Preliminary analysis of a crosswell seismic dataset: Noel tight gas field, British Columbia

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CREWES

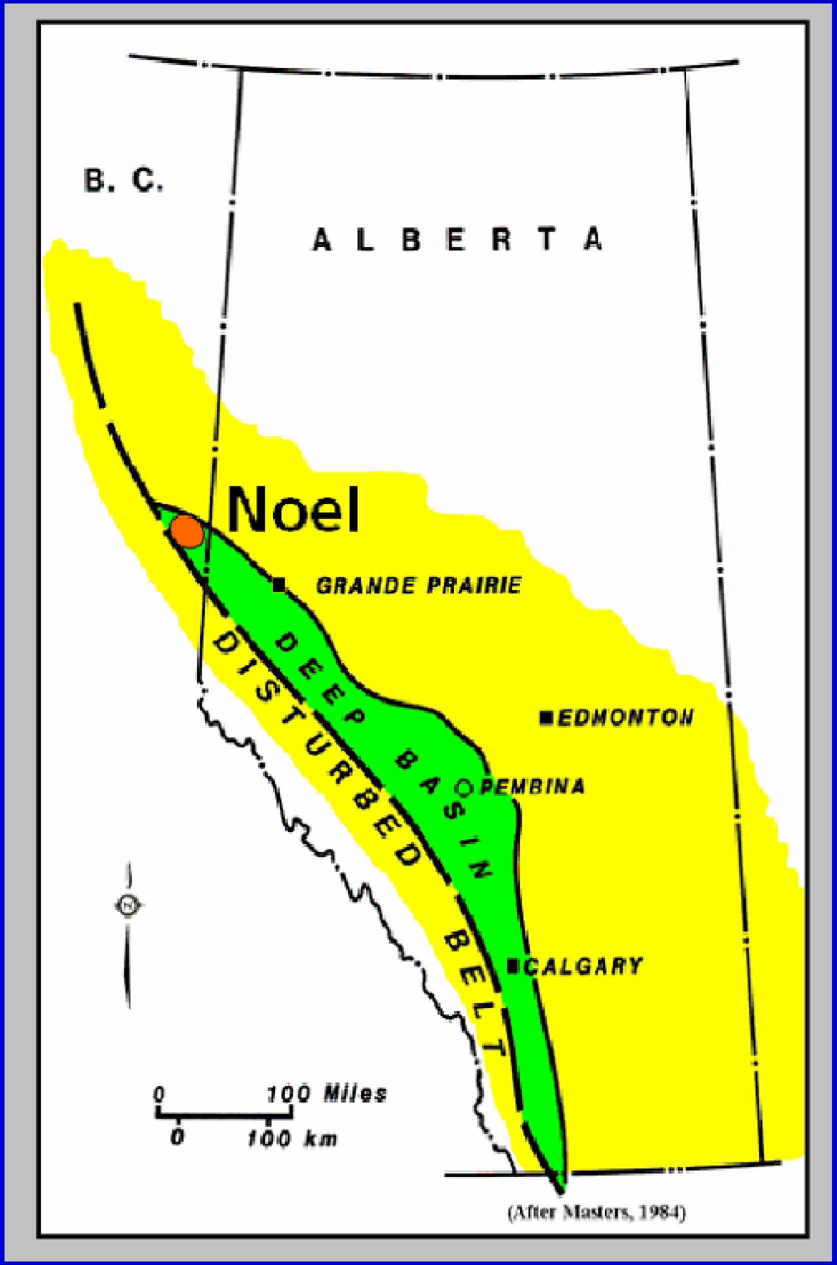
OUTLINE OF PRESENTATION

- INTRODUCTION
- FIELD ACQUISITION
- PRELIMINARY RESULTS
- FUTURE WORK
- CONCLUSION

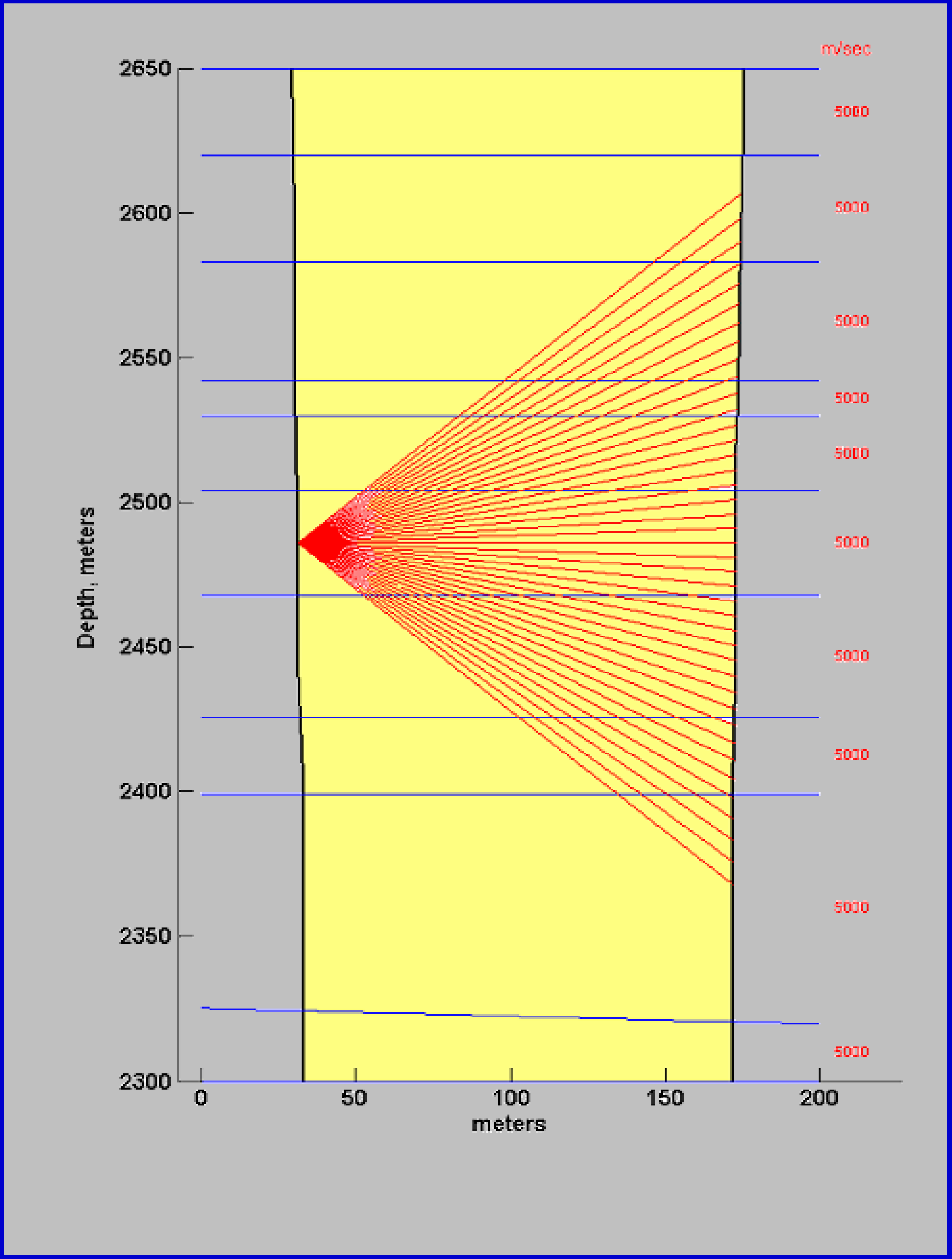
INTRODUCTION

- ***Purpose: high-resolution seismic imaging of tight gas sand channels at depths of 2400-2600m.***

