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Study on internal multiple elimination method on Land Seismic Data

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SUMMARY

Multiple is a tough issue in recent years, especially the internal multiples in deep earth. In this paper we proposed to construct virtual events to predict internal multiples. Then adopt the mean value multi-channel adaptive subtraction method for matching the multiple model and seismic data. However, the results depend on the parameters closely. We propose to apply the dynamic time wrapping method in order to accomplish the precise matching. And the regression of multiples can effectively improve the internal multiple elimination results when internal multiples are interfered with effective signal.

Key words: virtual events, internal multiple, matching filter.

INTRODUCTION

With the deepening of oil exploration, it is urgent to improve seismic data processing and imaging precision. In deep land exploration, internal multiples developed, thus weakening the effective wave. Severely affect the resolution of target stratum. It causes great difficulties for lithological description and reservoir analysis. In this paper, we propose to optimize the virtual events method and the adaptive matched filtering method in order to achieve the prediction and elimination of internal multiples. Considering the differences lie in predicted multiple model and original data, such as the time, amplitude and phase. We presented the dynamic warping method to solve the under-matched issue based on mean value multi-channel adaptive subtraction method (Liu, 2014).

In this paper, we will demonstrate the feasibility of this method using synthetic examples. It proves that the approach of our study can effectively supress the internal multiples.

METHOD AND RESULTS

Virtual events originated from representation theorem (Ikelle, 2006). Both the field data and model data are tested prove the feasibility of predicting internal multiples through this method. Virtual seismic events method based on Kirchhoff integral representation theorem. Move the underground reflection points up to surface, thus using surface scattering points constructing internal multiples. The adaptive matched filtering method converted the process of calculating L1 norm into the calculation of weighted L2 norm (Guitton and Verschuur, 2013). We considered the least square solution of original data and multiple model as the initial filter, calculate residual and weighted matrix. Then renewing the filter and computing the residual. At last acquire the final multiple model which is satisfied the error condition through iterative feedback process (Wu, 2013). Dynamic time wrapping method (Dave, 2013) is originated to calculate image's displacement, like the fault displacement, etc. In this paper, we suppose the single channel multiple model is called m, the original single seismic record is called d. And the time shift of each sampling point is called lag.

$$m[0 : N-1] \equiv (m[0], m[1], \dots, m[N-1])$$

$$d[0 : N-1] \equiv (d[0], d[1], \dots, d[N-1])$$

$$lag[1 : N-1] \equiv (lag[0], lag[1], \dots, lag[N-1])$$

Hence we can compute the error of each sampling point is

$$e[i, l] \equiv (d[i] - m[i+l])^2$$

And then through the calculation of minimum error we can obtain the precise time

Figures and Tables

I have used the 2D acoustic model described in Figure 1 using a finite-difference scheme. The surface is absorbing boundary. Modelling deep land seismic data internal multiples included (Figure 2). We can obtain the internal multiple model effectively through virtual events method. Furthermore we use adaptive match filtering method to match the amplitude and time between internal multiple model and synthetic data (Figure 3,4). For the condition that multiples and effect waves are blending, the waveform of multiples will distort after matching process. We adopt the waveform regression method to revise the distortional multiple model. Moreover we can solve the under-matched problem nearby the cross events through iteration process.

Figure 1 Acoustic model used to generated the data shown in Figure 2. The density(ρ), velocity(vp) and vertical extent(h) are shown for each layer. Surface is absorbing condition. x=8km, z=3km.

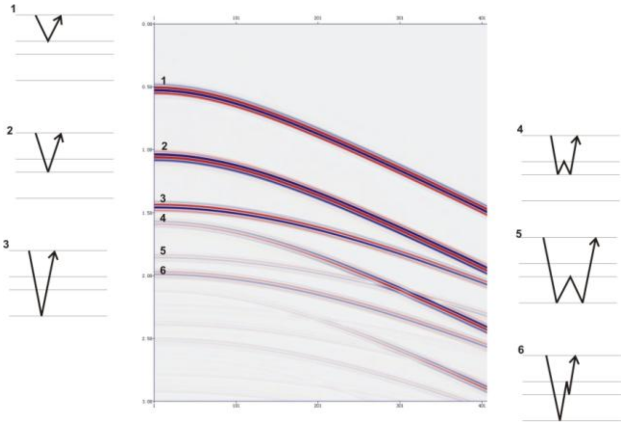

Figure 2 Synthetic data generated by 2D acoustic model.

CONCLUSIONS

To summarise, in this paper we talked about constructing virtual events method to predict internal multiples. It is easy to implement and has high computational efficiency as it is calculated in the frequency domain. We adopt the mean value multi-channel adaptive subtraction method. It can effectively improve the filtering results compared to the least energy match filtering method. However, the results depend on the parameters closely. We propose to apply the dynamic time wrapping method in order to accomplish the precise

