Improved resolution in depth imaging through reflection static corrections derived from model-based moveout

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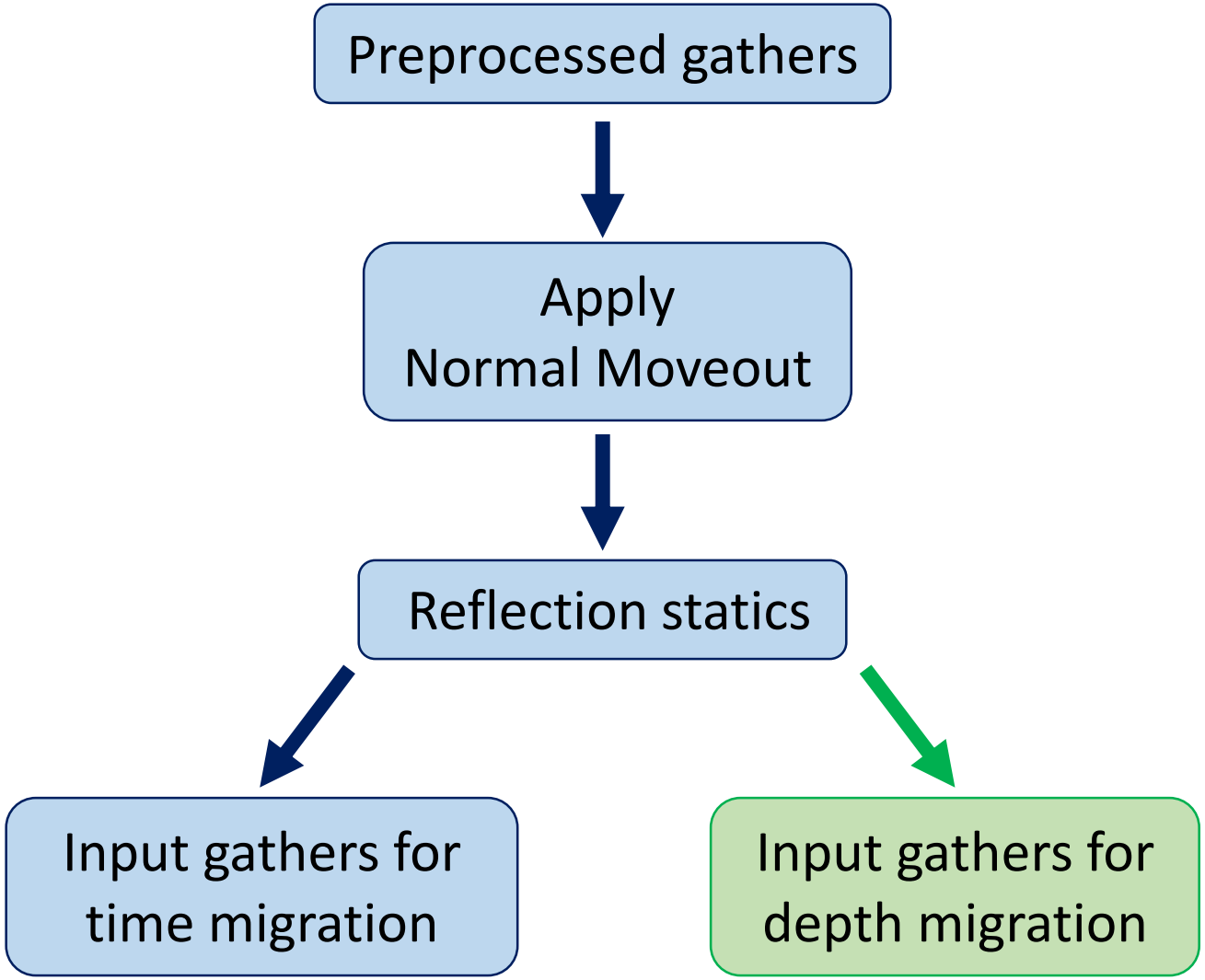
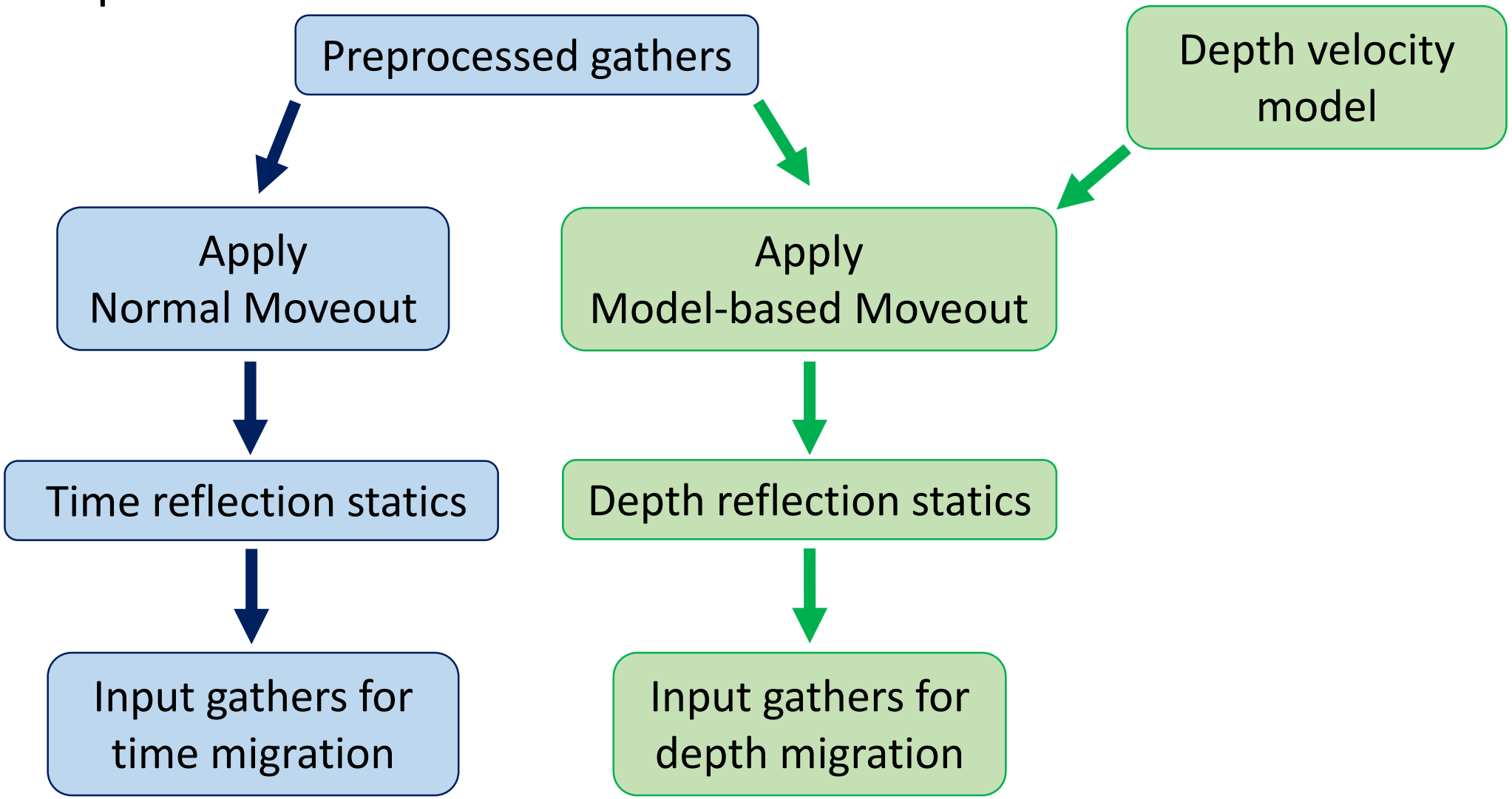
Outline

- Why
  - Definitions
  - Assumptions
  - Background
- How
  - Methodology
- What happened
  - Results
  - Conclusions
- Where to go from here
  - Future work
- Acknowledgements

Traditional statics workflow



Migration specific statics workflow



Definitions

Weathering layer

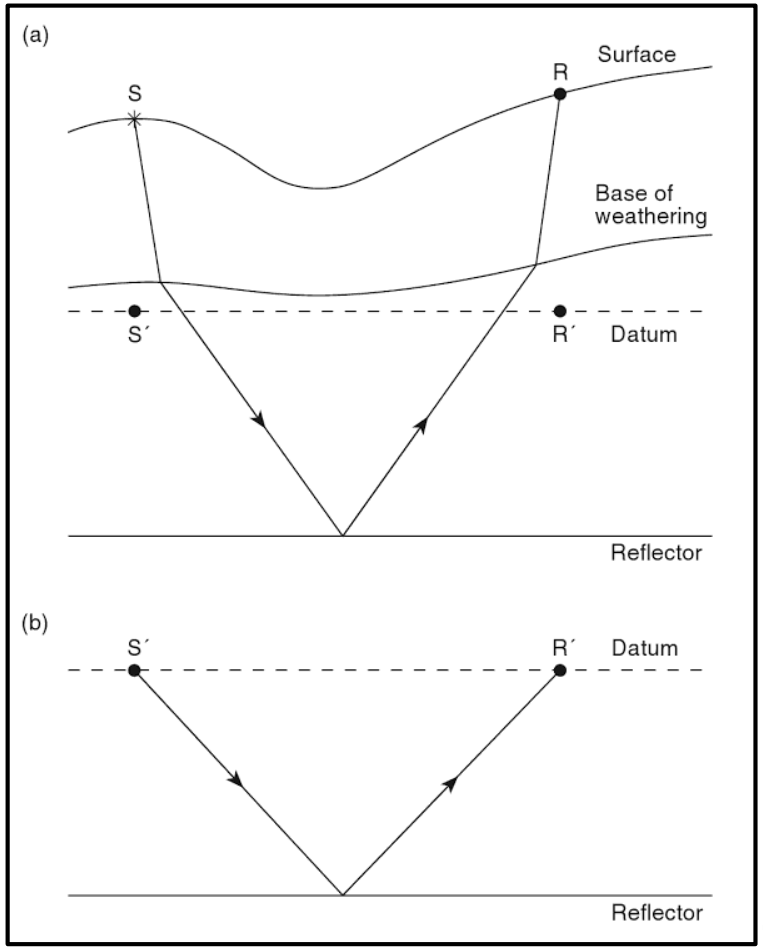
- Seismic weathering vs geologic weathering

Static corrections

- From surface to a datum

Reflection statics

- Based on reflector coherency



Cox (1999)

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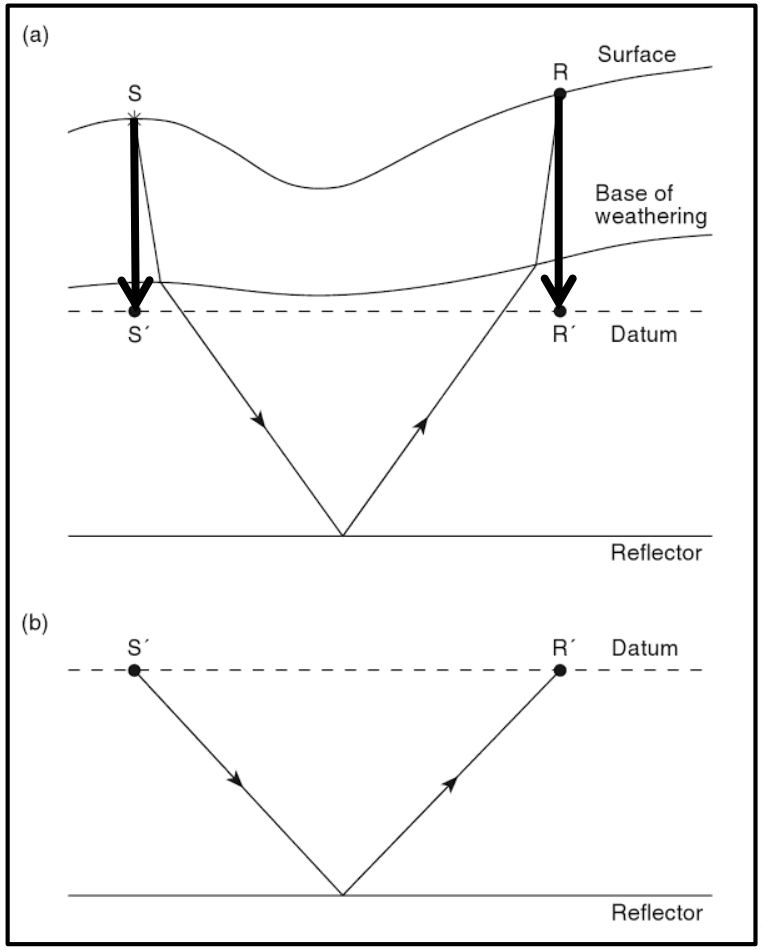


Cox (1999)

Assumptions

Weathering layer

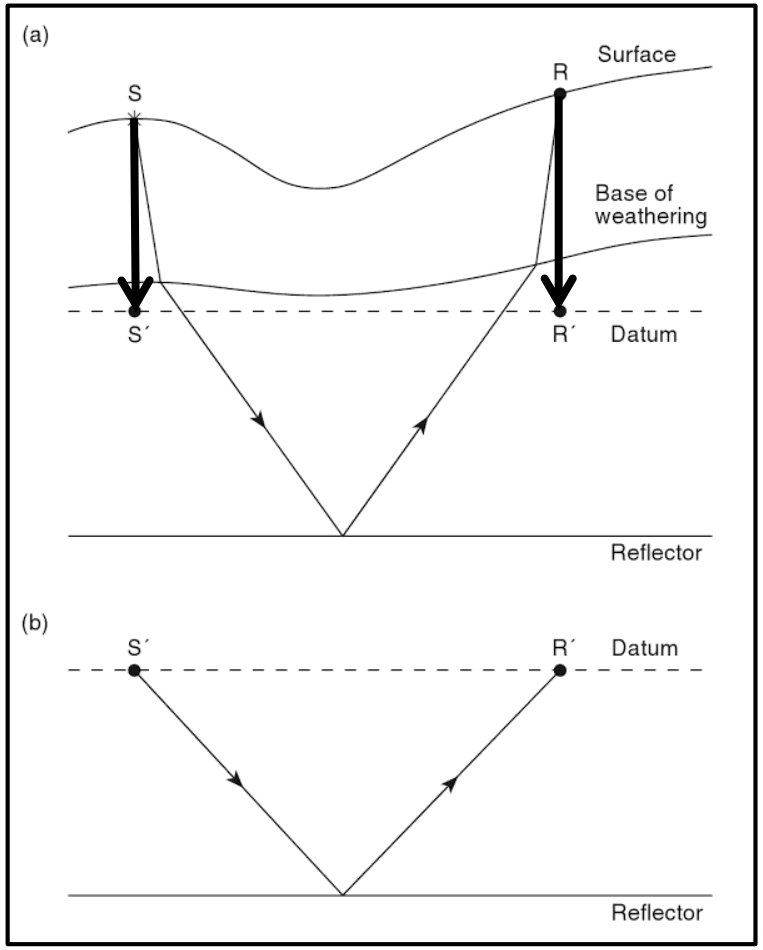
- Low velocity relative to the sub-weathering layer

Static corrections

- Ray paths are near vertical in weathering layer

Reflection statics

- Moveout is hyperbolic
- Lateral homogenous velocity



Cox (1999)

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Assumptions

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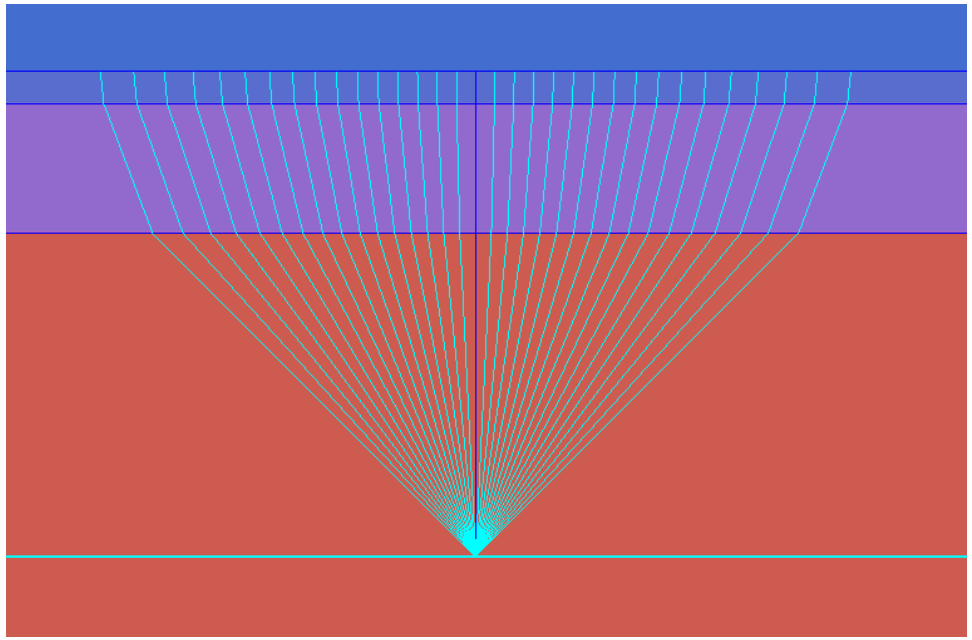
Simple Geology



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- Weathering layer has a low velocity relative to the sub-weathering layer
- Moveout can be approximated by a hyperbolic function

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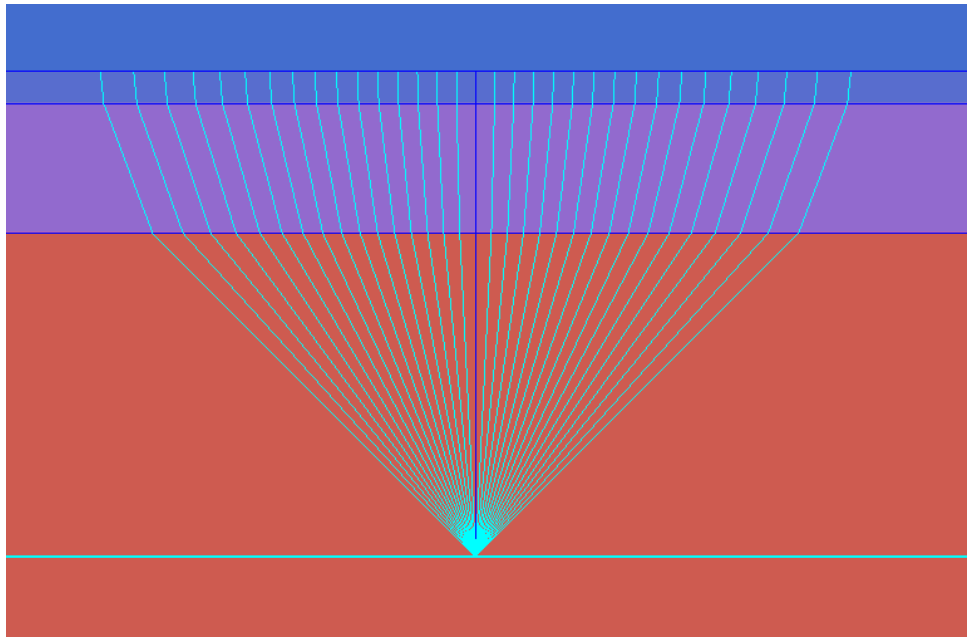

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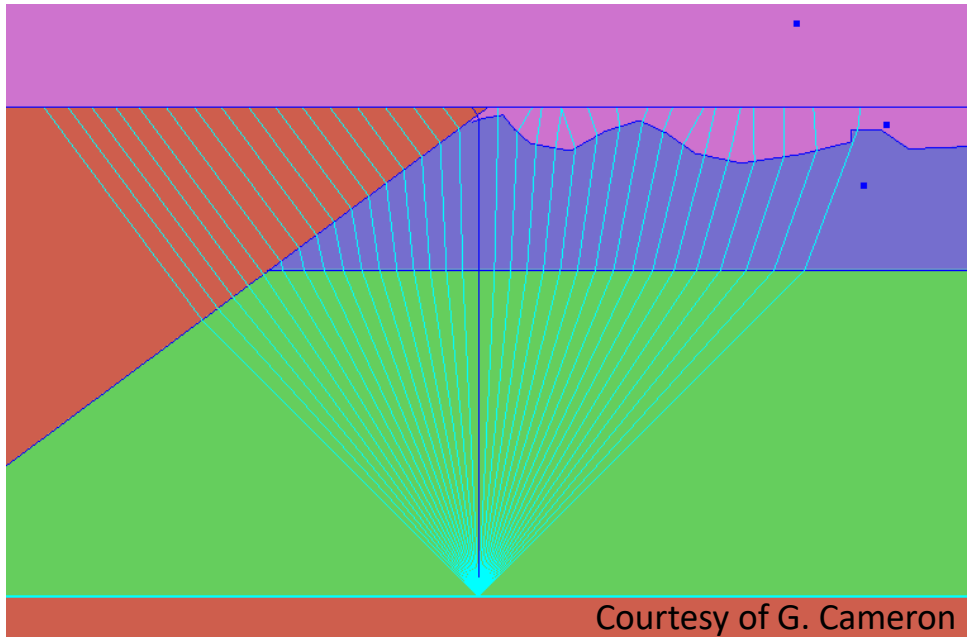

Courtesy of G. Cameron

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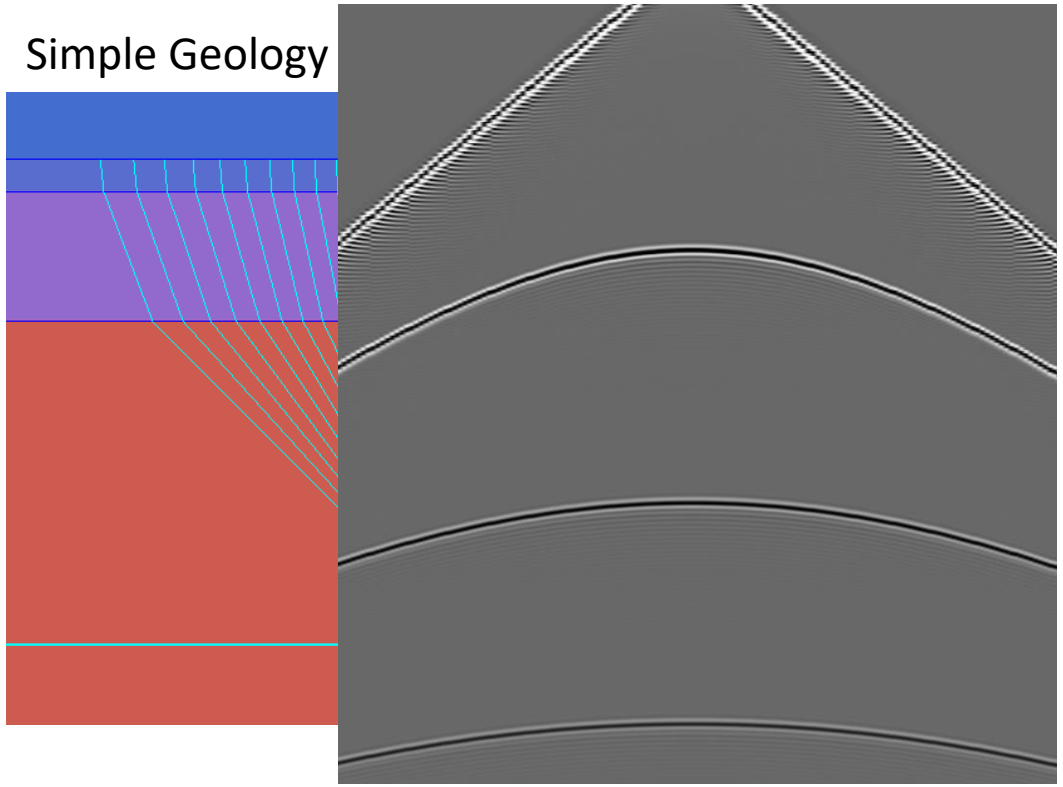

