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Marvin Blan #1
Seismic Inversion of 2D data

(as performed by Stephanie Nowak)

Seismic Inversion Process

Seismic inversion attempts to remove the effect of the wavelet and return the actual earth model

Seismic = Wavelet * Reflectivity Series + Noise

1. Well-to-seismic tie = Wavelet estimation
   - A good tie (correlation coefficient between the real and synthetic seismic trace greater than 85%), is necessary to estimate the wavelet properly.

2. Seismic processing
   - Noise: Filters can be applied to reduce the noise contribution.
   - Scaling: The seismic data is often scaled for easier structural interpretation.

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- Purpose: To determine if seismic inversion can estimate porosity “sweet-spots” in the Knox

- General Conclusions:
  - Well log modeling of the Marvin Blan #1 indicates that acoustic impedance can be used to predict porosity
  - Seismic quality is poor – large bandwidth to the data, but most of the high frequency signal is most probably noise (high frequency component cannot be modeled in the well logs)
  - Well-to-seismic tie is poor, which leads a poor inversion result
  - Filtering the seismic data produces a better well-to-seismic tie, but produces a low frequency inversion very similar to the background model
  - Lack of additional wells to tie to seismic makes it difficult to check the inversion accuracy

- My Opinion:
  - The Knox has little acoustic impedance variability – the changes are low frequency
  - High frequency changes predicted by the inversion are suspect – the tie is just not good enough for a reliable prediction at a small scale
  - Cleaning up the gathers may improve data quality

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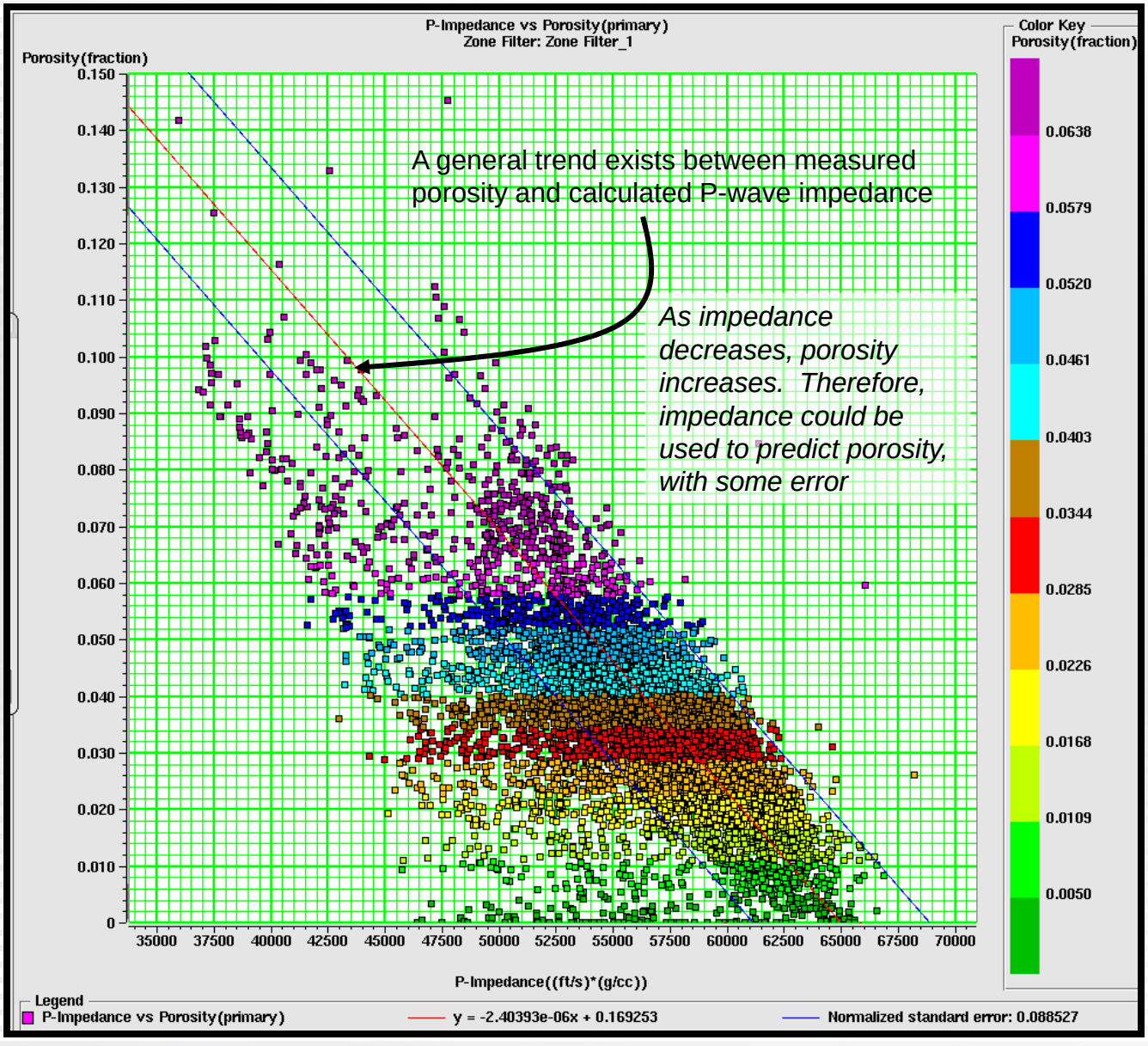
Porosity vs. Calculated P-Impedance for the Marvin Blan #1



Knox Interval Plotted, with Rose Run Sandstone removed from analysis window

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Inversion Conclusions

- Knox can be broken down into two acoustic impedance zones
  - Upper Knox (Beekmantown) is lower relative impedance
  - Lower Knox (Copper Ridge) is higher relative impedance
- Porosity
  - The inverse relationship between impedance and porosity suggests that the Upper Knox is more porous than the Lower Knox
  - No significant change in porosity associated with faulting

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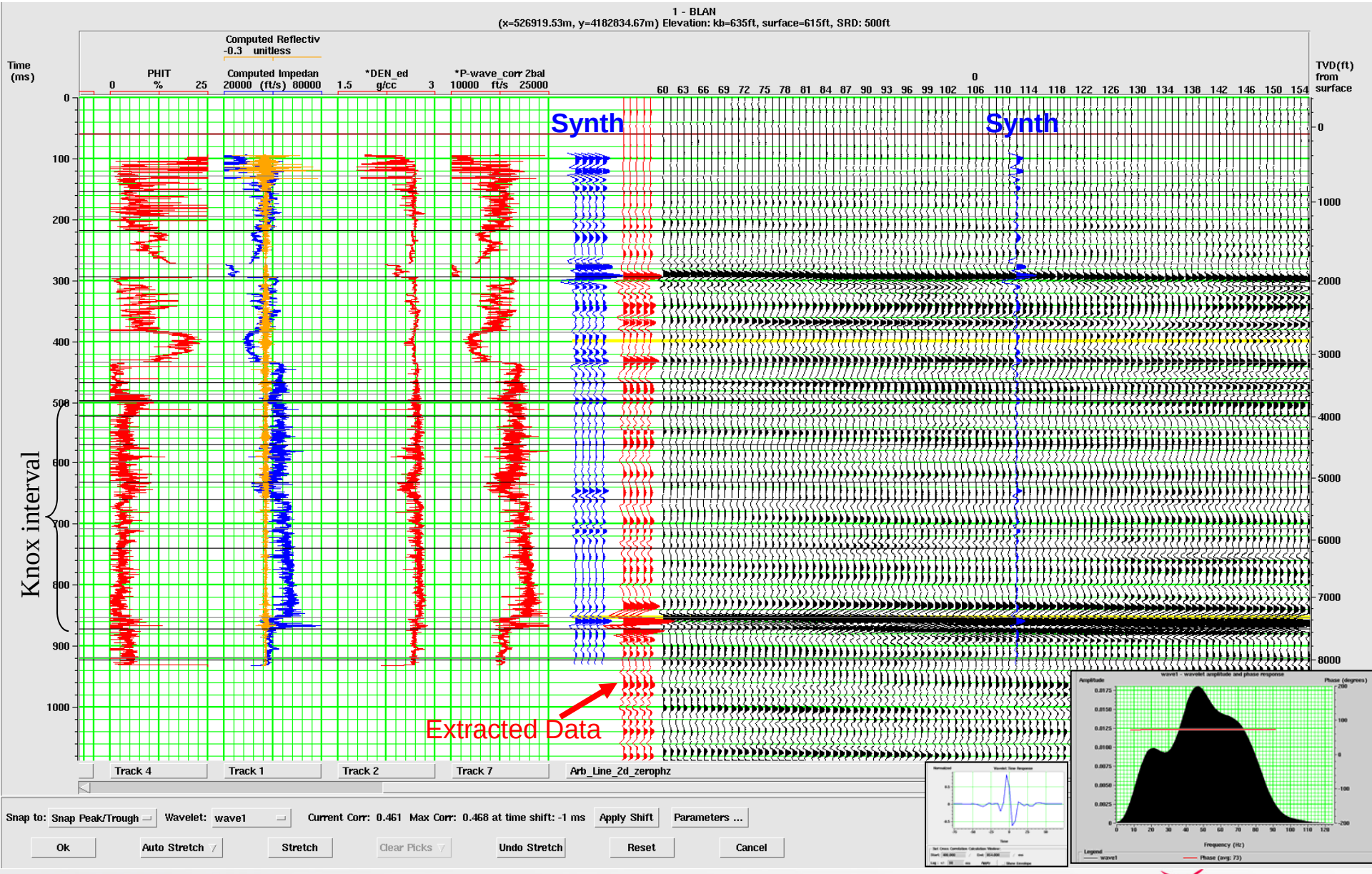
Well To Seismic Tie – Marvin Blan #1 to L201



Correlation between well and seismic is 46%, probably due to seismic data quality and the fact that the well is ~1200 ft off the seismic line.