Crosswell seismic survey location in NE British Columbia



Schematic diagram of crosswell seismic surveying



ACQUISITION

- ***Piezoelectric source***
- ***Hydrophone receivers***
- ***Moving source : 10m/minute***
- ***Source interval for recording = 0.75m***
- ***Receiver spacing = 1.5m***

ACQUISITION

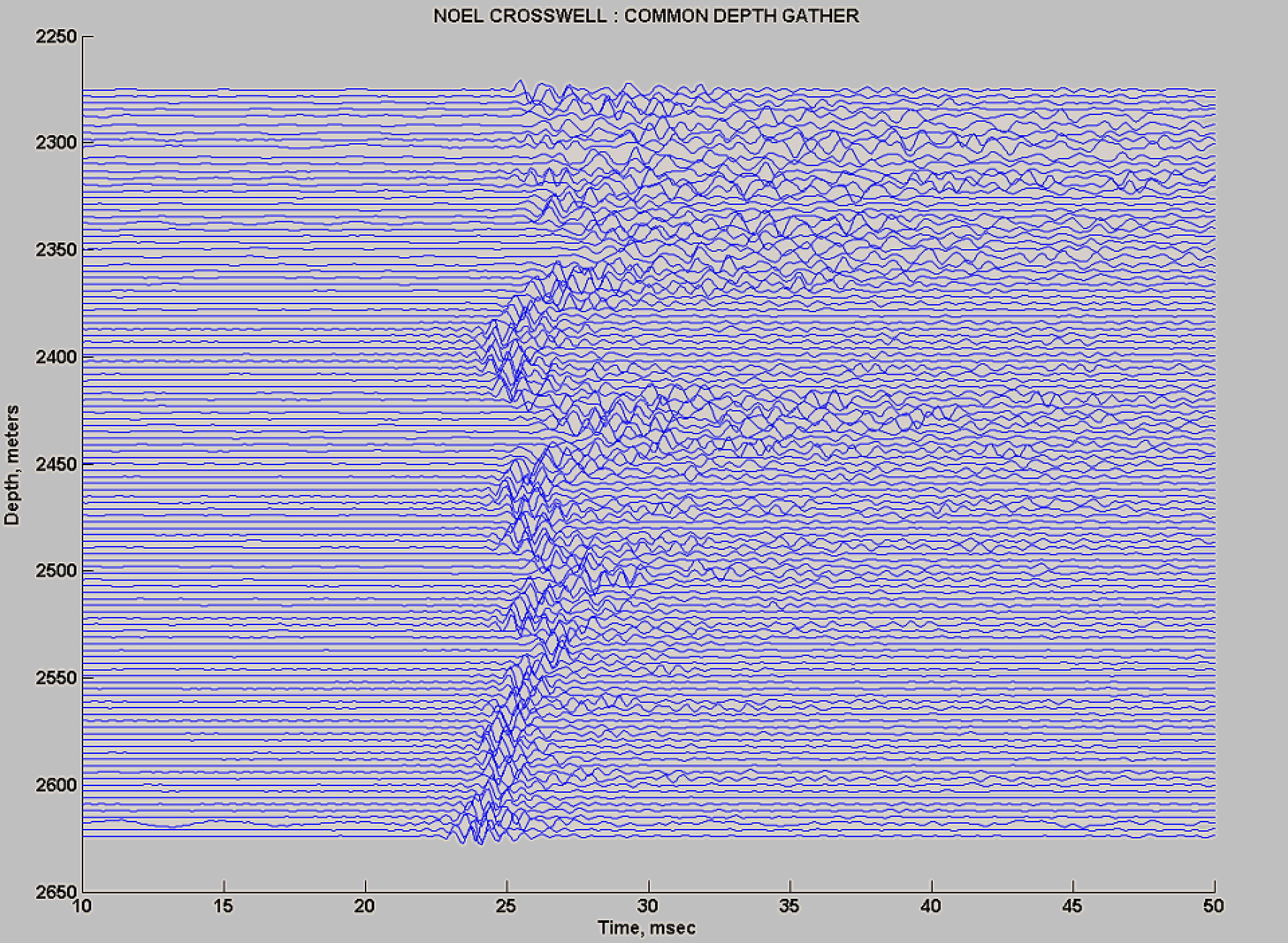
- ***1.1 second sweep 100 to 2000 Hz***
- ***1.6 second listen***
- ***0.125 msec sampling***

