Multiple Attenuation - A Case Study

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Summary

Multiple attenuation is a long standing problem in reflection seismic industry. There are two related aspects, multiple predictions and multiple attenuation. The attenuation of multiple reflections in surface seismic data has been a high priority in seismic industry for many years. Much partial solution exists that are able to tackle the problem in particular circumstances. There is however no method or group of methods that work in all area. In the history of multiple removal, algorithms have been based on two differentiating properties i.e. moveout and predictability. If primaries and multiples show different moveout behavior, algorithms are available that allow separation of primaries and multiples in a transform domain.

Introduction

The applications of seismic imaging techniques assume that the input data are free of multiples. We of course know that this is not true and that the presence of multiples leaves us with spurious images and amplitudes. Some times primary events create outstanding multiples to perplex and perturb seismic interpreters. In current technology, we view the primaries as signal and multiple as the unwanted noise. Methods that attenuate multiples can be classified as belonging to two categories.

1- Property that differentiates primary from multiples.
2- Predict and then subtract multiples from seismic data.

The above features can be roughly categorized into periodicity and separability. The first group assumes that the key difference between multiple and primary is that the multiples are periodic while primaries are not. The second group assumes that by applying some transform to the data, the separation between primaries and multiples can be distinctly achieved and by muting a portion of the data in transform domain, multiples can be attenuated. The transform is based on a feature that differentiates the difference in moveout between primary and multiple events. Many methods exist to remove multiples and they are useful when their assumptions and prerequisites are satisfied. Table -1 shows the different algorithm for multiple suppression used in the industry.

Parabolic Radon Transform is one of the effective tool for multiple attenuation and is extensively used in the industry. Radon transform first Transform the data Fig.1(a) in model parameter domain Fig.1(b) where primary and multiple are well separated . In the model parameter domain multiples are windowed Fig.1(c) and primaries are muted Fig.1 (d). Data is reconstructed using inverse Radon Transform to get only the modeled multiples which were subtracted from the original data to obtain the primaries only.

Table -1

Domain	Algorithm	Features
t	Predictive decon	Periodicity
τ-p (tau-p)	Radon transform +Predictive decon	Periodicity
t-x	Stacking	Separability
f-k	2D-FT + reject filter	Separability
τ-p (tau-p)	Radon Transform + reject filter	Separability
f-k	3D-FT + reject filter	Separability

Methodology

This paper illustrates the attenuation of multiple using least square Radon Transform in frequency –offset domain. First model of primary and multiple events are computed. This computation is based on data decomposition into user defined parabolas and performed using the least square method in the frequency–space (f-x) domain for each frequency of the pass band defined by Fmin. and Fmax. This consists in carrying out stacks according to various parabolas. Events corresponding to parabolas with greater curvature are considered to be multiples. Events corresponding to parabolas smaller then the threshold are considered to be primary events. Then subtract the multiples from input gather resulting primaries only.

Case study

We applied our multiple attenuation schemes to a 2D- Seismic data acquired in Kopili Valley area, of Assam

