

**Poststack Driven Prestack Multiple Attenuation – A Case Study from KG-PG Basin***Afsal.K.Ismail \*, Kumar G.V.R., Sastry M.H., ONGC Chennai,*

Ismail\_AfsalK@ongc.co.in

**Keywords**

De-multiple, Inter-bed/ Peg-leg multiples, Pre-stack, Offset planes.

**Summary**

The primary reflections in onshore seismic data in KG-PG basin are always masked by the presence of inter-bed/ peg-leg multiples. The subsurface imaging in the area has always been a challenging task, especially when multi-vintage pre-stack merging is considered. (Amit Kumar Bhakta *et. al.* SPG 2017). The basaltic Razole trap and other shallower primary reflectors act as multiple generators in this area. These peg-leg multiples masks the events in Raghavapuram and Syn-rift sediment sequences and sometimes extends its presence within the basement also. The presence of Razole trap is seen from 500 ms to 2500 ms TWT. Regardless of the type of multiples, they have two common properties that can be exploited to attenuate them with varying degree of success — periodicity and move-out that is different from primaries. The marginal or insignificant difference in the move out of the primaries and peg-leg multiples makes the effective velocity of the peg-leg multiple close to the primary events. This fails the available techniques to isolate the inter-bed multiples based on Radon multiple attenuation or other move-out based techniques. When geometric spreading correction is applied using the primary velocity function, it results in enhancement of the amplitudes of multiple reflections. Predictive deconvolution alone does not suffice attenuating the multiples. They need to be tackled using variety of algorithms & worked out in different domains, such as, f-x, f-k,  $\tau$ -p depending on the type of multiple and cost of process execution. In the following section we chose periodic property of the peg-leg multiples to attenuate them. Situations arise, when peg-legs are detected in post stack stage and their attenuation is desired then & there. With this as a central idea we opted filtering of peg-leg multiples in Offset planes. Moreover, periodicity of multiples are more or less preserved in this case for the very reasons that we chose to work on 'stacked' section, i.e. common offset planes obtained from offset classes in the pre-stack domain. The Offset

classes after multiple attenuation and migration are sorted back in CDP-Offset gathers.

**Introduction**

Multiples in seismic data can be classified in different classes, such as, water-bottom, free-surface, peg-leg, intra-bed & inter-bed multiples. The periodicity and move-out will be different for multiples and primaries and most of the de-multiple techniques works based on the above. While these techniques seem to have a good conceptual basis, their performance on field data can be disappointing. There are several possible explanations for this. First, for velocity discrimination techniques to be effective, significant move out differences must exist between primaries and multiples. Inter-bed multiples are not attenuated with this technique since these multiples do not reflect from the free surface. Inter-bed multiples are often reflected between closely spaced events, giving them an effective velocity very similar to primary events. Because there is little move-out discrimination, inter-bed multiples do not respond to Radon multiple attenuation or other move-out based techniques (David Brookes, Leading Edge 2011) Periodicity of multiples is preserved for the ideal case of zero offset and horizontally layered earth. At nonzero offsets, periodicity often is destroyed even for the horizontally layered case. There is also a problem caused by the application of geometric spreading correction, when it is applied using the primary velocity function. This type of correction usually results in enhancement of the amplitudes of multiple reflections. (Yilmaz, 2011)

Subsurface imaging is a challenging task in KG basin when multi-vintage pre-stack merging is considered. This is because of presence of basaltic Razole trap in the shallow depth. When seismic waves propagate through basalts, three major things occur:

- i) Maximum energy is attenuated due to absorption and dispersion.

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ii) High acoustic impedance contrast between basalt and overlying sediment at shallower depth amplifies ground roll. This type of coherent noise masks both near and far offset reflections at shallow and deeper level.

iii) Peg leg multiple are generated from basalt and it interferes with the signals.