Preliminary processing includes :

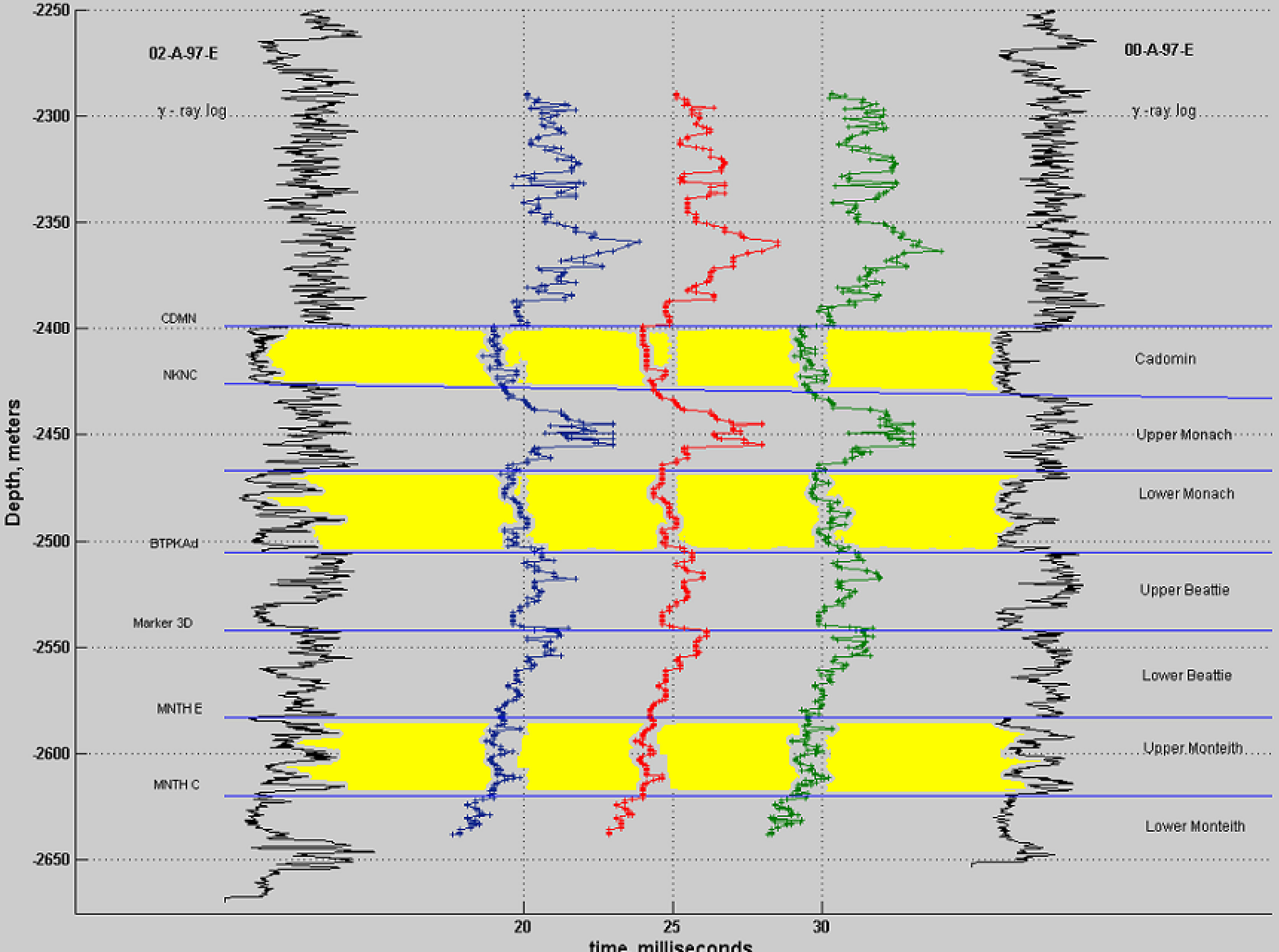
- *Crosscorrelation;*
- *sorting and display of gathers;*
- *first arrival time picking;*
- *ties to geology and gamma logs;*
- *creation of velocity tomogram.*

