

What is new with Ocean Bottom Nodes

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Dolphin Geophysical and Stanford University

Houston Geophysical society, Acquisition and Processing SIG, 12/18/2014 **Delivering powerful solutions**

OBN = Ocean Bottom Nodes

- Title given back in October
- Since then I left the company which was doing ocean bottom nodes. Dolphin is not (yet) doing OBN
- Have permission from data owners (Apache, Maersk, Chevron) to show the results
- Joint imaging, not yet commercial, from Stanford University

Combining streamers and OBN

- Acquisition with containerized node crews
- Processing with joint imaging



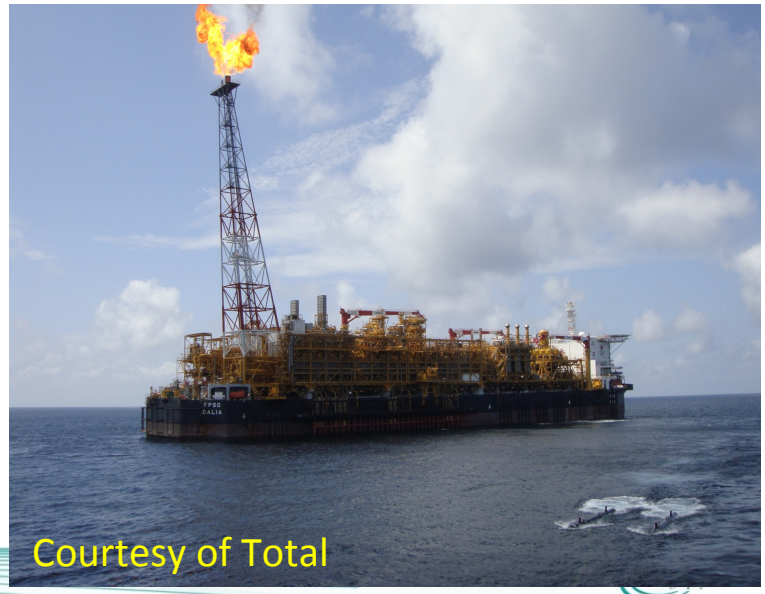
Motivation

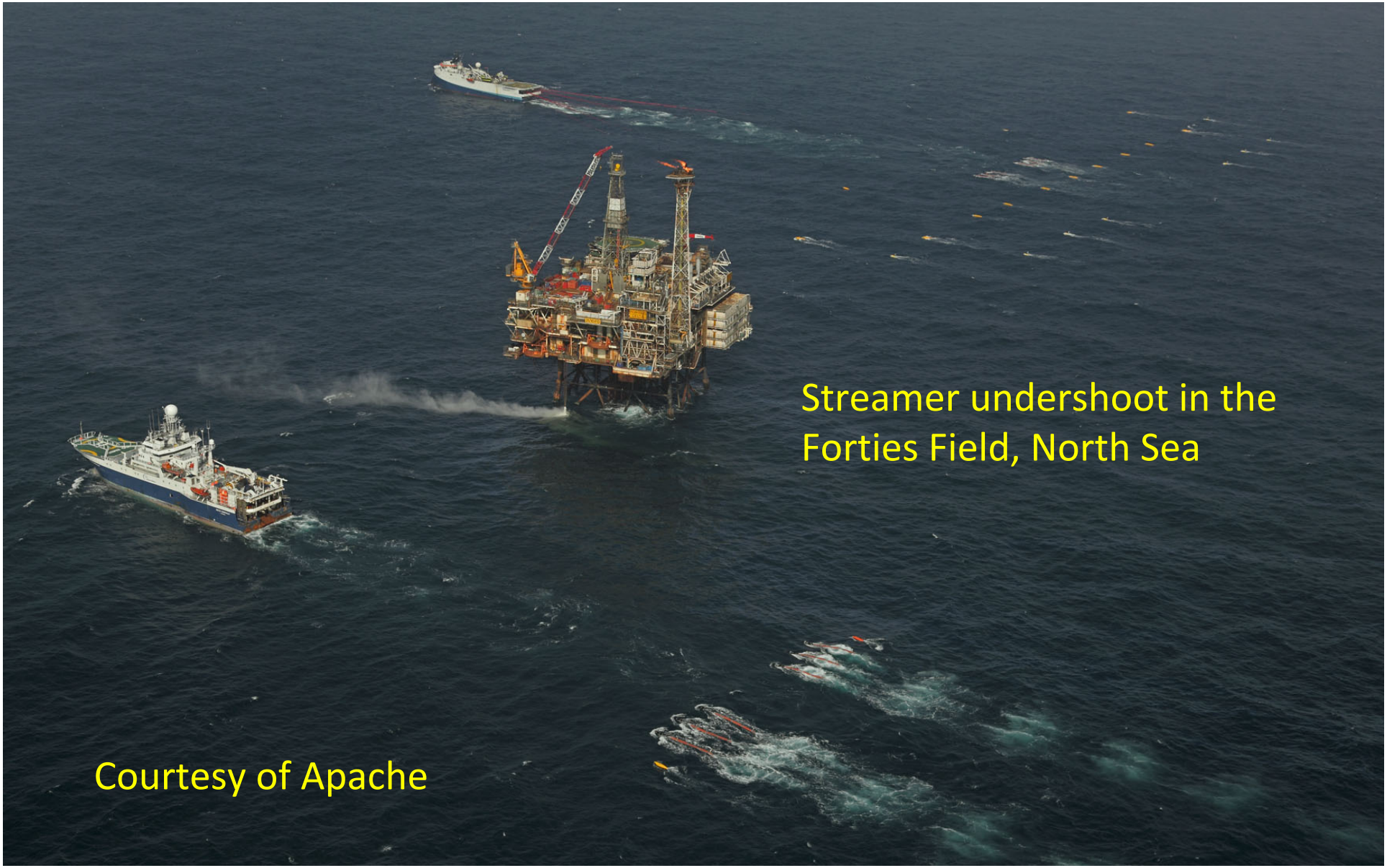
Streamers provide high quality data at an affordable cost

- Surprisingly high repeatability for 4D
- WAZ: Wide Azimuth Towed Streamers (WATS)
- AVO provide shear information and imaging low acoustic impedance targets

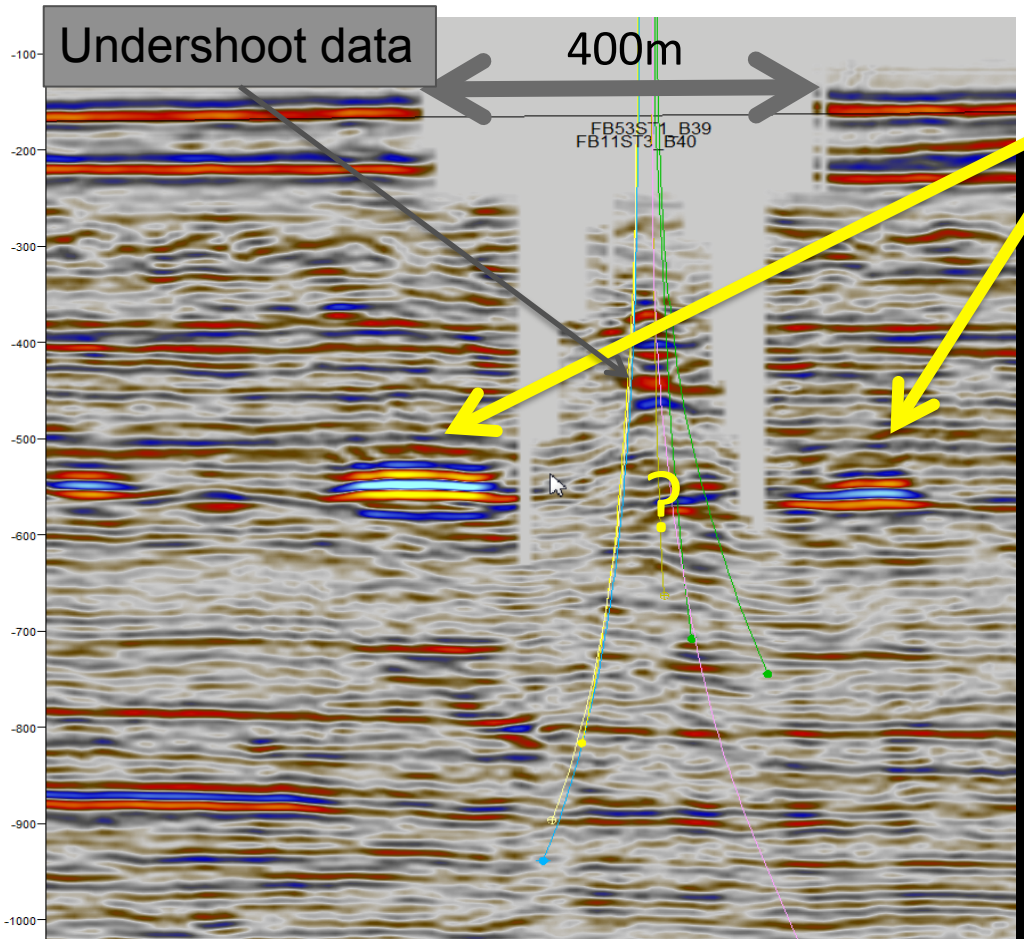
What is not above expectations

- Obstructions
- Imaging with multiples
- Full azimuth (FAZ)
- Shear waves in addition to AVO

