

KMS Technologies - KJT Enterprises Inc.

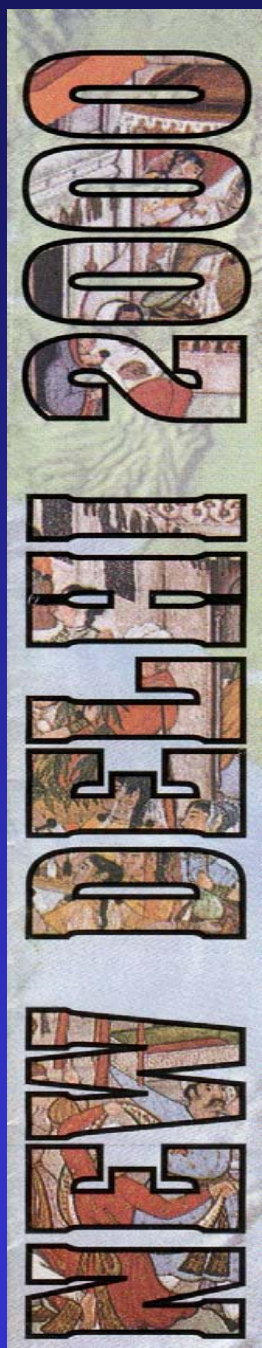
Presentation

Strack, K.-M., Merry, H., Walter, L., Ayres, W.

2000

**A quantum leap in borehole seismic
acquisition**

**Society of Petroleum Geophysicists/Society of
Exploration Geophysicists
Conference & Exposition on Petroleum
Geophysics, New Delhi**



A quantum leap in borehole seismic acquisition

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W. Ayres¹, **K.-M Strack**^{1,2}

Feb 2000



¹ Geospace Engineering Resources Inc.

² KMS Technologies - KJT Enterprises Inc.

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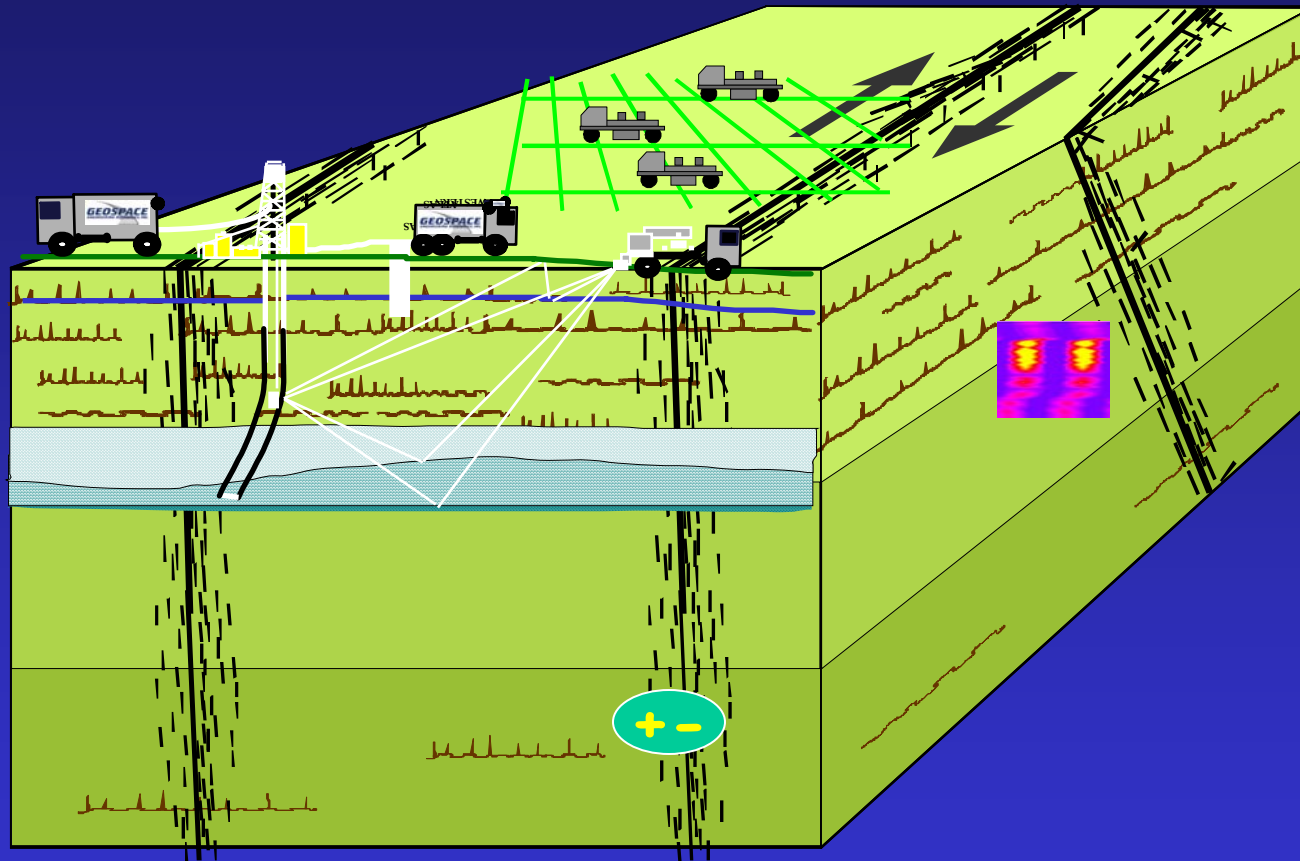
Outline

- Motivation
- Introduction to BHS
- The new system
- Crosswell applications
- Single well applications
- Summary

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Borehole seismic - the critical link

