INVERSE SCATTERING INTERNAL MULTIPLE ATTENUATION: IMPLEMENTATION ON SYNTHETIC DATA AND PHYSICAL MODEL DATA

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OUTLINE

- Introduction
- Theoretical Framework
- How the algorithm works?
- Synthetic data application
- Parameter testing
- Physical model data
- Discussion of results
- Conclusions and future work

INTRODUCTION

Multiple events can be mistaken for primary reflections, and may distort primary events and obscure the task of seismic interpretation.

A method due to Araujo and Weglein (1994) predicts and attenuates all orders of internal multiples.

This method derives from the inverse scattering series and attenuate internal multiples without any a-priori knowledge about the subsurface.

In this work, we implemented 1D version of the algorithm for normal incidence and applied on synthetic data and physical model data.

THEORETICAL FRAMEWORK

1D normal incidence internal multiple Attenuation

The first term in the internal multiple attenuation series for the 1D normal incidence case is (Araujo et. al., 1994):

$$b_{3IM}(k_z) = \int_{-\infty}^{\infty} dz'_1\, e^{k_z i z'_1} b_1(z'_1).\int_{-\infty}^{z'_1-\epsilon} dz'_2 b_1(z'_2).\, e^{-ik_z z'_2} \int_{z'_2+\epsilon}^{\infty} dz'_3 b_1(z'_3).\, e^{ik_z z'_3}$$

$b_{3IM}(k_z)$ is a prediction of the internal multiple present in the data. It is in the k_z-domain, where k_z is the conjugate of pseudo-depth ($z=c_o t/2$).

The $b_1(z)$ entries are the input data traces in pseudo-depth domain.

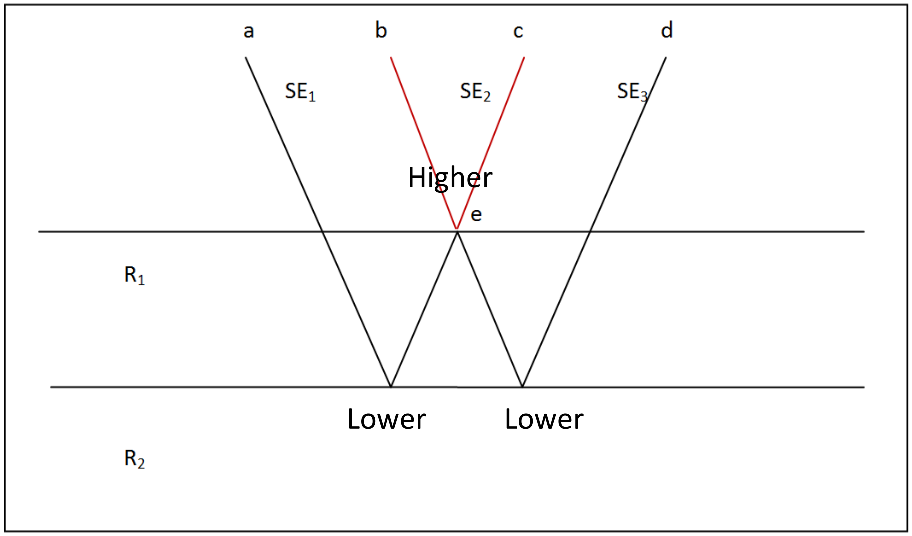
ϵ is related to width of the wavelet

The algorithm is *searching* for the correct subevents.

How the algorithm works?

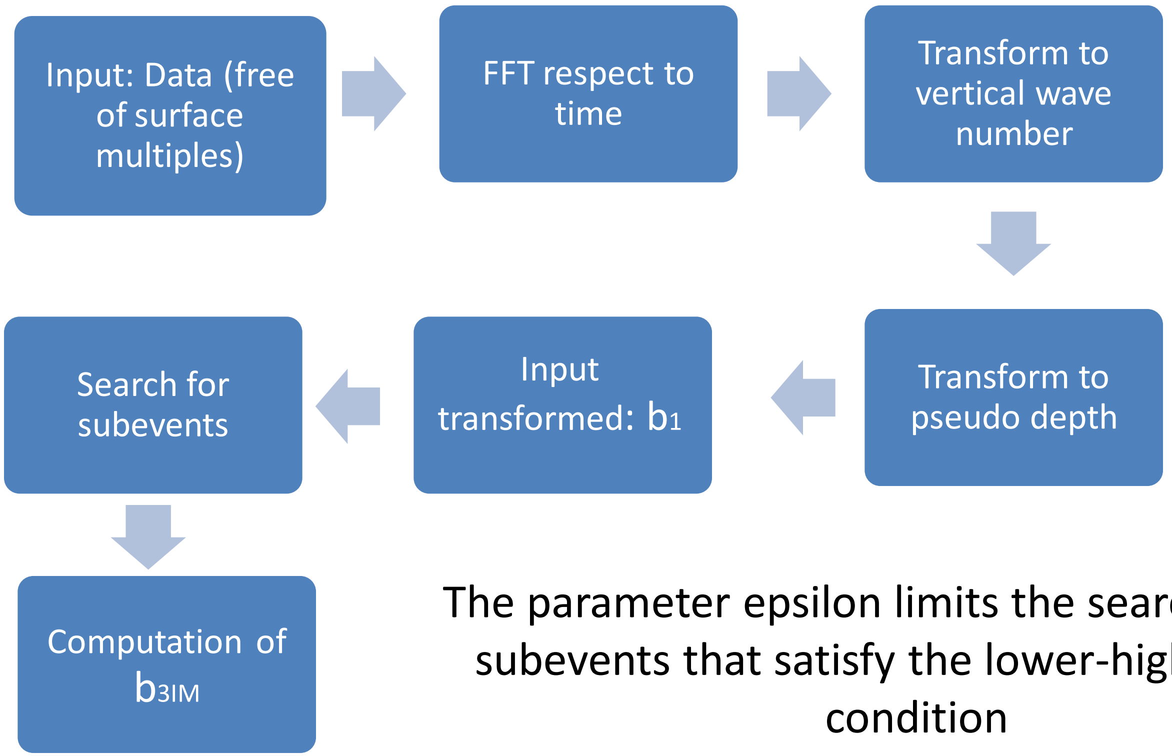
The convolution of two arrivals will sum the travel time of those events, and the crosscorrelation will subtract their travel times.

