

1.5D Internal multiple prediction in $\tau - p$ domain: physical modelling and synthetic results

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Abstract

Inverse scattering series algorithm has been verified theoretically as a wise way to eliminate internal multiples both for marine and land datasets, and more benefits can be achieved in plane wave domain than in wavenumber-pseudo depth domain. We presented internal multiple prediction in plane wave domain using inverse scattering series on physical modeling data collected in marine environment and synthetic data generated with well-log on land.

Physical modeling test

A five-layer physical model was built using water, polyvinyl chloride (PVC), aluminum and Plexiglas, provided by CREWES. Source and all receivers in a fixed step-size of 25m are located at 20m depth below surface. After gather collected, a basic seismic processing flow was applied, such as top muting, bandpass filtering of 10-20-70-90Hz, AGC and spiking deconvolution, the initial processed data is shown in Figure 1.

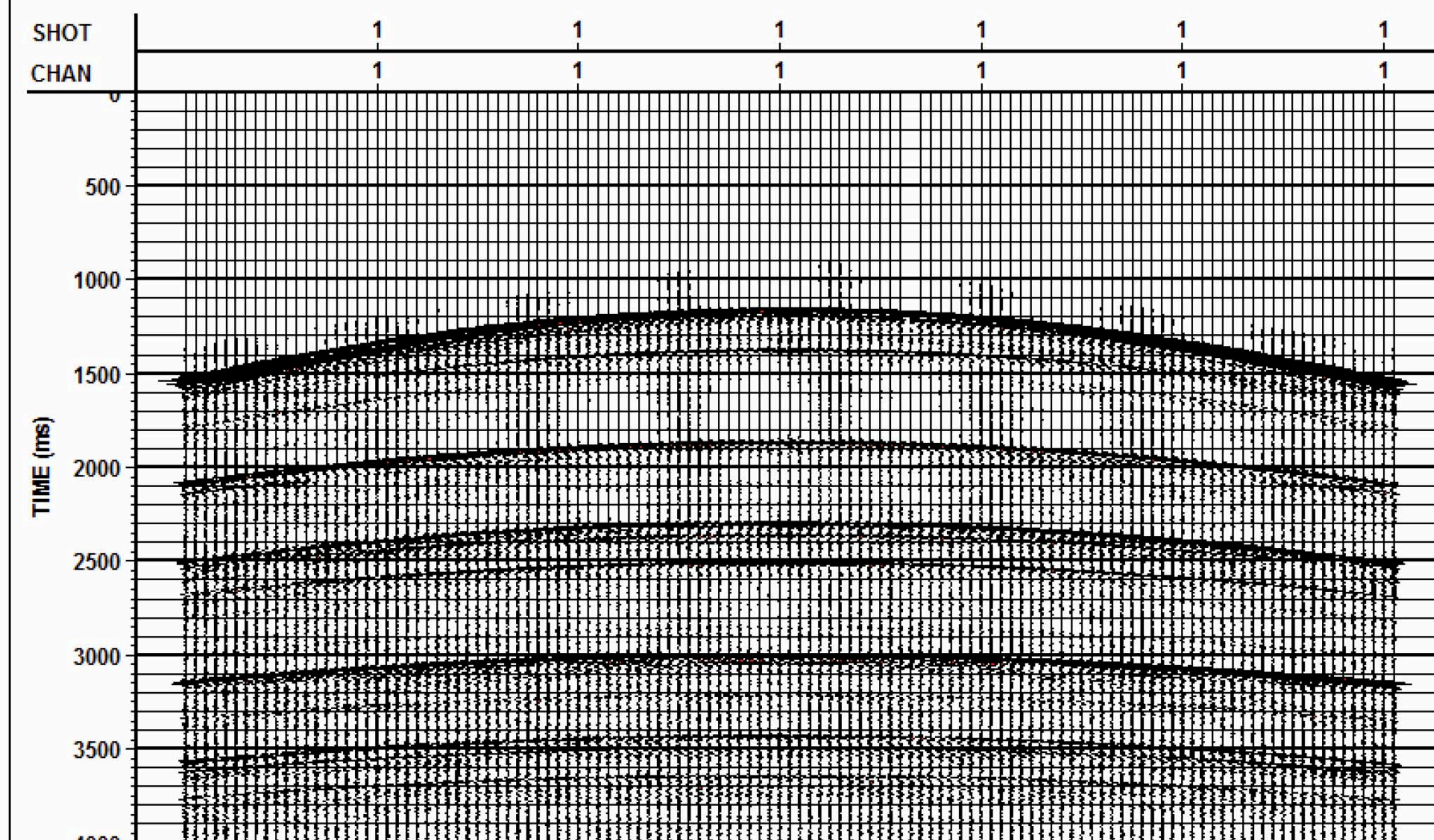


FIG. 1. Physical modelling data after preprocessing

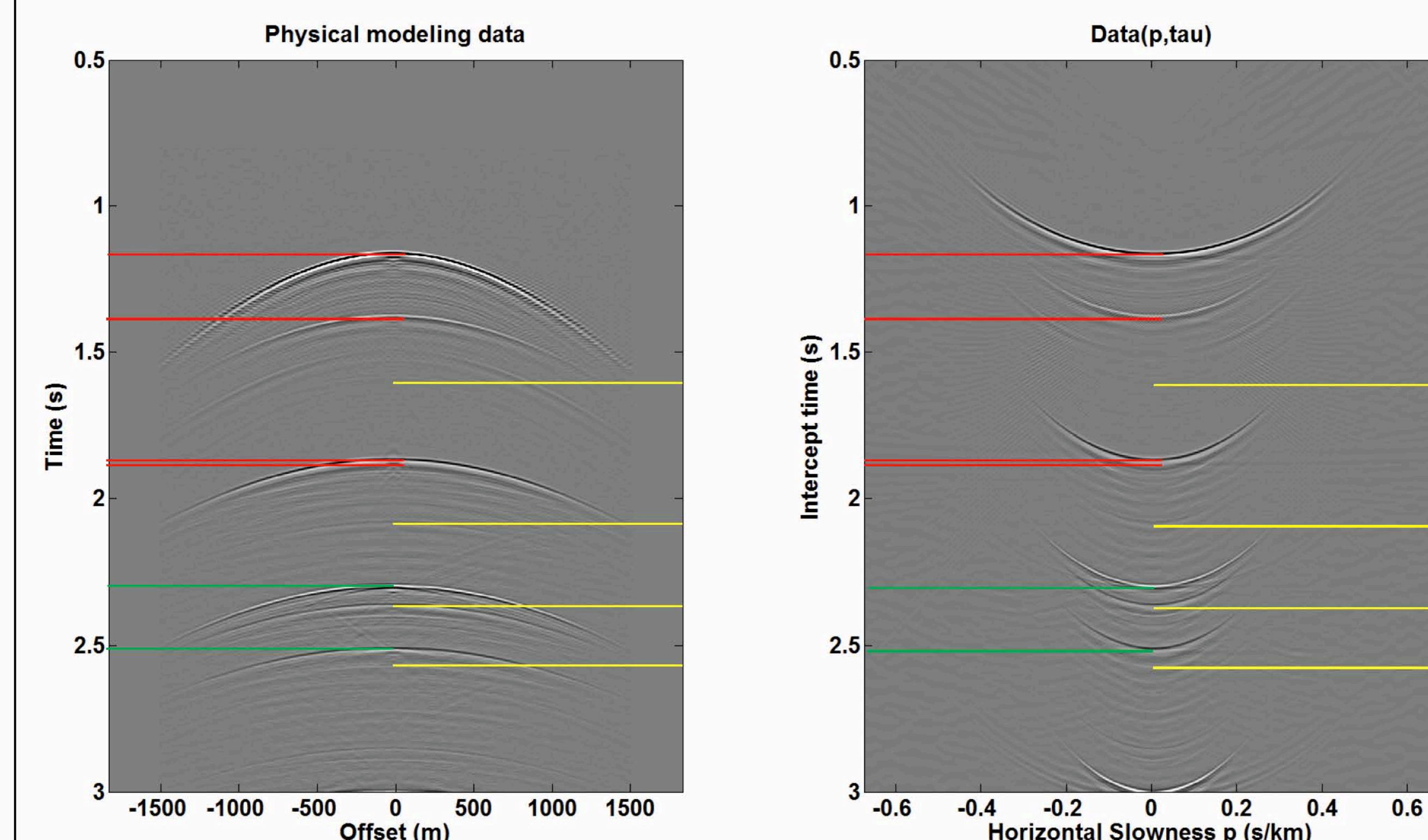


FIG. 2. Physical modelling data in $\tau - p$ domain, primaries indicated in red, FSMs in green, IMs in yellow

Figure 2 shows the physical modelling data in $\tau - p$ domain and at zero-offset travel time, all primaries are indicated in red, all free-surface multiples are indicated in green and all internal multiples are indicated in yellow. All four 1st order internal multiples prediction using inverse scattering algorithm are shown in Figure 3.

