

# The Evolution of Resolution Seismic Acquisition Considerations for Optimum Quantitative Interpretation

October 24, 2012

Presented by:

Laurie Weston Bellman



August, 2007: Oil Sands Imaging  
founded by Laurie Bellman to provide  
seismic reservoir characterization  
consulting for oil sands clients

May 1, 2012



## THE LANDSCAPE HAS CHANGED.

**Oil Sands Imaging is now Sound Qi.**

We began by providing cutting edge Quantitative Interpretation (QI) services to help in situ oil sands producers maximize recovery with detailed and accurate reservoir predictions.

This quickly began attracting attention among those seeking the same high degree of precision in their conventional and unconventional environments.

To better reflect our growing and diversified client base, we have adopted a new name – and a flexible new approach to business based on collaborative Quantitative Interpretation solutions that are scalable to your needs and project parameters.

**Sound science. Sound results. Sound Qi.**

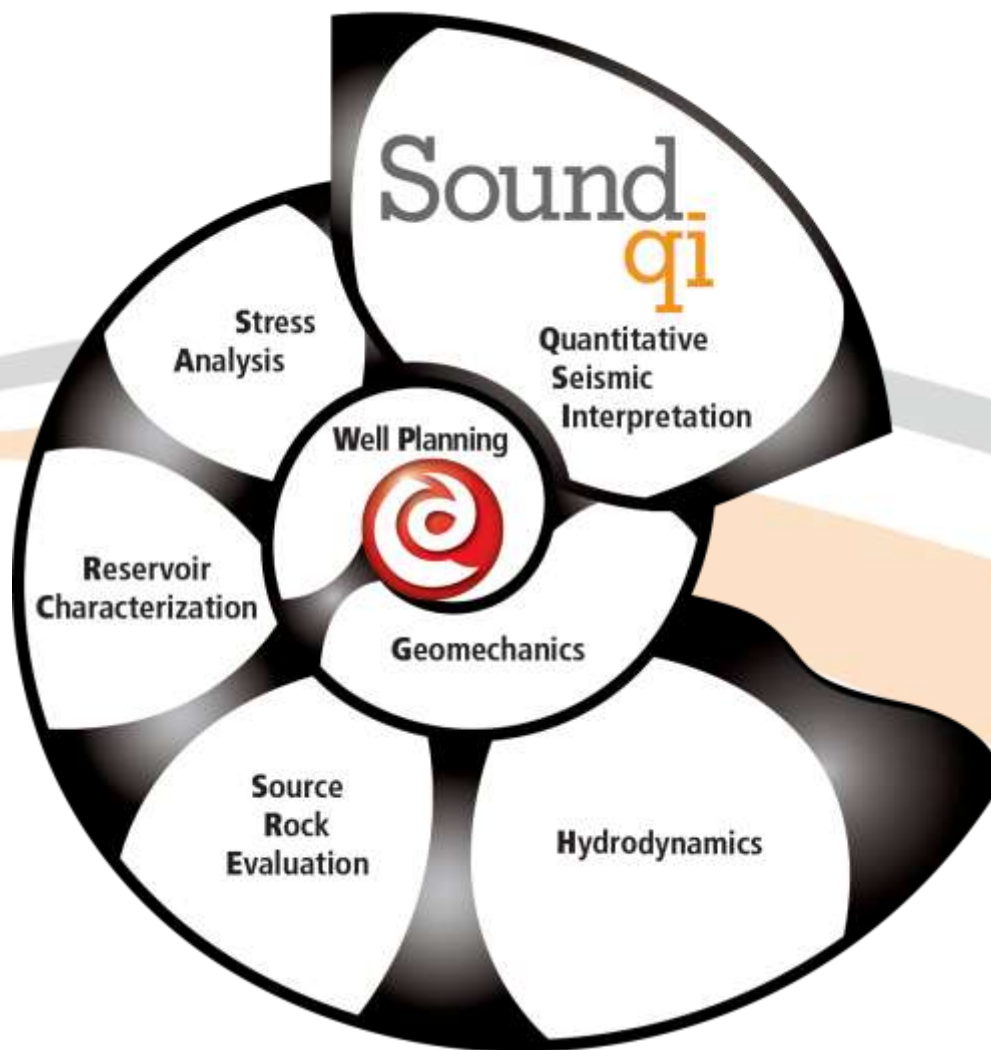
# Sound

ADVANCED EARTH IMAGING **qi**

Sound-Qi.com 400.736-8800 Avenue SW Calgary T403.237.6686

Sound  
qi

September 1, 2012



# The Evolution of Resolution Seismic Acquisition Considerations for Optimum Quantitative Interpretation

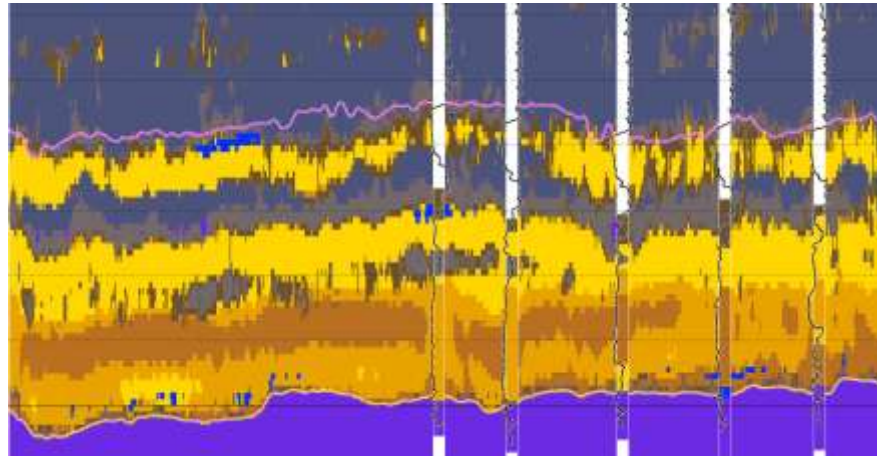
October 24, 2012

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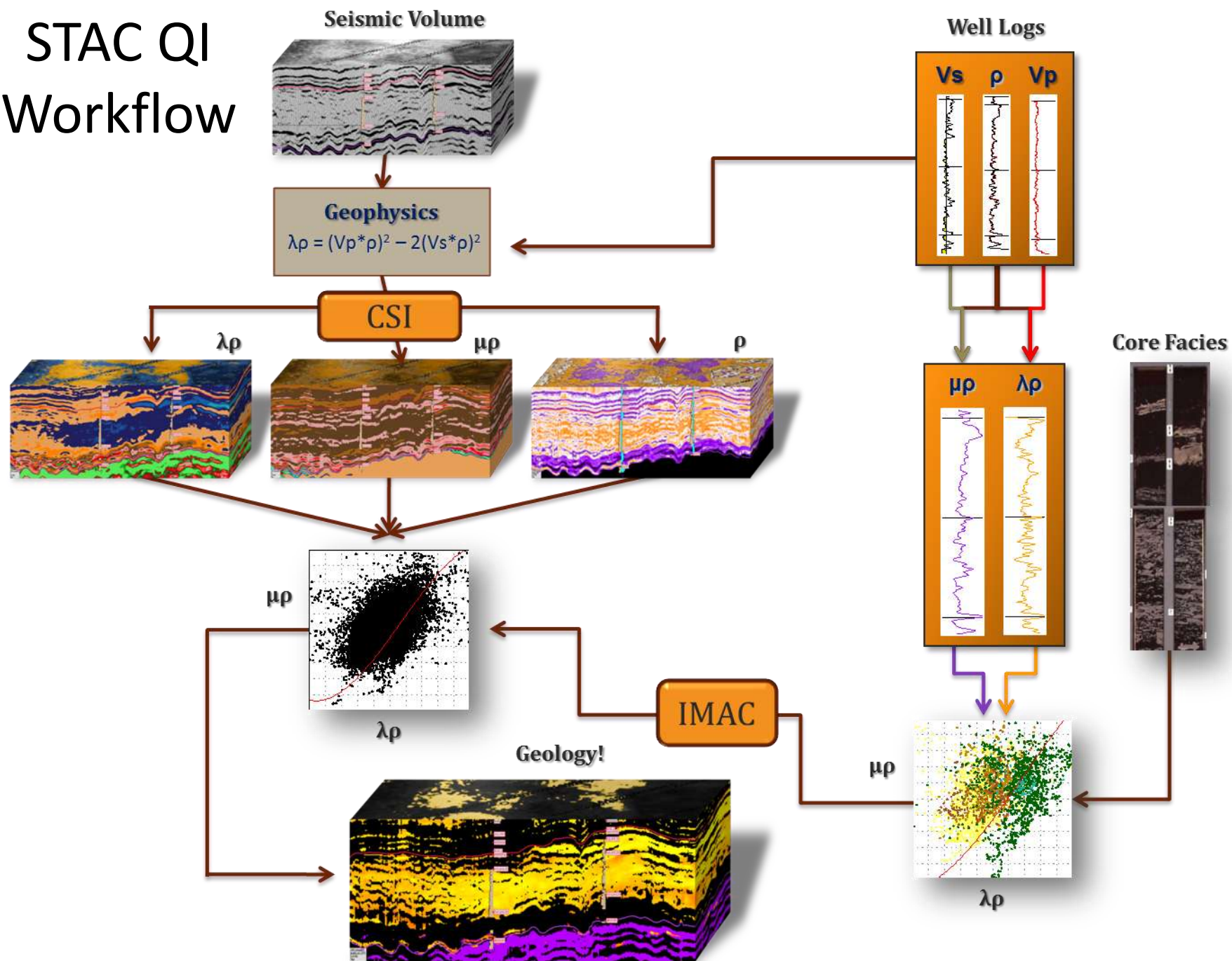
- Conventional seismic interpretation provides geometry.
- **Quantitative interpretation** tells us about rock properties by rearranging the seismic amplitude values to represent geology.



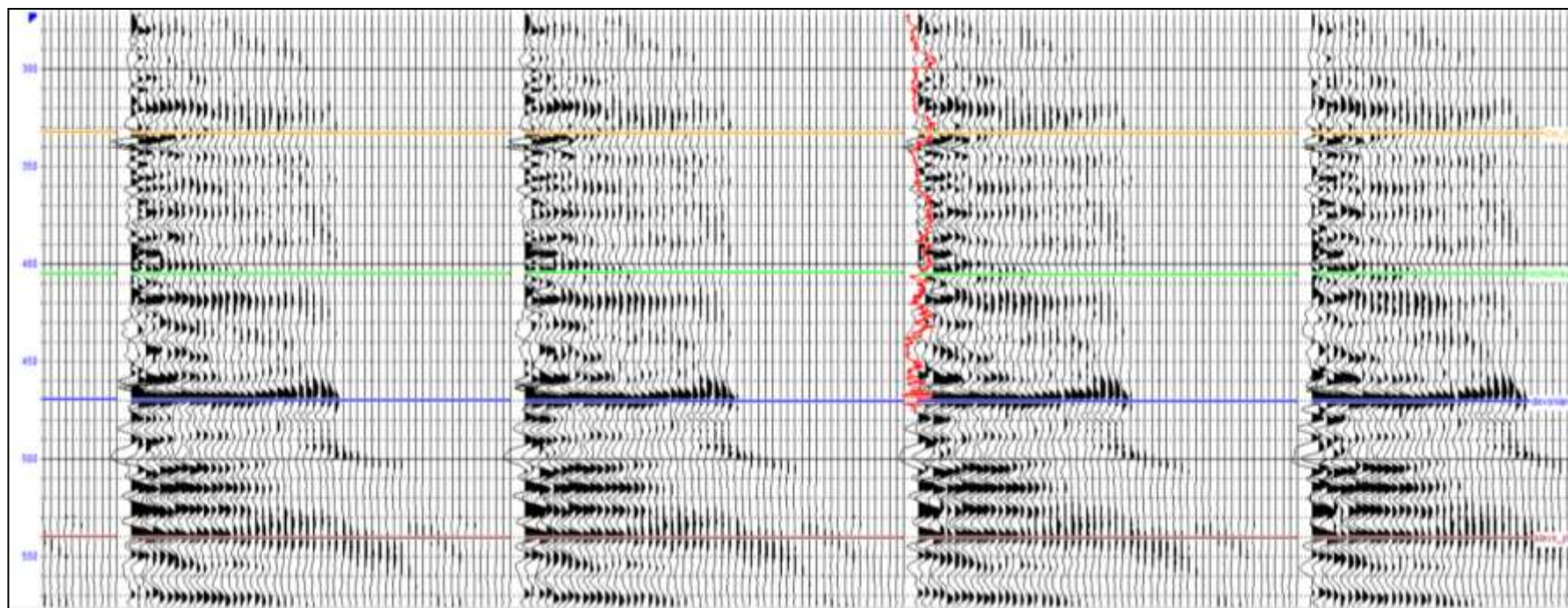
Resolution?



# STAC QI Workflow



# Processed CDP Gathers





- Modeling Study
  - create AVO synthetics from a well with variations in offset sampling parameters
  - perform AVO and inversion on synthetic datasets
- Real Data Experiment
  - decimate and interpolate a well-sampled real dataset
  - run the STAC workflow on each version and compare ultimate facies prediction results