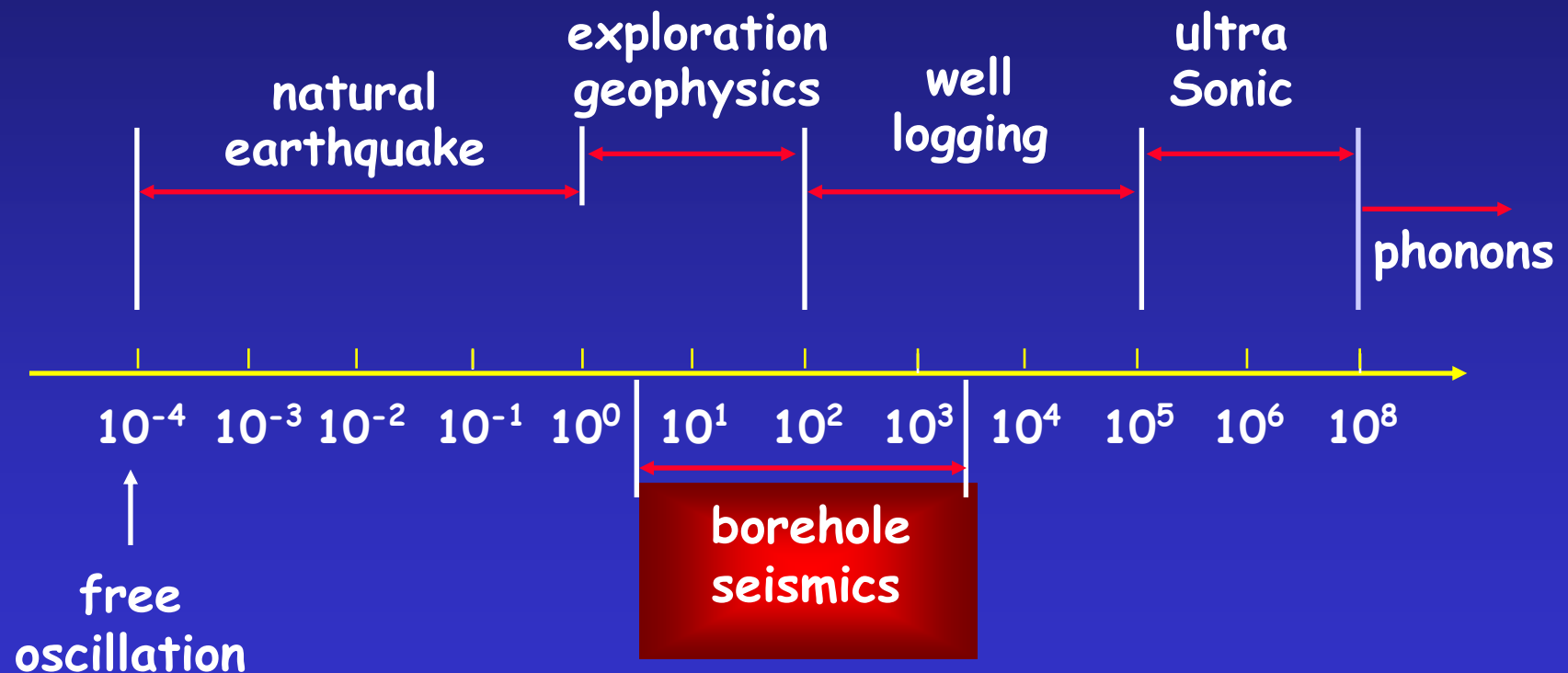


KMS99001II

KMST000018a

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SEISMIC SIGNAL FREQUENCIES



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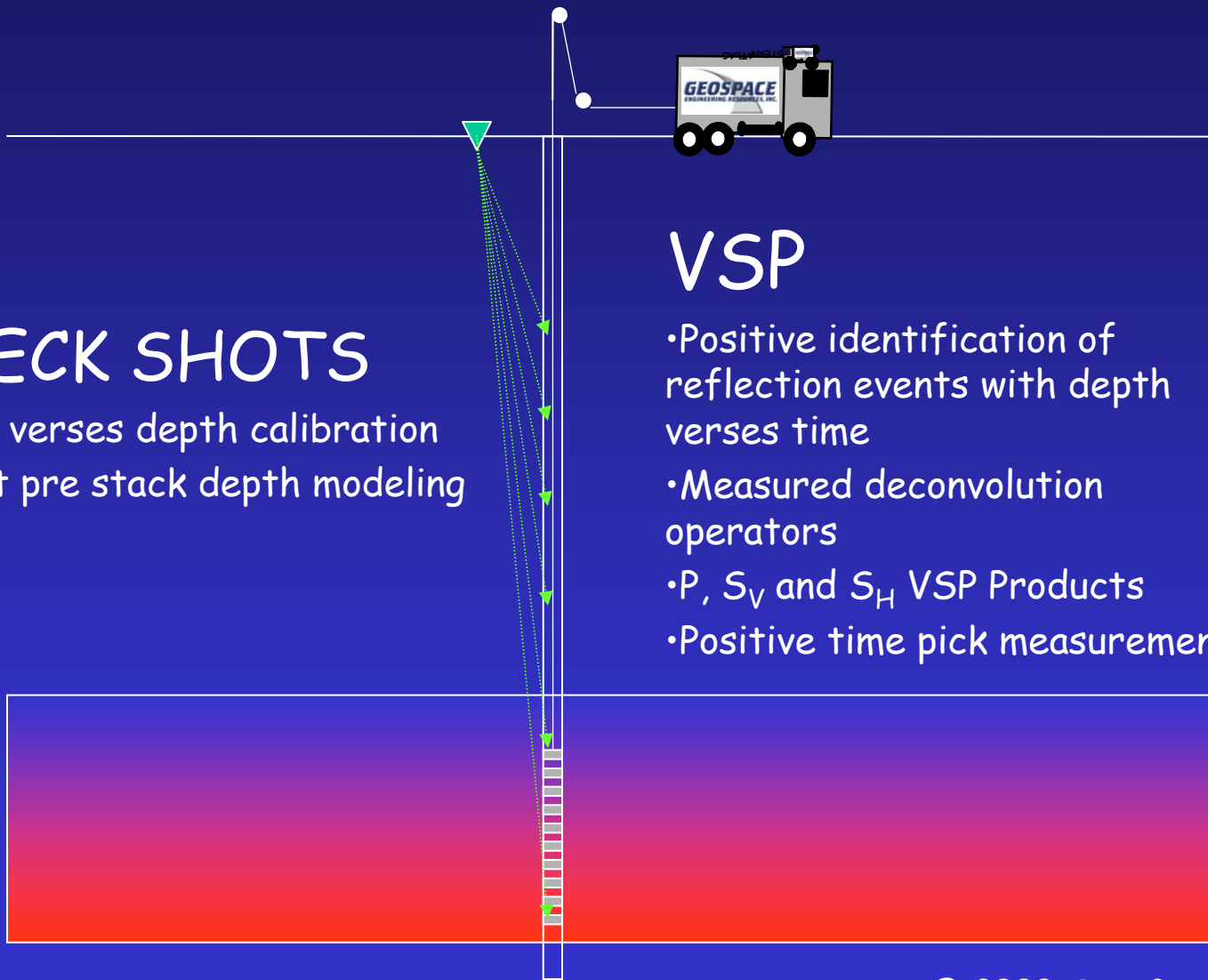
Check shot VSP

CHECK SHOTS

- Time verses depth calibration
- Input pre stack depth modeling

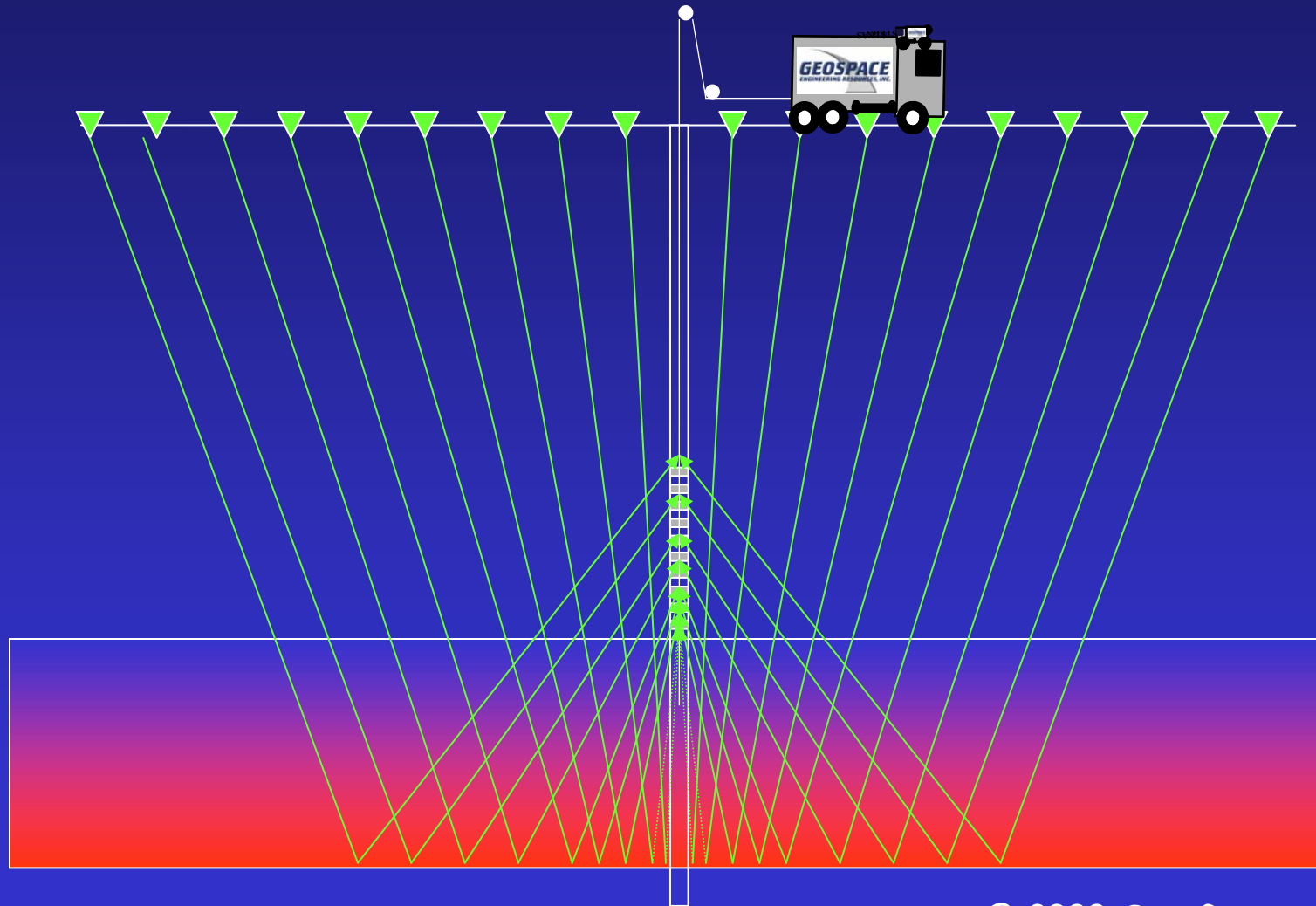
VSP

- Positive identification of reflection events with depth verses time
- Measured deconvolution operators
- P , S_V and S_H VSP Products
- Positive time pick measurement



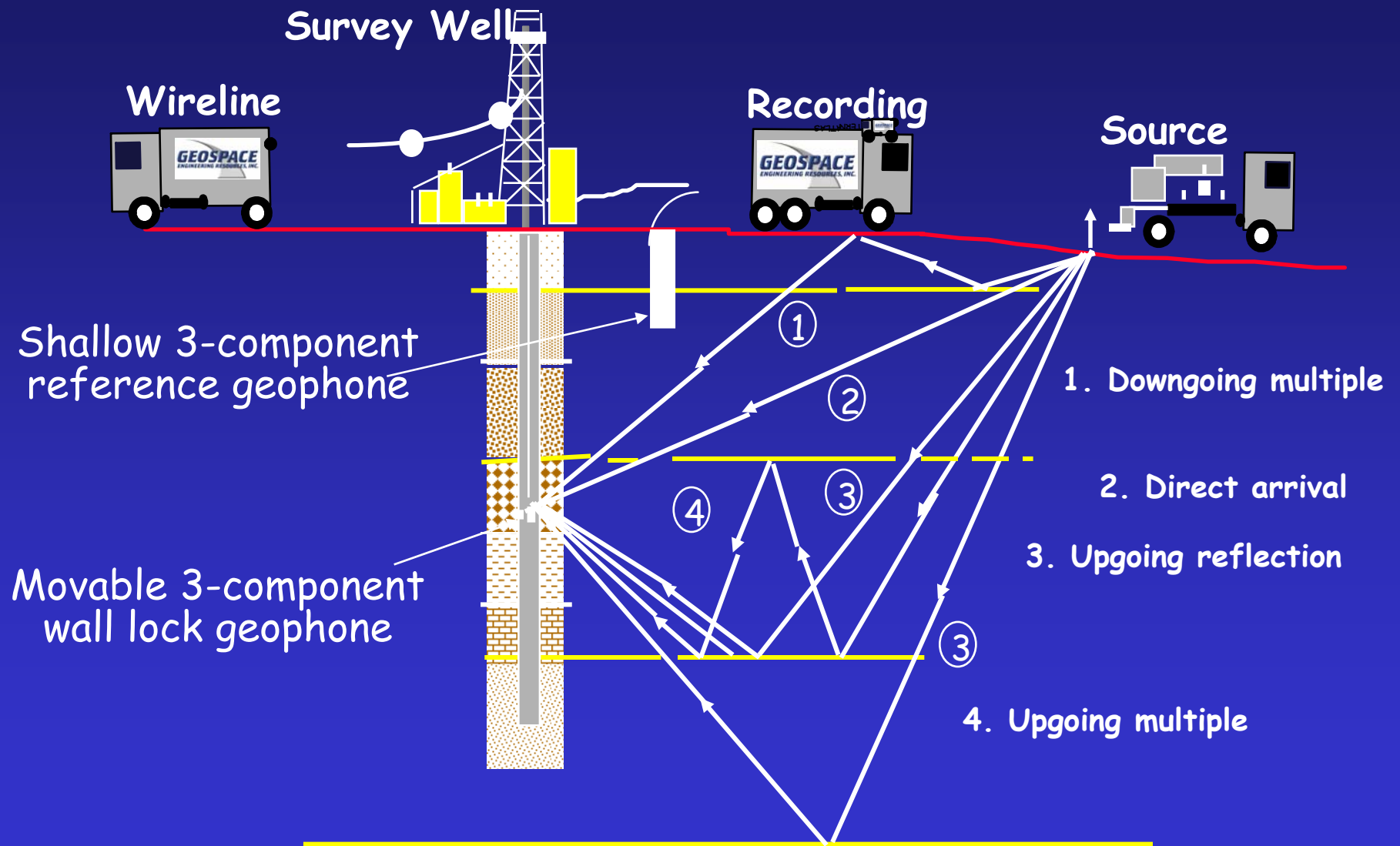
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3D VSP & walkaway Standalone or simultaneous