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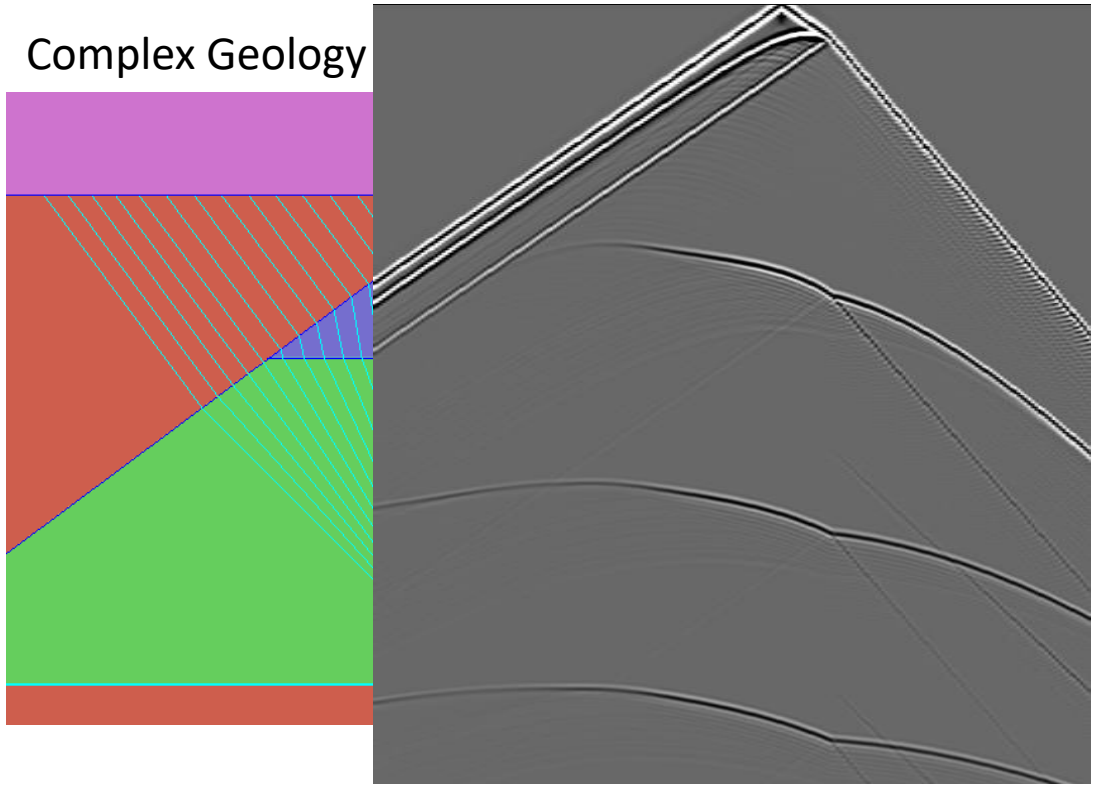

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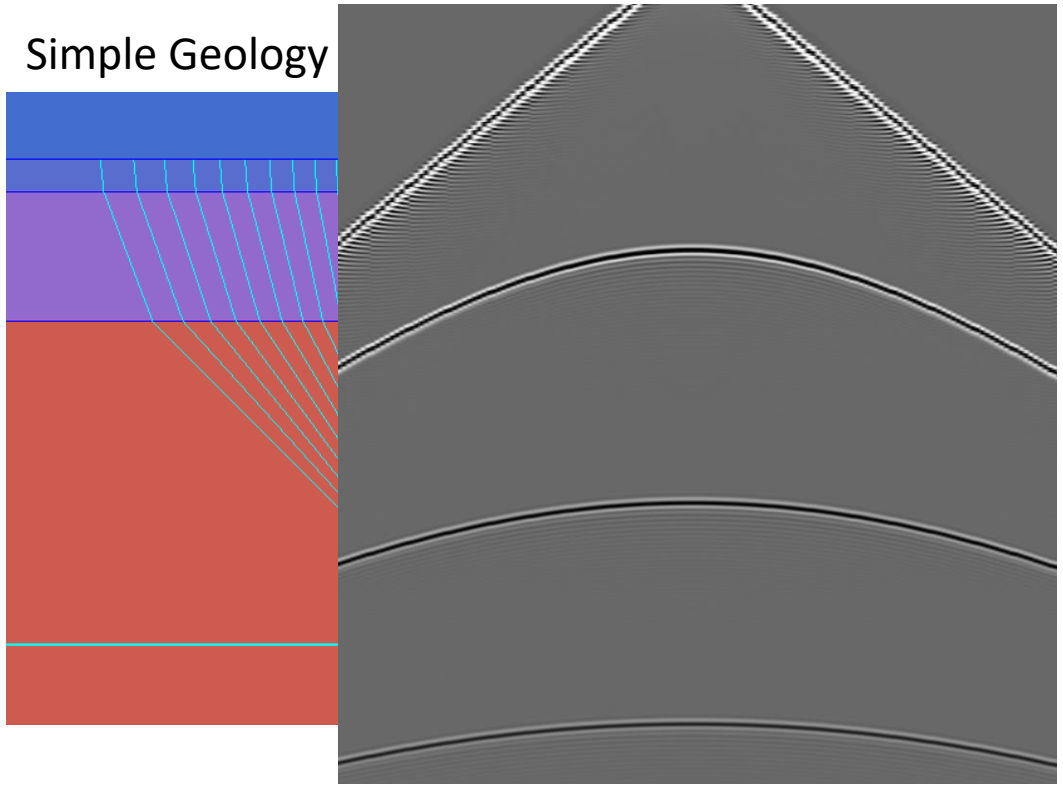

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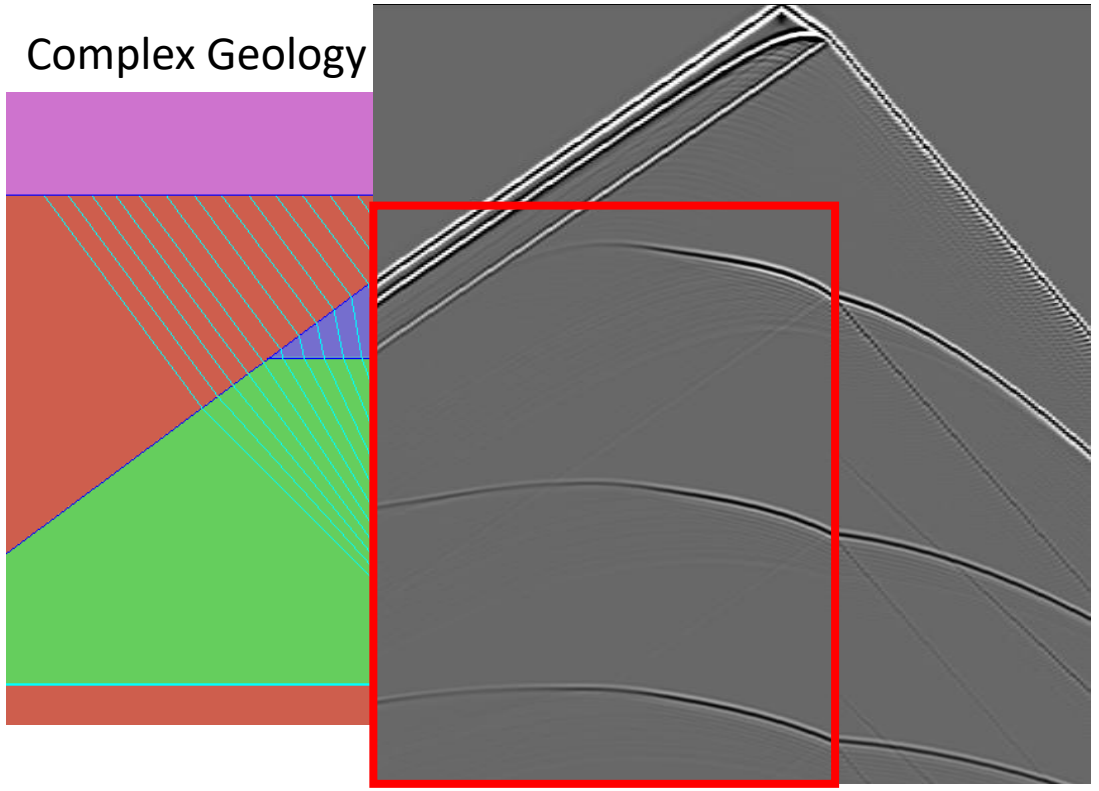
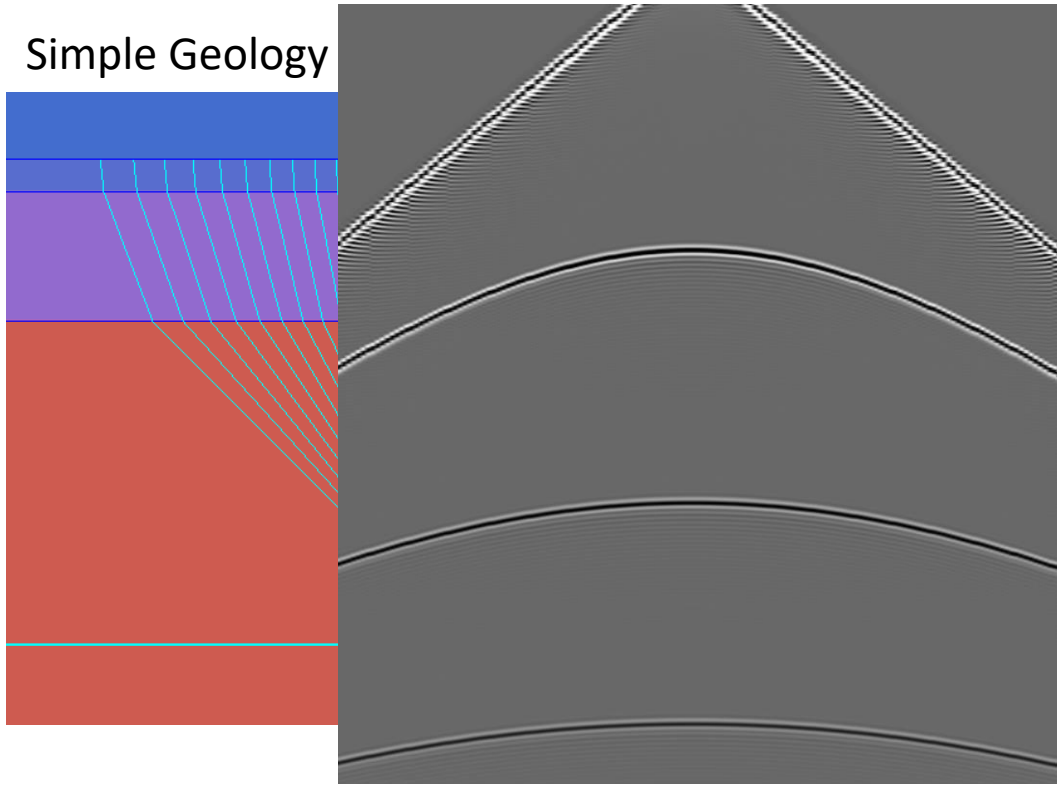


Methodology

$$t_{NMO} = \sqrt{t_0^2 + \frac{x^2}{V_{RMS}^2}}$$

$$t_{MMO}(z) = t_s(z) + t_r(z)$$

Simple Geology



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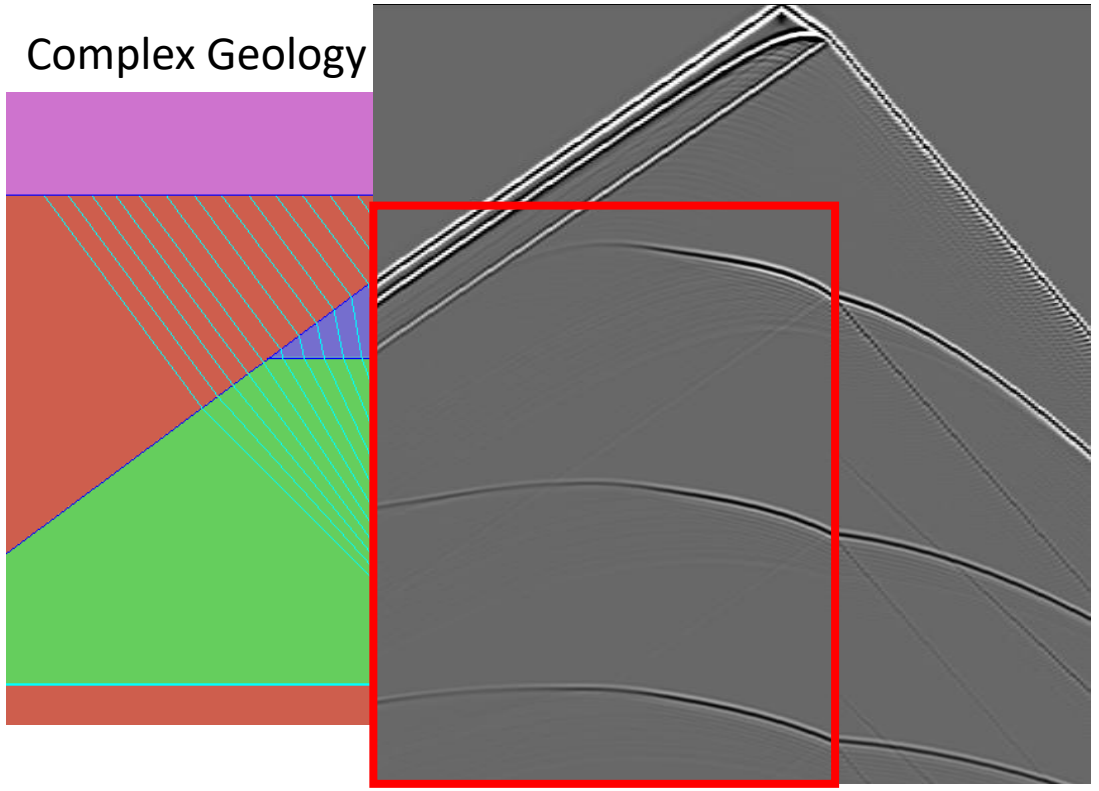

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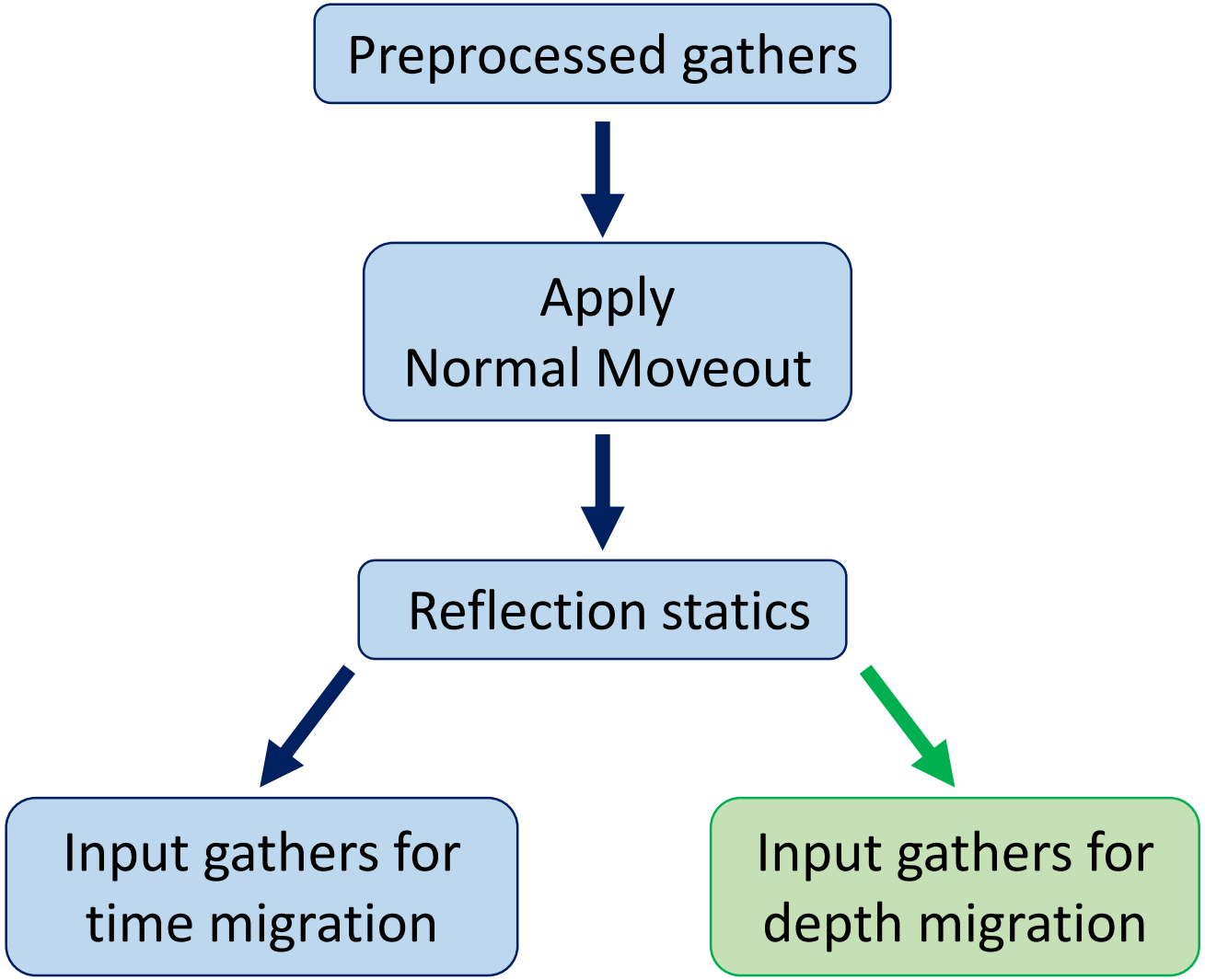
Traditional statics workflow



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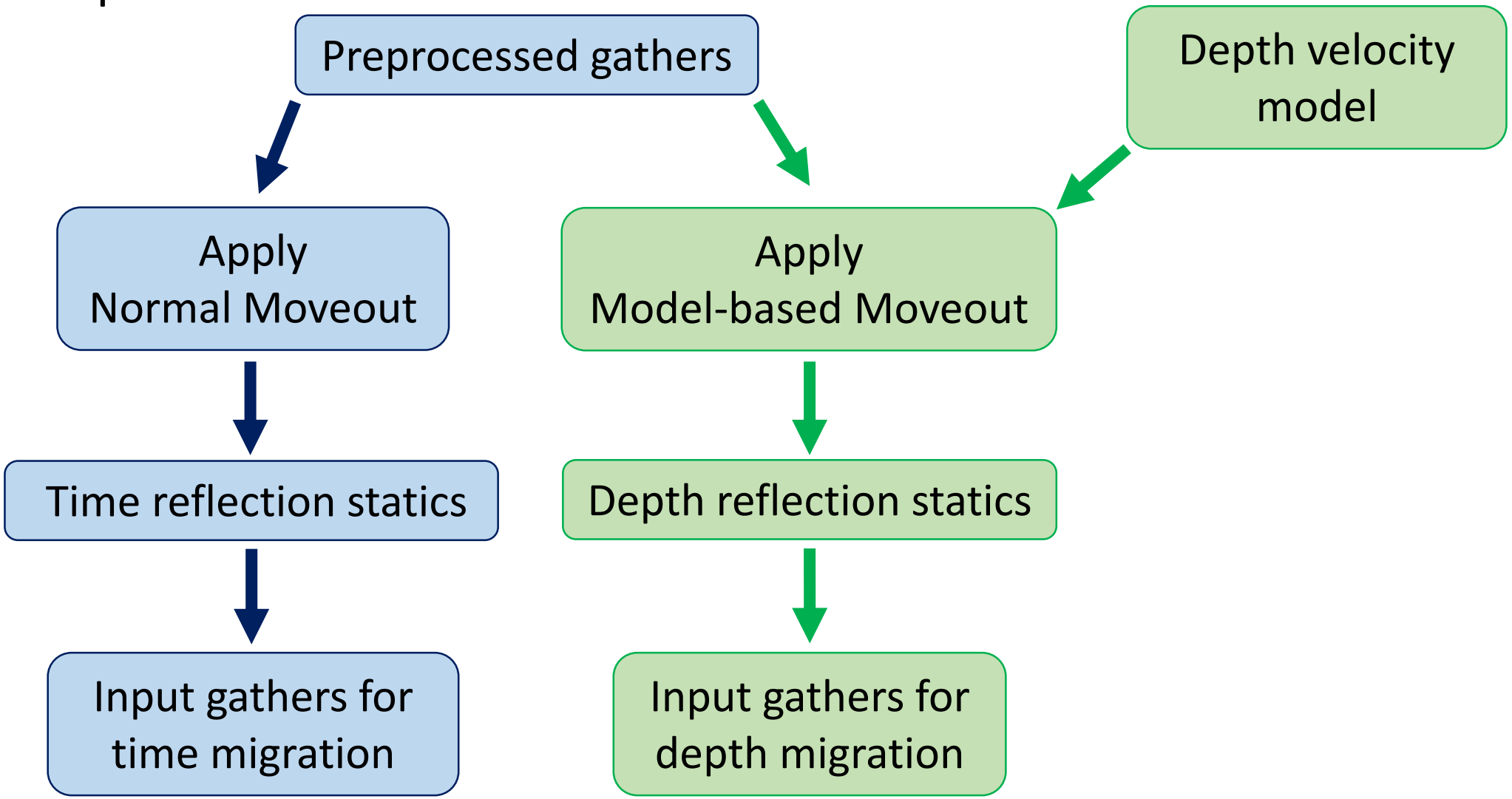
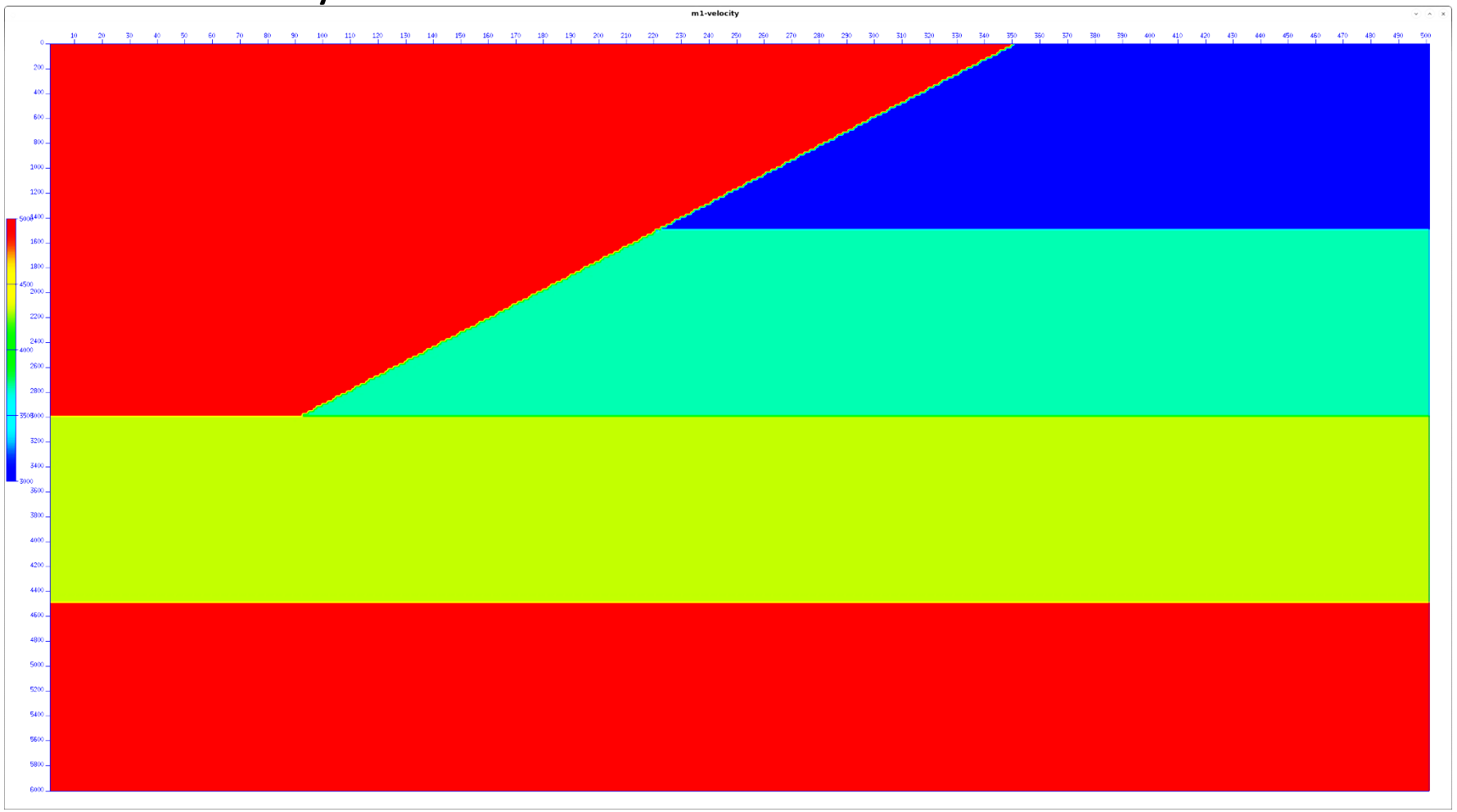