RESULTS

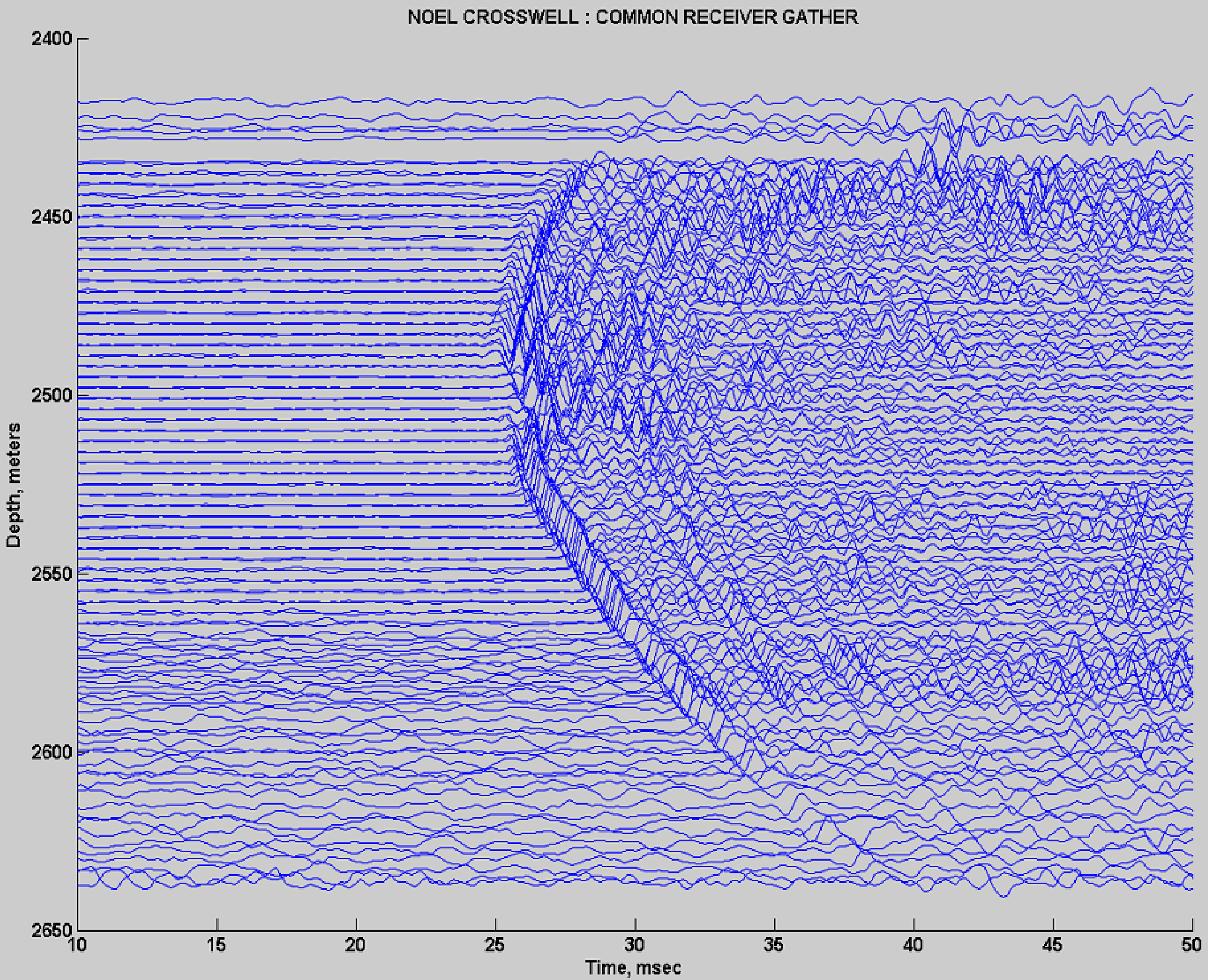
- ***The next slide shows a common depth gather, indicating that the data is of high quality***
- ***The following slide compares the natural gamma ray logs in the two wells with the first arrival times (three different estimates; the middle profile goes with the time scale) of the common depth gather.***
- ***Also shown are the geological formations and boundaries. The target zones of exploration interest, the sands of the Cadomin, Lower Monach, and Upper Monteith formations, are high-lighted in yellow.***
- ***The correlation of first arrival times with gamma ray response and geology is excellent.***


NOEL CROSSWELL : COMMON DEPTH GATHER
Depth, meters
Time, msec
2250
2300
2350
2400
2450
2500
2550
2600
2650
10
15
20
25
30
35
40
45
50