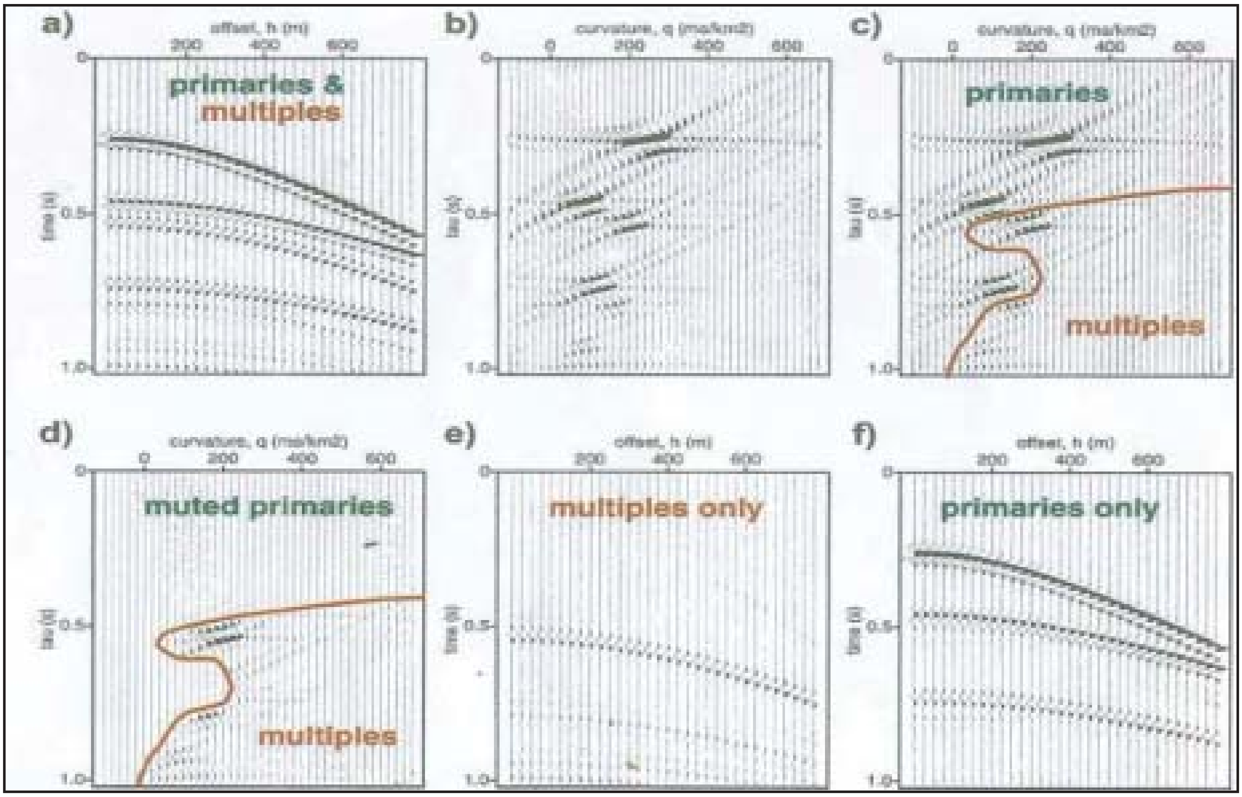

Fig. -1 Multiple–removal methodology using the parabolic Radon transform

and Assam Arakan Basin. The processing steps include geometrical spreading amplitude correction, deconvolution, demultiple and residual static applications. The trace interval in CMP gathers is 12.5 mts. Fig.2 to Fig. 7 illustrates the CMP gathers in study area before and after multiple attenuations highlighting the primary and multiple events, coherency display of velocity functions and its NMO corrected gathers.

Fig-2 to Fig.7 show the CMP gathers before and after multiple attenuation. Interference between primary and

