A New Method of Multiple Attenuation: Multiple Identification and Subtraction

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Summary

The Radon transform method used in multiple attenuation has a resolution problem due to pattern similarity. If we focus on identifying patterns of primaries and multiples based on seismic knowledge, we can identify and remove multiples without the resolution problem. We call this method "multiple identification and subtraction" (MIDAS). The data examples prove the advantage of this method.

Introduction

The Radon transform method is widely used in multiple attenuation. The problem of the Radon transform for demultiple is in resolution. The resolution problem in the Radon transform for multiple attenuation comes from singularity, which is the nature of the method. The high resolution Radon transform methods both in frequency and time are developed. For example, Sacchi and Ulrych (1995) suggested a high resolution Radon transform method in frequency domain. Most recently, Schonewille and Aaron (2007) showed that their high resolution Radon transform in time domain provides a further improvement of the resolution in the curvature direction in many cases compared with that in the frequency domain. Cao (2006) summarized the developments of multiple attenuation methods in her thesis. To avoid the resolution problem in the Radon transform method, I propose a new method to deal with multiple-attenuation: multiple identification and subtraction (MIDAS).

New Method: MIDAS

We search for and identify the patterns of primaries and multiples in the time domain. Then we preserve the primaries and remove the multiples (subtraction). The method itself has no resolution problem at all. A proper search procedure and pattern identification criterion is needed to guarantee success. If we put all identified patterns (primaries and multiples) into the Radon domain (t-v), we obtain the Radon transform without resolution problem. The difference between MIDAS and Radon transform methods is in initial purpose. Radon transform methods focus on general numerical solution for multiple-attenuation. MIDAS focuses on identification of primaries and multiples of seismic data. The seismic knowledge is built into the identification software to obtain better results.

The search pattern can be hyperbolic or parabolic, or other. Generally speaking, it is more accurate for the hyperbolic pattern and is more efficient for the parabolic. Today's computer memory is much larger than twenty years ago. If the computation program is optimized sufficiently, the hyperbolic pattern can be very efficient too. To guarantee accuracy, I optimize the program to use accurate hyperbolic pattern (Dix formula):

$$T = \sqrt{T_0^2 + \frac{x^2}{v^2}}$$

Where *T*, T_0 is two-way traveltime at offset *x* and 0 respectively, *x* is offset, and *v* is velocity.

Data Examples

In first synthetic data example (model A) there are twenty one events, one primary and twenty multiples with different curvatures: moveouts at the far offset are distributed evenly from 10 ms to 200 ms (Figure 1a). The results after multiple-attenuation by MIDAS are shown in Figure 1b and multiples identified and removed by MIDAS are shown in Figure 1c. The results are almost perfect and they clearly show that MIDAS has no resolution problem. The results with high resolution Radon transform (HRR) in frequency domain using parabolic pattern are shown in Figure 1 (d) and (f) with multiples removed from moveouts 20 ms and 4 ms respectively. The corresponding removed multiples are show in Figure 1 (e) and (g). Due to the resolution problem, the high resolution Radon transform method cannot completely remove less than 30 ms moveout multiples without damaging the primary (Figure 1 (d) and (e)). It removes about half of primary and still leave significant 10 ms moveout multiple (Figure 1 (f) and (g)). In second synthetic data example (model B) there are twenty five events with many overlaps, three primaries and twenty two multiples with different curvatures: moveouts at far offset are 10, 15, 18, 25X3, 30X2, 35X2, 40, 45, 50X2, 60X2, 180, 200, 225, 260, 280, 300 ms. This example is a little closer to a real data situation and clearly shows the importance of multiple attenuation, if prestack data are requested in interpretation. The model and the results with MIDAS and high resolution Radon transform are shown in Figure 2. The conclusion is the same as in model A. The real seismic data are quite noisy. To verify the advantage of the new method MIDAS when applying it to the real data sets, I add strong random noise to model A (noise model A) and model B (noise model B). The noise models, A and B, are shown in Figure 3(a) and Figure 4(a) respectively, and the results of multiple attenuation with MIDAS and high resolution Radon transform, are also shown in Figures 3 and 4. The conclusion is kept the same for the noise models A and B. This indicates that the MIDAS does not only work well for perfect synthetic data, it can also work well for real data sets. The real data results with MIDAS are encouraging. We will show real data results in the presentation.

Conclusions

The <u>m</u>ultiple <u>id</u>entification <u>a</u>nd <u>s</u>ubtraction (MIDAS) method proposed in this paper has no resolution problem. The pattern identification criterion is important to guarantee success. It just focuses on identifying patterns, so it is easy to handle many requests and special cases. To guarantee accuracy, using accurate hyperbolic pattern should be considered.

This technique also can be used to construct missing data.