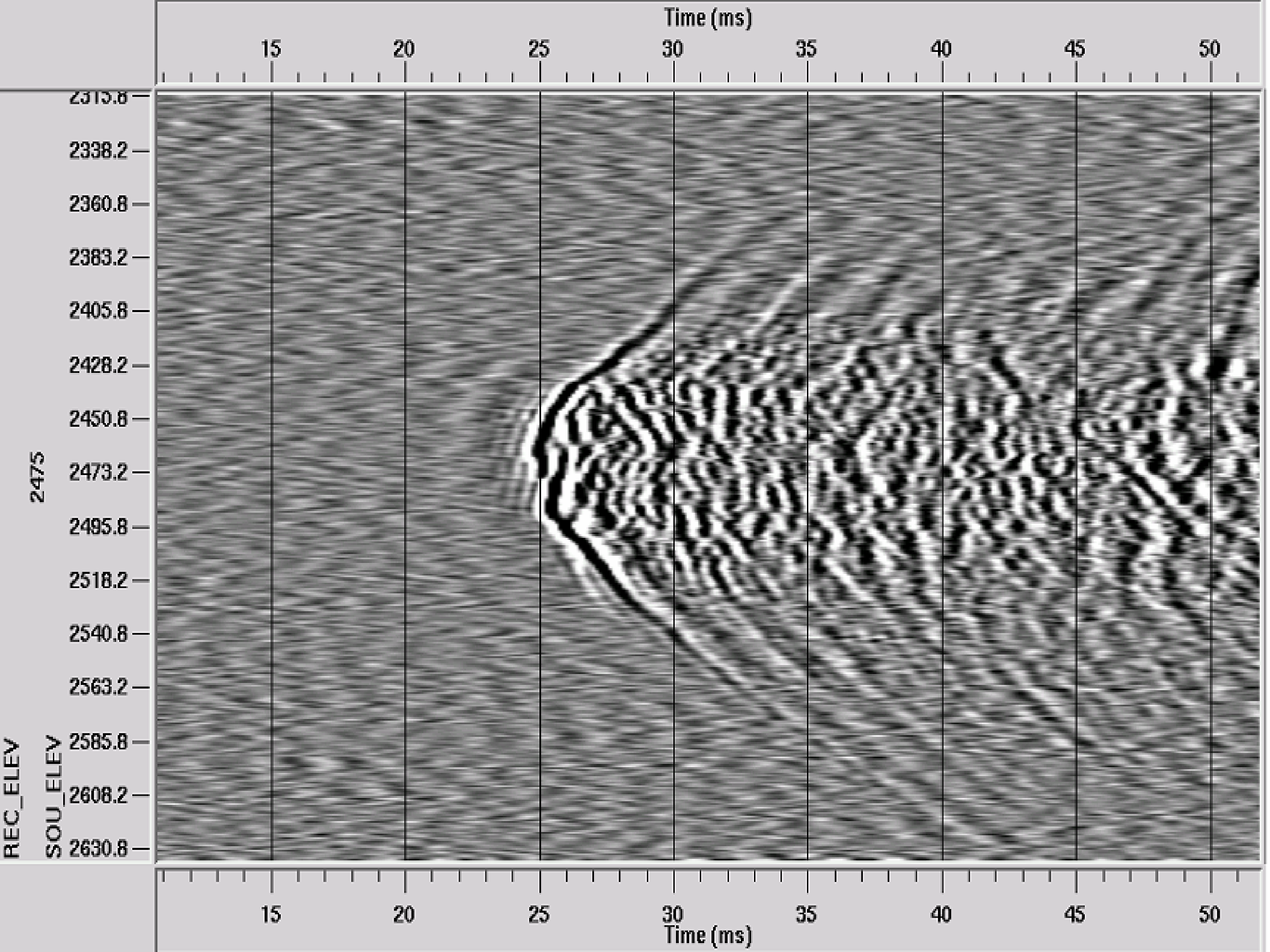
First Arrival Times, Horizontal Rays



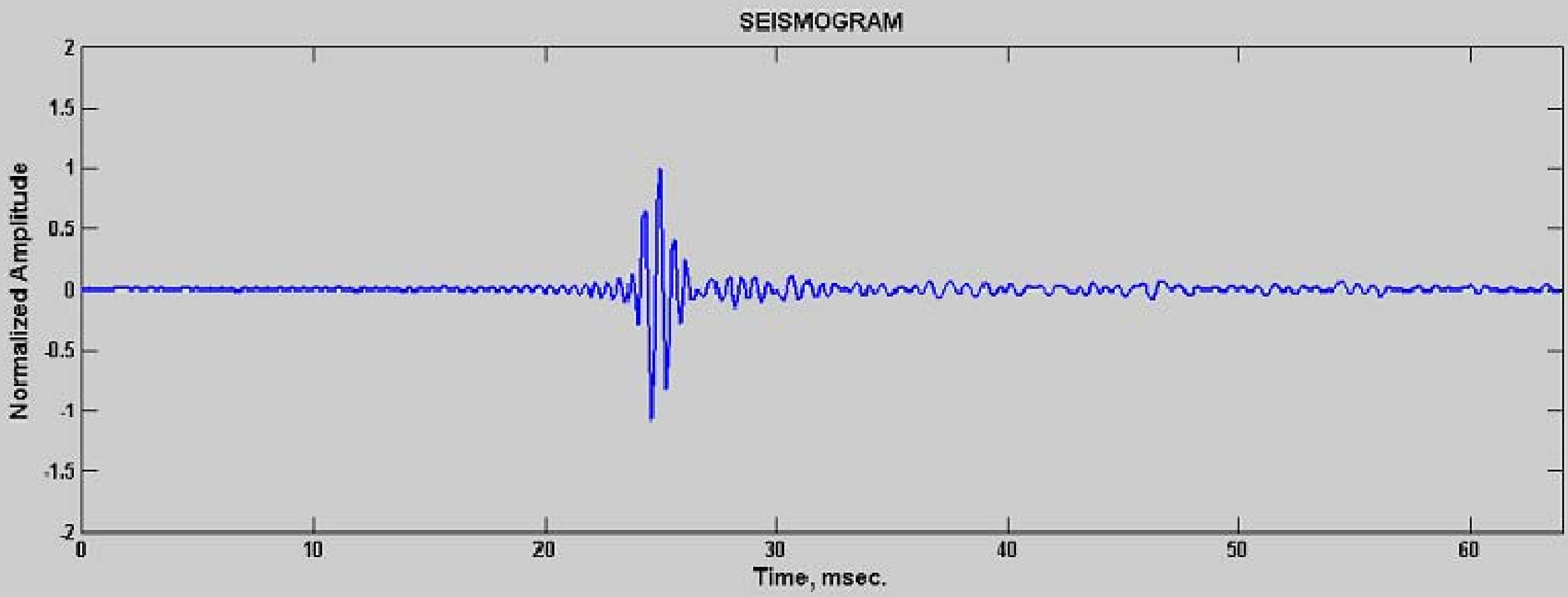
- ***The next two slides shows common receiver gathers.***
- ***The first CRG is a wriggle trace plot; the second CRG is a variable density grey scale display and shows a remarkable amount of detail.***
- ***The spectrum of a typical seismic trace is shown next. There is energy in the 100 to 1500 Hz range, with dominant frequencies about 1700 Hz.***
- ***The potential of this dataset for very high resolution imaging is great.***