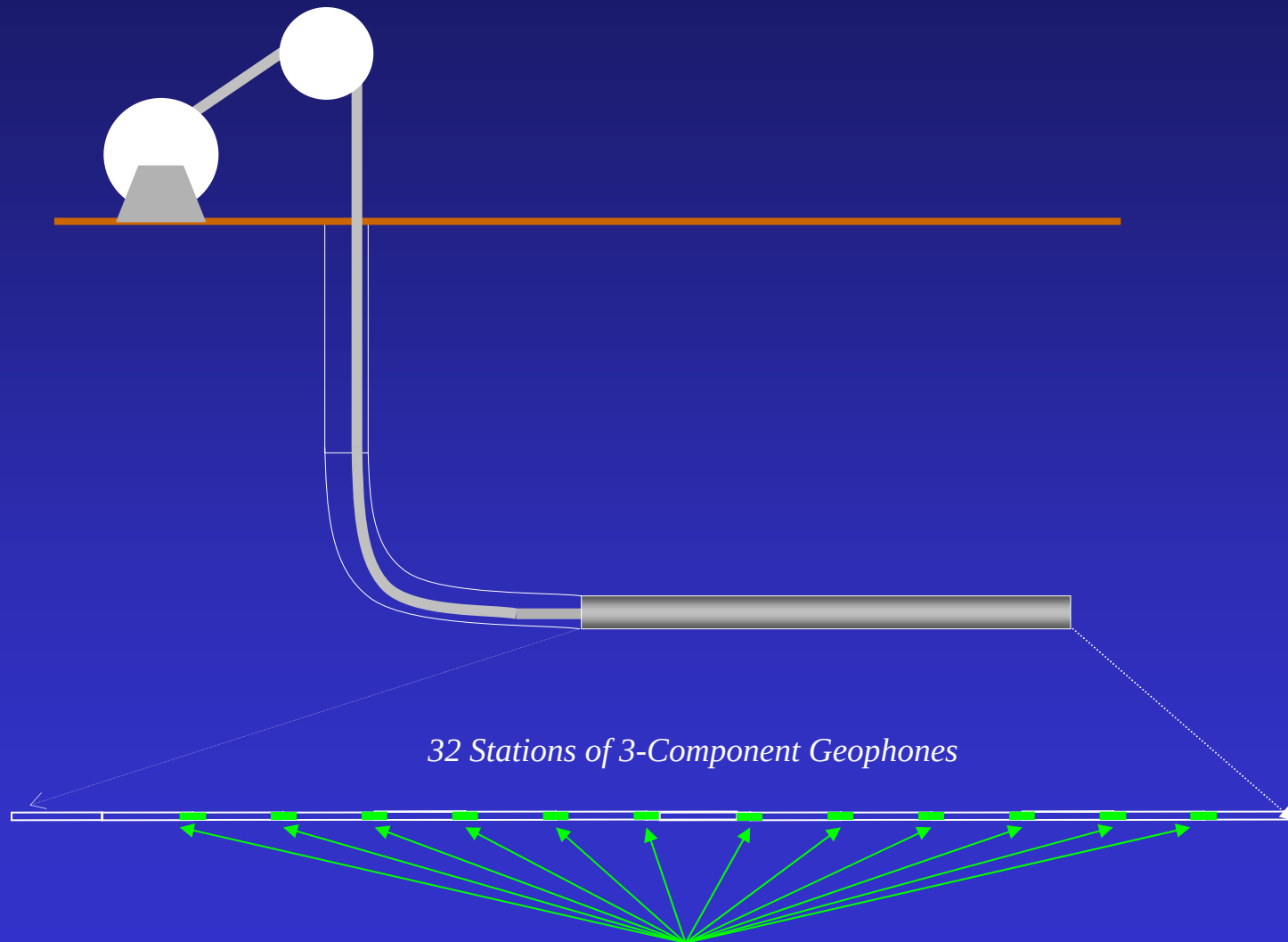
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BOREHOLE SEISMIC SCHEMATIC



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SeisTube in horizontal well



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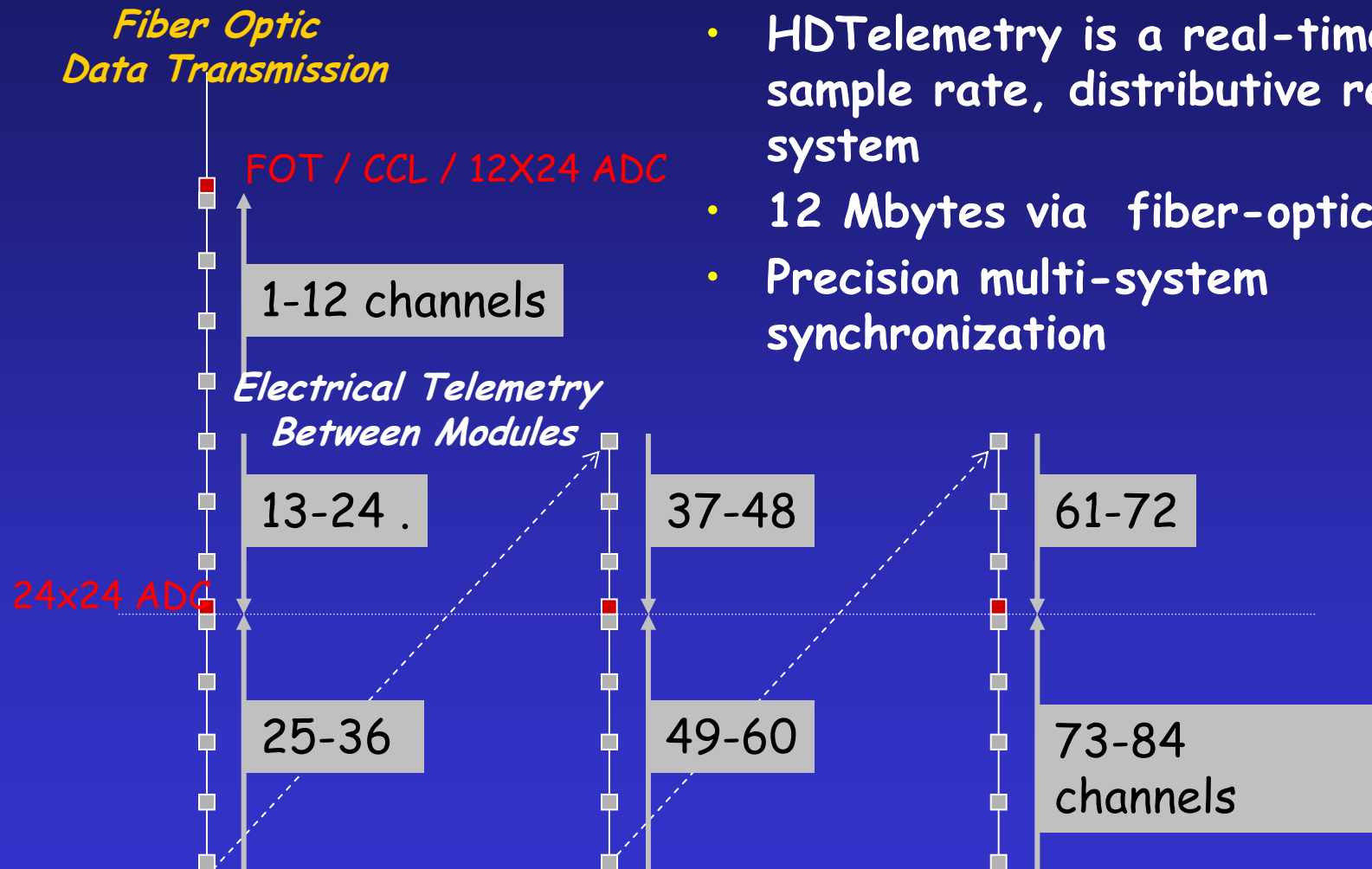
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High Definition Downhole seismic system

- HDTelemetry is a real-time, high sample rate, distributive recording system
- 12 Mbytes via fiber-optics
- Precision multi-system synchronization



HDSeis - distributive system



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- 12 Mbytes via fiber-optics
- Precision multi-system synchronization

High Definition Downhole seismic system

96 Channels configurations

Small
Aperture
•Xwell



Large
Aperture
•VSP
•3DVSP
•Micro-
Seismic



Hydrophone
Streamer
•XWell



Receiver
Array

Uniwell.
Single well



Downhole
Orbital
Vibrator



Downhole sources - comparison

Source	Bandwidth	Typical Range	Shots per Hour	Relative Cost
Air Gun	1,000 Hz	< 2000 Meters	500	\$15K per day
PZT	10,000 Hz	< 250 Meters	3600	\$5K per day
Orbital Vibrator ***	400 Hz	< 750 Meters	240	\$5K per day
Axial Vibrator	250 Hz	< 3000 Meters	15	\$75K per day

*** Minimizes Tube Wave Generation in Borehole

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High Definition Downhole Orbital Vibrator

- Exclusive license to manufacture & use DHOV from Conoco, Inc.
- Free-hanging device
- Energy produced by spinning eccentric masses
- 50 to 400 Hertz bandwidth
- Actual (True) sweep measured in tool
- Operates on standard 7-conductor wireline
- Crosswell tomography or uniwell

