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Pre-stack Merging of 3D Vintages : A case History from Assam Arakan Fold Belt

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Summary

Pre-stack merging of 10 vintages of overlapping 3D seismic data of 632 sq. km acquired in several field seasons using different equipment and different orientations of acquisition geometry. The datasets were processed earlier individually. Understanding the strati- structural features of the pay sands within Bokabil Upper and Middle Bhubans, delineation of the pay sands and understanding the areal extent of the pay units in totality was main objectives of the project. Starting with geometry merged gather, pre-stack merging in a master grid was carried out. The exercise involved stage wise QC of individual vintages in addition to those in master grid. The complete data was subjected to 3D Pre-stack Time Migration (PSTM) using Kirchoff's approach. This work briefly discusses the salient features of the nuances involved.

Introduction

Pre-stack merging of 10 vintages of overlapping 3D volume were undertaken with the objective of understanding the strati-structural features of the pay sands within Bokabil, Upper and Middle Bhubans, delineation of the fault patterns and understanding the areal extent of the pay units in totality. The areal extent of the data was 632 sq. Km. in the gas producing fields of Assam Arakan fold belt area. The project led to the successful delineation of a new structure providing valuable thrust to the exploration activity. Signal conditioned gather with deconvolution was taken as input to master grid for merging. Distributions of major vintages are shown in figure- 1.Vintage-1 was acquired in 2006-07 field season with SN-388. Vintage-2 comprises of two smaller seismic investigations acquired in two different field season (FS 2007-08 and 2008-09) using UL-428. Vintage-3 comprises of four small seismic investigations acquired in field season 2004-2007 having varying shot geometry because of close proximity of international border. Vintage-4 were having three different seismic investigations shot in two different field seasons by two different geophysical party using UL-428. Vintage-1, vintage-2 and vintage-4 were processed earlier using same processing grid and the orientation of the acquisition geometry was same. However all parts of vintage-2 were shot with orthogonal End-On geometry and all parts of vintage-4 were orthogonal split-spread geometry. Acquisition grid for all parts of vintage-3 was different from that of other Vintages. However, all the seismic investigations of vintage-4 were merged earlier. So, geometry merged gathers and migration velocity volumes were available for all the vintages individually (Figure 1). So, altogether 10 different seismic investigations are grouped in four vintages for convenience of processing and utilising apriori information available. Even after the merging there is a big data gap in the central part of the merged volume because a sanctuary falls within the area.

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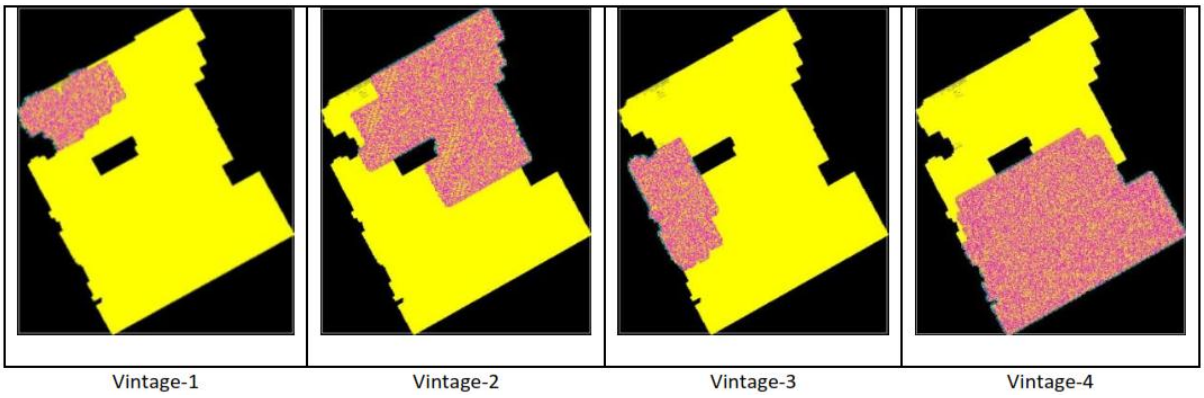


