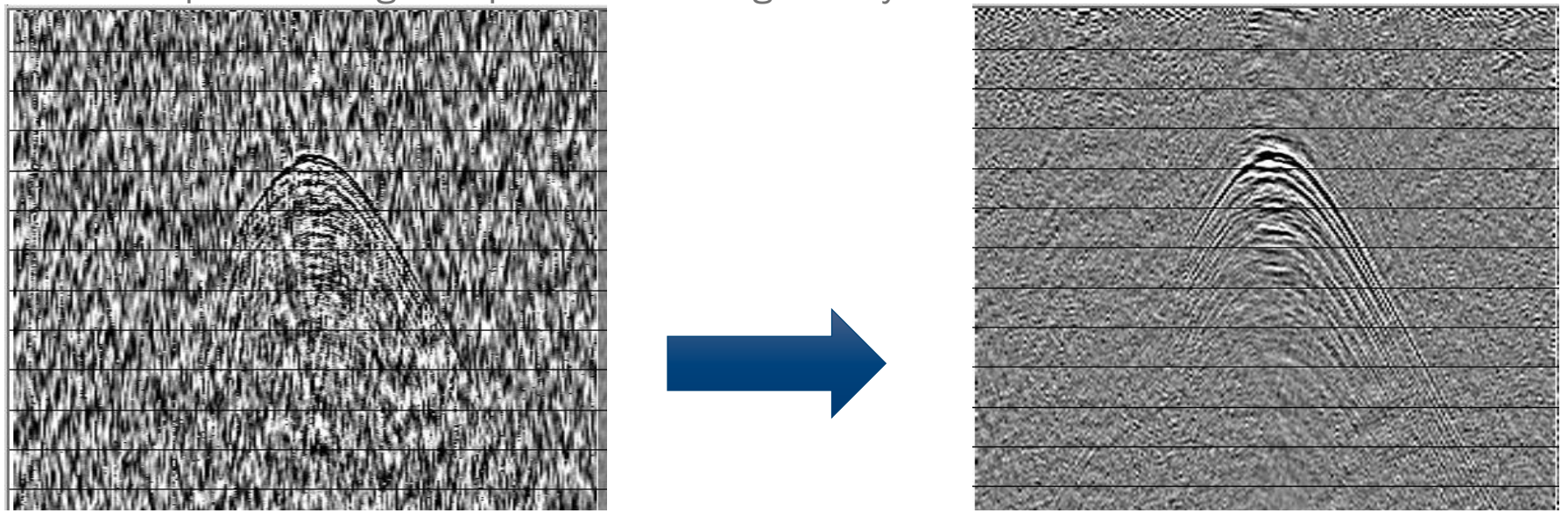




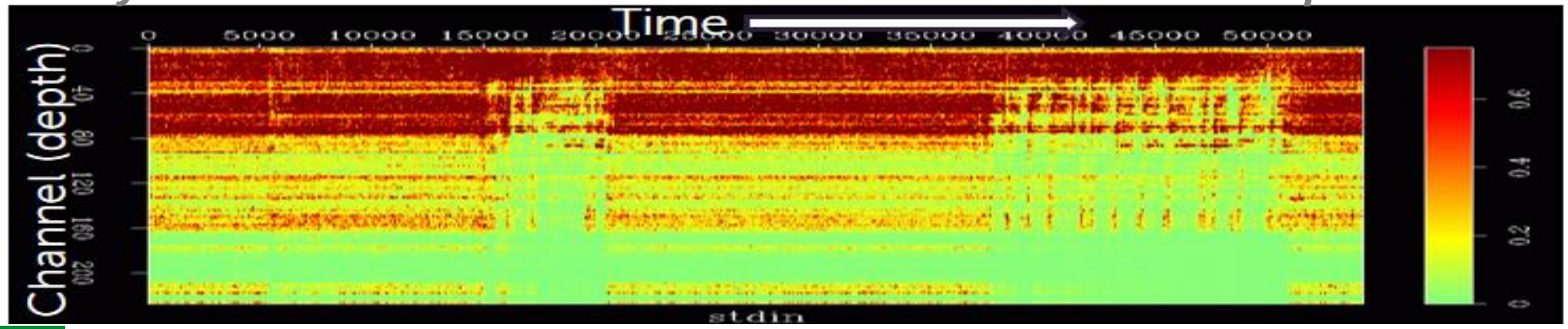
AbdulRahim et al, 2017

Below Gas Cloud - Offshore SE Asia

Multiwell 3DVSP acquired during dual production string activity



Signal analysis enables us to extract seismic data from variable production noise