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References

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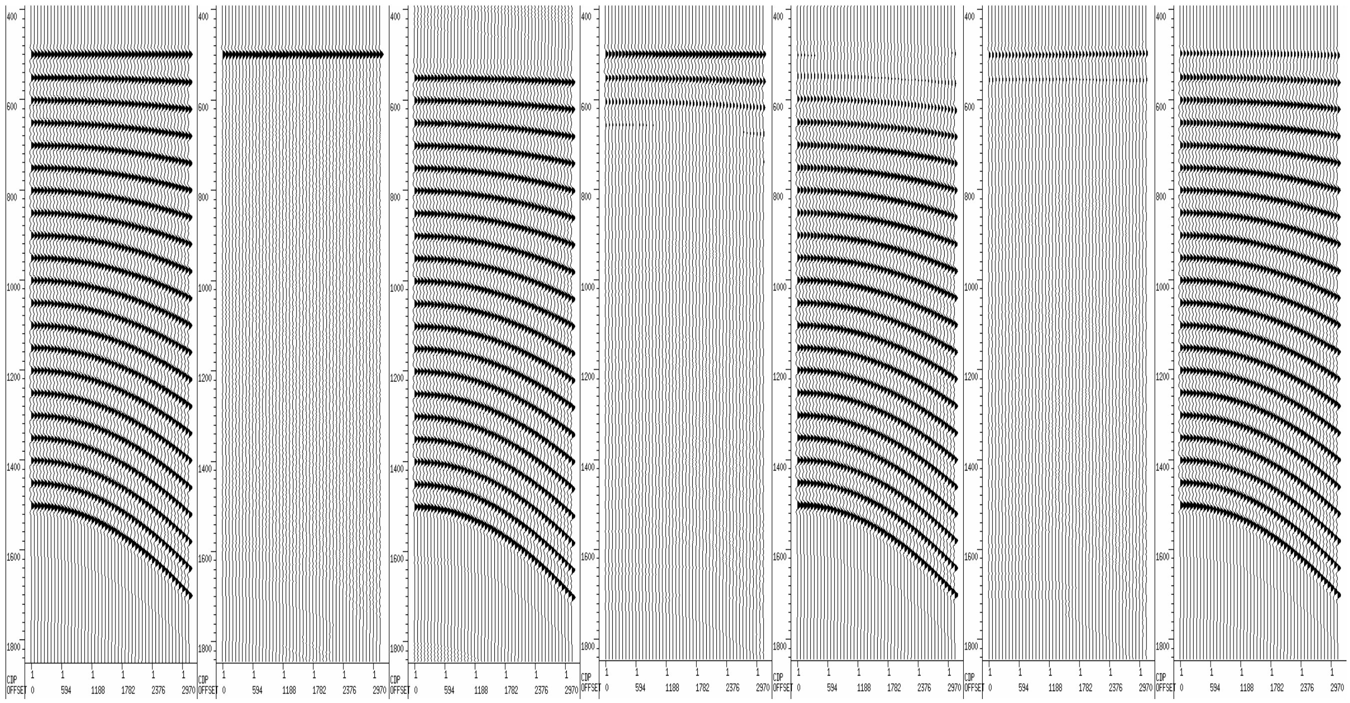
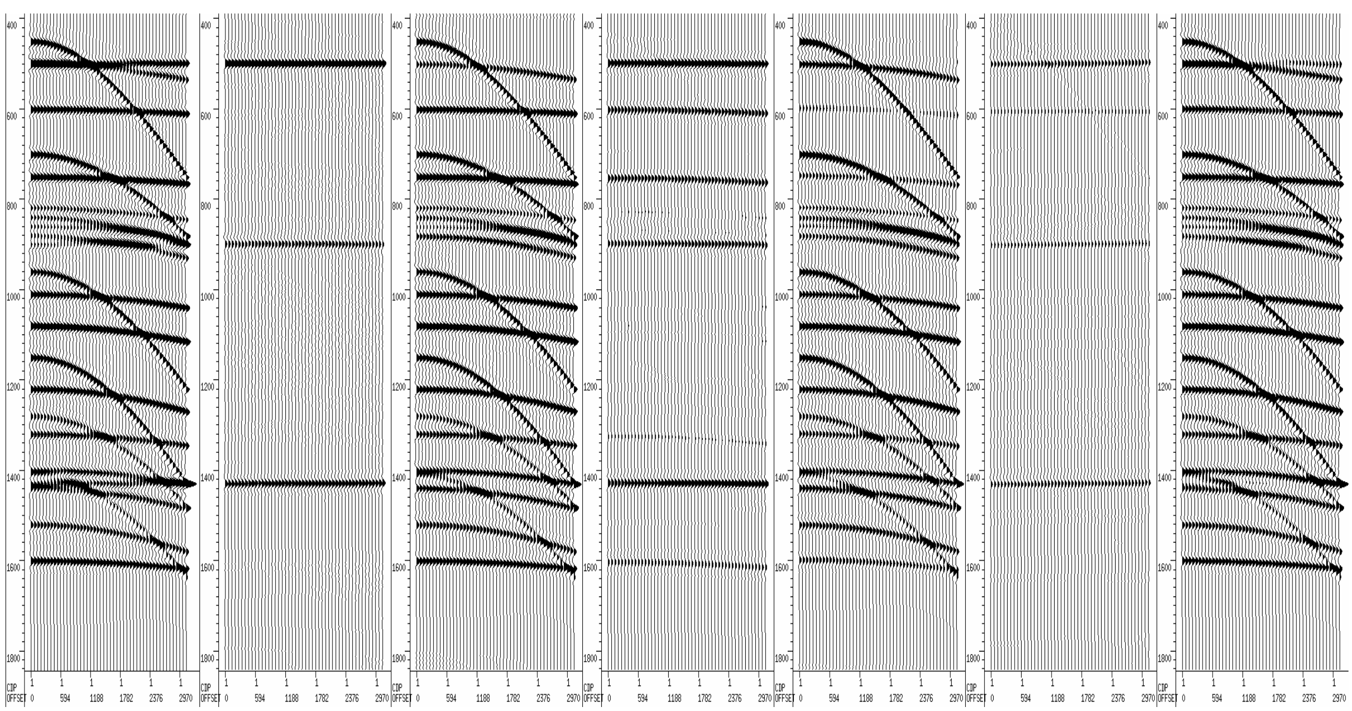