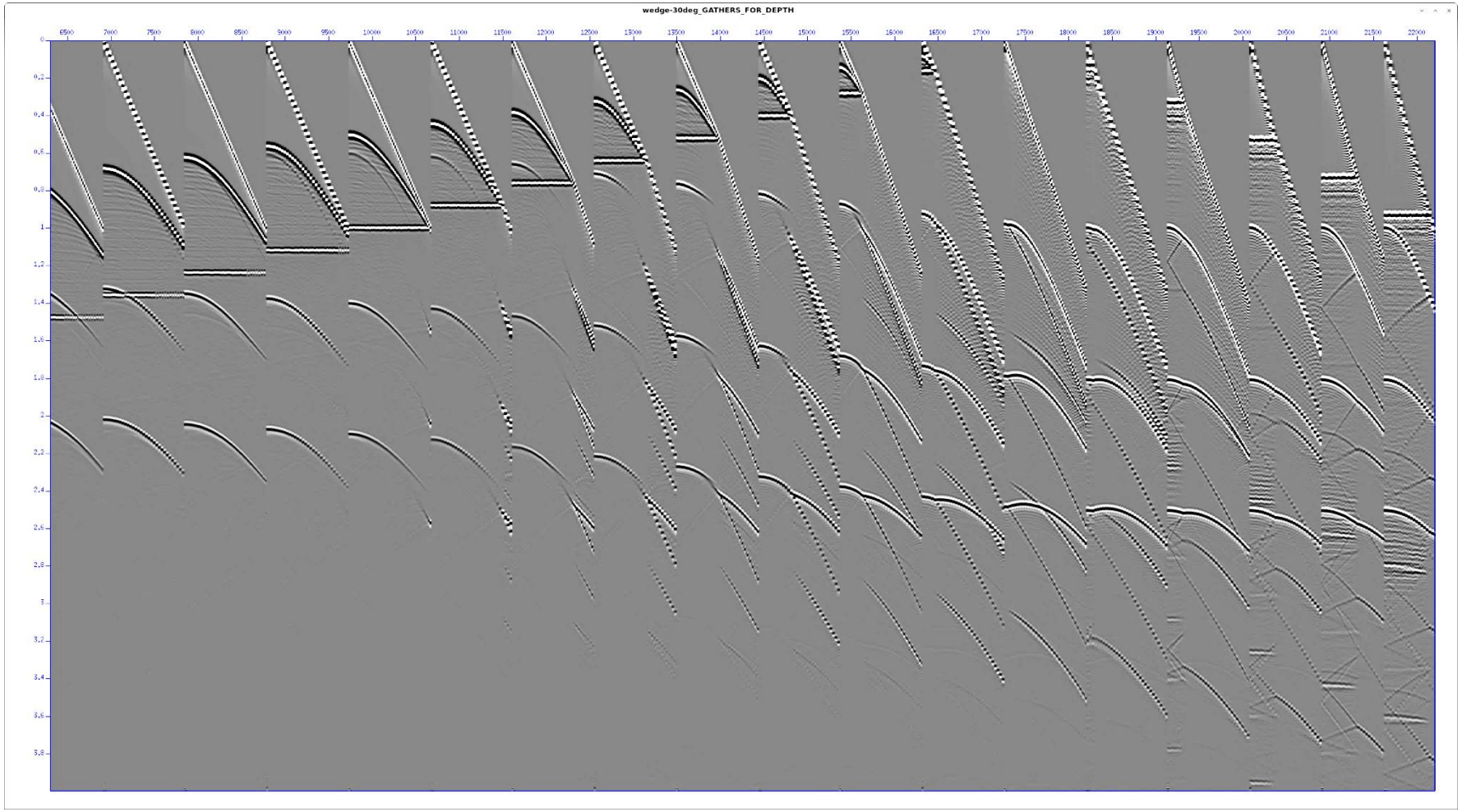
Normal Moveout (Time) vs Model-based Moveout (Depth)

Thrust Velocity Model



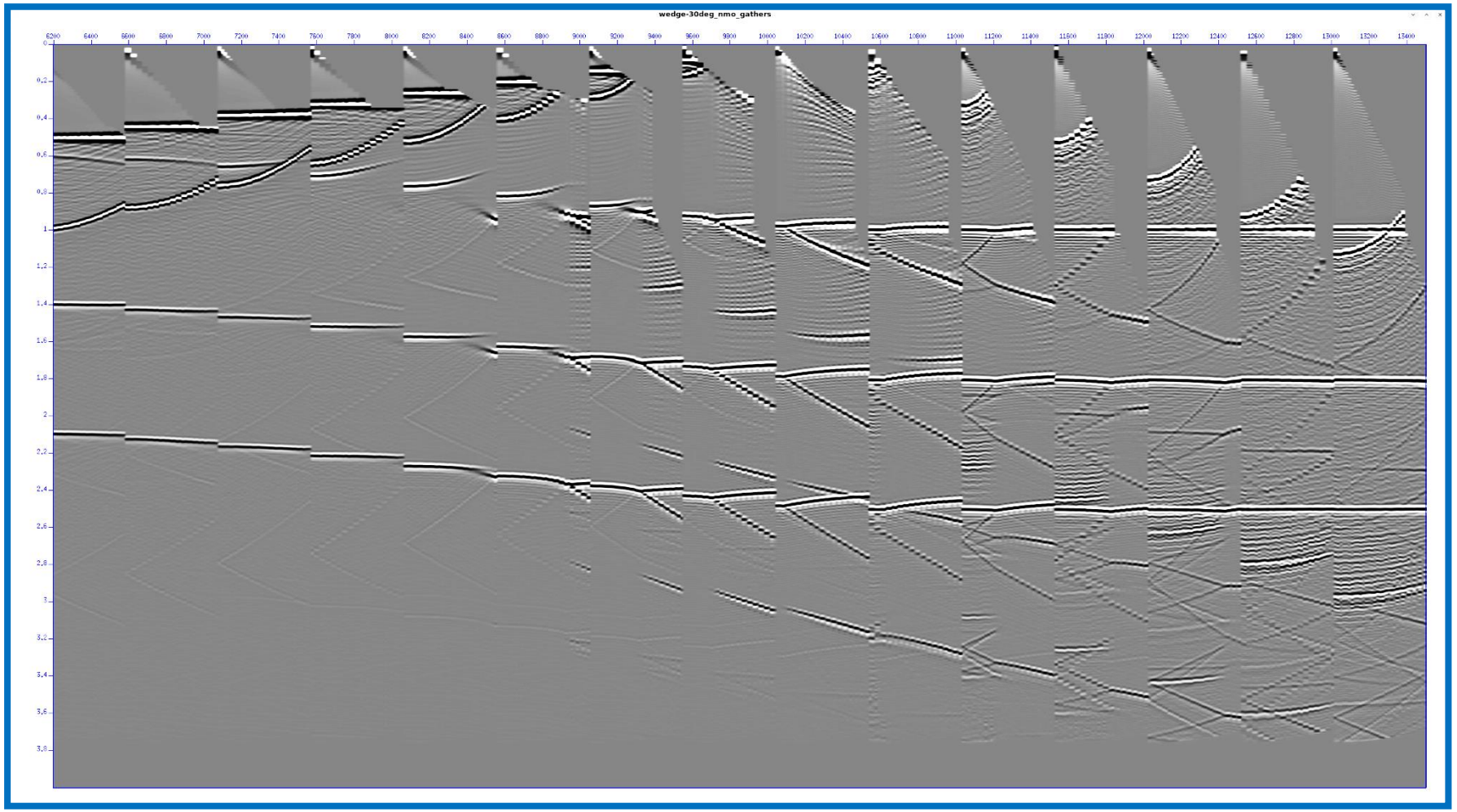
Normal Moveout (Time) vs Model-based Moveout (Depth)

Uncorrected Gathers



Normal Moveout (Time) vs Model-based Moveout (Depth)

NMO Corrected Gathers



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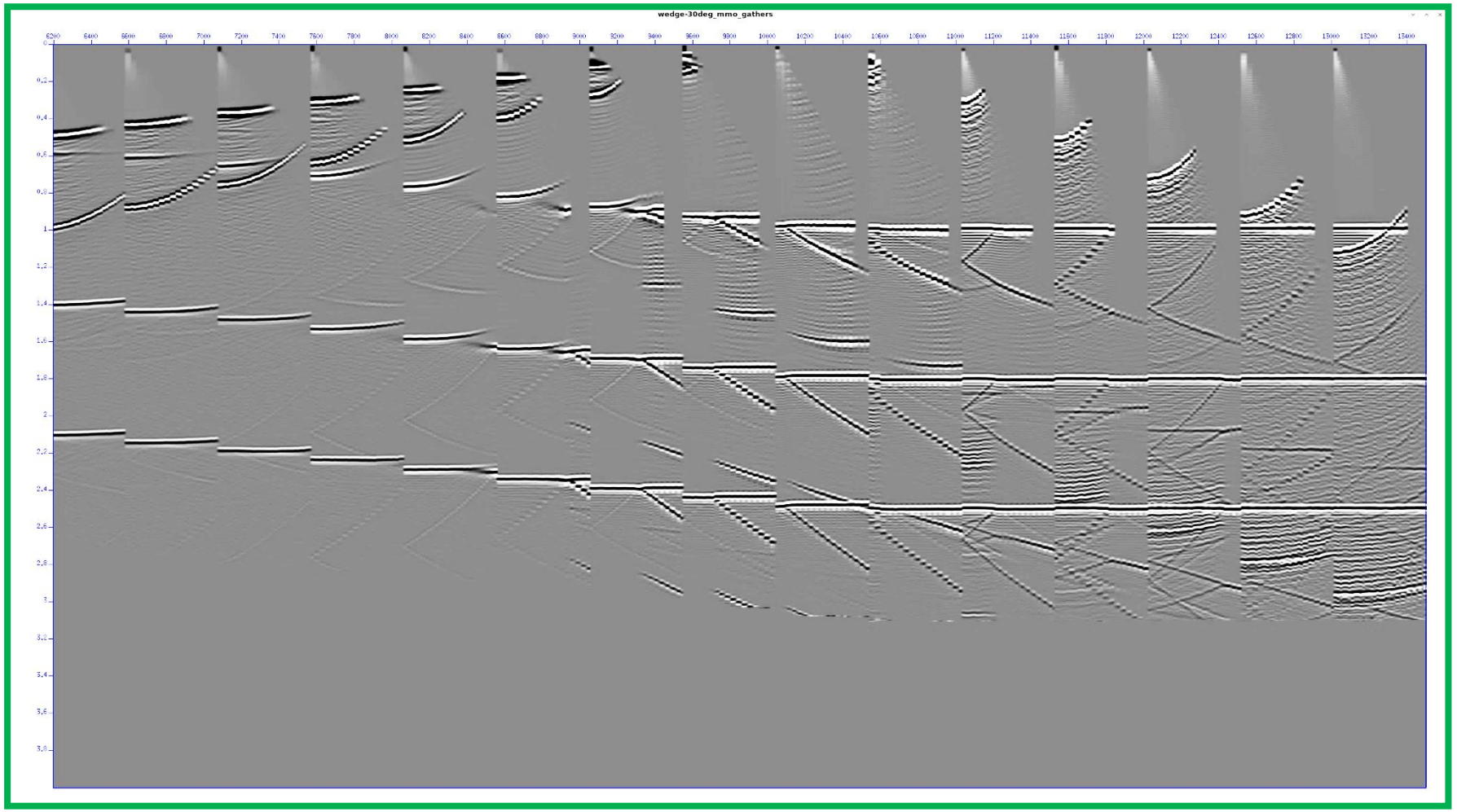

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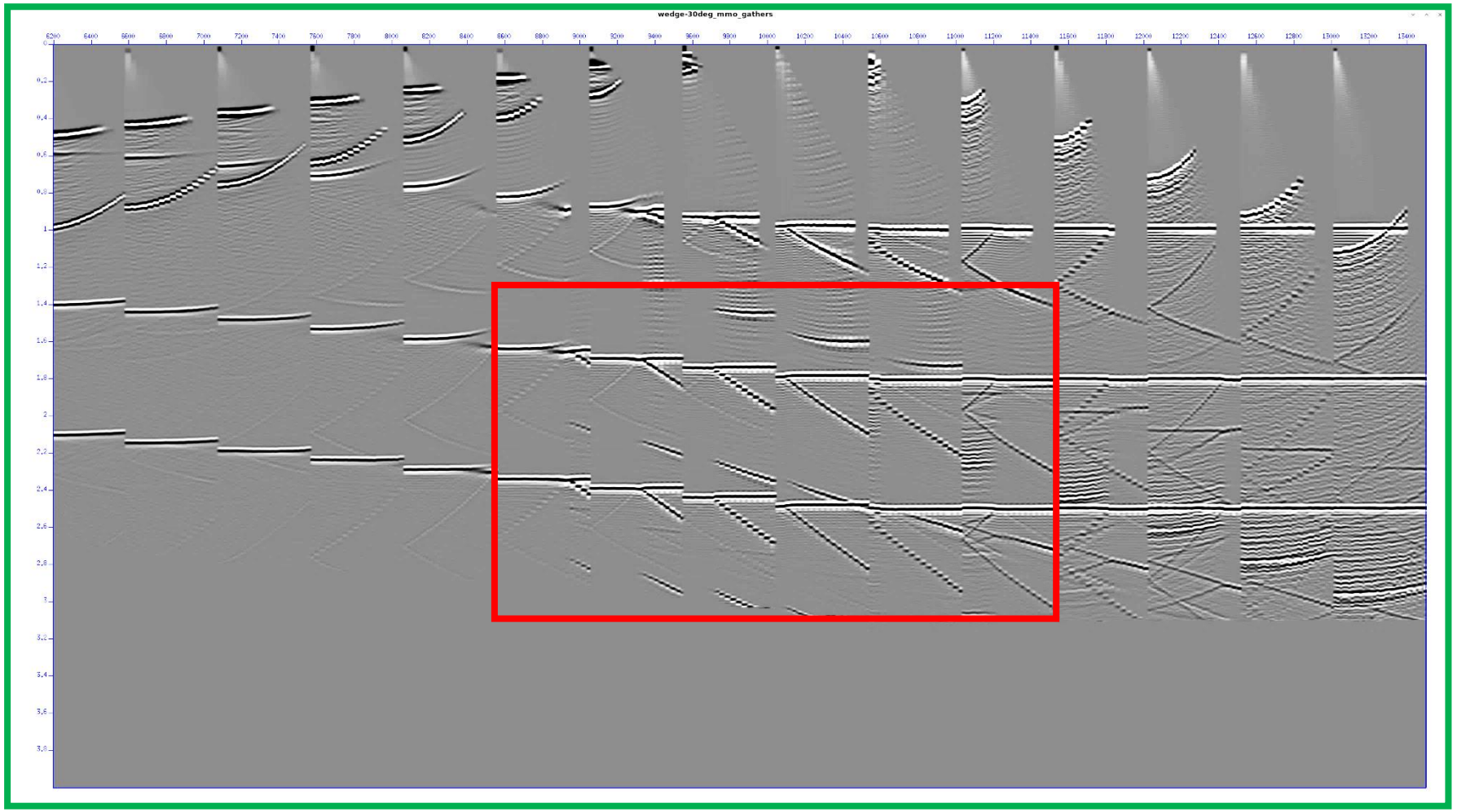

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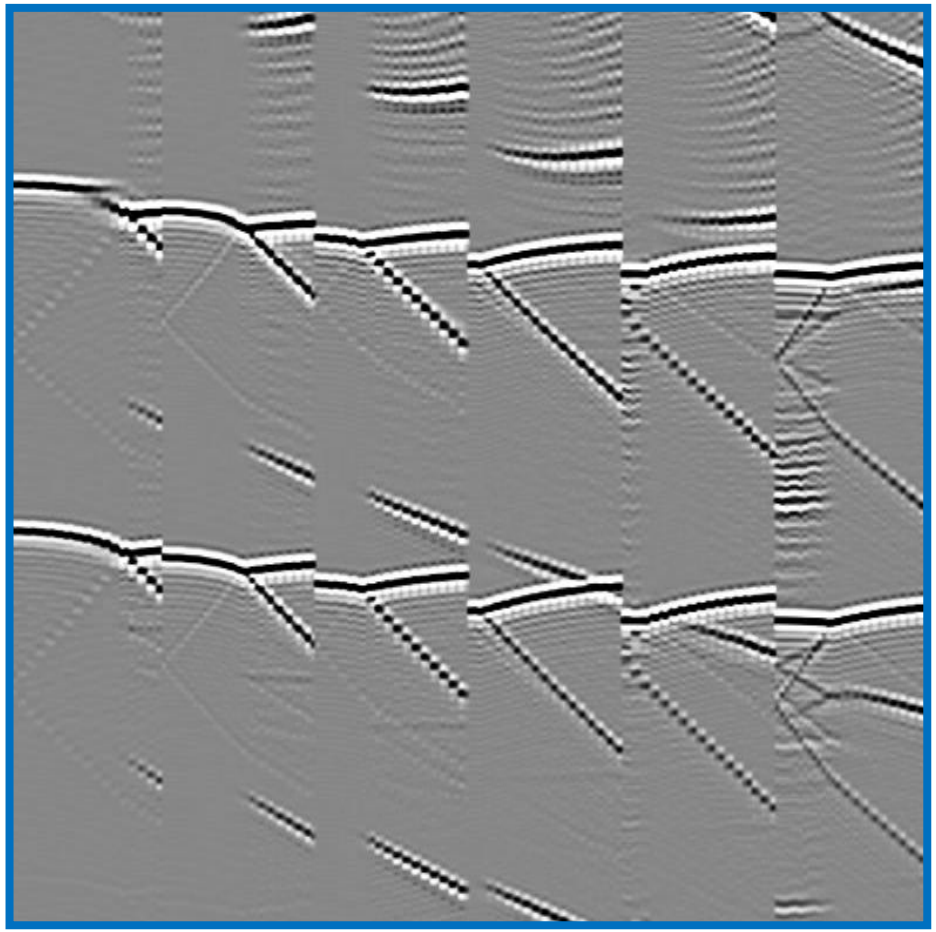