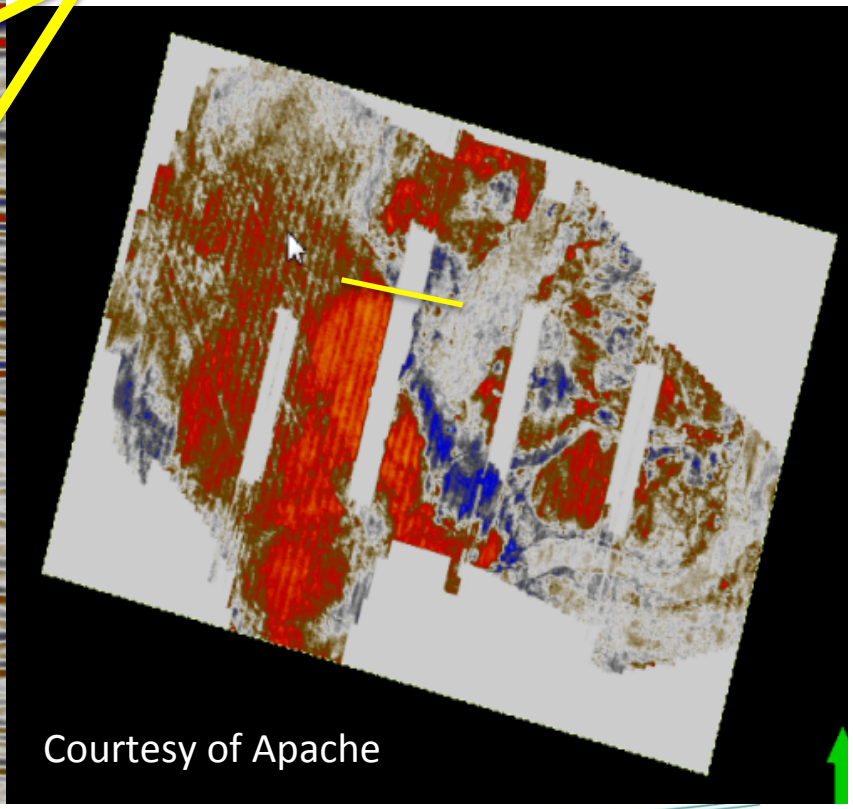



Streamer undershoot in the
Forties Field, North Sea
Courtesy of Apache

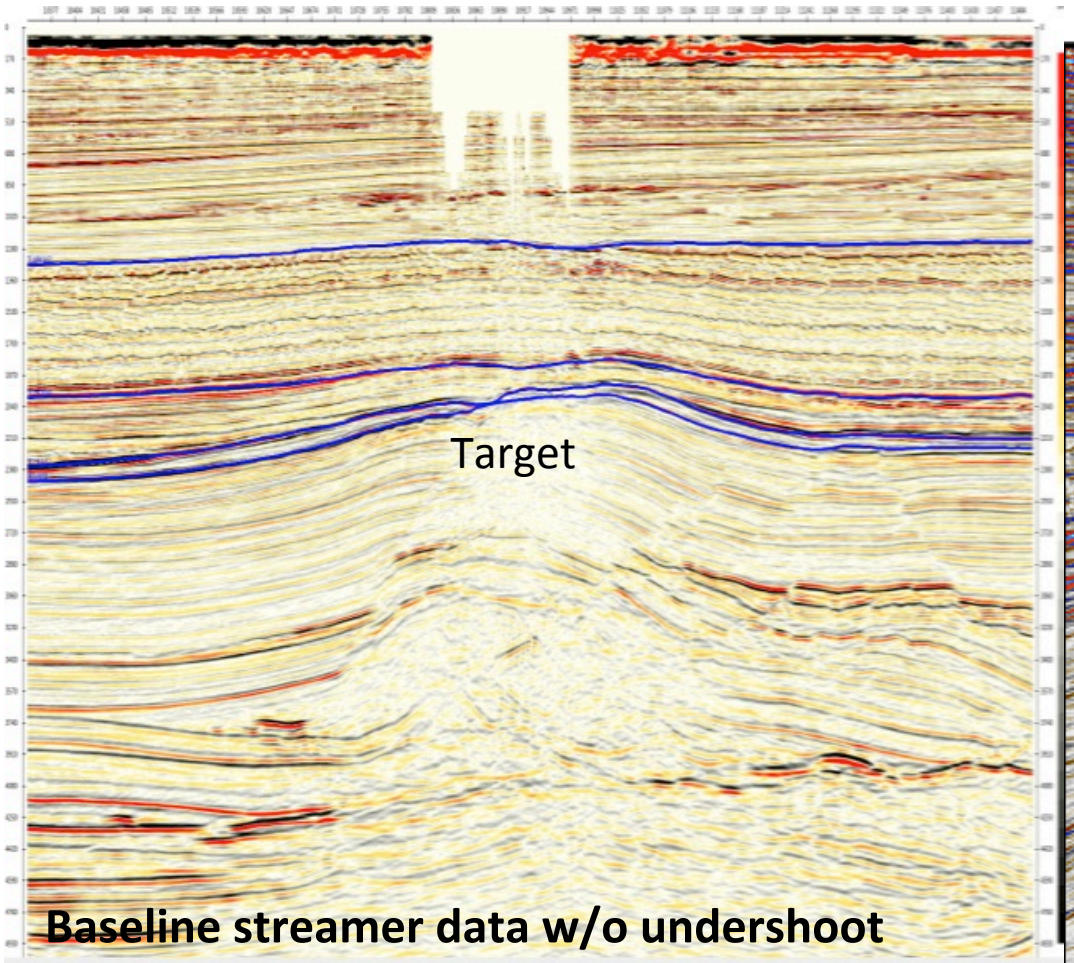
Forties



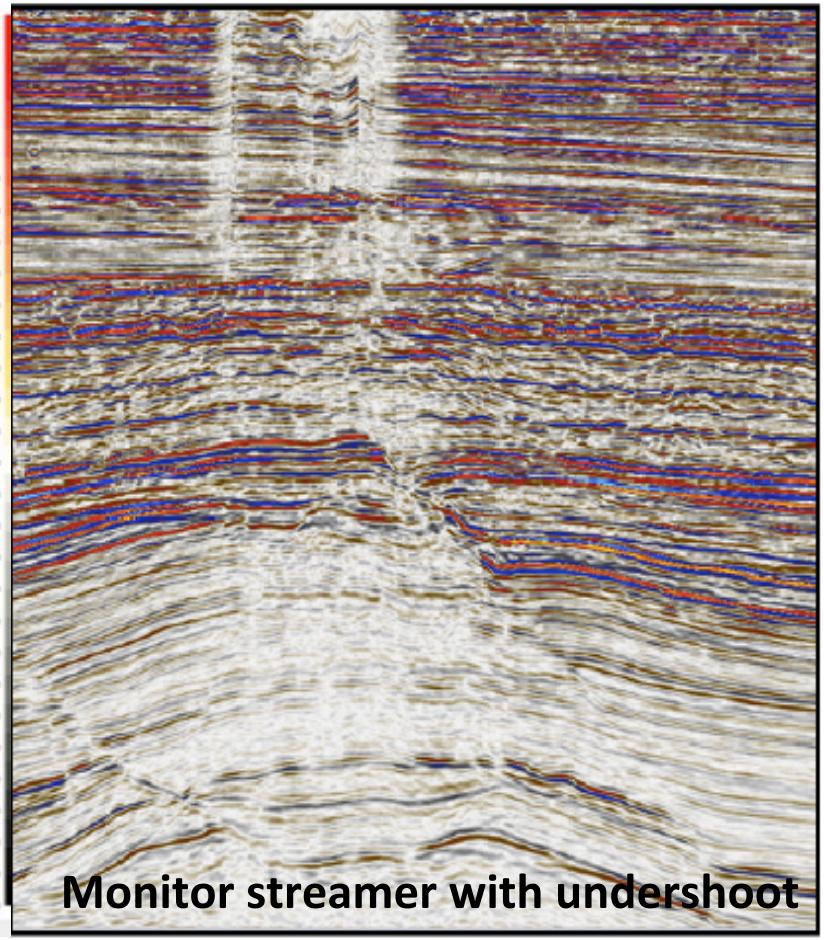
Shallow gas drilling hazards



Dan



Baseline streamer data w/o undershoot

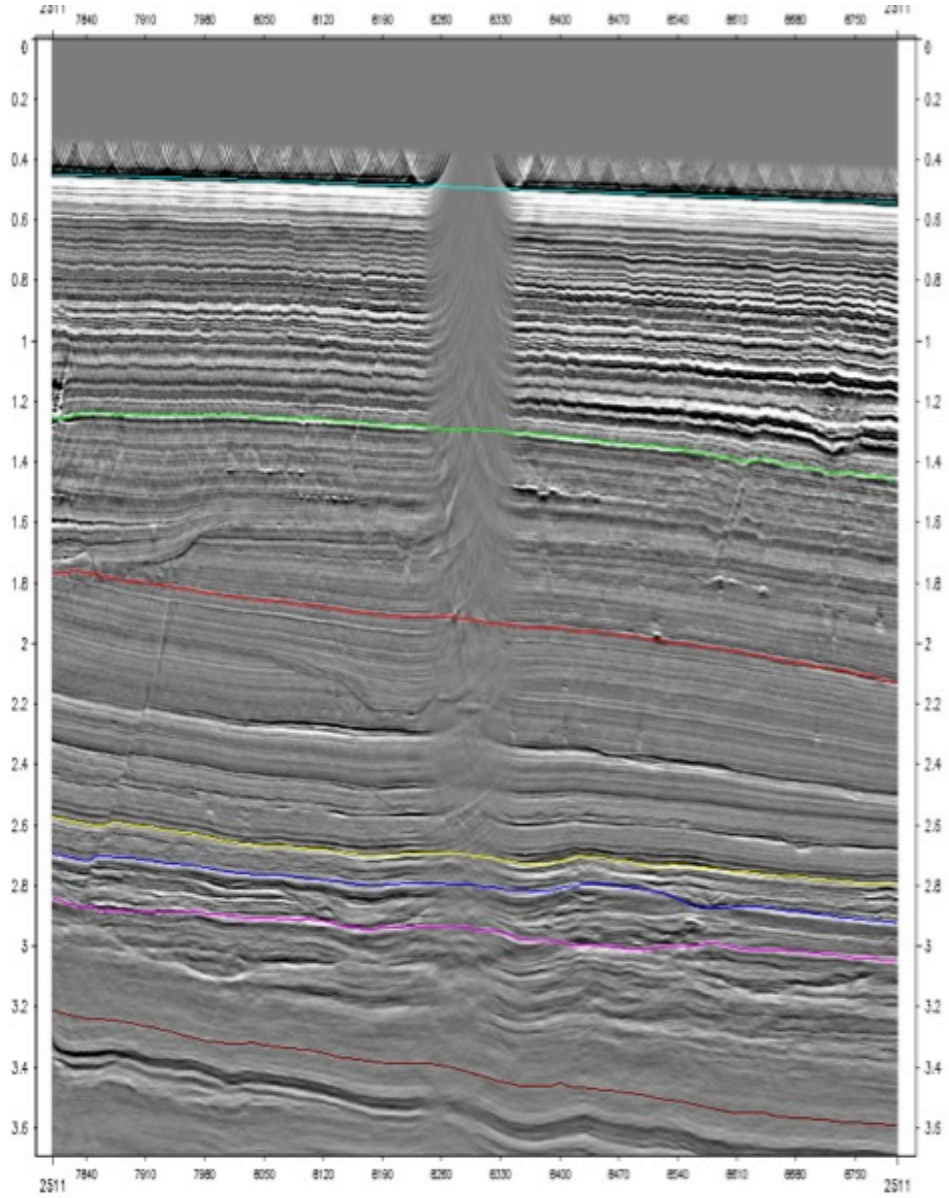


Monitor streamer with undershoot

Courtesy of Maersk

TL

Streamer data without undershoot

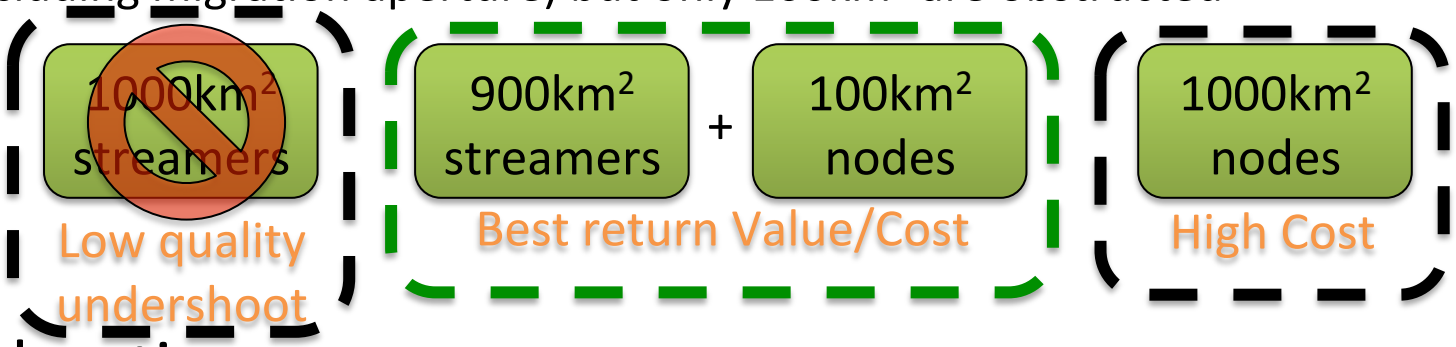


Courtesy of Chevron

Combined streamers and nodes

Reservoir Development and Production

- Use nodes mainly in the obstructed/problem areas
- For example, a producing filed may require 1000km^2 of seismic coverage (including migration aperture) but only 100km^2 are obstructed



Exploration

- Obstructed areas (deep targets under producing fields)
- Very long offsets and full azimuth for Full Waveform Inversion

Combined streamers and nodes: enablers

- The ROV (Remotely Operated Vehicle) vessel is the largest cost item
- Don’t pay for it when you don’t use it
  Enabler: **containerized node crew**
- Don’t pay for it where you don’t need it:
  Enabler: **combined streamers and nodes**
  which is enabled by joint imaging and joint survey design

Dolphin geophysical

Three case history surveys

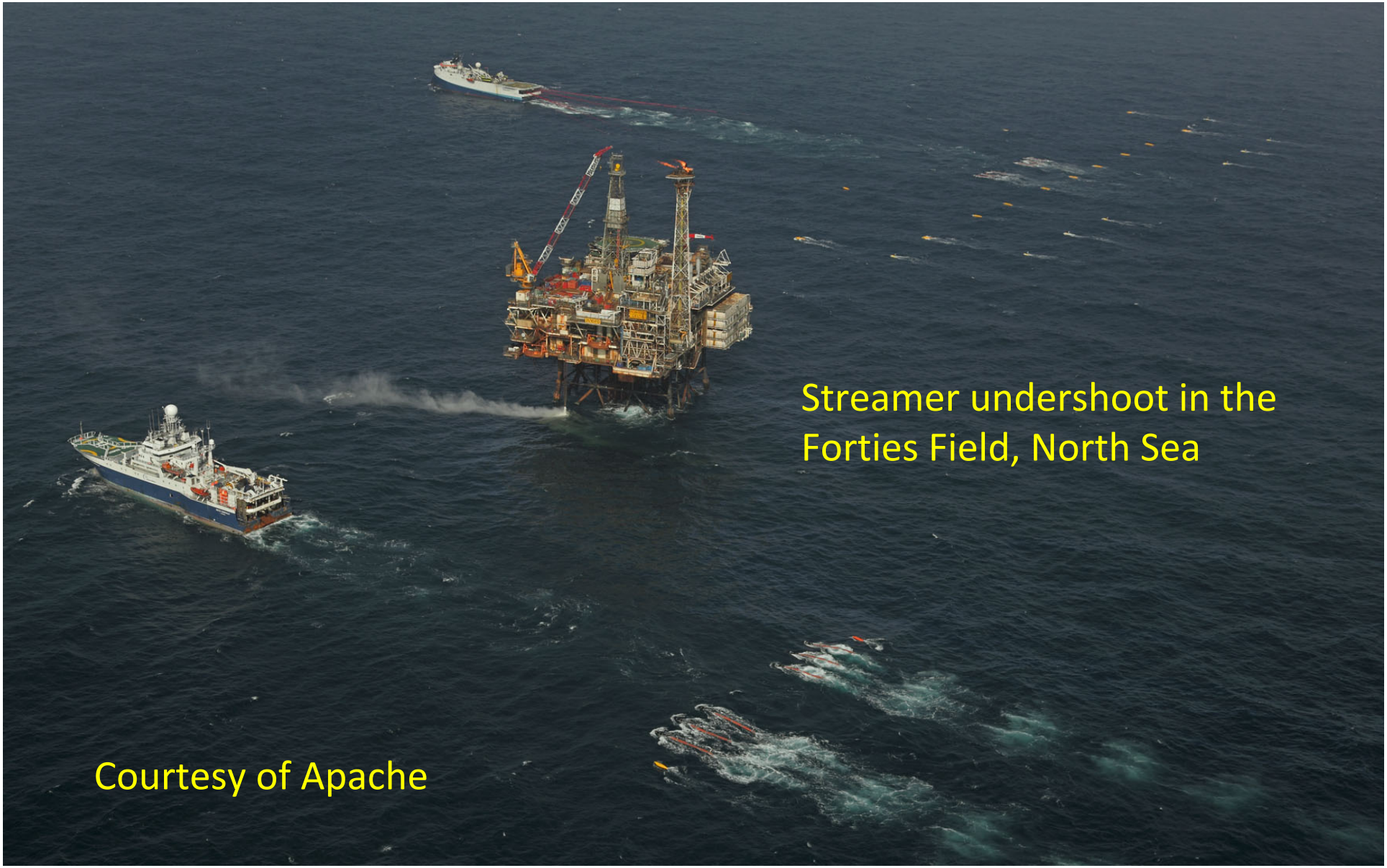
Field	Operator	#nodes	Mob/Demob location	Mob/ demob days	ROV vessel
Forties	Apache	50+10	Aberdeen	3/2	Resident
Dan	Maersk	959	Bergen	7/4	Dual*
TL	Chevron	220	Offshore	2/1	Resident

* The node vessel did ROV work in the field while waiting for the shooting

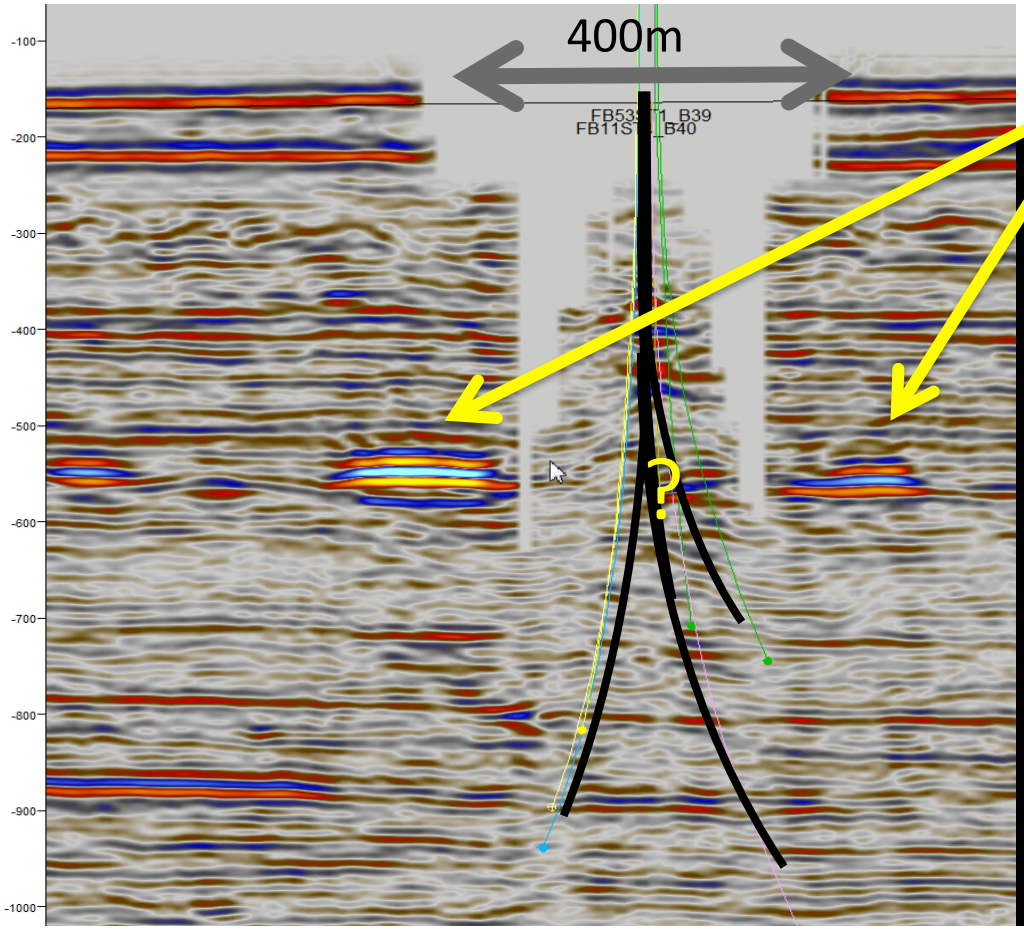
Forties: drilling hazards 3 platforms in 14 days

Field	Operator	#nodes	Mob/Demob location	Mob/ demob days	ROV vessel
Forties	**Apache**	**50+10**	**Aberdeen**	**3/2**	**Resident**
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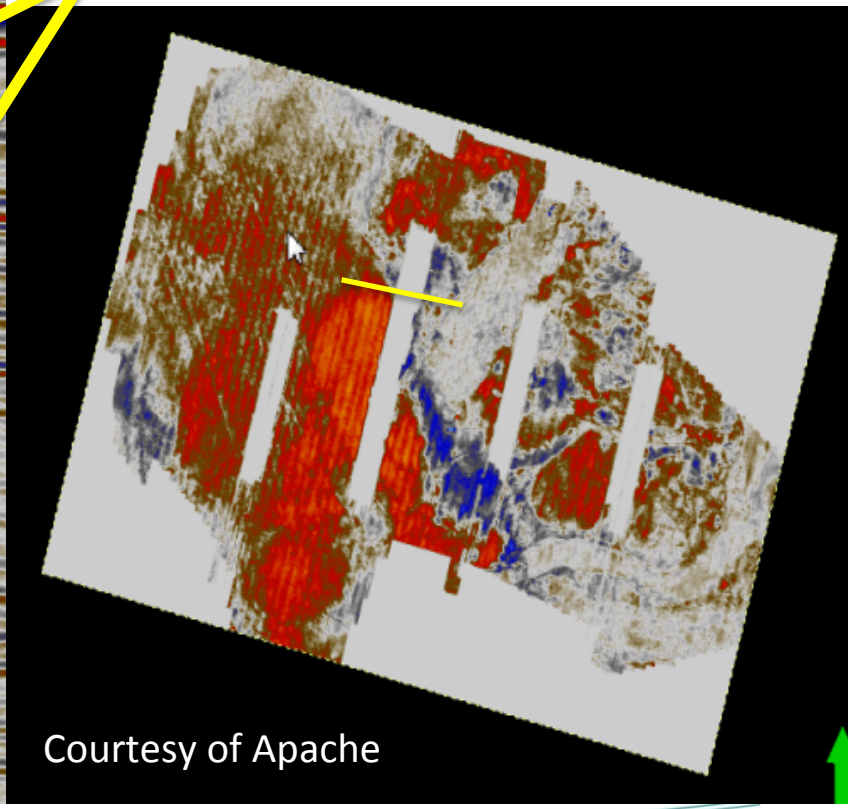
* The node vessel did ROV work in the field while waiting for the shooting


