Dip Filter for Enhancement of Subsurface Imaging at Deeper Prospects – A Case Study

Arjeesh Gupta, D.K.Vishnoi, K.M.Danak* & D.Chatterjee
GEOPIC, ONGC, Dehradun

Summary

After thorough exploration of Eocene and shallower prospects in Western Onland Basin, the focus has shifted to deeper prospects. The available seismic data is reprocessed with the deeper objectives. But, the presence of strong, linear events below 2000 mS in the sections of Western Onland basin was not correlatable to any geological feature. This event was seen on the post stack migrated sections also. Even the pre stack time or depth migration could not eliminate the effect of this event. Careful analysis of the raw shot gathers revealed the presence of high velocity noise. A dip filter was designed to precisely suppress the noise in the pre stack data. This filtered data when subjected to pre stack time migration, the resulting subsurface imaging was free from noise seen earlier and the processed data was interpretable.

Introduction

Reprocessing of 2D data of Western Onland basin is being done for re-evaluation of the blocks. The eastern part of processed section exhibited a strong linear event below 2000 mS and cutting across the Paleocene reflectors. This event could not correlated to any genuine geological feature. As the conventional post stack time migration did not help in proper imaging of the subsurface the data was subjected to prestack time and depth migrations, which also could not improve the imaging. A careful analysis of the raw gathers revealed the presence of high velocity (~ 5500 m/S) linear noise. This noise was suppressed by designing a dip filter. Application of this dip filter resulted in gathers free from this noise. Taking filtered gathers as input for the subsequent processing followed by prestack time migration resulted in section which was well correlatable with geological significance.

Geological set-up

The area of study falls in the western part of Western Onland basin of India and lies east of an established hydrocarbon producing field. Paleocene and lower/middle Eocene pays are the main exploration and development targets in the area. However, Reservoir sands encountered in the well drilled in the adjoining block and the sands within Paleocene seen in the well drilled in the area are additional exploration targets in the study area (Fig.1).

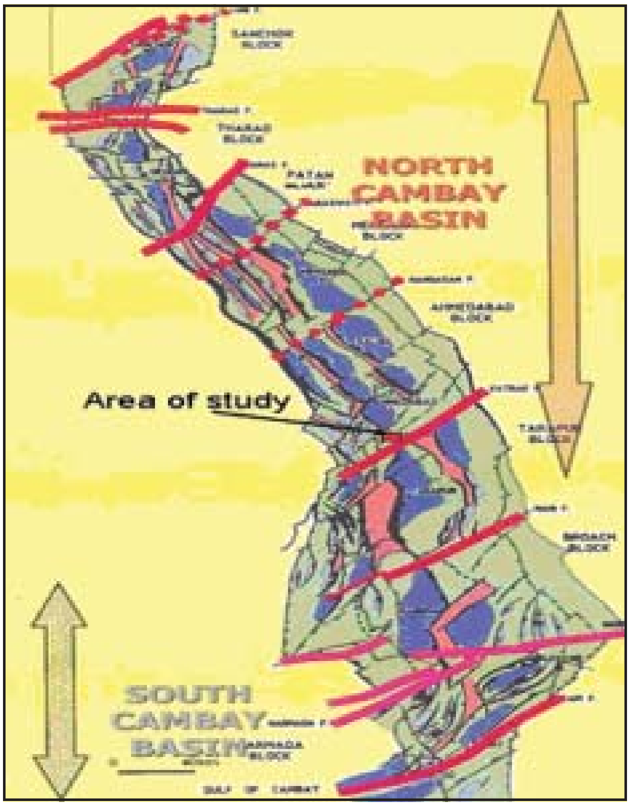

Fig.1: Location map showing area of study

Methodology

Normal time domain processing of seismic data was carried out. The stacked data exhibited strong linear, dipping alignment below 2000 ms in the eastern part of the section cutting across the Paleocene reflections (Fig.2).

Presence of this event made interpretation extremely difficult as this event could not be correlated to any known geological feature in the area. The event was first attributed to the part of diffraction generated from the

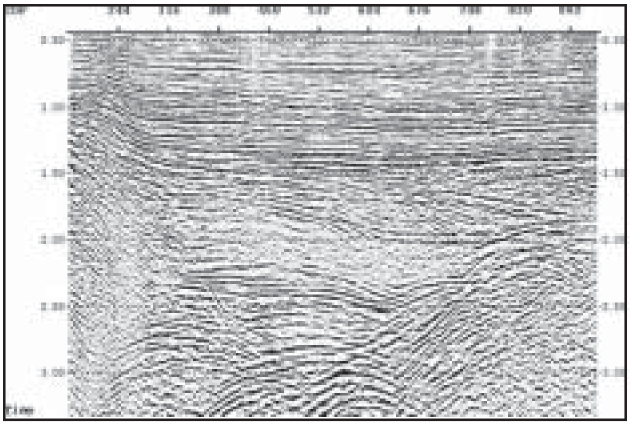

Fig.2: Linear dipping alignment of events

possible faults present in the far eastern part of the area. But, when the data was subjected to conventional post stack time migration, these alignments were not collapsed although all other diffractions were properly migrated in other parts of the section (Fig.3).

