



## Enhanced Imaging of Subsurface by Pre-Stack Merging of Multi-Vintage 3D Data Sets and its Prestack Time Migration – A Case Study

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### Summary

*A small 3D land seismic data set, whose aerial extent is less than the desired migration aperture, is subjected to full 3D Pre-Stack Time Migration. Then imaged subsurface will be encroached by the migration artifacts and may relinquish the scope of proper interpretation. So, to obtain fully migrated data in the area of interest, the data are to be added from the neighboring area with honoring the optimum migration aperture requirement and extended beyond the area of interest to preserve the captured reflection and diffraction energy in the pre stack mode. The present data set is pre-stack merged seamlessly with available old vintage data sets with appropriate conditioning, then PSTM has brought out clearly the structurally complex basement, which would not have been the case, had we not included the old data.*

### Introduction

The aperture required for migrating a seismic data depends on the maximum dip present, the depth and offset. What if the desired aperture is more than the survey dimension? Here we are in a situation where the data can not be subjected to full PSTM for want of more data. An attempt was made to ‘borrow’ data from earlier campaigns in the adjacent areas to meet the aperture requirement and merged in pre stack mode to rebuild a new single data set which seems to be recorded as a single project. 3D PSTM with the ‘padded’ data has resulted in improved imaging.

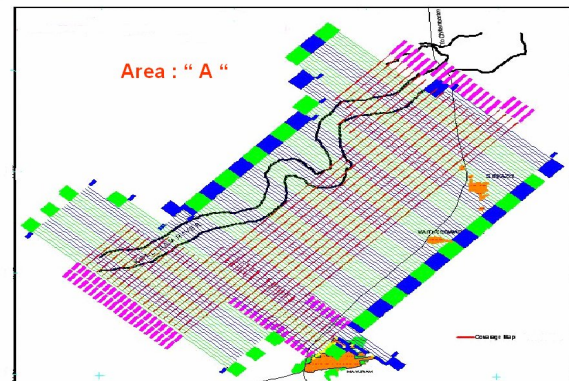


Figure 1: Coverage Map of the area “A” shows irregular shape of acquisition.

The data under processing belongs to Cauvery Basin of Southern India. The area extend is 4 km X 16 km., the bin size is 20 X40 m. and the fold is 42. The maximum target depth is 3.5 km i.e. basement. The data was acquired in an



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irregular manner due to some logistics as well as due to natural calamities.

Even, the seismic data was acquired in the area with varying number of channels which reflects variation of foldage in the area.

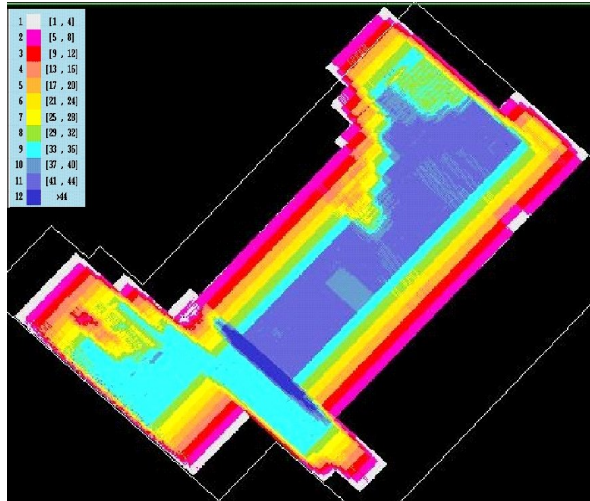


Figure 2: Fold map of area "A".

## The Task

As the basement is expected to be structurally complex, the expected aperture is about 10 km. whereas width of the data area only 4 km. Faithful imaging of the subsurface is possible if the area is extended by adding data from old campaigns. Essentially the data need to be pre-stack merged with the neighboring data sets.

Here, we deals with three data sets of three different vintages, one is the recent data of area marked "A" of Cauvery basin and other two lies adjacent to area "A" in South-West and South-East marked as "B" & "C" respectively.

All the three data sets had been grided with the same grid origin to get a single data volume and processed the merged data set with the specific attention to key issues of pre stack merging.

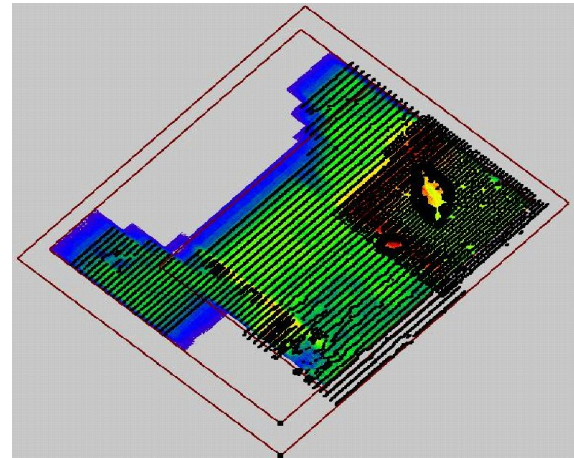


Figure 3: Coverage map of recent vintage "A" merged with old vintage "B" & "C".