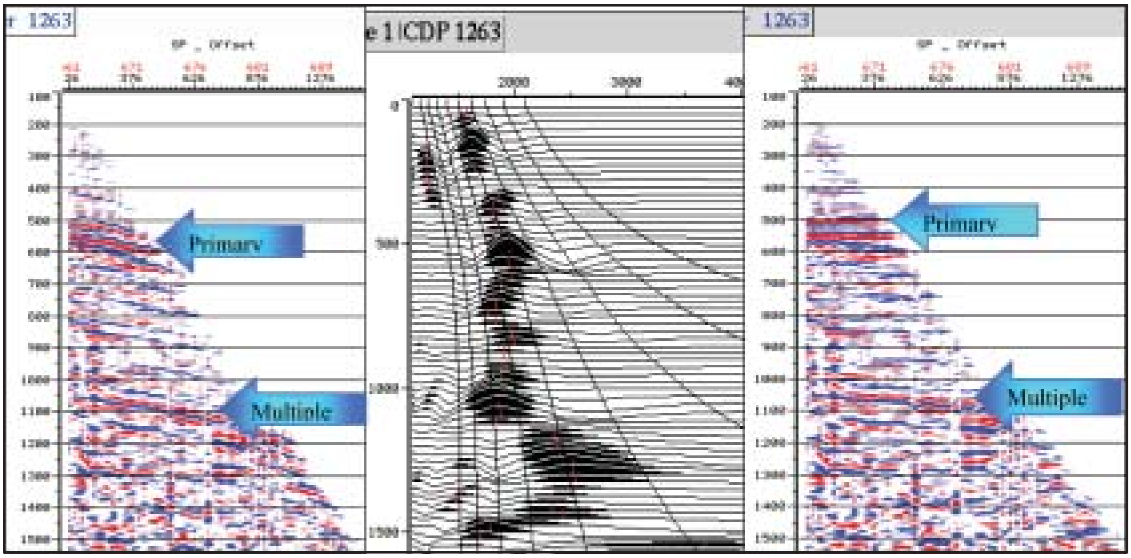

Fig-2 Decon gather before multiple attenuation (uncorrected and NMO corrected)

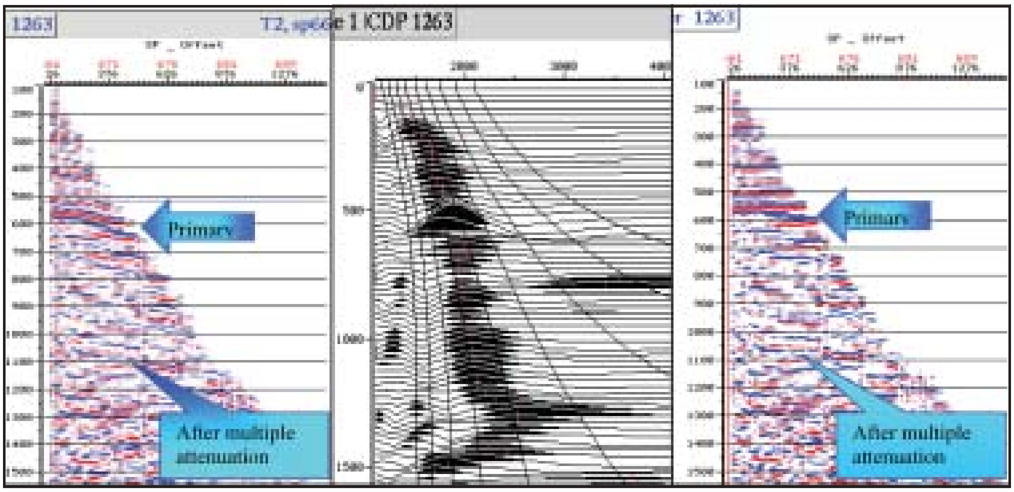

Fig-3 Decon gather after multiple attenuation (uncorrected and NMO corrected)

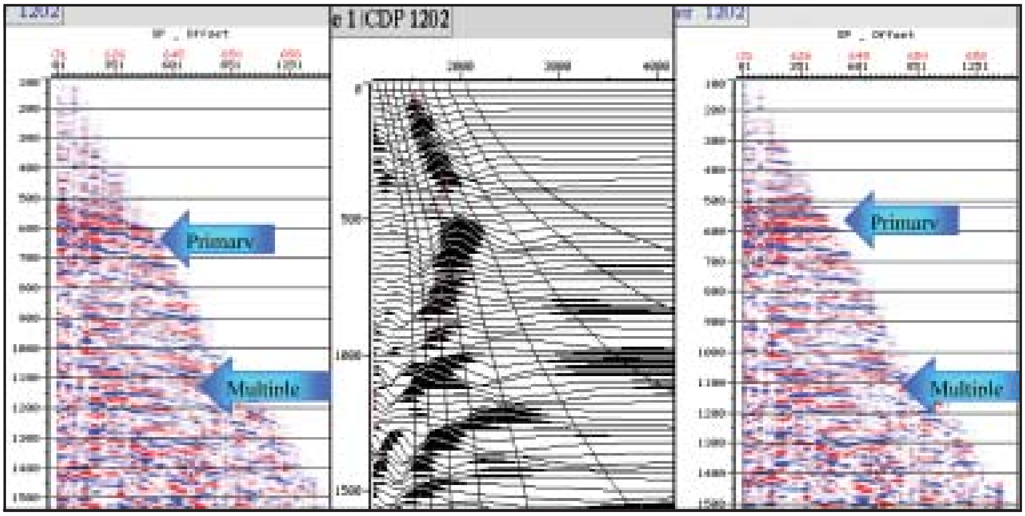

Fig-4 Decon gather before multiple attenuation (uncorrected and NMO corrected)