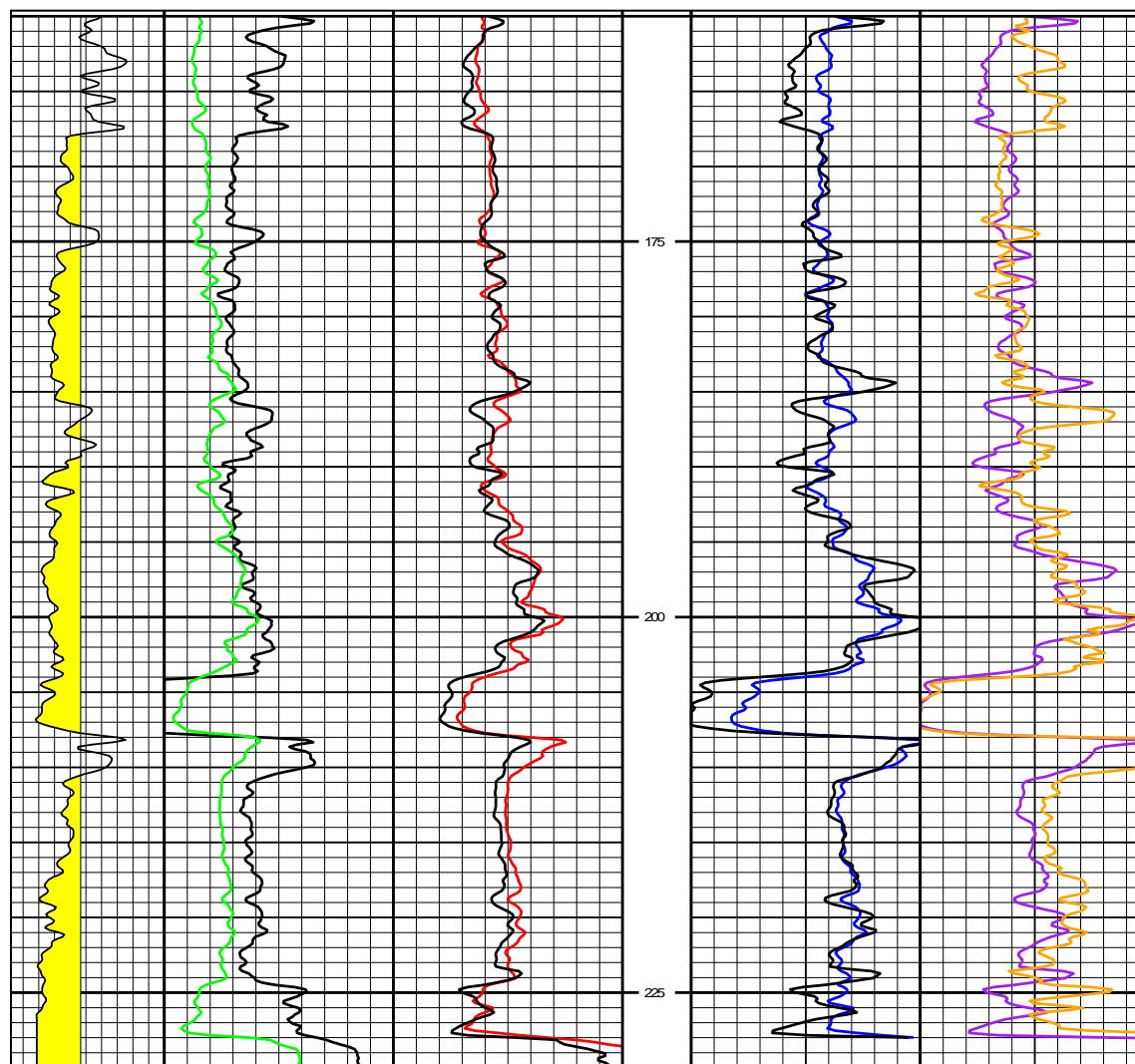
GR

Rho,  $DT$

$V_p$ ,  $V_s$

$Z_p$ ,  $Z_s$

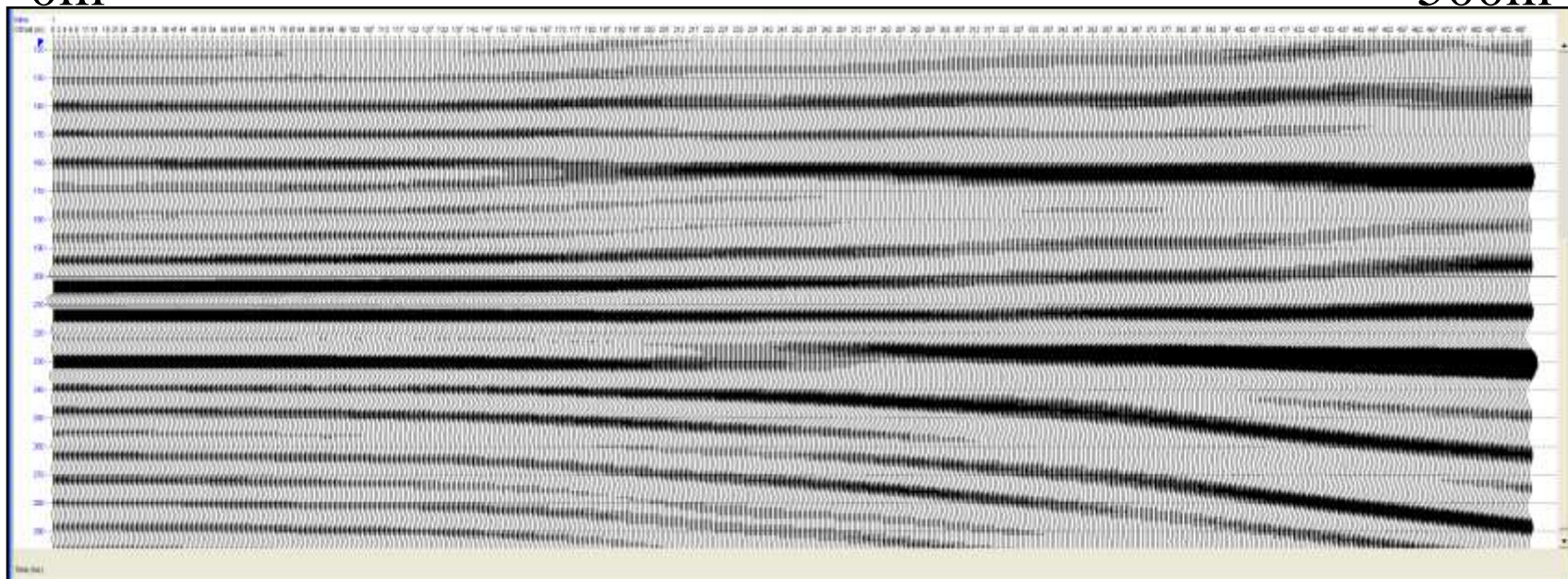
$LR$ ,  $MR$



← Zone of investigation  
4m

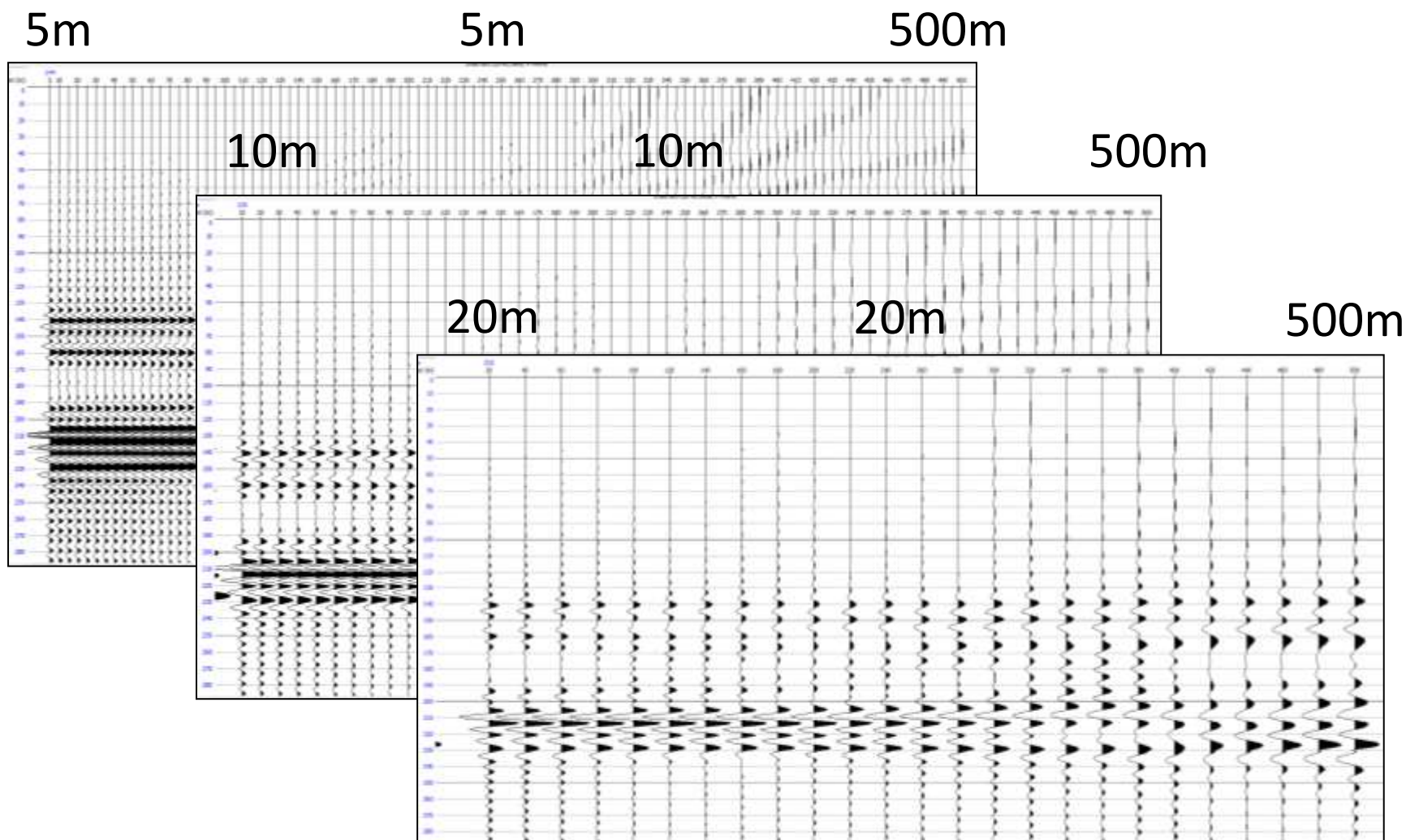
0m

500m

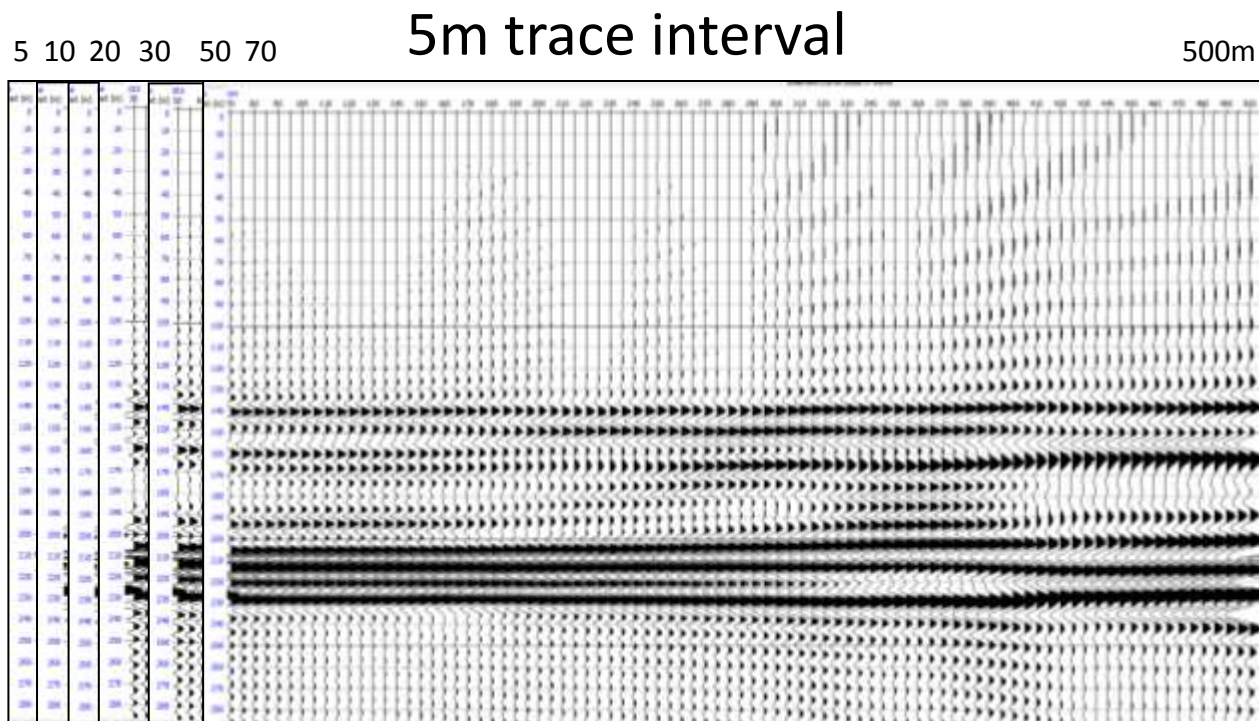


10/20-170/190 Hz

# Increase trace interval



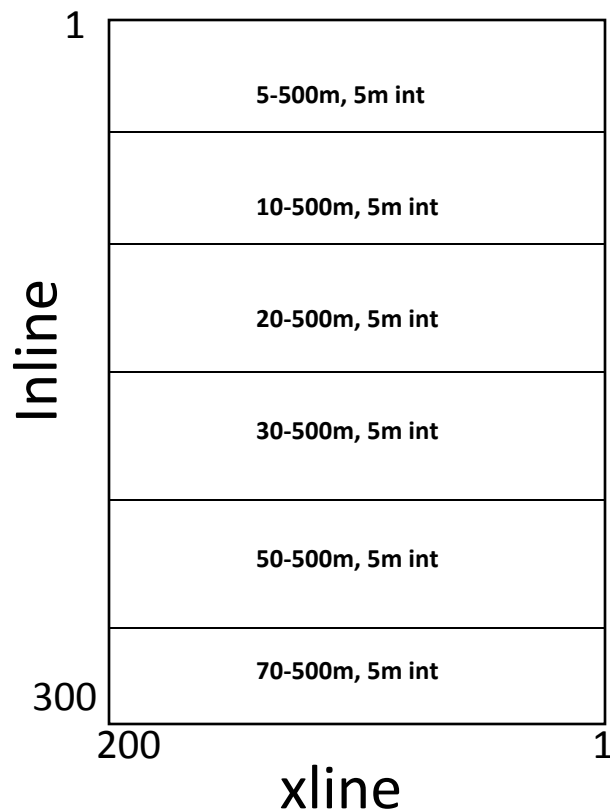
# Increase distance to first trace



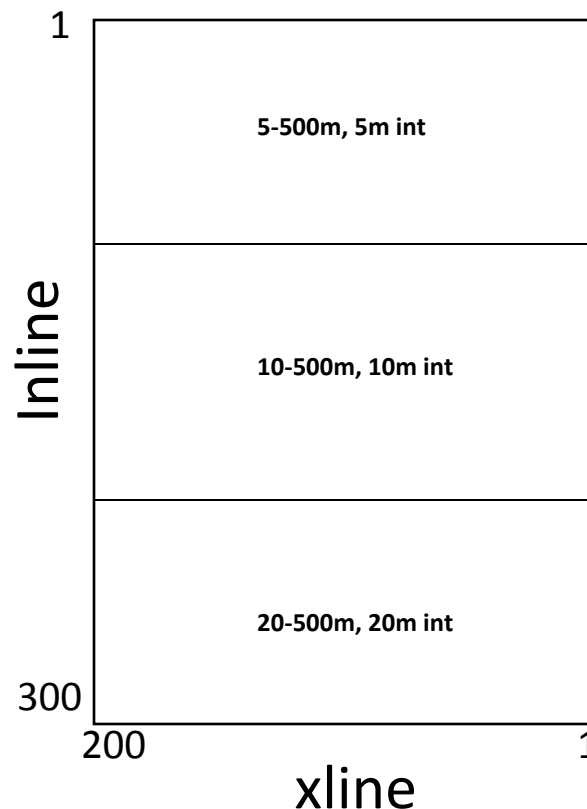


# Construct Synthetic 3D

Distance to first trace varied



Distance between traces varied



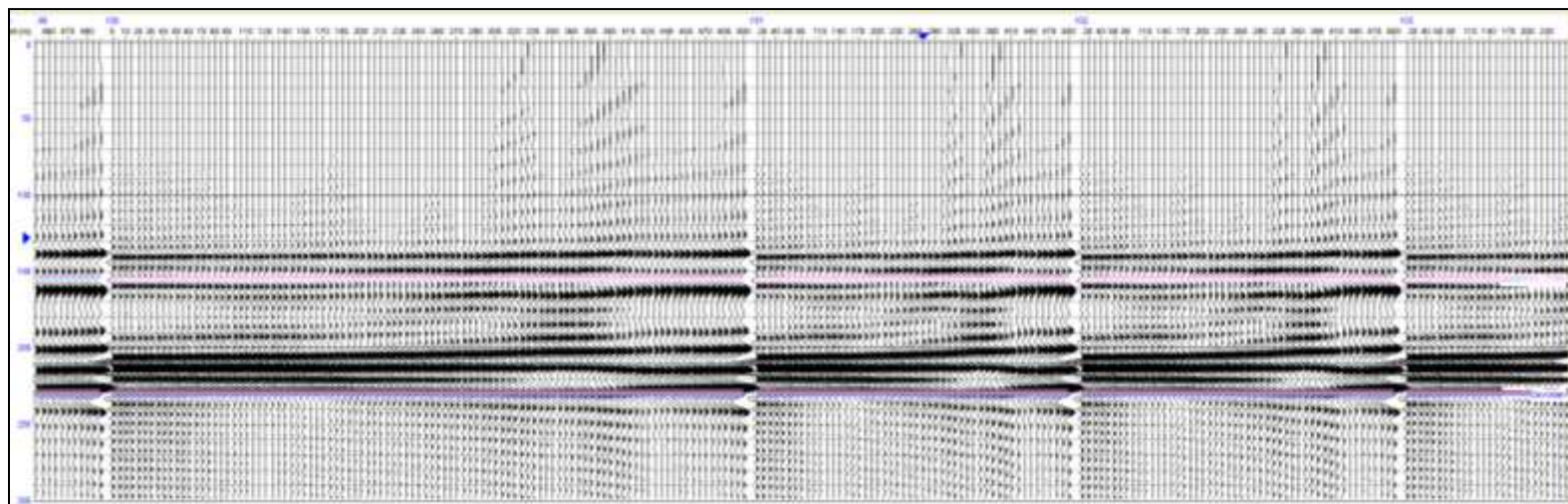