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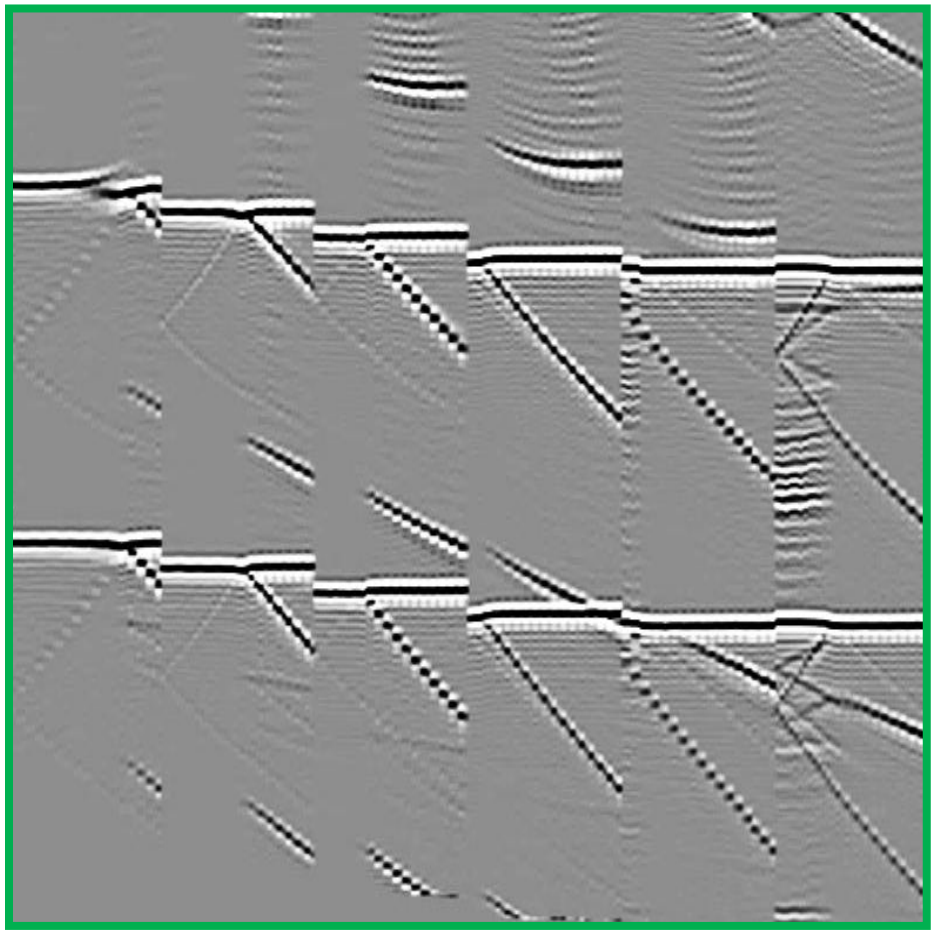
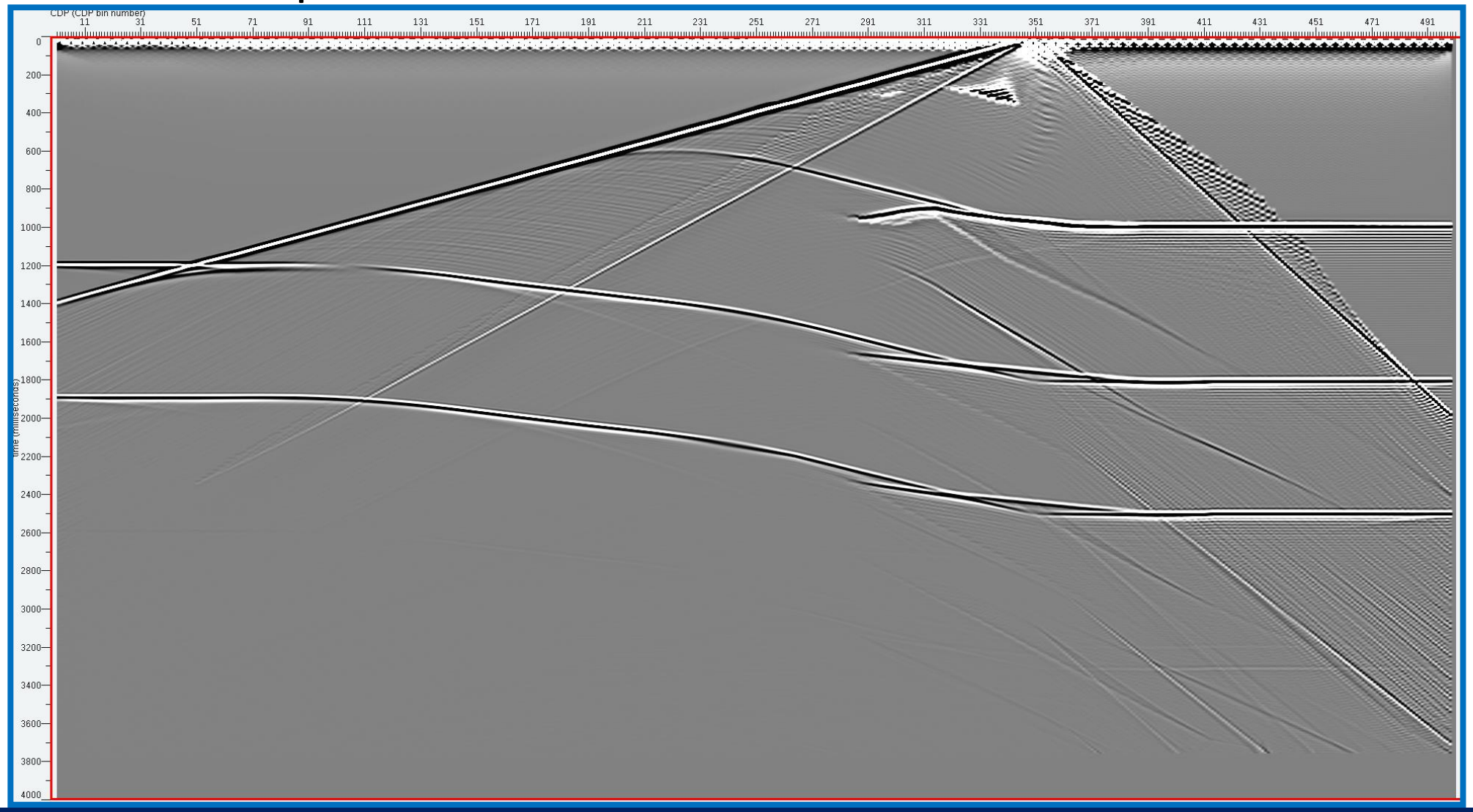


Methodology

Time NMO stack prior to reflection statics



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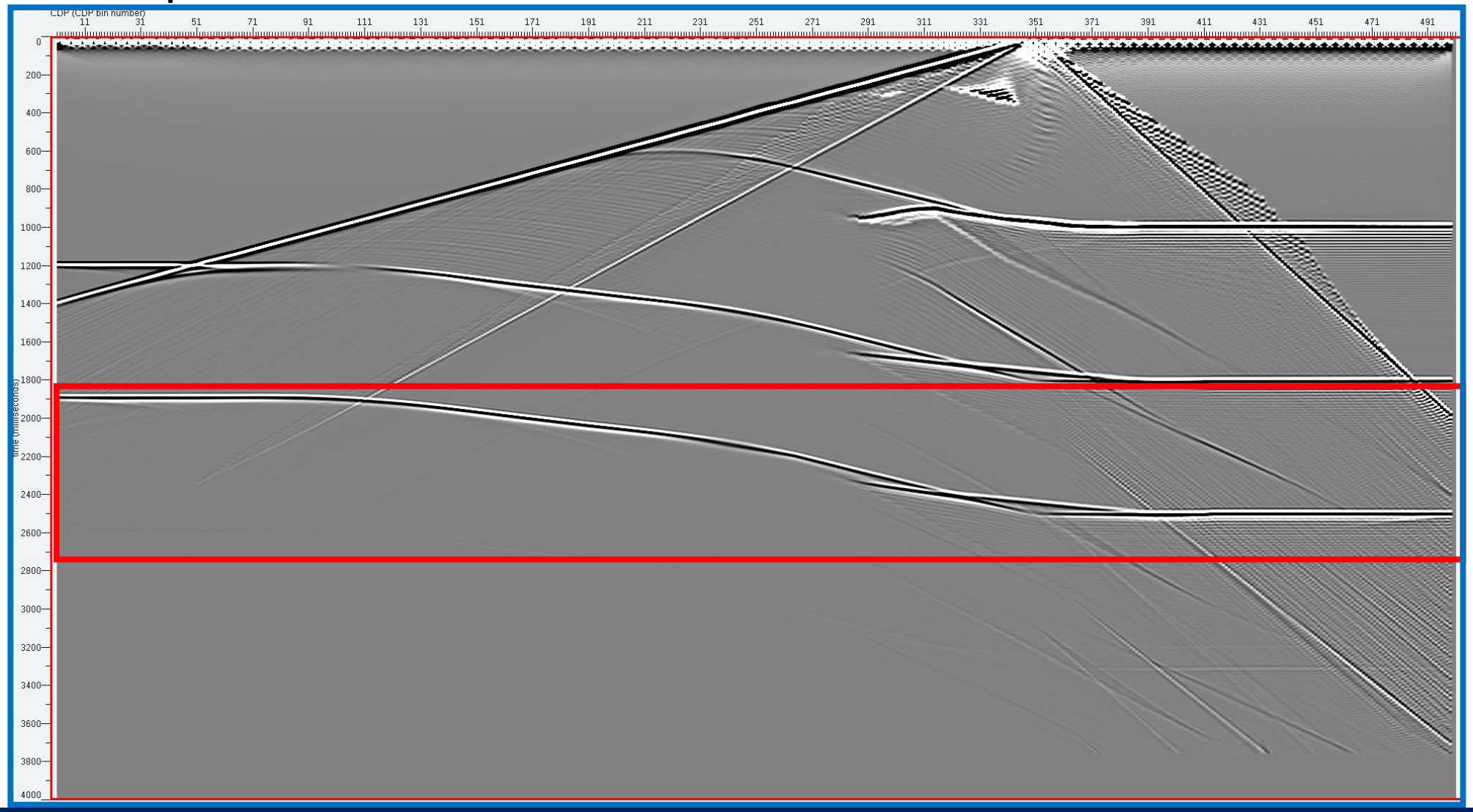

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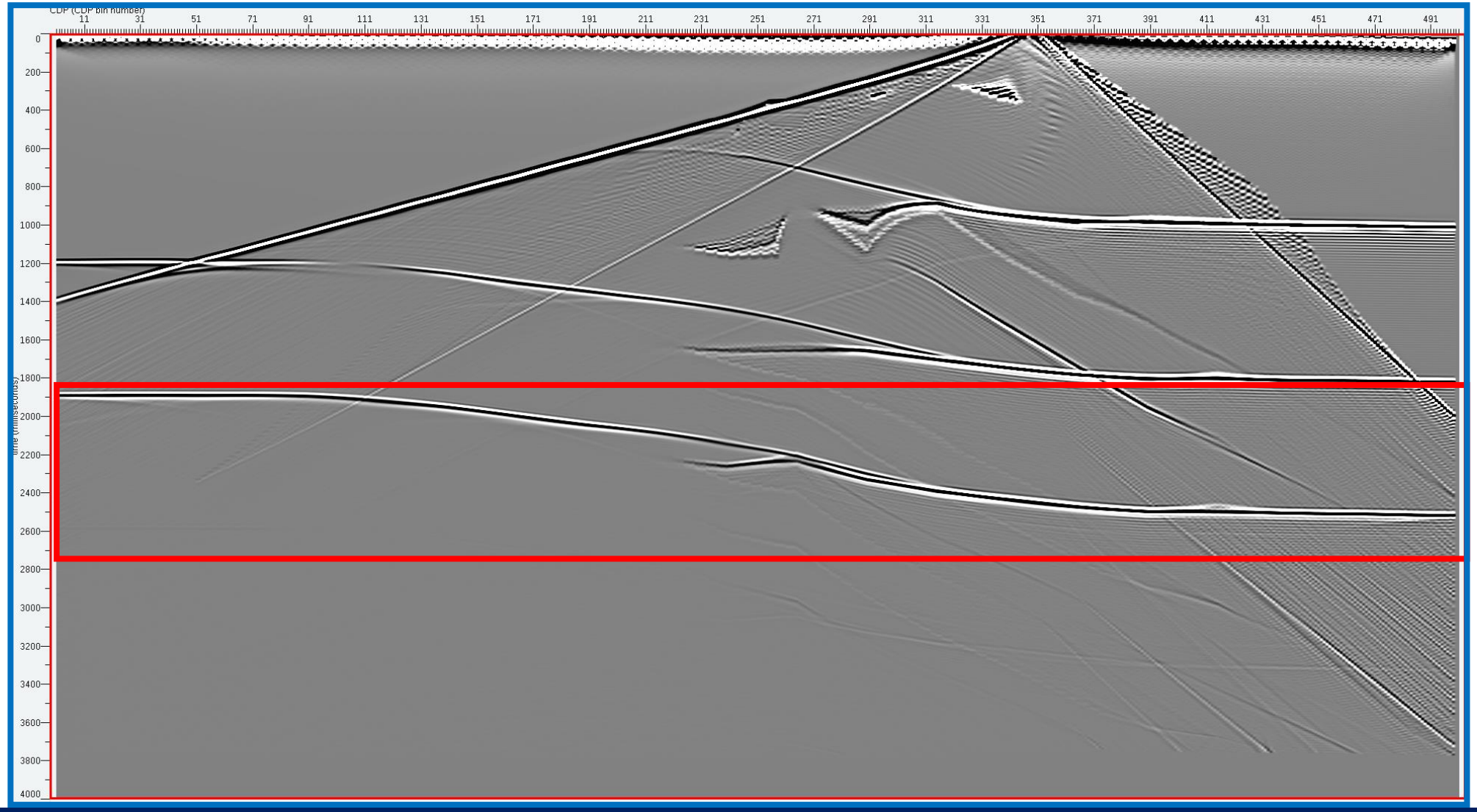
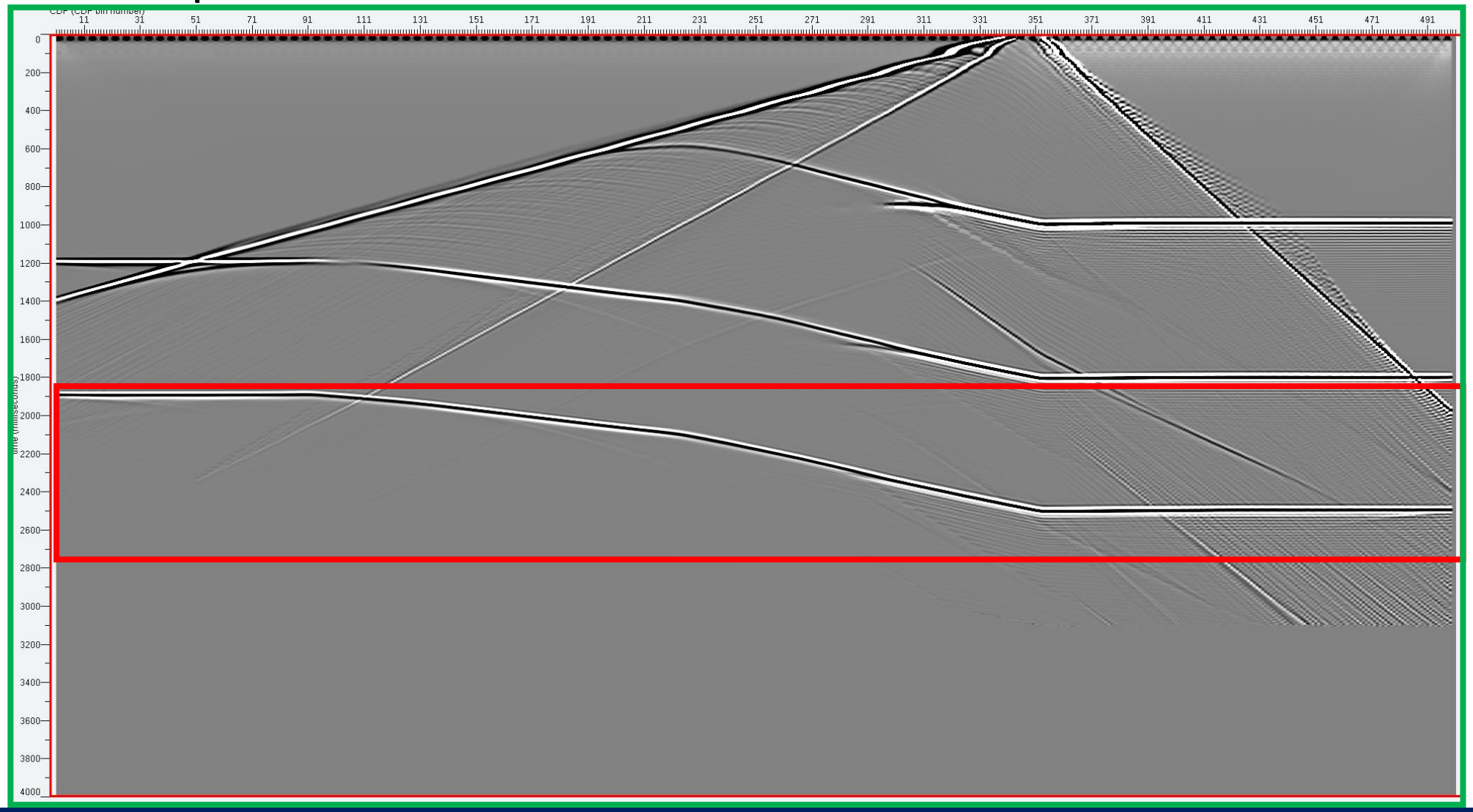
Time stack after reflection statics



Methodology

Depth stack prior to reflection statics



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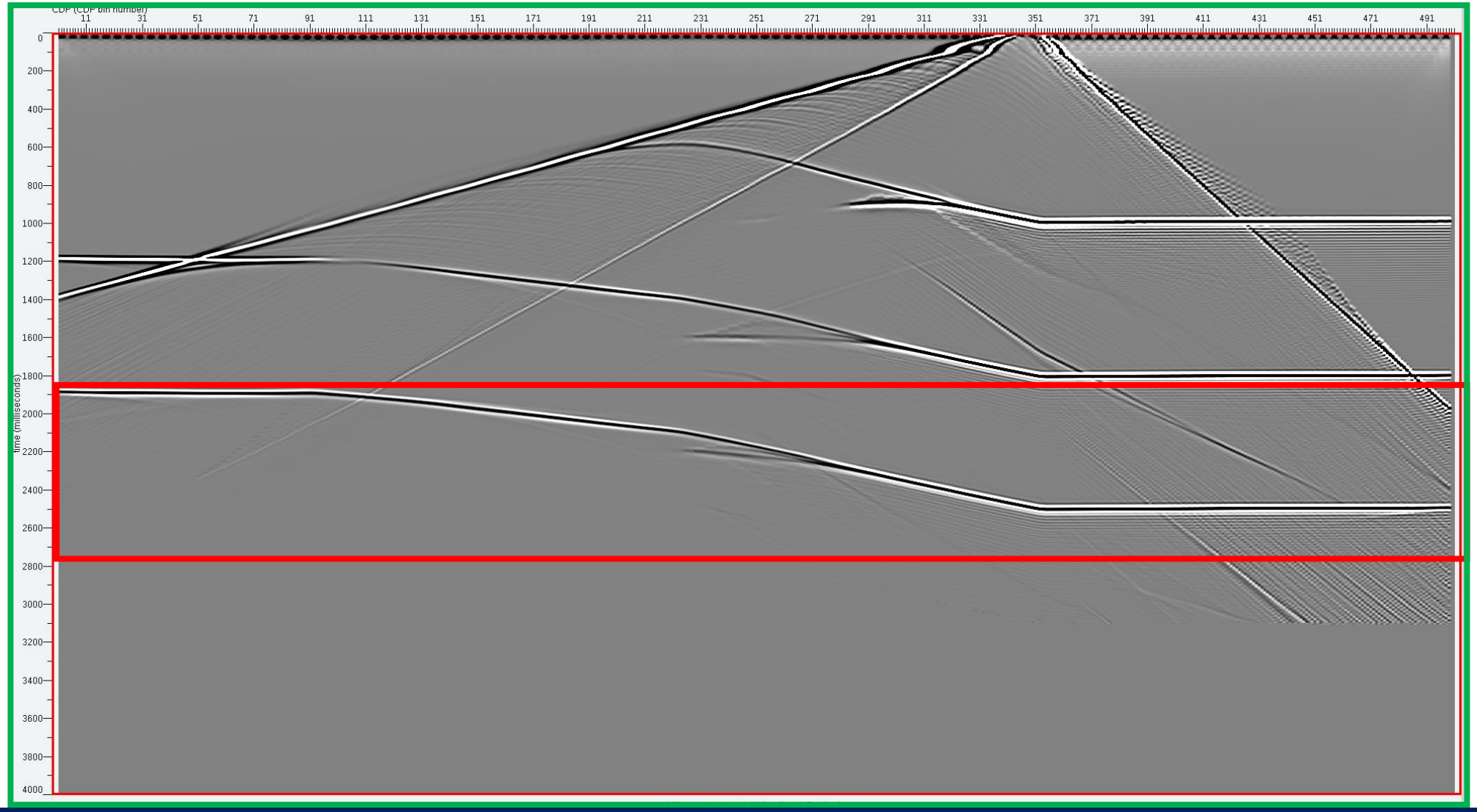
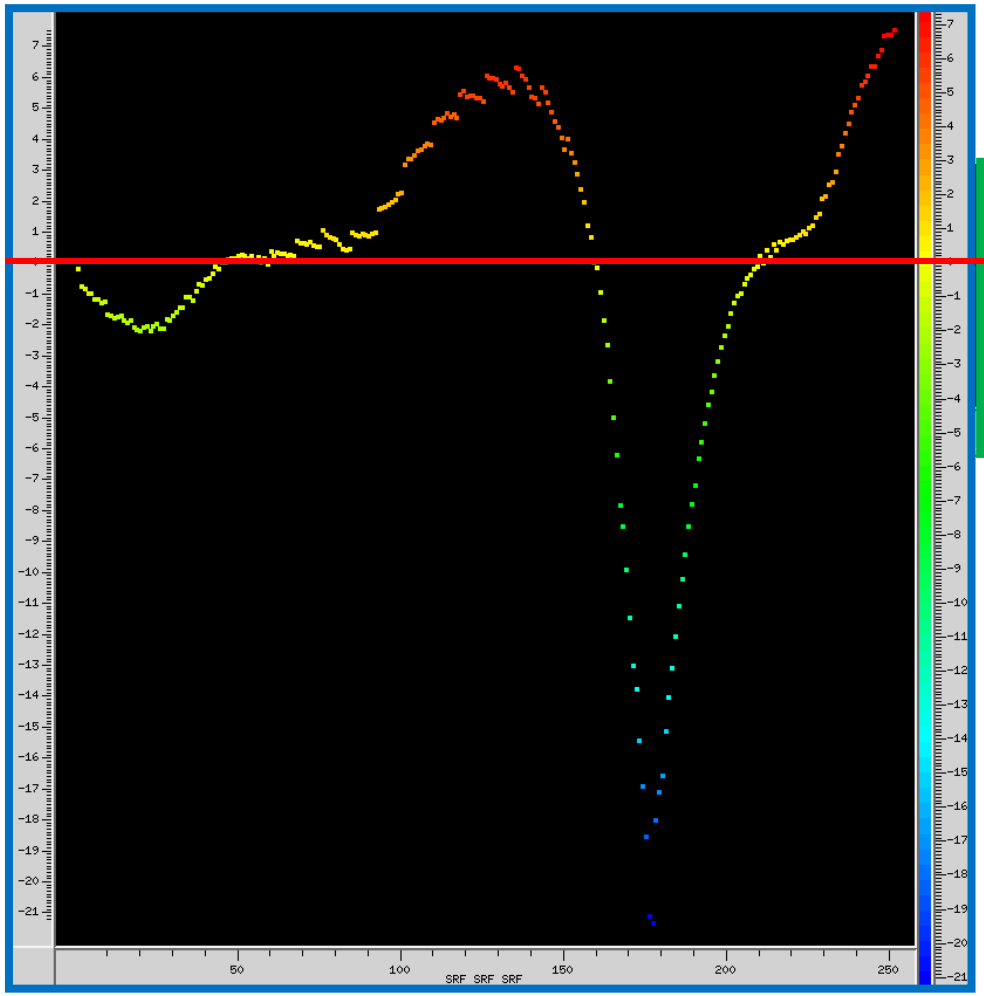
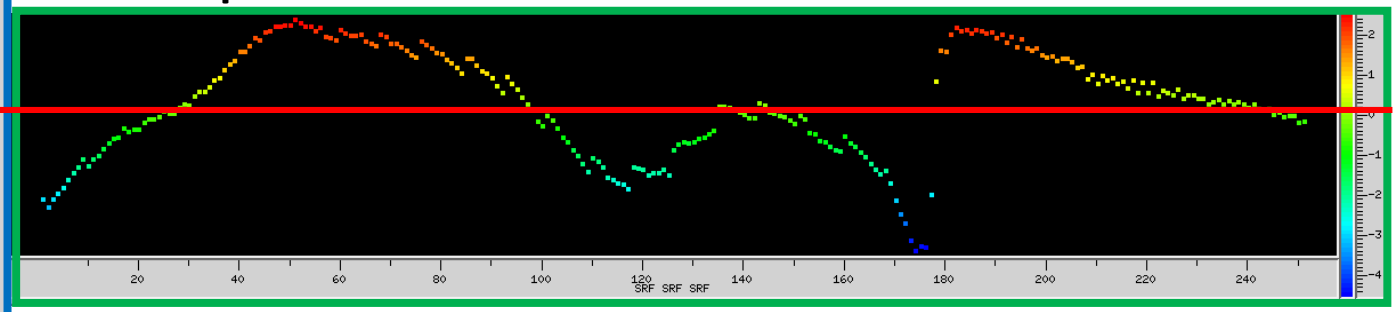