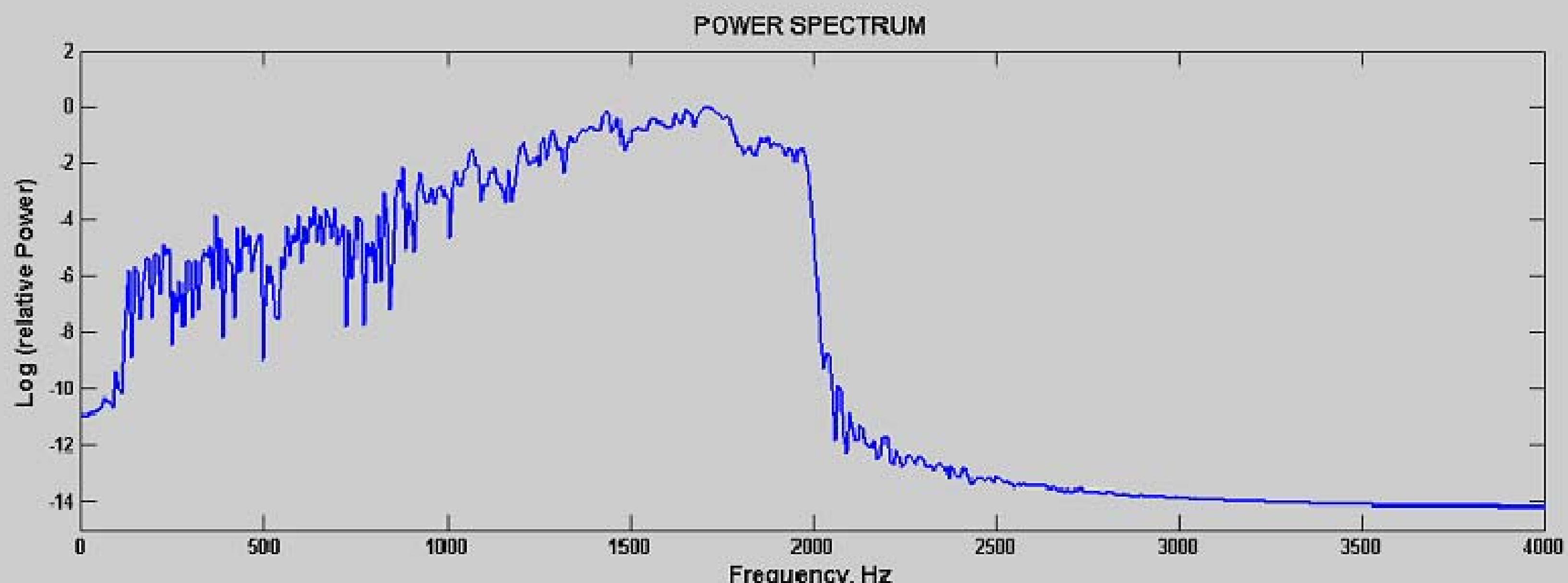


NOEL CROSSWELL : COMMON RECEIVER GATHER
Depth, meters
2400
2450
2500
2550
2600
2650
Time, msec
10
15
20
25
30
35
40
45
50