Every cdp represents identical geology

# Synthetic CDP's in Synthetic 3D

5m trace interval

10m trace interval

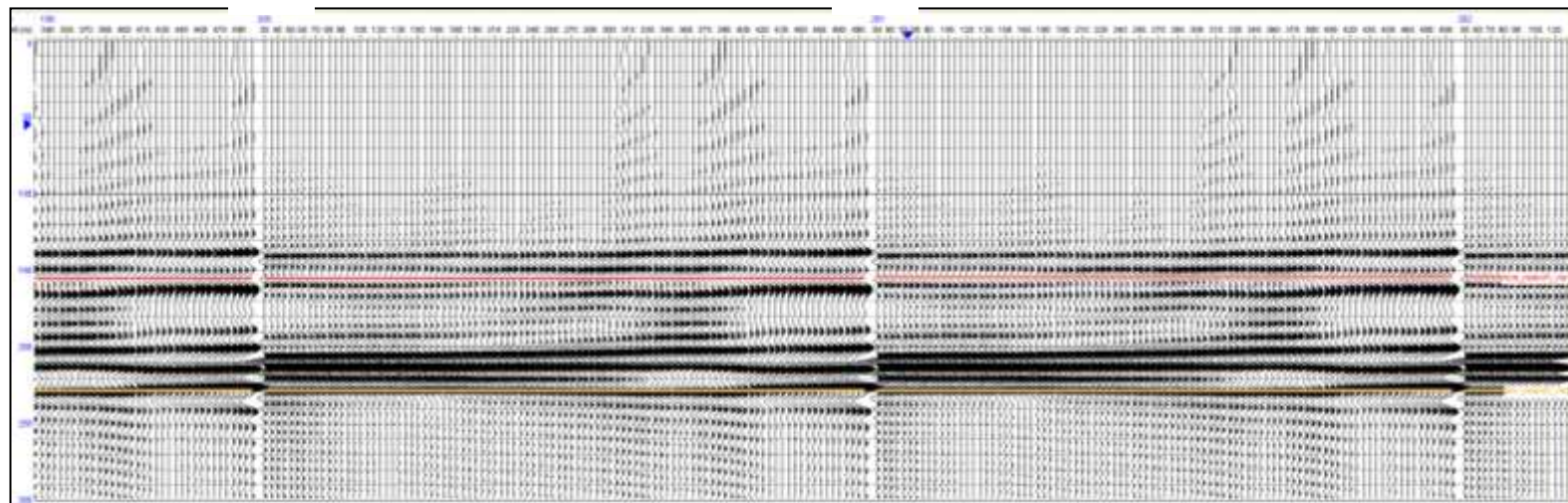
offset  
interval  
variation



30m

50m

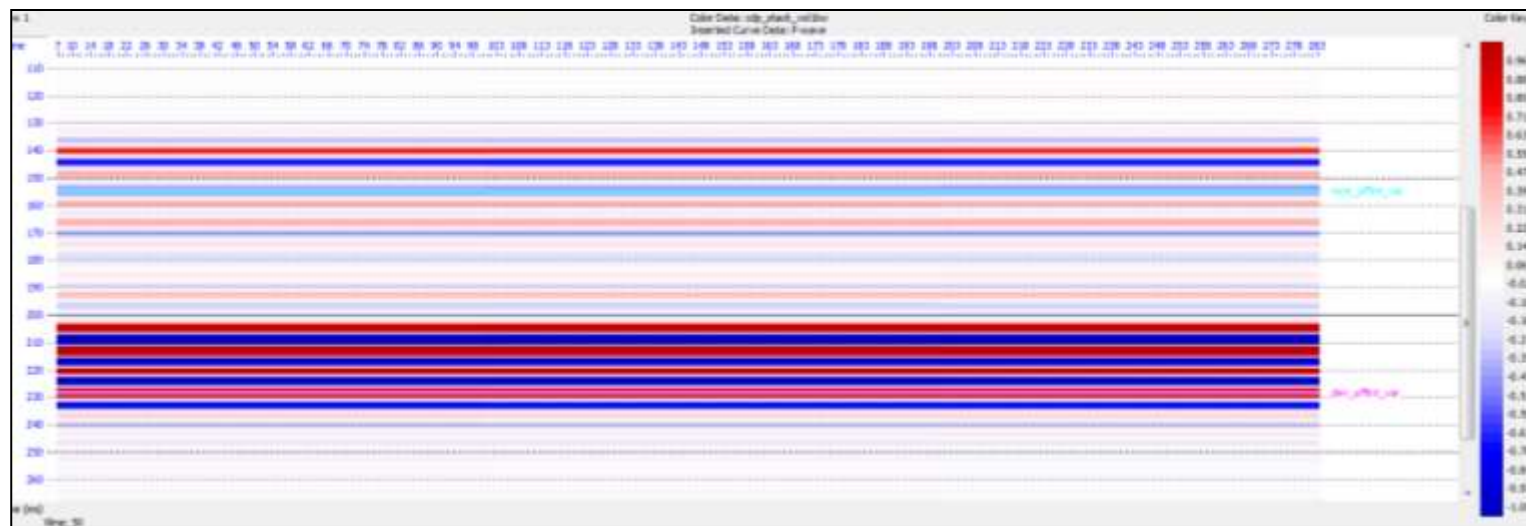
near  
offset  
variation



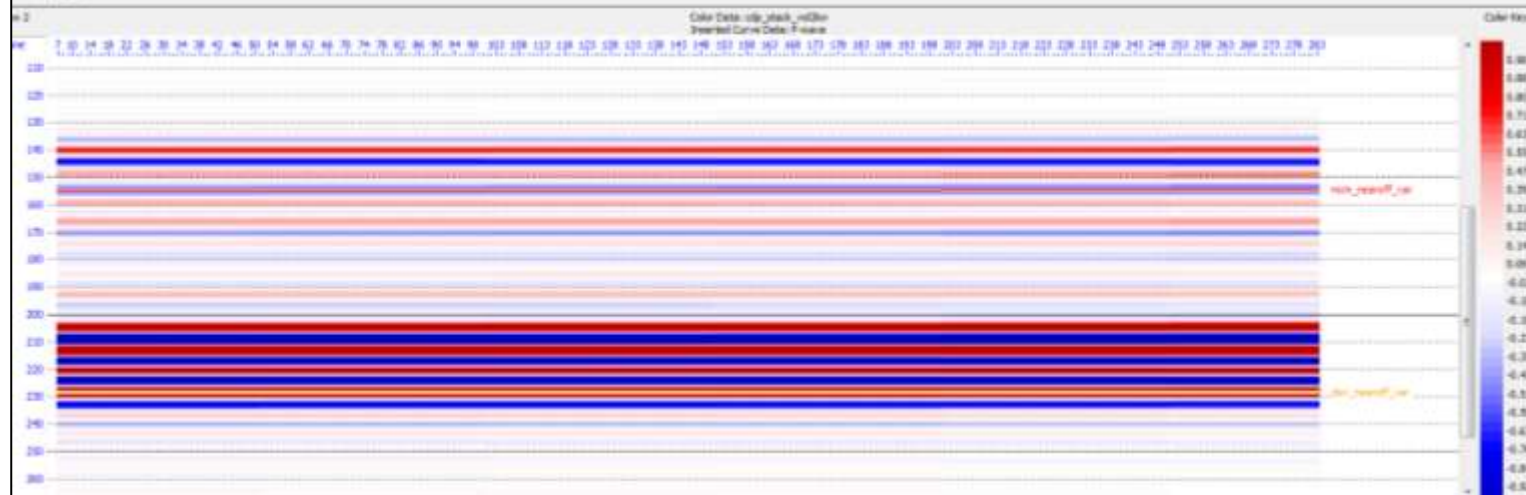
N

S

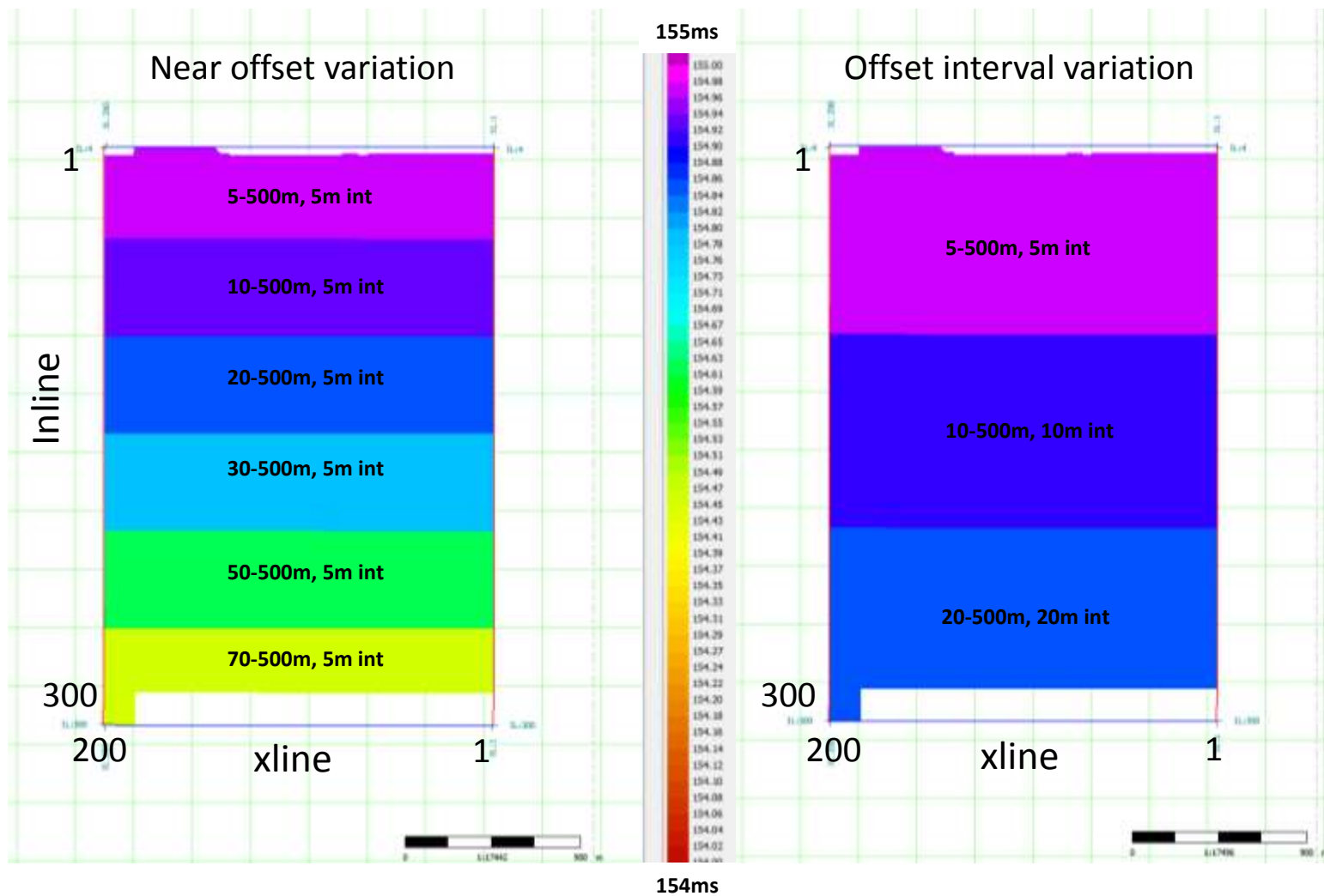
offset  
interval  
variation



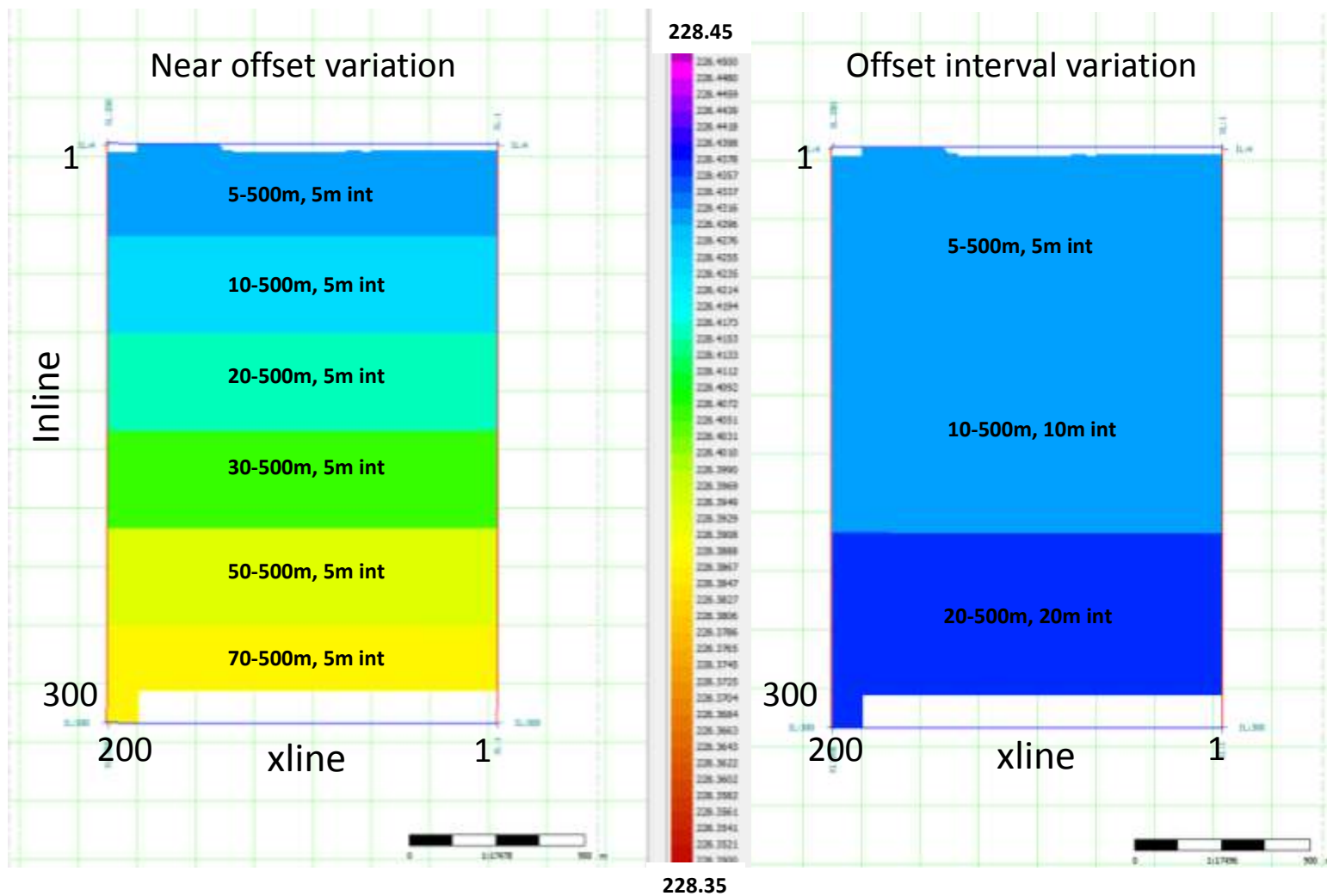
near  
offset  
variation



# McMurray Horizon Time Structure



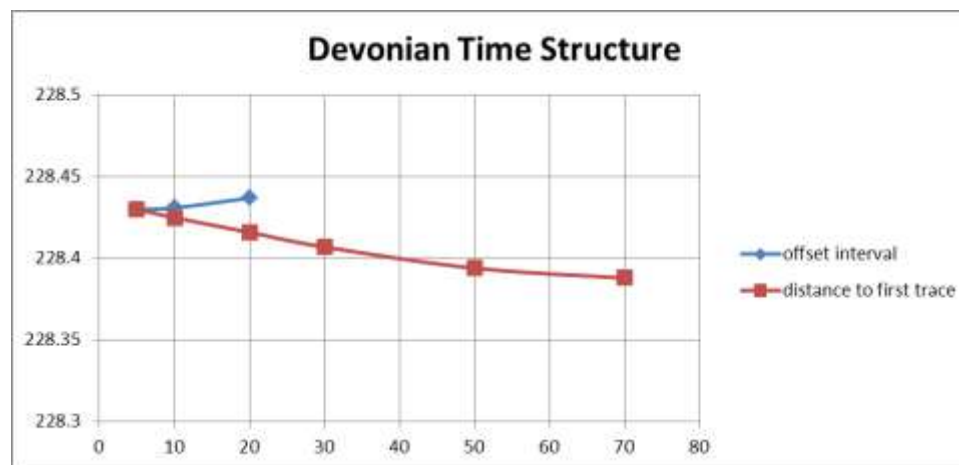
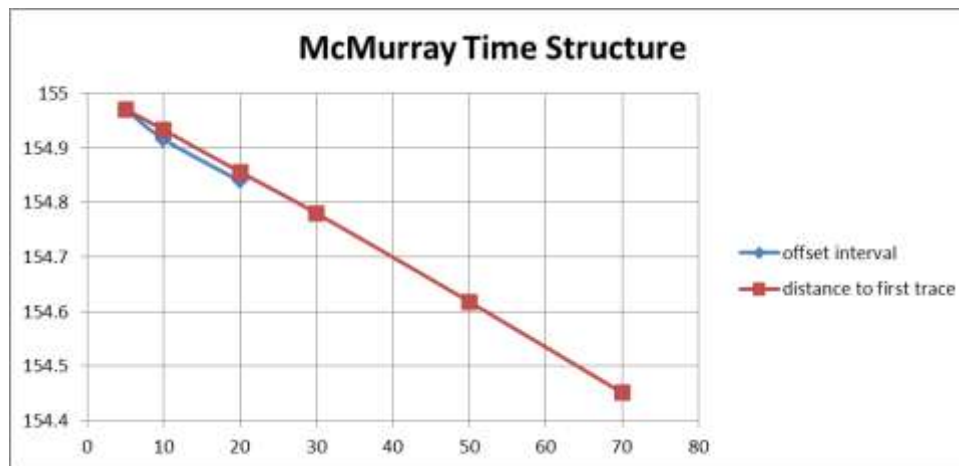
# Devonian Horizon Time Structure