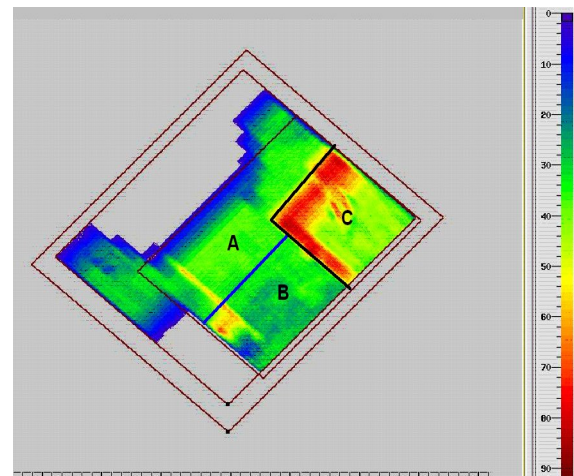


Figure 4: Fold map of merged data of areas "A", "B" & "C".

## Issues and Solution

All together three data volumes are to be pre stack merged. As the three different vintage were recorded in different times with different instrument and geometry, a following few key issues are to be addressed before and during pre stack time migration.

- Field statics are not computed in the same fashion, leading to static shifts from volume to volume. The average static shifts in the overlapping pickets are estimated and applied.
- Trace amplitude may differ among the different vintages due to spherical divergence factor, use of different size of dynamite, use of varying number of receiver elements in each receiver location and different K-gain in every vintage. Then amplitude decay rates of each data to be analyzed and smooth amplitude scale factor is estimated and applied to the old data sets to normalize the average amplitude. However, no phase shift is observed among the data sets.
- All the three data set had been 'grided' with the common grid origin and bearing. Fold variation was



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observed in the overlapping zone and the same had been taken care by 'geometrical weighting' during PSTM.

### Processing sequence

The data was subjected to full 3D PSTM with an aperture of 10 Km. after conventional processing sequences like spherical divergence correction, surface consistent amplitude correction, surface consistent deconvolution, residual statics and conditioning etc. Then pre-stack time migration on conditioned gathers results in good continuity of events seamlessly across the individual areas and clear imaging of the subsurface as well as clear imaging of fractured basement.

The below mentioned sections both cross-line and in-line of combined vintage which overcomes aperture requirement and few key issues, depicts the clear imaging of subsurface.

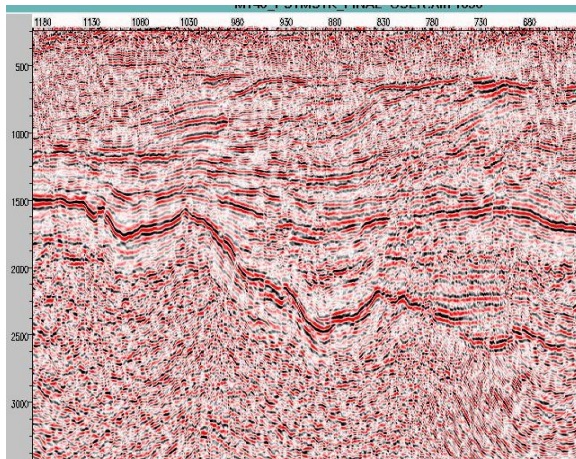


Figure 5: Pre stack time migration -Crossline after adding data.

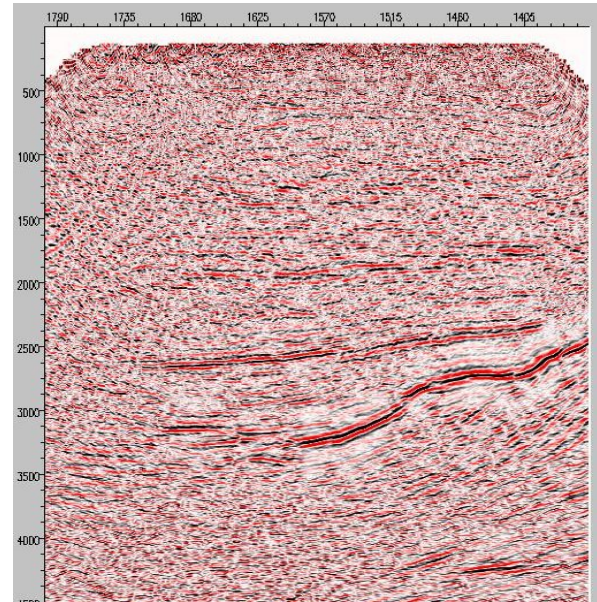


Figure 6: Pre stack time migration - Inline without adding data from adjacent areas.