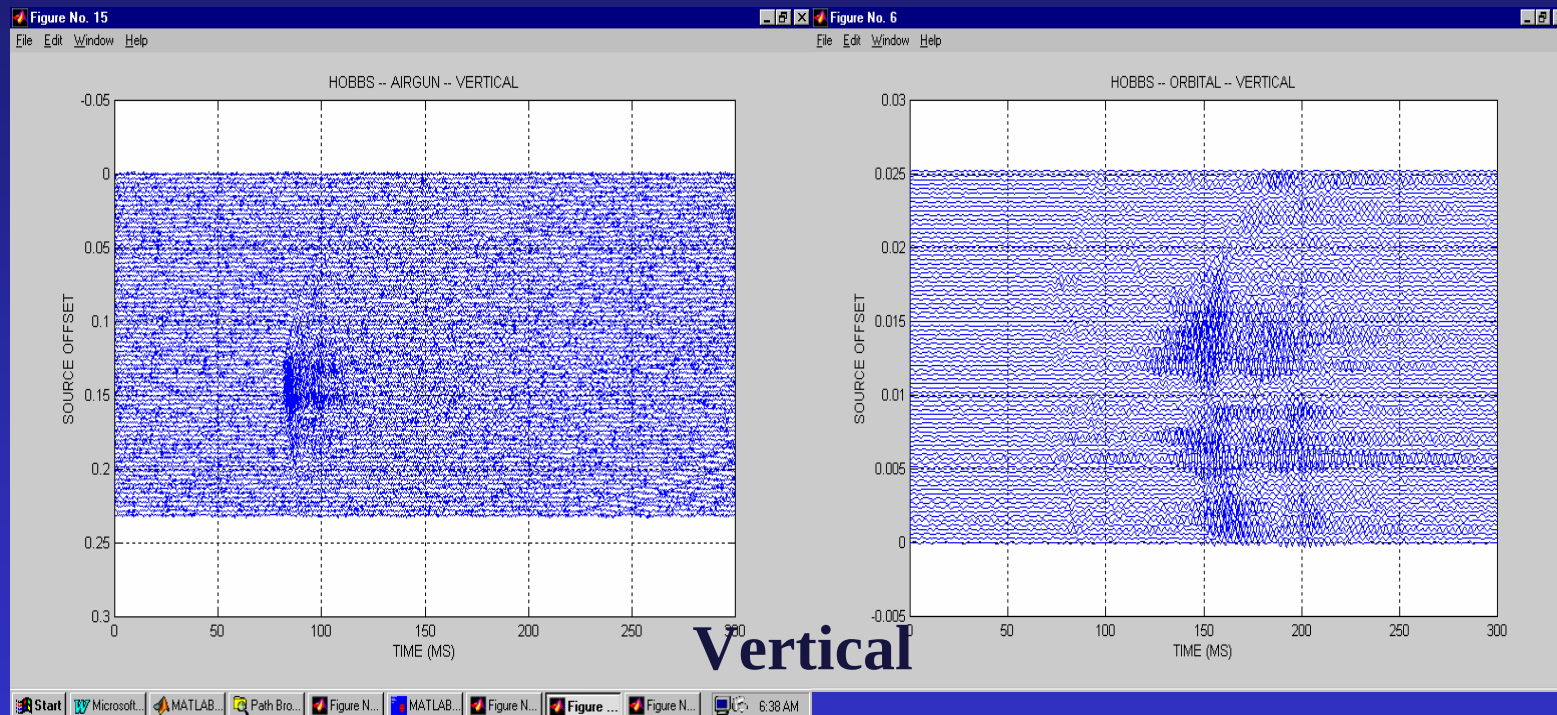


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Cross-well Common receiver gather

120 cu.in Air Gun

Orbital Vibrator



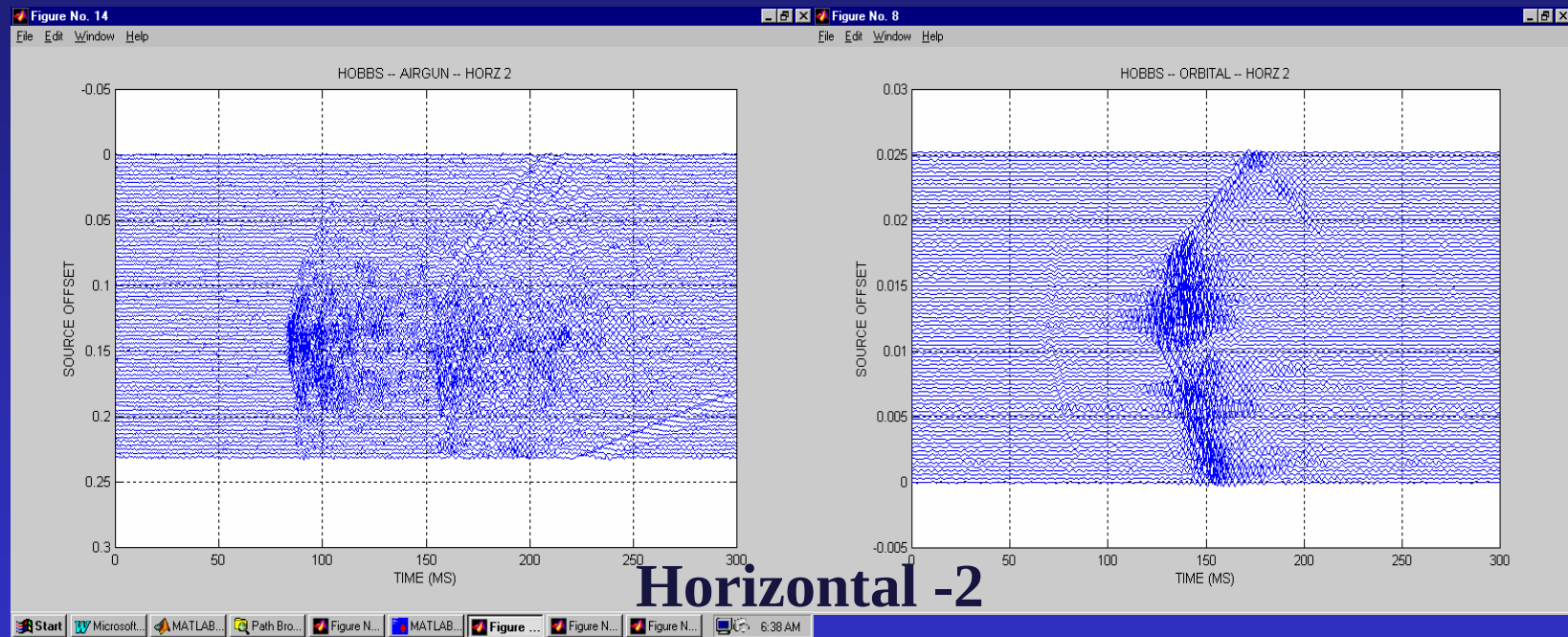
← Well Spacing ~ 460 meters →

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Cross-well Common receiver gather