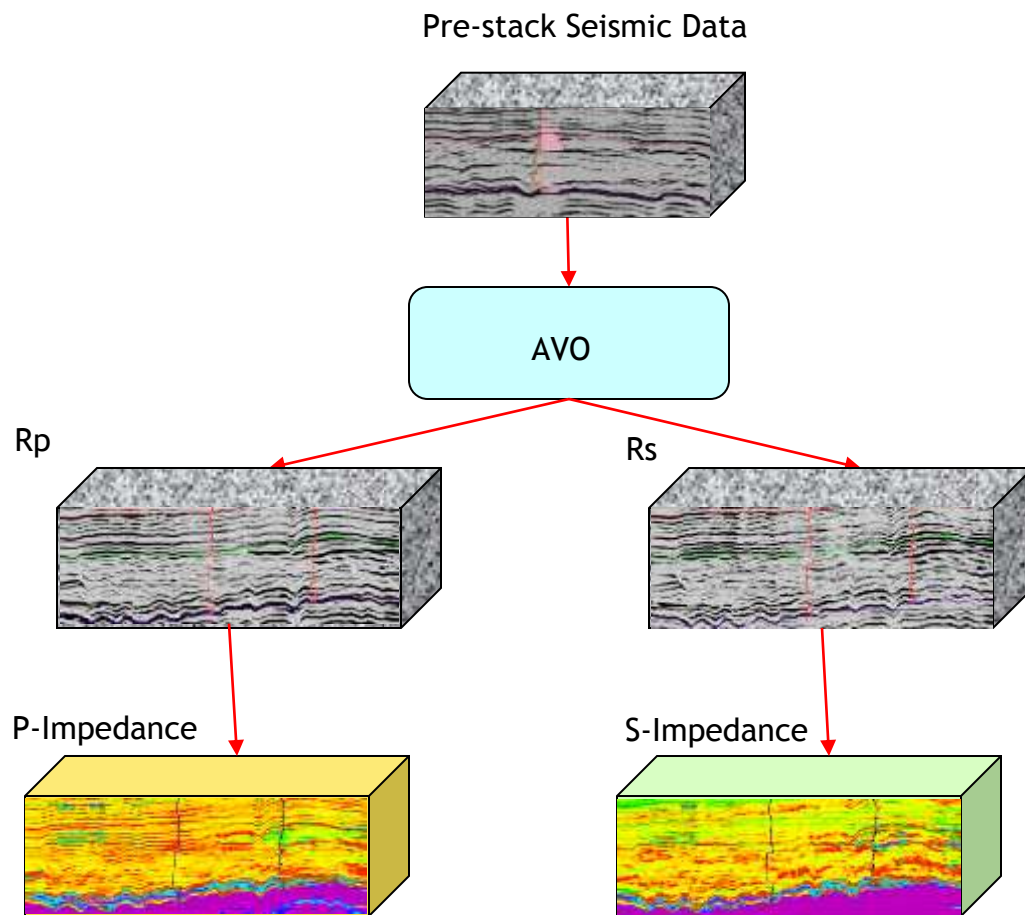




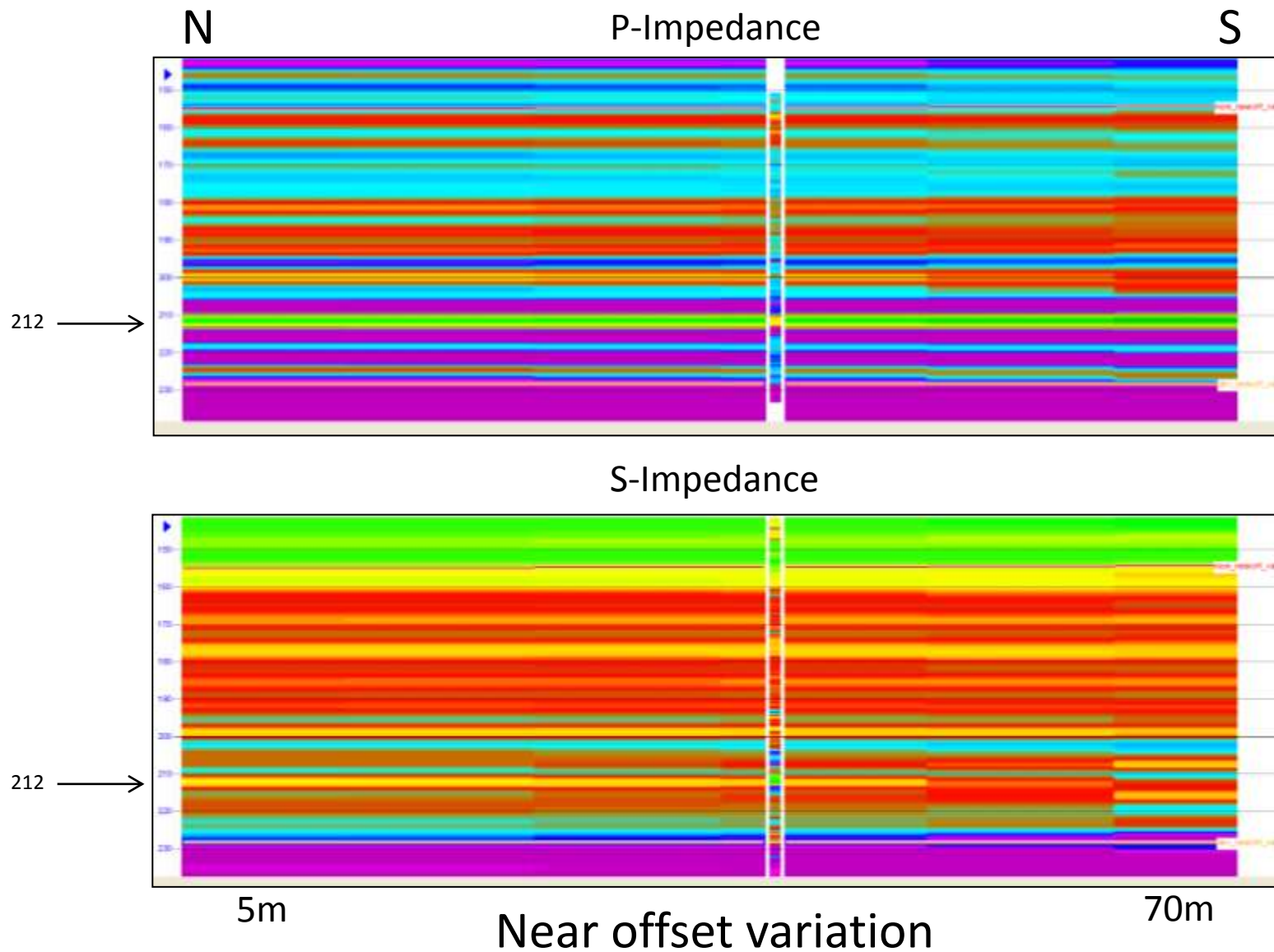
# Time Structure Variations

Horizon time



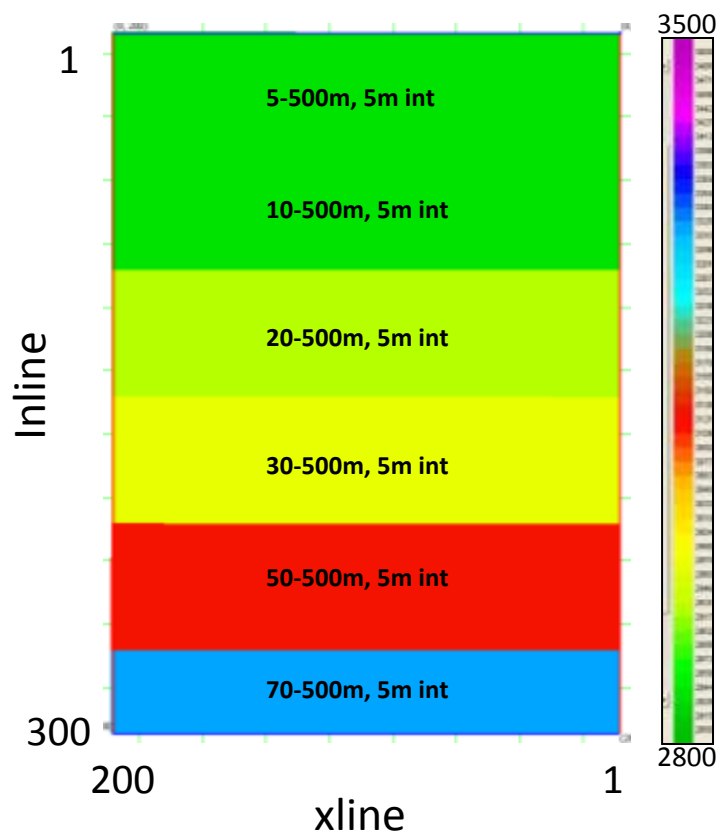


# Synthetic Impedance Profiles

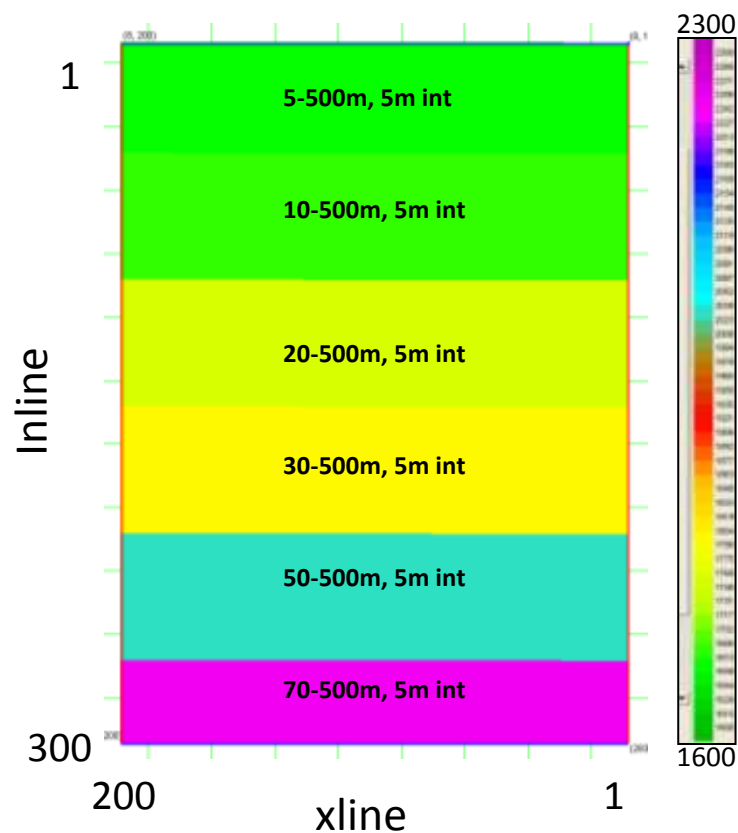


# Near Offset Variations

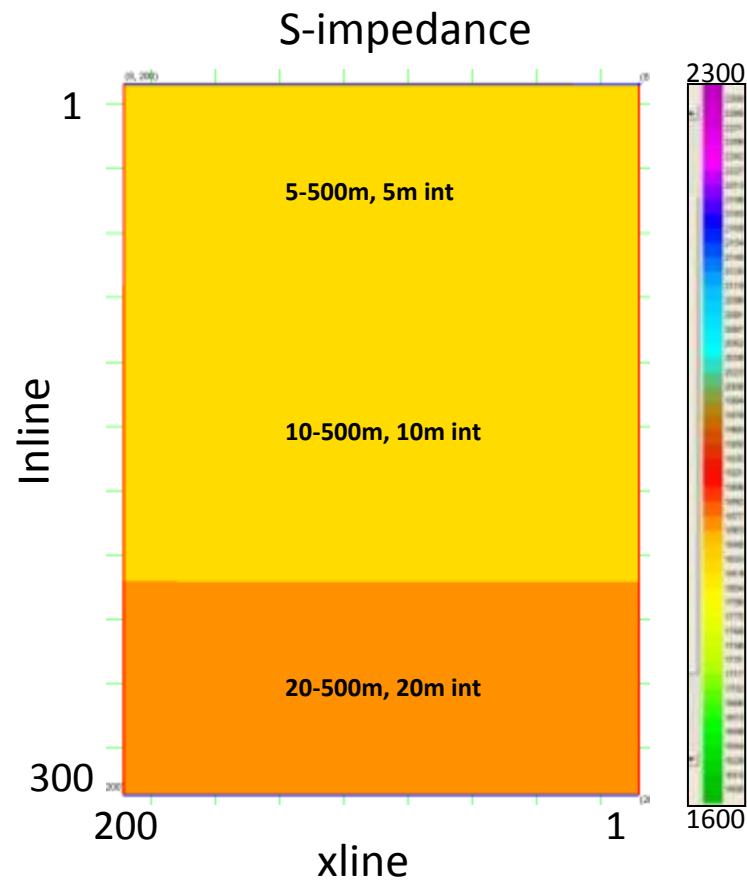
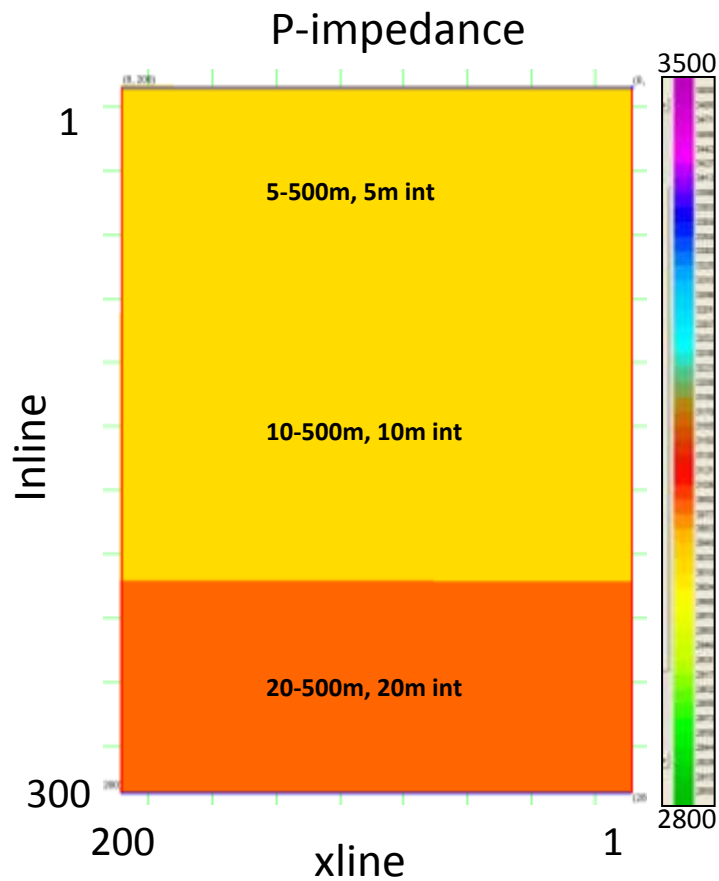
P-Impedance