Figure-1: Distribution of the major vintages within the total volume

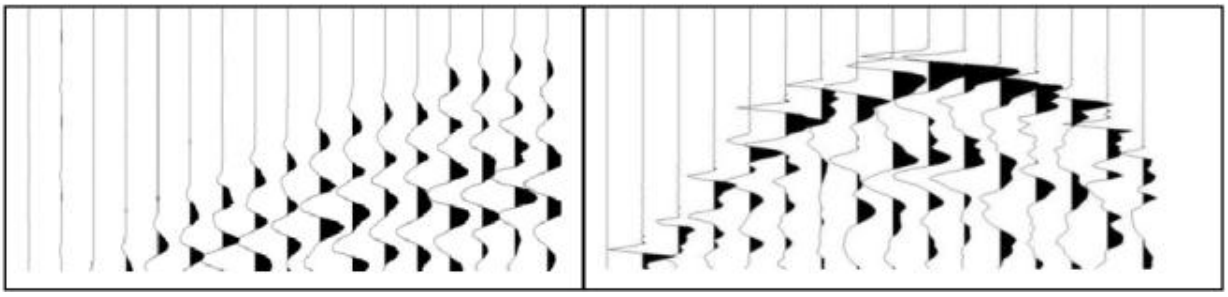


Figure-2: QC for recording polarity

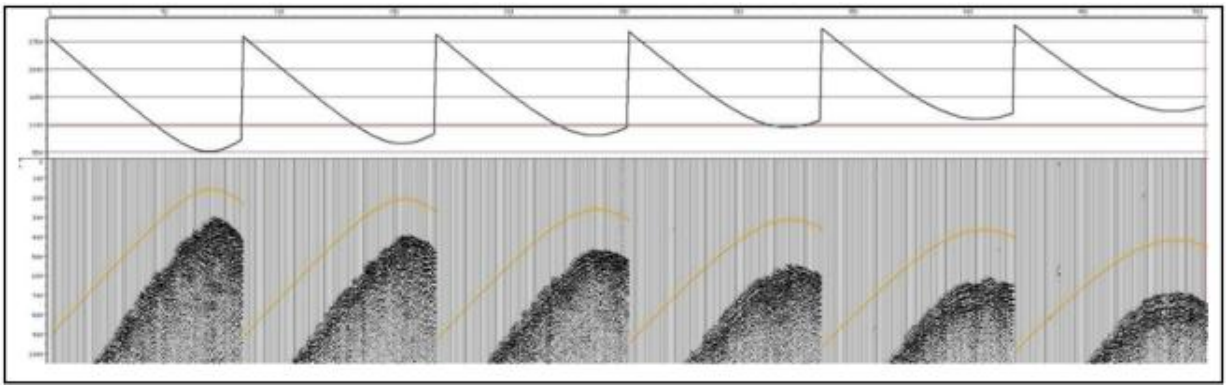


Figure-3: QC for geometry merging

Pre-processing

The input datasets were analysed and a scheme of work was decided. The polarity checks of the data were done (Figure-2). Since geometry merged gathers were taken as the starting point of the project, quality and accuracy of the geometry merging were checked by plotting offset and mute function on the gather (Figure- 3). The frequency contents of all inputs were checked to decide the final band pass filter for the data. The overall frequency band of all the vintages was similar. No shaping filter design was done for any vintage, which, normally, is the case for any merging exercise. Since data were acquired in different field seasons by different party using different instruments and different shooting geometry the S/N ratio available in

the data were varying. Particularly, in the anticlinal parts of vintage-3, the zone of overlap between vintage-2 and vintage-4 (i.e., south western part of vintage-2 and north western part of vintage-4) were of major concern. After the data of all vintages were loaded to the master grid, the source receiver distribution, foldage of total volume were compared with the time slice (Figure-4). This helps in ascertaining the amplitude issues as a function of bin population.

Processing Sequence

Editing and swath-wise de-noising of the data was implemented for minimizing noise bursts and groundroll. All the swaths were merged to form a complete volume and surface consistent amplitude balancing was done to remove the effect of variation in shot-receiver ground coupling. A two window deconvolution before stack was chosen after testing.