### Theory and Methodology

Basaltic Razole trap in KG Basin, along with some shallower sediment sequences are high velocity layer which produces high impedance contrast with overlying or underlying subsurface layers. Only small fraction of energy is allowed to pass through it and rest of seismic energy gets reflected back to surface. Razole trap is present within time zone of 500 ms to 2500 ms TWT. Multiples are the set of spurious events interfering with seismic data. Their presence on a section is due to the fact that an acoustic impedance contrast between two adjacent layers reflects down-going waves in upward as well as downward direction. A certain amount of seismic energy, therefore, is not transmitted from one layer to the next through the stratigraphic horizons along a simple two-way path. It remains trapped within a given formation and rebounds again. These multiples can obscure, or sometimes be mistaken for genuine reflections.

In this paper, we emphasized on proper peg-leg multiple attenuation to get better subsurface image below basalt. Razole trap having high impedance contrast with underlying or overlying sediments also acts as a peg-leg generator. A pattern recognition method has been used to attenuate the peg-leg multiples.

For peg-leg removal, Specified Peg Leg attenuation in three dimension (SPLTD) of M/s CGG software was used. SPLTD performs an attenuation of multiples defined explicitly either by an external model or by a succession of reflections implicated in the multiples path. It looks for the patterns of multiples and the primary events. It removes peg-leg by filtering of spatio-temporal gates in FX domain (Anil Kumar Semwal IOSR-JAGG 2016). We are less likely to get (in the application window) a geological event in conformity with the inline and in crossline multiple than in a single direction. As a result, the method allows working in smaller spatial gates, thus increasing filtering efficiency. In addition, it does not require flattening prior to attenuation. It applies to the 3D

volume located, defined in a constant window, or by horizon pickings. Filtering occurs in a primary spatial gate that is displaced with overlaps in the inline and cross line directions. The gate dimensions and overlaps are defined by the user. The peg-leg attenuation model has been shown in Figure 1. Here Pickings defined as Pick1, Pick2, and Pick3, have been built to characterize the reflectors. The application window where the multiple is assumed to be, is defined by Pick4 and Pick5. The method uses the WIND1 and WIND2 windows to build the multiple models to be suppressed from the application window.

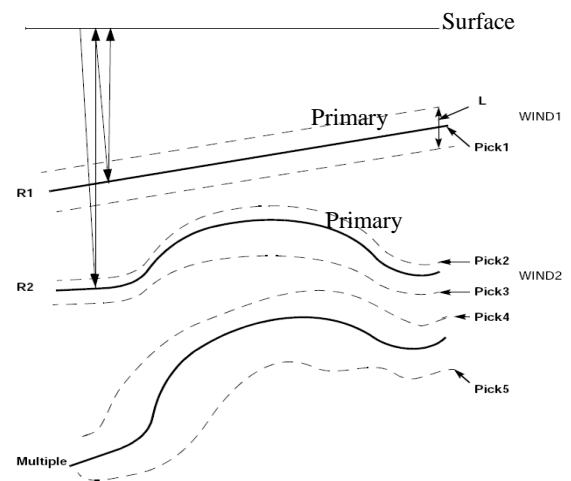


Figure 1: A model for peg-leg attenuation, illustrating the path of peg-leg.

### Case Study

Pre-stack merge of five 3D seismic volumes acquired from Krishna-Godavari basin were considered for the study. Most of the seismic surveys were performed with more or less similar acquisition geometry parameters and acquisition instruments.

Key issue has been the Peg-leg multiples generated by Razole trap. These peg-leg multiples masks the events in lower and Syn-rift sediment sequences and sometimes extends its presence within the basement also. Peg leg multiple attenuation was attempted in pre-stack gathers, in offset planes as if it is done in a post stack domain. A total of 70 offset planes (Offset classes of 80 m each) were considered after regularization of the data. Multiples were attenuated in each offset planes before migration. Methodology involves defining the primaries which is largely determined with the help of geological markers/ log data/ VSP/ Synthetic seismic.

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Both steps are important, to identify the possible multiple generators (primaries) as well as to model the possible multiples. The model used for processing and the peg-leg reflection path considered are illustrated in Figure 2.