S-Impedance

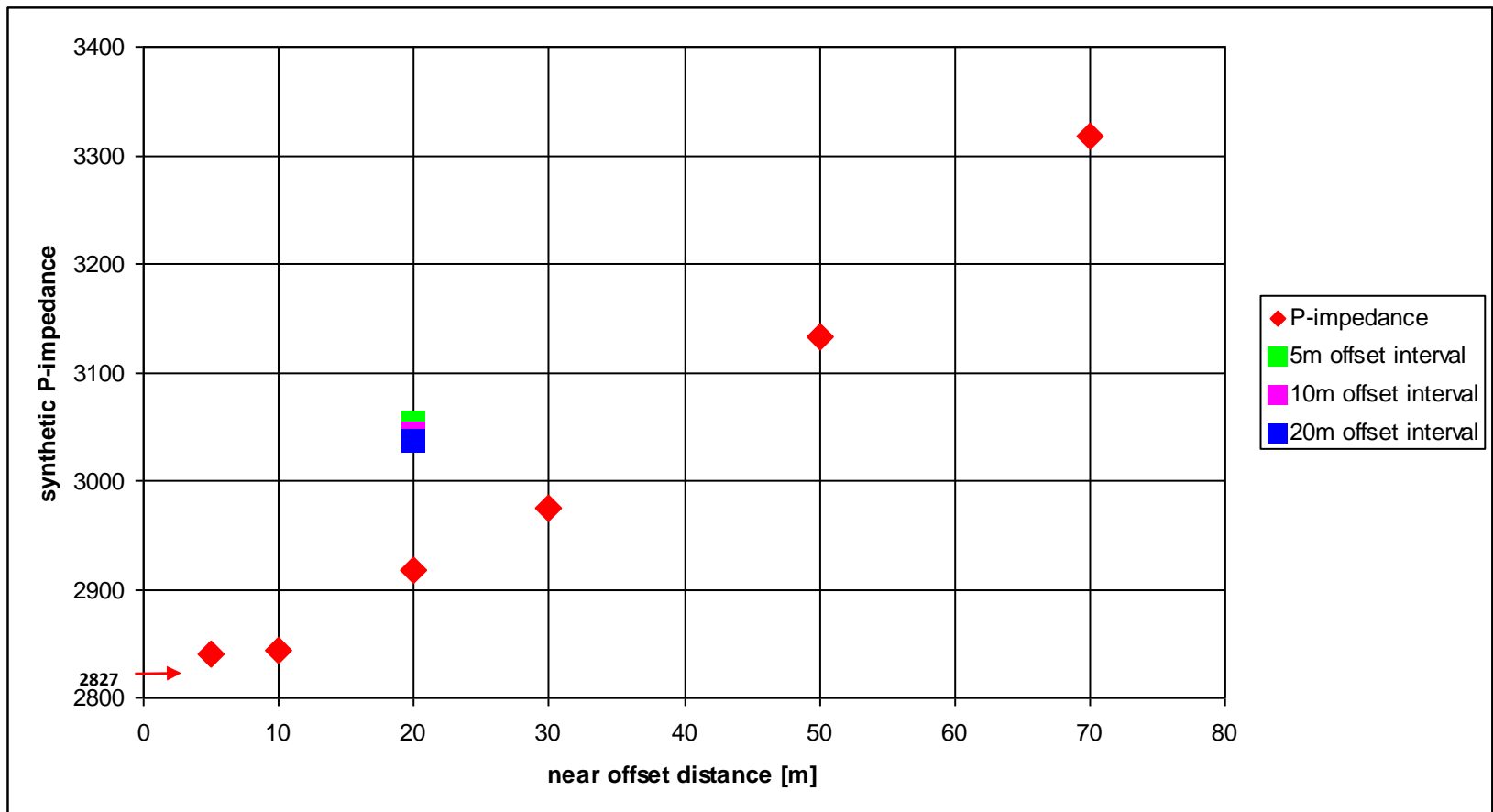


# Offset Interval Variations



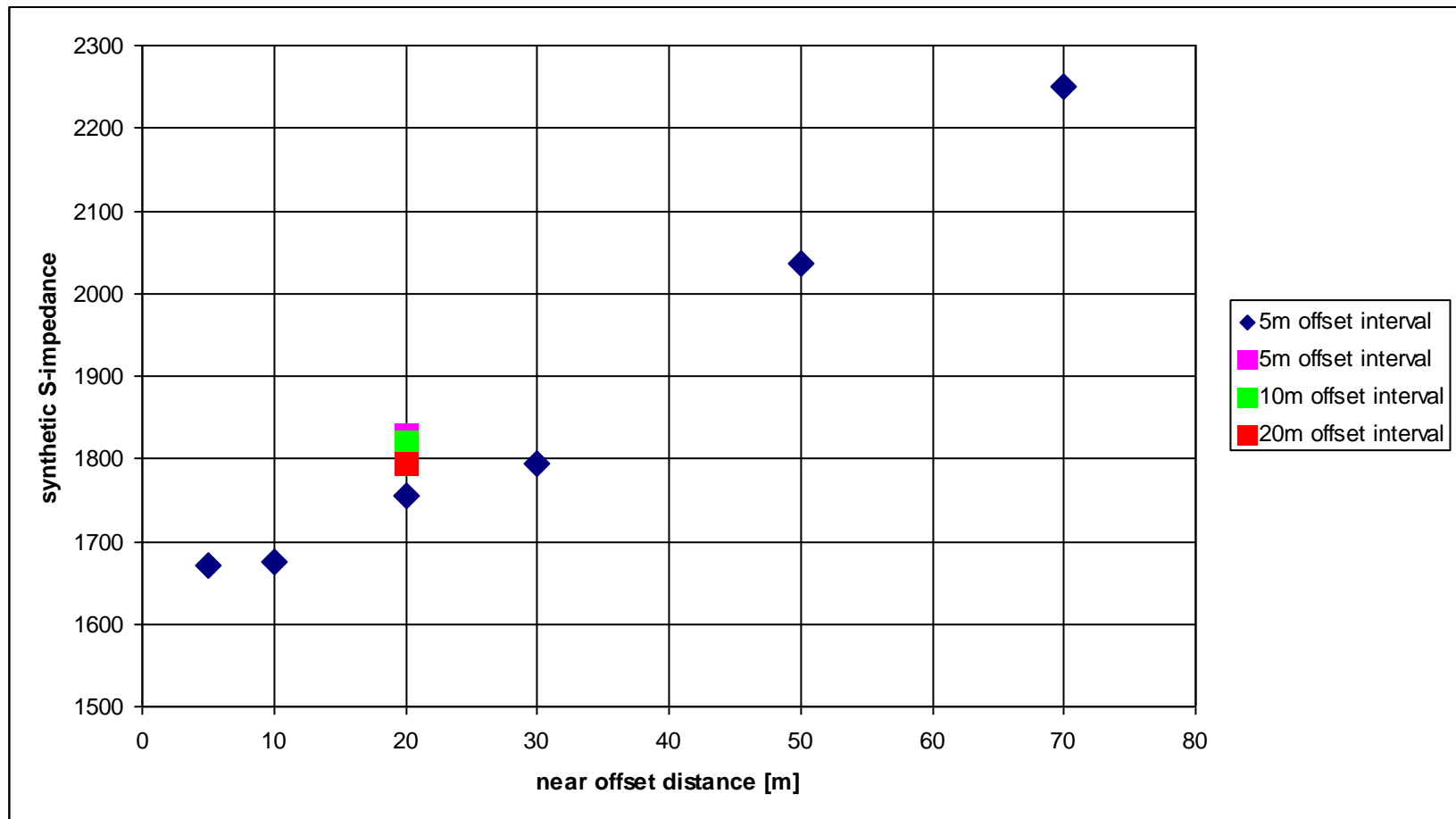


# Synthetic P-impedance



Actual P-impedance from well: 2827 [m/s\*kg/m<sup>3</sup>]

# Synthetic S-impedance

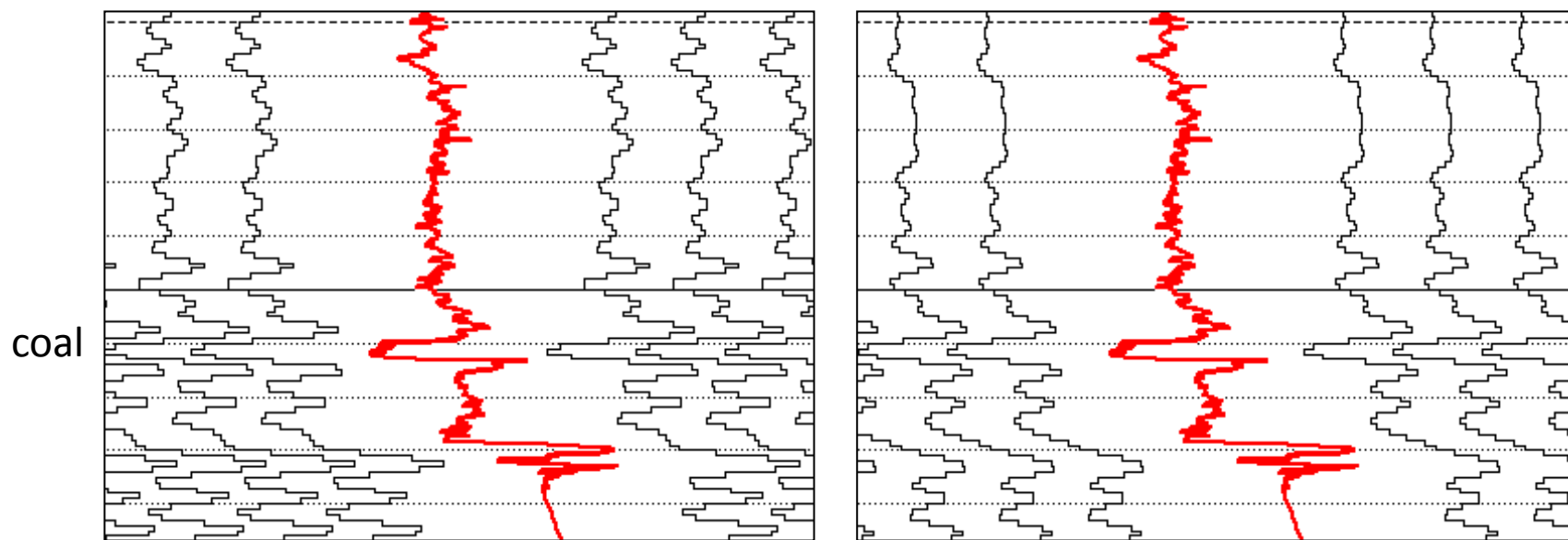


Actual S-impedance from well: 926 [m/s\*kg/m<sup>3</sup>]

# Actual vs Predicted Impedance Log

5m first trace

70m first trace



P-impedance log

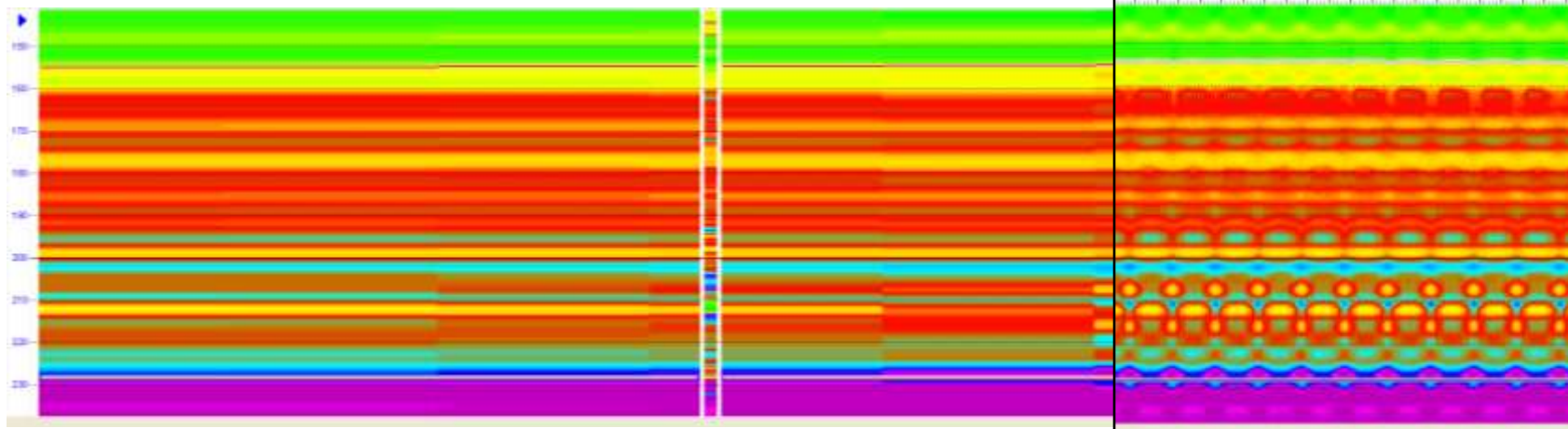
Inversion accuracy is affected by nothing more than missing near offsets.