Methodology

Time receiver statics

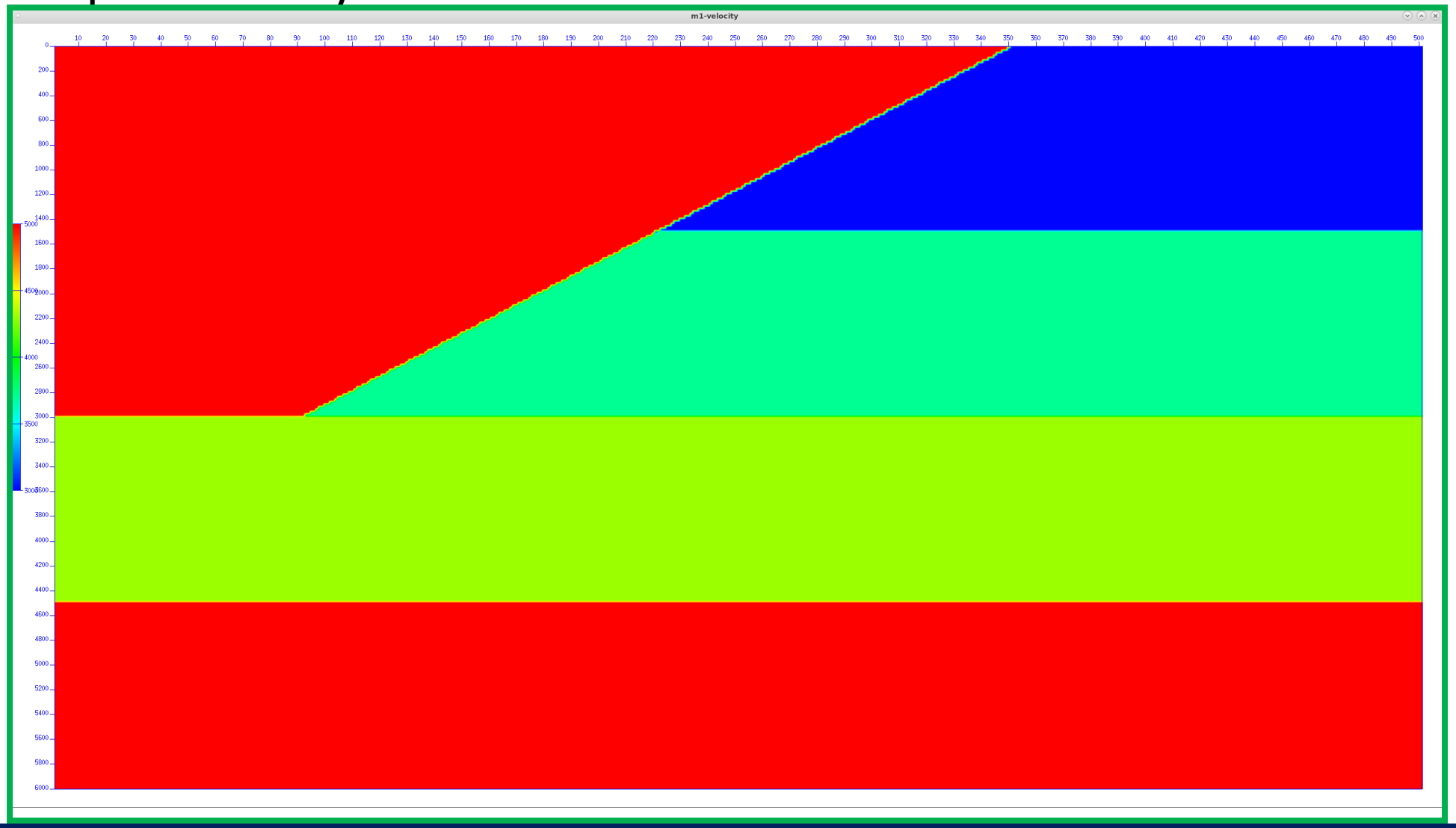


Depth receiver statics



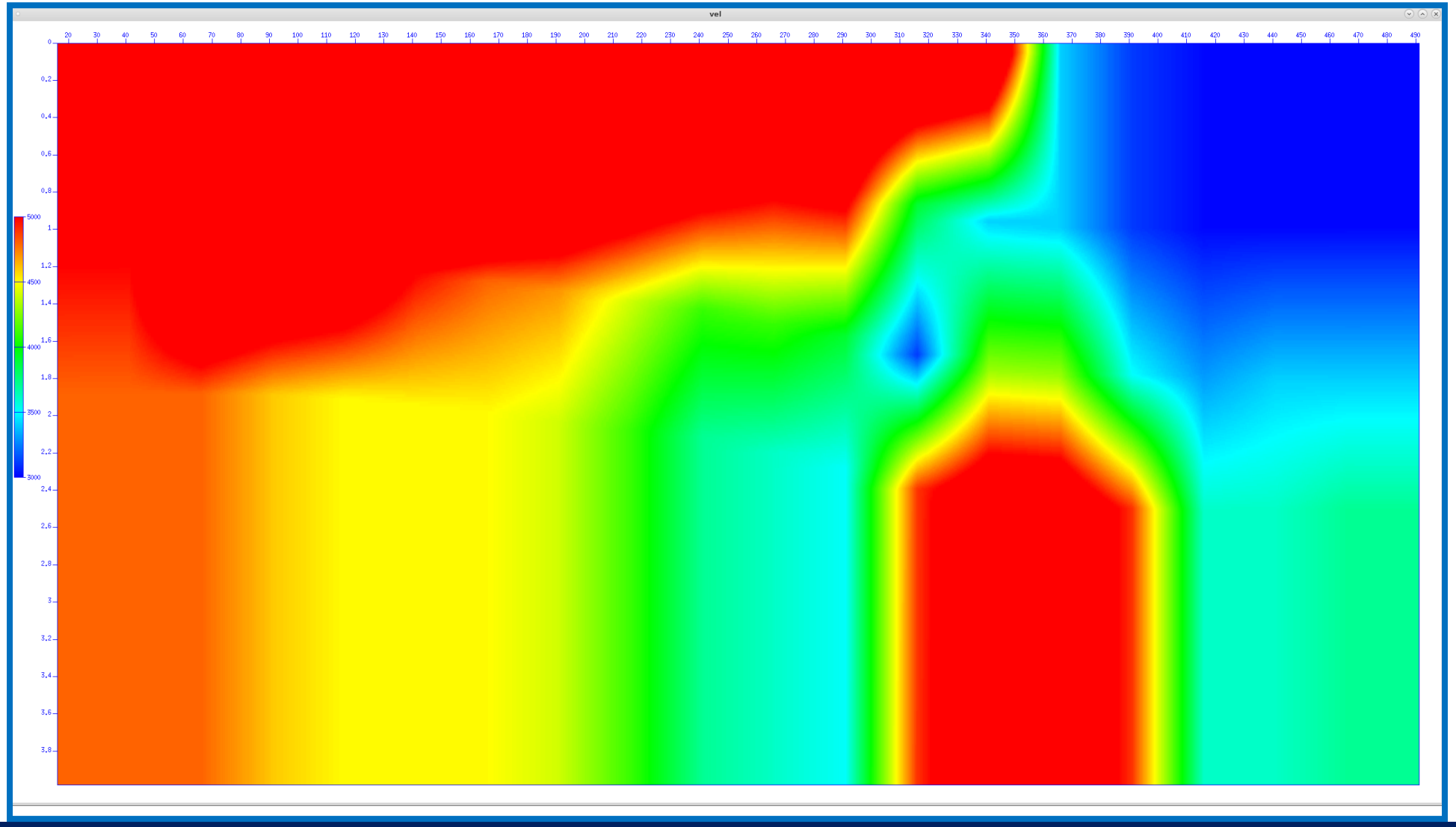
Results

Depth Velocity Model



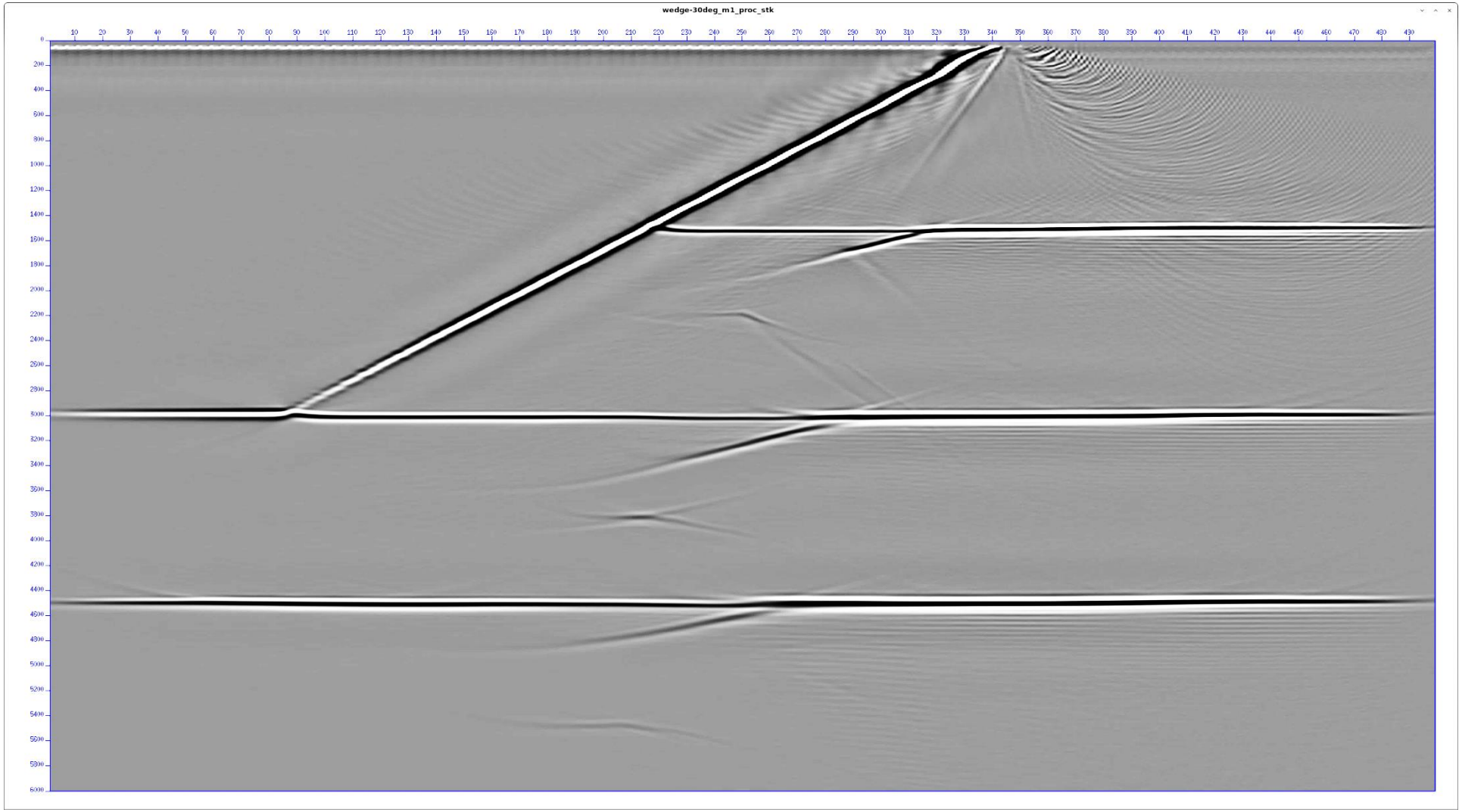
Results

Time NMO Interval Velocities



Results

Depth Migration, no statics applied



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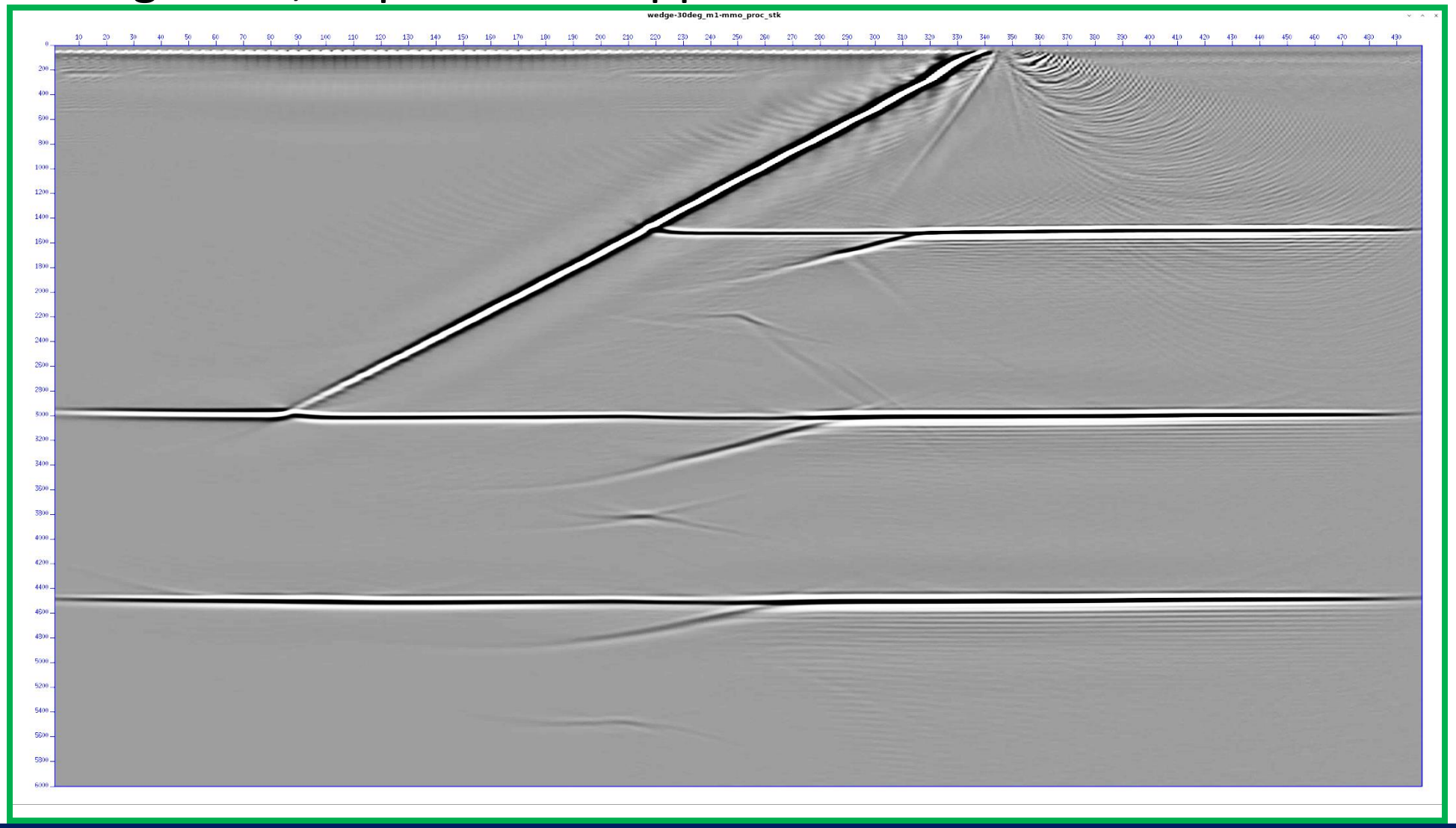

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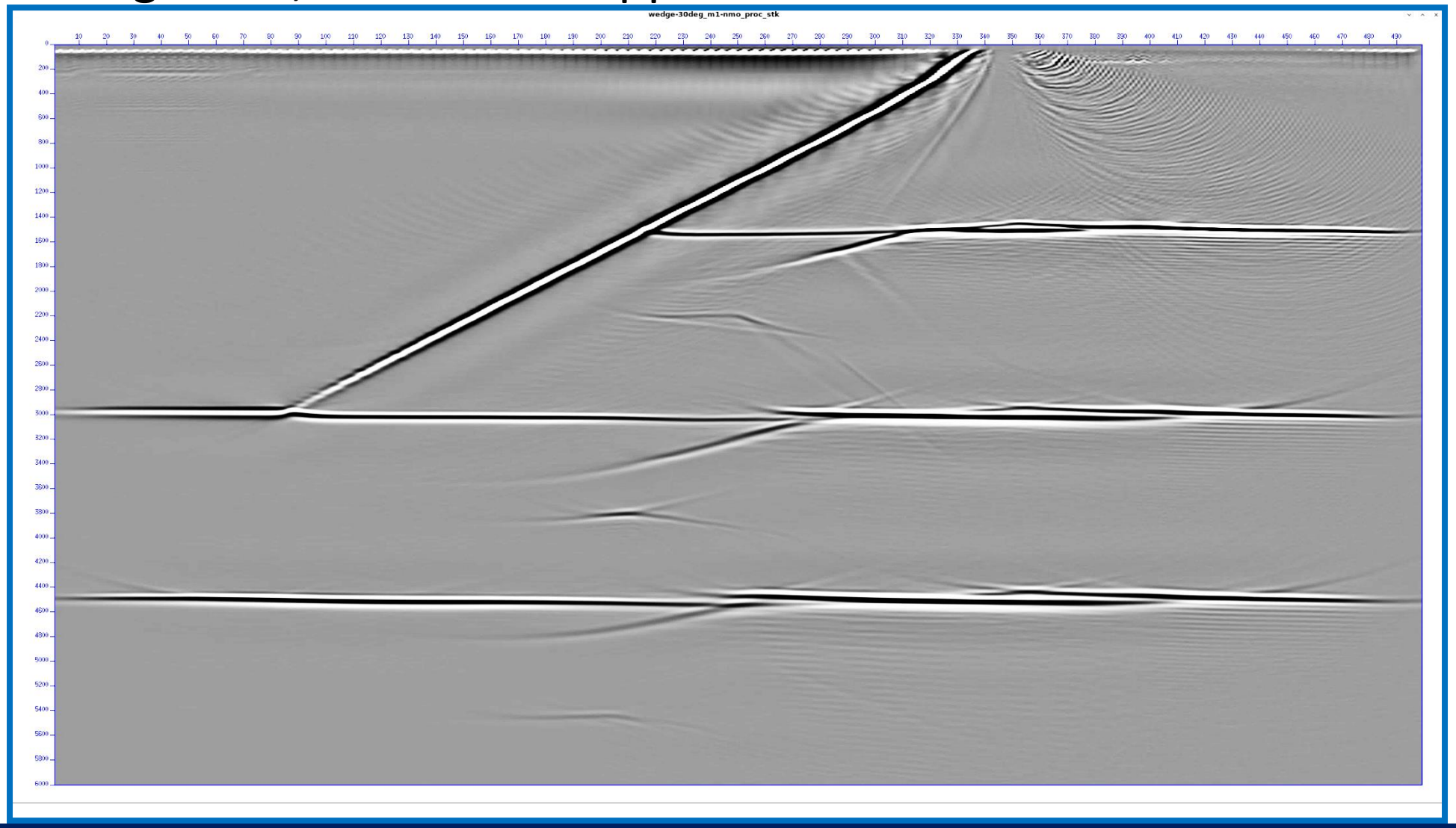

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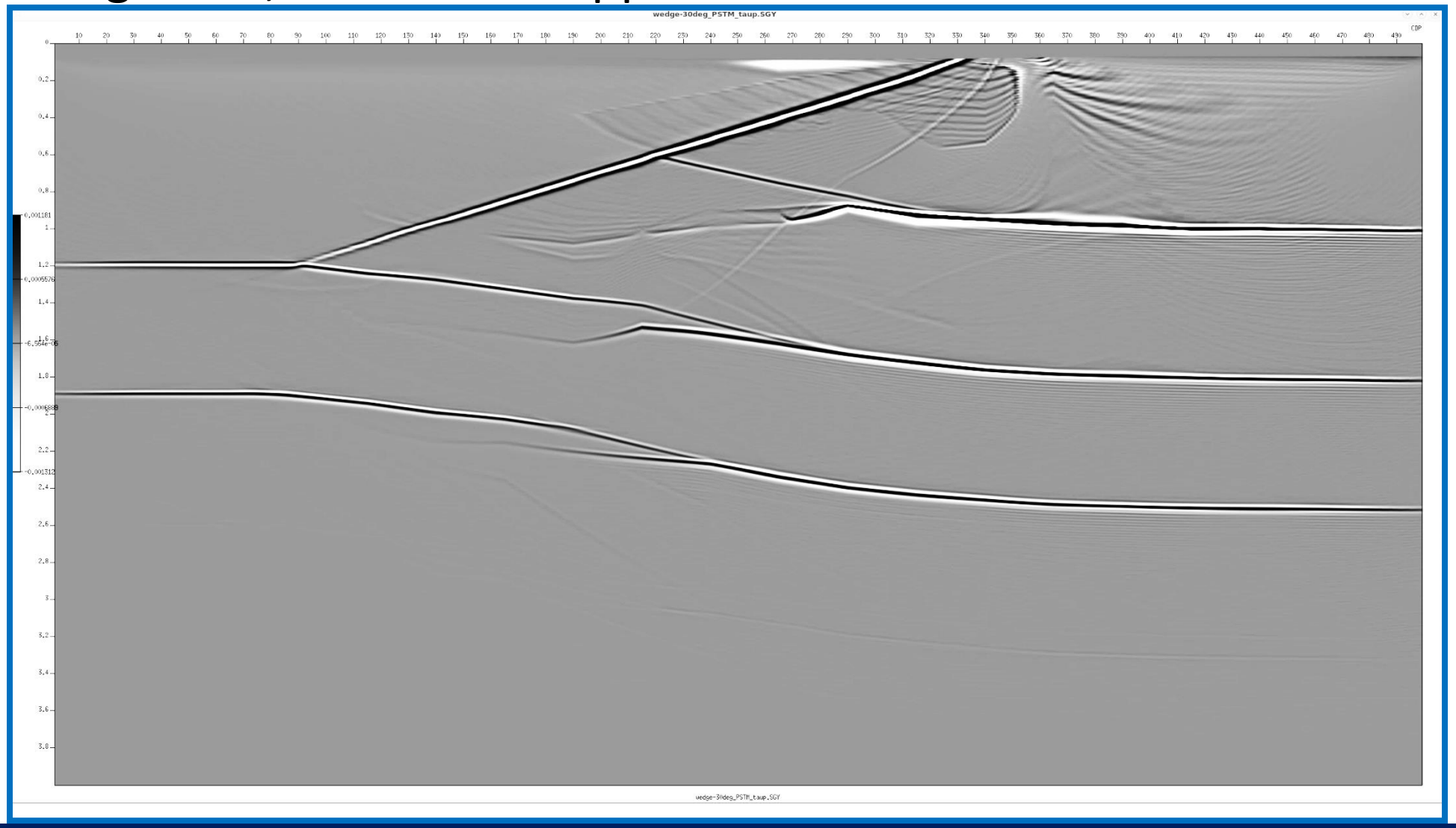