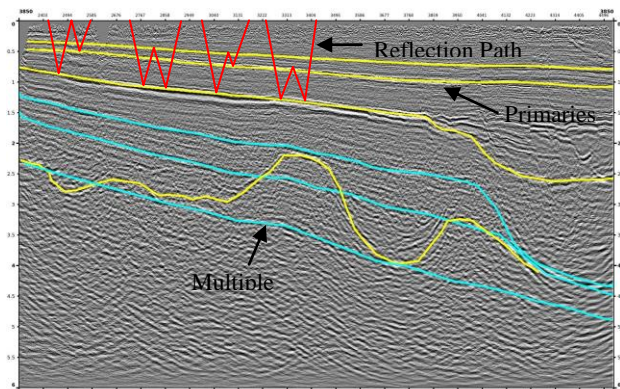


Figure 2: Multiple attenuation model used during processing. Peg leg path is indicated in red line.

VSP data from the wells within the area have been used to identify multiples (Figure 3).

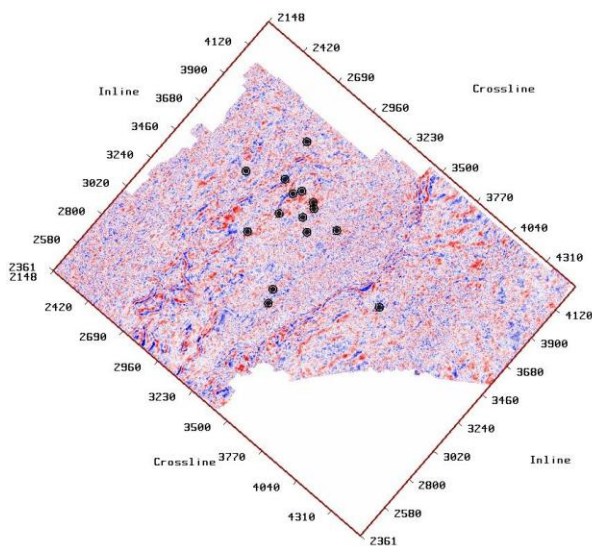


Figure 3: Well locations considered for multiple identification and validation.

Outside corridor stack from VSP should be free of inter-bedded multiples. Inside corridor will have multiples. Comparing each corridor stack with the surface seismic will confirm the existence of inter-bedded multiples. This method has been used to identify the peg-leg

multiples in the seismic data and attempted to remove (Figure 4).

The VSP corridor stacks have been overlaid on seismic data at the well locations and were compared. The identified multiple was absent in VSP data as shown in Figure 5.

From the time differences of the identified multiples, possible peg-leg generators (primaries) were identified from the surface seismic and those were picked as horizons which were used to model the data.

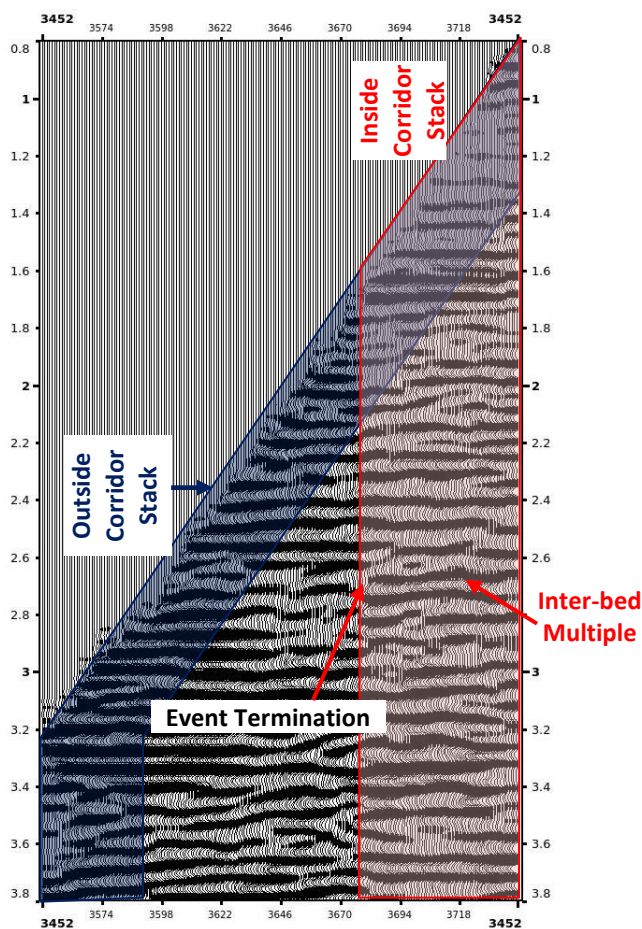


Figure 4: Method of determining peg-leg multiples by comparing inside and outside corridor stack from VSP data.