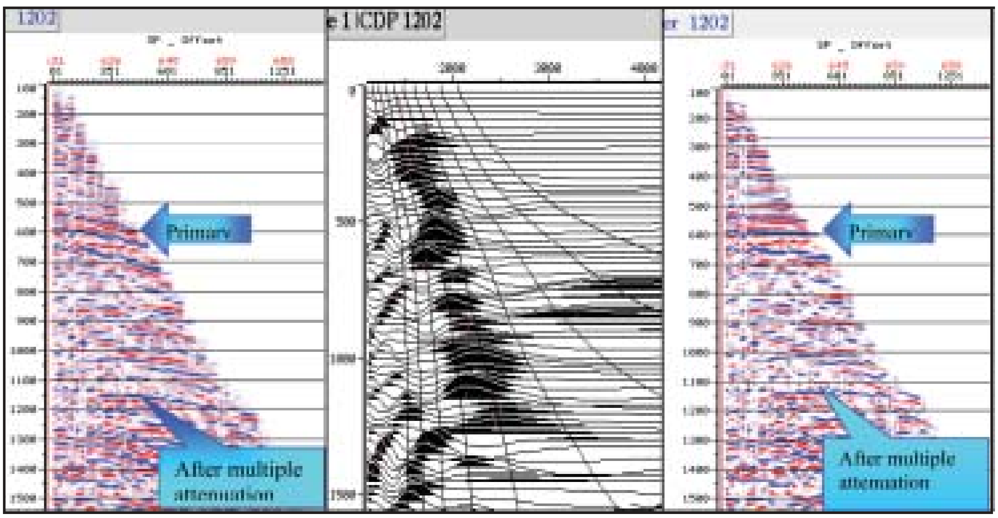

Fig-5 Decon gather after multiple attenuation (uncorrected and NMO corrected)

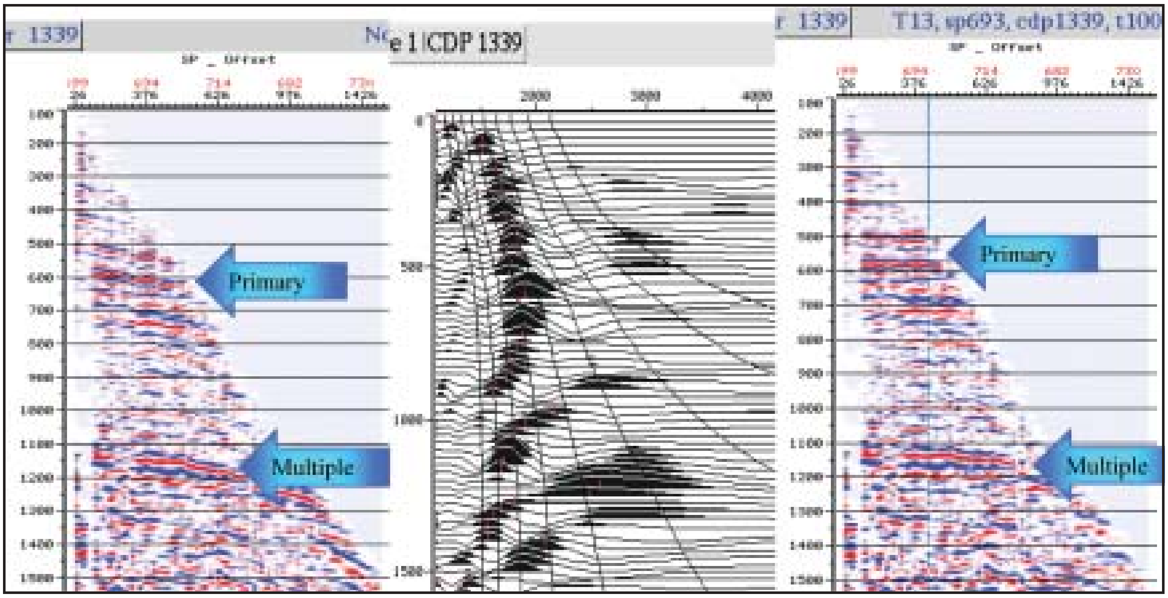

Fig-6 Decon gather before multiple attenuation (uncorrected and NMO corrected)