Streamer undershoot in the
Forties Field, North Sea
Courtesy of Apache

No image under the platforms with streamers



Shallow gas drilling hazards




NO SMOKING
FCV 3000


NO SMOKING
FCV 3000


NO SMOKING
FUGRO
FCV 3000

+10 nodes



Dolphin geophysical

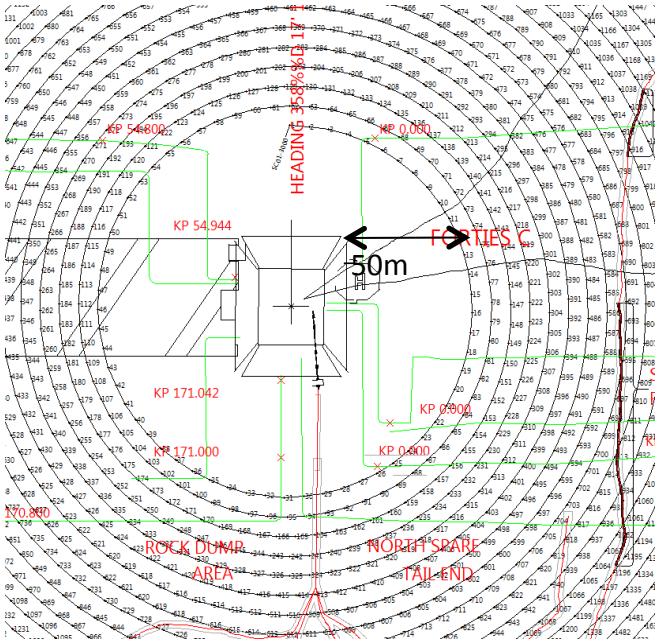

MGW 10 000KG
TARE 8 000KG
PAYLOAD
2000KG
005

Spiral shooting

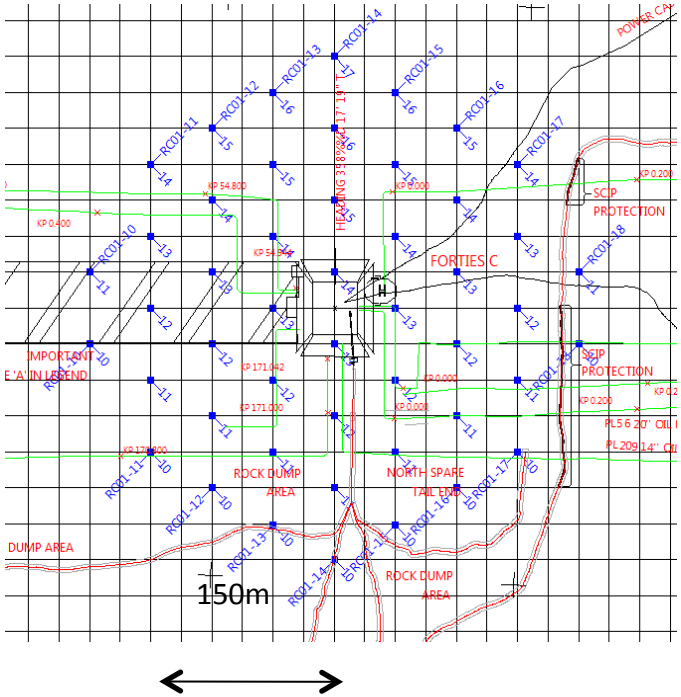


Source and node geometry—preplot

Spiral source

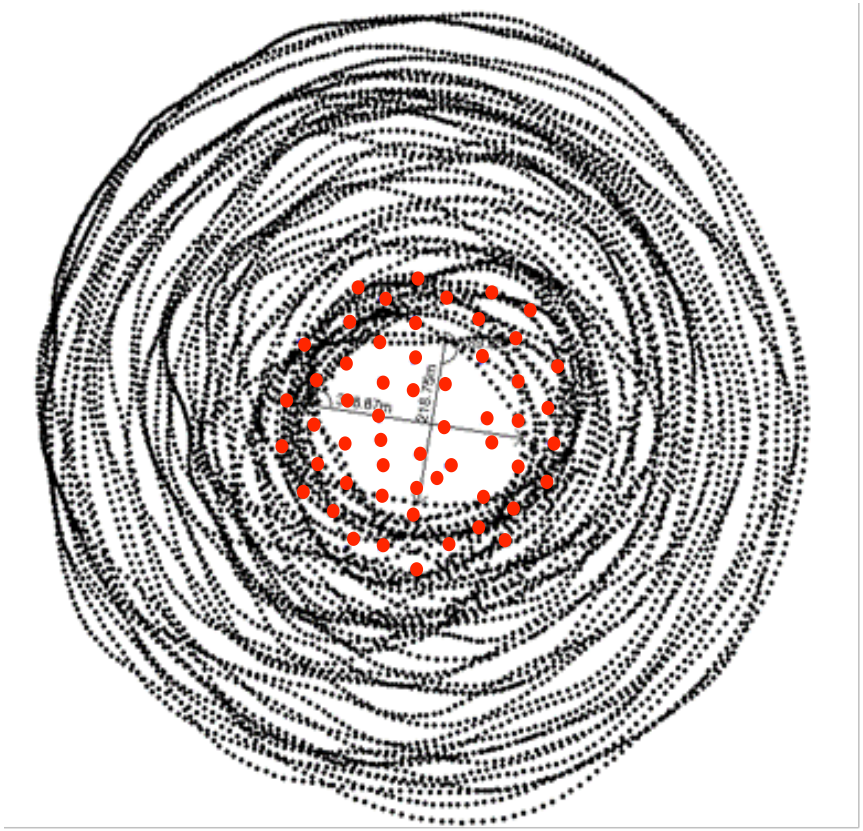


Hexagonal receivers

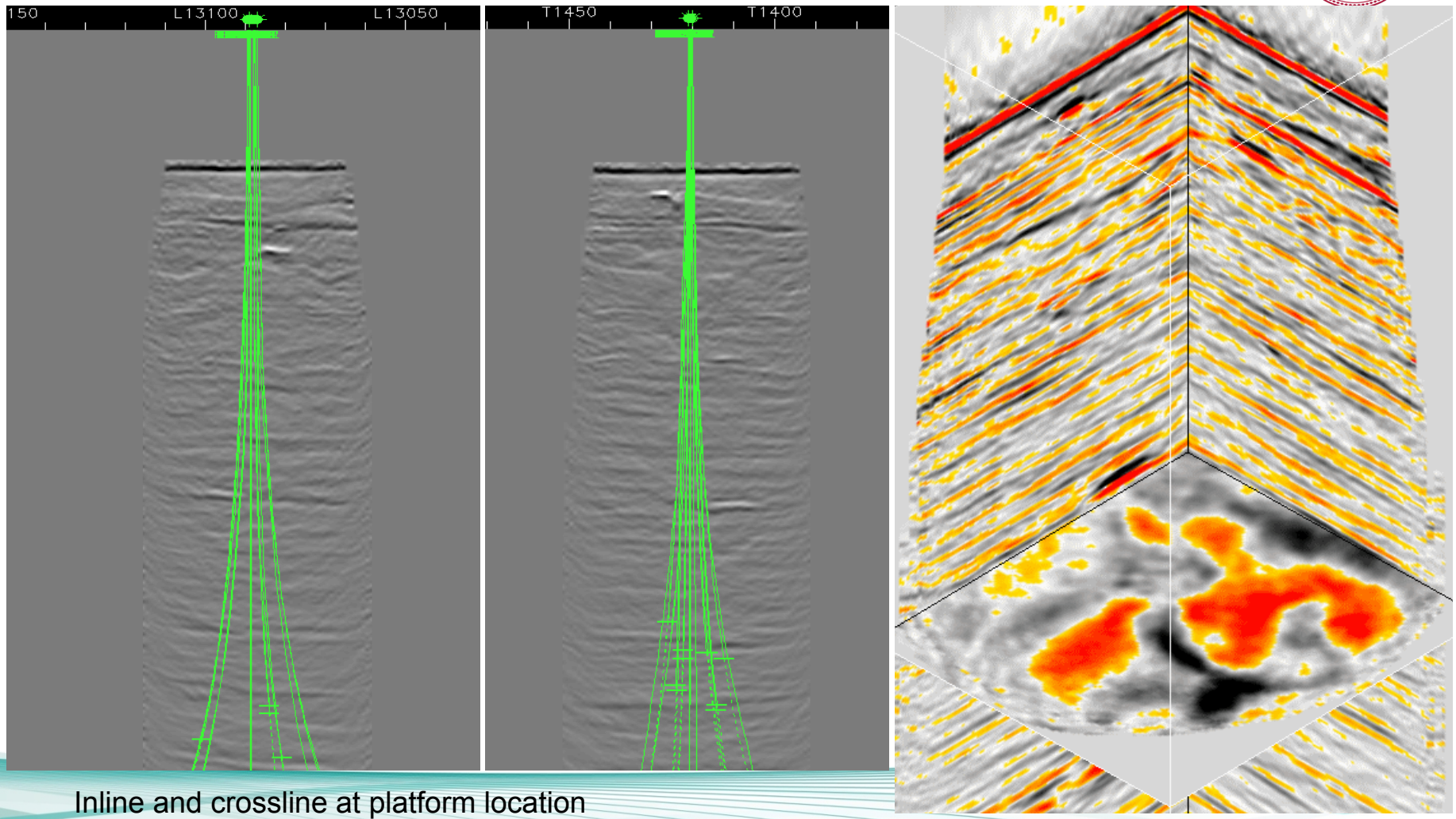


sparse nodes, dense shots





Node images (each platform)

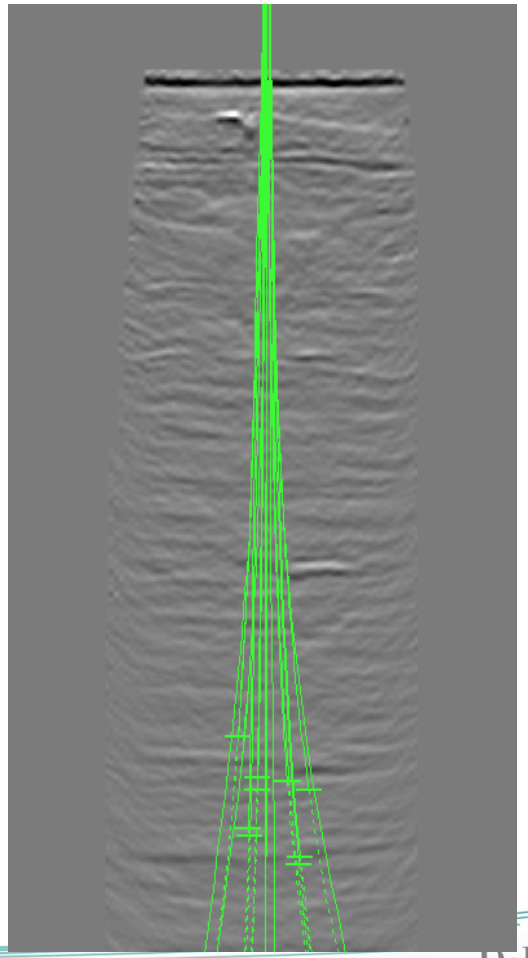


Inline and crossline at platform location

Streamers

Nodes

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Dolphin geophysical

DAN survey: Streamers baseline, combined monitor

Field	Operator	#nodes	Mob/Demob location	Mob/ demob days	ROV vessel
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Dan	**Maersk**	**959**	**Bergen**	**7/4**	**Dual***
TL	Chevron	220	Offshore	2/1	Resident