Therefore, the travel time of subevent 1 and 3 will be summed while the travel time of subevent 2 will be subtracted.



This algorithm selects all the subevents that suit the **lower-higher-lower** and then combines theirs amplitudes and phases to construct a multiple.

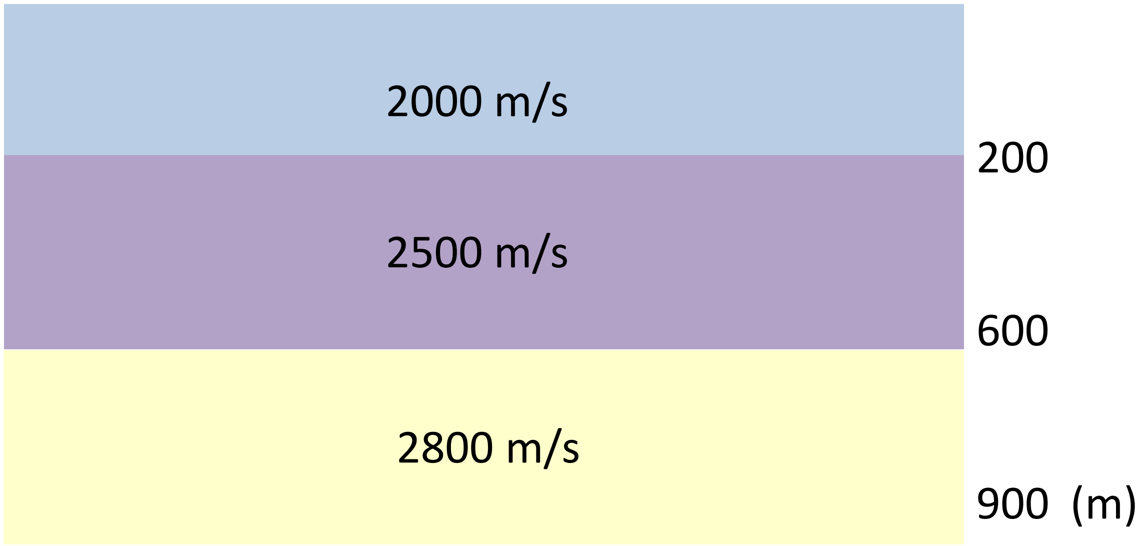
IMPLEMENTATION



The parameter epsilon limits the searching of the subevents that satisfy the lower-higher-lower condition