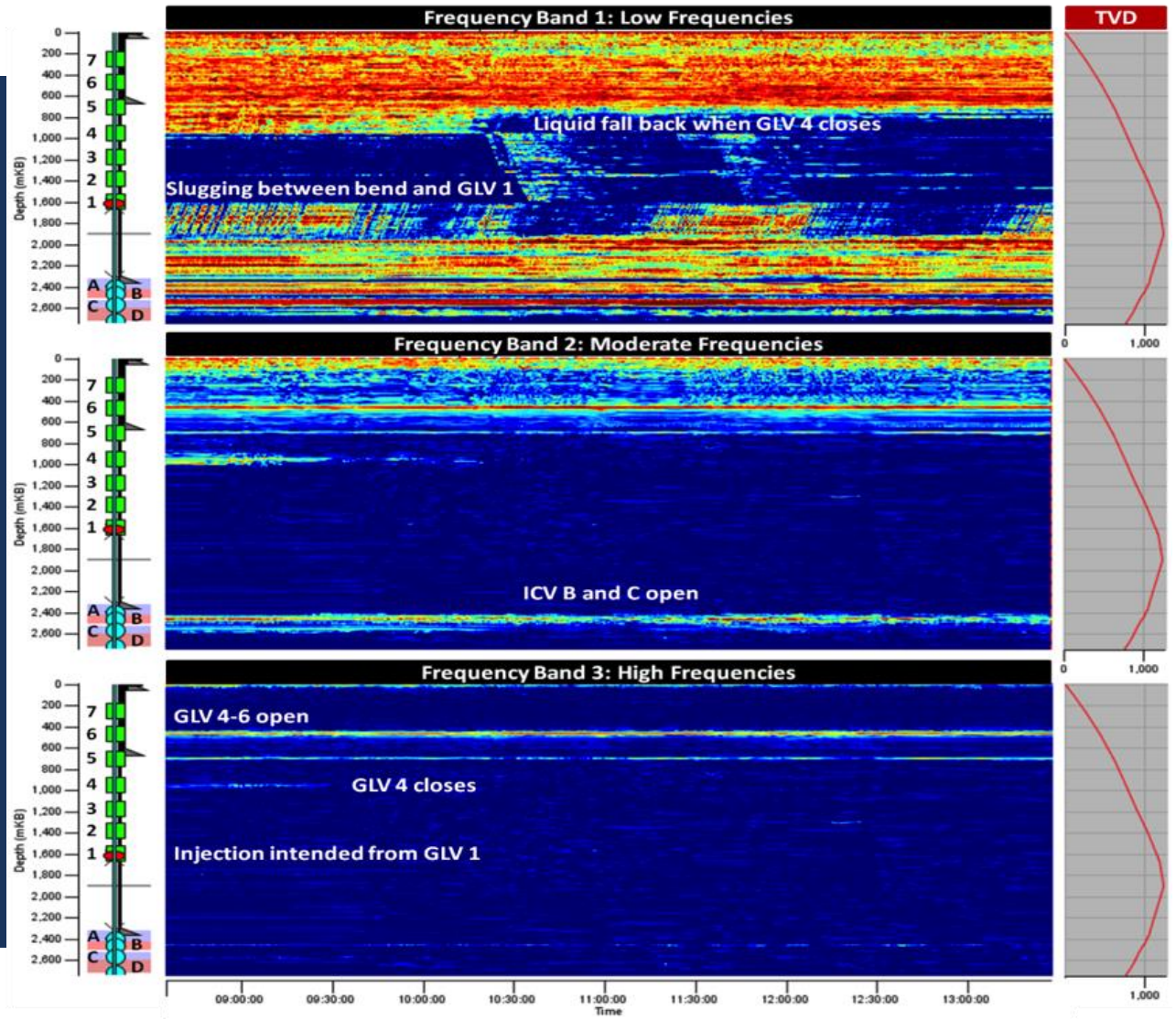
AbdulRahim et al, 2017

Information in Different Frequency Bands

A Wealth of Information

A single DAS measurement can convey different information in different frequencies:

- Low frequencies:
  - Liquid transport
  - Fluid interfaces
  - Thermal disturbances
- Medium frequencies:
  - Flow through ICVs
  - Flow past obstacles
- High frequencies:
  - Flow through GLVs



in 't Panhuis, SPE-170917-MS

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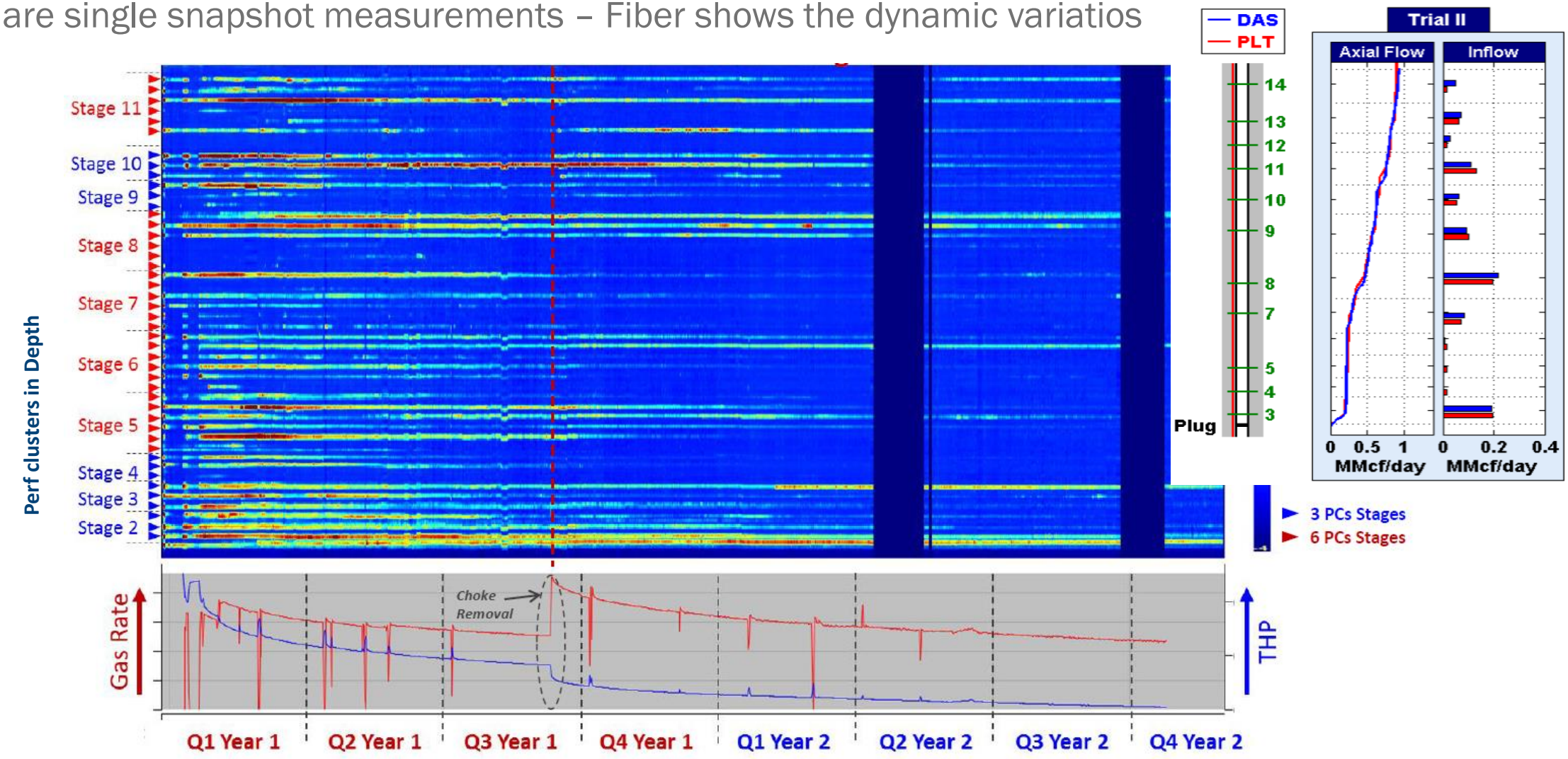
Assess Entire Reservoir Production Over Time

PLTs are single snapshot measurements – Fiber shows the dynamic variatios



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Conclusions

- DAS IU can measure seismic waves from active or passive sources and fluid signals from the well engineering
- Changing optical settings in the IU can enhance the responses that are of interest → Not all signals are created equal and should be interrogated with certain considerations
- DAS data is repeatable and suitable for low-cost 4D seismic surveys
- Dual DAS measurements can enhance signal processing across multiple disciplines → Geophysicist's Noise can be Petroleum Engineer's Signal!
- Opportunities for fiber sensing may include subsea

Questions

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