*** The node vessel did ROV work in the field while waiting for the shooting**

Dolphin geophysical

Dan monitor survey: combined streamer and nodes

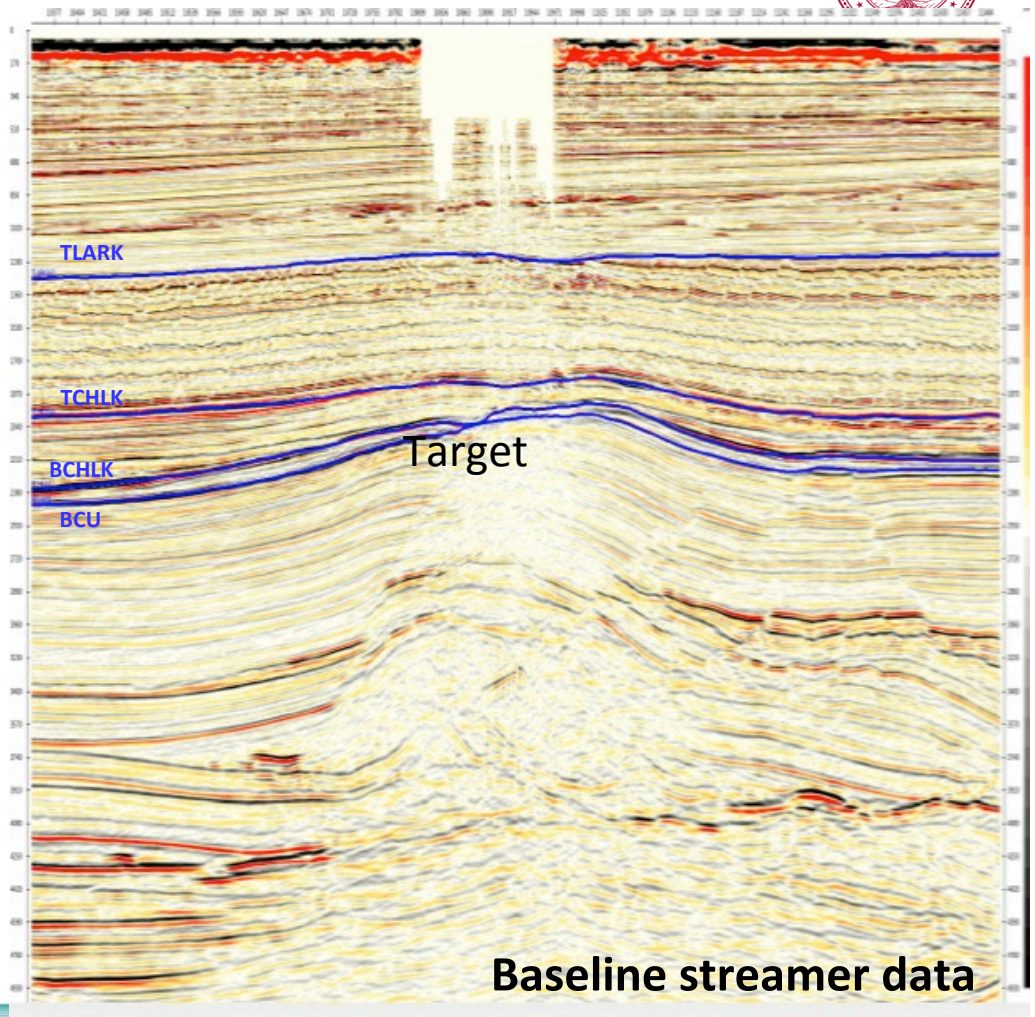
Obstructions

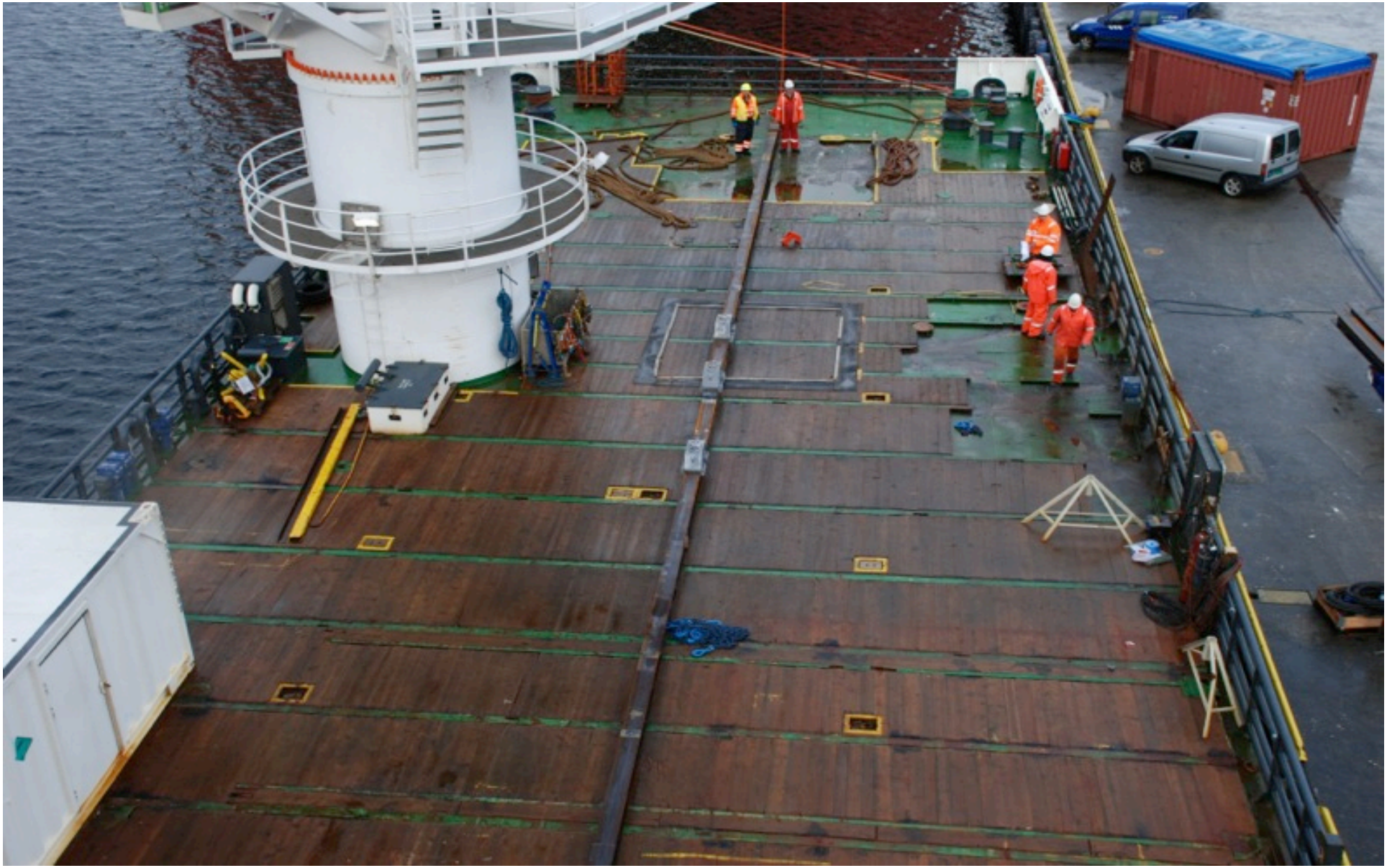
Full azimuth

Shear waves



Streamers and dual vessel






2D

Streamers+undershoot

Streamers+Nodes

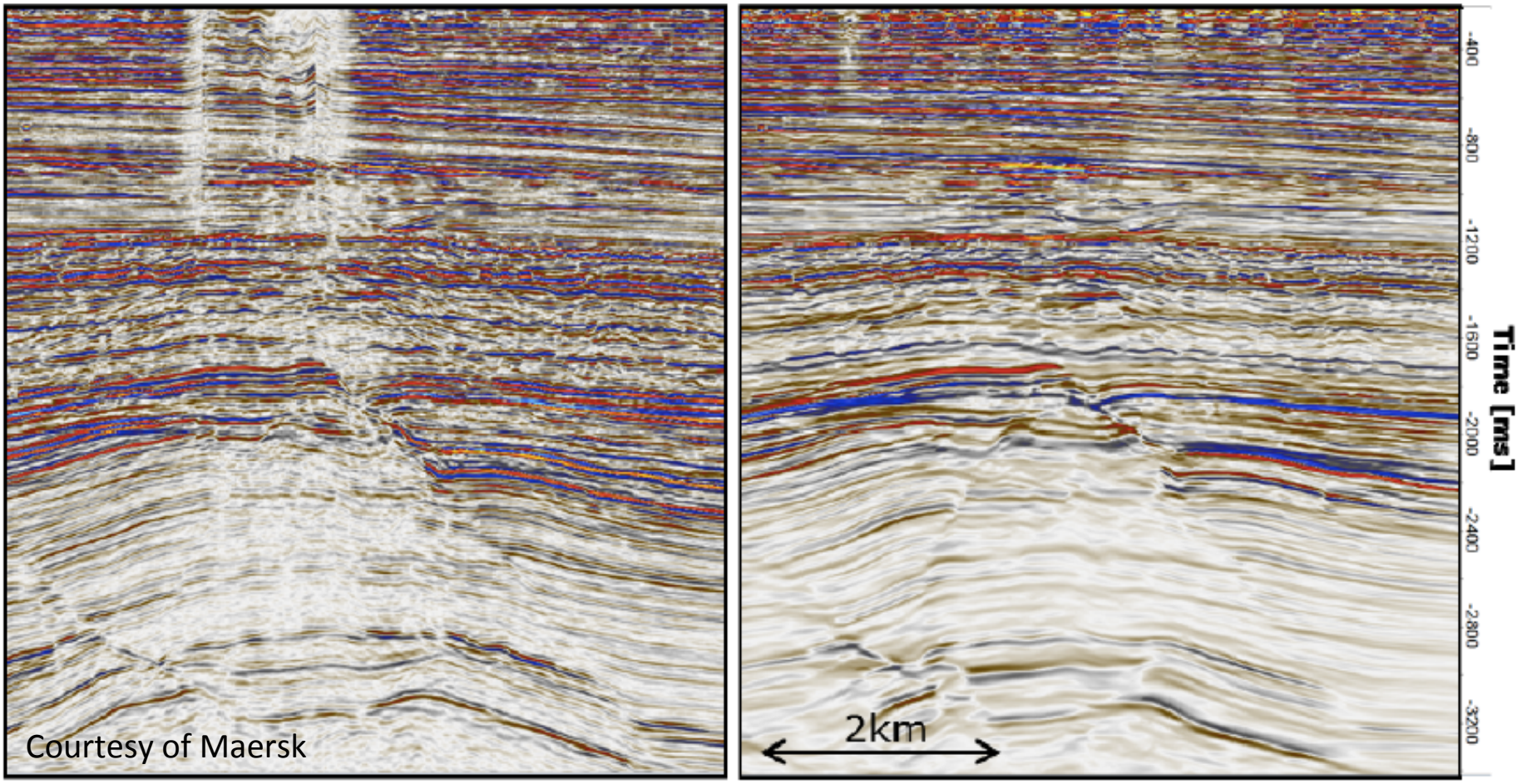


Figure 3 Comparison between 2012 Streamer acquisition with undershoots and OBN RTM results

TL: combined broadband monitor

Field	Operator	#nodes	Mob/Demob location	Mob/ demob days	ROV vessel
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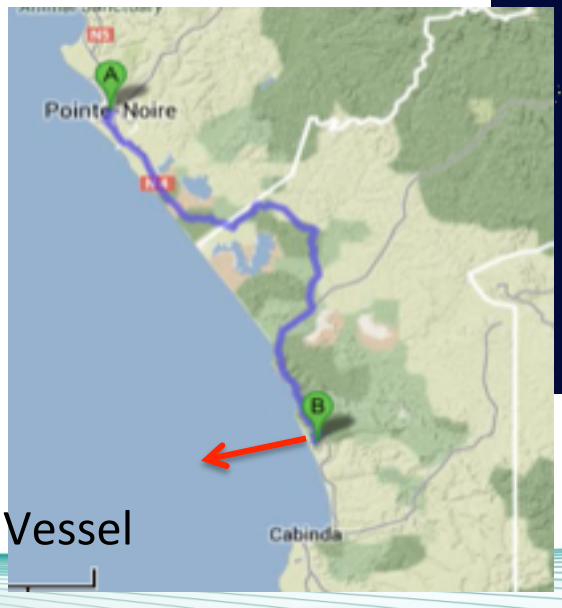
Dolphin geophysical

TL offshore mobilization

The Nodes and the handling equipment were shipped to Ostend, flown to Pointe Noire and trucked to Malongo

Shipped by PSV to TL field



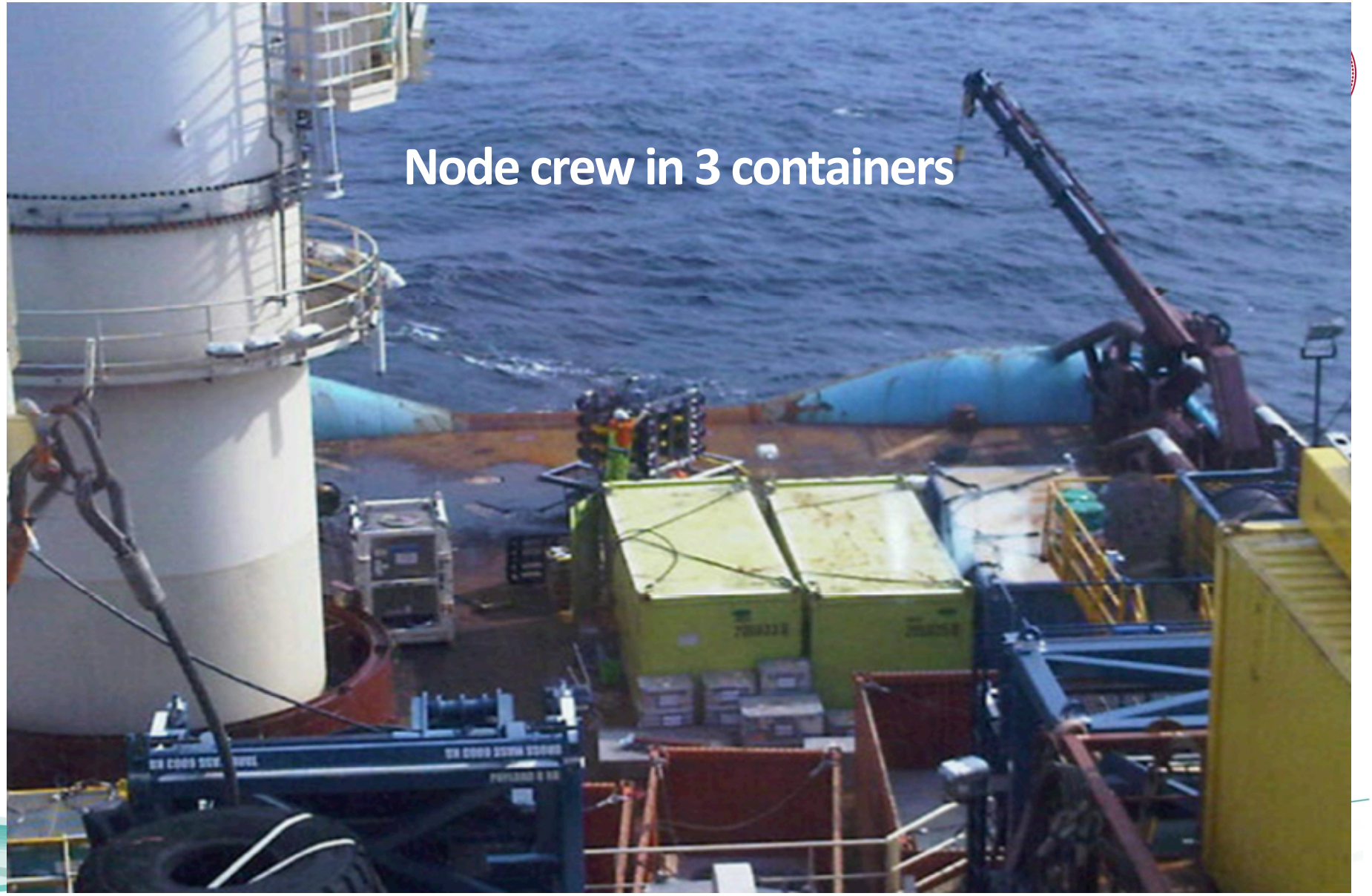


PSV=Platform Supply Vessel


Platform
crane from
the psv ...

… to the ROV vessel



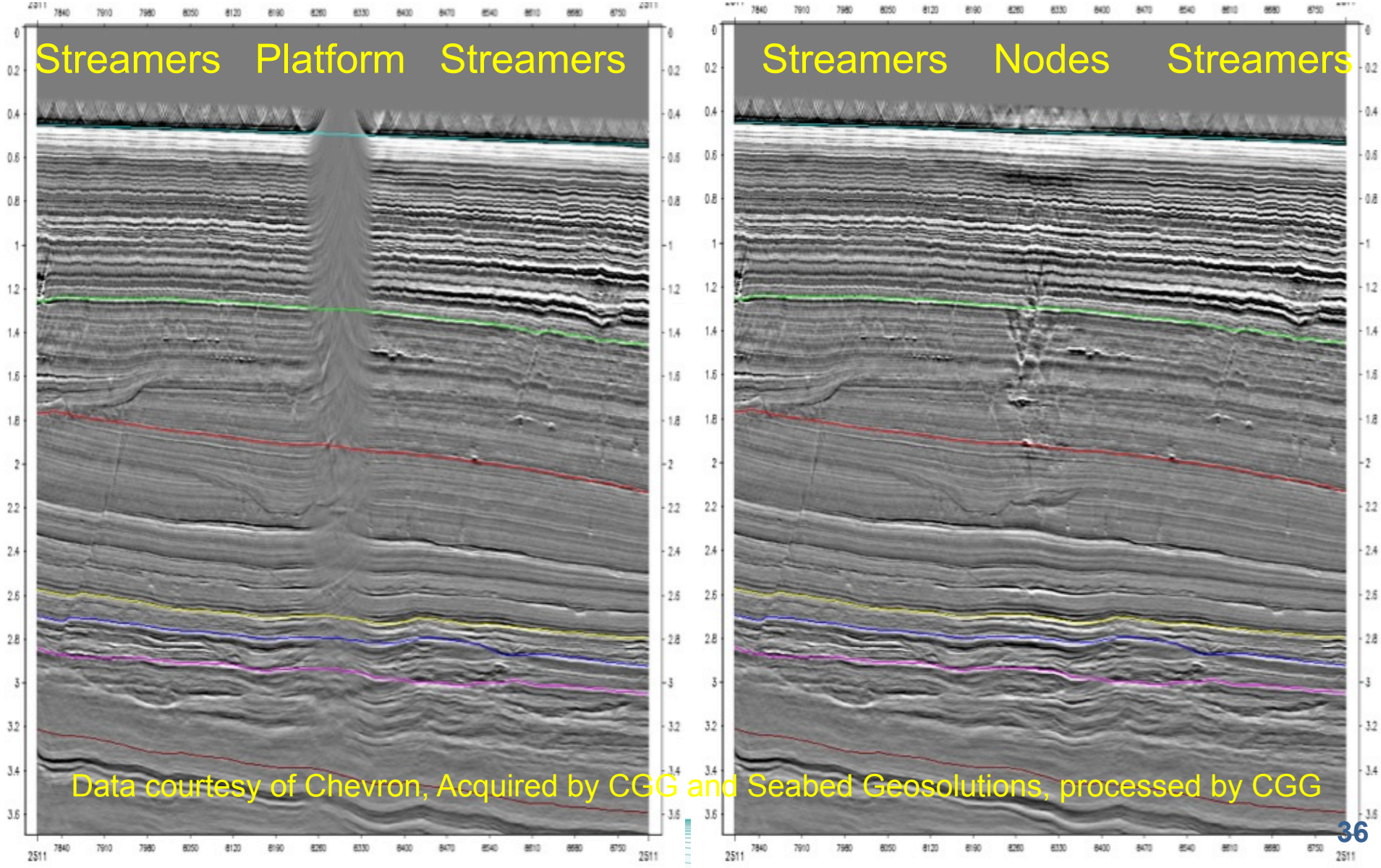

Node crew in 3 containers

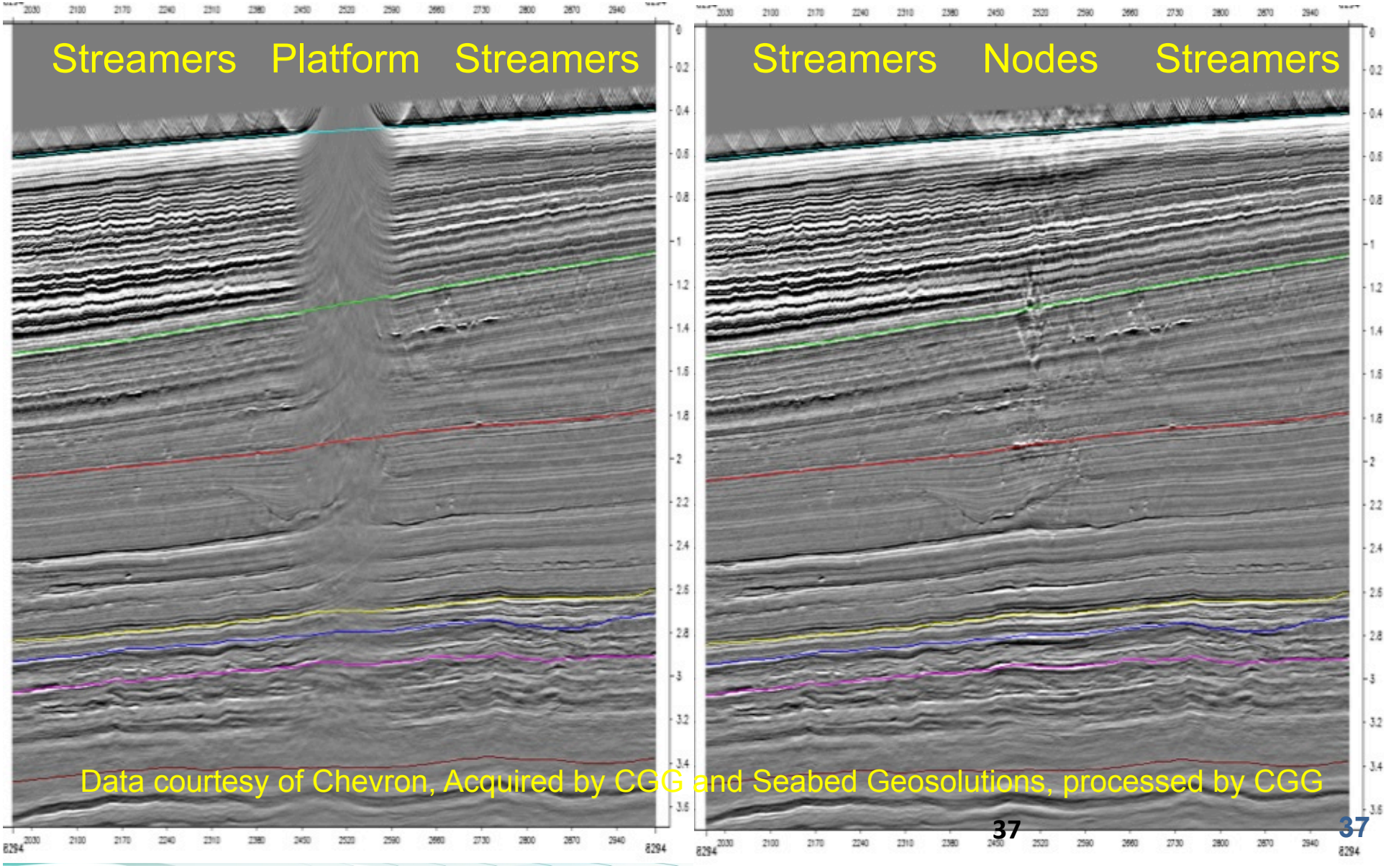


Node deployment Using the ROV vessel crane



Crane from the ROV vessel to the PSV


Streamers Platform Streamers
Streamers Nodes Streamers
Data courtesy of Chevron, Acquired by CGG and Seabed Geosolutions, processed by CGG