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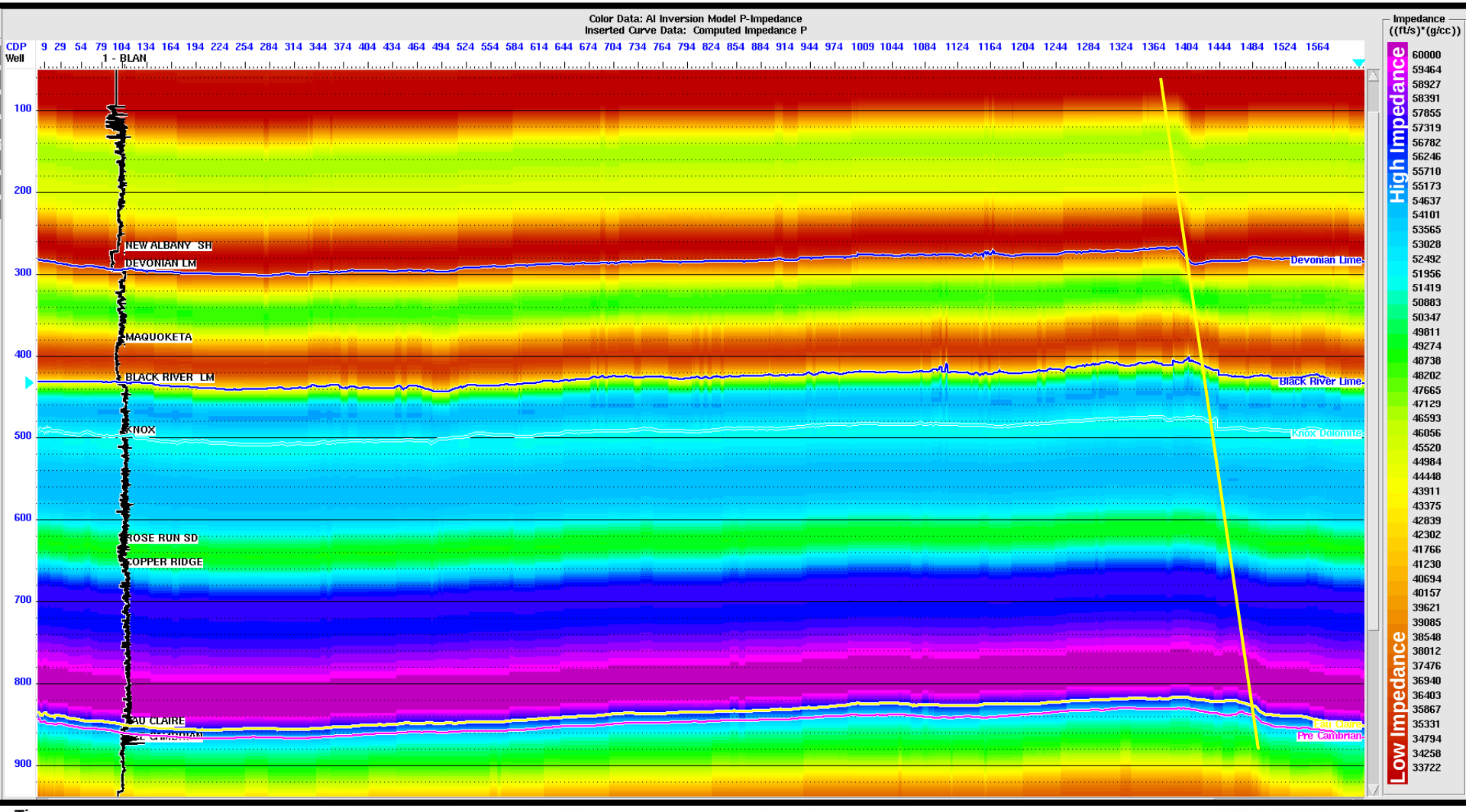
Low Frequency Background Model

– Low frequency version of P-Impedance from well interpolated along horizons



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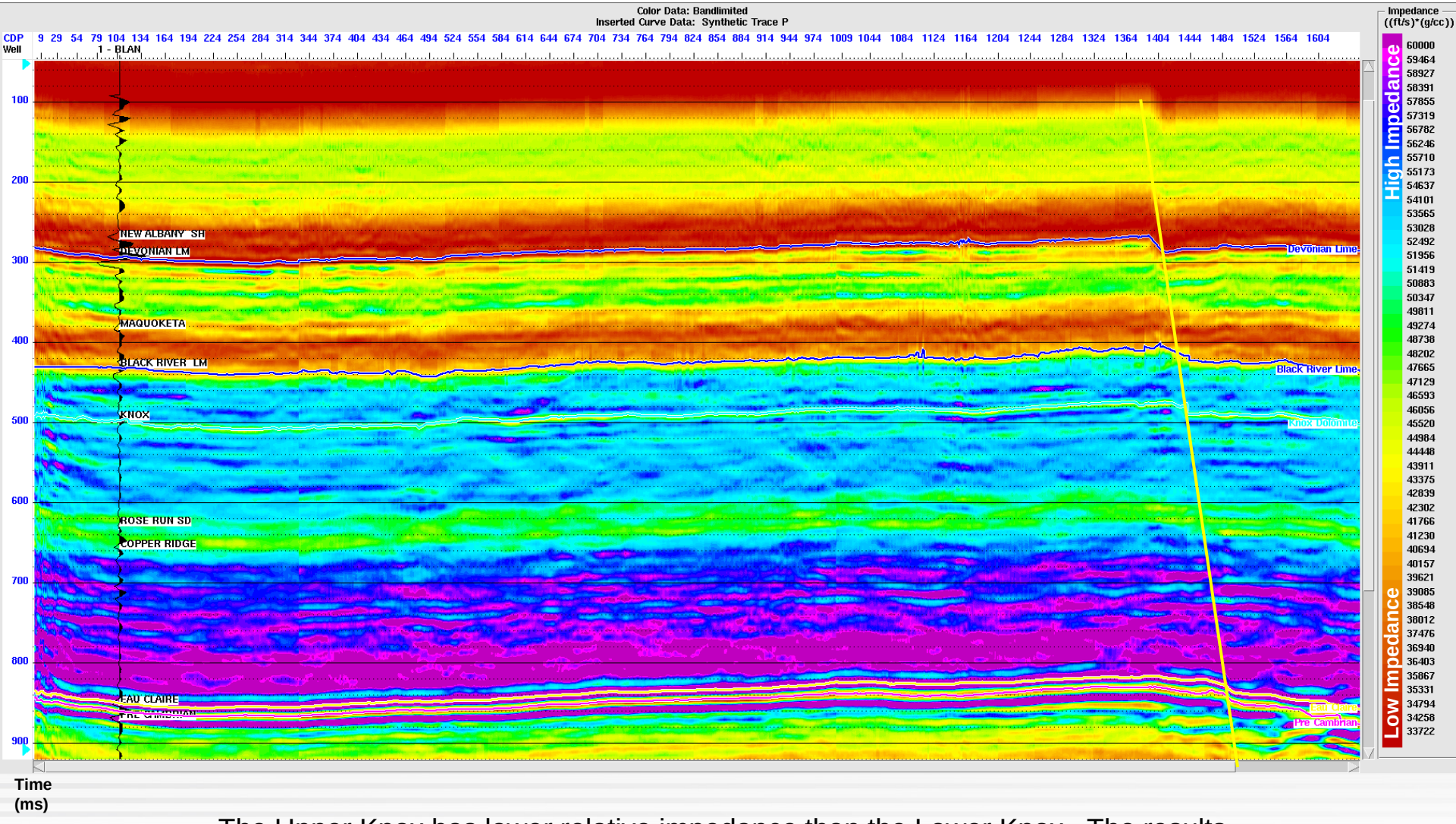
Band-limited Inversion Result



The Upper Knox has lower relative impedance than the Lower Knox. The results do not suggest lower impedance surrounding the fault location.

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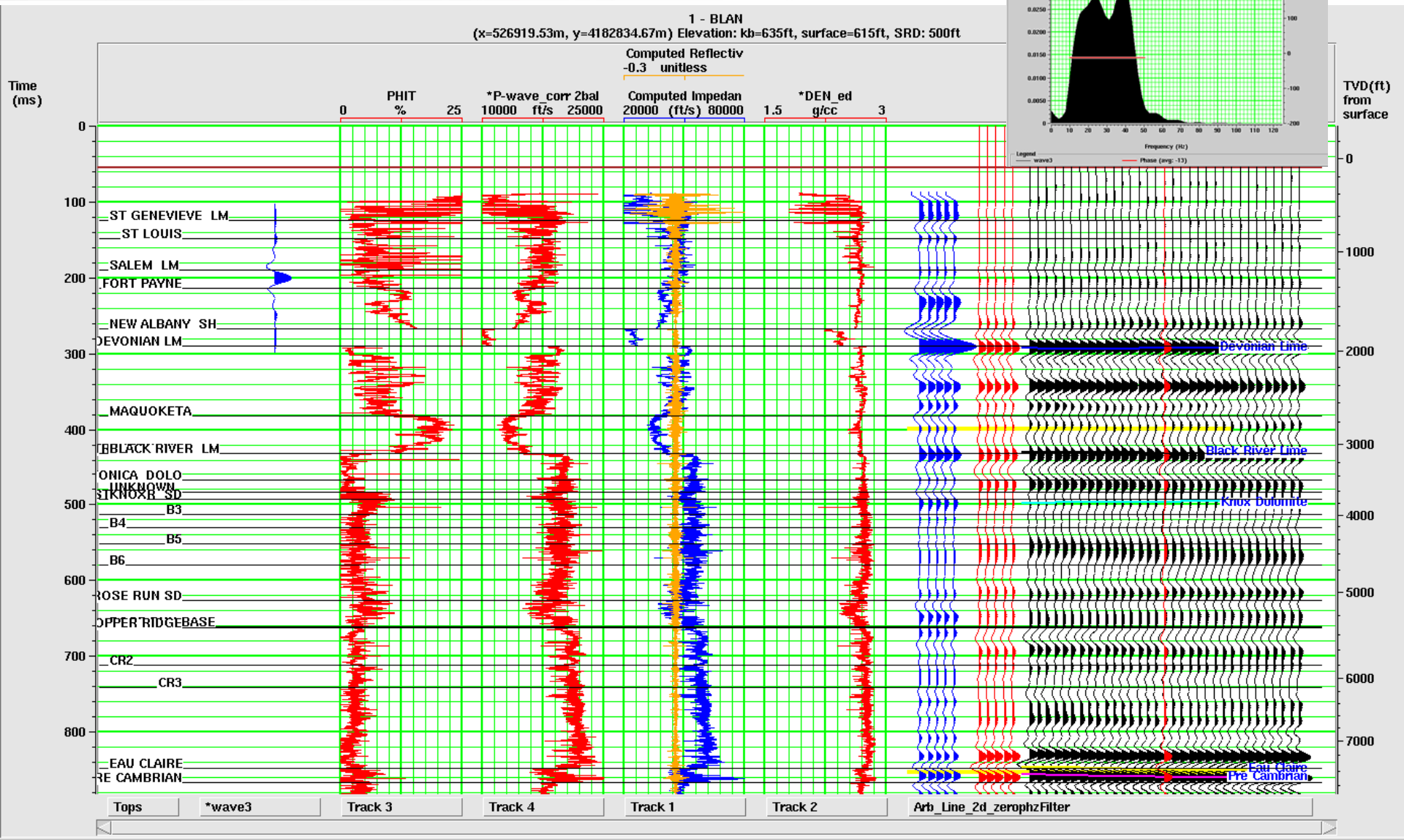
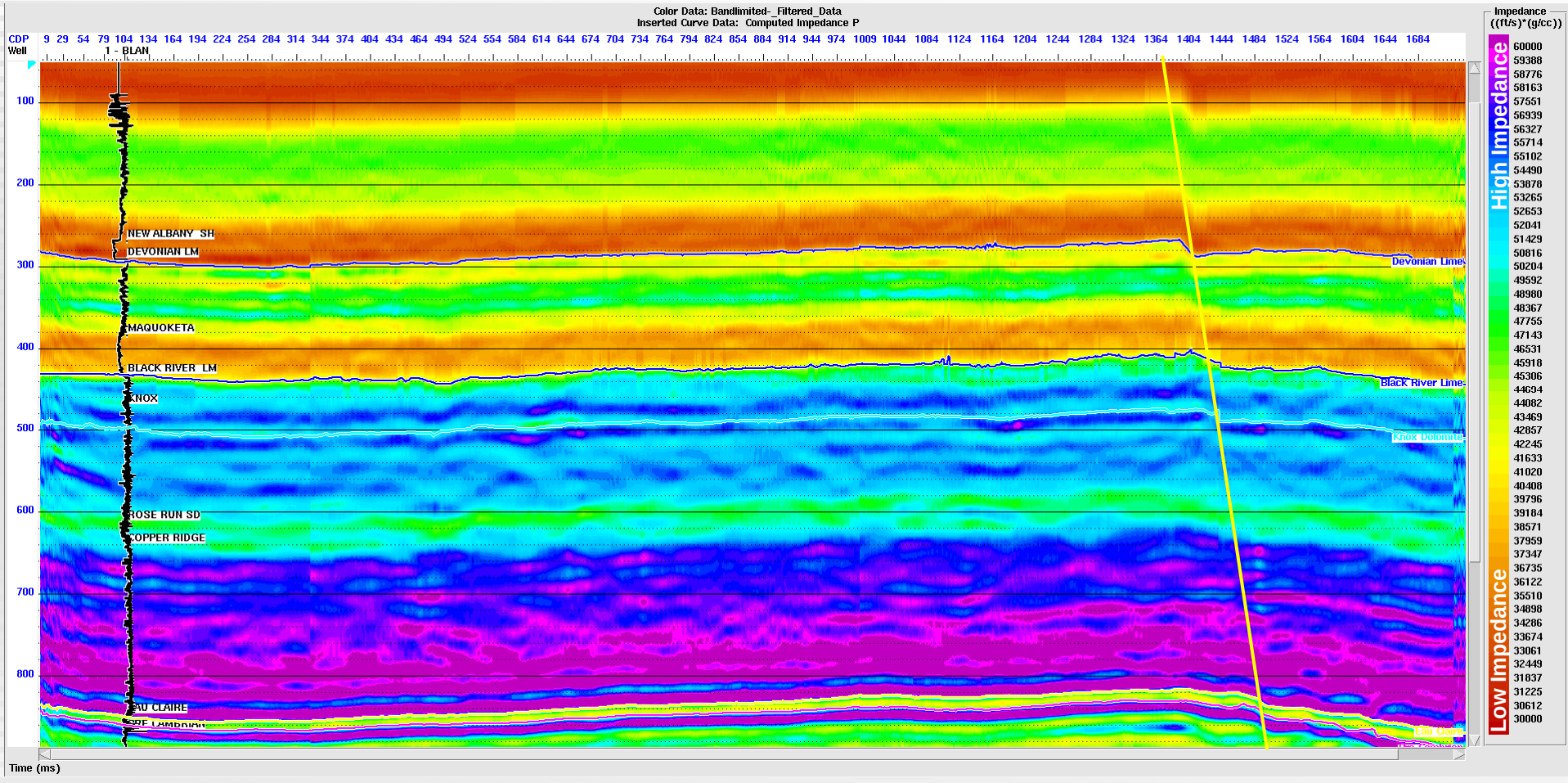
Well-to-Seismic Tie on Filtered Seismic Data