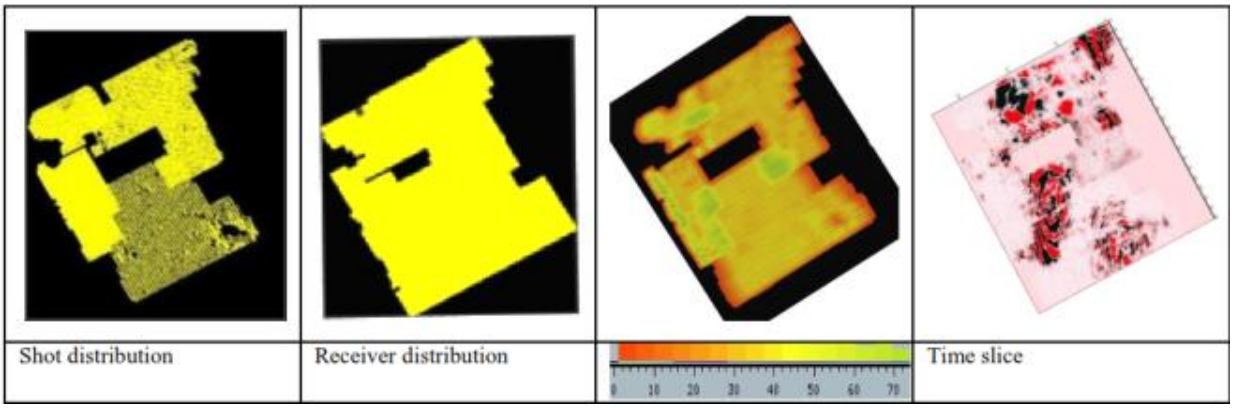
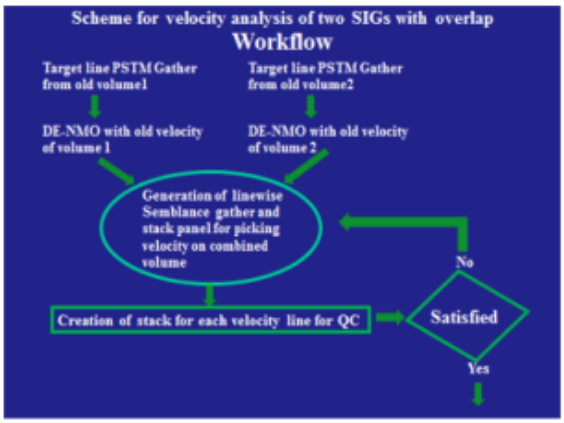


Figure-4:(from left to right) Shot distribution, receiver distribution, foldage map and time slice



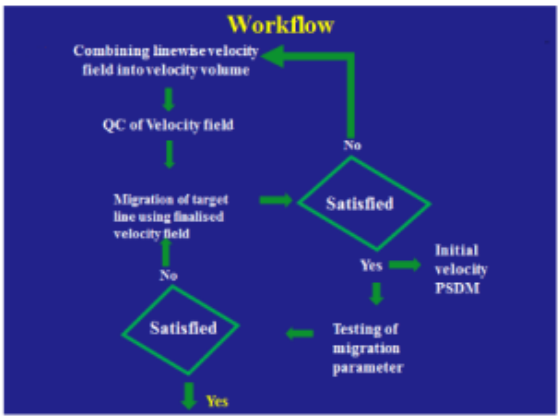


Figure-5: Scheme of velocity model building

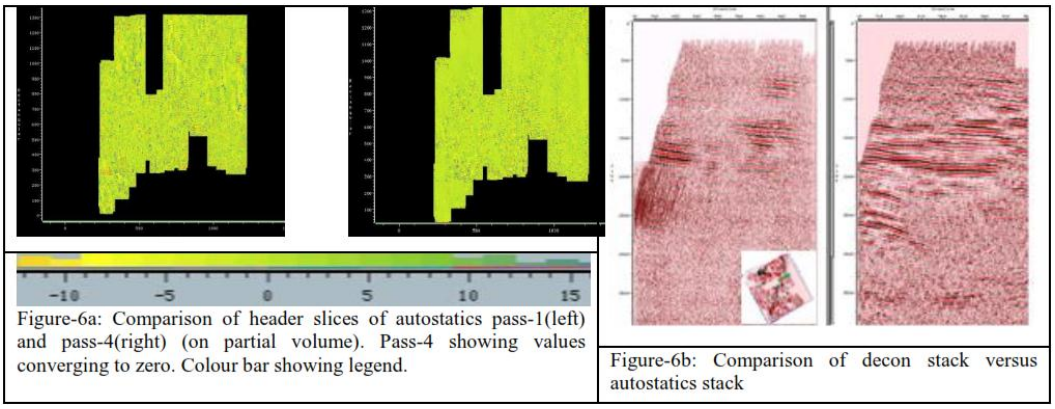


Figure-6a: Comparison of header slices of autostatics pass-1(left) and pass-4(right) (on partial volume). Pass-4 showing values converging to zero. Colour bar showing legend.