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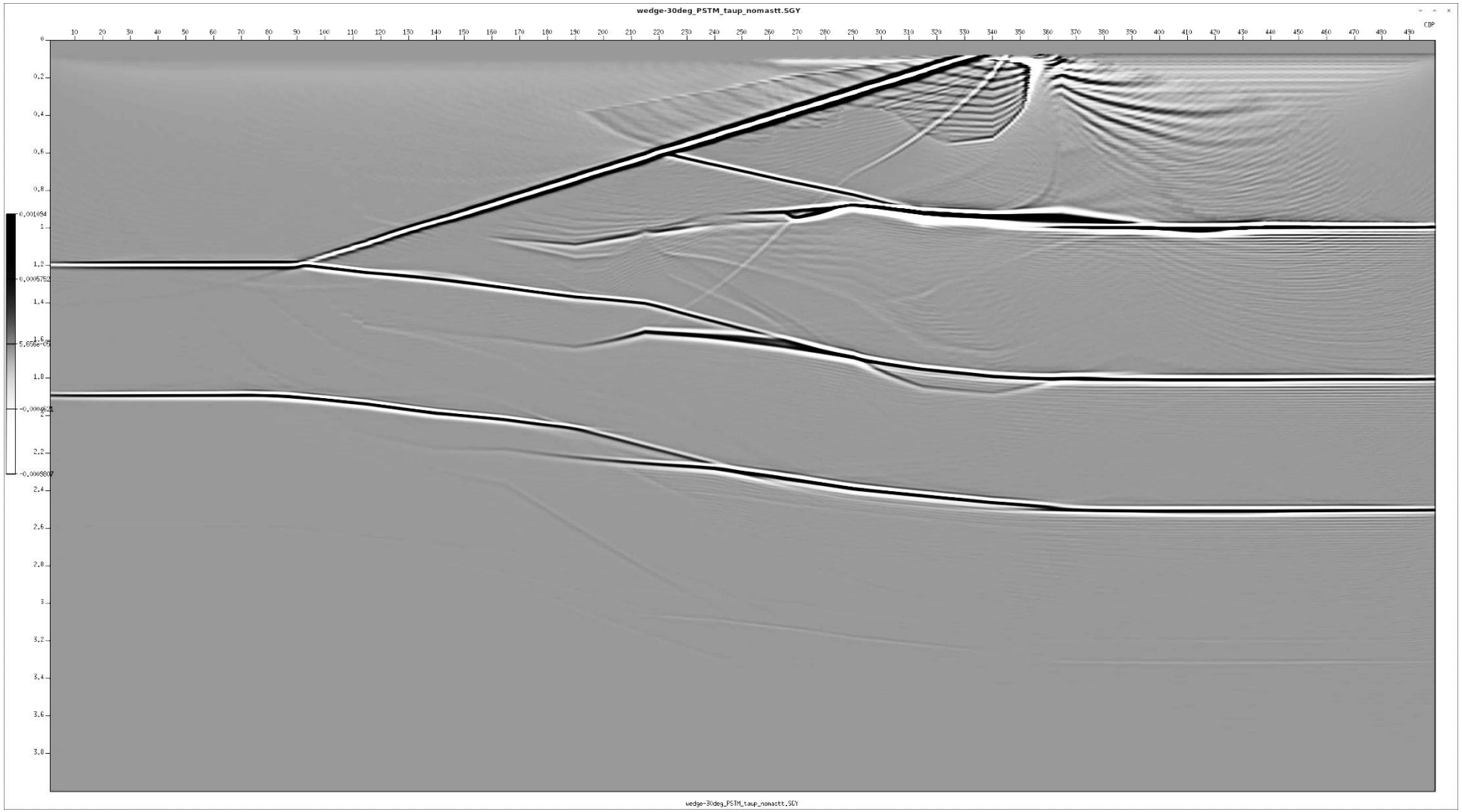
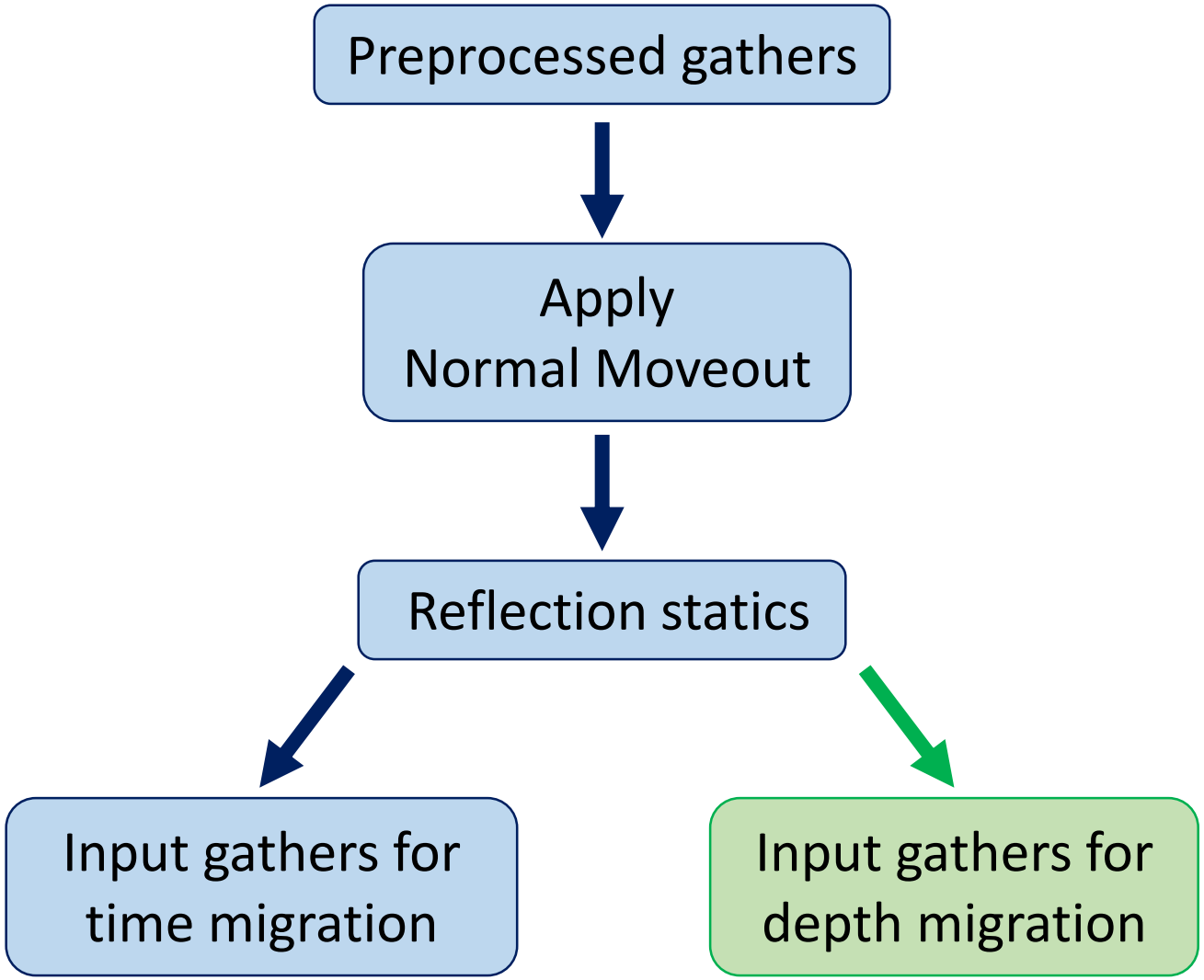


Conclusions

Traditional statics workflow



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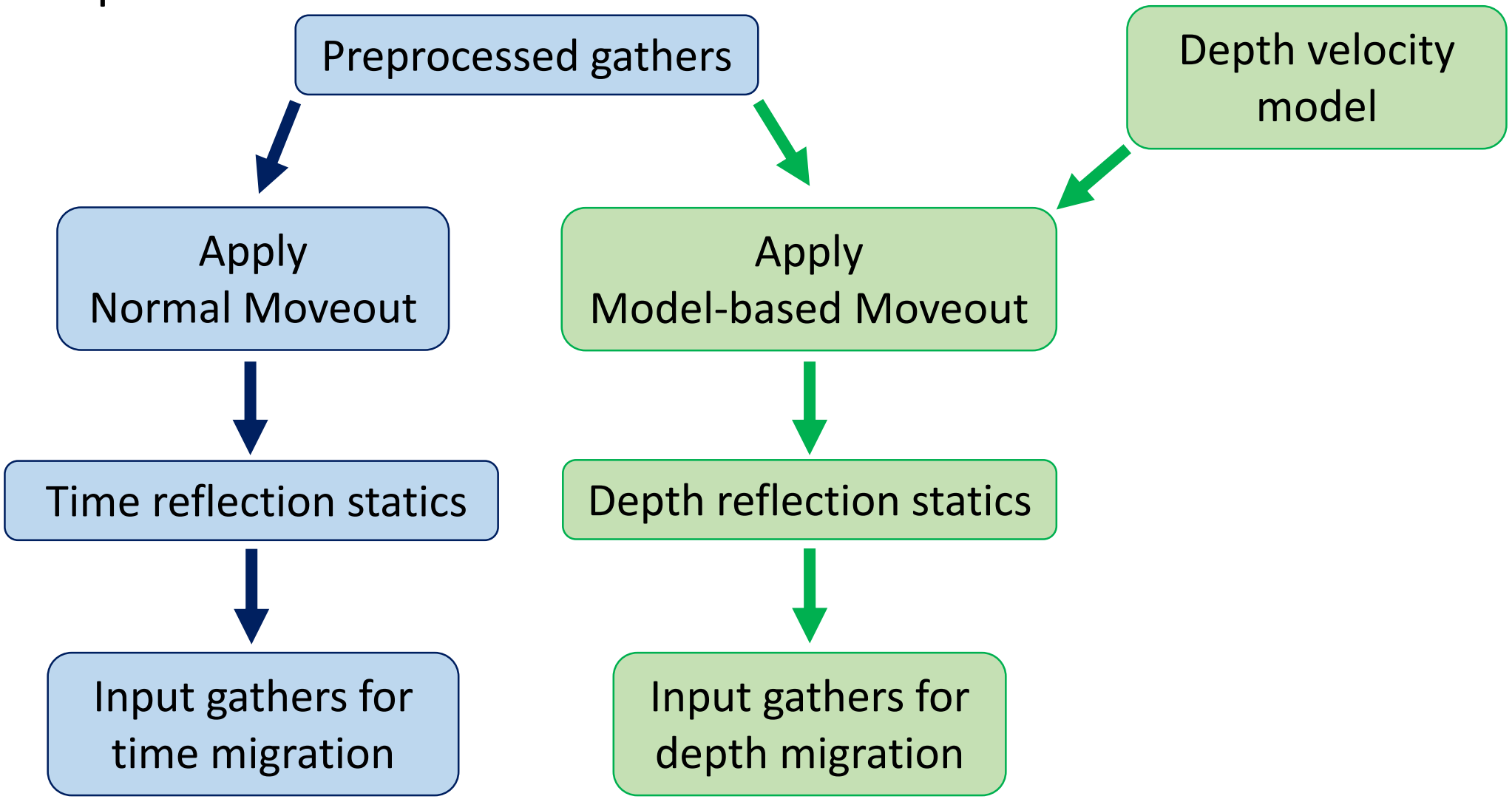

Conclusions

- Time statics are coupled to time processing
  - Traditional statics workflow creates anomalies in depth migration
- In structured data, the NMO assumptions breakdown
  - Cannot assume lateral velocity homogeneity
- Depth imaging should have different statics from time processing
  - Data should be conditioned specific to migration type

Future Work

- Synthetic model with statics
- Synthetic model with more subsurface structure
- Test sensitivity to velocity accuracy
- Test real data from foothills environments

Acknowledgements

- Thrust Belt Imaging
  - Greg Cameron, Marc Langlois, and Rob Vestrum
- CREWES staff, advisors, and students
- CREWES Sponsors
- NSERC, grant CRDPJ 461179-13
- Mitacs through the Mitacs-Accelerate program.

Acknowledgements

Thank you

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UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
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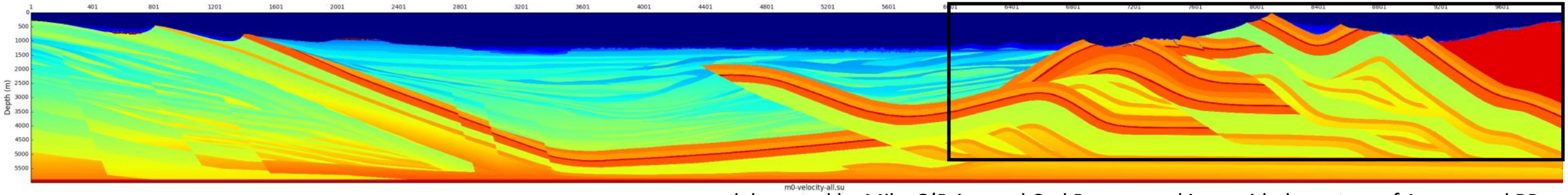
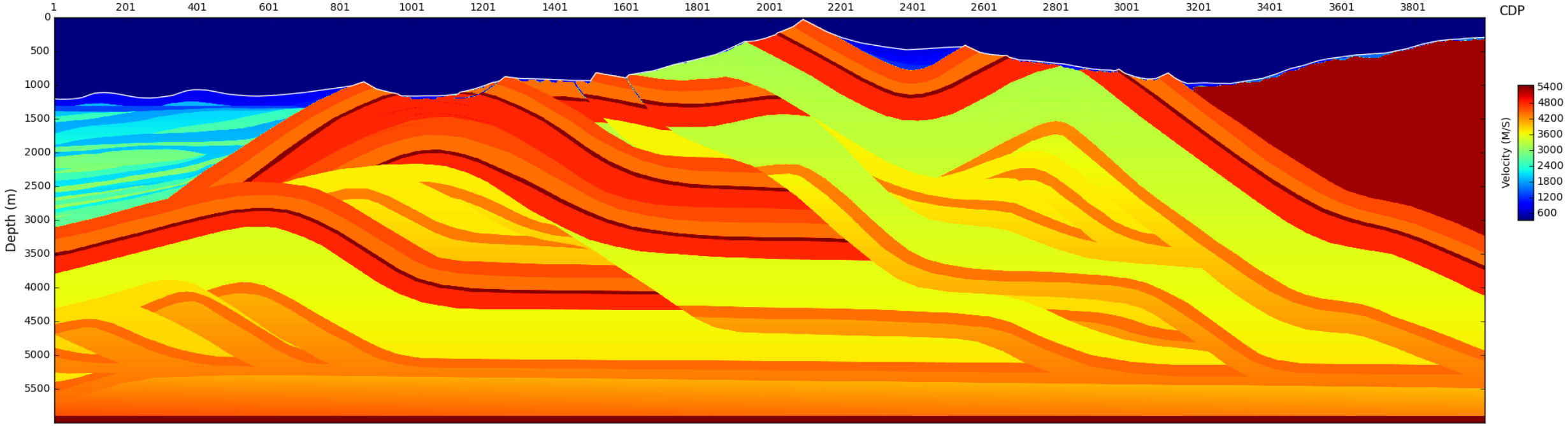
Supporting slides

- BP 1994 Acoustic Synthetic model, Statics Benchmark



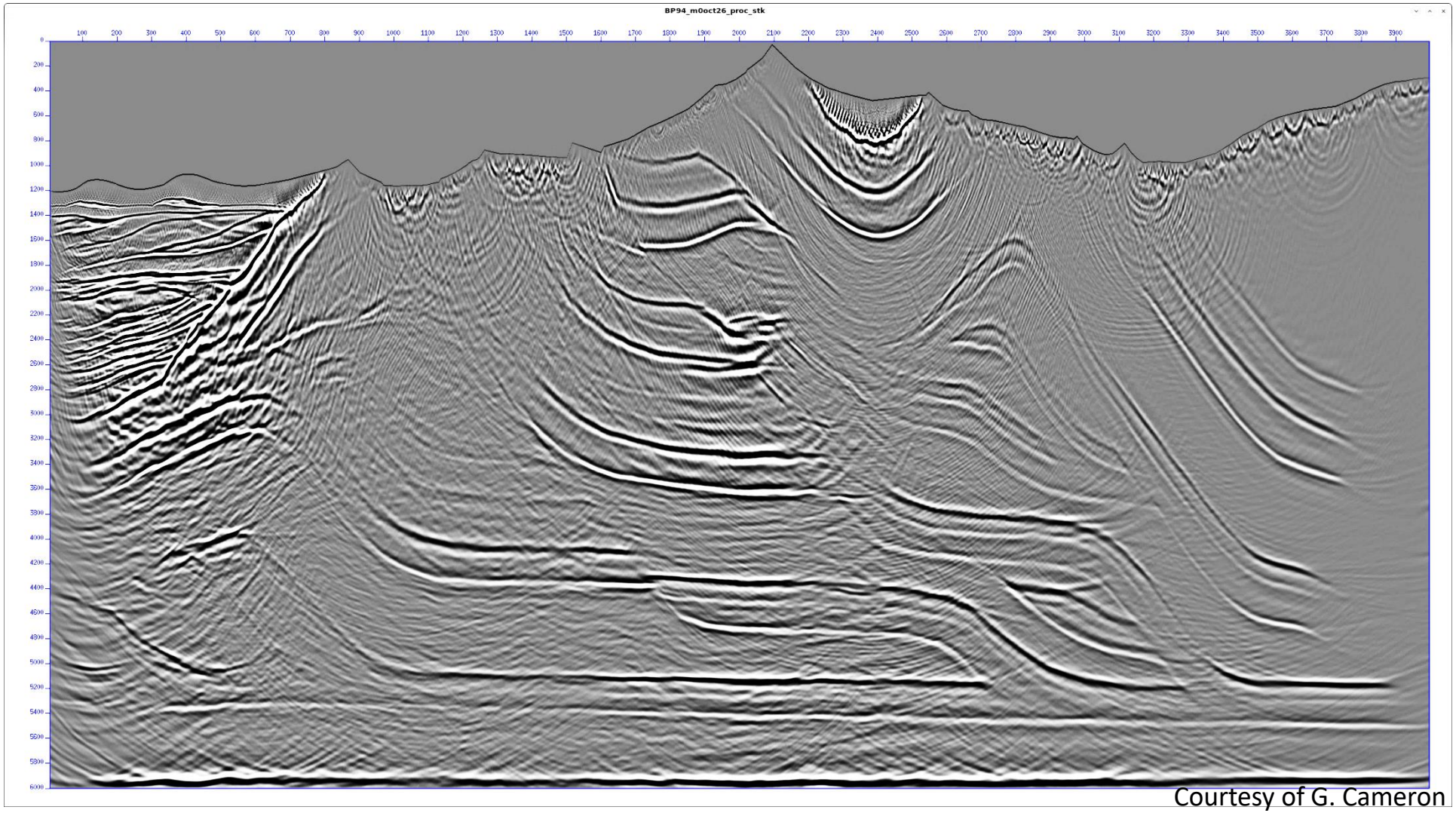
model created by Mike O'Brien and Carl Regone and is provided courtesy of Amoco and BP



Courtesy of G. Cameron

Supporting slides

- Depth Migration, no statics applied



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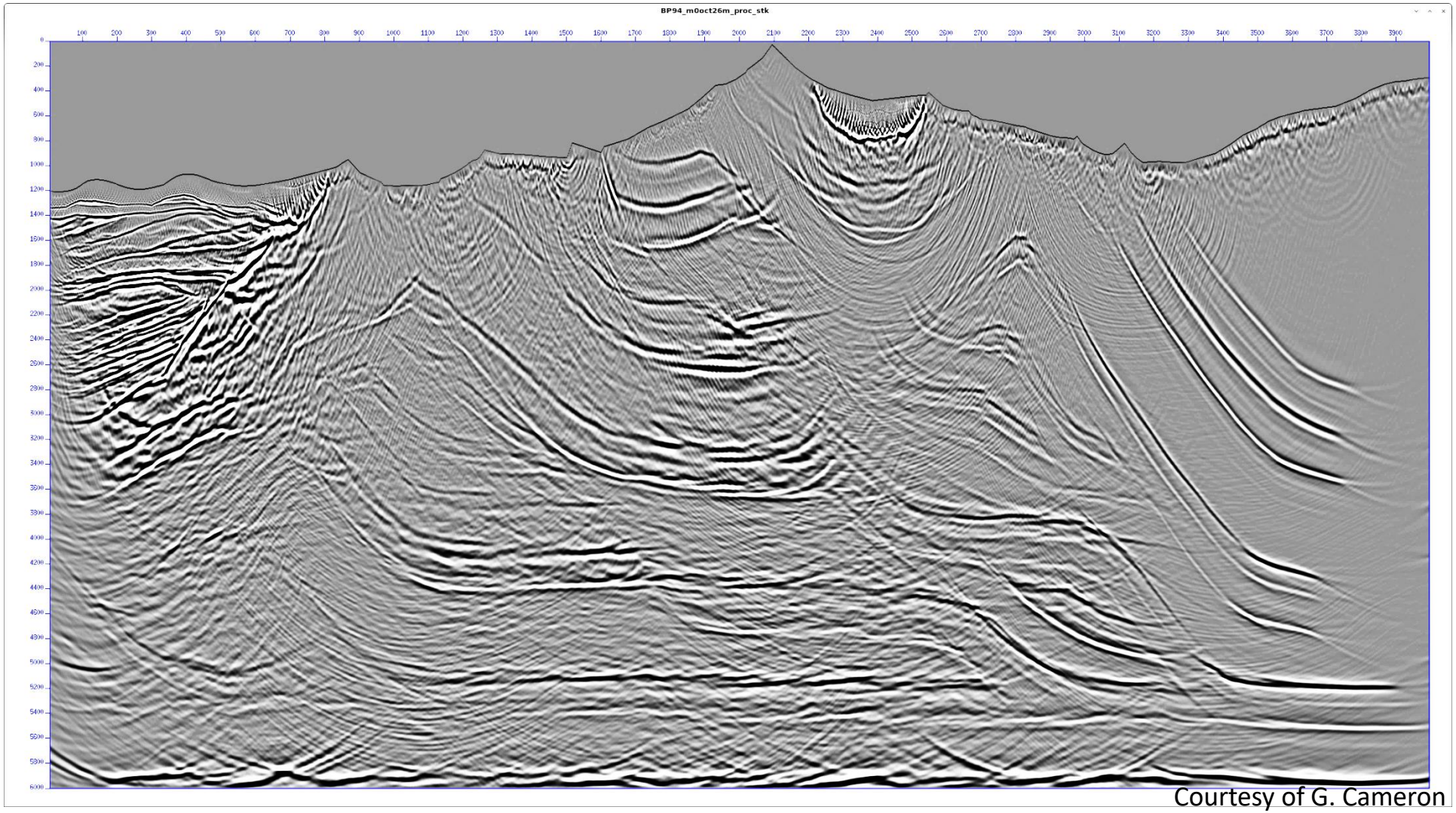