120 cu.in Air Gun

Orbital Vibrator



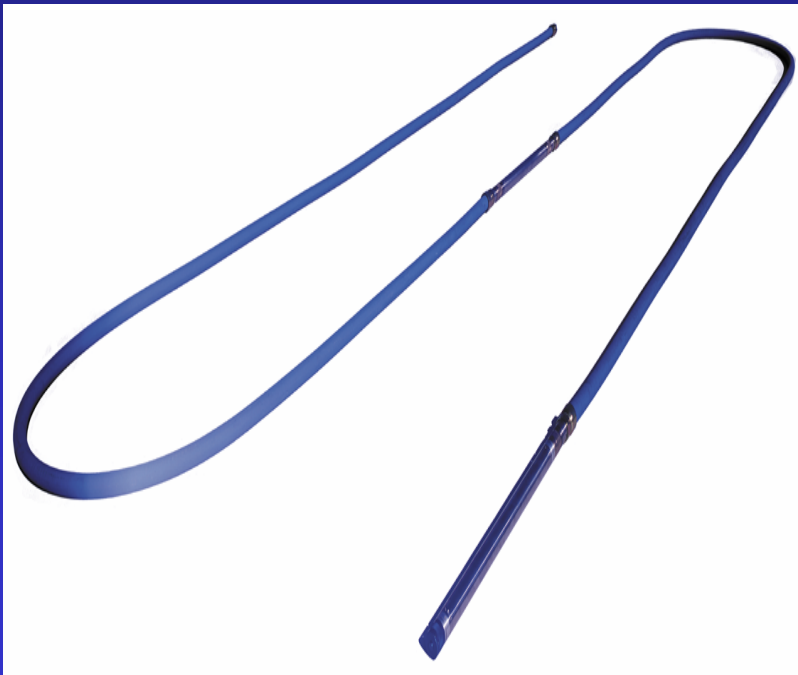
Well Spacing ~ 460 meters

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Borehole Tools

Retrievable sensor options

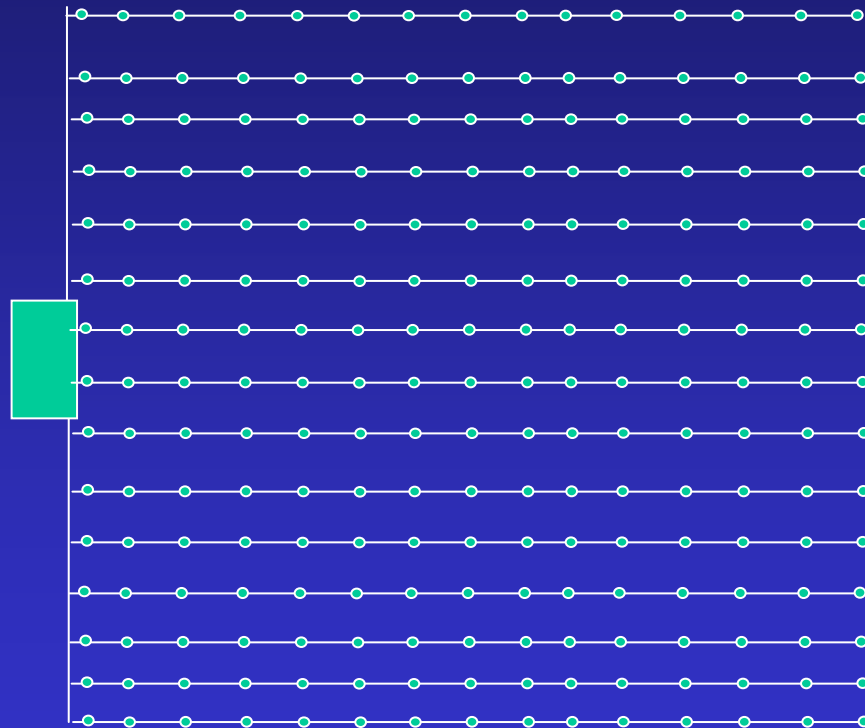
- Hydrophone streamer



- Oil-filled streamer
- DEEP-ENDER 5000 hydrophone with pre-amp

Permanently installed Receiver layout

Platform



**4-Component
Receiver Grid**

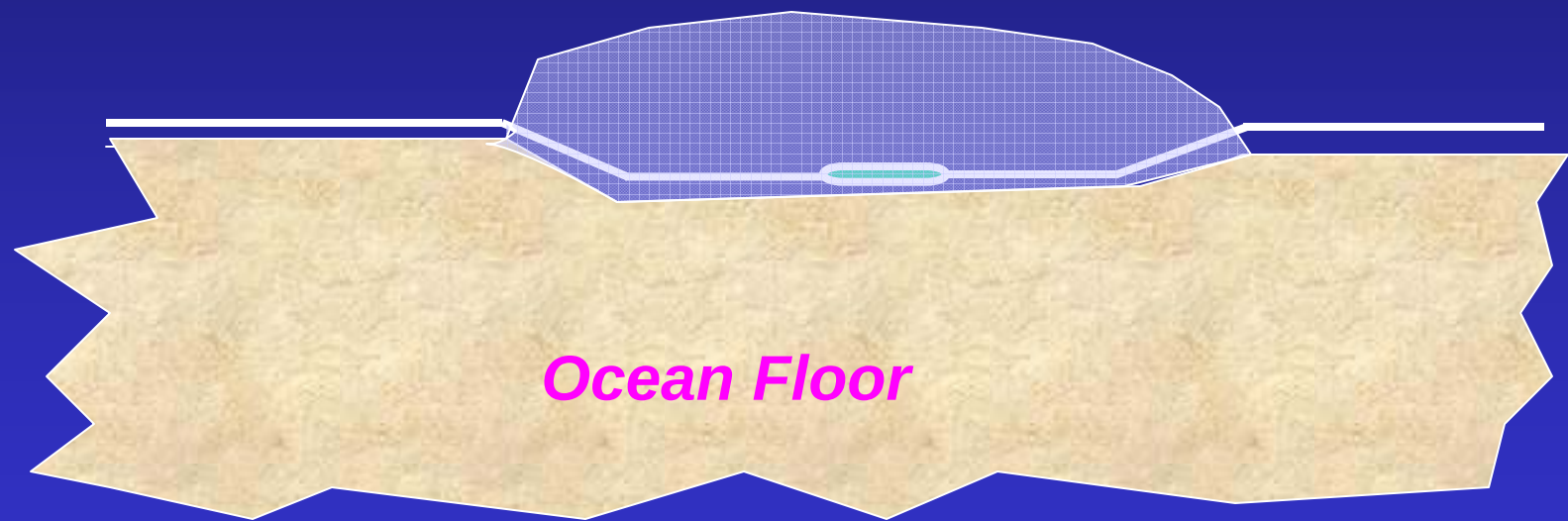
7 km x 7 km

**250m phone
spacing**

**500 m line
spacing**

1710 channels

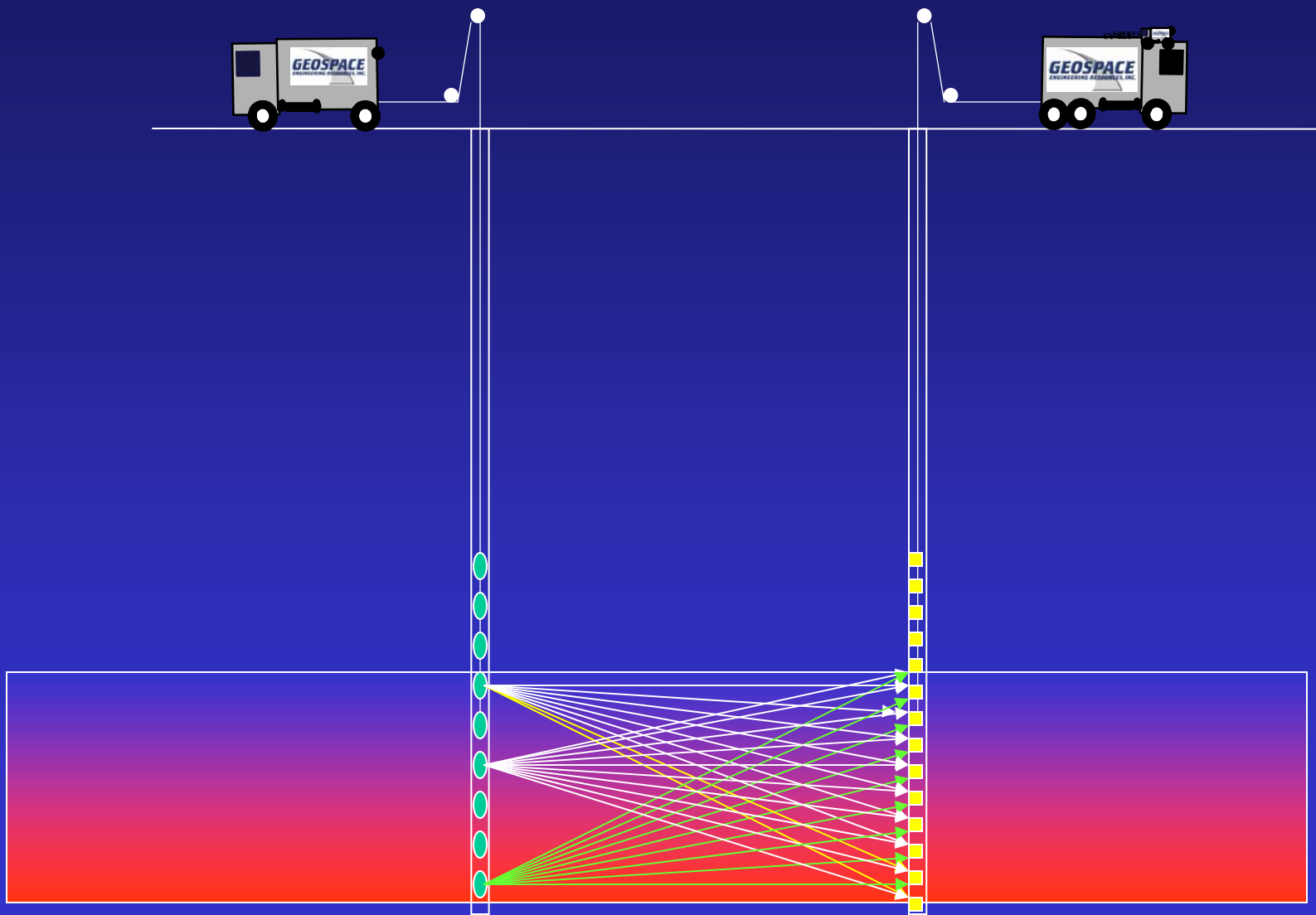
ROV entrenched receivers



Outline

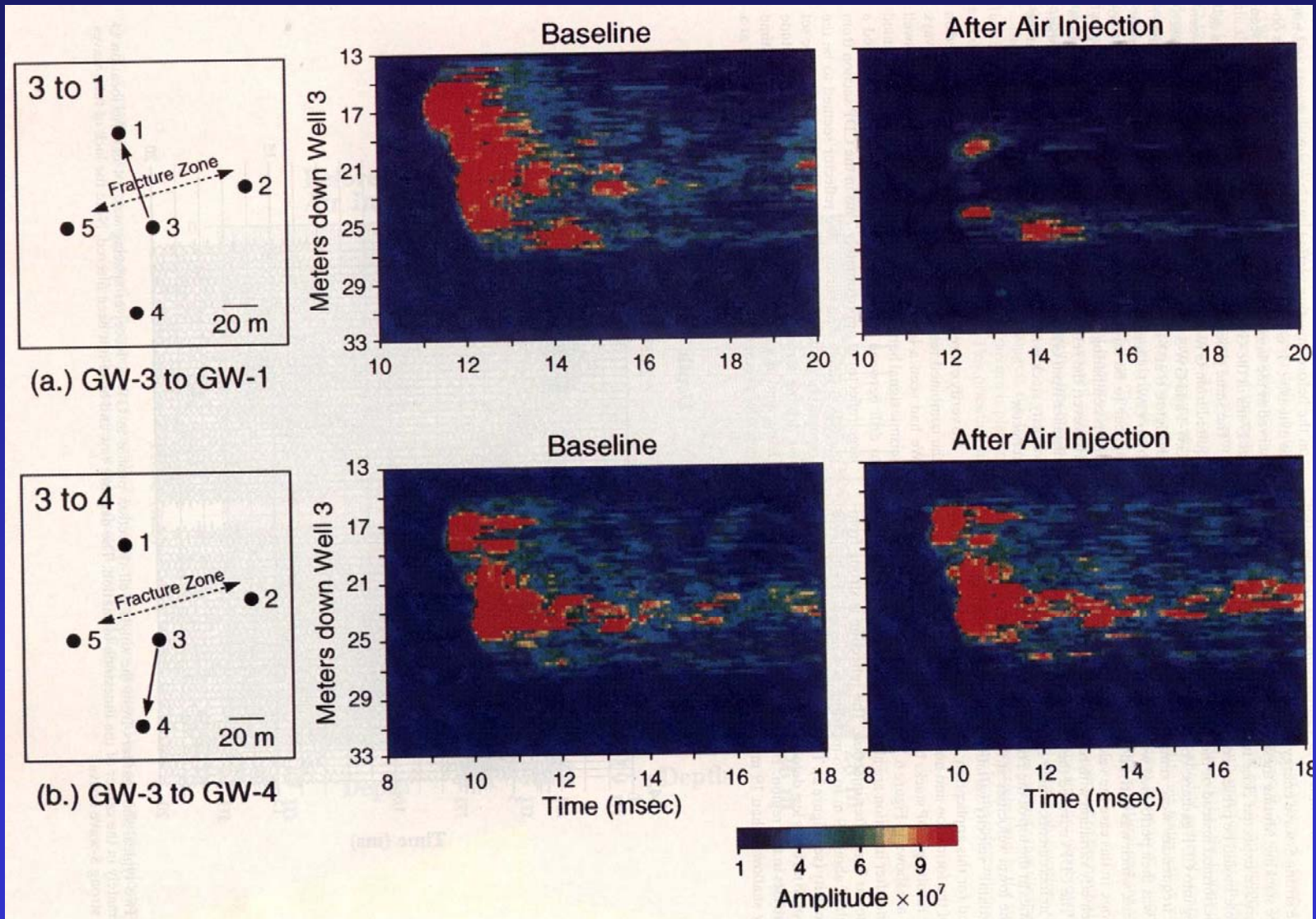
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Cross well