Streamers
Platform
Streamers
Streamers
Nodes
Streamers
Data courtesy of Chevron, Acquired by CGG and Seabed Geosolutions, processed by CGG

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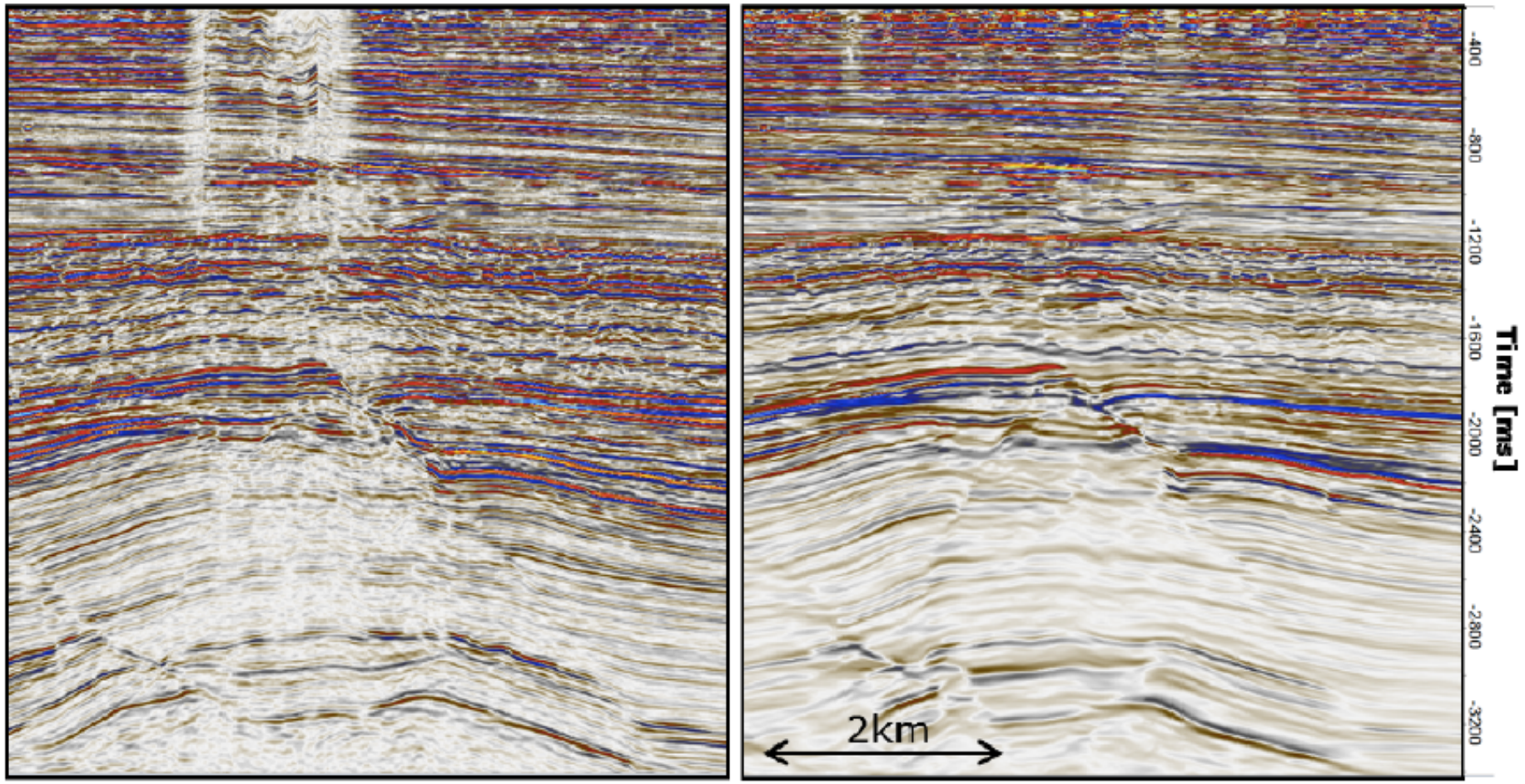