63% Correlation

Seismic data filtered 0-12.5-38-55

Band-limited Inversion Result – Filtered Seismic Data



Filtered data gives a low frequency similar to background model.

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Back-ups

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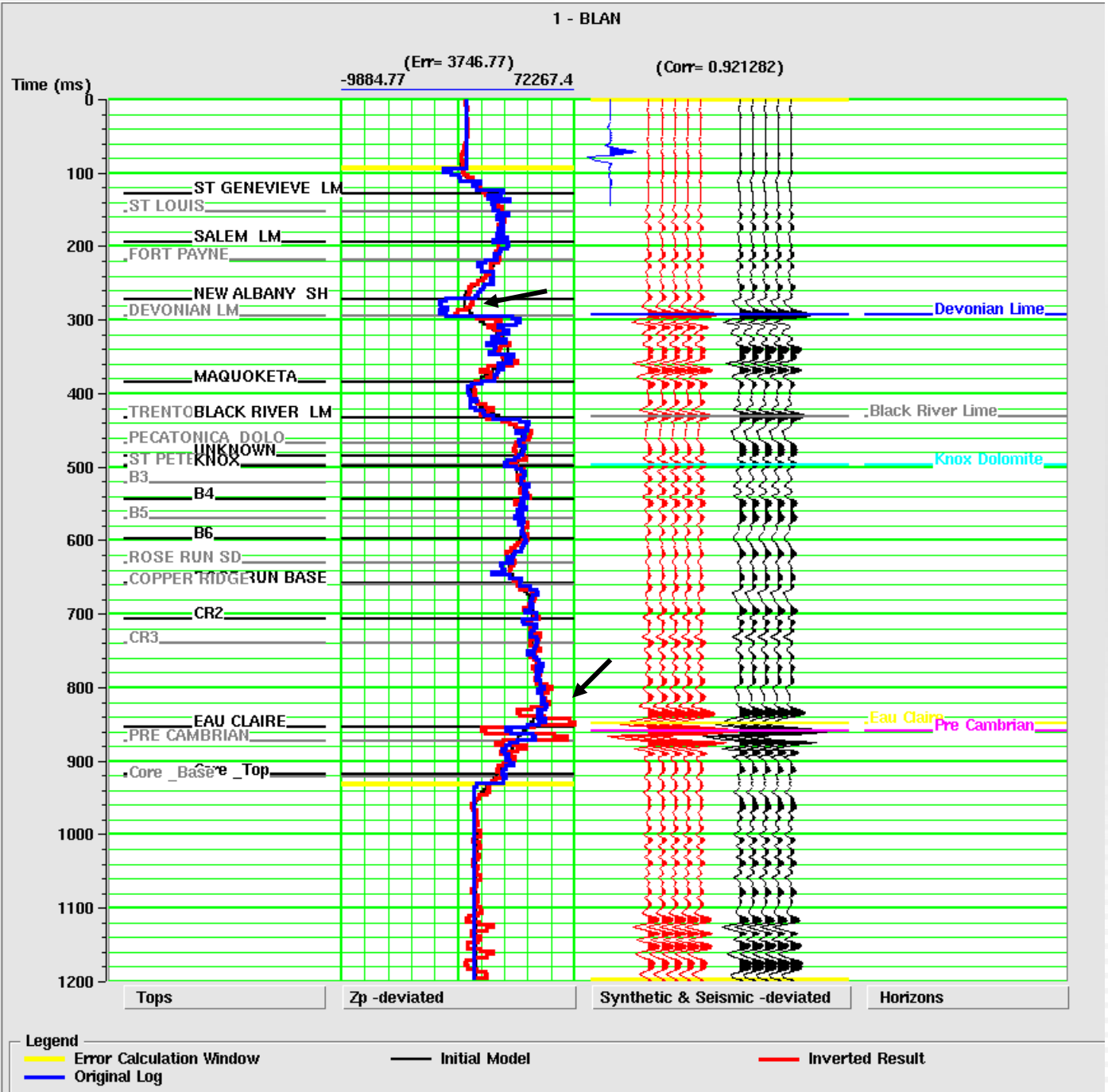
Bandlimited Inversion – Log Vs. Inverted Result



Bandlimited Inversion with 35Hz High –Cut Frequency Constraint.

Character of original log (blue) is preserved with inversion (red), although scale is not (note arrow locations)

*The next slide shows two cross-plots: one showing the original log vs. the inverted result and another showing the inverted results vs. the background model (black)

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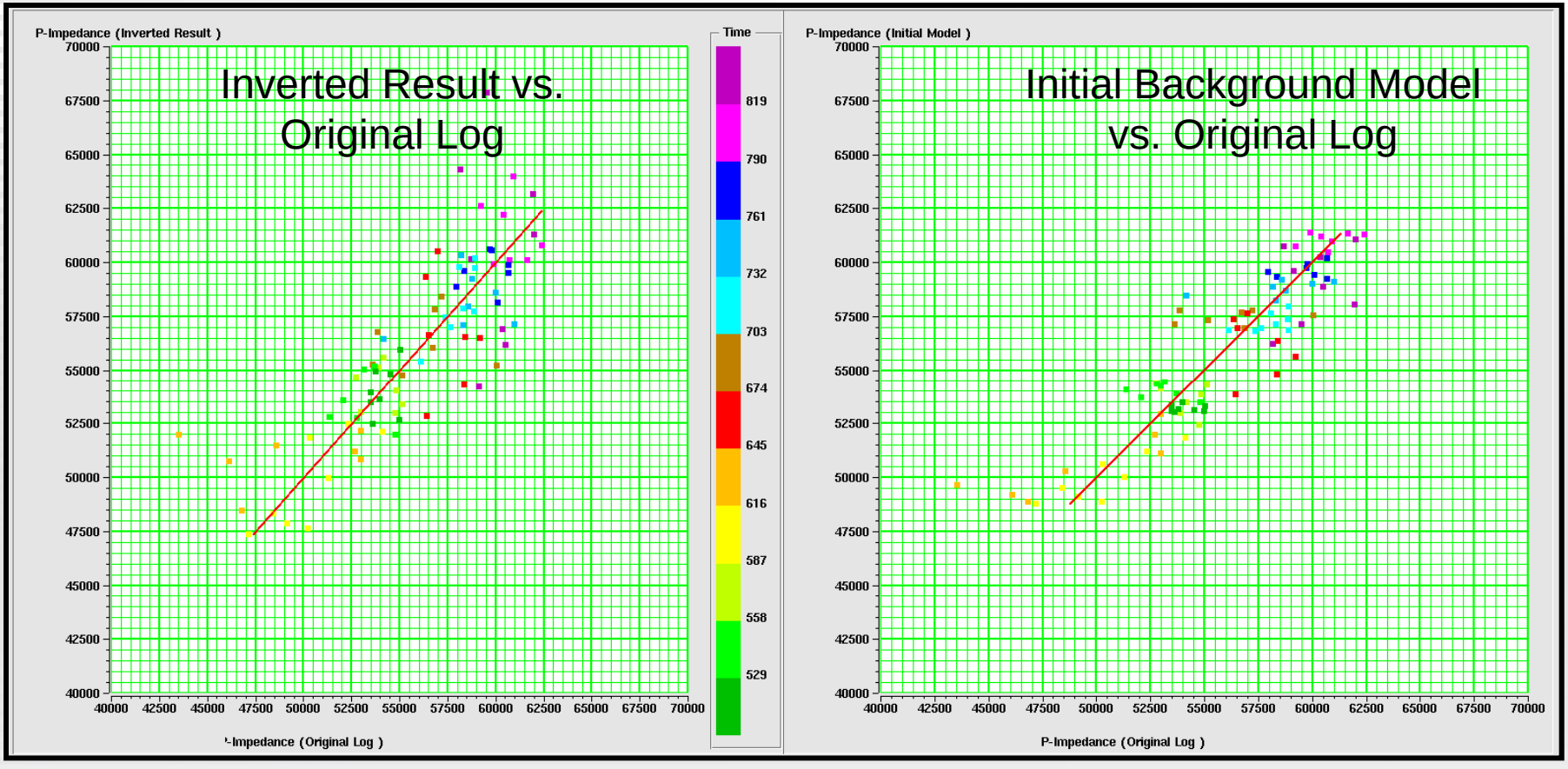
Bandlimited Inversion – Log Vs. Inverted Result



The inverted results for the Knox formation (both upper and lower) show about the same amount of error, but results are more scattered than the plot of the initial background model vs. original log. This indicates that the seismic is not adding any additional accuracy to our inversion.