Assuming the imaging problem in post stack time migration process, the data was subjected to prestack time migration. But, the result was same and the output was still showing the presence of this event (Fig.4).

To have better control over the velocities and thereby over migration process, a depth-interval velocity model was built through coherency inversion (Fig.5) and the data was prestack depth migrated expecting the output to be free from this event. Although, the subsurface imaging improved through prestack depth migration, but still the end result was contaminated in the eastern part of the section (Fig.6). This led to change our assumption and the raw data was carefully analyzed to find out the reasons for this event. Analysis of raw shot gathers revealed presence of very high velocity (~ 5500 m/s) noise in the gathers. A dip filter was designed to precisely suppress this noise.

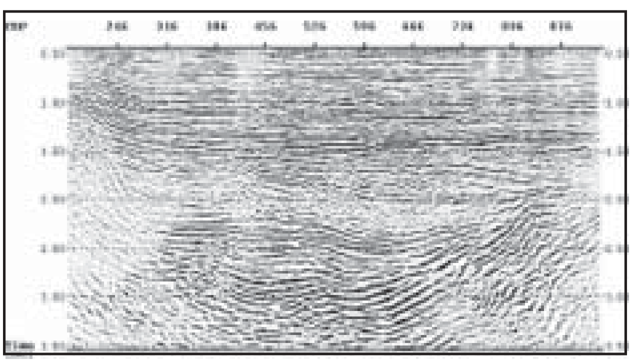

Fig.3: Post stack time migrated section

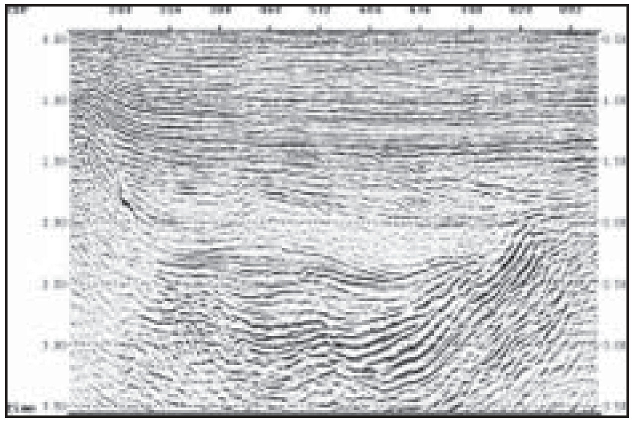

Fig.4: Pre stack time migrated section

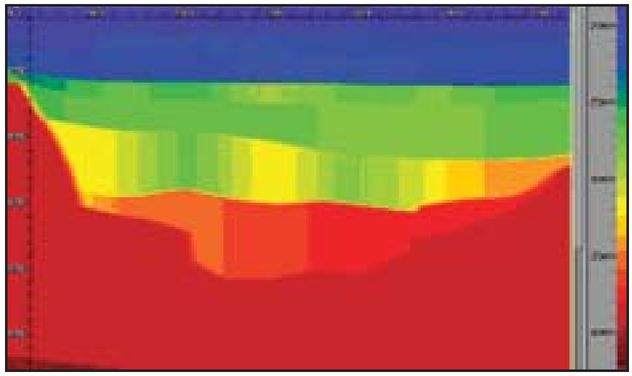

Fig.5: Depth Interval velocity model

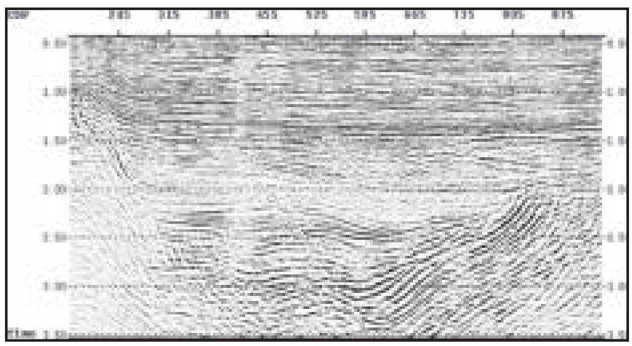

Fig.6: Pre stack depth migrated section

Dip filter

The function of this filter is to remove noise, manifested as transverse dipping events, from gathered or stacked seismic data. This is done by designing a two-dimensional filter of user-specified size. The filter when applied to input traces, removes dipping coherent energy within the user specified range of dips. Theoretically, the application designs an f-k filter based on a user-specified range of dip and performs a Fourier transform to transform it from the f-k domain to the x-t (space-time) domain.

Raw shot gathers after pre processing were subjected to NMO correction. These NMO corrected gathers were then filtered using the dip filter with optimized parameters and the output gathers were free from this noise (Fig.7 & 8).