Combining streamers and OBN

- Acquisition with containerized node crews
- Processing with joint imaging

Streamers+undershoot

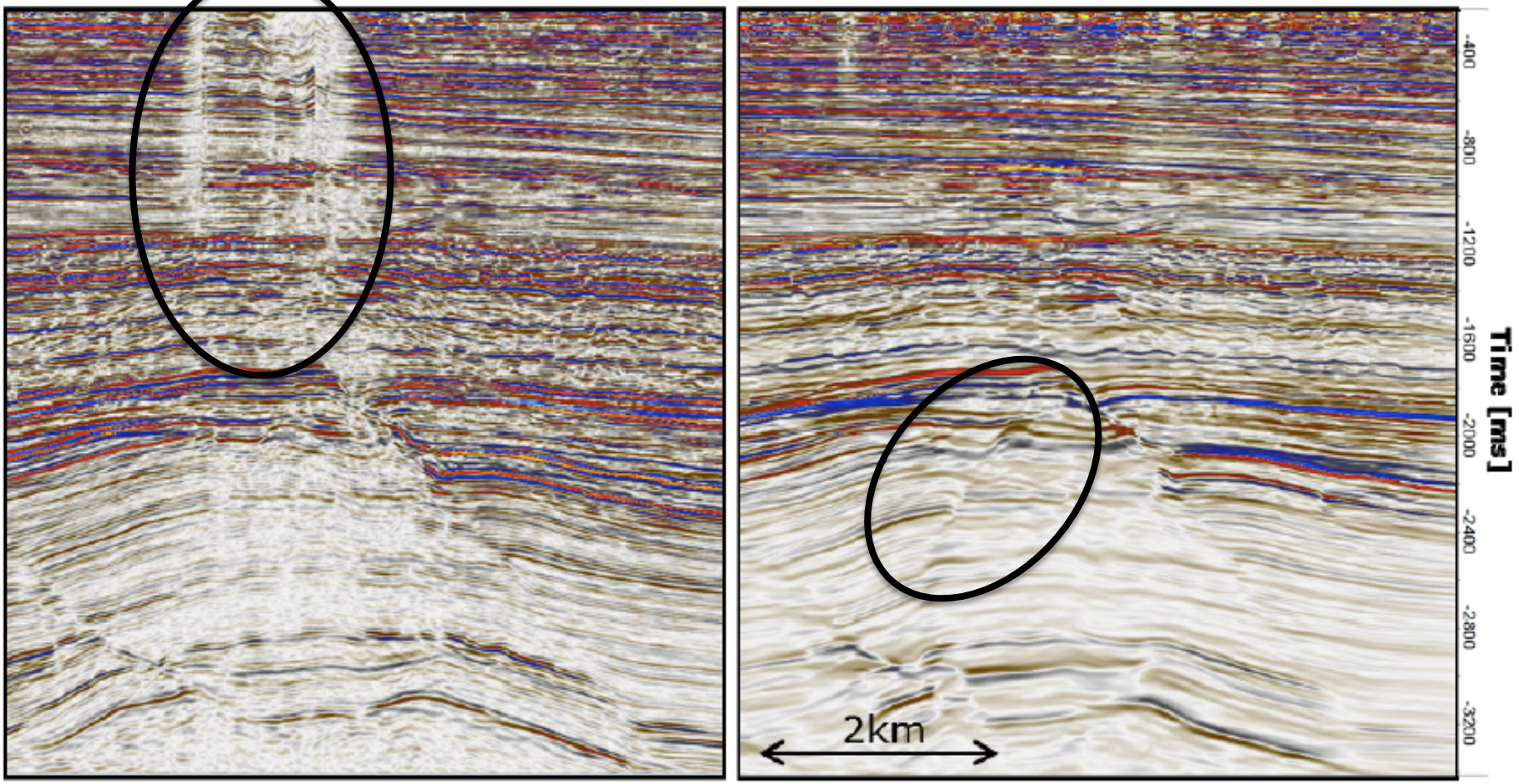
Streamers+Nodes



Courtesy of Maersk

Streamers+undershoot

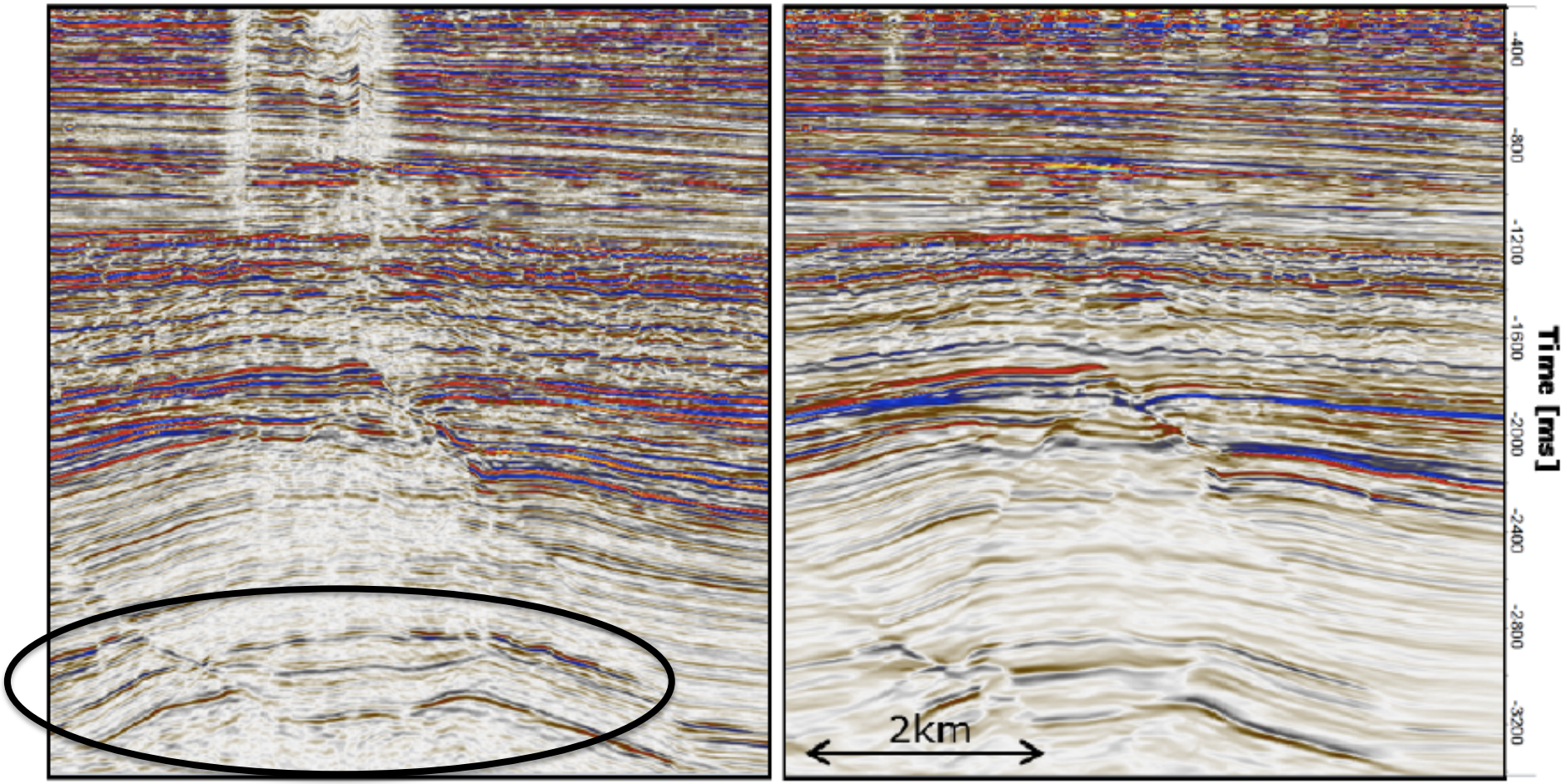
Streamers+Nodes



Courtesy of Maersk

Streamers+undershoot

Streamers+Nodes

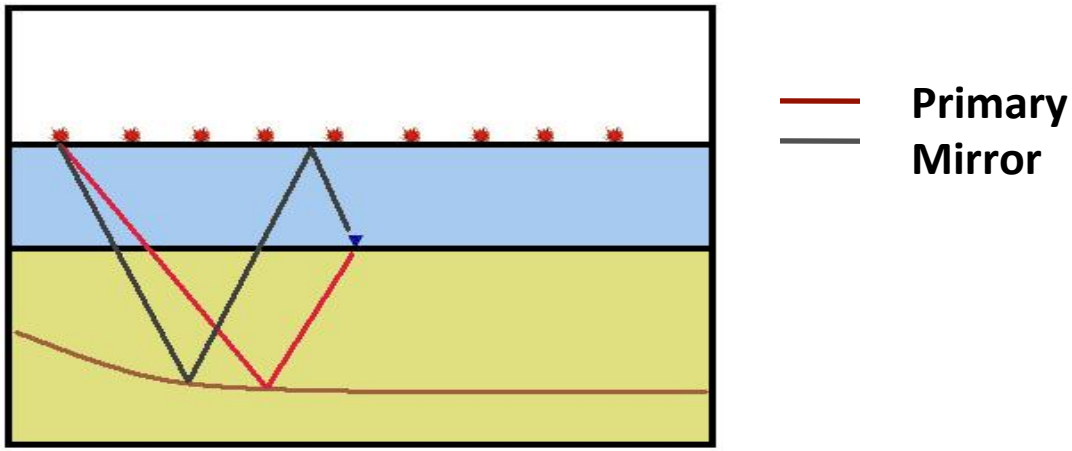


Courtesy of Maersk

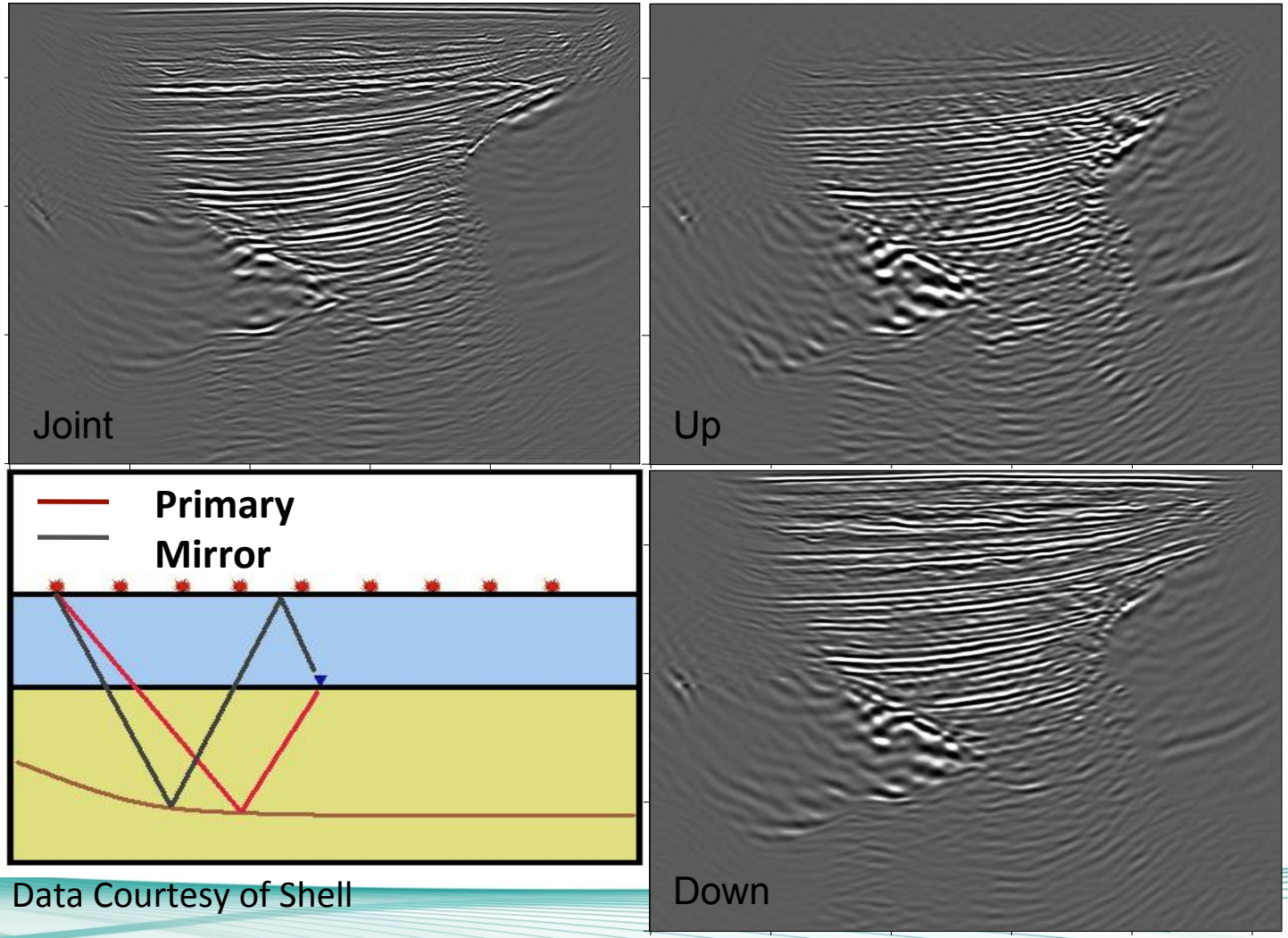
Joint imaging (Mandy Wong)

Joint imaging of Up and Down

$$min\left(\|\mathbf{L}_{\uparrow}\mathbf{m}-\mathbf{d}_{\uparrow}\|^2+\|\mathbf{L}_{\downarrow}\mathbf{m}-\mathbf{d}_{\downarrow}\|^2\right)$$

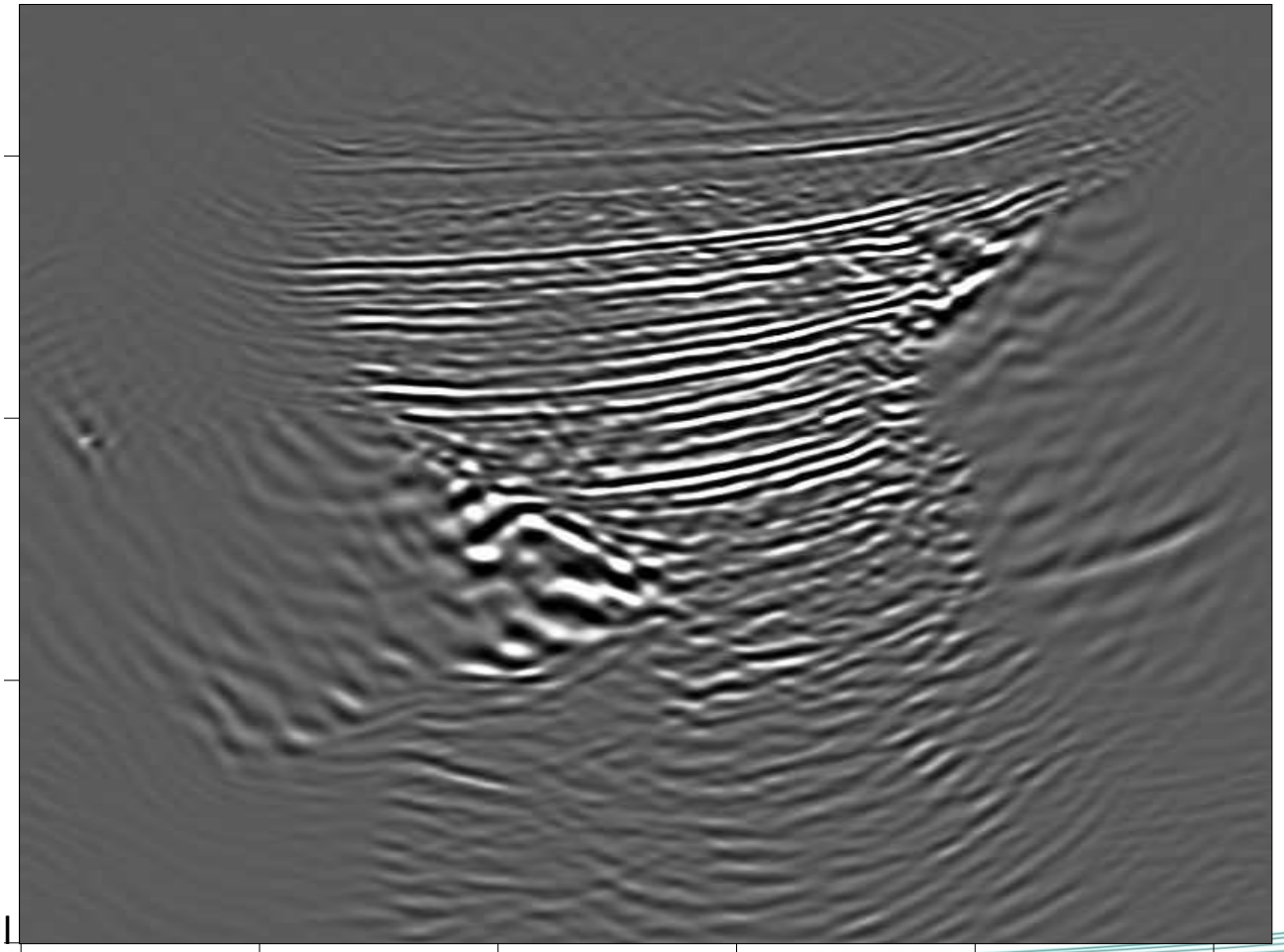


Joint imaging (Mandy Wong)



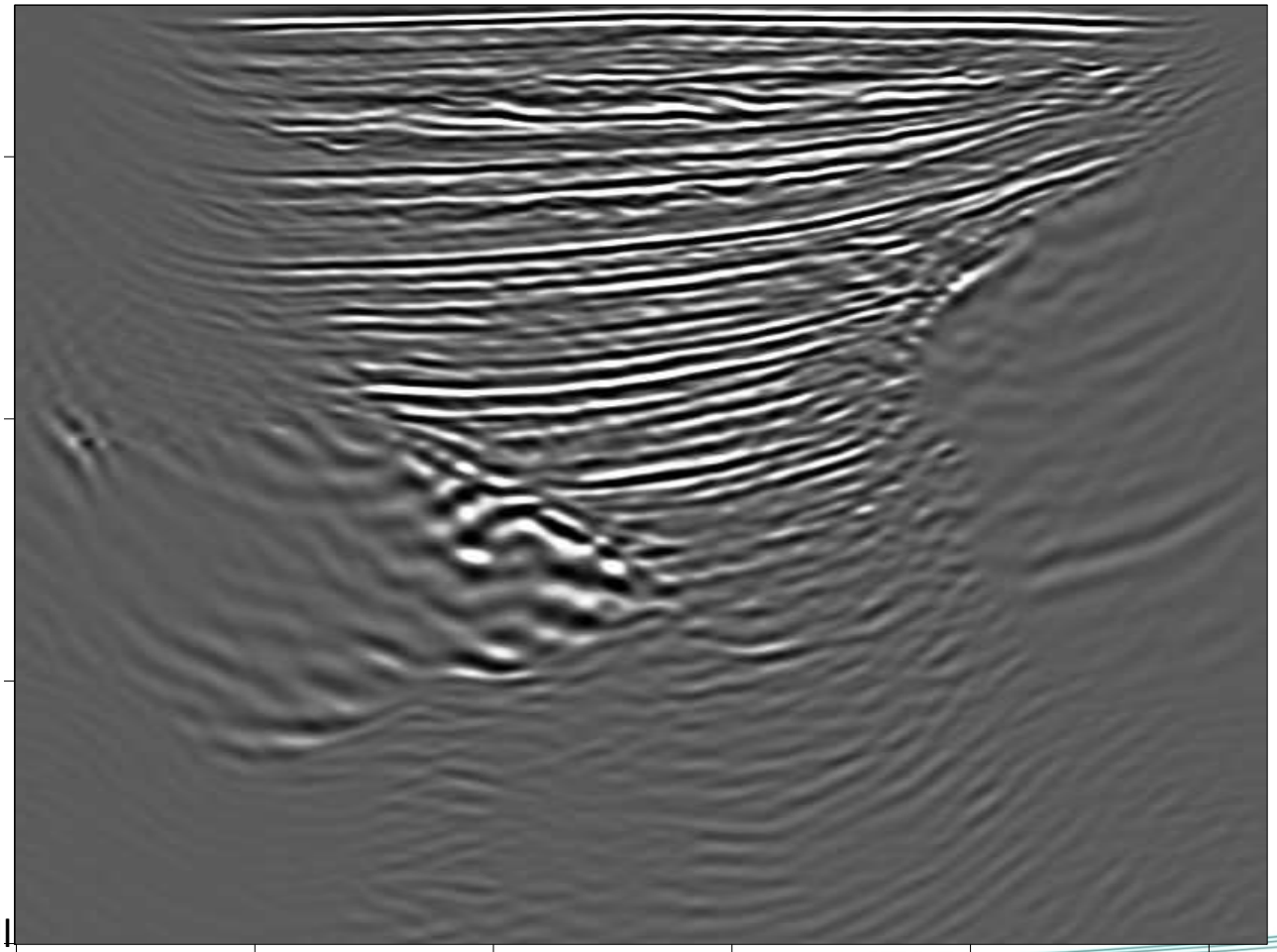
Data Courtesy of Shell

Up (Mandy Wong)



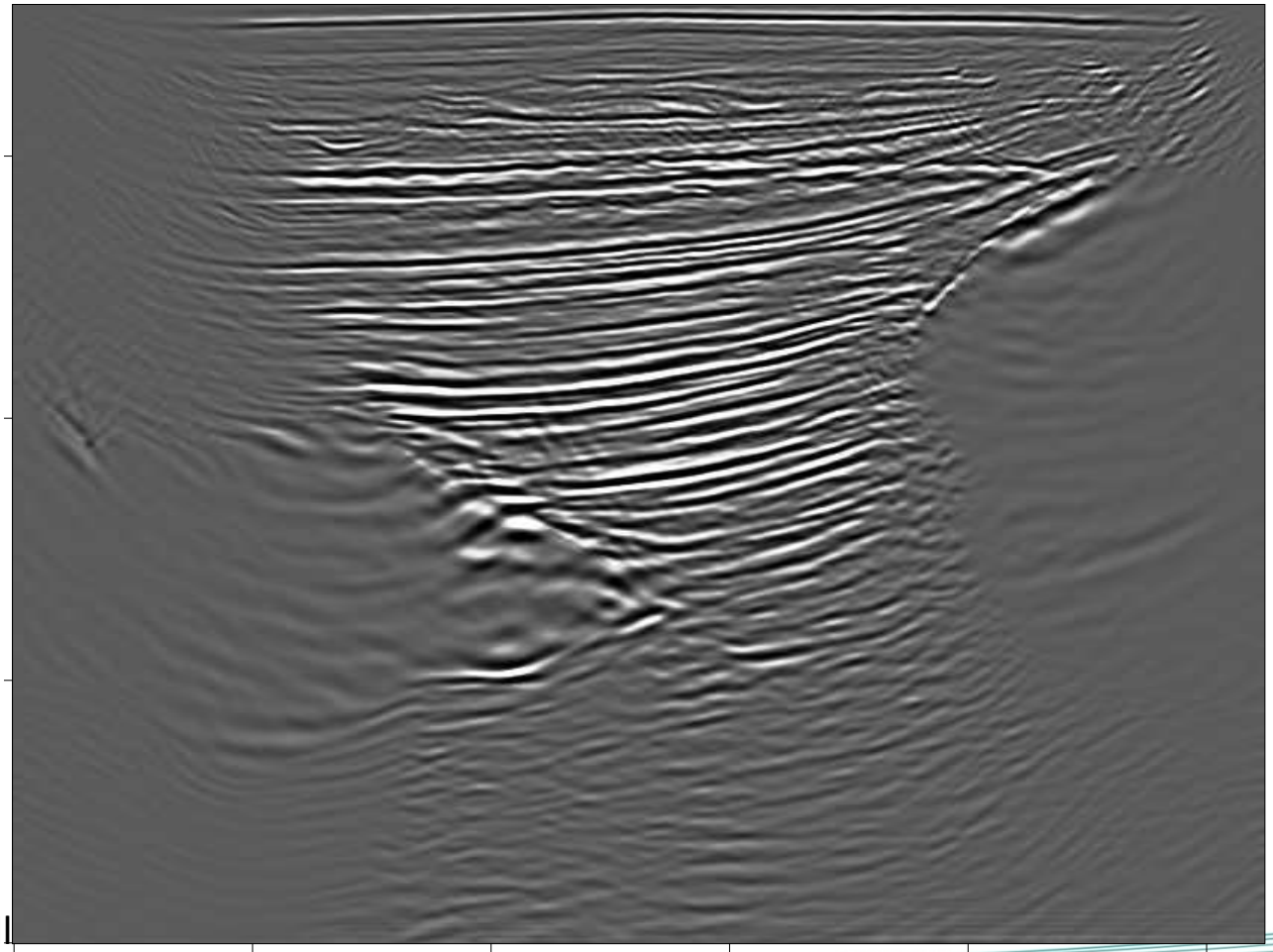
Courtesy of Shell

Down (Mandy Wong)

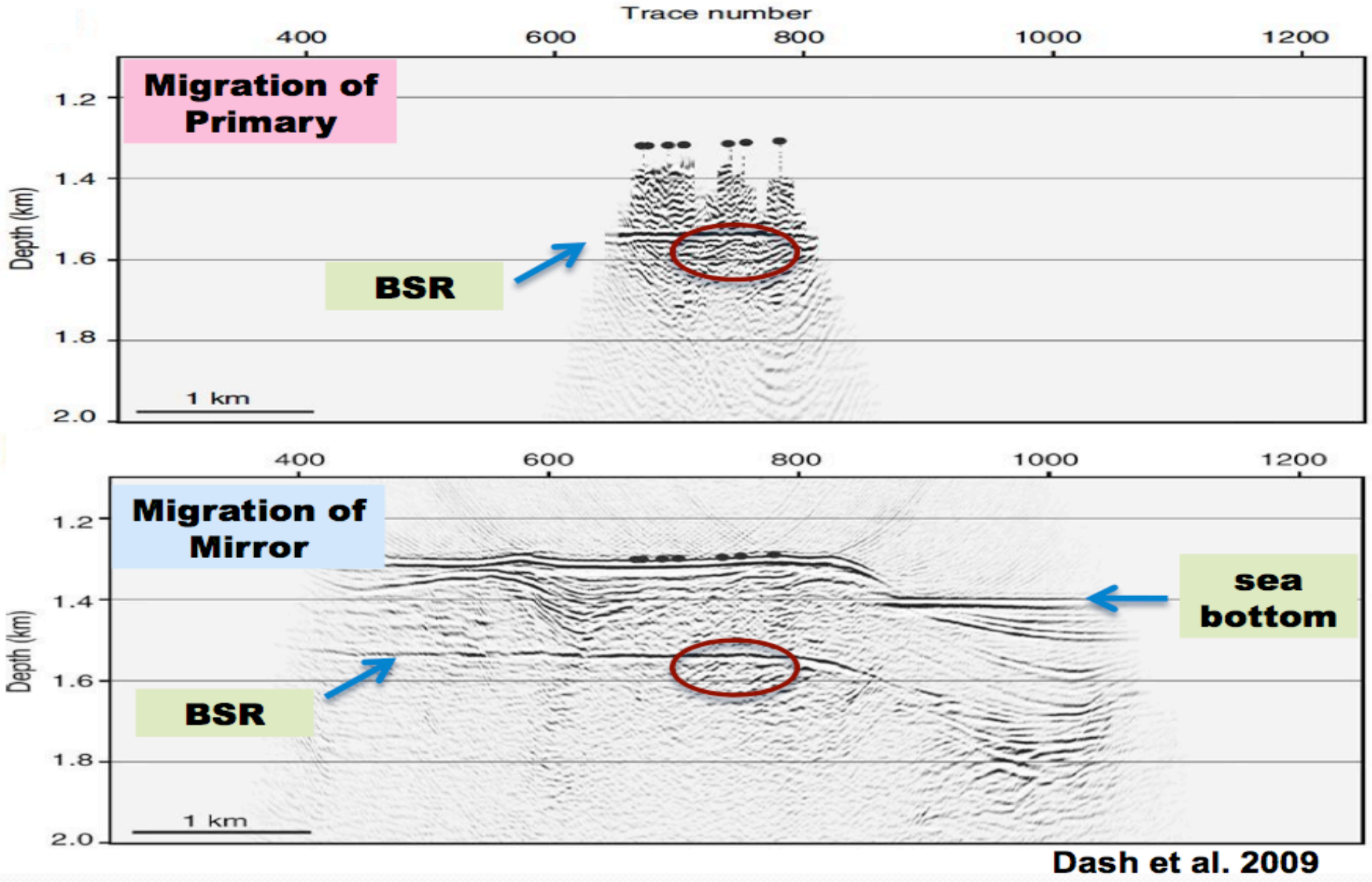


Courtesy of Shell

Joint (Mandy Wong)