# Near Offset Variations

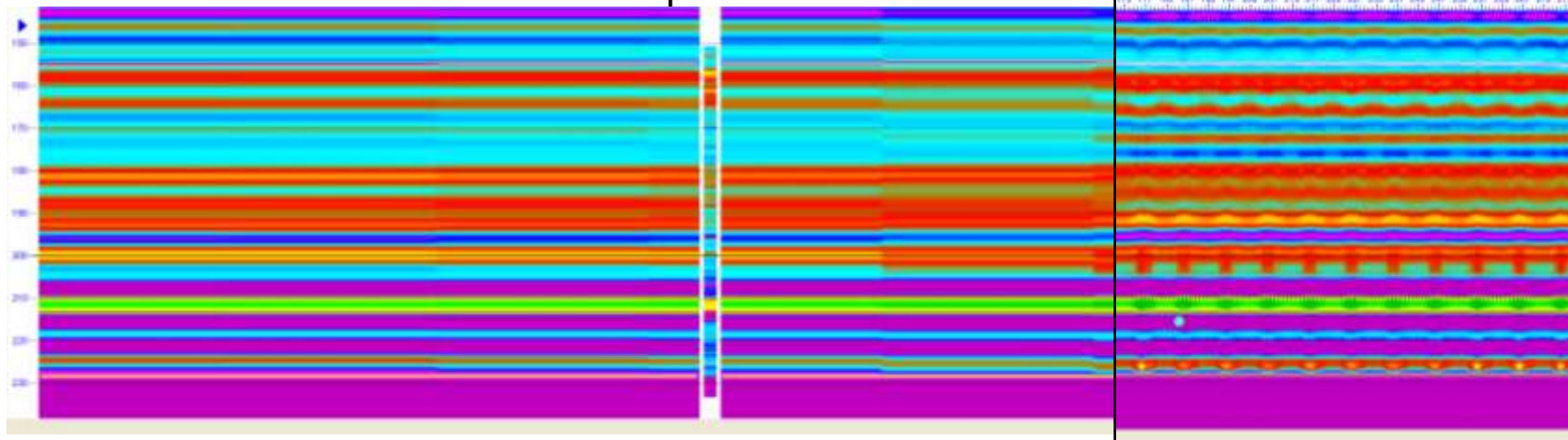
5m

S-Impedance

70m



P-impedance

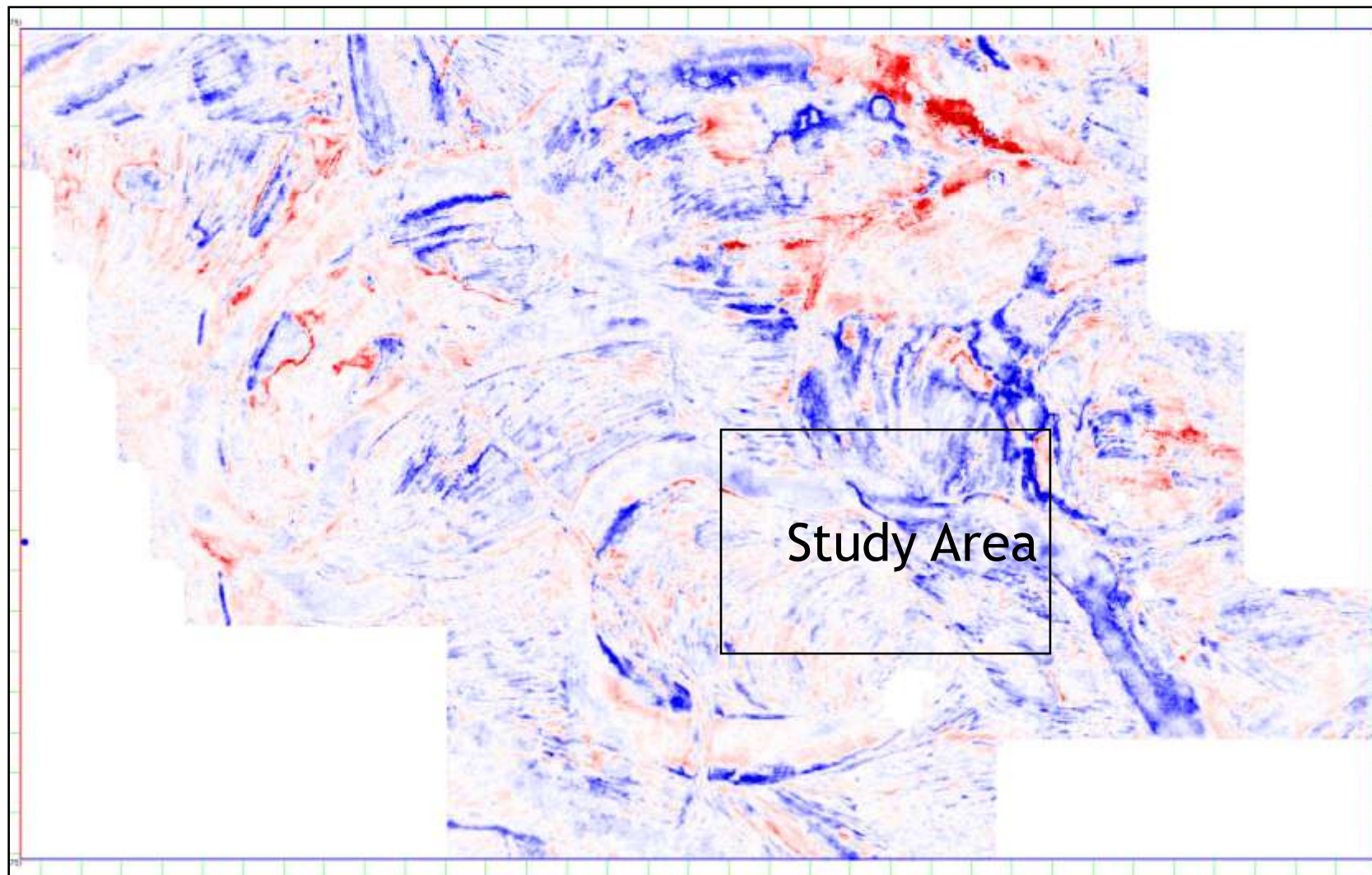


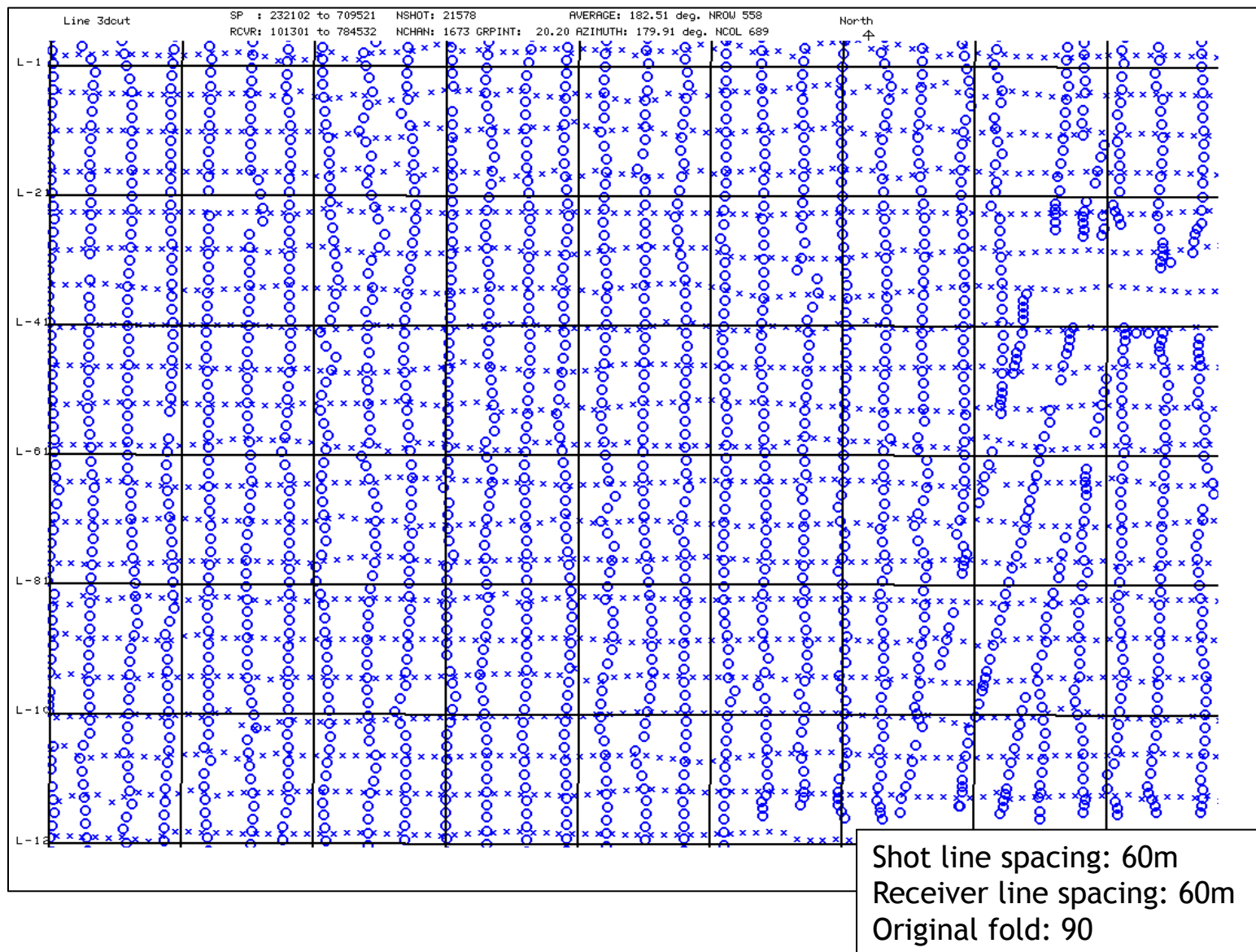
- Variations in horizon picking and impedance estimation are related to acquisition geometry not geology
- Accuracy of inversion predictions (resolution) decreases with increasing distance to first trace of a CDP
- Distance to first trace has a more significant effect than trace interval within a CDP



1. Original data: subset of a well-sampled Nexen oil sands  
3D

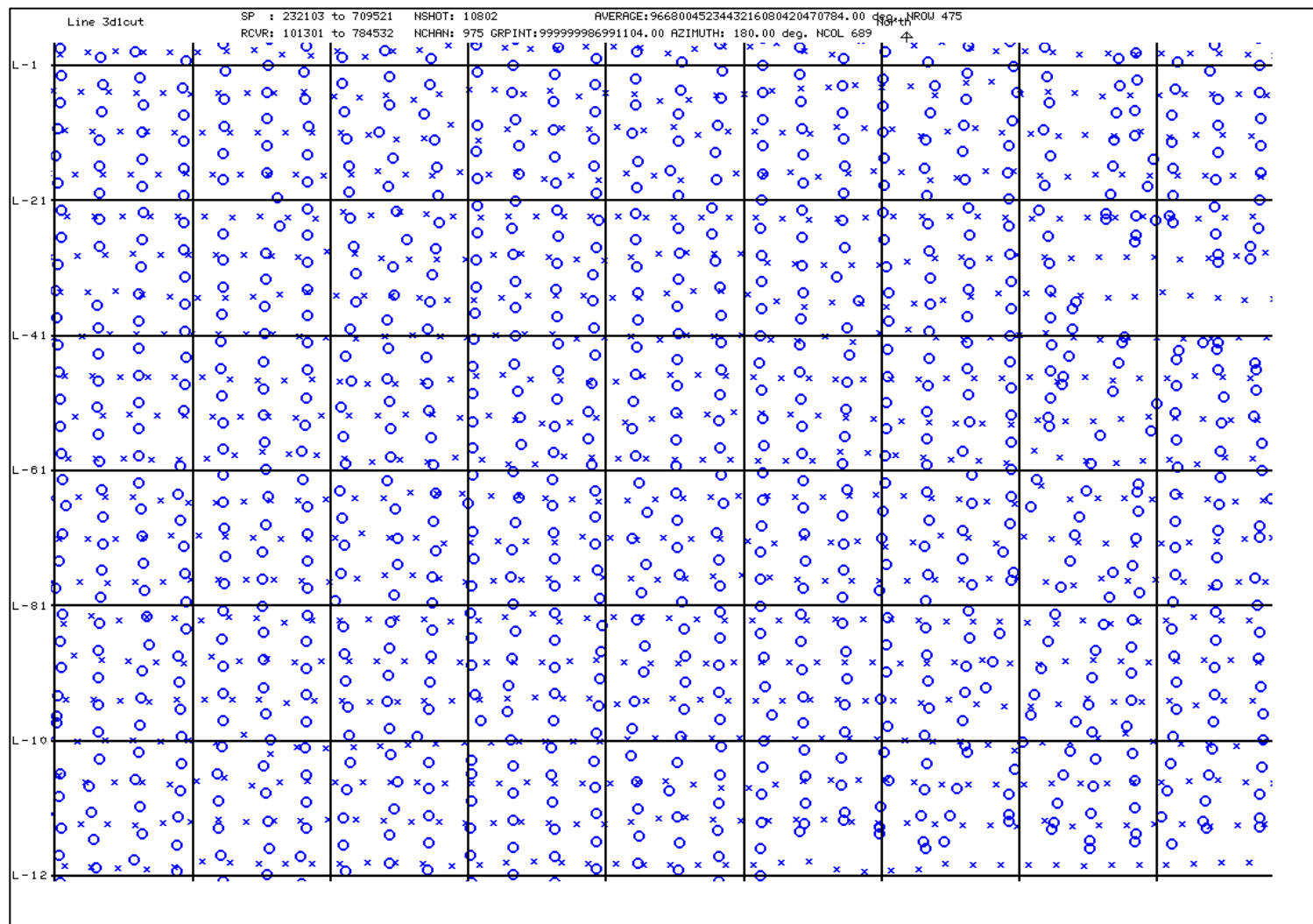
# Conventional Seismic Time Slice





1. Original data: subset of a well-sampled Nexen oil sands 3D
2. V1: Original data decimated by removing every 2<sup>nd</sup> shot and receiver (1/4x fold); offset interval increase

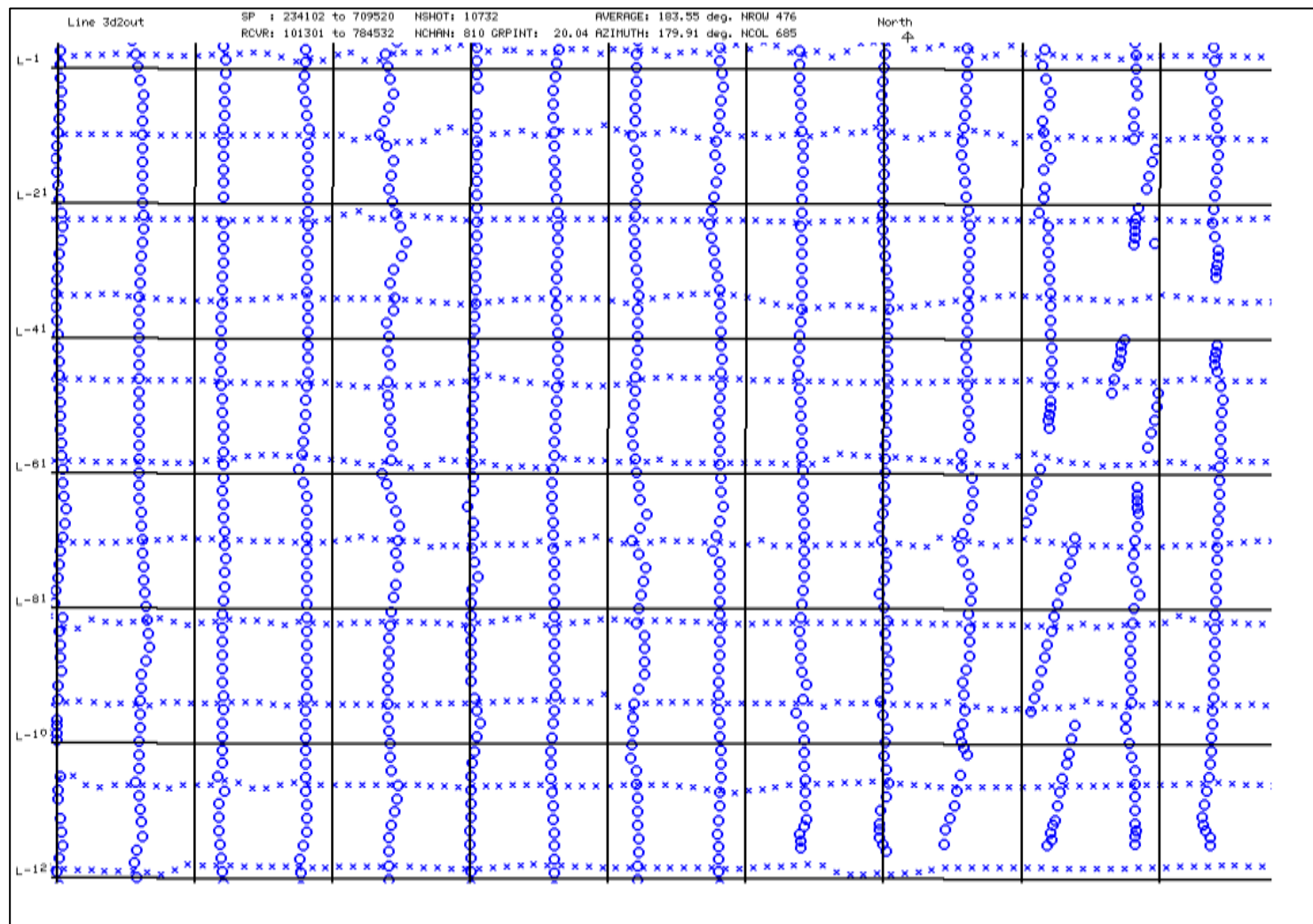
# V1: Drop every other receiver/shot





1. Original data: subset of a well-sampled Nexen oil sands 3D
2. V1: Original data decimated by removing every 2<sup>nd</sup> shot and receiver (1/4x fold); offset interval increase
3. V2: Original data decimated by removing every 2<sup>nd</sup> shot and receiver line (1/4x fold); near trace distance increase

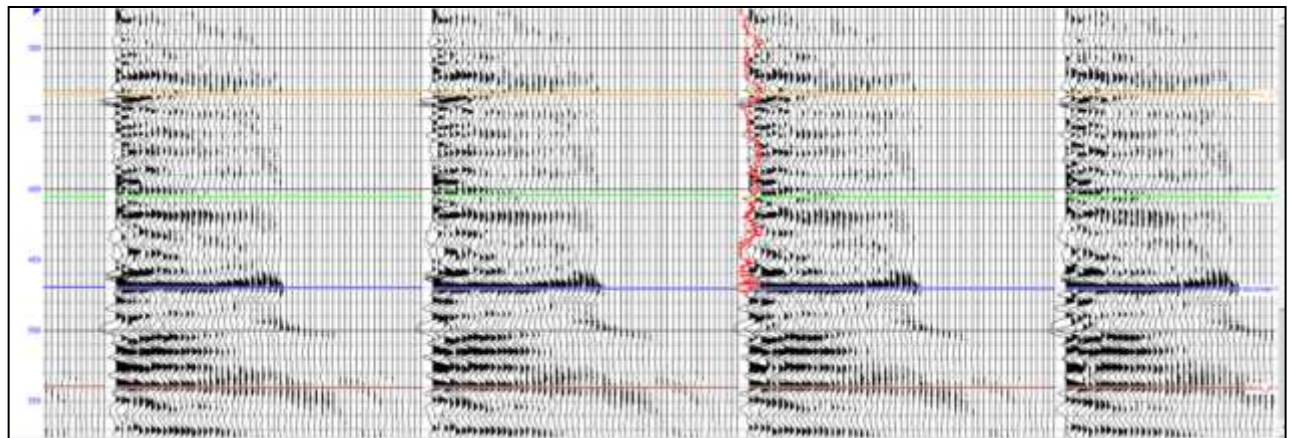
## V2: Drop every other receiver/shot line



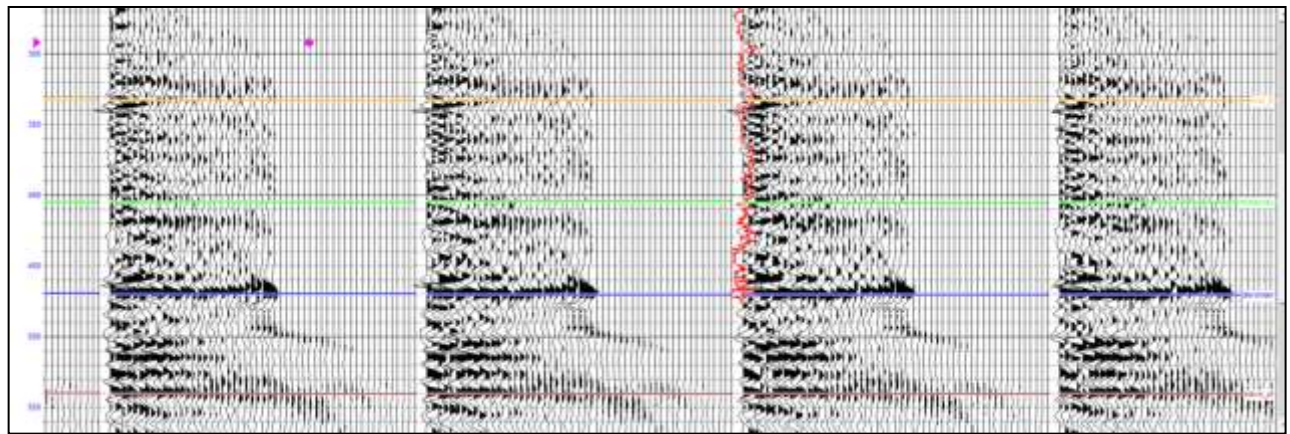
1. Original data: subset of a well-sampled Nexen oil sands 3D
2. V1: Original data decimated by removing every 2<sup>nd</sup> shot and receiver (1/4x fold); offset interval increase
3. V2: Original data decimated by removing every 2<sup>nd</sup> shot and receiver line (1/4x fold); near trace distance increase
4. Interpolated V1
5. Interpolated V2
6. Interpolated original (4x fold)