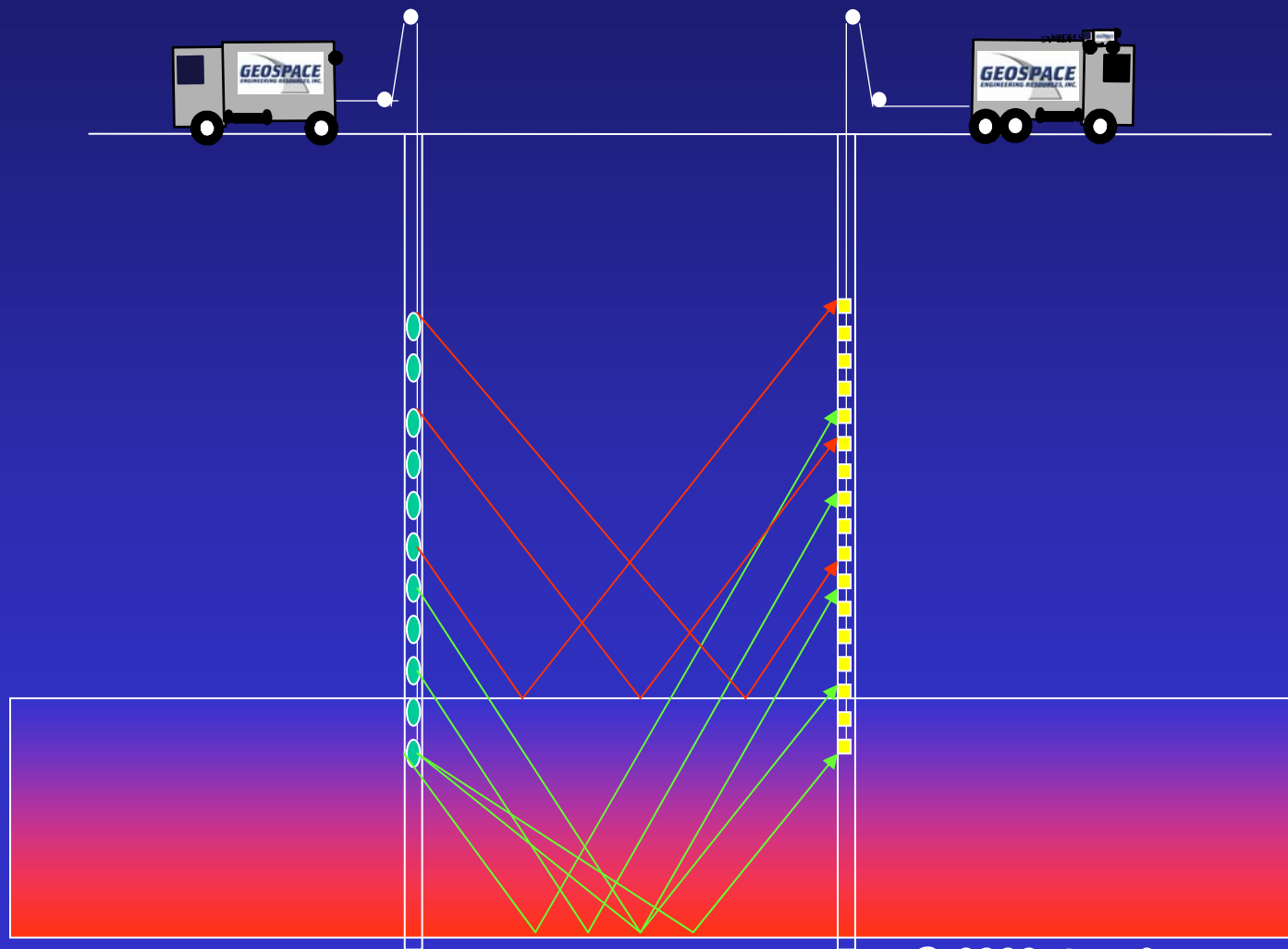
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Crosswell example (Majer 1997)



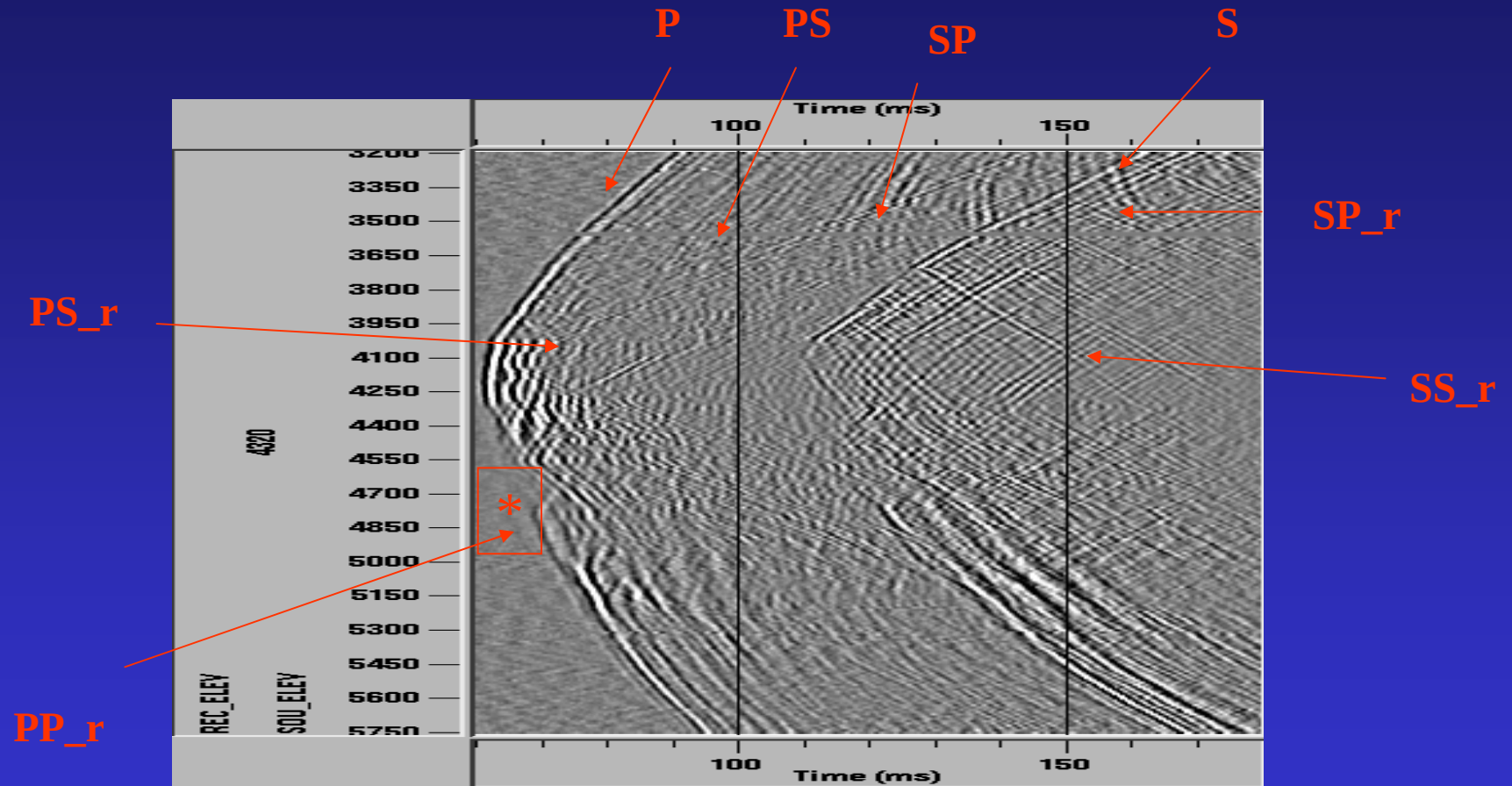
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Reflection tomography