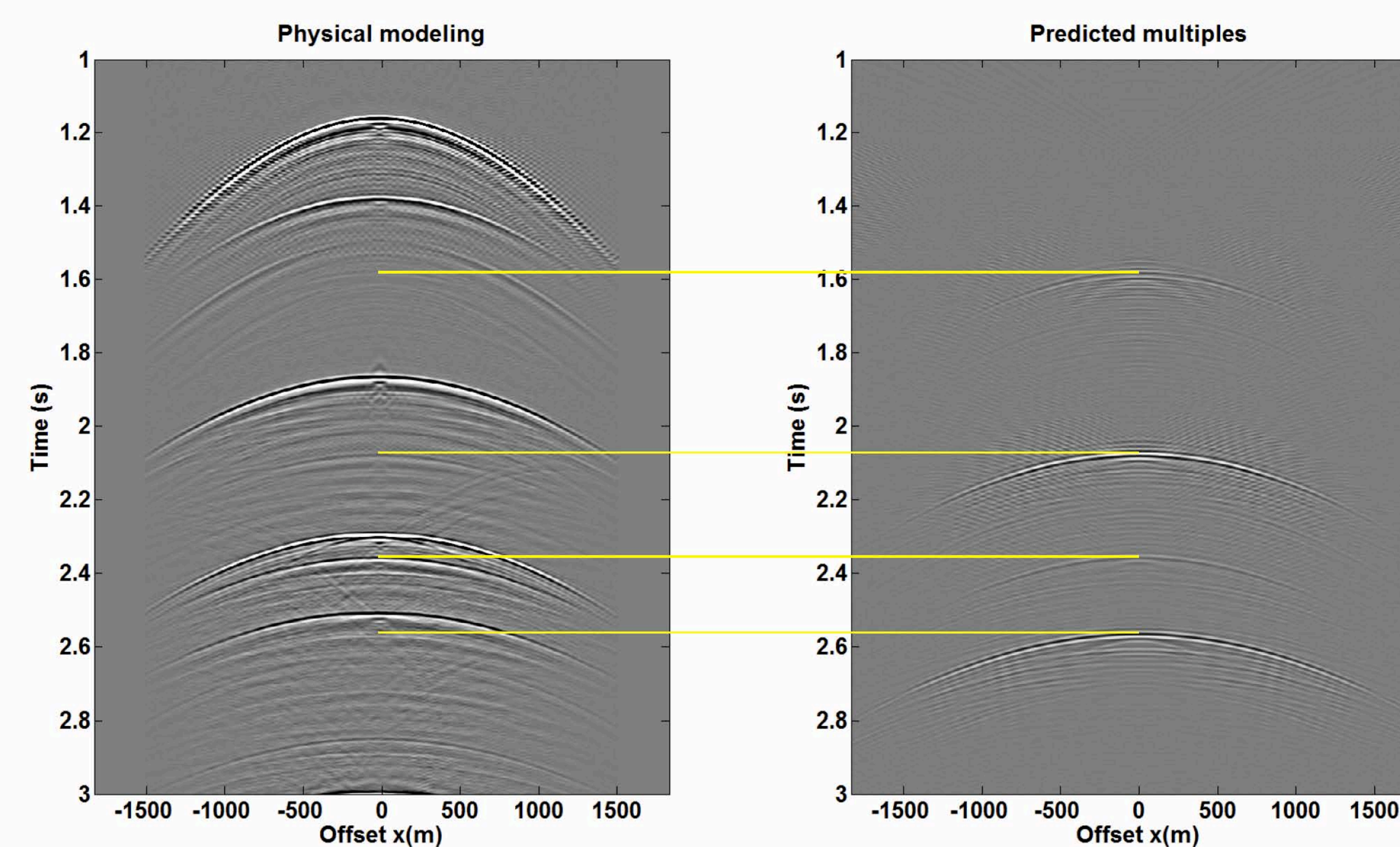


FIG. 3. Internal multiples predicted results

Synthetic data test

The velocity model was created using well 12-27, collected by CREWES at Hussar, Alberta in 2011, to examine the feasibility of ISS algorithm on land data with thin layers.