Prestack data set that contains the predicted multiples

SYNTHETIC DATA APPLICATION

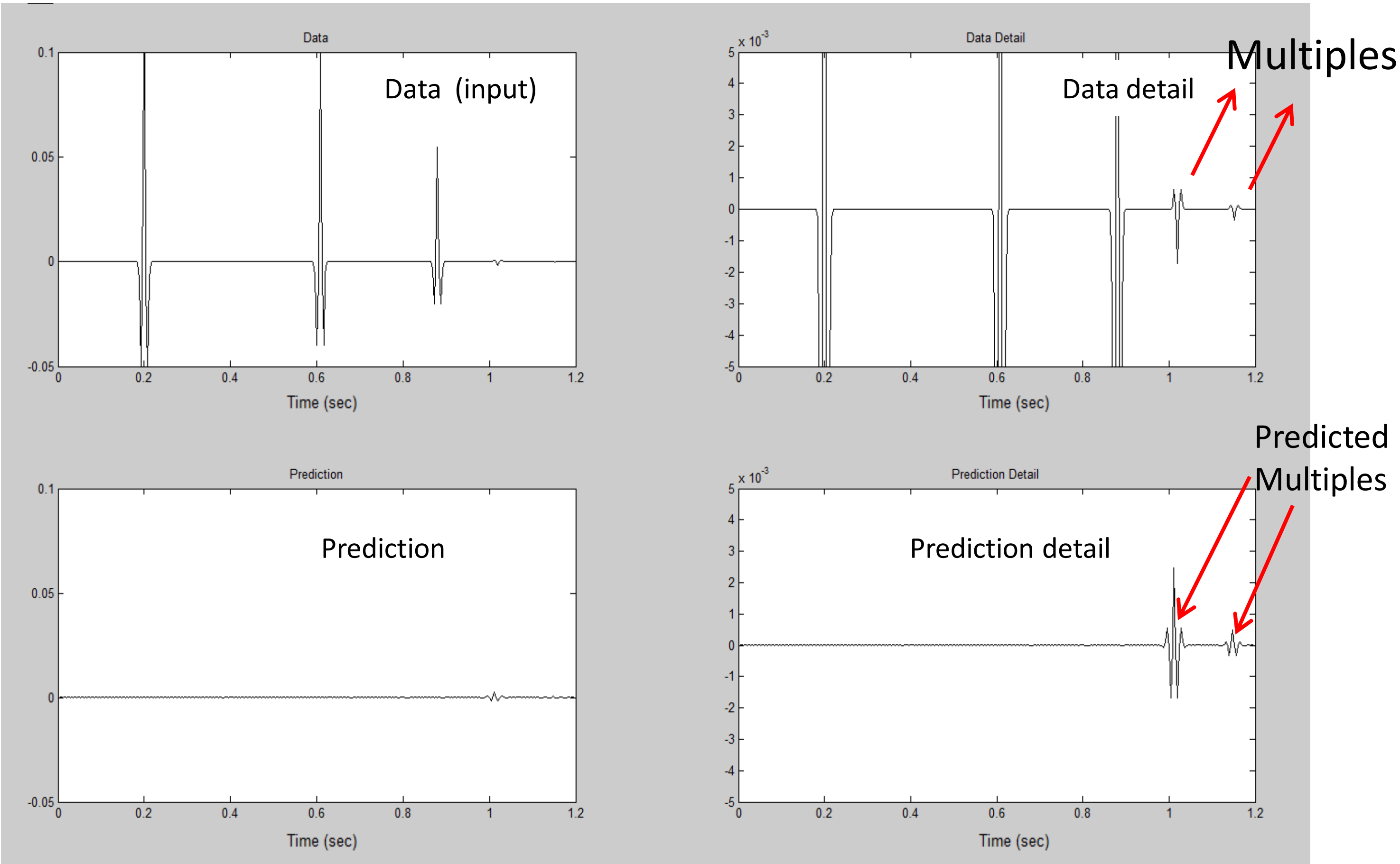


Sketch of the synthetic model used

Sample number: 512
Interval sample time: 3ms
Type of wavelet: Ricker
Wavelet central frequency: 60Hz
Wave speed of the source/receiver medium: 1500m/s

SYNTHETIC DATA

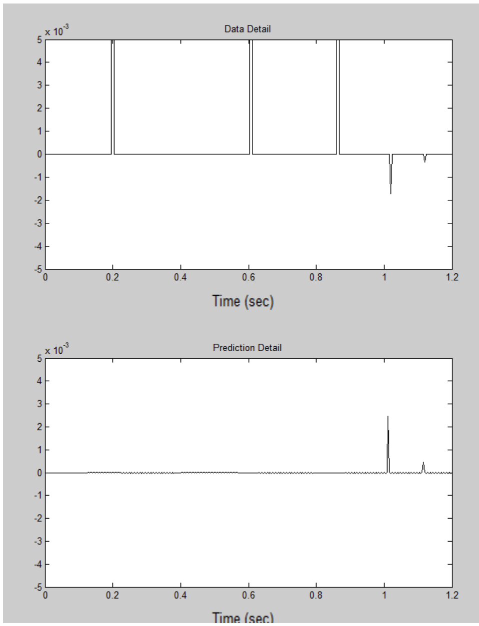
Epsilon : 7 (sample points)



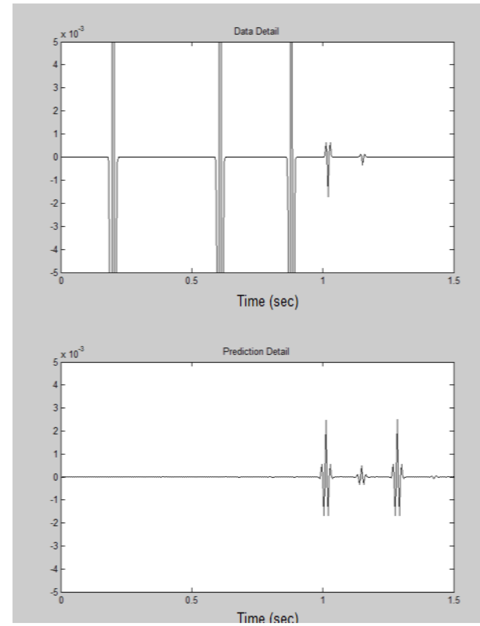
Application of the 1D internal multiple attenuation algorithm for the synthetic model.