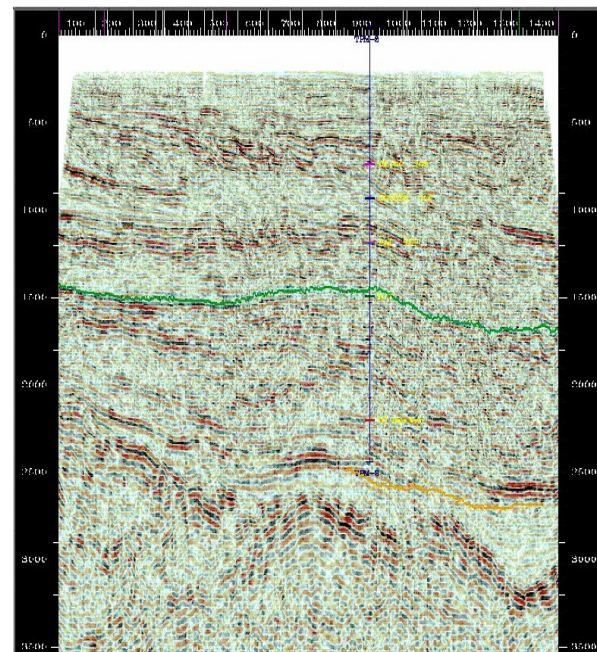


Figure 8: Previously processed 2D line.



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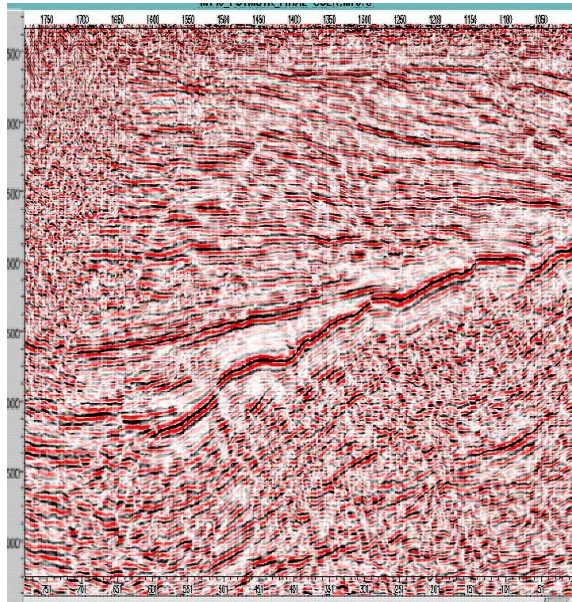


Figure 7: Pre stack time migration - Inline after adding data from adjacent areas.

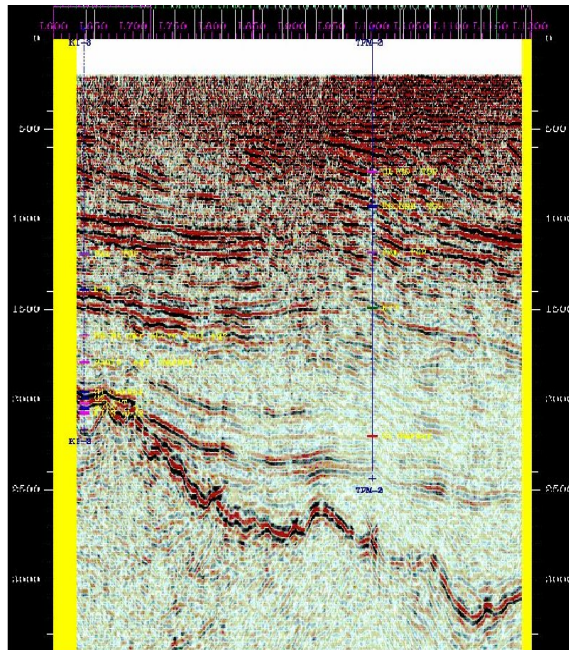


Figure 9: 3D Crossline corresponding to 2D line.

## Value addition

The extensive study and analysis of final processed output of merged data brings out the following significant observation in terms of mapability of data as well as from the point of view of interpretation.

- The major advantage of 3D merging is the significant imaging improvement at the edge over the individual 3D volume.

- Strati-structural features particularly pinch out prospect against the basement has been clearly delineated.
- Clear fault delineation gives additional dimension in pre stack imaging.
- Improvement over previously processed data with present merged data shows clear imaging of subsurface.

## Conclusion

Data from adjacent areas which have been effectively utilized for providing full aperture to PSTM and judiciously removal of key anomalies in methodical and sequential fashion enhance the imaging of subsurface. The migrated sections clearly brought out the strati-structural features associated with the basement apart from the shallower events. With the advent of revolutionized technology in geophysical domain, 3D data volume which were acquired over a period of several years in a Basin merged in pre stack mode and processed in pre stack time migration results in accurate imaging of three dimensionally complex structure and gives the clear view of the Basin and helps to identify hydrocarbon potential in the area.

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