# PSTM gathers

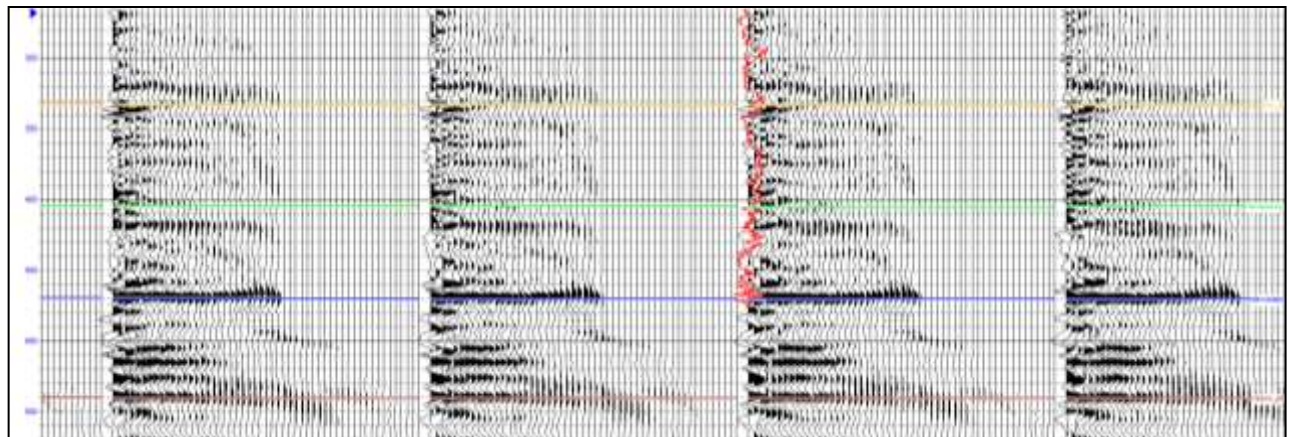
Original

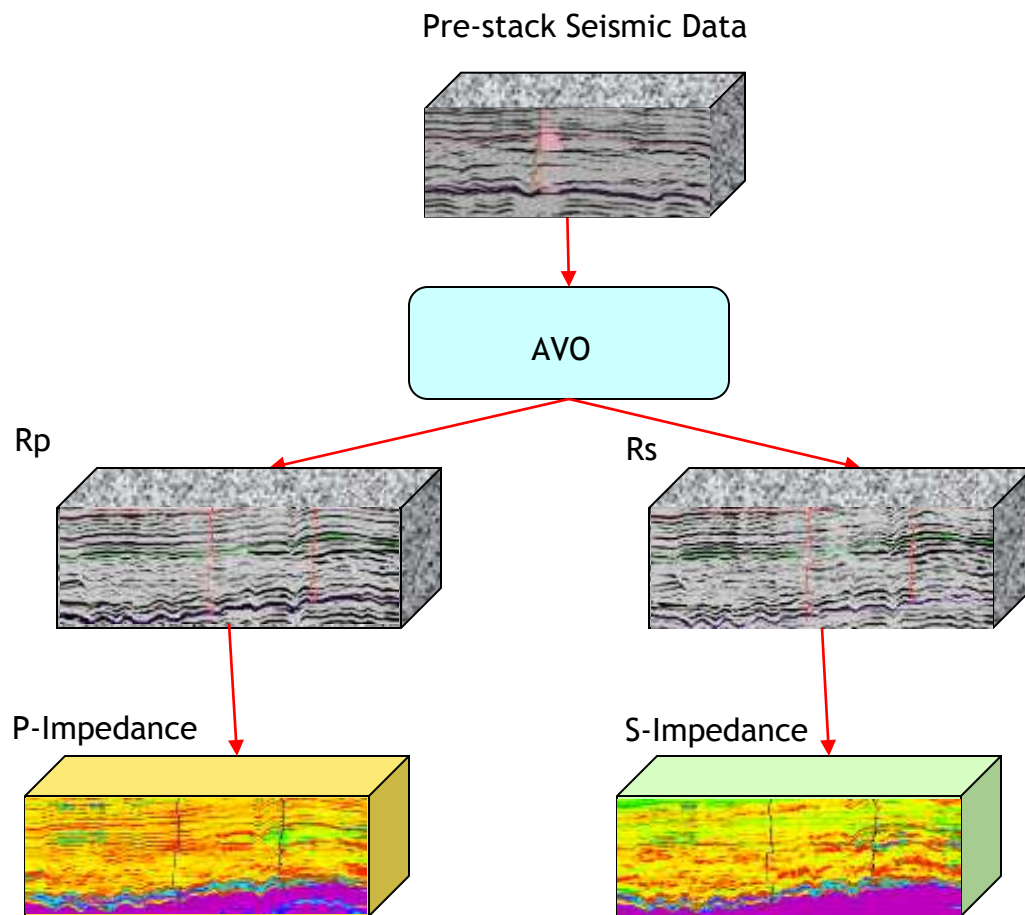


V1



Interpolated  
V1

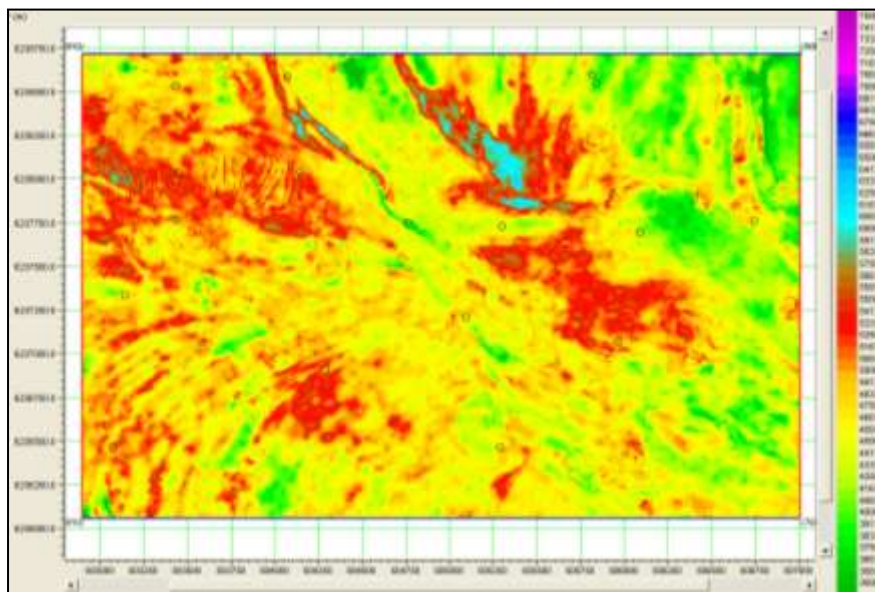




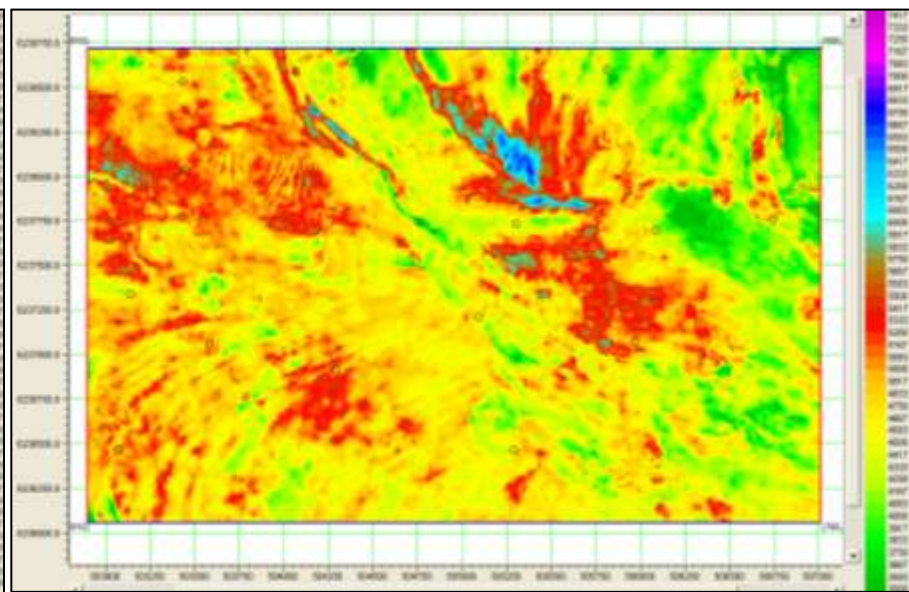


# P-impedance

## V1 and Interpolated V1



Original

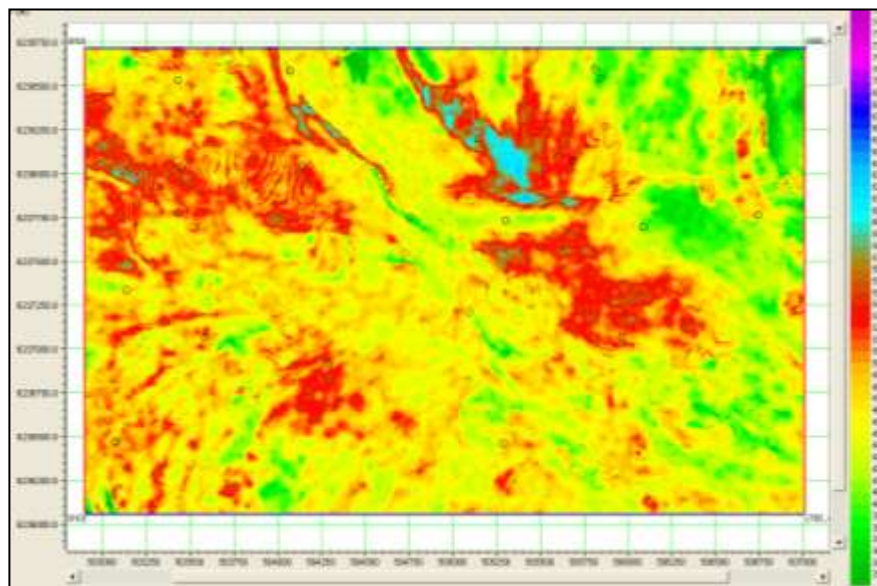


V1

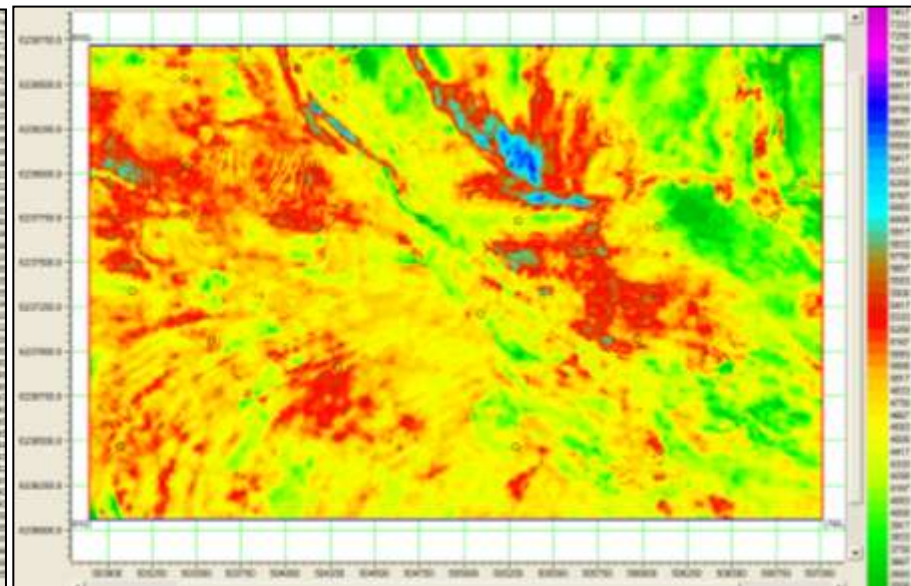


# P-impedance

## V1 and Interpolated V1



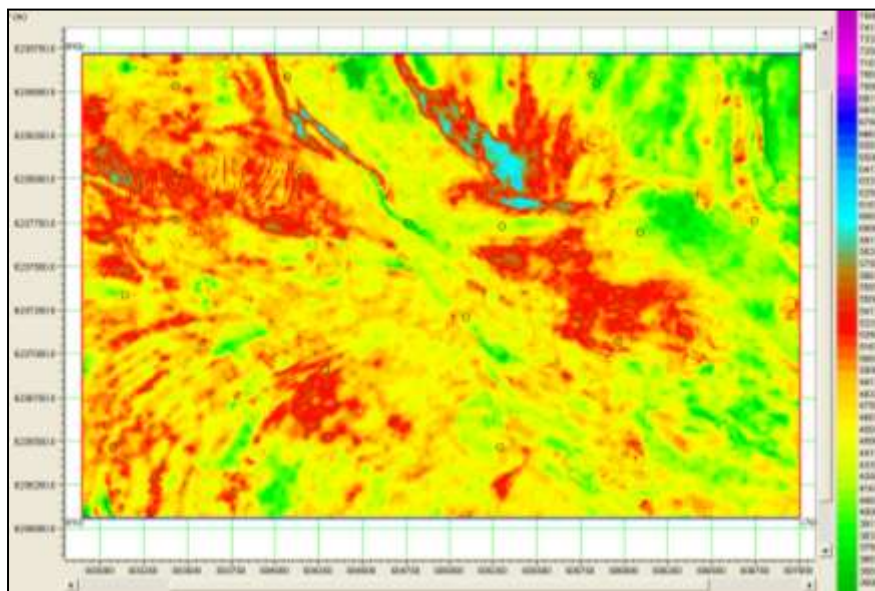
Interpolated V1



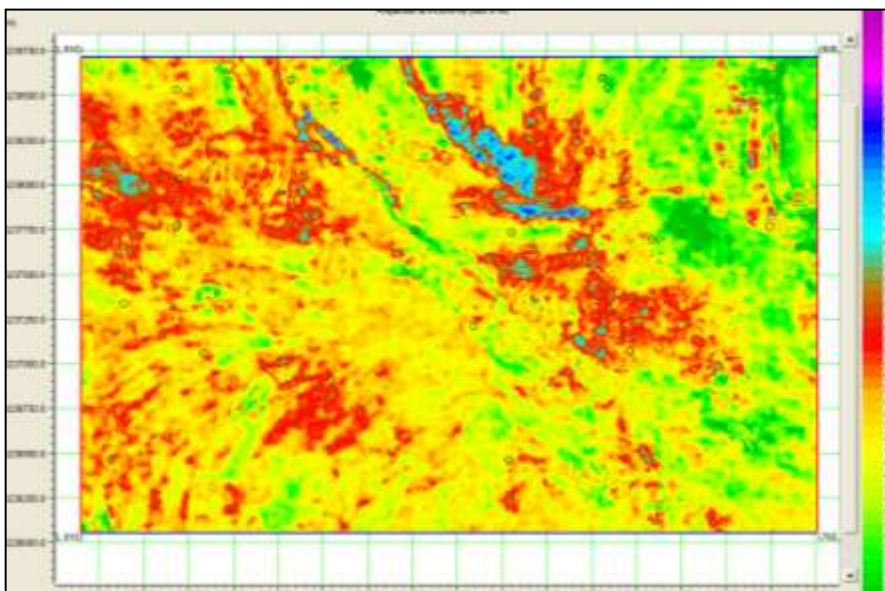
V1

# P-impedance

## V2 and Interpolated V2

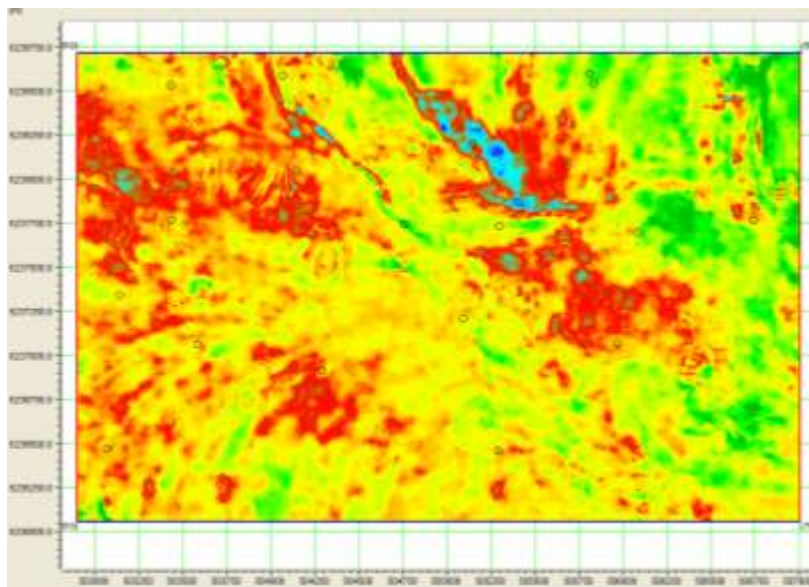


Original

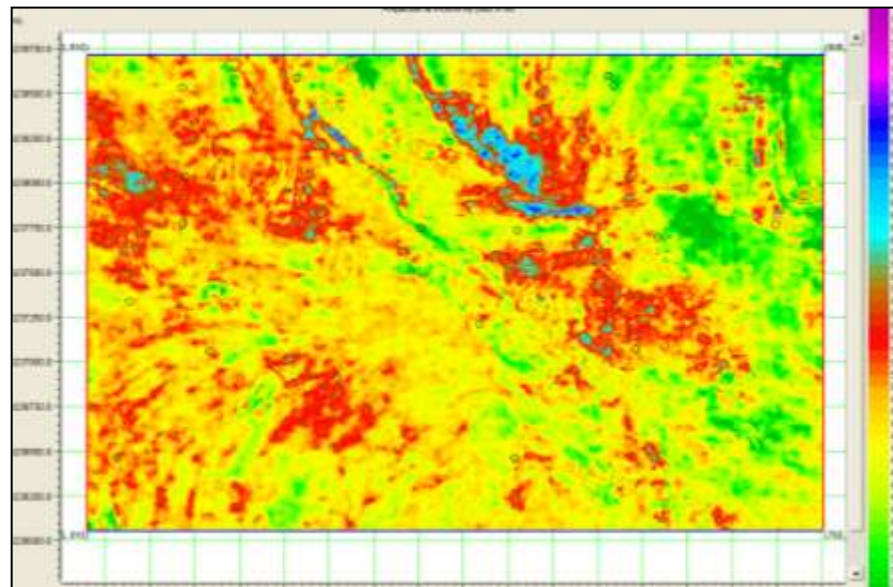


V2

# P-impedance V2 and Interpolated V2



Interpolated V2

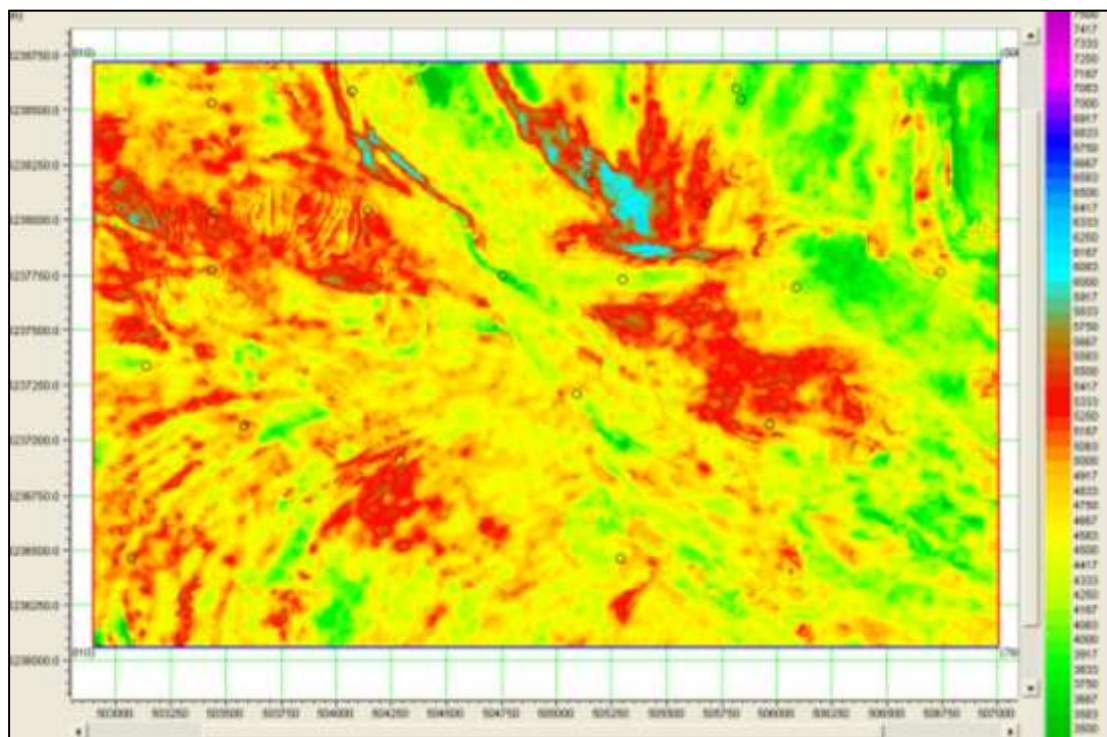


V2



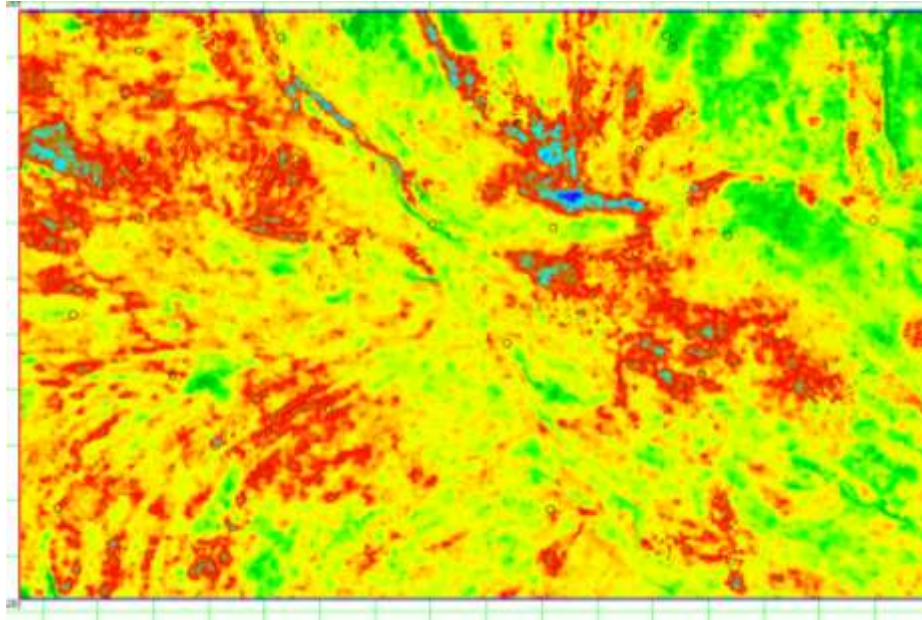
# P-impedance

## Original and Interpolated Original



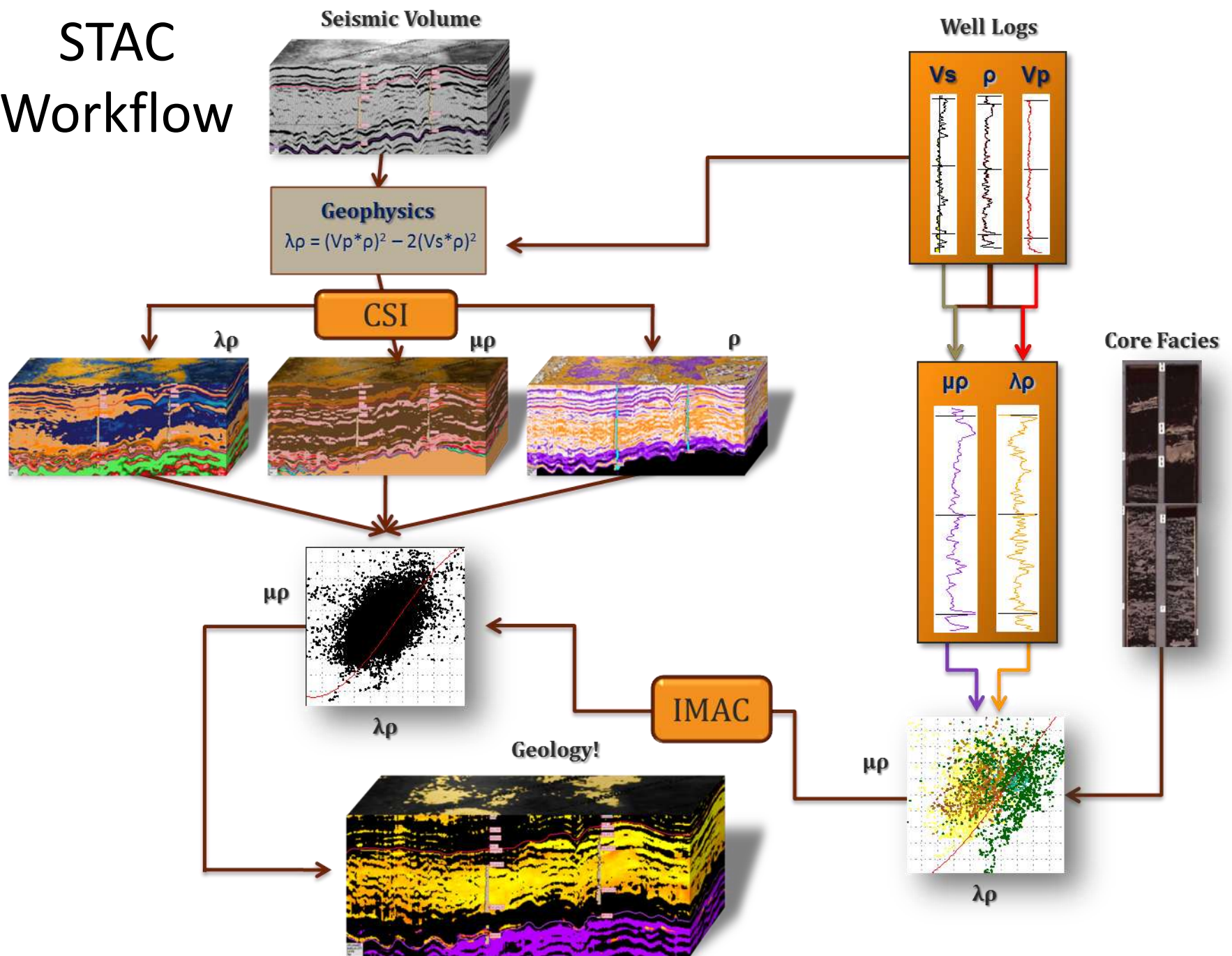
Original