The model was initially tested on post stack data to check the efficacy of the model and then applied in offset planes in pre-stack domain. Each major multiple were treated in separate window as a caution, and not to hamper any signal. An example of de-multiple done in offset plane 11 (offsets from 800 m to 880 m), before

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and after and its difference are shown in Figures 6, 7 and 8 respectively.

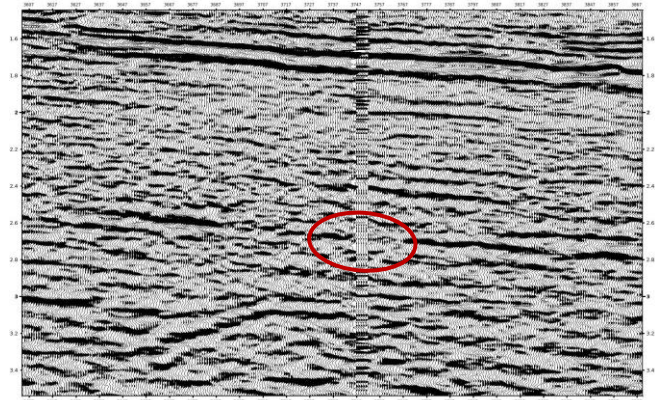


Figure 5: Zero Offset VSP Corridor stack overlaid with the surface seismic validating the Peg-leg multiples in the area.

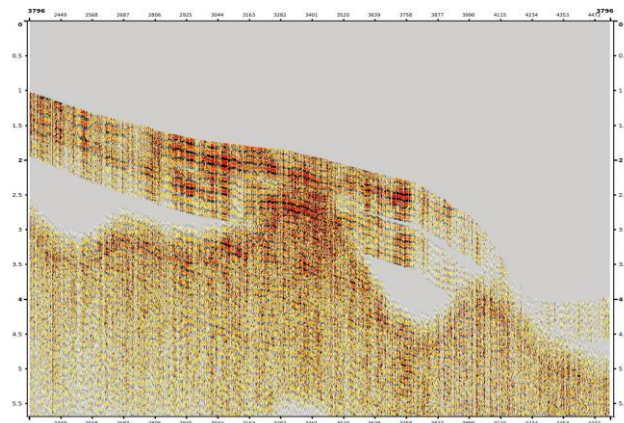


Figure 8: Difference of data in Figures 6 and 7.

The methodology was adopted in all offset planes separately and then migrated and stacked. A comparison of the migrated stack without any multiple attenuation and migrated stack, after multiple attenuation is shown in Figures 9, 10 and 11 respectively.

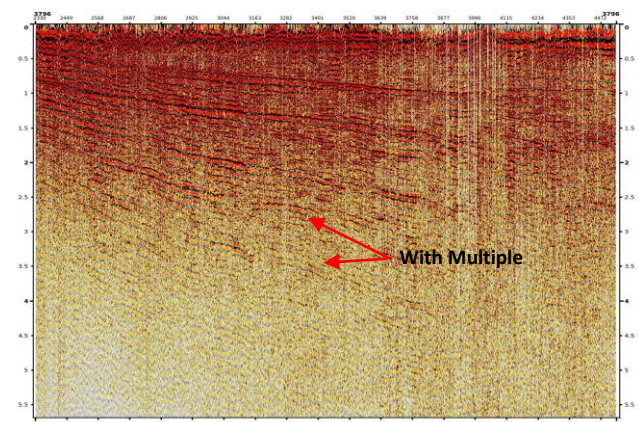


Figure 6: Offset plane 11, before multiple attenuation.