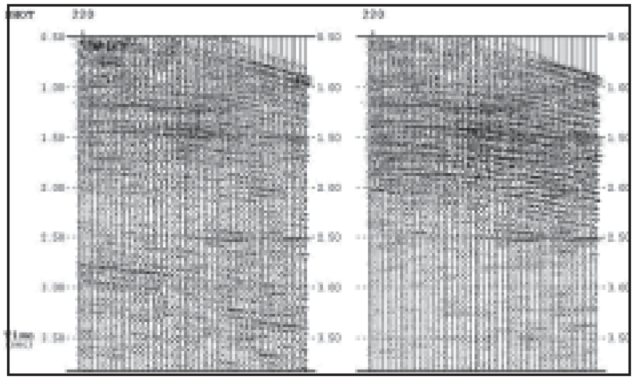

Fig.7: Suppression of noise through dip filter at shot location#1

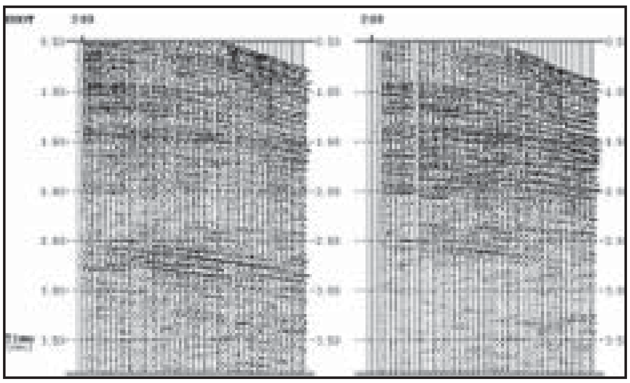

Fig.8: Suppression of noise through dip filter at shot location#2

Taking this data as input for subsequent processes, the end result after prestack time migration was showing enhanced imaging at the level of Paleocene without loss of structural or stratigraphic imaging at lower & middle Eocene level and the section could be easily interpreted (Fig.9).

Comparison of PSTM stacks from unfiltered and filtered data shows improvement in imaging around target levels (Fig.10). Data of other profiles, from the same area, were also processed using the same sequence and the result was improved imaging of deeper prospects (Fig.11).

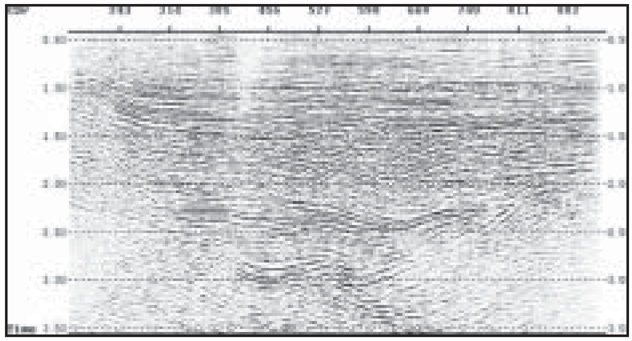

Fig.9: Final migrated section showing improvement at the level of Paleocene

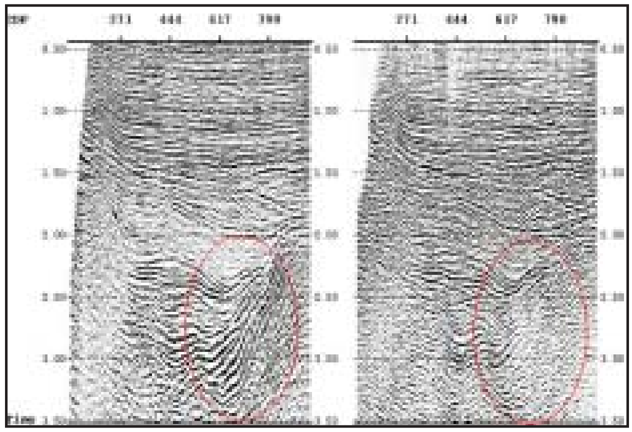

Fig.10: Comparison of PSTM stacks of unfiltered gathers (left) and filtered gathers (right).

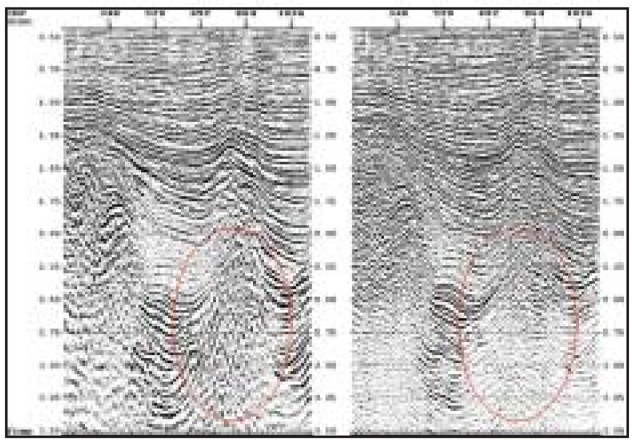

Fig.11: Comparison of PSTM stacks of unfiltered gathers (left) and filtered gathers (right) of other profile from the same area.

Conclusion

Use of precisely designed dip filter has effectively suppressed the strong linear noise from shot gathers and the end product (PSTM stacks) exhibited enhanced subsurface imaging at deeper levels. The processed section would lead to delineation of prospects around Paleocene level in a better way and help in enhancement of reserve accretion.

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