Prestack Time Imaging of Subsurface Beneath Basalt in Krishna-Godavari Basin, India – A case study

Amit Kumar Bhakta *, Ranbir Singh*, Afsal K Ismail*, Matibar Singh*, ONGC
bhakta_amitkumar@ongc.co.in

Keywords: Sub basalt imaging, Gabor deconvolution, Peg-leg multiple attenuation

Summary

Subsurface Imaging below basalt in Krishna-Godavari (KG) basin is a challenging task as basalt is a high velocity layer which produce high impedance contrast with overlying or underneath subsurface layer. Basalt impedes penetration of seismic energy down below and only small fraction of energy is allowed to pass through it and rest of seismic energy gets reflected back to surface. So Gabor deconvolution in such type of data set is much more effective as it compensate for attenuation and boost the frequency spectrum. Seismic reflection amplitude will be improved below basalt in deeper horizon. In KG Basin, basalt known as Rajole trap is present within time zone of 500 ms to 1500ms. In this paper, we emphasized on proper denoising of ground roll, Gabor deconvolution as well as multiple attenuation to get better subsurface image below basalt. Rajole trap having high impedance contrast with underlying or overlying sediments also acts as a Peg-leg generator. Peg-leg multiples are very common in KG basin and needs to be suppressed. Denoising, Gabor deconvolution and Specified Peg-leg multiple attenuation using pattern recognition method are used to improve or enhance the imaging particularly in syn-rift and basement.

Introduction

Subsurface imaging is a challenging task in KG basin when multi-vintage prestack merging is considered. This is because of presence of Rajole trap in the shallow part. When seismic waves propagates through basalts, three major things occurs
I) Maximum energy is attenuated due to absorption and dispersion.
II) High acoustic impedance contrast between basalt and overlying sediment at shallow 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.

These three key issues are addressed and resolved during conventional processing by denoising of data in different domains, Gabor deconvolution and removal of Peg-leg multiples through pattern recognition method.

Theory and Method

Effective denoising of data was performed in frequency domain by Frequency dependant Noise Attenuation method in cascading manner, which attenuates high amplitude noise in decomposed frequency bands. This utilises frequency dependent and time variant threshold values of amplitude samples within defined trace neighbourhoods. Denoising is done after application of field supplied statics followed by spherical divergence correction. With judiciously selected values for parameters like amplitude and frequency, both incoherent and coherent noise were suppressed in cross-spread domain.

*Processing centre, GPS, Chennai
Another key issue of subbasalt imaging is attenuation factor. Attenuation is commonly expressed as effective Q, which is a combination of the intrinsic attenuation, describing energy loss due to the propagation through media, and apparent attenuation describing attenuation due to scattering, transmission, mode conversion, etc. As the attenuation coefficient Q tends to be numerically lower, heavy loss of valuable frequencies can be observed below the trap. Q filtering is an exponential decay in time and frequency. So any kind of compensation function should grow exponentially in both time and frequency which makes it inherently unstable. Apart from these, errors in the assumed model of Q attenuation can cause faulty reconstruction. There has been numerous studies on Q compensation but largely an accurate solution remain elusive. This is where Gabor deconvolution scores over others as Gabor operator is data driven. It doesn’t require any pre-knowledge or assumptions about the attenuation function.

Key issue is Peg-leg multiples generated by Rajole trap. 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 up as well as down. 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. Peg leg multiple attenuation was attempted in post stack mode.

VSP data has been used to identify multiples. Outside corridor stack 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.

Methodology involves defining the primaries which is largely determined with the help of geological markers or log data.

For pegleg removal, Specified Peg Leg attenuation in three dimension (SPLTD) of M/s CGG software was used. This works on the method of pattern recognition. It looks for the patterns of multiples and the primary events. It is to be emphasized that multiple like primary is a single spatially predictable event. It removes pegleg by temporal spatial filtering in FX domain. The dimension of the spatial operator window is crucial, as a small window shows similar characteristics for both primary and multiple and large window beyond a limit can miss out the chance of pattern recognition.
Prestack Time Imaging of Subsurface Beneath Basalt in Krishna-Godavari Basin, India – A case study

Fig-5(b) Time migrated section after multiple attenuation.
Multiples on either side of basement is removed.

Fig-6(a). Time migrated section before multiple attenuation.
Multiple encroaching sequence and basement marked in oval shape.

Fig-6(b). Time migrated section after multiple attenuation.
Multiples on either side of basement is removed.

Conclusion

Prestack Time Migration (PSTM) of multi-vintage 3D seismic data in a part of KG basin has improved imaging and focusing, especially at synrift and basement levels, having hydrocarbon exploration interest.

Improvement in imaging is possible through a judicious processing flow and parameter for the key issues of ground roll, frequency attenuation and peg leg multiple interference within the zone of interest.

“Multiples or multiple removal;” who is winning?” is still unanswered. As the land seismic data does not posses perfect acquisition geometry, multiple attenuation on prestack data by pattern recognition method pose difficulties during generation of multiple model and adaptive subtraction. For this reason, Peg leg removal is attempted on stack data.
None-the-less, stack data is free of multiples and imaging is improved without affecting the primaries.

References


Acknowledgments

Thanks are due to Director(E), ONGC, for according permission to publish/present this paper. The views expressed in this paper are soley of the authors and do not necessarily endorsed by ONGC.

Authors are indebted to Sh. T. Rajendran, GGM(Geology), Basin Manager, Cauvery basin, Sh. S.K.Kaplesh, GM (GP), HGS, Chennai, and Dr.G.V.R.Kumar DGM(GP) for their constant encouragement and support throughout this study.