PARAMETER TESTING

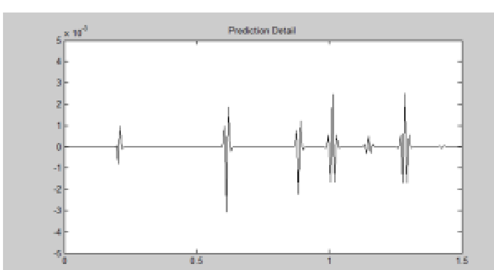
Effects of the Wavelet



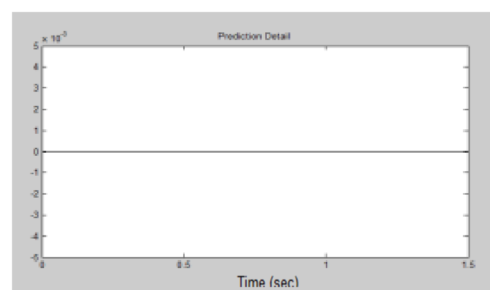
Missing internal multiples in the input



Underestimation of epsilon value



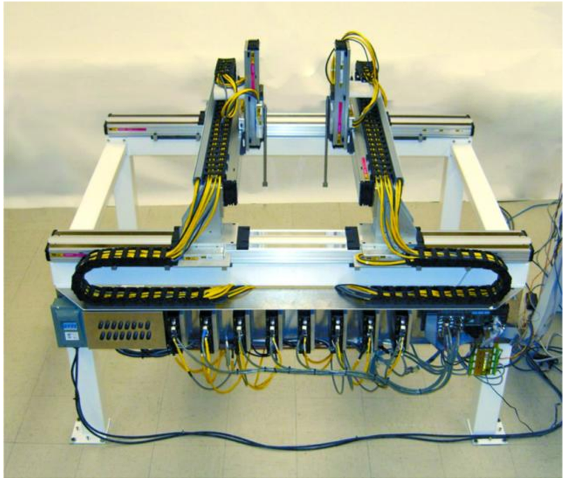
Overestimation of epsilon value

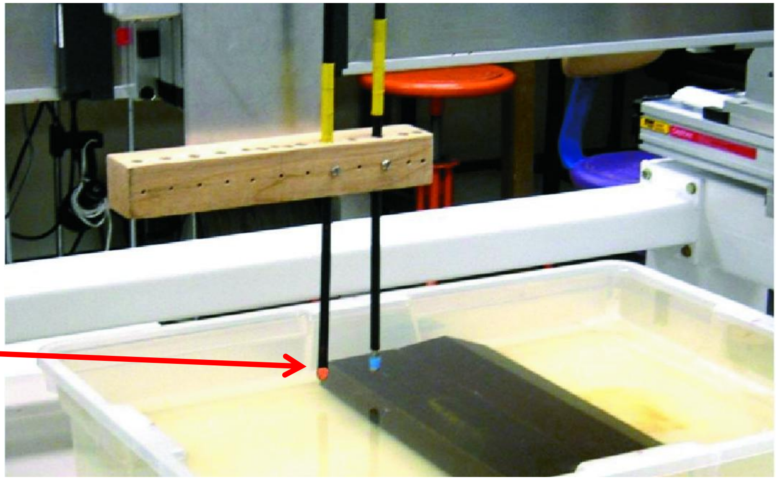


PHYSICAL MODEL LAB

- ***Objective:*** *high quality seismic data, no noisy, with clear and strong primaries and, including internal multiples.*

- Arrays of small ultrasonic source and detector transducers.
- Digital data acquisition is performed by circuits boards.
- Operating system used is Windows XP
- The movement of the transducers is automatically synchronize with the recording of the seismic signals.
- A pair of transducers are attached to the bottom tips of two rods.
- The source and the receiver were slightly immersed in the water. The frequencies emitted varying between 5 to 100Hz (field scaled).