The initial background model appears to closely approximate the actual impedance at the well location. The Knox does not have much inter-formational impedance variability, so a smooth background model will closely approximate the log response.

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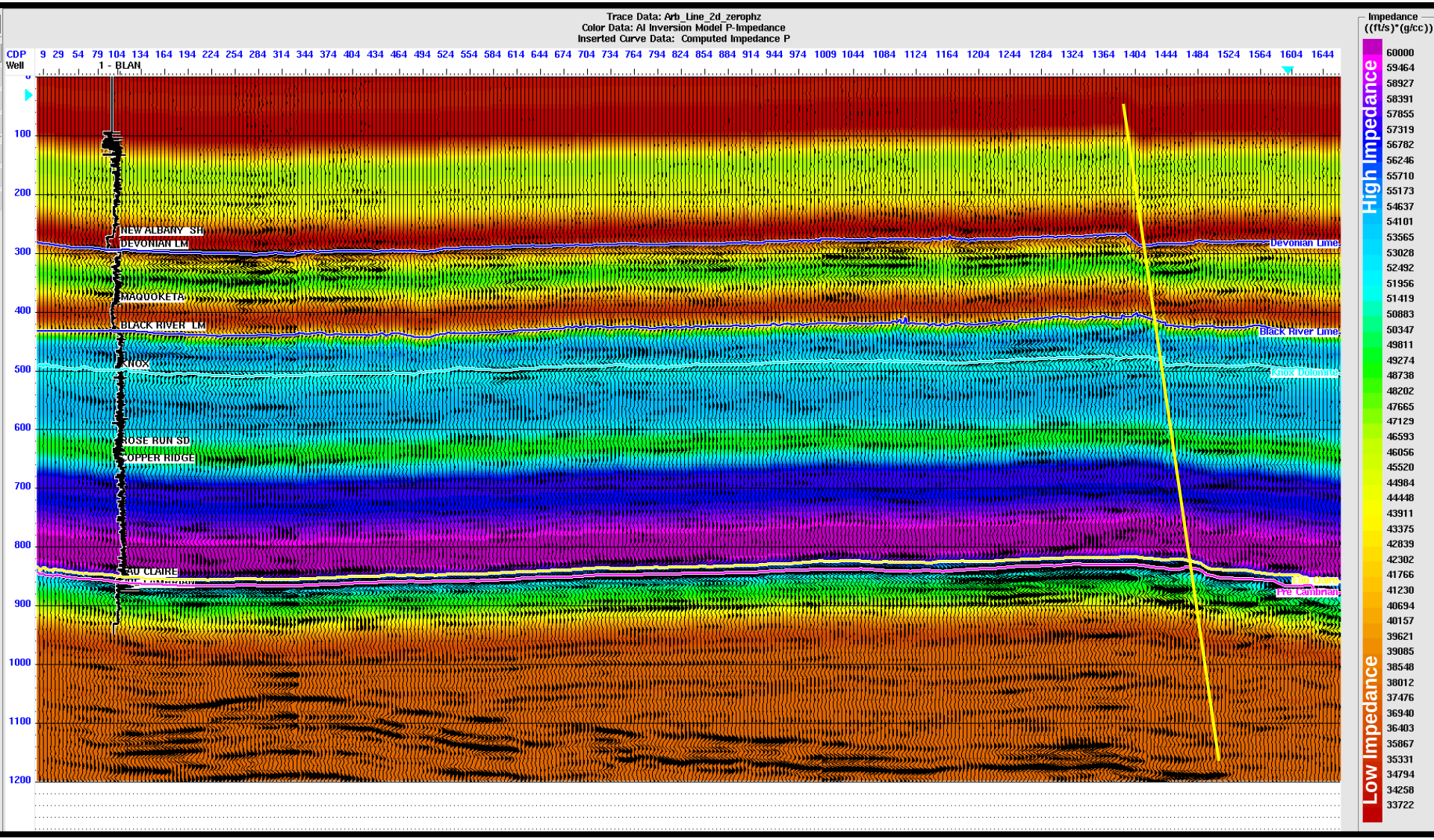
Low Frequency Background Model

– Low Frequency version of P-Impedance from Well Interpolated along Horizons



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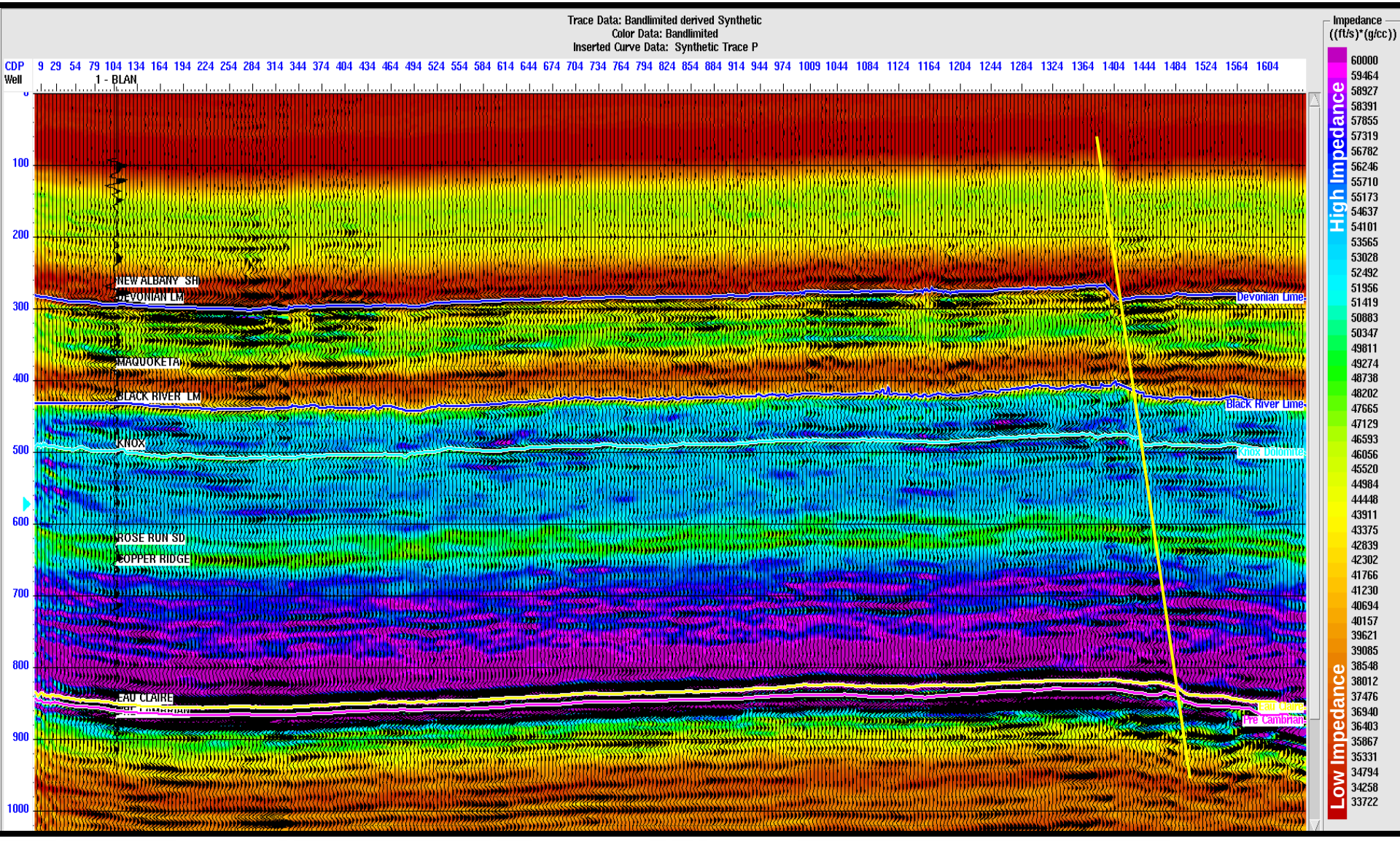
Band-limited Inversion Result