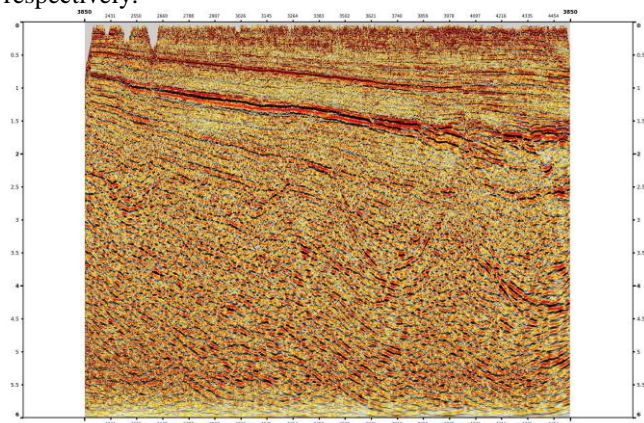


Figure 9: PSTM Stack, without any multiple attenuation.

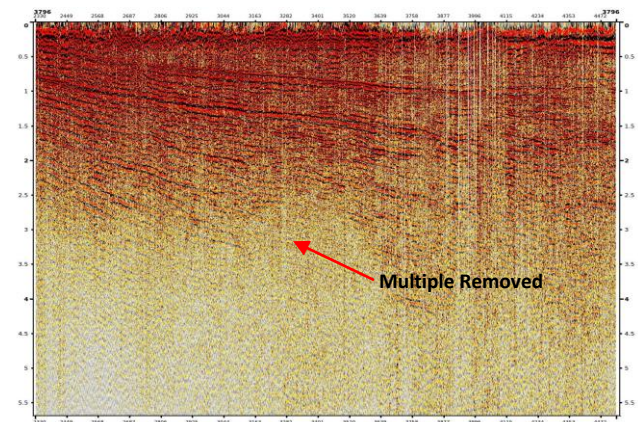


Figure 7: Offset plane 11, after multiple attenuation.

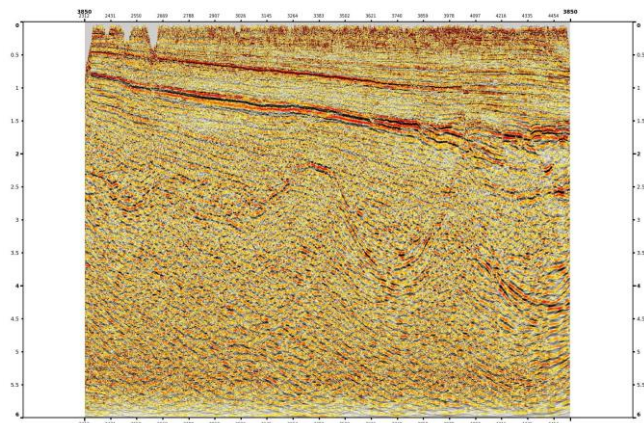


Fig 10: PSTM Stack after multiple attenuation in pre-stack domain.

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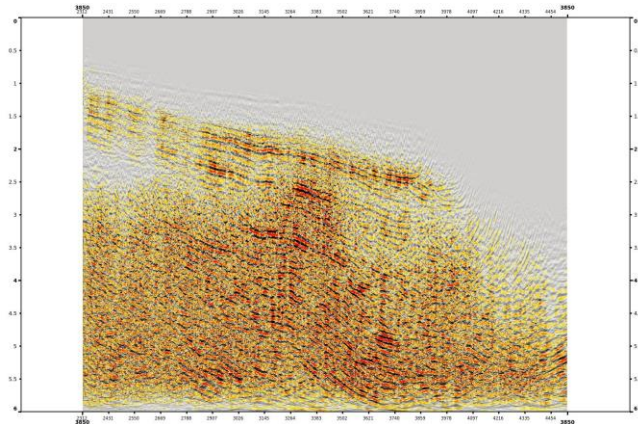


Figure 11: Difference of PSTM Stacks before and after multiple attenuation.