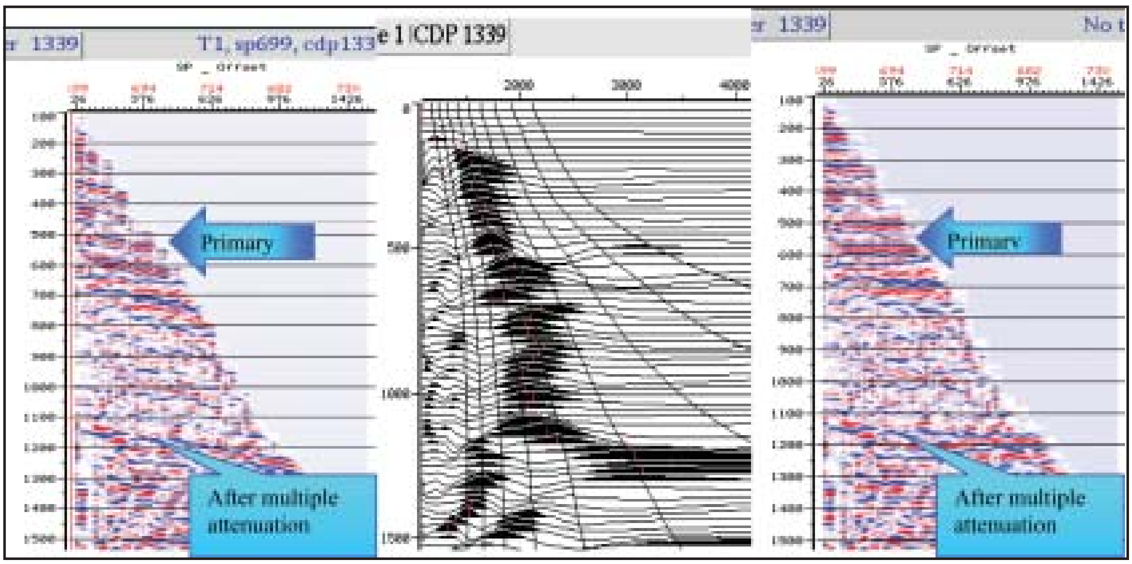

Fig-7 Decon gather after multiple attenuation (uncorrected and NMO corrected)

multiple events occur at around 1150ms.After demultiple, the multiple energy is effectively removed using parabolic Radon transform.

Fig.8 shows the stacked section before and after multiple attenuation. It is important to note that on real data it is difficult to speak of complete multiple elimination after demultiple process. There is always a possibility of residual multiple energy on the section and this is probably the main reason that we call our method "multiple attenuation rather then multiple elimination".

Conclusion

Basically there are two correct approaches to multiple attenuation (1).Distinguish and separate the