The well-log was resampled by 2m interval, and the finite-difference shot gather was generated with the multi-thin layer velocity model built using P-wave velocity of well 12-27. The P-wave sonic log, density log and velocity model are shown in Figure 4.

Figure 5 shows the finite-difference shot record both in offset domain and in $\tau - p$ domain. As we can see, there are two bright-spot effects in large p range which will not be considered in the processing of prediction.

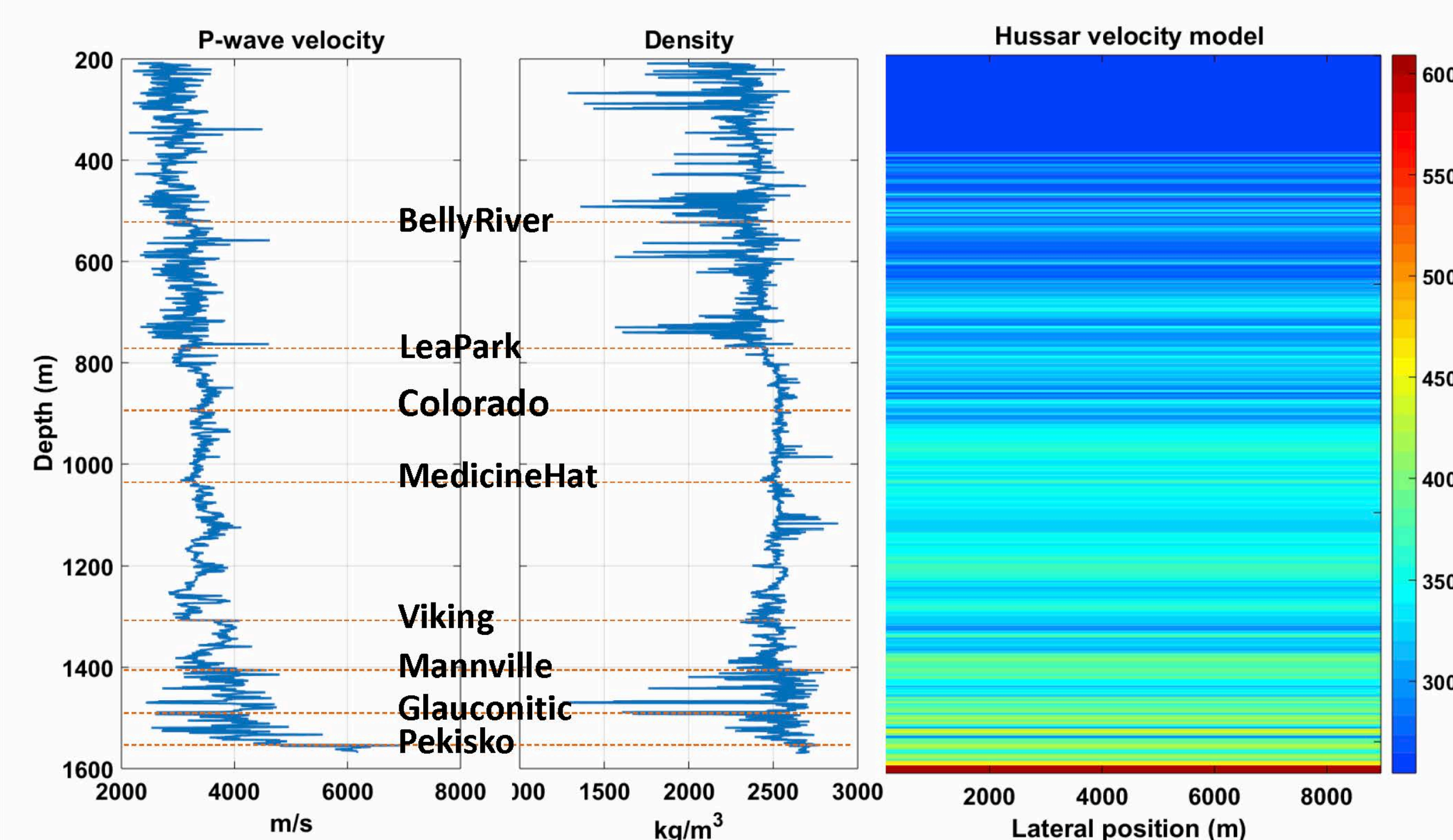


FIG. 4. Well 12-27 at Hussar and synthetic velocity model

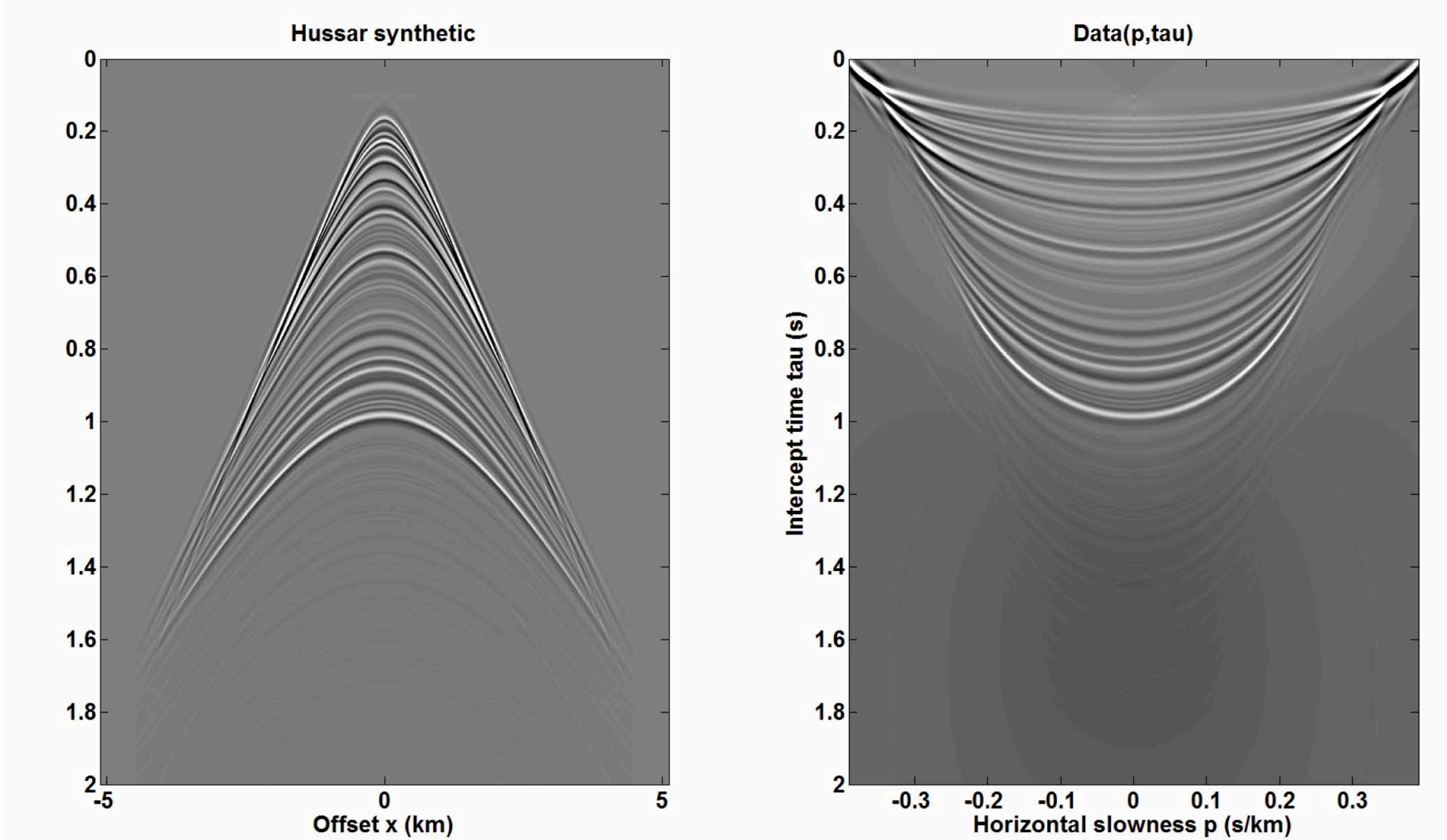


FIG. 5. Synthetic shot gather and its $\tau - p$ transform

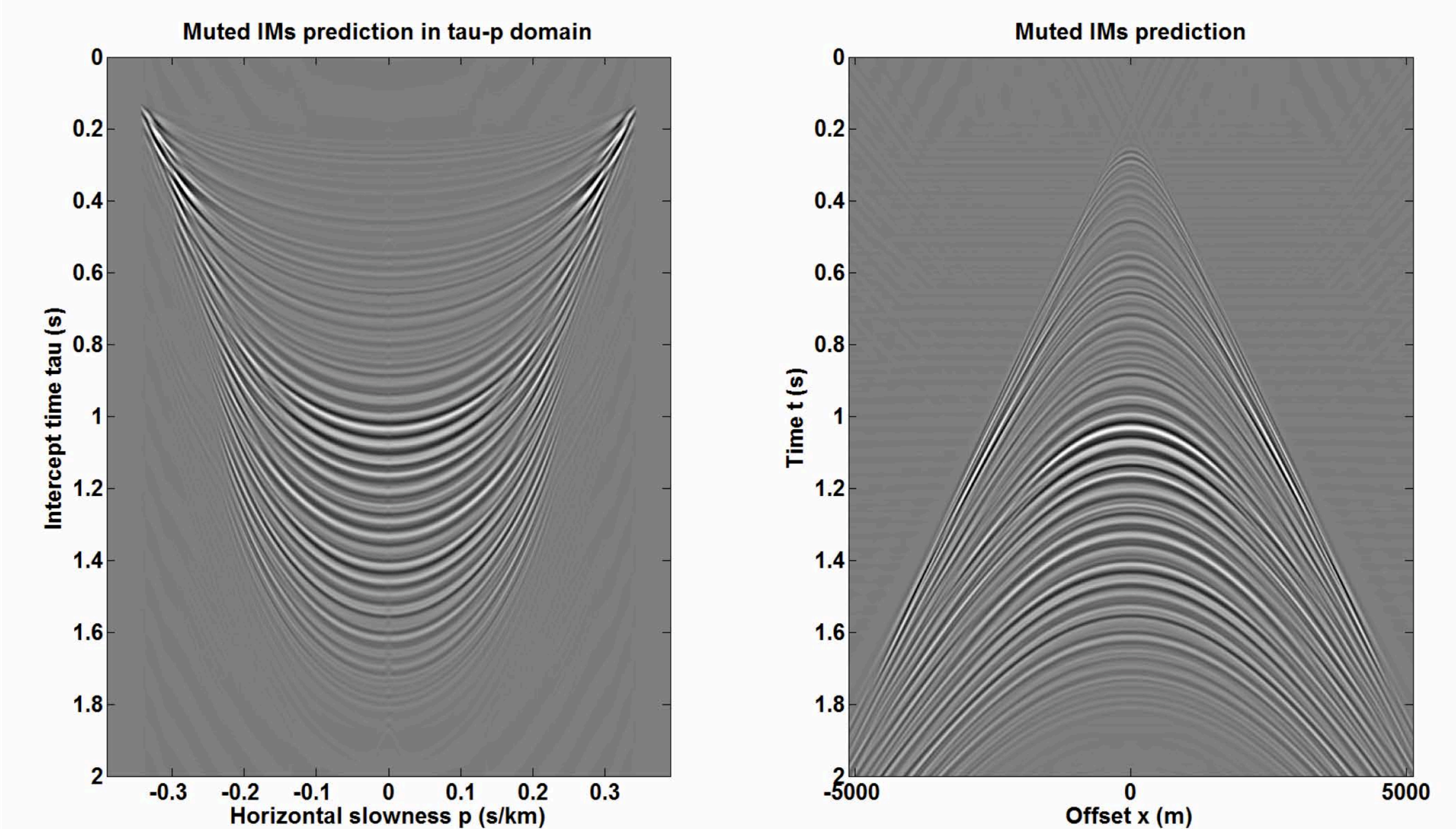


FIG. 6. Internal multiples predictions using plane wave ISS algorithm in $\tau - p$ domain and space-offset domain

Conclusion

Internal multiples prediction tests both on physical modelling data in marine environment and synthetic land data exemplified the plane wave domain inverse scattering series algorithm can be an efficient and wise approach to eliminated internal multiples. More relevant and practical benefits can be achieved based on plane wave ISS algorithm.

Acknowledgements and References

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References can be found in relevant reports:

“1.5D internal multiple prediction: physical modelling results”

“Internal multiple prediction in the tau-p domain: 1.5D synthetic results”