9th Biennial International Conference
& Exposition on Petroleum Geophysics

"HYDERABAD 2012"

P-352

Suppression of Multiples by High Resolution Parabolic Radon Transform using Bulk Shift in Complex Area

J.Kole*, Rajesh Madan, D. Chatterjee, Dr. S. Viswanathan, *ONGC*

Summary

High resolution Parabolic demultiple is one of the standard processing techniques for attenuating multiple reflection energy from seismic data set. But, in deep water, non horizontal water bottom area, this technique fails to remove the water bottom multiple at near offset and suffers from spatial aliasing effect. This is due to violation of underlying assumptions of parabolic radon demultiple. This study will show how the deep water bottom multiple can be removed effectively just by lowering the velocity field/bulk shift. Data examples show the following benefits

(a) Better multiple removal and signal preservation.

(b) Removal of alias noise in course of demultiple process without pre-interpolation.

(c) Lowering of computational cost by decreasing number of parabola.

Keywords*: Sparse decomposition, Singular value decomposition, HRPRT, spatial aliasing and perturbation*

Introduction

Multiples reflections are a serious problem in deep water prospect of India's Kerala Kankan offshore where sea beds are inclined and high velocity contrast due to presence of basalt over Mesozoic. Here, High resolution Radon transform and SRME are failed to remove the multiple and also incapable to handle aliasing problem in case of long offset data. In this paper we will show these problems can easily be solved simply by applying bulk shift or by lowering the velocity. Also, computation time will be reduced.

Here we will compare the results of High resolution parabolic Radon in case of staking velocity before bulk shift and staking velocity after bulk shift for moderate and long offset data.

High resolution parabolic radon transform using bulk shift

High resolution Parabolic Radon transform is based on the assumption that trajectory of the residuals after NMO correction is parabolic and method of decomposition of matrices is sparse decomposition. Due to this method of decomposition, high resolution radon transform perfectly model the parabolas and transform the primaries and multiples into separate distinct points in radon space. So, system does not have any problem to remove the multiples in a surgical way. As the energy is focussed at a distinct point in radon space, so there is no scope of leakage of multiples energy towards the primary energy at near offset and vice versa at higher offset. Hence, high resolution radon transform removes the multiples energy perfectly and can handle the spatial aliasing problem in case of long offset data set.

SPIC, WOB, Mumbai, ONGC
jyotirmoykole@yahoo.in

But, a practical result of HRPRT is very much unsatisfactory in case of deep water prospect, particularly where sea beds are inclined. This may be due to inclination of water bottom for which trajectory of the nmo corrected (staking velocity) gather is not parabolic. We failed to remove the multiple effectively after changing different parameters of radon demultiple module such as moveout range and number of parabolas. Then we studied its performance after applying different bulk shift and picking velocity in each case. We observed that after certain bulk shift, same HRPRT is working very well. We have tested its performance over moderate offset (6000m) and long offset (12000km) data set.

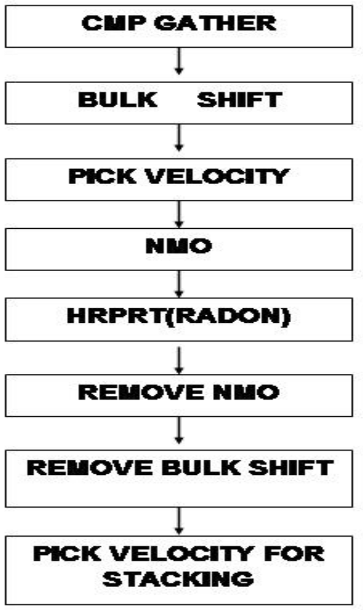

Figure 1: Processing Flow

Now, question is why is it so effective after certain bulk shift? The velocity will be decreased due to bulk shift and hence the move out range between consecutive traces will be reduced. Due to reduction of velocity field, the trajectory of the nmo corrected gather becomes parabolic. Hence, HRPRT module is capable to focus the multiple and primary energies at distinct points in radon space. Consequently, perturbation of multiple energy at near offset and primary energy at higher offset have been stopped. This may be the probable causes for better performance of HRPRT after bulk shift in respect of removal of multiples at near offset, preservation of primaries at higher offset in case of long offset data and to stop the leakage of high frequency aliased noise.

Processing sequence for multiple removals using lower velocity is shown in figure 1.

Results

First we compared the results in case of moderate offset (6000m). It is shown in fig. 2. The fig 2(b) is the demultiple gather using normal velocity field. The fig.2(c) is the demultiple gather after bulk shift. In normal method, there is a remnant of multiple at near offset but it works very well in reduced velocity field. The both the data sets are free from high frequency noises.