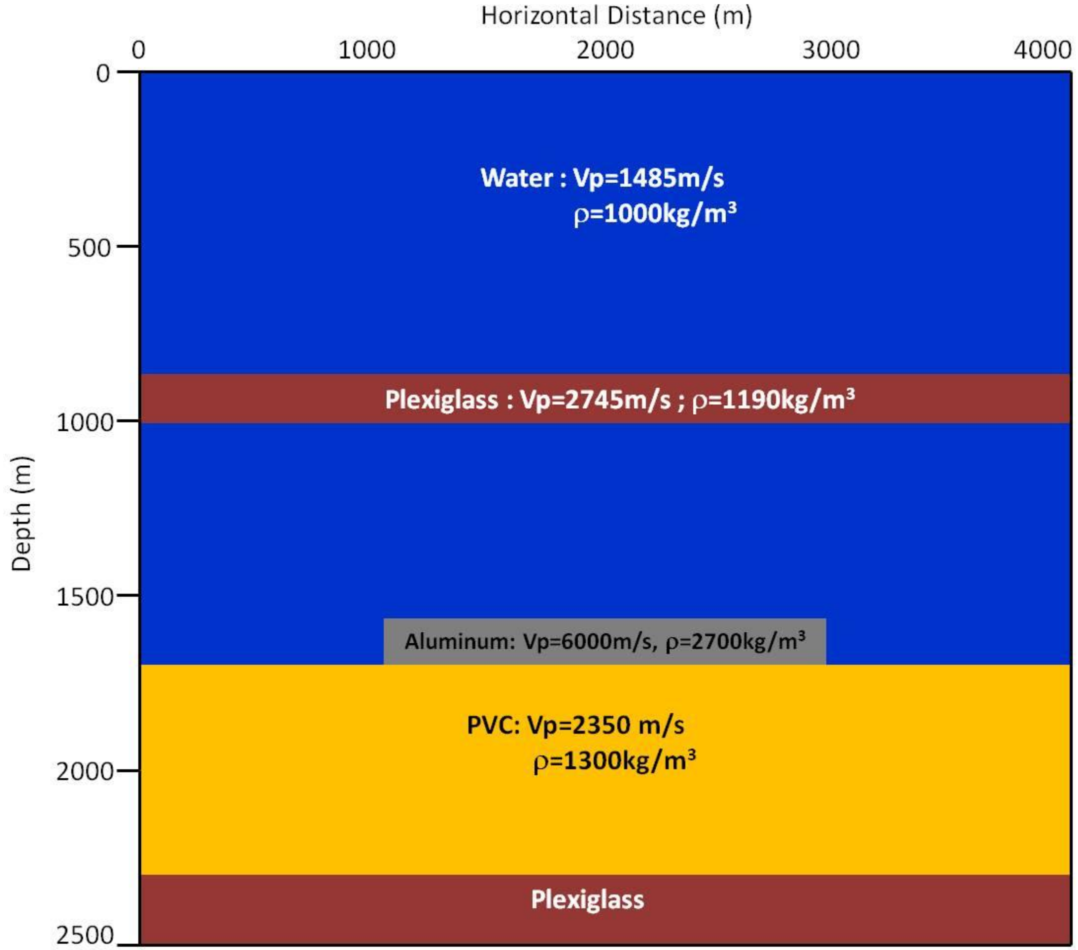




Physical Model Facility.
Adapted from: Joe Wong, Kevin W. Hall, Eric V. Gallant, Rolf Maier, Malcolm B. Bertram, and Don C. Lawton.