Figure-6b: Comparison of decon stack versus autostatics stack

Stacks, time slices and foldage distribution map after deconvolution, were generated (Figure-4) to check the quality. PSTM gathers of previous processing of vintages as well as RMS velocity volumes were available for initial velocity model building. Scheme of velocity model building of entire volume is shown in figure-5. Autostatics computations were done for entire volume. Four passes of autostatics were run, stacks and time slices were generated. Comparison of header slices at initial and final Autostatics volume shown in Figure-6. RMS velocity and stage of autostatics and comparison of sections were overlaid to check conformity with major geological structures of the area (Figure-7). Entire volume was subjected to 3D PSTM using Kirchoff's approach. Random noise attenuation was done on PSTM gather (Figure-8) to minimize the smeared noise prior to stacking. Space variant mutes were picked before stacking. Post stack noise attenuation and filter were applied in f-x-y domain.

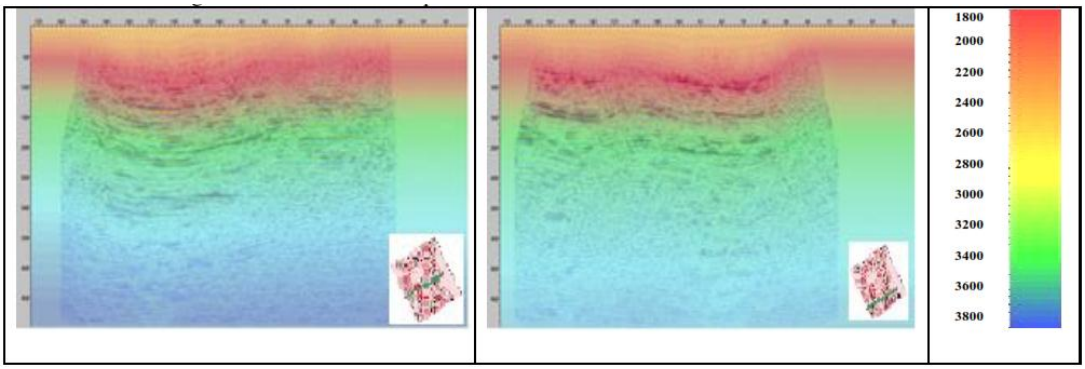


Figure-7: Composite display of RMS velocity and stack section

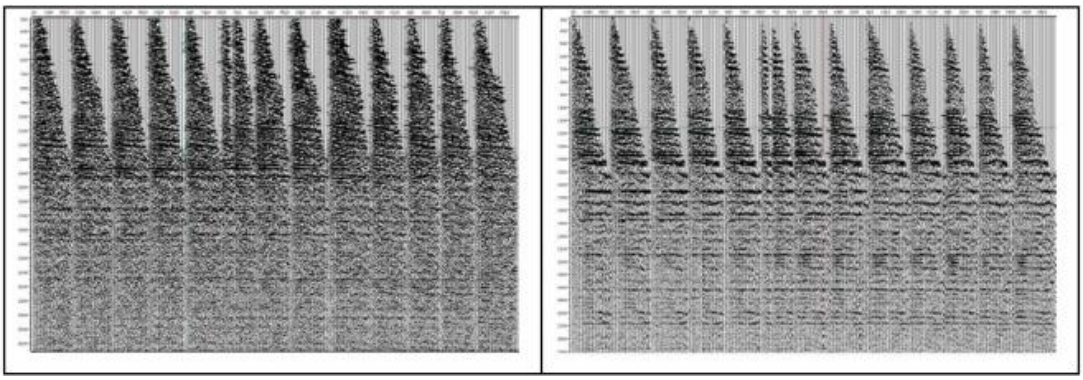


Figure-8: PSTM gathers before (left) and after (right) denoising

Conclusions

Signal conditioning followed by pre-stack merging and PSTM resulted in better subsurface imaging in zones of overlap. Some in-lines from final volume are displayed in Figure-9. Improvements in the strati- structural features after post-stack processing are shown in Figure-10b. A new feature was delineated south of overlap zone between vintage-2 and vintage-4 (Figure- 10c). Difficulty of imaging overlap zone of vintage-2 and 4 and anticline of vintage-3 were overcome to a greater extent. Anticline in the Vintage-3 and overlapping zone of vintage-1 and vintage-2 indicate better imaging. Figure-10c shows a new structure identified on a reconstructed line from the volume and figure-10a shows time-slice at 2200ms.