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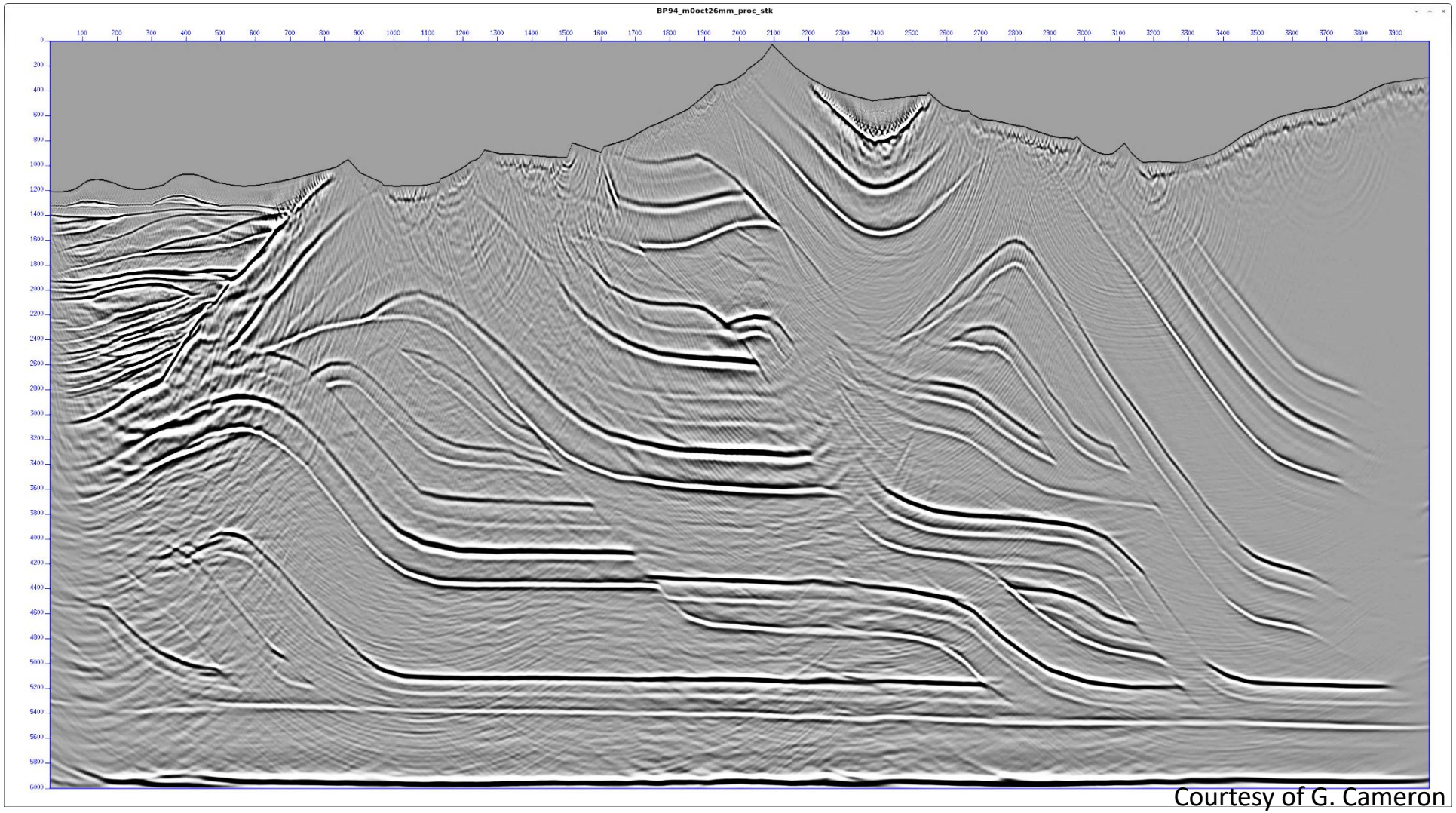

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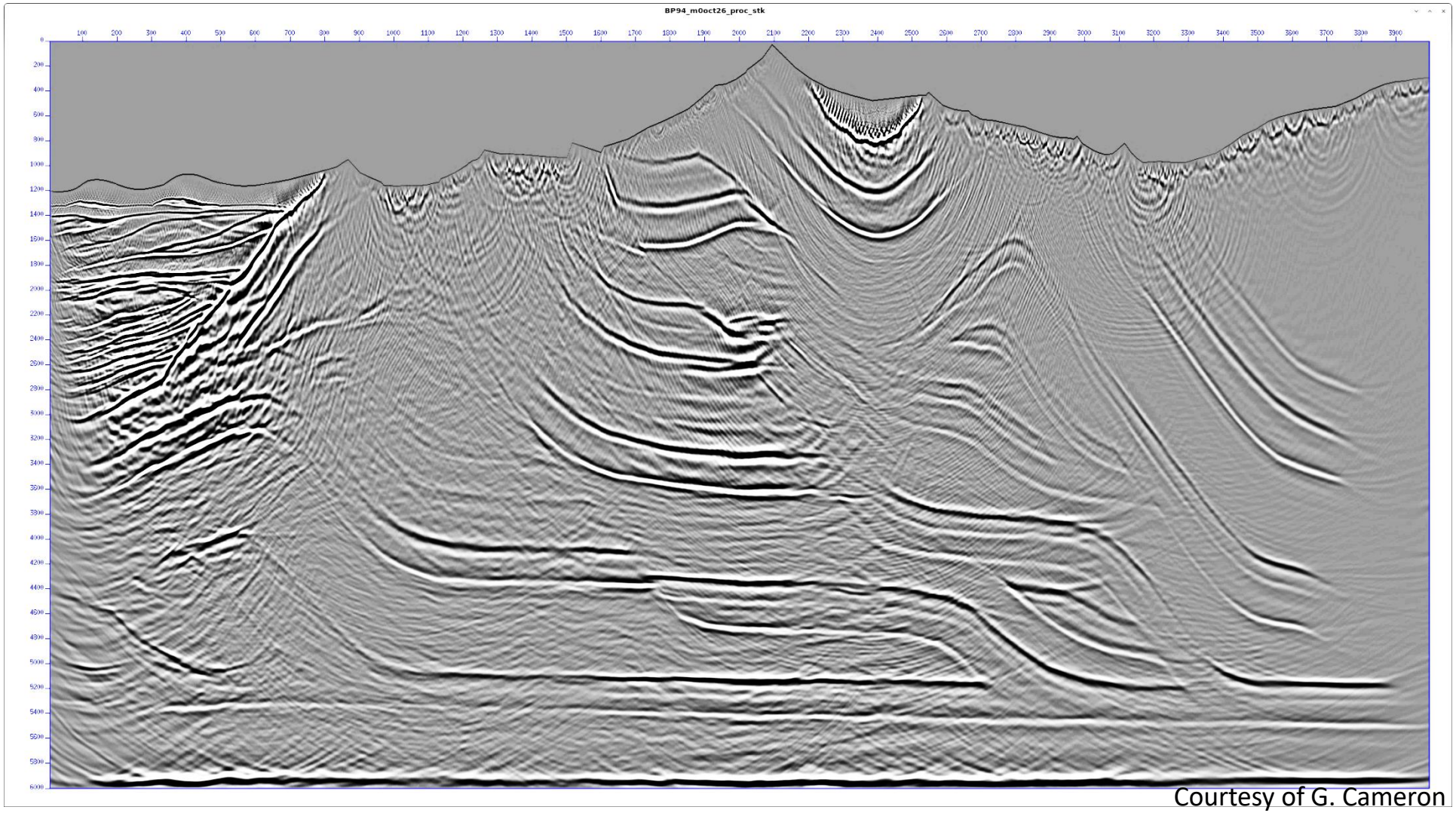

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Supporting slides

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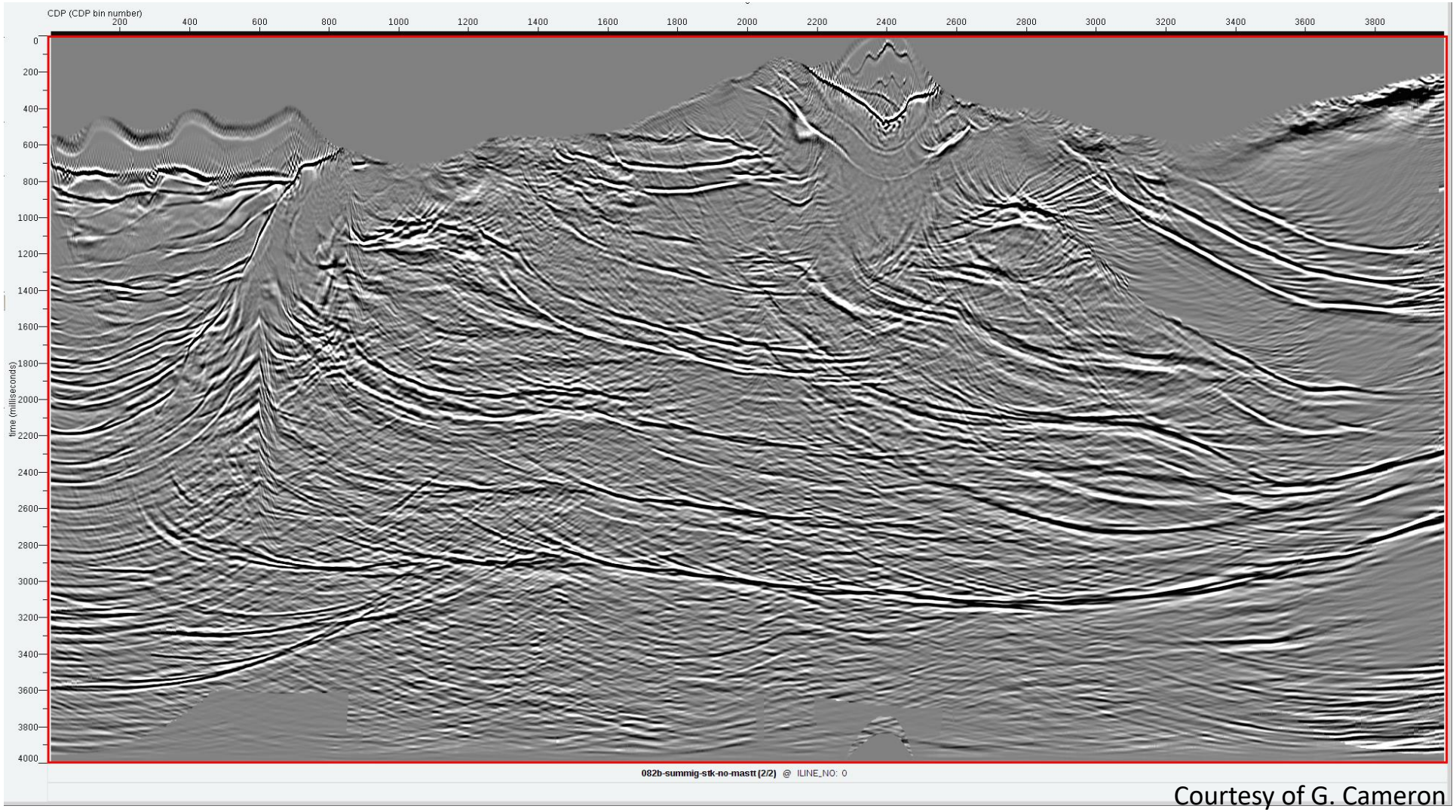

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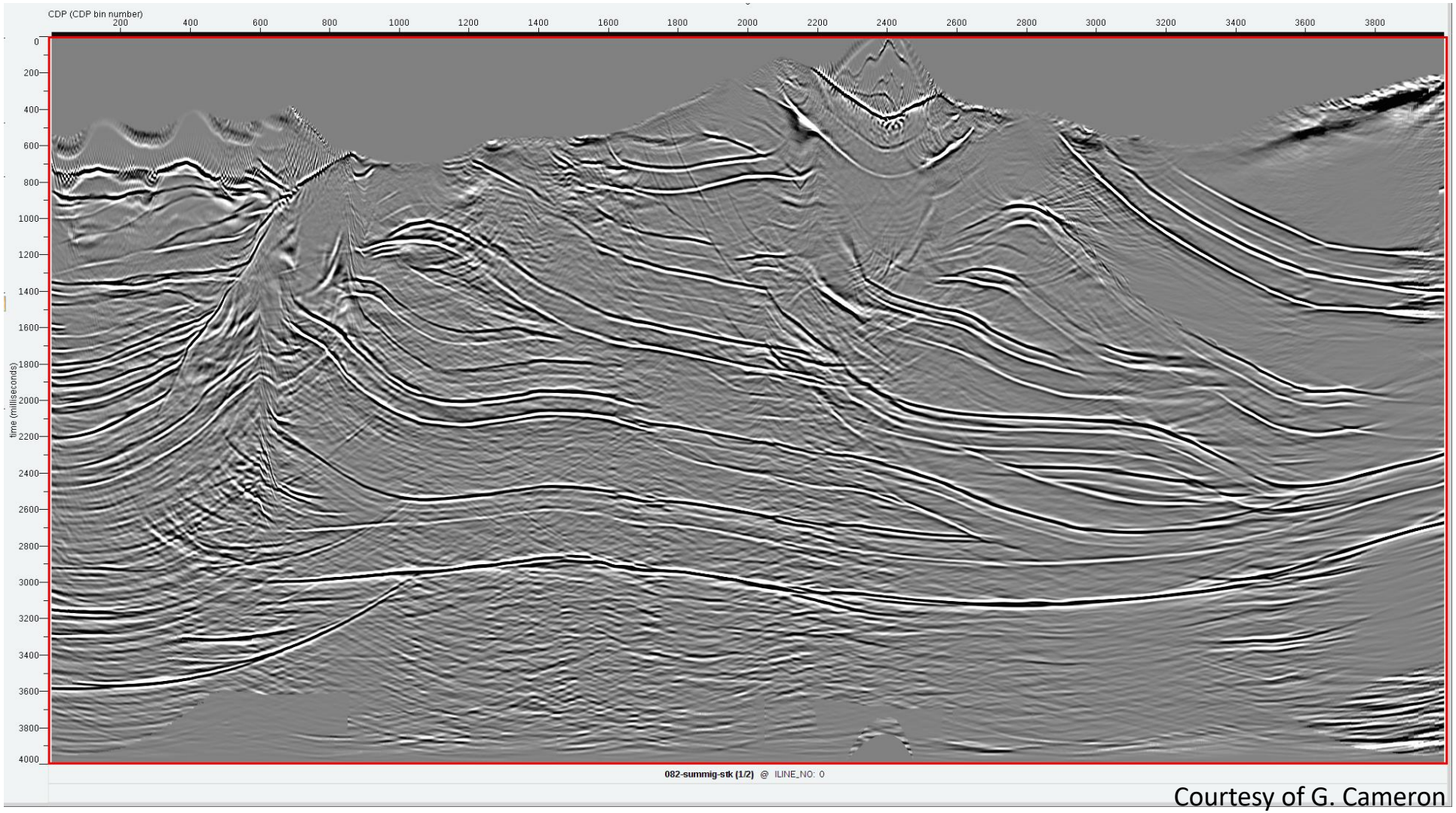

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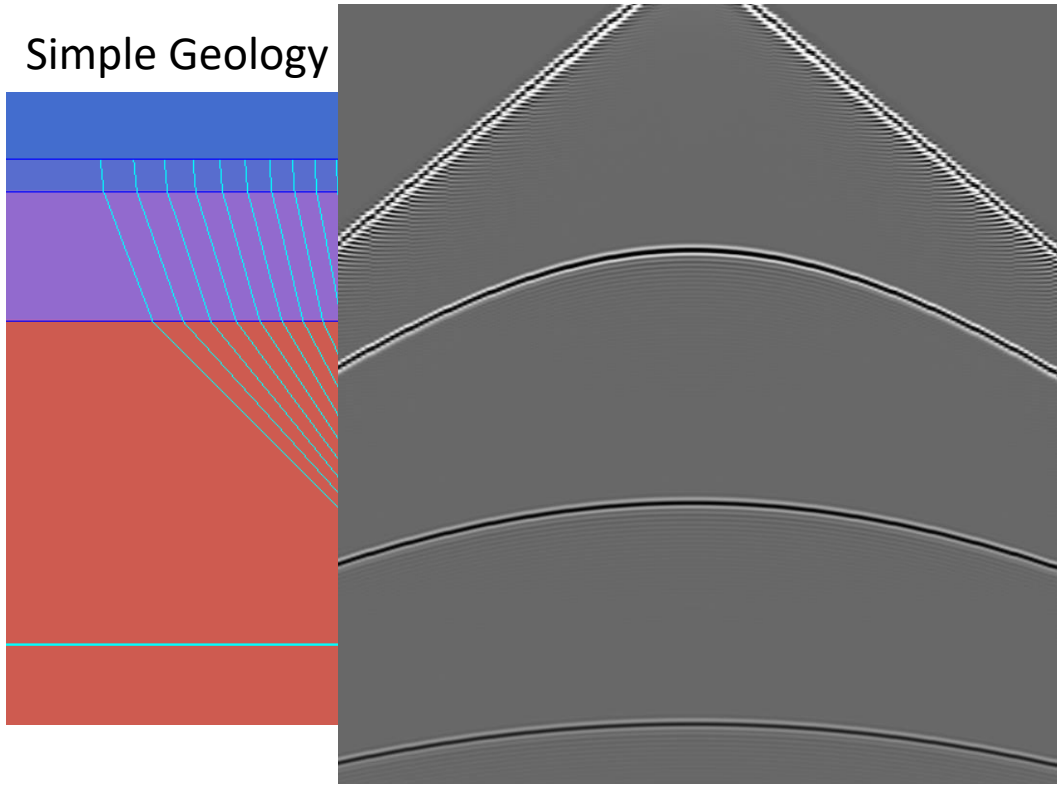
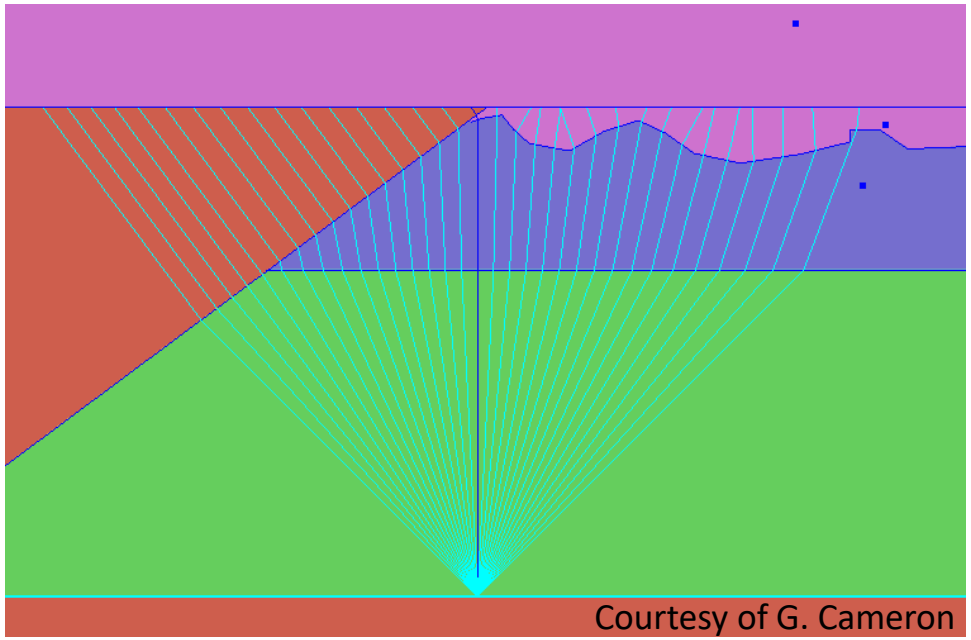
- Moveout can be approximated by a hyperbolic function