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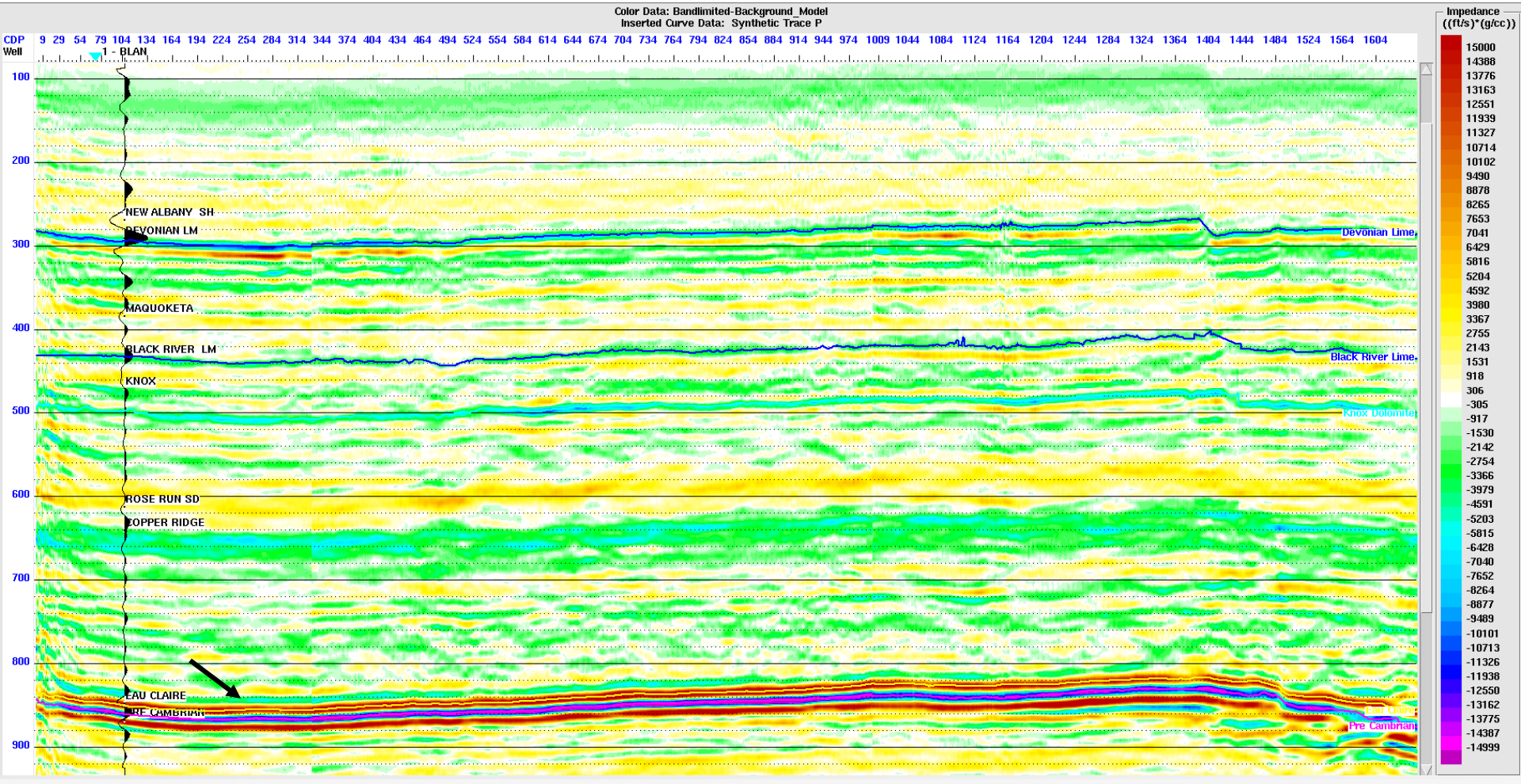
Inverted AI (Bandlimited) with background AI removed



Note the strong deviation from background at the EauClaire and Precambrian horizons

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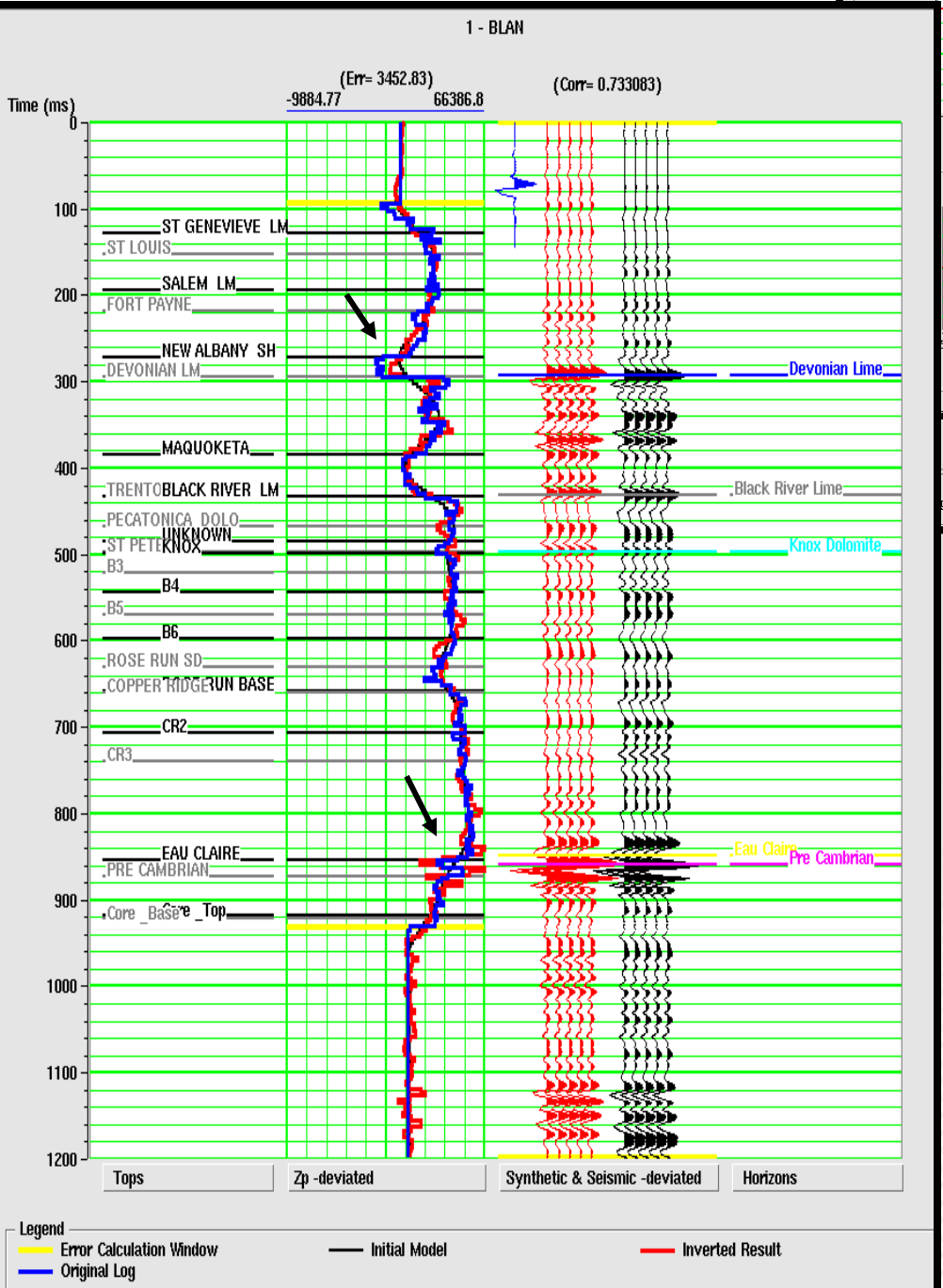
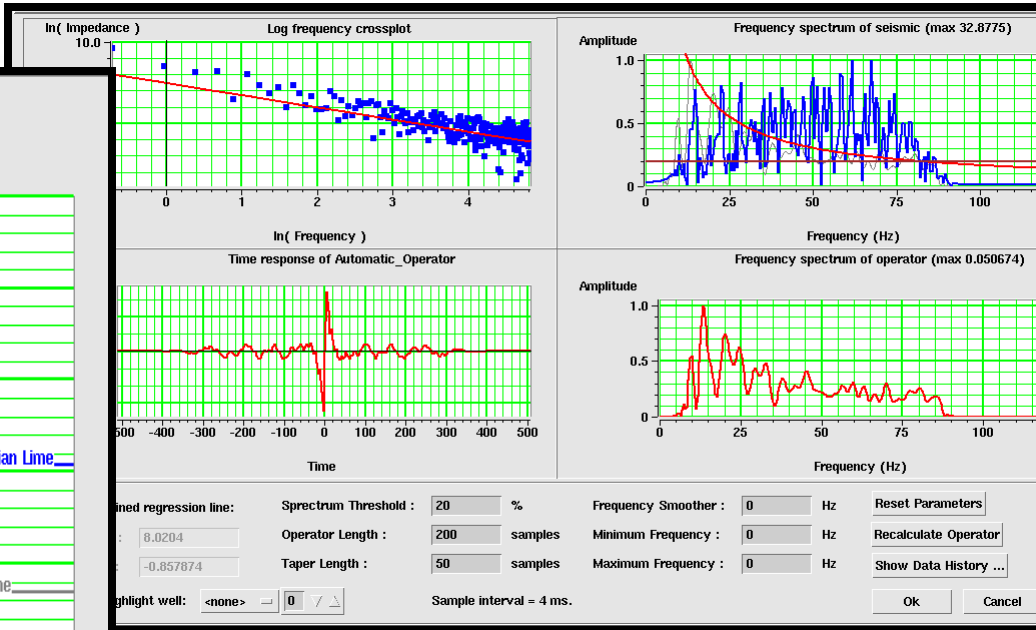
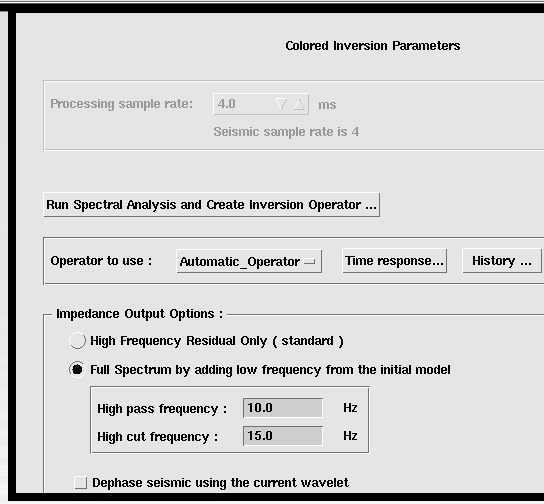
Colored Inversion