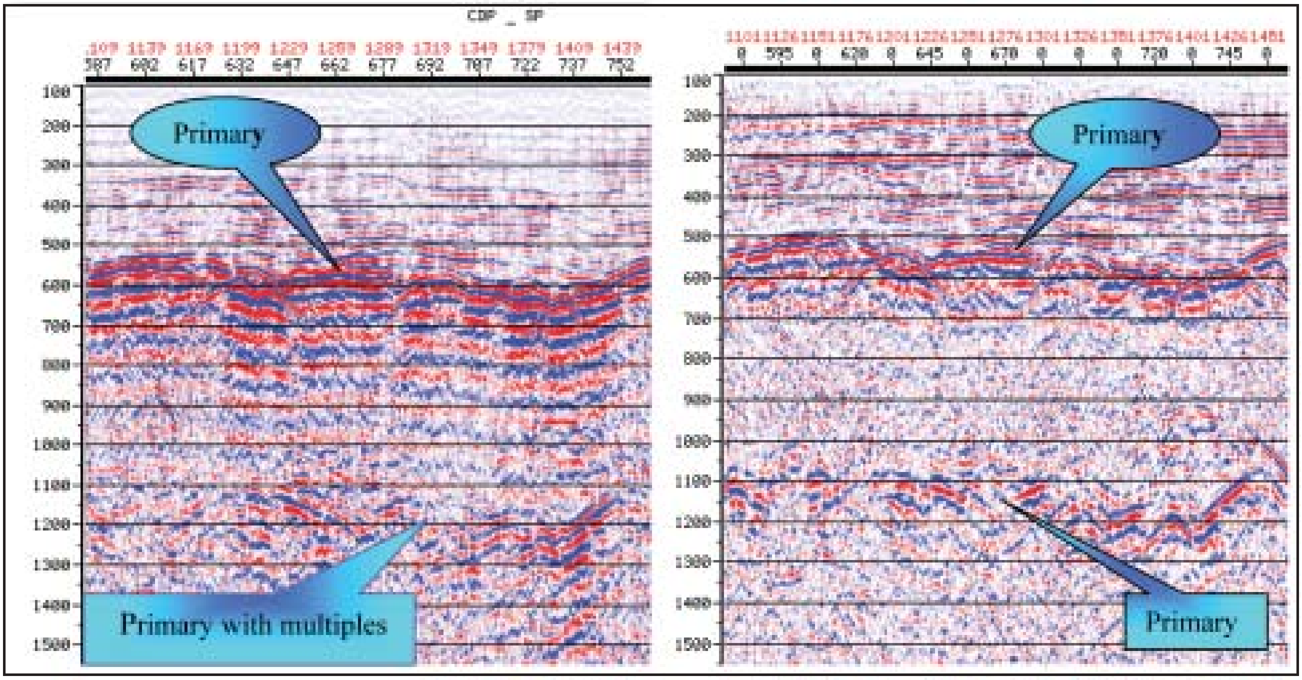

Fig-8 Seismic section before and after multiple attenuation

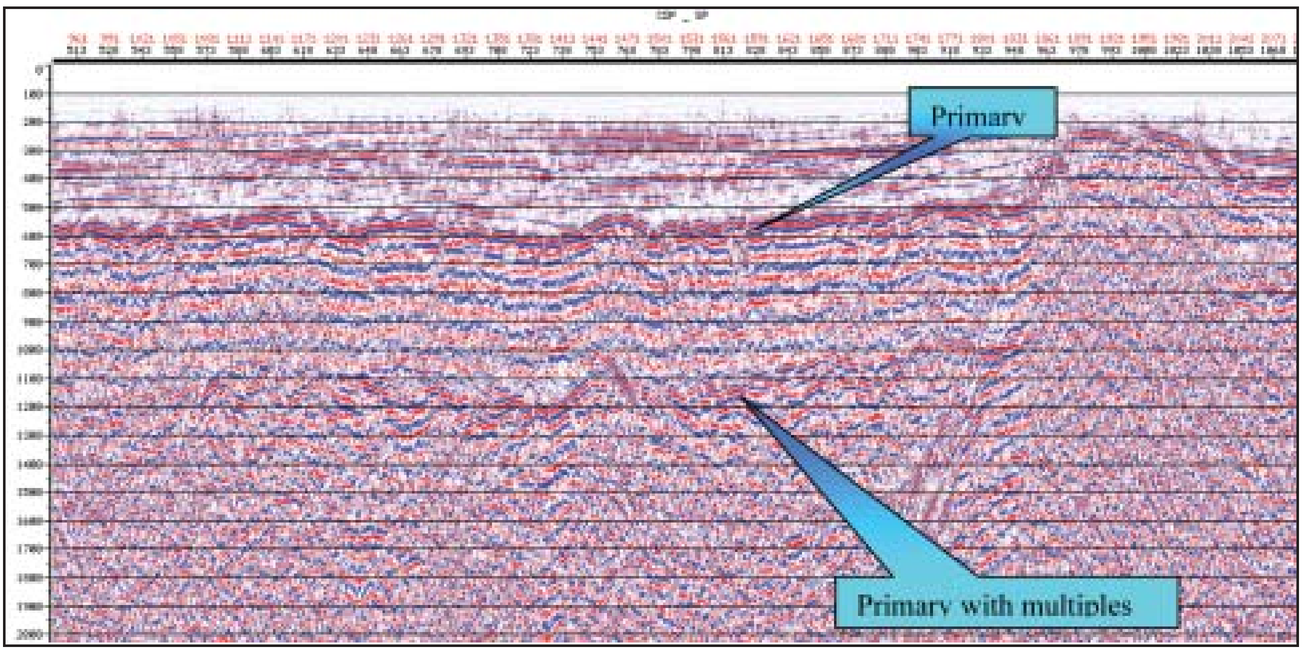

Fig.9 Seismic Section before Multiple Attenuation

multiples from primaries (2).Predict and subtract the multiples from the data. These broad categories contains several subgroups