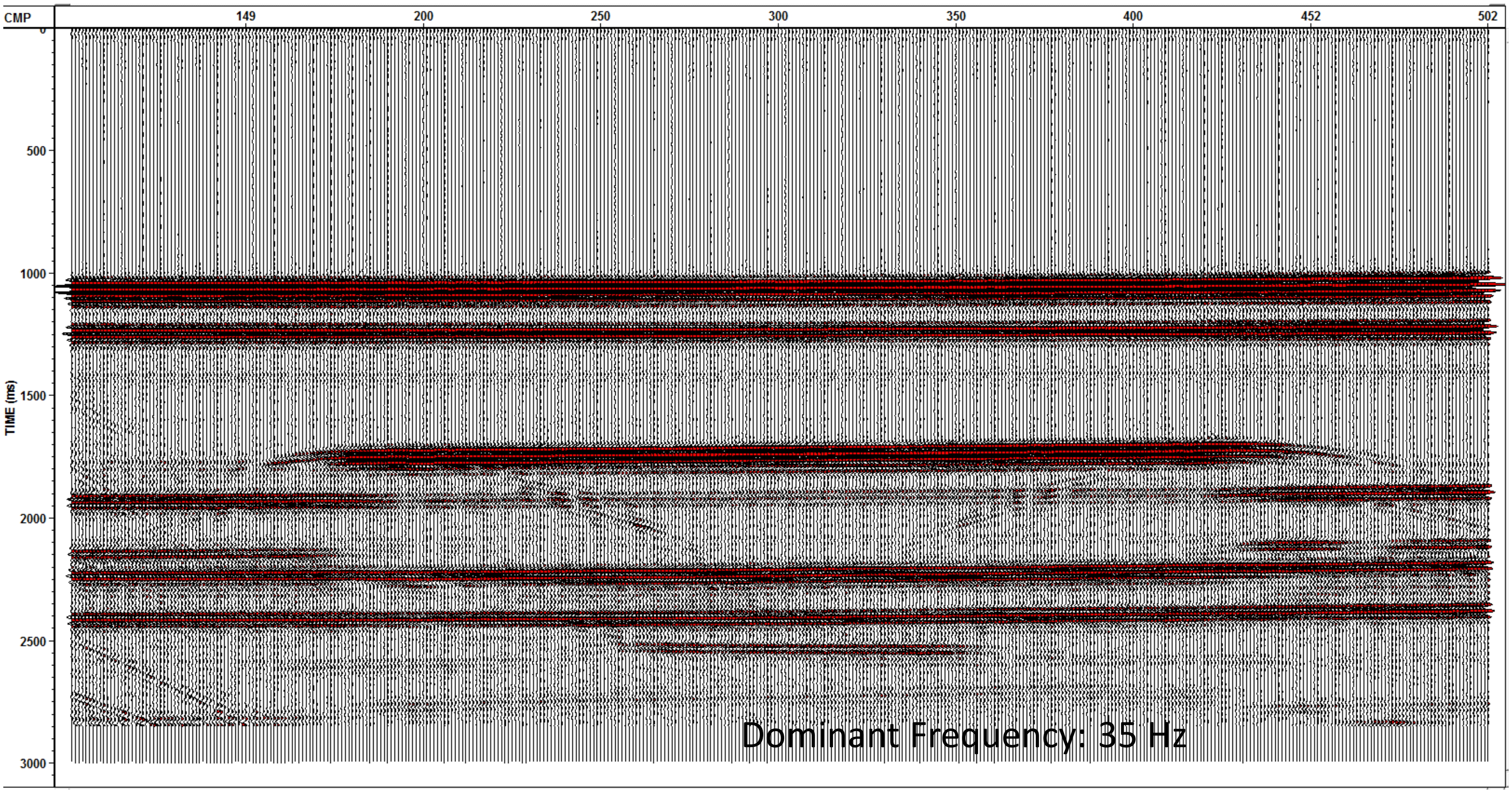
PHYSICAL MODEL DESIGN

High contrast of Impedance



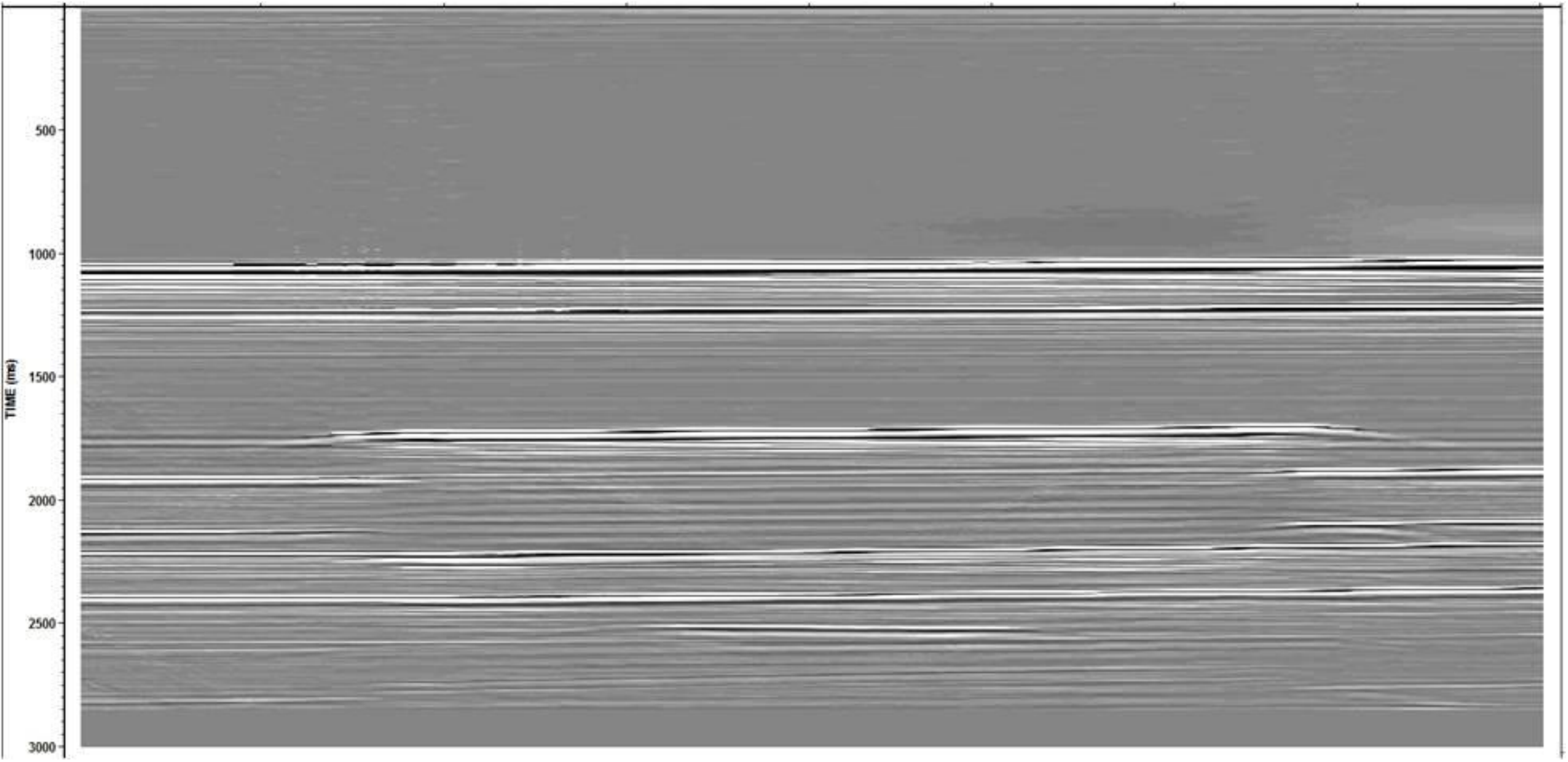
Sample interval is 1ms.
Receiver interval of 10m
Source interval of 10m.