73% Correlation between modeled and real seismic data

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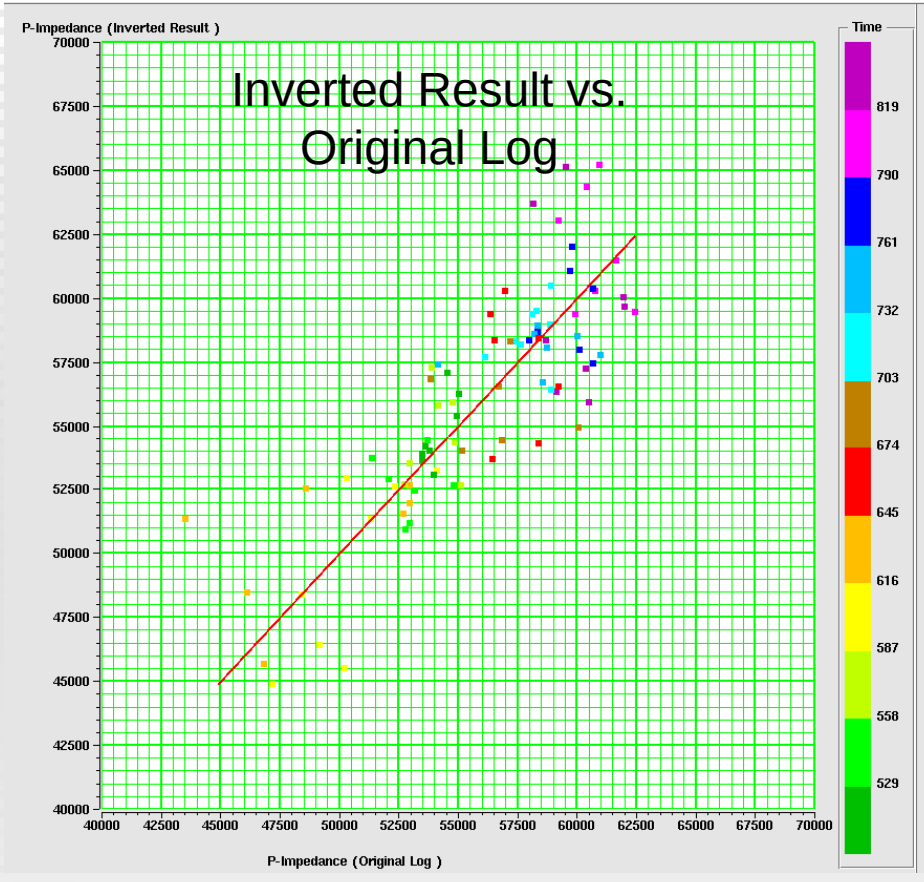
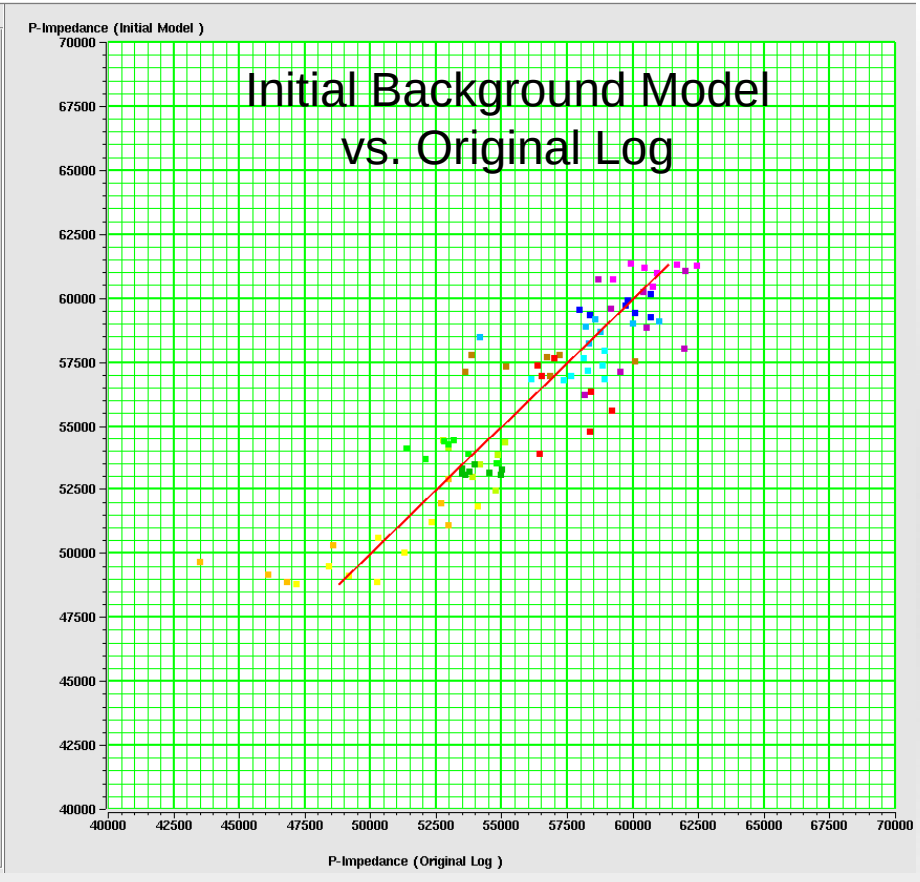
Colored Inversion





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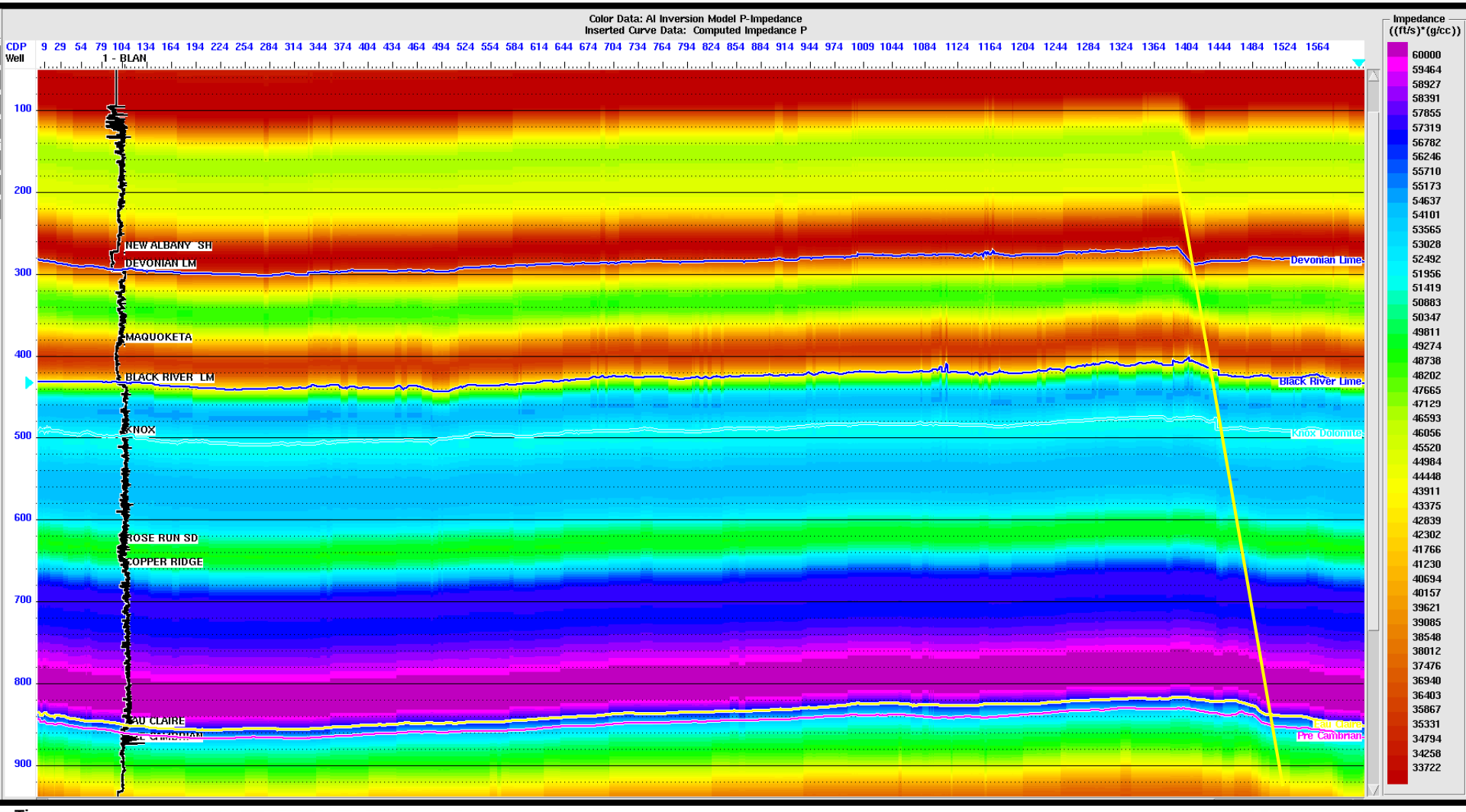

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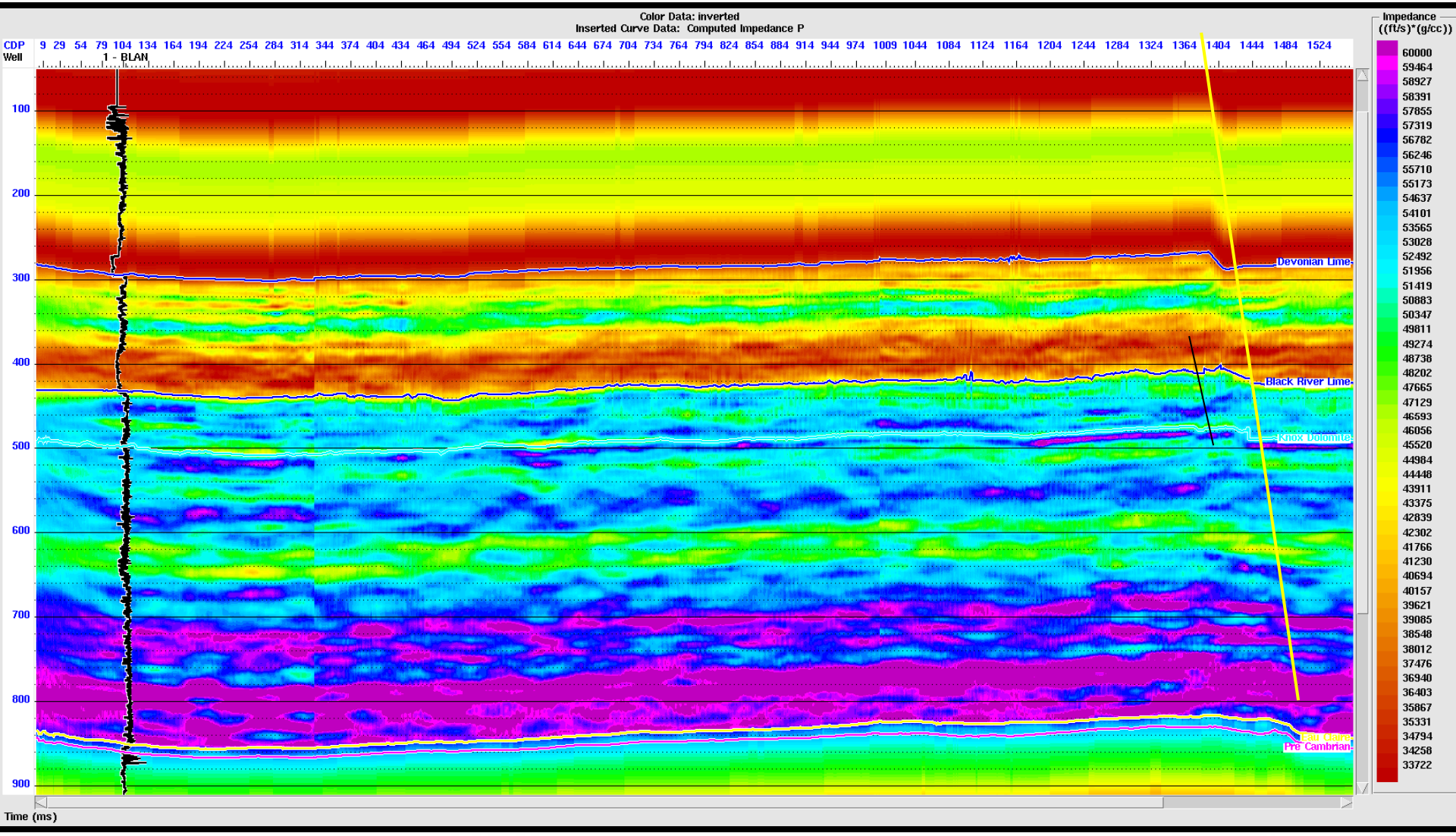
Colored Inversion Result