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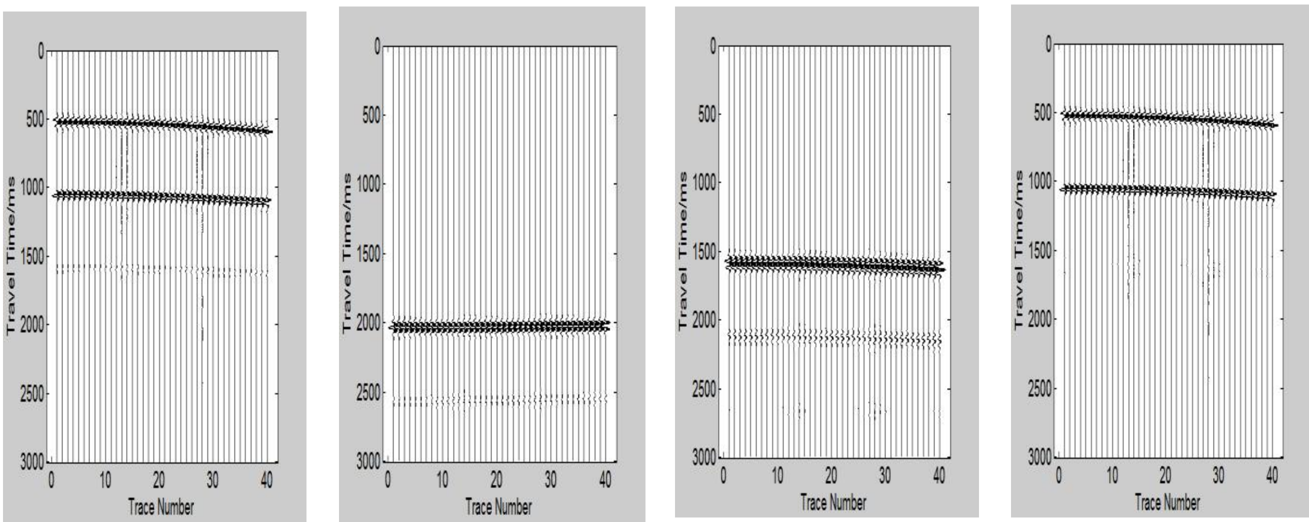

a b c d

Figure 3 a) synthetic seismic data; b) constructed virtual events; c) internal multiple; d) the result of internal multiple adaptive matching and subtraction.

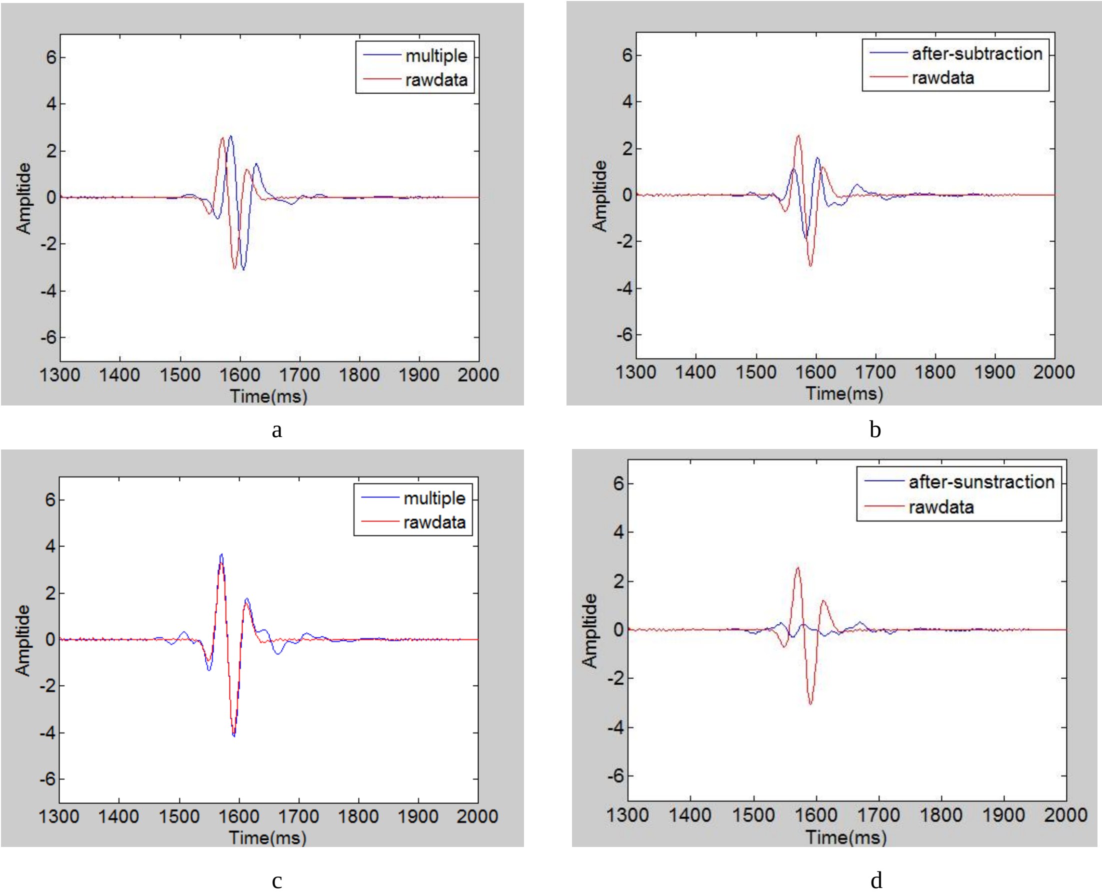

Figure 4 Single channel for dynamic time wrapping results. a) internal multiple and original seismic data before using dynamic time wrapping method; b) comparison between internal multiple suppression and original seismic data before using dynamic time wrapping method; c) comparison between internal multiple and original seismic data after using dynamic time wrapping method; d) comparison between internal multiple suppression and original seismic data after using dynamic time wrapping method.