Courtesy of Shell

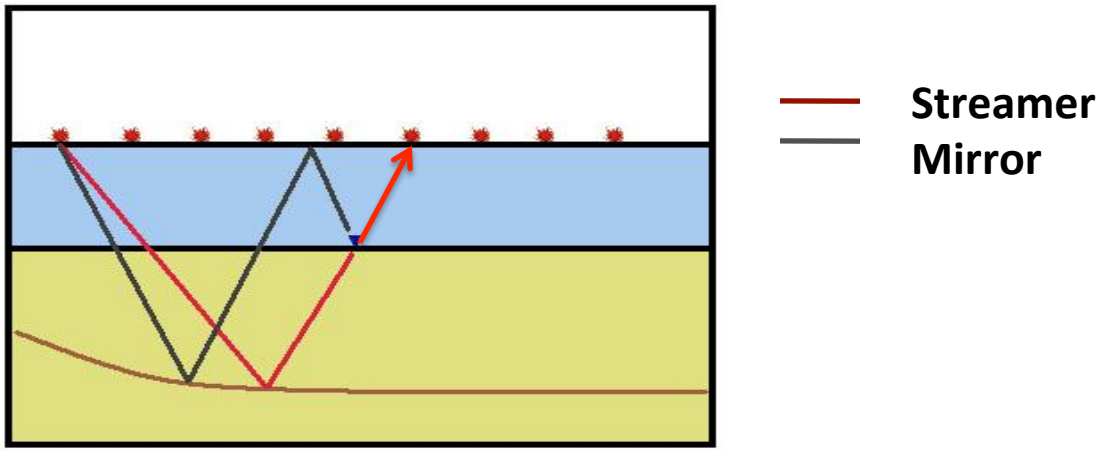


Dash et al. 2009

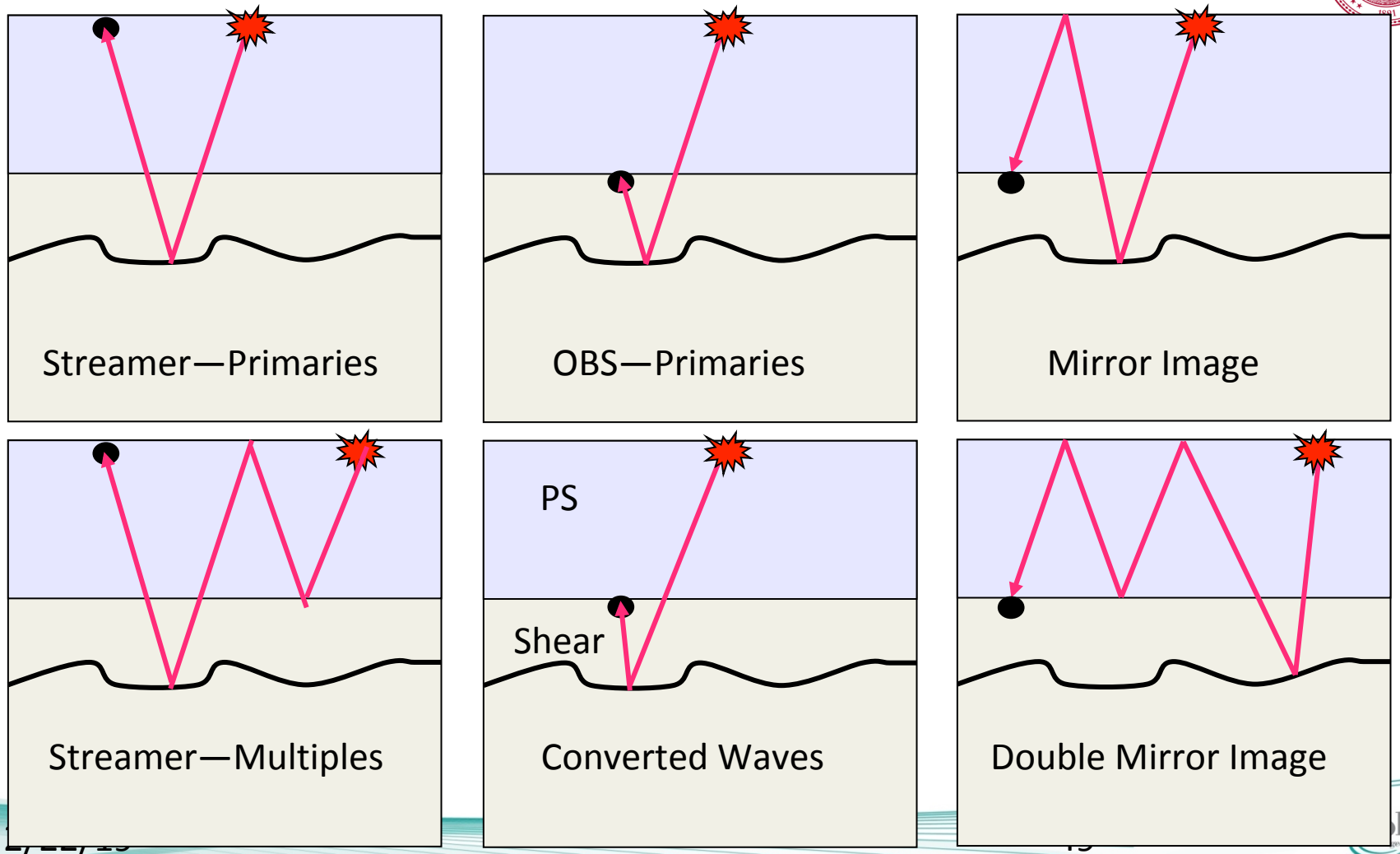
Joint imaging (Up+Down->Surface+Down)

Joint imaging of Up and Down

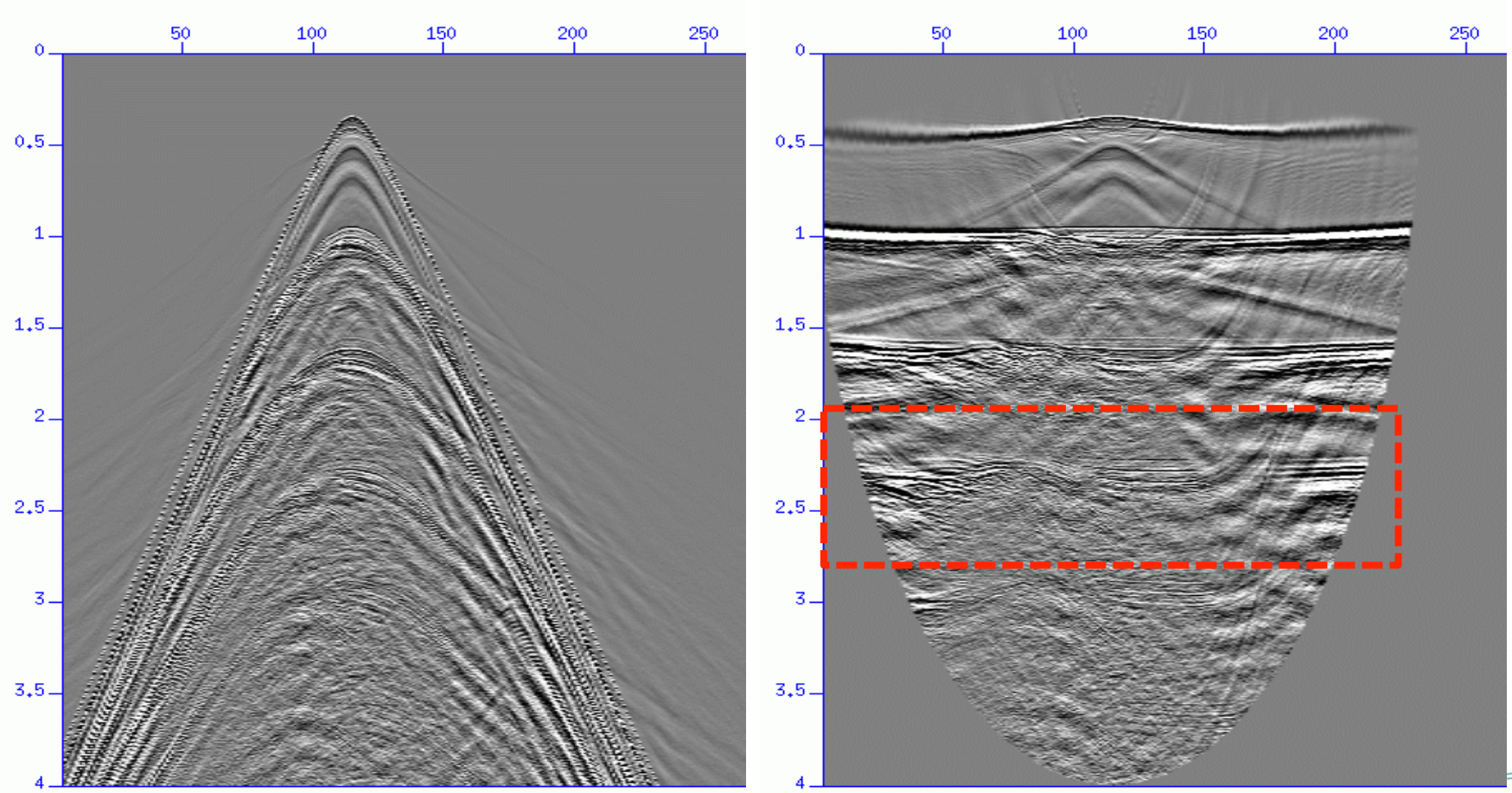
$$min\left(\|\mathbf{L}_{s}\,\mathbf{m}-\mathbf{d}_{s}\,\|^{2}+\|\mathbf{L}_{\downarrow}\mathbf{m}-\mathbf{d}_{\downarrow}\|^{2}\right)$$