RAW DATA



High quality seismic data, no noisy, with clear and strong primaries and internal multiples.

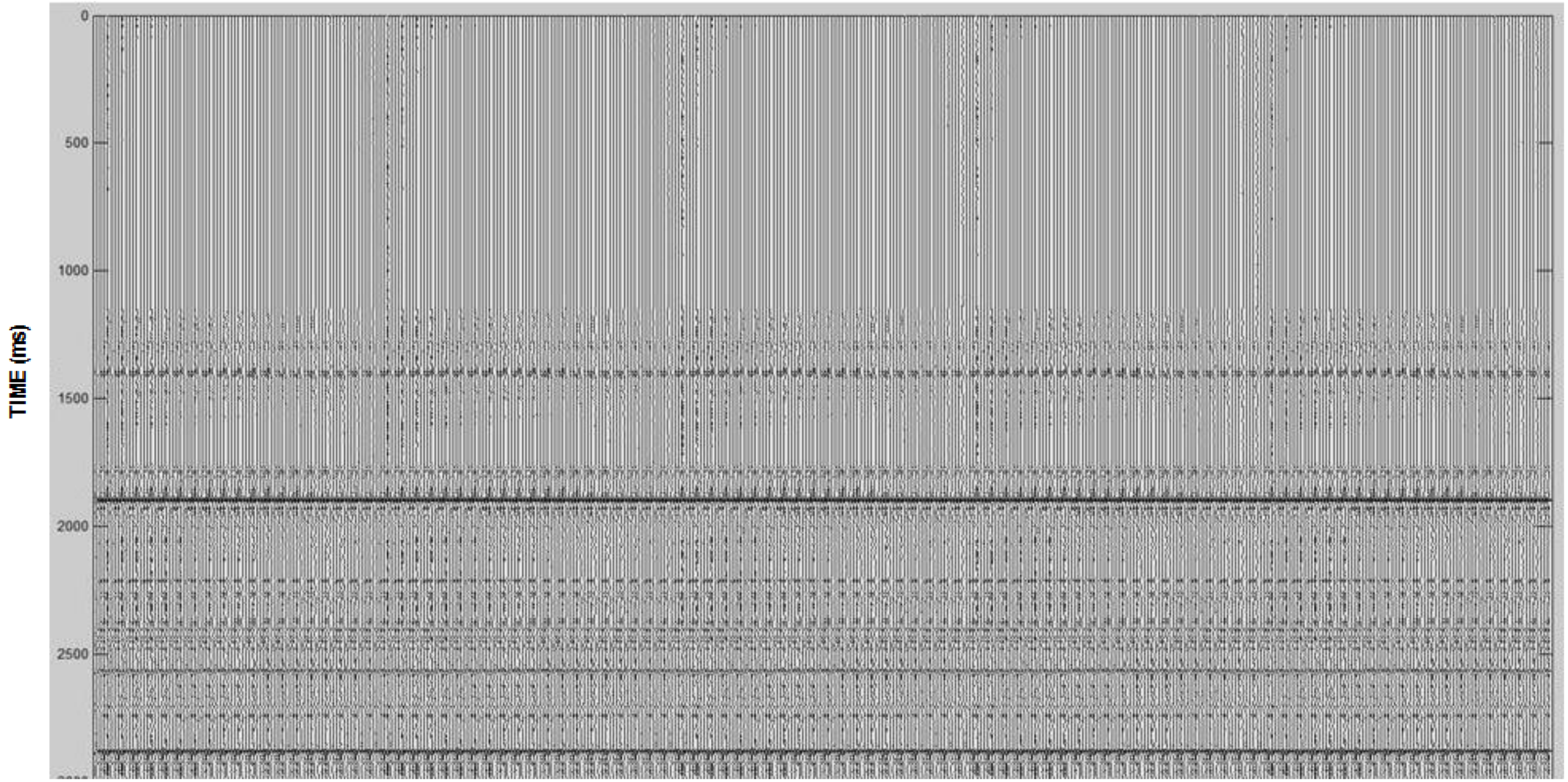
INPUT: DATA AFTER PROCESSING



PROCESSING OF THE DATA INCLUDE: deconvolution, statics, noise attenuation filter .