The fig.4 is the comparative study of both the methods in case of long offset data sets. Here, normal method suffers from removing multiples and high frequency aliased noise fig4 (b) but it works very well in the reduced velocity field fig.4(c).

We know that sparse decomposition is faster than singular value decomposition provided order of matrix is less than 256. But, in case of deep water and long offset data set, move out of water bottom multiples is very high, so required number of parabola is very high. But, when we apply nmo with lower velocity the move out is less and hence, required number of parabolas is less than 256 and consequently speed of HRPRT in reduced velocity field is faster than normal method.

Conclusion

By using proper bulk shift the draw back of high resolution Radon transform in case of complex areas can be removed effectively. Radon transform is highly cpu intensive jobs. So, the amount of bulk shift should be taken in such a way so that high resolution radon transform will work efficiently using less than 256 number of parabolas and in this case run time will be considerably reduced.

References

Hampson, D., 1986, Inverse velocity staking for multiple elimination, Journal of Canadian Soc. of Exploration Geophysicists, 22, pp. 44-45.

Thorson, J. R., and Claerbout, J. F., 1985, Velocity stack and slant stack stochastic inversion, Geophysics, 50, pp. 2727-2741.

Hargreaves, N., and Cooper, N., 2001, High resolution Radon de-multiple, 71st SEG International Ann., Mtg., Expanded abstracts, Ms 2.7.

Foster, D. J., and Mosher, C. C., 1992, Suppression of multiple reflections using the Radon transform, Geophysics, 57, pp. 386-395.

Acknowledgements

The authors express their sense of gratitude to ONGC to provide technical and infrastructural facilities to carry out the work and Director (Exploration) for the permission to publish the work.

The authors sincerely thank to Sri PSN Kutty, ED- COED, WOB, Mumbai and Sri D. Dutta, ED-HGS, Mumbai for their guidance and constant encouragement.

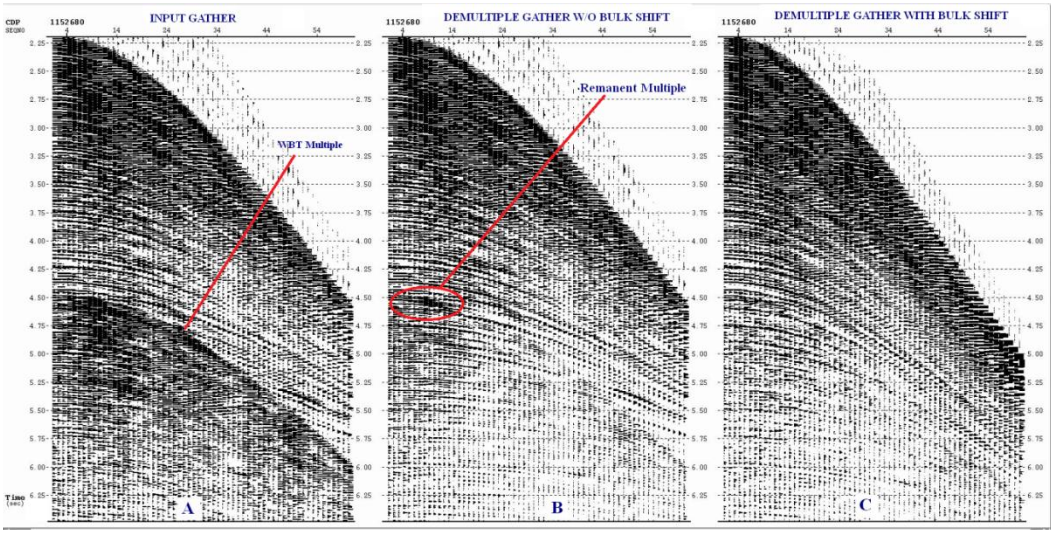

Figure 2: High Resolution Radon demultiple in case of moderate offset data. (A) Input gather; (B) Demultiple gather without bulk shift, it is failed to remove the multiple at near offset; (C) Demulple gather using bulk shift, it is effective to remove multiple.