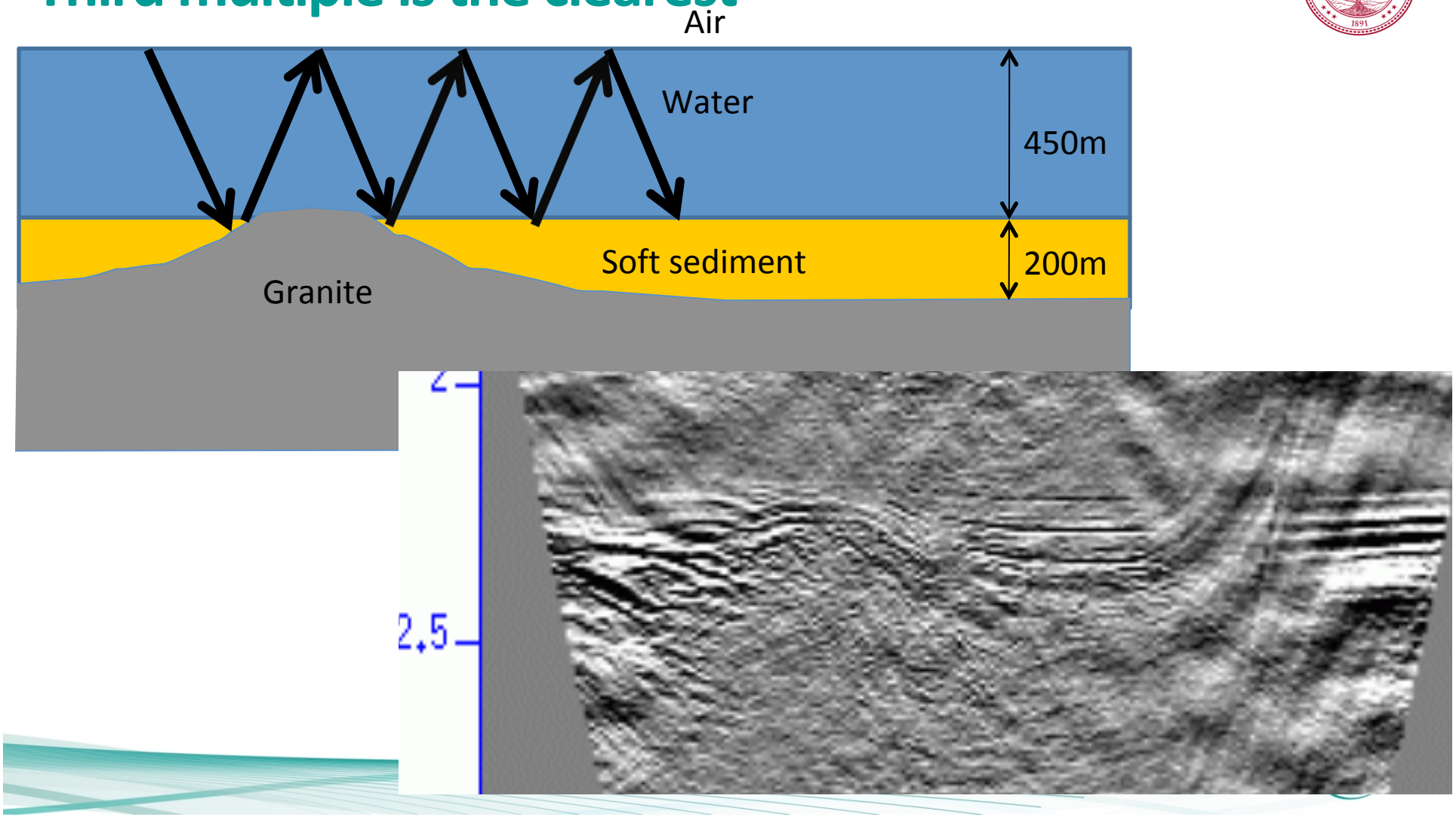
Multi-mode imaging



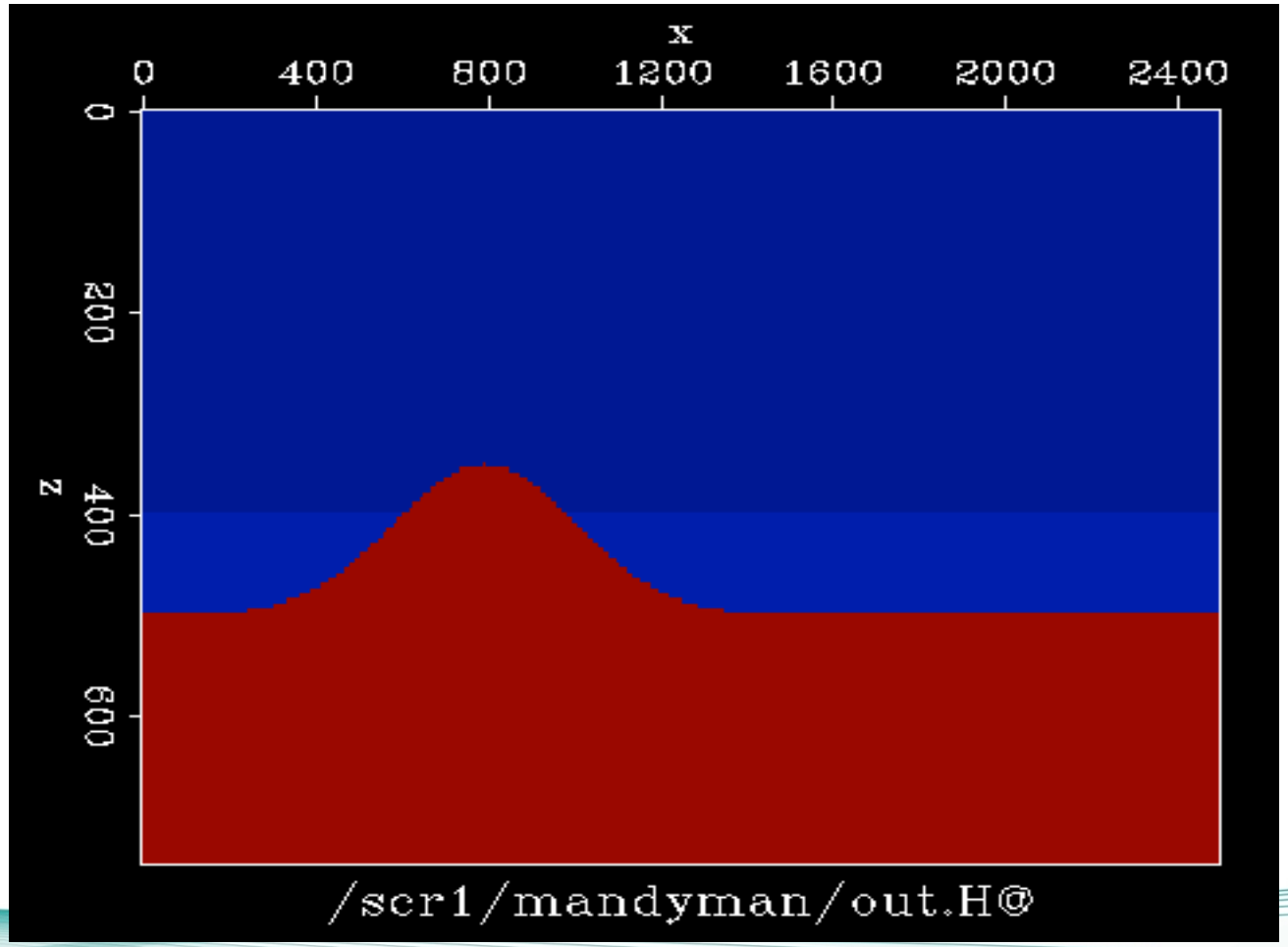
Hydrophone data before and after NMO



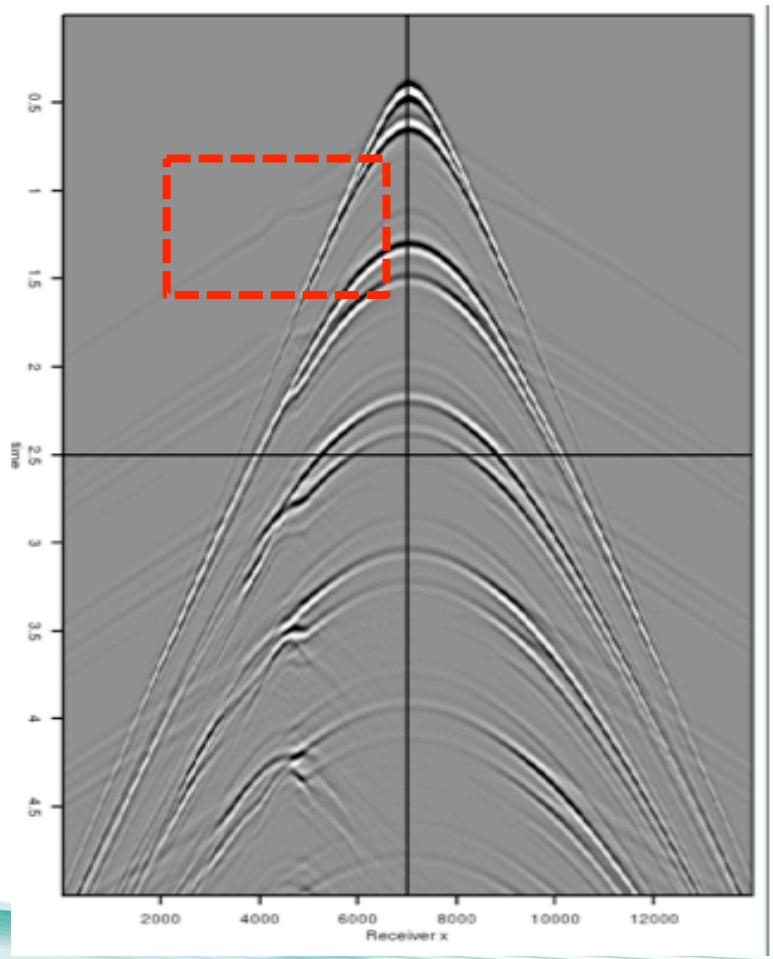
Third multiple is the clearest

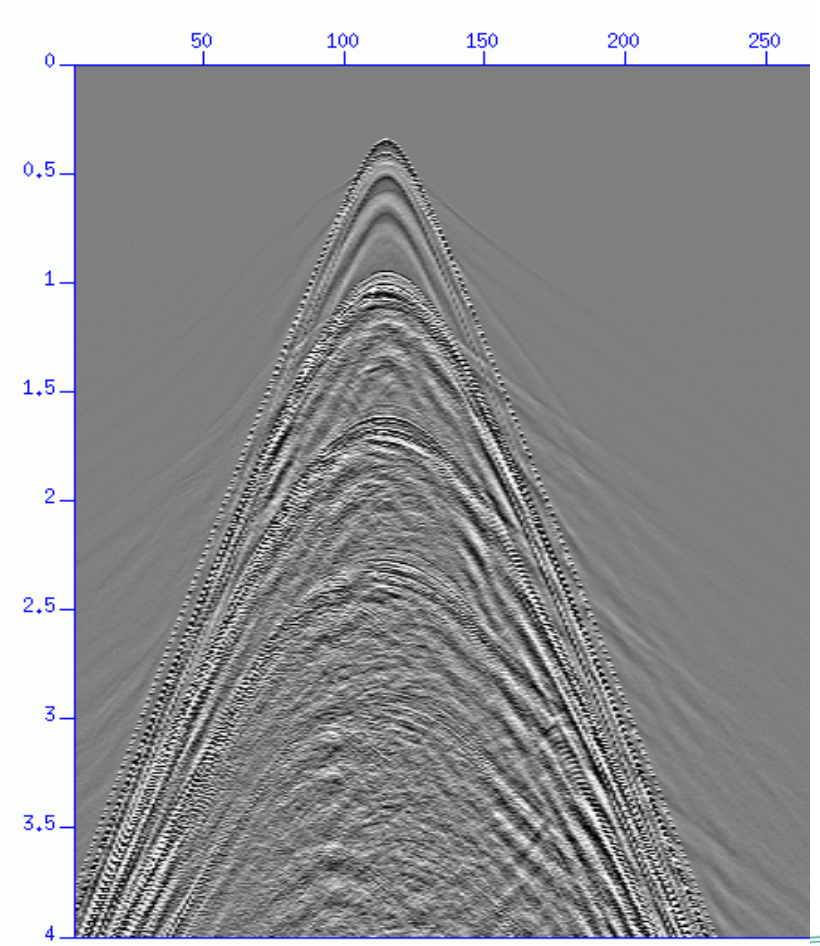


Model guessed from the third multiple

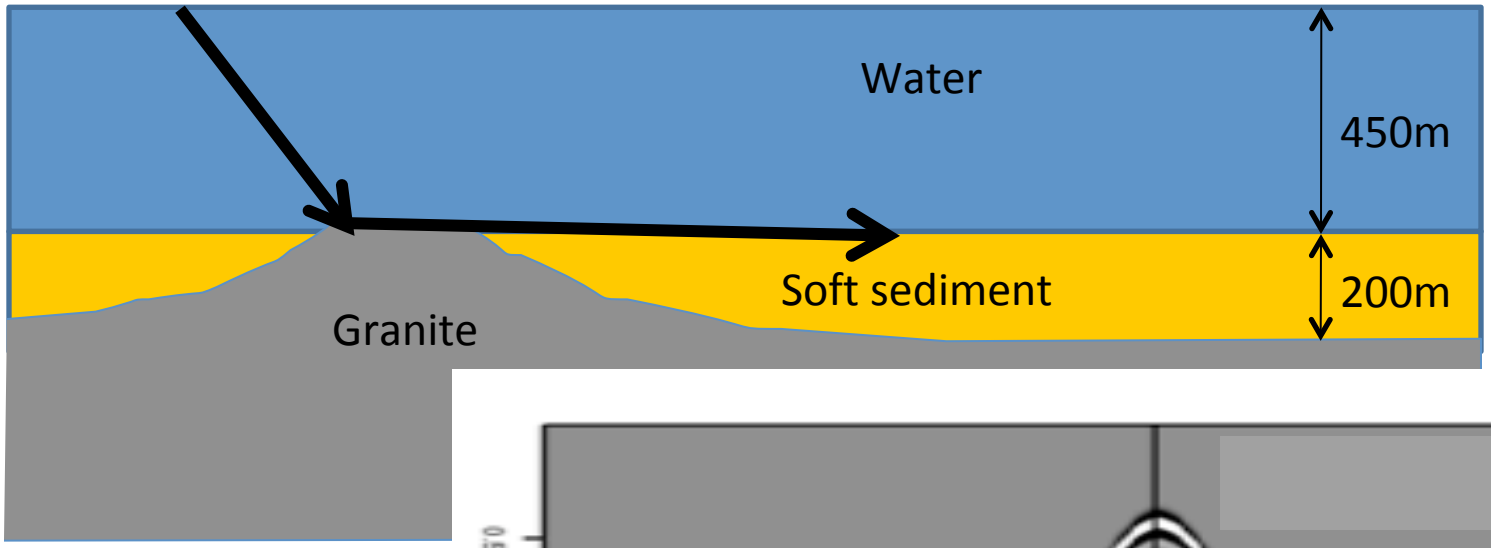


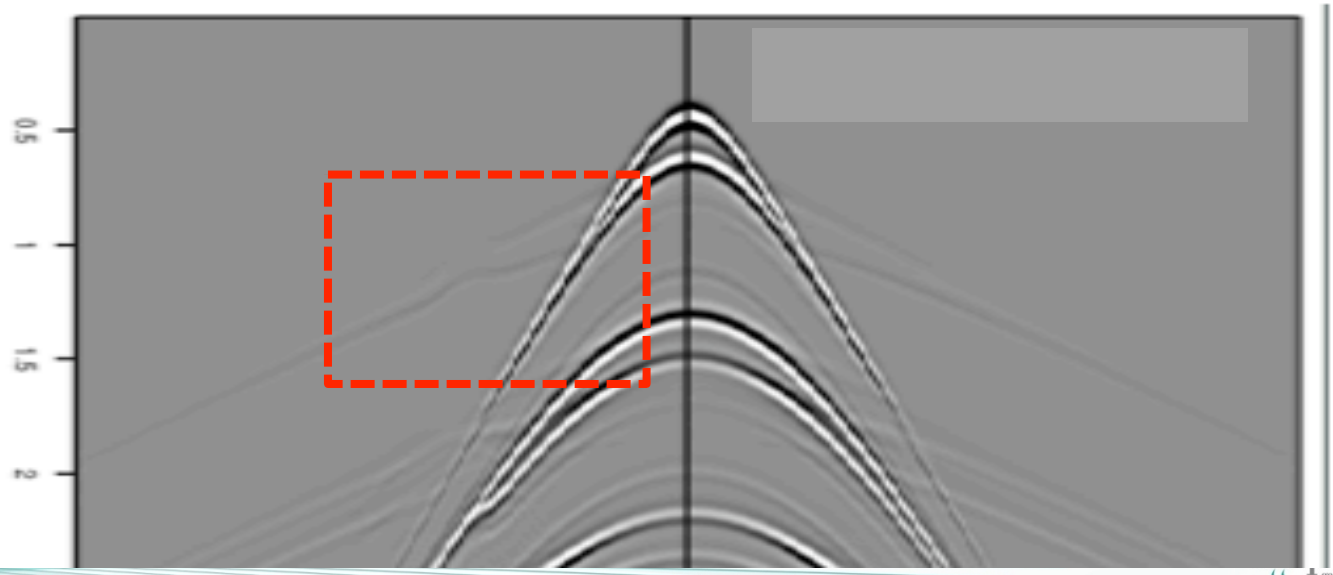
Data guessed from the third multiple Vs real data



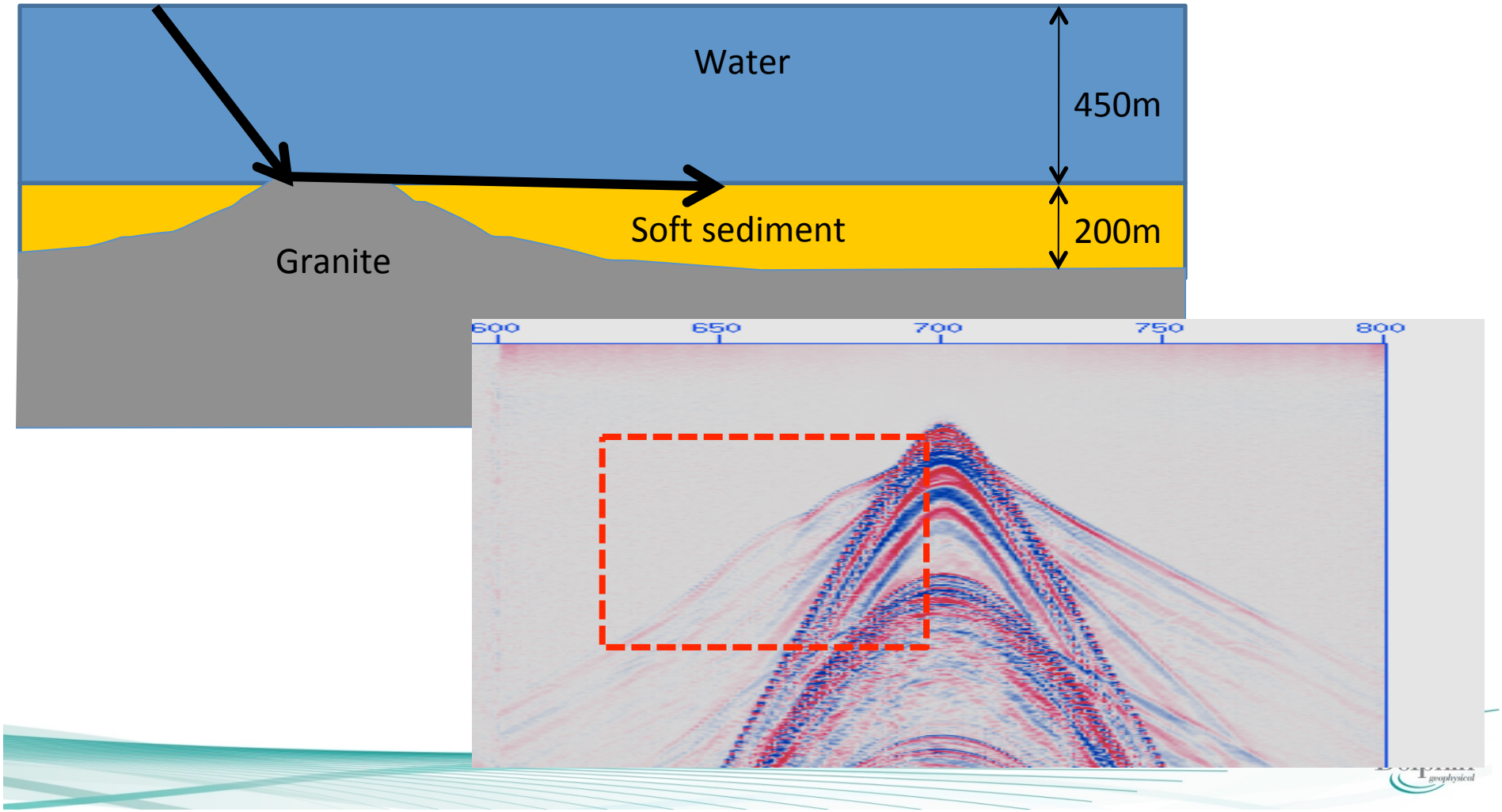


The refraction: synthetic data





The refraction: real data



Summary

Combined streamers and OBN

- Containerized node crews
- Multi-mode joint imaging
  - Streamers
  - Up
  - Down
  - Refractions (FWI)
  - … (PS)