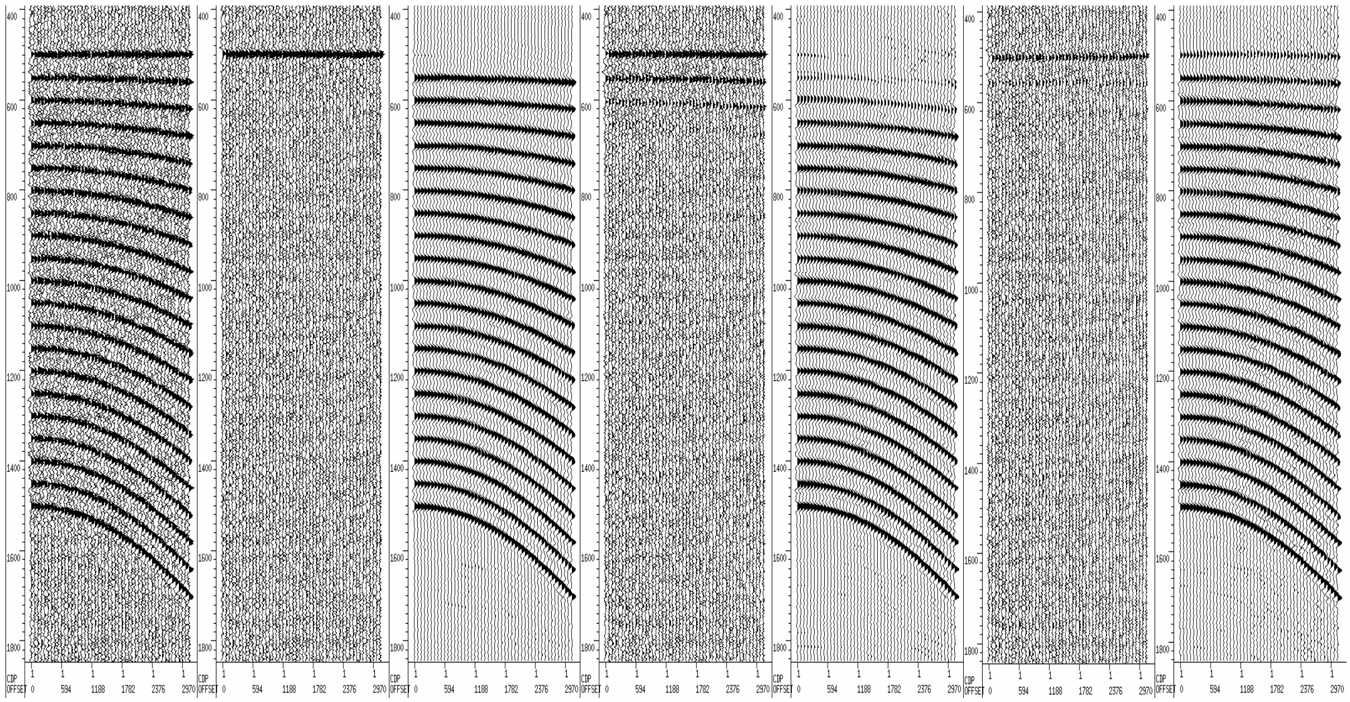
(a) (b) (c) (d) (e) (f) (g)

Figure1: Synthetic data (model A): twenty one events, one primary and twenty multiples with different curvatures: moveouts at far offset distributed evenly from 10 ms to 200 ms (a). The results of multiple attenuation using (b) MIDAS; (d) HRR with removing from moveout 20ms; (f) HRR from moveout 4ms. Corresponding removed multiples are shown in (c), (e) and (g) respectively.