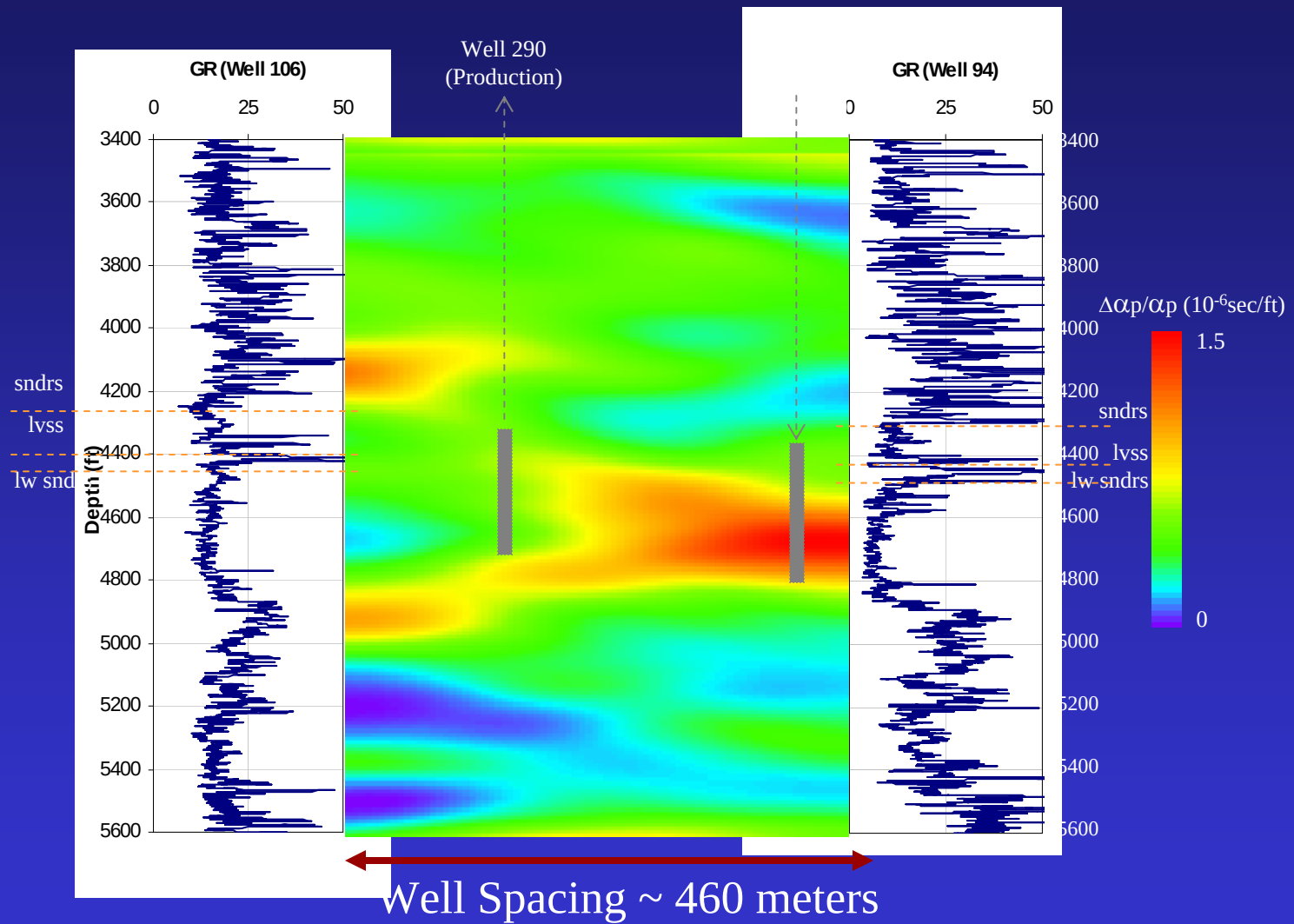
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Tomography data example



Courtesy of Texaco Inc.
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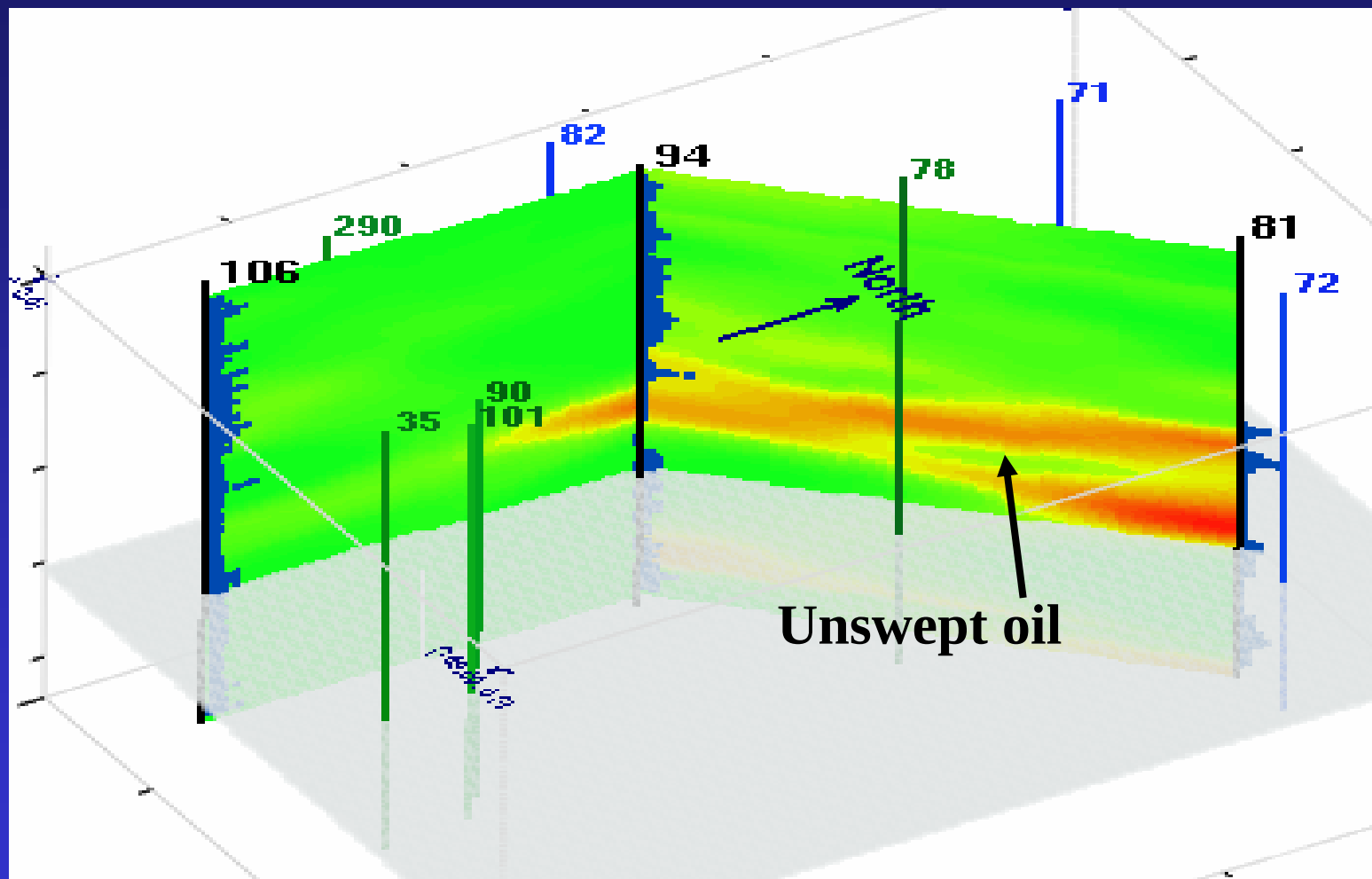
Cross-well tomography example



Courtesy of Texaco Inc.

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Spliced section



Courtesy of Texaco Inc.

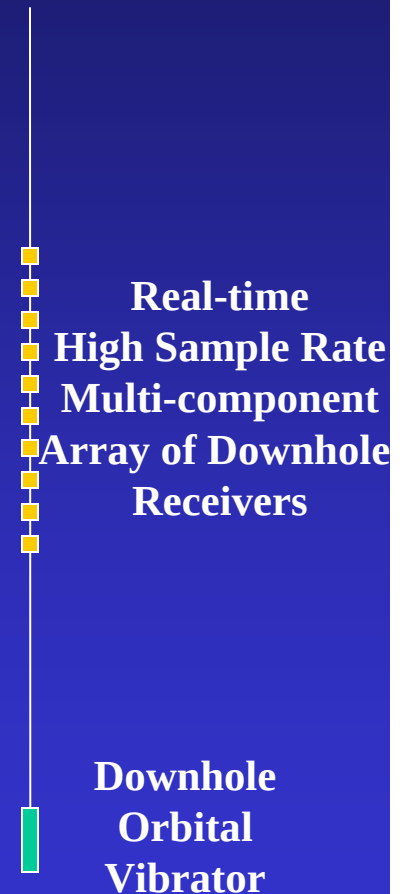
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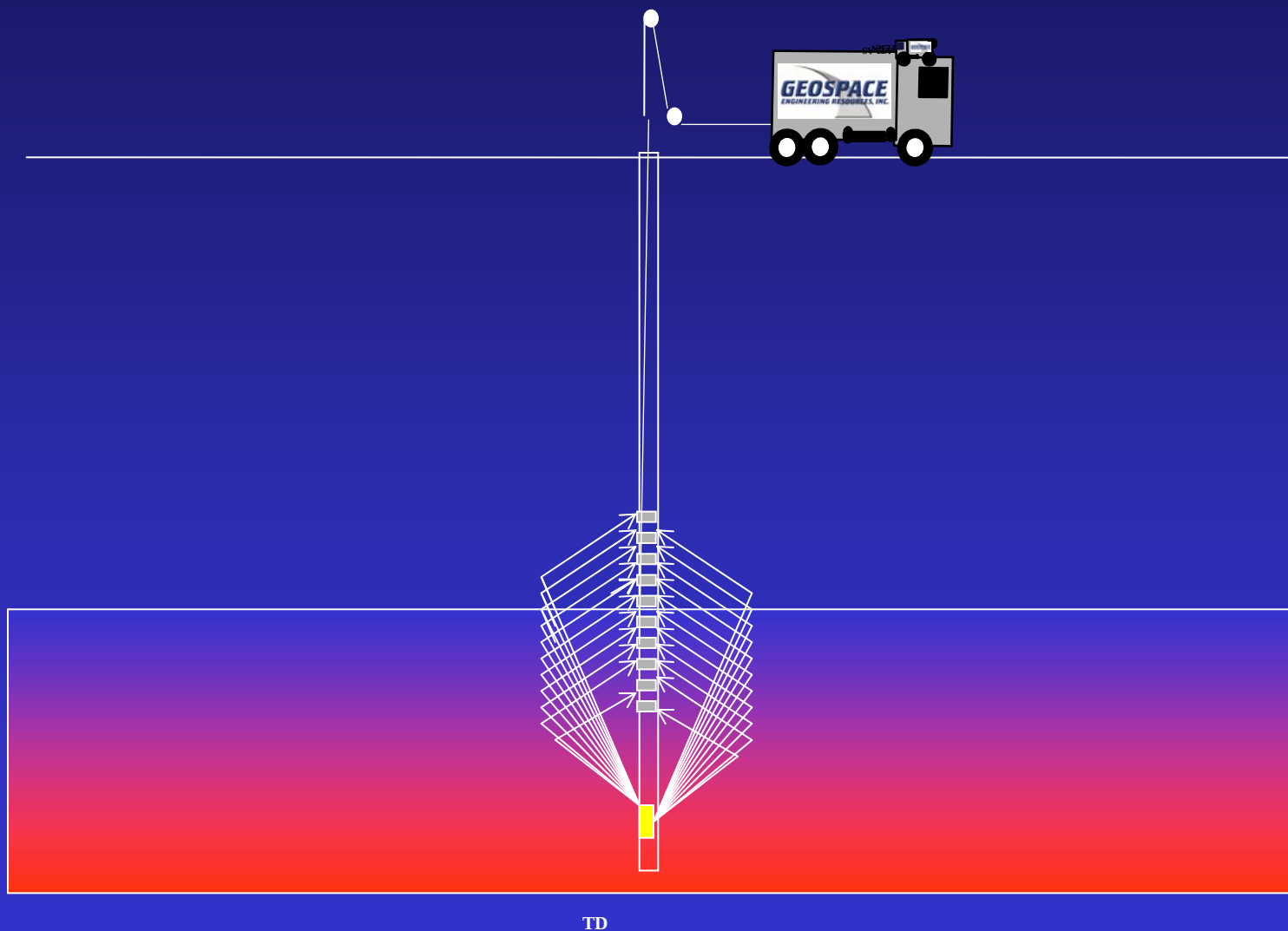
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Single well seismic system