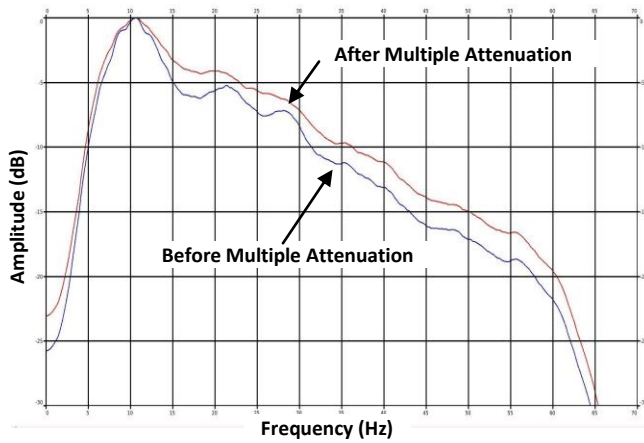


Figure 12: Comparison of frequency-amplitude spectrum before (blue colour) and after multiple attenuation (red colour).

After multiple attenuation, an enhancement has been seen in the frequency amplitude spectrum, as shown in figure 12.

A comparison of the migrated gathers sorted in CDP-offset domain, before and after multiple attenuation and its difference are shown in Figures 13, 14 and 15 respectively.

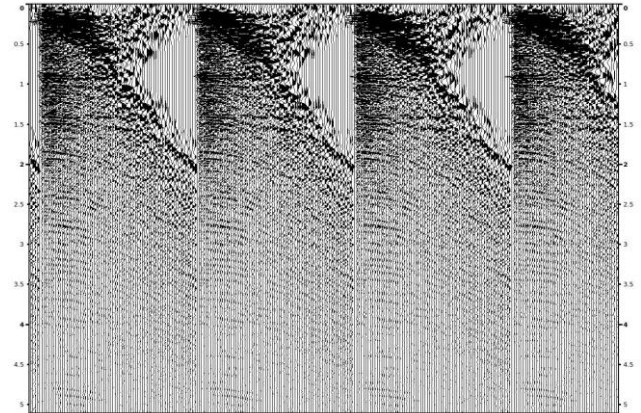


Figure 13: PSTM gathers sorted in CDP domain without multiple attenuation.

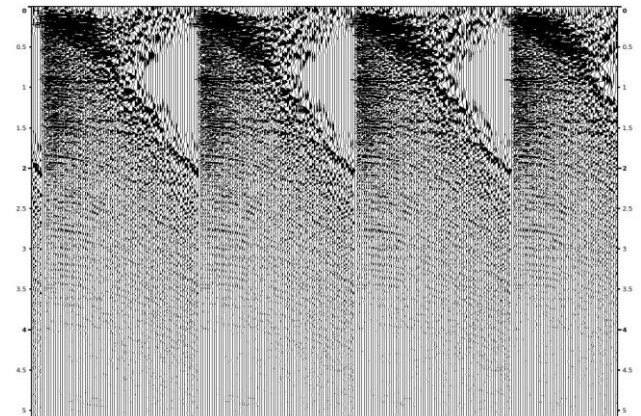


Figure 14: PSTM gathers sorted in CDP domain after multiple attenuation.

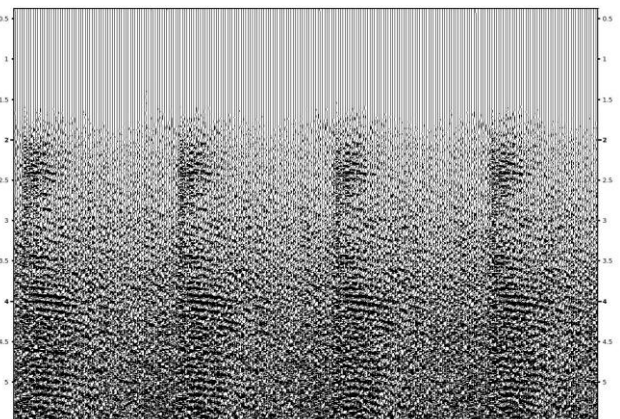


Figure 15: Difference of figures 13 and 14.



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### Conclusions

It is attempted to attenuate peg-leg multiples from offset planes created from pre-stack gathers prior to migration and processed results show a sufficient degree of success in this endeavor by taking into consideration the relative show up of primary reflections, their continuity and the boosted amplitude spectrum. Moreover, it is relatively far inexpensive in terms of process time for the very reason that input is more like a stack section and in comparison to other higher computation dependent de-multiple techniques.

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