Simple Geology



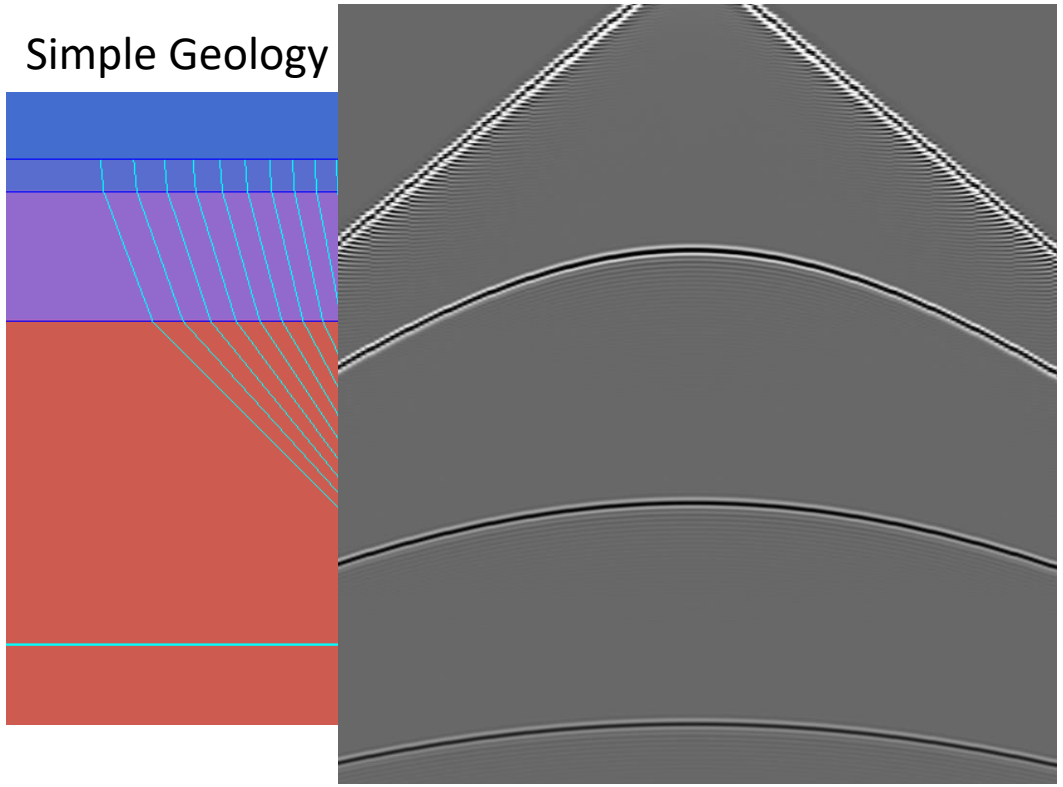
Complex Geology



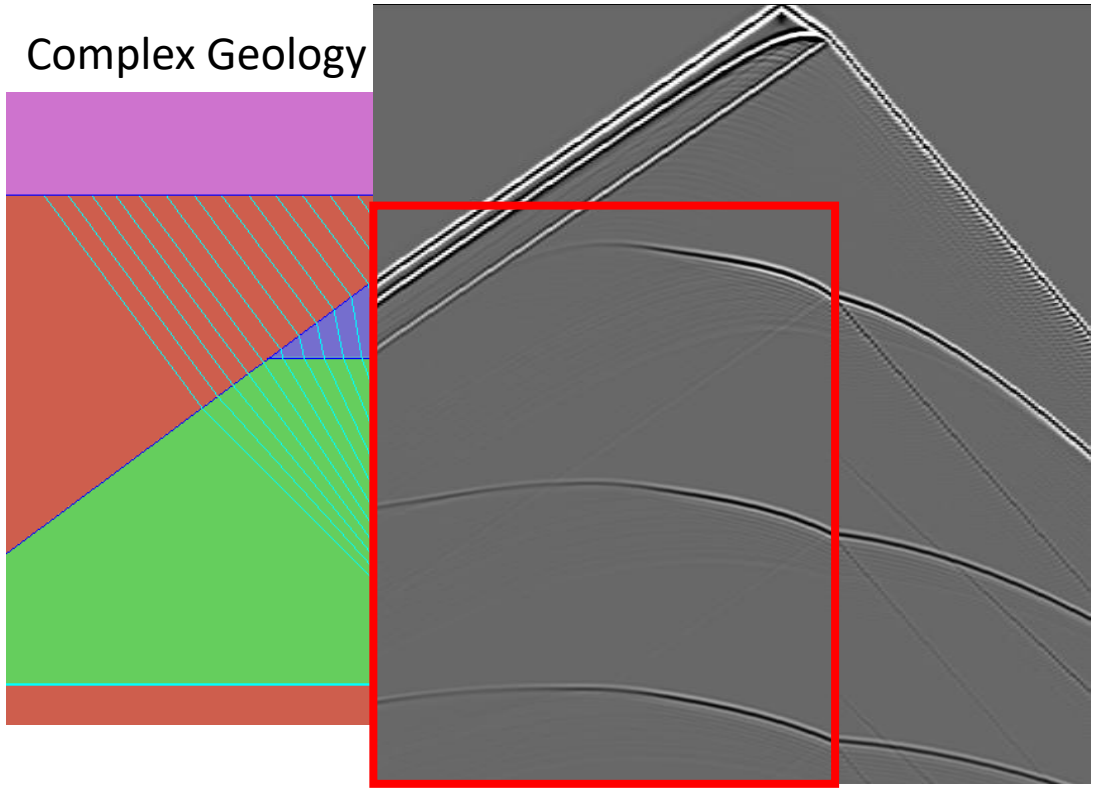
Methodology

$$t_{NMO} = \sqrt{t_0^2 + \frac{x^2}{V_{NMO}^2}}$$

Simple Geology

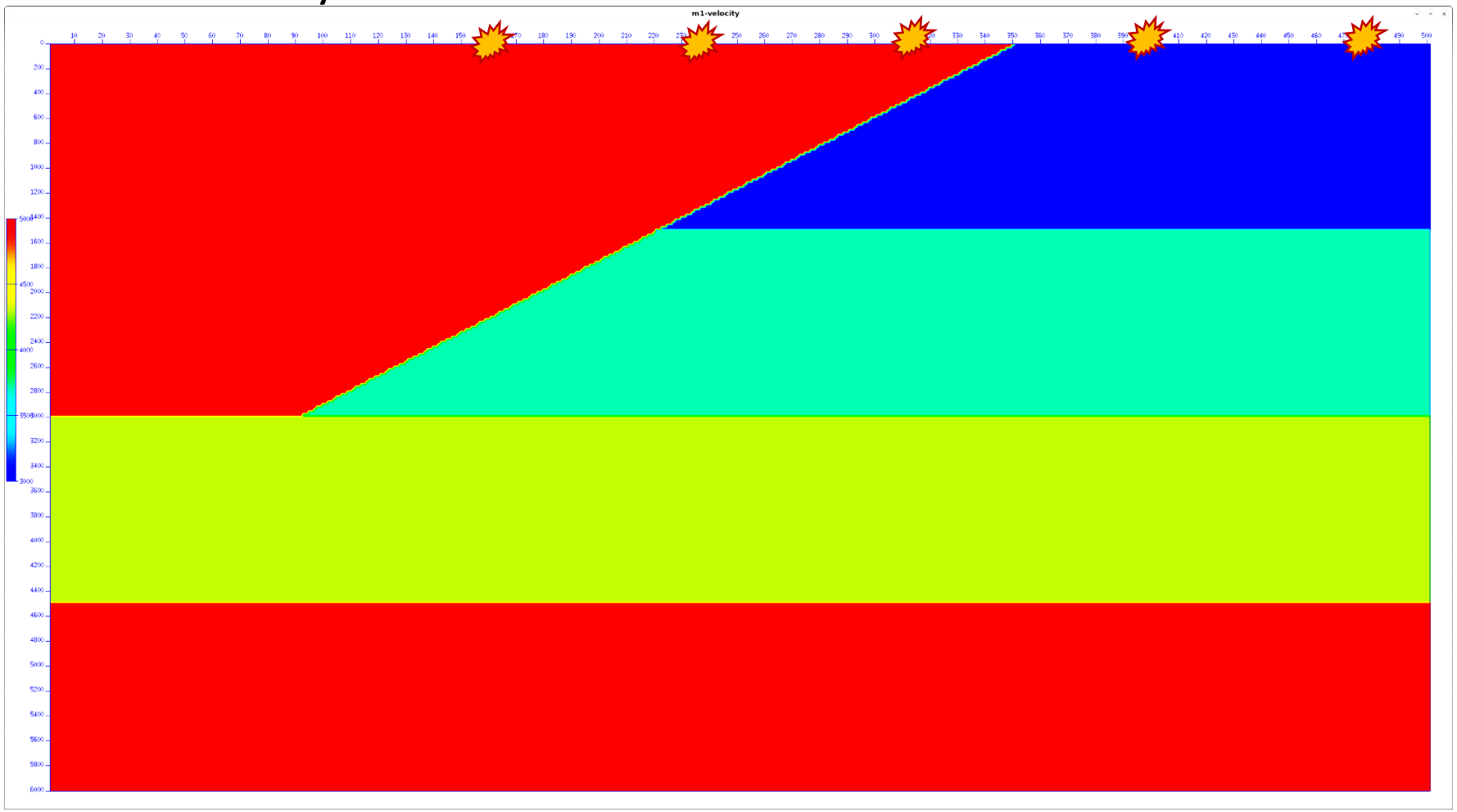


Complex Geology



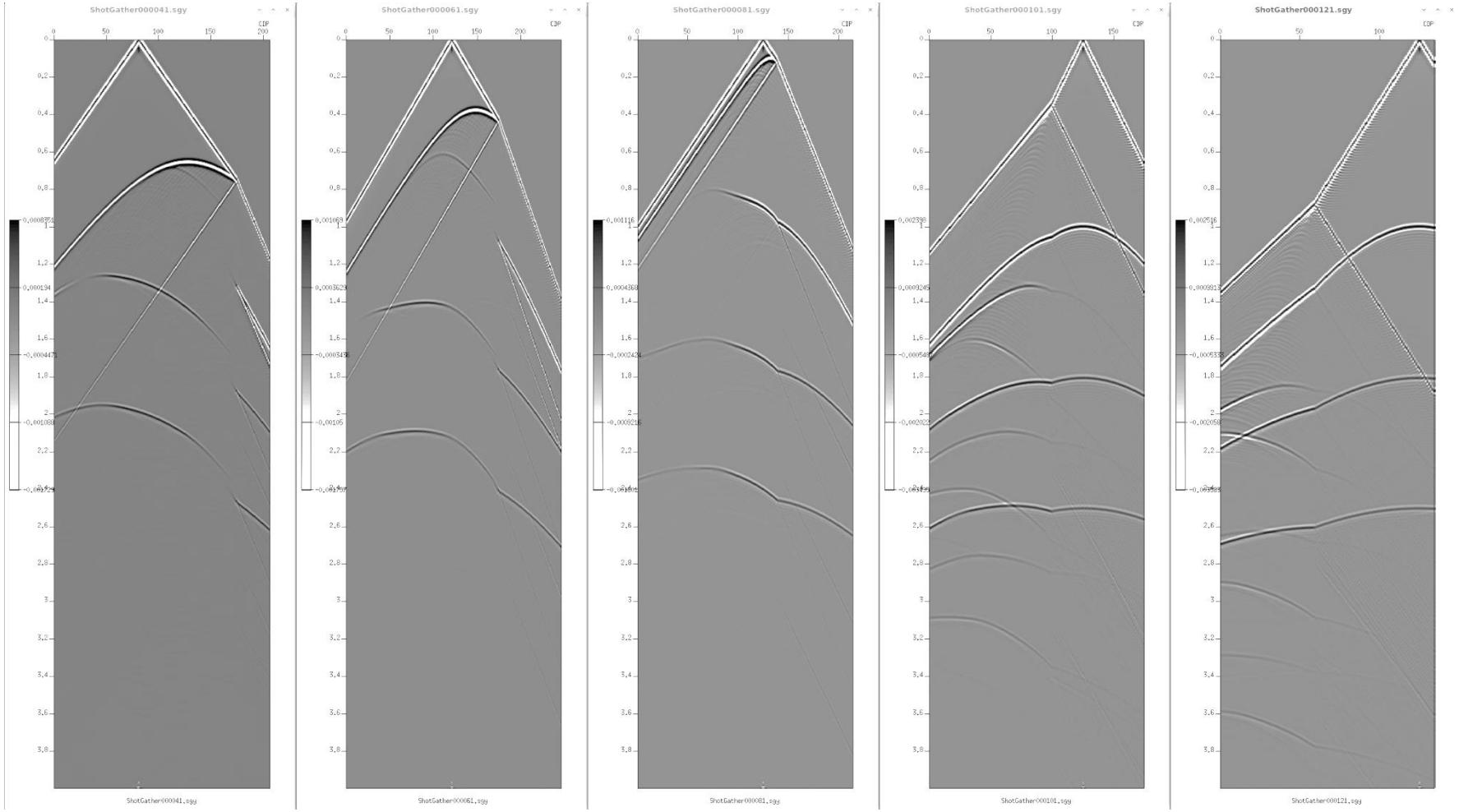
Normal Moveout (Time) vs Model-based Moveout (Depth)

Thrust Velocity Model



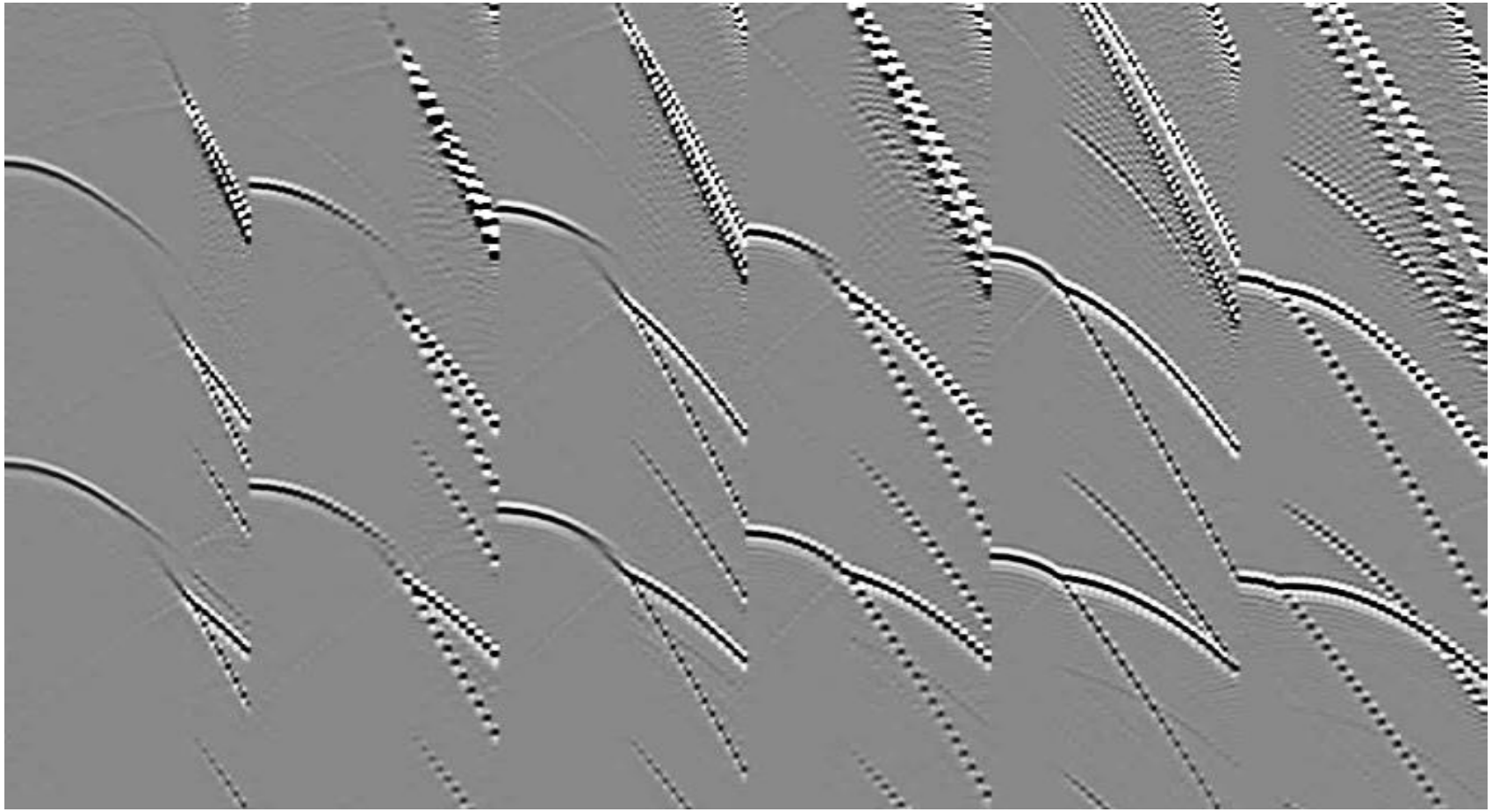
Normal Moveout (Time) vs Model-based Moveout (Depth)

Shots from Model



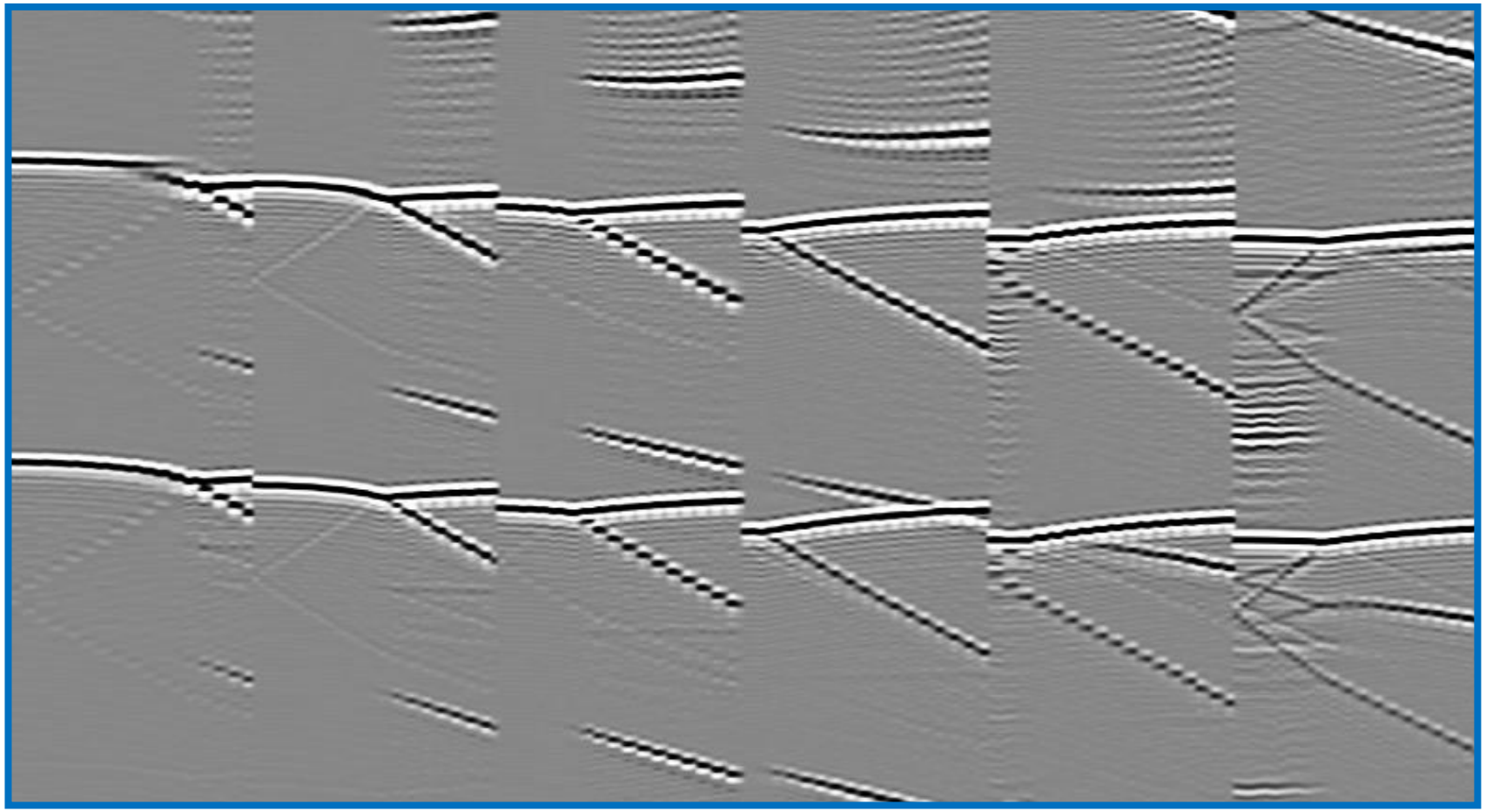
Normal Moveout (Time) vs Model-based Moveout (Depth)

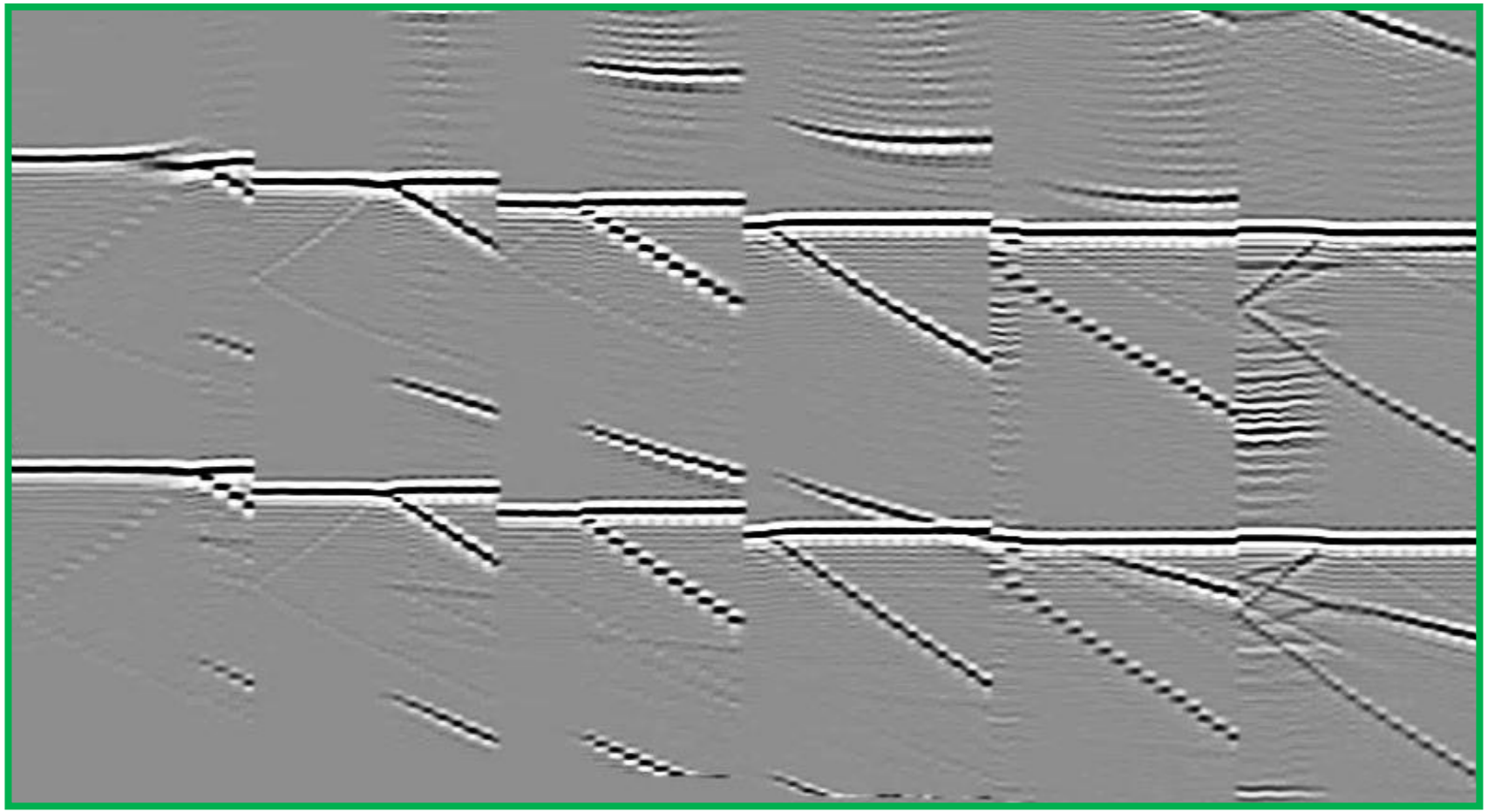
Uncorrected Gathers



Normal Moveout (Time) vs Model-based Moveout (Depth)

NMO Corrected Gathers



Normal Moveout (Time) vs Model-based Moveout (Depth)

MMO Corrected Gathers