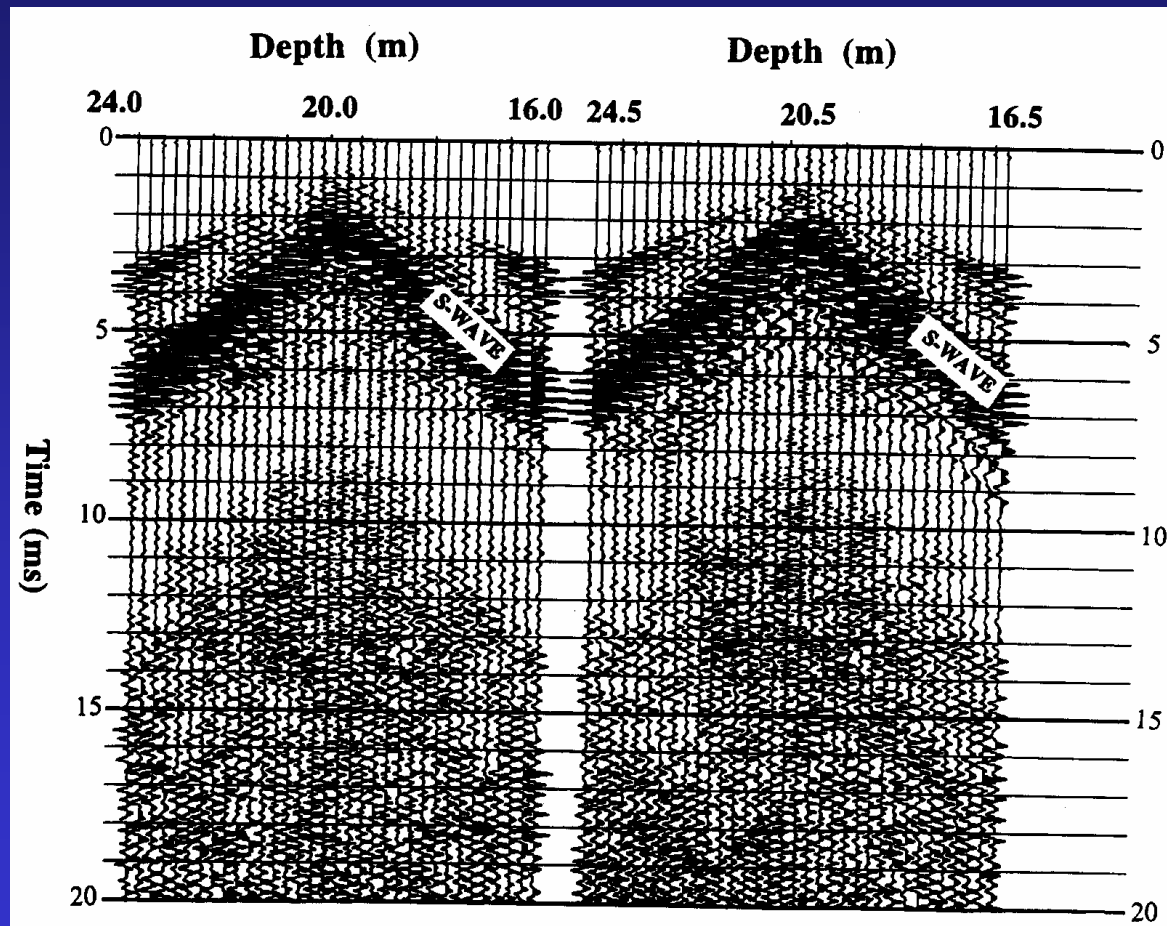
- Time lapse reservoir monitoring
- Horizontal wells (steering, FE)
- Vertical wells (proximity, bypassed production)
- Orbital Vibrator minimized tube wave
- Uniwell or Single-well technique was developed by consortia (Edingburg, SIC)



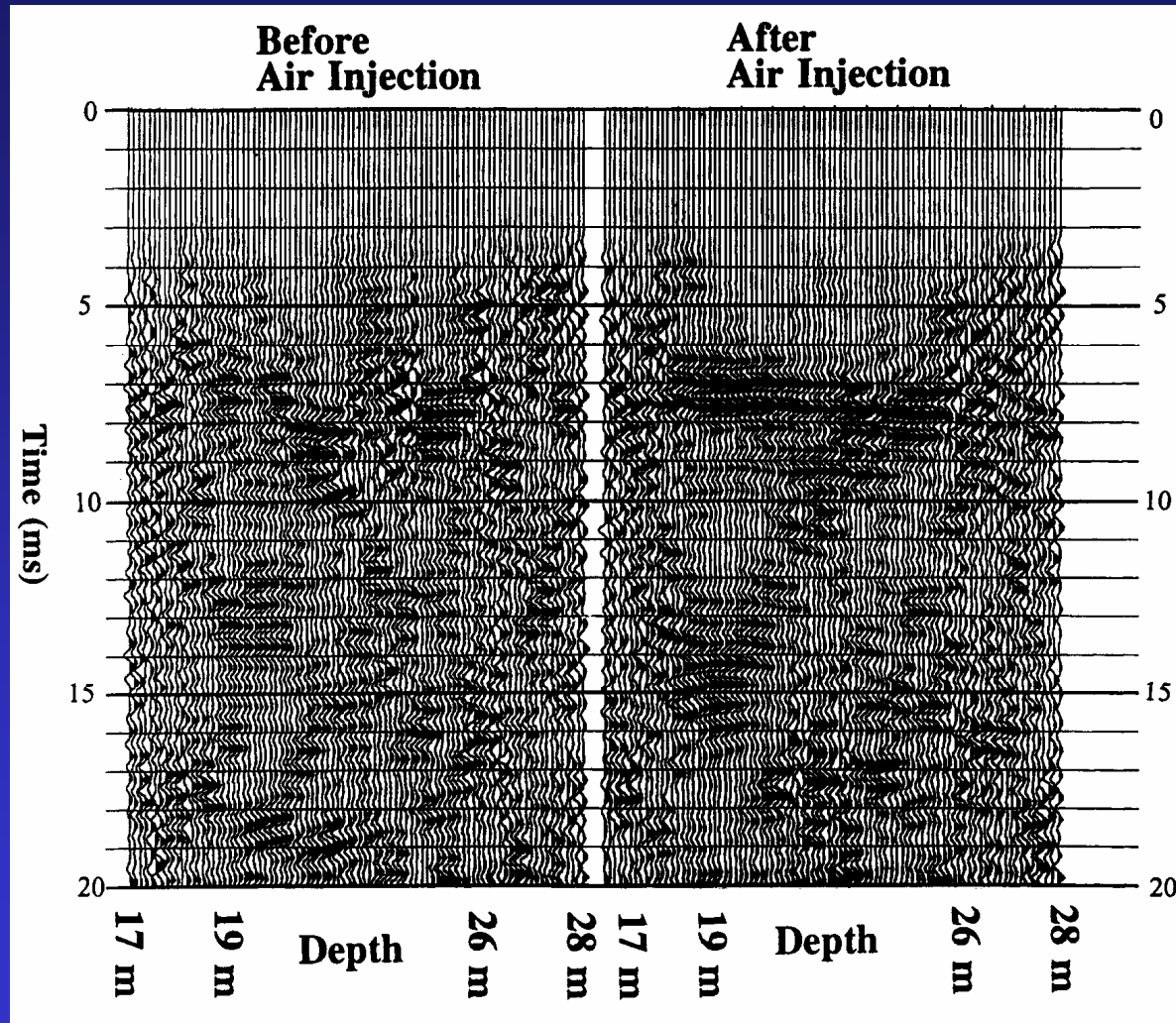
Single Well acquisition



Single well: shot gather



Single well: time lapse



Fracture drilled afterwards



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Summary

- BHS improves productivity via multi-level
- 24 bit gives better S/N
- Optical wireline allows real time recording
- Crosswell faster w/ more data
- Large aperture frac monitoring is a breeze
- Single well possible w/ Orbital vibrator

Acknowledgements

We thank Texaco for data. Amoco, Texaco, Exxon and Conoco. These collaborations were essential for the technology. Salt imaging consortium and Uniwell consortium supported single well field trials. E. Majer, M. Sheen, P. Underwiesen and others a special thanks

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