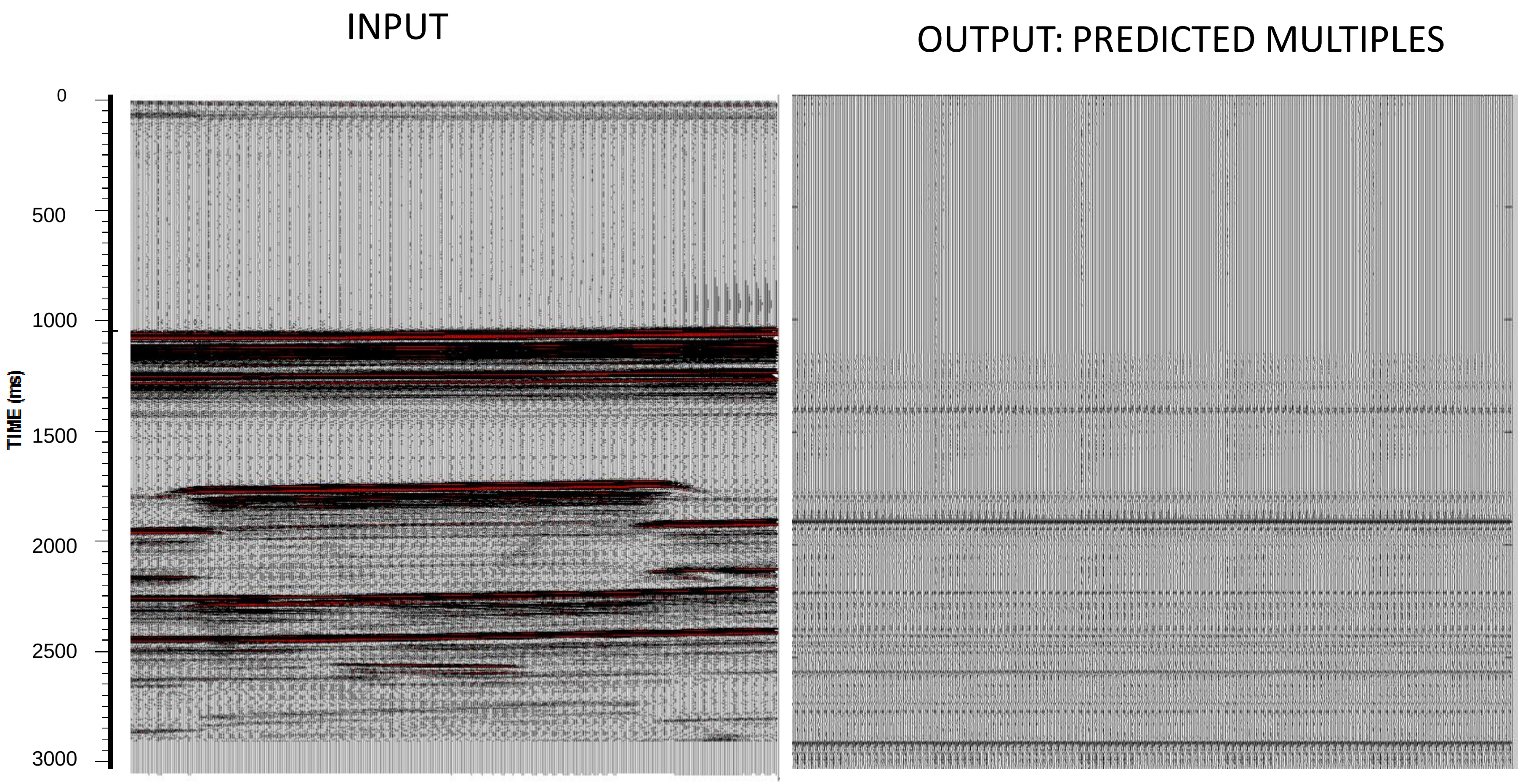
OUTPUT: PREDICTION

Epsilon : 50 sample points



Application of the Inverse Scattering internal multiple attenuation algorithm using common offset physical model data as input.

RESULTS



Setting at epsilon value of 50 (sample points) we predicted internal multiples reflections at 1.4, 1.9, 2.3, 2.6 and 2.7 seconds as we expected according to the model.

CONCLUSIONS AND FUTURE WORK

Based on the results found, several conclusions can be drawn:

- For synthetic model the algorithm works satisfactory, predict multiples in the correct time and the amplitude is similar.
- The output prediction depends strongly on the parameter epsilon. For the synthetic data the value of epsilon that performed the best prediction was 7, and for the physical model data was 50.
- Pre-processing (e.g. statics, deconvolution, filtering) of the data is required.

FUTURE WORK:

- Improve deconvolution to remove the effect of epsilon.
- Implement the algorithm in field data
- Subtraction of the internal multiples

ACKNOWLEDGMENTS

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Thank you!

QUESTIONS ?