of methods each in turn with specific strength and limitations. The least square Radon Transformation is an effective tool for multiple attenuation in this case study.

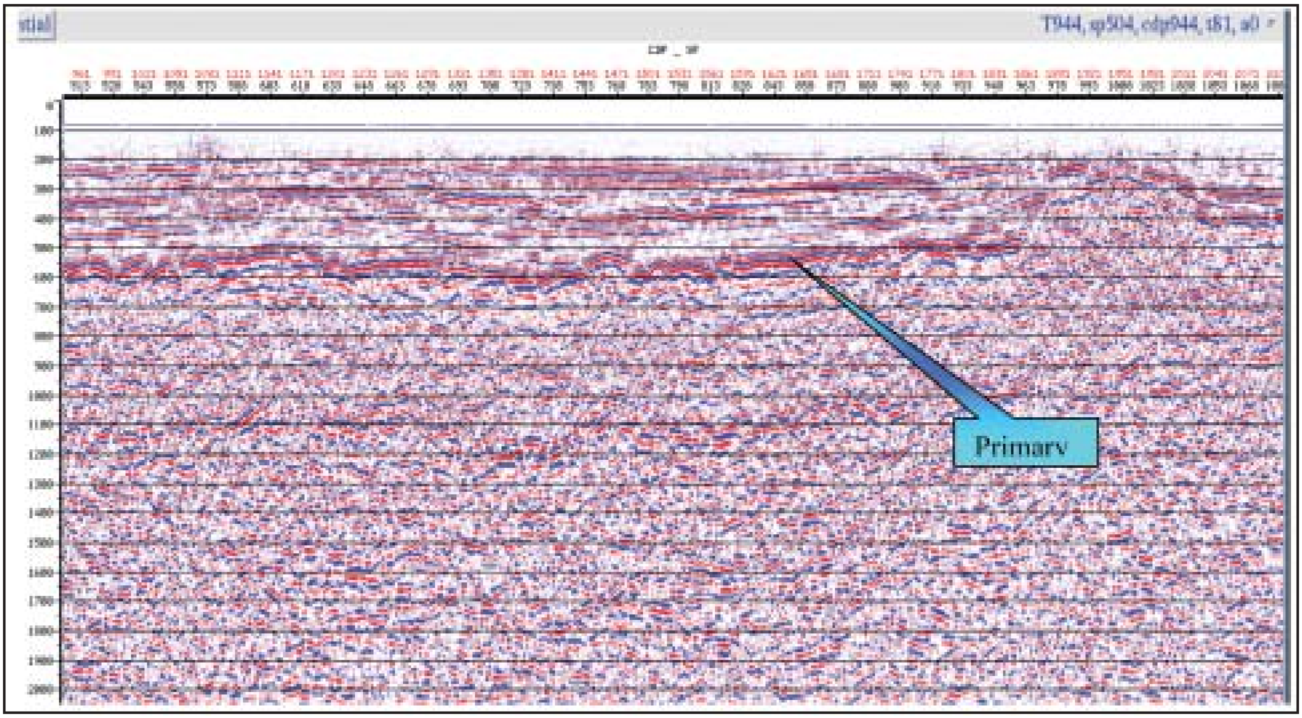

Fig.10 Seismic Section (After Multiple Attenuation).

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