# P-impedance Original and Interpolated Original



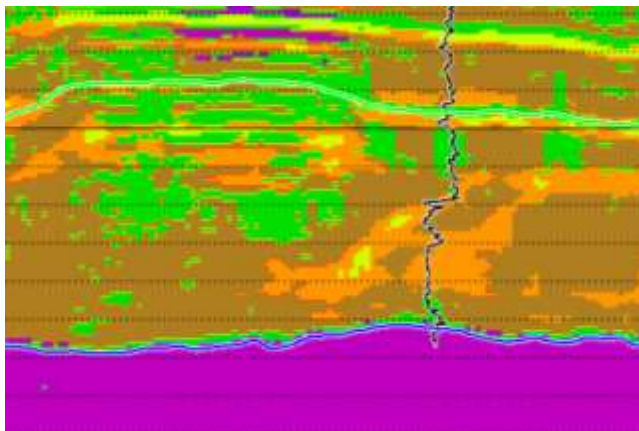
Interpolated Original

# STAC Workflow

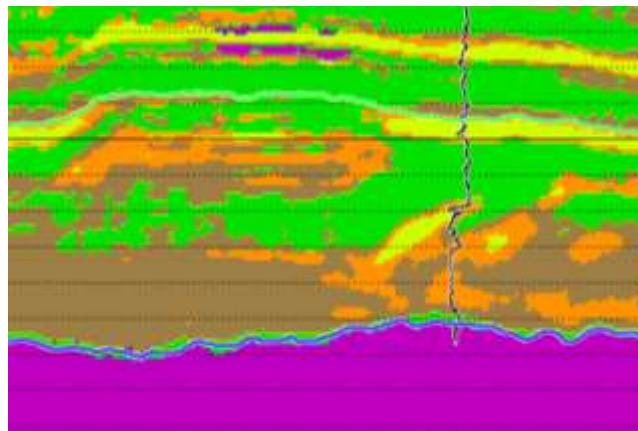




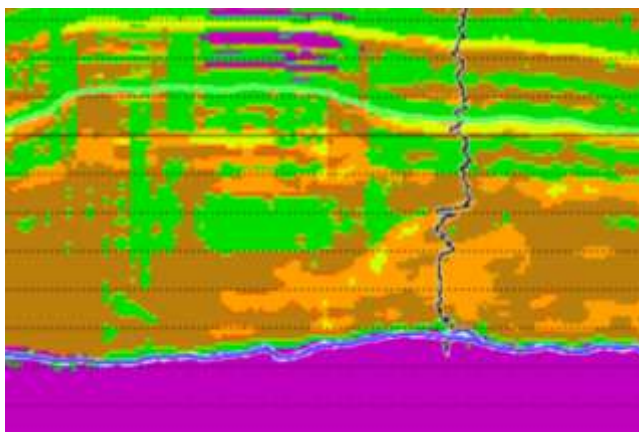
Original



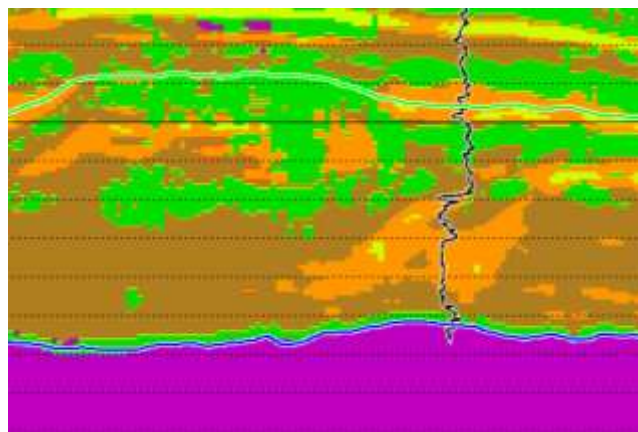
Interpolated  
Original



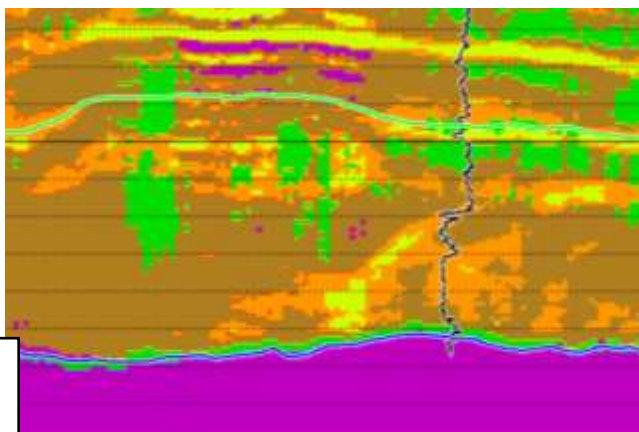
V1



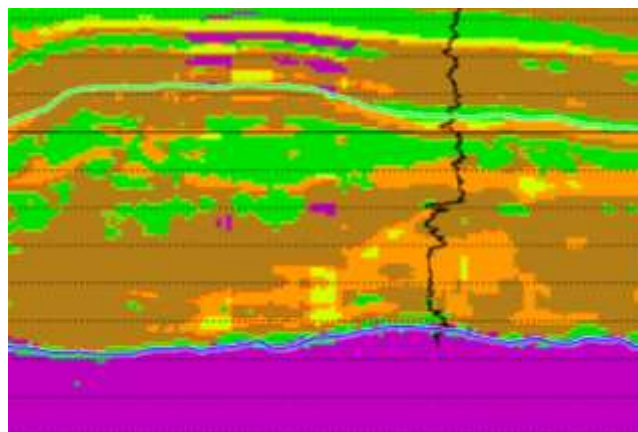
Interpolated  
V1



V2



Interpolated  
V2



- Shale
- Bitumen reservoir
- Wet reservoir
- Gas reservoir
- Devonian

- Distance to first trace in a CDP has a significant effect on AVO/inversion results – more so than the offset interval
- Both model and real data analysis shows resolution is affected by acquisition geometry
- Interpolation can benefit poorly sampled data for AVO
- Interpolation can improve apparently well-sampled data

- Nexen Canada Inc.
- Keith Wilkinson – Key Seismic
- Jeff Deere – Key Seismic