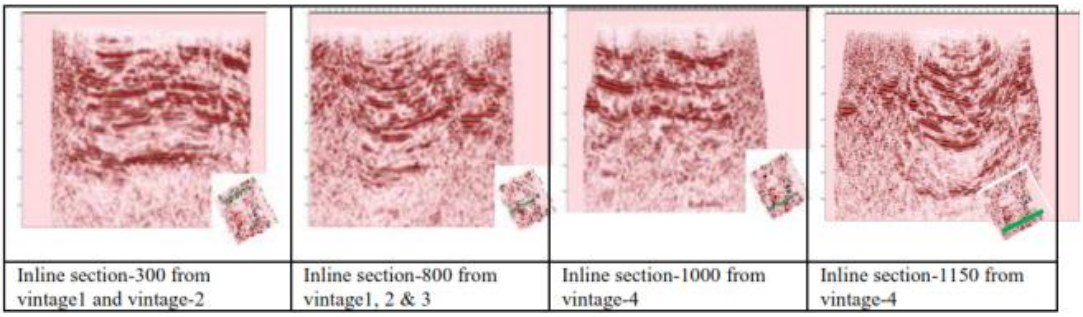


Figure-9: Inline PSTM sections across the volume (from north to south)

Figure-10a: Time slice (2200ms)

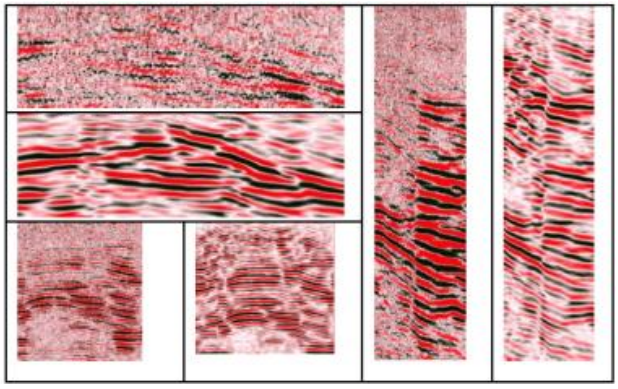


Figure-10b: Sections before and after post-stack processing

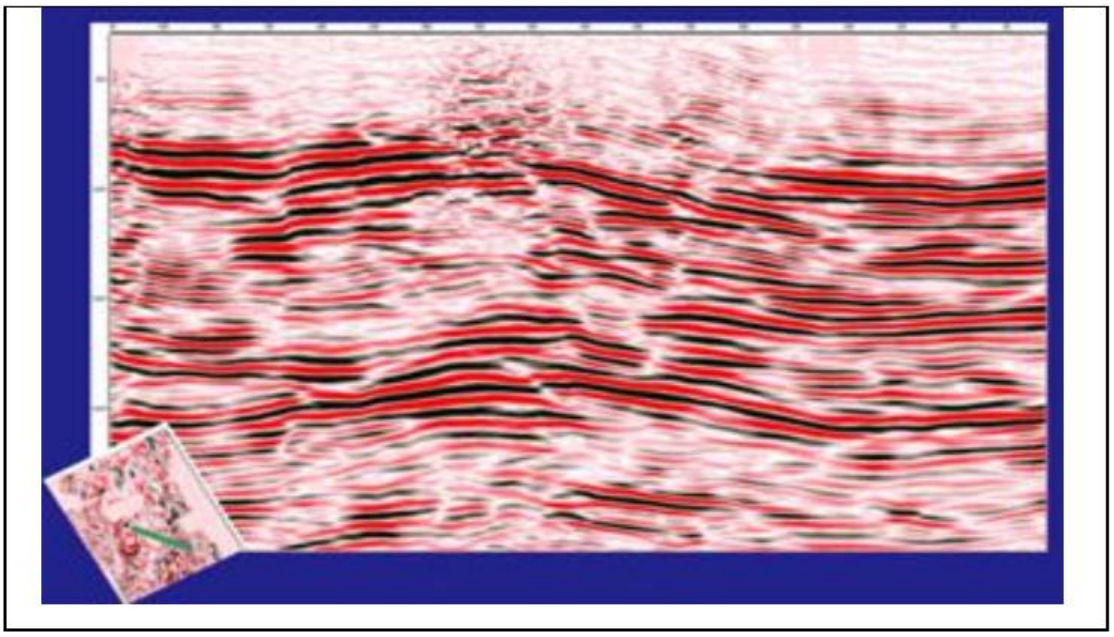


Figure-10b: Newly identified feature

Acknowledgements

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