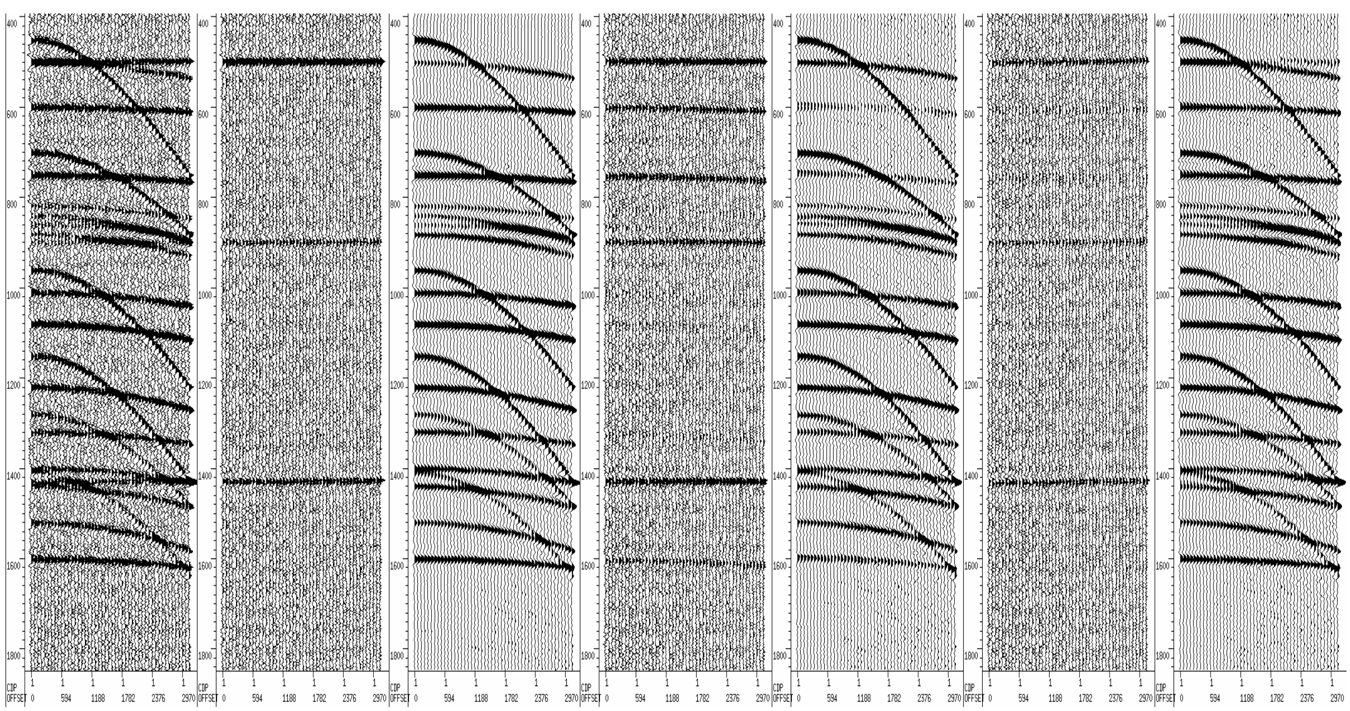
(a) (b) (c) (d) (e) (f) (g)

Figure 2: Synthetic data (model B): twenty five events, three primaries and twenty two multiples with different curvatures: moveouts at far offset are 10, 15, 18, 25X3, 30X2, 35X2, 40, 45, 50X2, 60X2, 180, 200, 225, 260, 280, 300 ms (a). The results of multiple attenuation using (b) MIDAS; (d) HRR with removing from moveout 20ms; (f) HRR from moveout 4ms. Corresponding removed multiples are shown in (c), (e) and (g) respectively.



(a) (b) (c) (d) (e) (f) (g)

Figure 3: Synthetic data (noise model A): the same as Figure 1 (model A), but strong random noise is added.



(a) (b) (c) (d) (e) (f) (g)

Figure 4: Synthetic data (noise model B): the same as Figure 2 (model B), but strong random noise is added.