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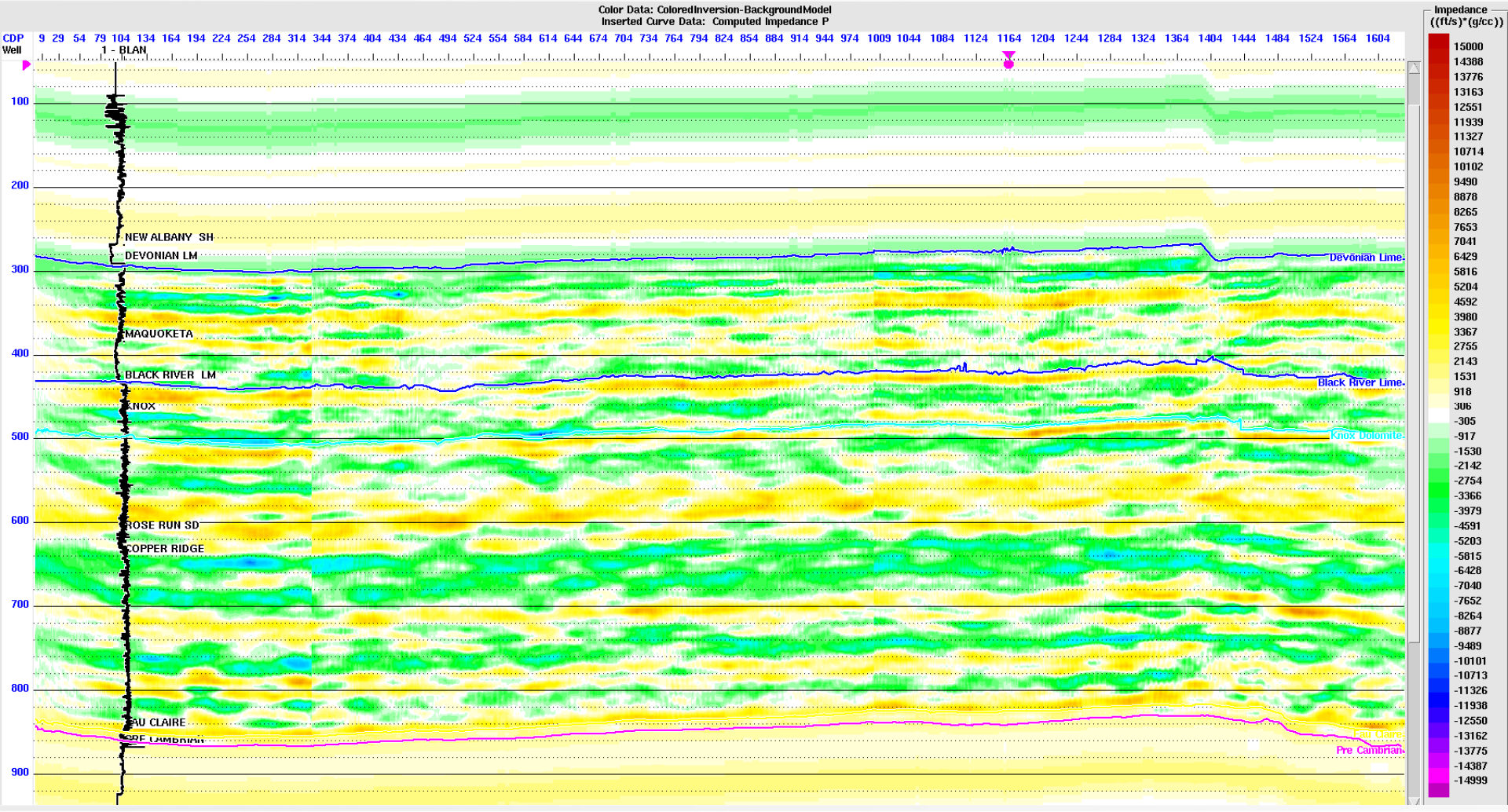
Inverted AI (Colored Inversion) with background AI removed



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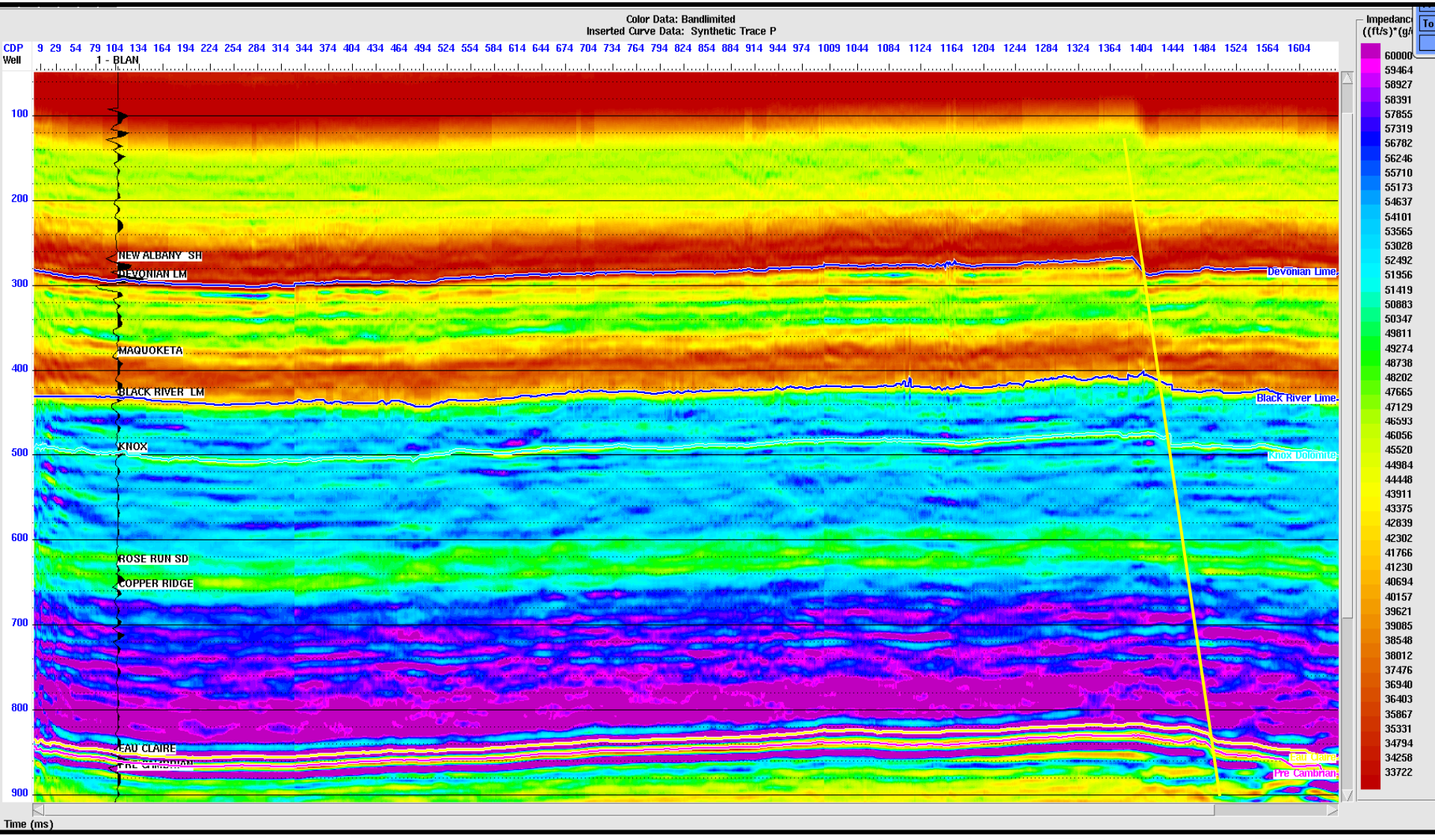
Band-Limited Inversion Result



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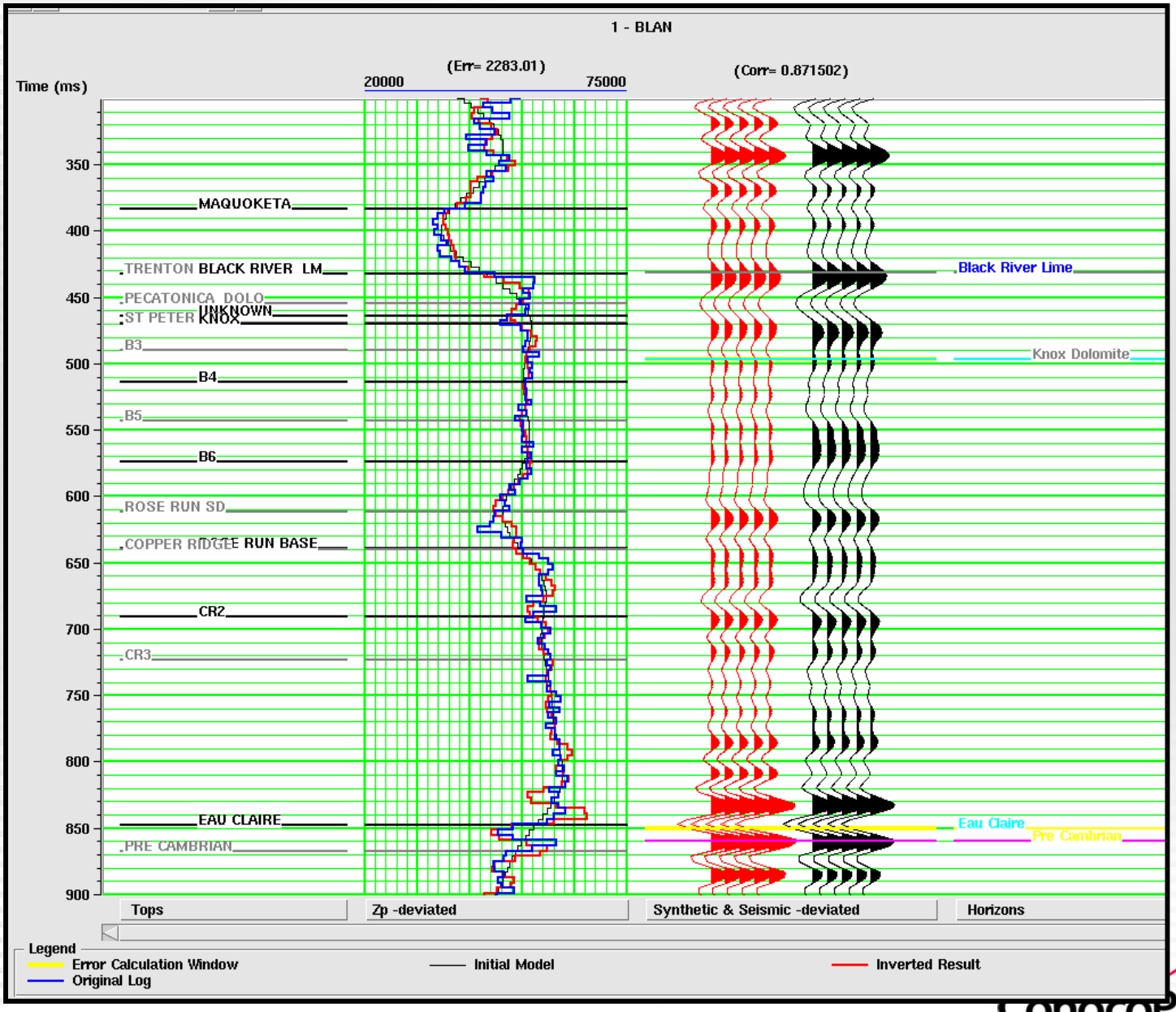
Bandlimited Inversion – Filtered Seismic Data