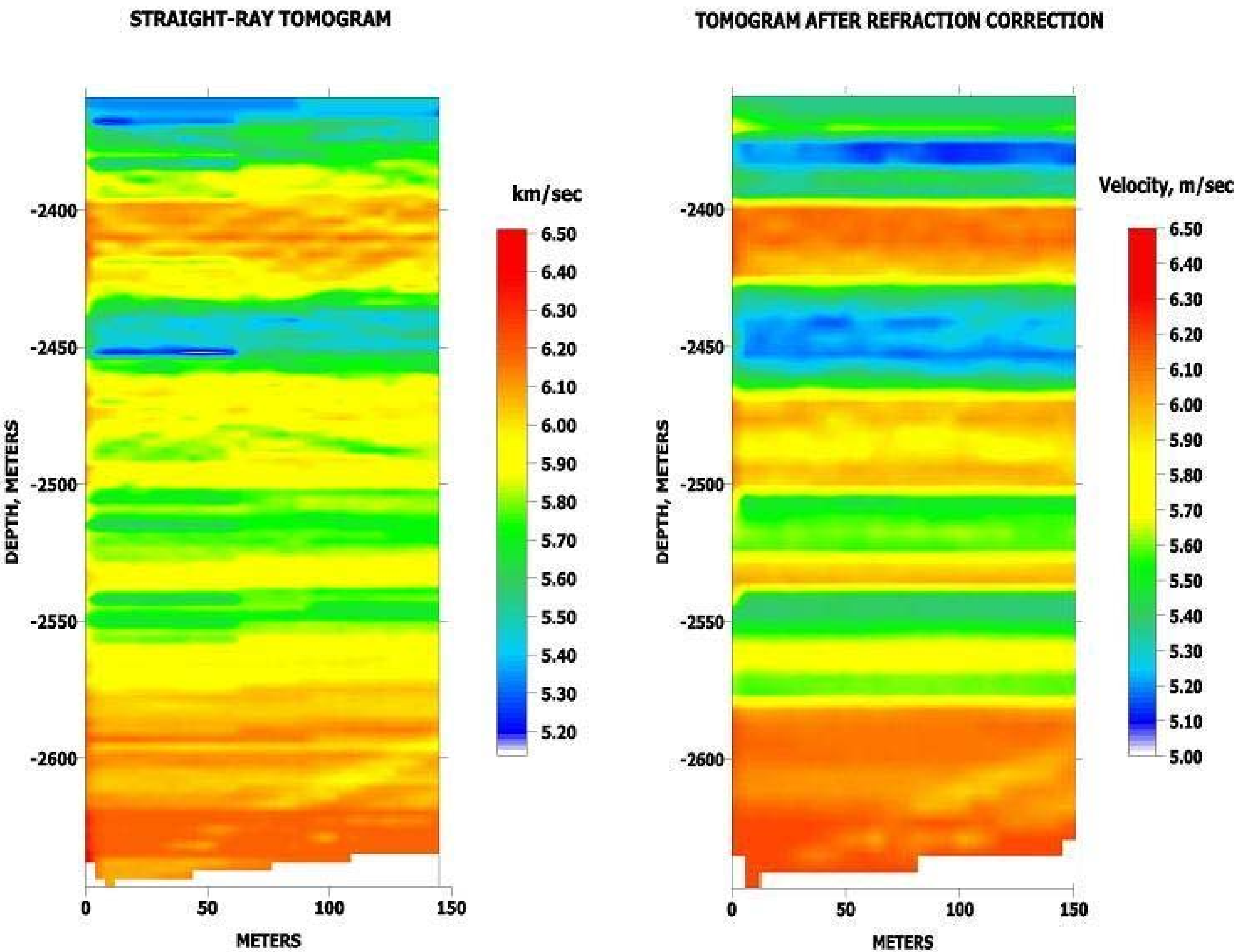


Time (ms)
15
20
25
30
35
40
45
50
2315.8
2338.2
2360.8
2383.2
2405.8
2428.2
2450.8
2473.2
2495.8
2518.2
2540.8
2563.2
2585.8
2608.2
2630.8
2475
REC_ELEV
SOU_ELEV


SEISMOGRAM
Normalized Amplitude
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
10
20
30
40
50
60
Time, msec.

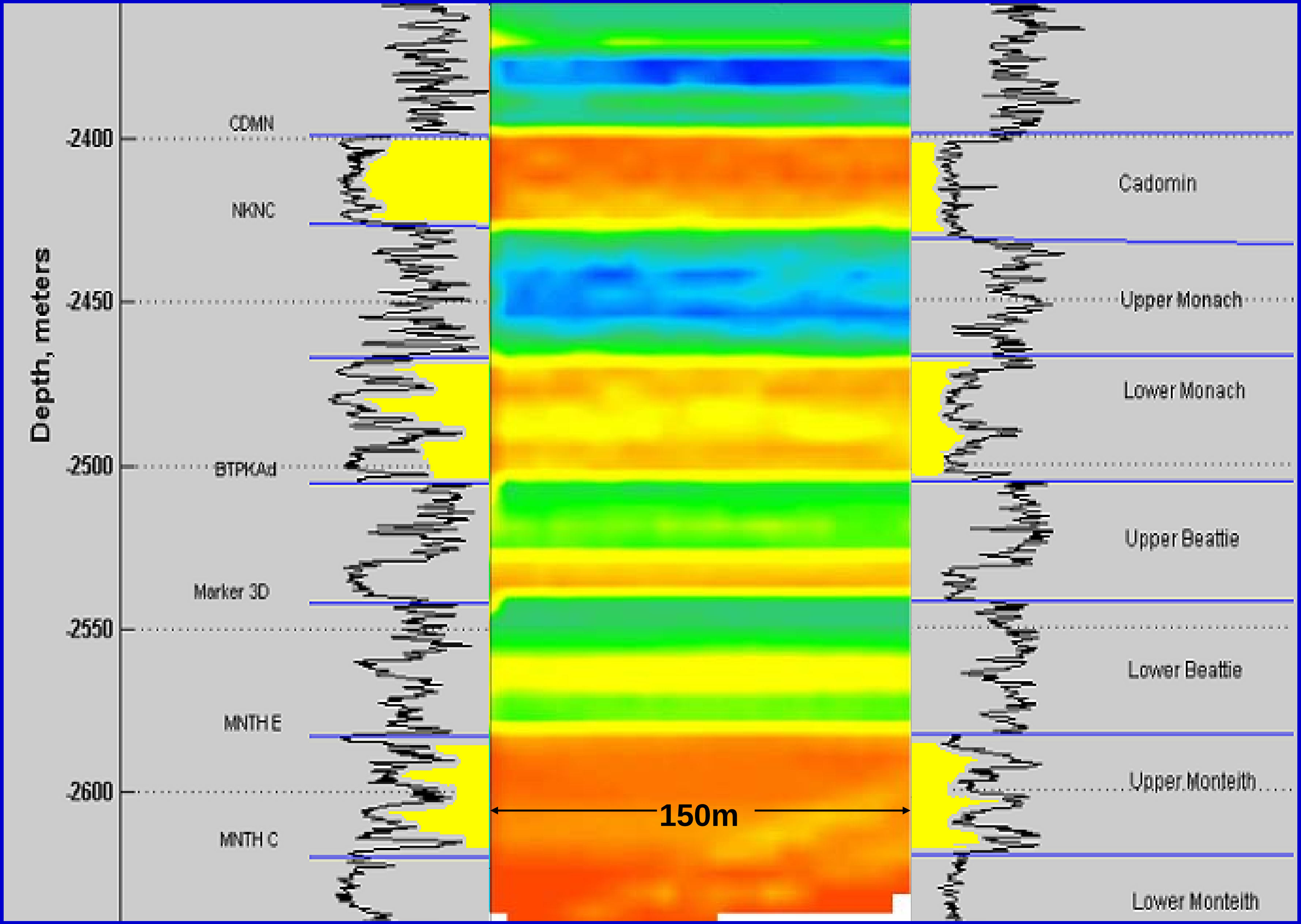

POWER SPECTRUM
Log (relative Power)
2
0
-2
-4
-6
-8
-10
-12
-14
0
500
1000
1500
2000
2500
3000
3500
4000
Frequency, Hz