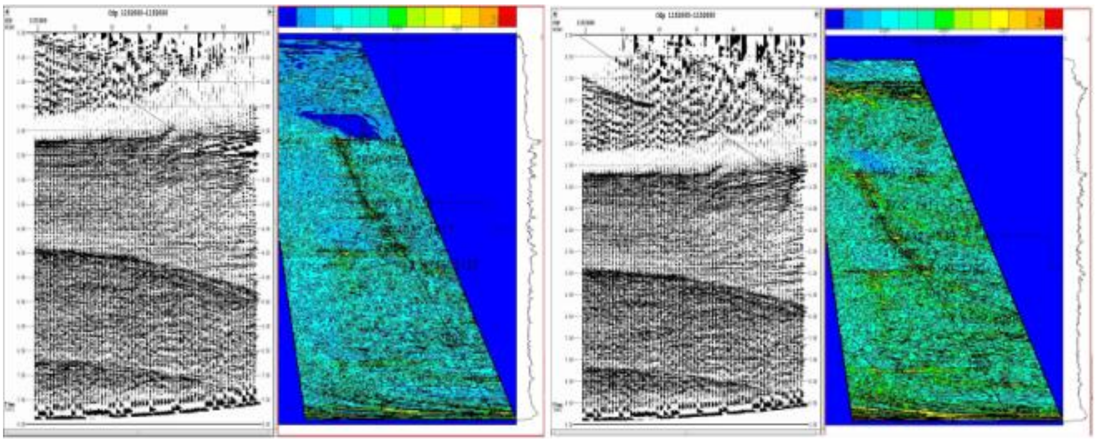

Figure 3: Velocity Analysis of Fig 2A after Bulk Shift   Velocity Analysis of Fig 2A(W/O bulk shift)

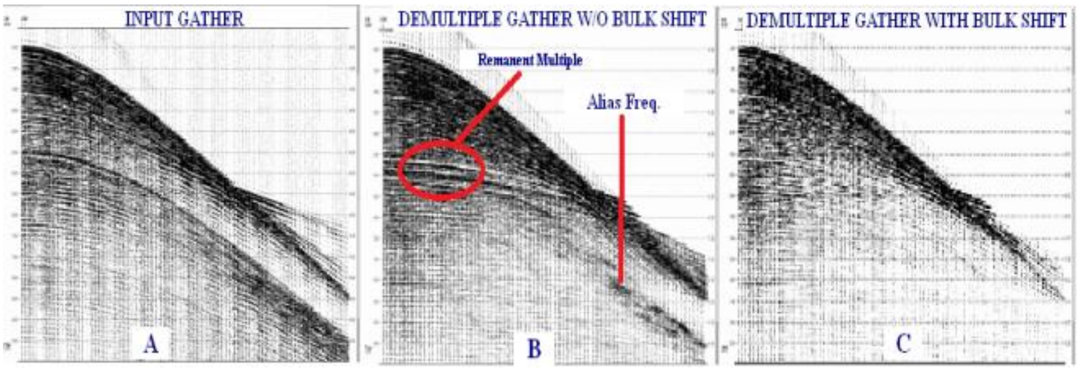

Figure 4: High resolution Radon in case of long offset data. (A) Input data; (B) Demultiple gather without bulk shift, it is failed to remove the multiple at near offset and also failed to handle aliased frequency; (C) Demultiple gather after bulk shift, it is successful to remove the multiples and effective to stop the leakage of high frequency aliased energy.

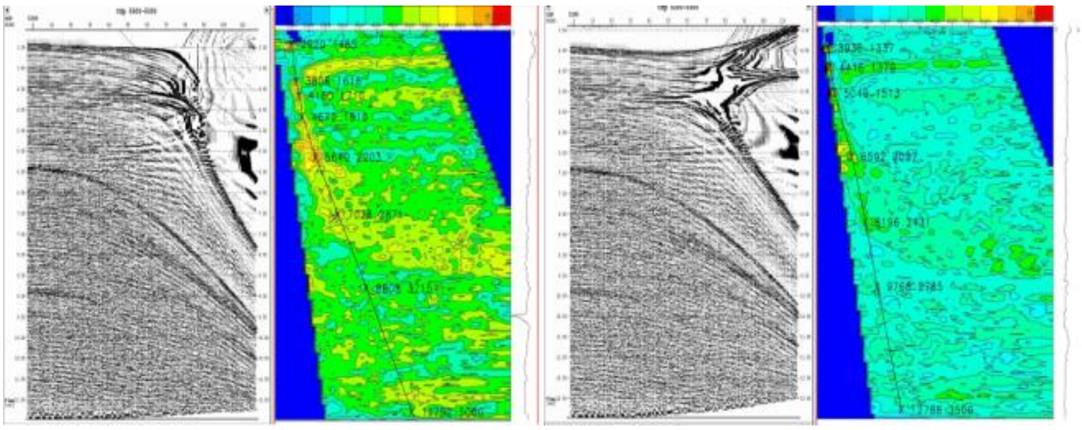

Figure 5: Velocity Analysis of Fig 4A(W/O bulk shift) Velocity Analysis of Fig 4A after Bulk Shift