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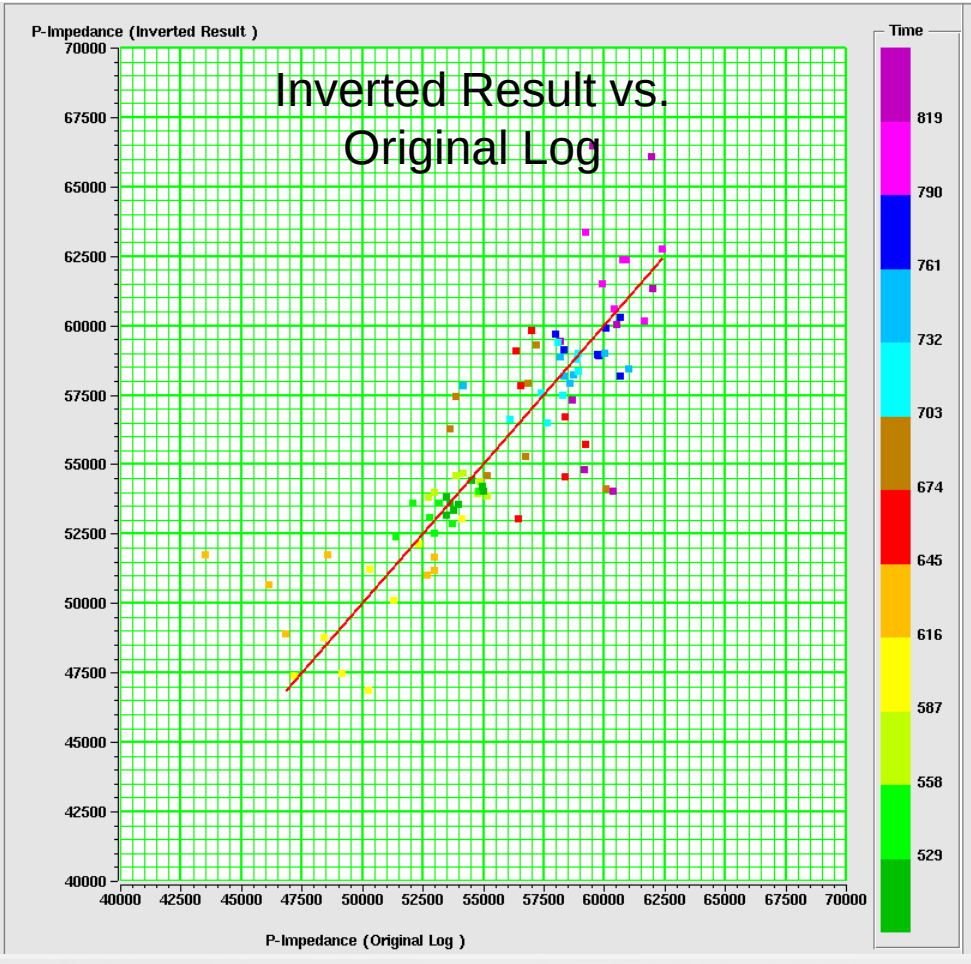
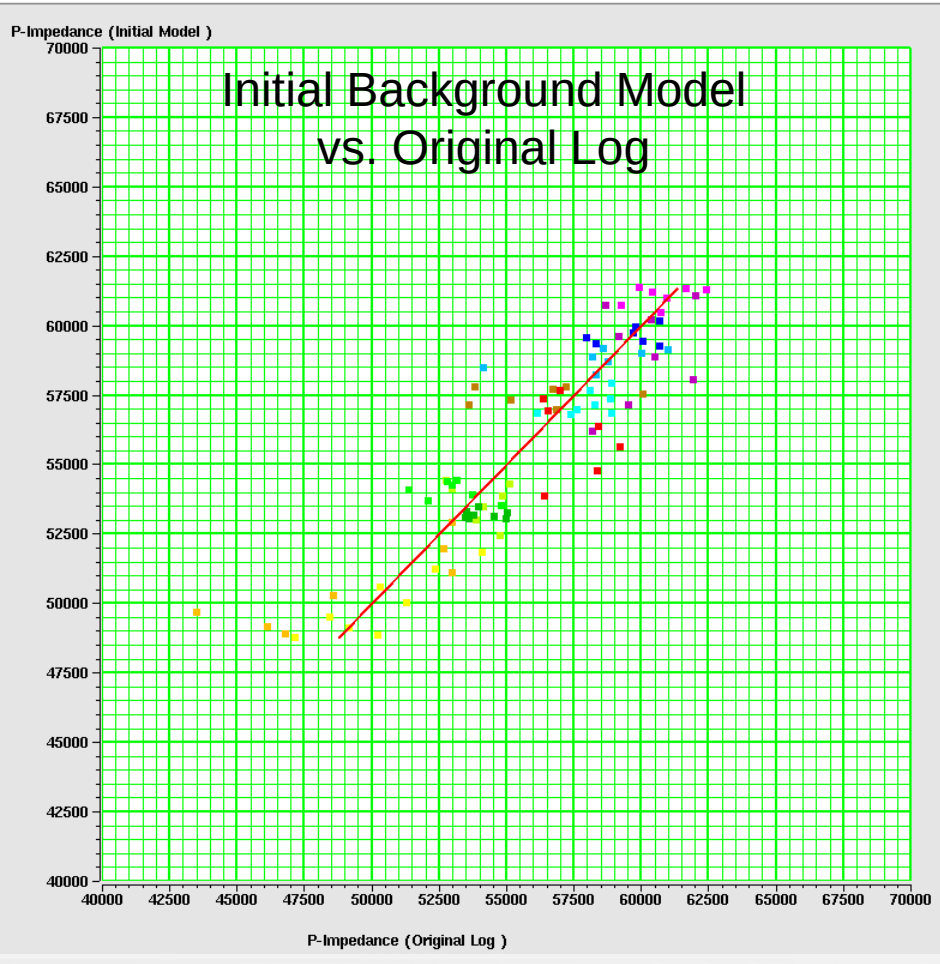
Seismic data filtered 0-12.5-38-55





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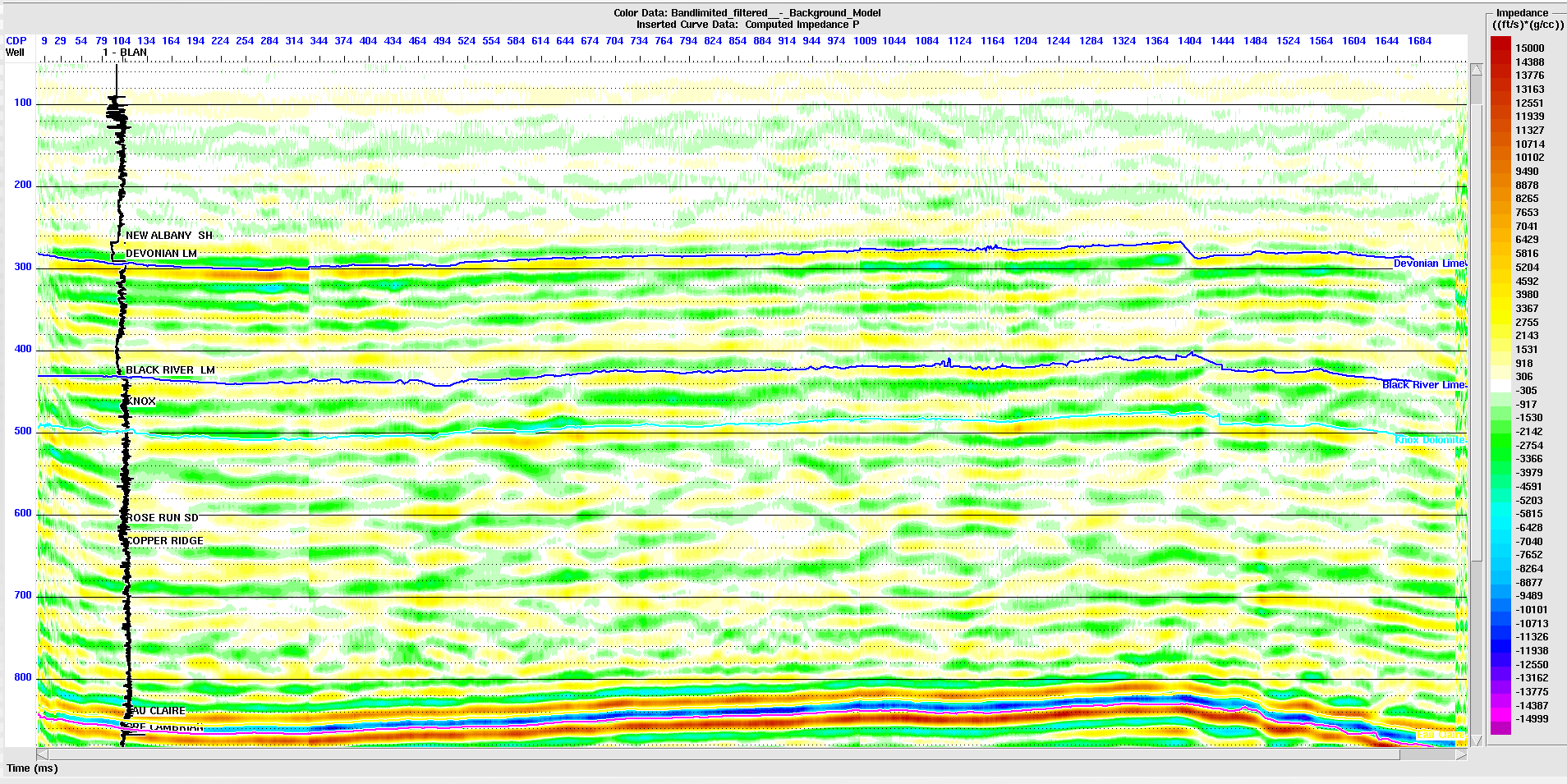
Bandlimited Inversion – Background Model



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