- *Two velocity tomograms are shown in the next slide.*
- *The first tomogram was created by straight-ray back-projection with strong emphasis on the horizontal rays.*
- *The second tomogram was created the same way except that the first arrival times through the low velocity zones have been corrected (approximately) for the refraction paths through the adjacent high velocity zones.*



STRAIGHT-RAY TOMOGRAM
TOMOGRAM AFTER REFRACTION CORRECTION
DEPTH, METERS
-2400
-2450
-2500
-2550
-2600
METERS
0
50
100
150
km/sec
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
Velocity, m/sec
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00

Tomogram inset between γ-ray logs



CONCLUSIONS

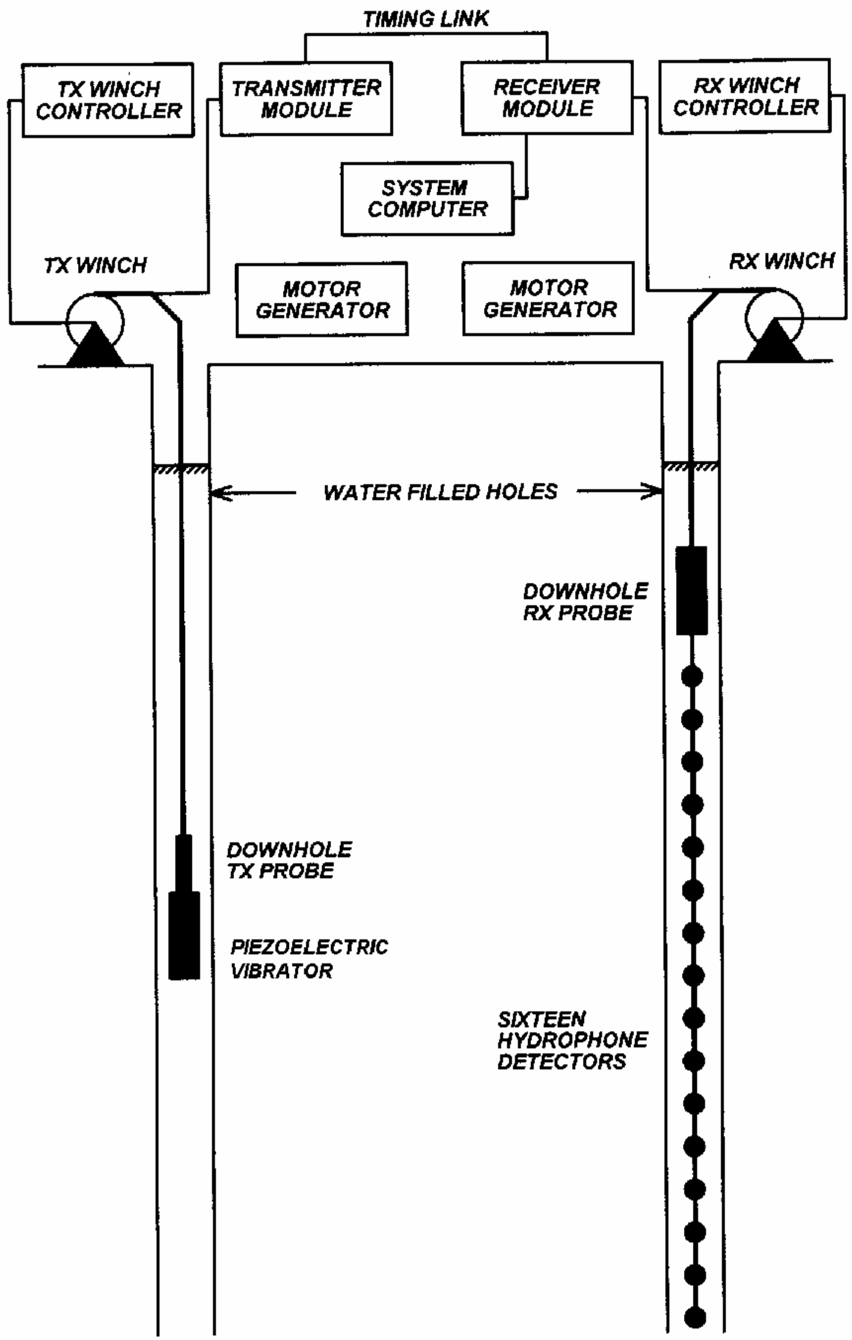
- ***The crosswell dataset is of good quality***
- ***First arrival times correlate well with the geology and natural gamma logs.***
- ***Tight sampling in depth (.75m intervals) and high frequencies indicate excellent resolution potential***
- ***P-wave velocity tomogram clearly delineates the boundaries between sandstone and siltstones & shales***

FUTURE WORK

- ***Improve the P-velocity tomogram (anisotropy, improved modeling)***
- ***Separate up- and down-going reflected wavefields***
- ***Reflectivity imaging via mapping and migration of both wavefields***
- ***Search for and use S-waves***
- ***Fully integrate with well logs and geology***
- ***Estimate gas saturation***

ACKNOWLEDGEMENT

We wish to thank BP Canada Energy Company, in particular Geoff Fraser, for permission to use this crosswell dataset.


TIMING LINK
TX WINCH CONTROLLER
TRANSMITTER MODULE
RECEIVER MODULE
RX WINCH CONTROLLER
SYSTEM COMPUTER
TX WINCH
RX WINCH
MOTOR GENERATOR
MOTOR GENERATOR
WATER FILLED HOLES
DOWNHOLE RX PROBE
DOWNHOLE TX PROBE
PIEZOELECTRIC VIBRATOR
SIXTEEN HYDROPHONE DETECTORS


95 7 7