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Seamless Pre-Stack Integration of Streamer Datasets with Q-Marine Dataset – A Case Study from Eastern Coast of India

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Summary:

A need for comprehensive study over the overlapping 3D Seismic data sets as a single volume along with the well data was felt to evolve a meaningful geological model and to understand the sand geometry with depositional environment in a better way for further hydrocarbon exploration in the area. Also integration of multi prospects into one mosaic is now common industry practice. Current work is probably a maiden & successful attempt to integrate conventional streamer data sets with Q-marine data set in pre-stack mode. Existing pre processed Q-marine data was taken as reference and other two datasets were matched after due consideration of attributes like amplitude, frequency, phase, wavelet, offset and brought to the level of Q-Marine data. The distinction at the junction of the prospects of final Pre-stack time migrated volume has brought to zero error. The detailed study shows the features like high amplitude anomaly present in individual dataset remained intact rather show better on the merged volume. Current paper deals with the methodology adopted for carrying out integration of two conventional streamer datasets with base Q-marine dataset.

Introduction:

The main issues in merging several 3D data sets have been envisaged using varying acquisition and processing technology. The goal was merging of datasets at Pre Stack stage to combine the 3D data of three different blocks (A, B, C) pertaining to Eastern Coast of India **(Fig-1).** The three blocks were acquired with different objectives by different vendors with different acquisition parameters over a different period of time. Blocks A, & C were acquired with conventional streamer mode whereas Block B was acquired with the Q- marine technique which is propriety in the industry and considered to be the high frequency data. The task was to bring the data of A & C blocks to the level of block B before pre-stack migration. Before proceeding to processing, some aspects related to these three prospects were identified as below:

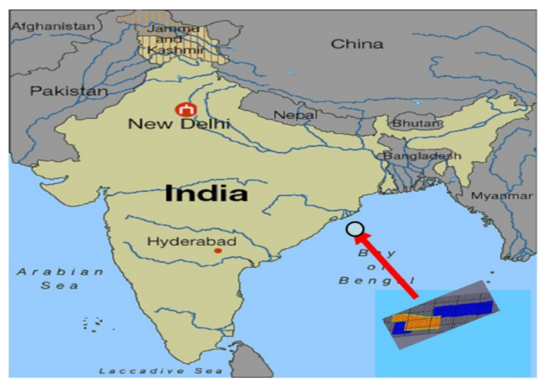

Fig1: Location Map of the block under study

a) Q-marine data being considered as very high frequency and processed by the proprietary vendor in the industry as compared to the normal conventional data.
b) Existing Q-marine data set processed output up to de-convolution was taken as the base for merge.
d) Though one of the dataset was recorded up to 6.0 sec, the processing was carried out upto 8.0 sec to cope up with other prospects.

e) Since the Maximum offset in one of the prospect 'C' was available 5300 mtrs, therefore, offsets and fold were restricted to 5300 mtrs even in the case of Q-Marine data.

f) Data for block A and C was brought to the decon level using pre processing parameters of block B and these datasets were taken as input for merging process.

Methodology:

The 3D seismic data in the area was acquired by different contractors, using different instruments, gun arrays, record length, gun signature etc. over different periods of time **(Table-1).** The data of all three prospects was critically analyzed and decided to consider the decon applied data set of Q-marine processed by proprietary vendor as standard and the other two data sets from raw field data were brought up to the decon application keeping all the pre-processing parameters up to decon as applied to Q-marine data as far as possible. Key issues related with any merging technique are Orientation, fold, offset, phase, frequency, amplitude, static, wavelet, velocity analysis, pre stack migration and post processing. These aspects for merging are discussed below:

Orientation: There was variation in the orientation of shooting direction but keeping the orientation of the survey for block B, the processing grid of 12.5 x 25 m was selected **(Fig-2)**

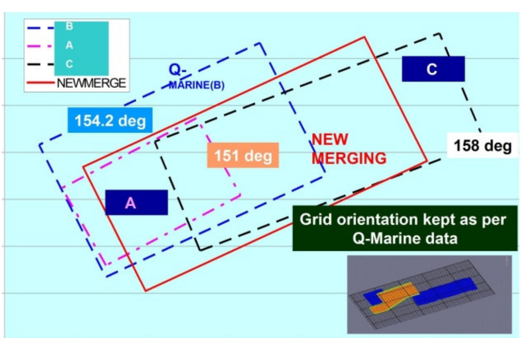

Fig2: Grid Orientation of Blocks A, B & C

Fold & Offset: The acquisition fold was varying from 53 to 60 with the far offsets varying from 5300 M to 6200 M. Since at one of the block, the maximum offset was upto5300 M, the offsets were restricted to 5300M for all blocks. The offsets were regularized within a CDP gather by trace interpolation so that all offsets were available.

Phase & Frequency: Input phase and frequency at overlap zones was critically analyzed for each block. Base block 'B" was zero phase therefore with the help of time variant inverse Q filtering, the phase & frequency were brought to the same level keeping block B as standard.**(Fig-3).**

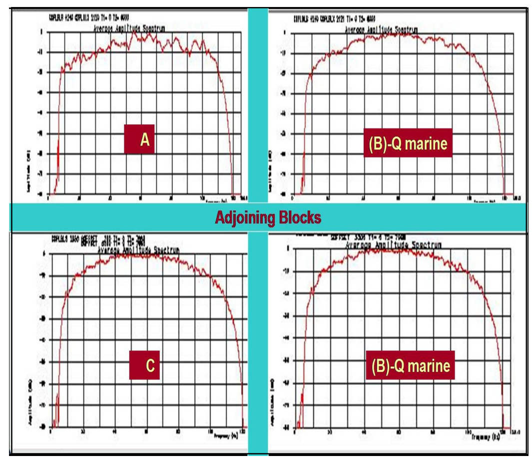

Fig3: Amplitude spectra compared with adjoining blocks

Amplitude: Decay curves for each prospect were studied at the overlap zones and constant scalar functions were applied to the individual prospects to match with each other so that relative amplitudes are preserved.**(Fig-4).**

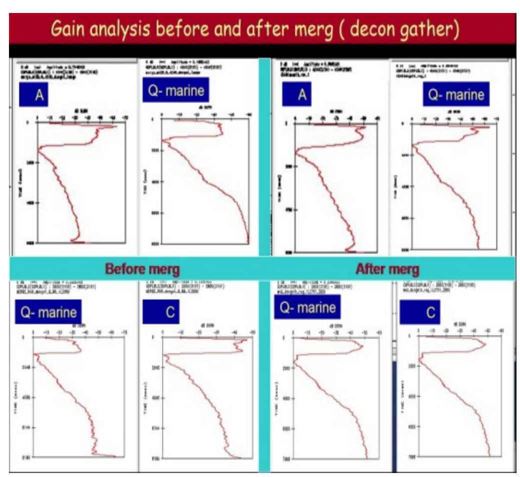

Fig4: Gain analysis compared with adjoining blocks

Static: A time shift of -20ms & -18ms was applied to prospect A & C respectively to match individual block with base block 'B'.

Wavelet: After matching, fold, offset, phase, frequency and amplitude, the wavelets at the overlap zones/ junctions of prospects was extracted and analyzed. It was observed that the wavelet was varying within the base block B and no single wavelet within overlap zones could be extracted to match with other prospects. However it was observed that these wavelets were nearly matching at the junctions. These three datasets were again analyzed after migration and found the wavelets at the junction almost identical. The difference in the extracted wavelets is the evidence for matching of wavelets at junctions.

Precision Velocity Analysis: Velocity analysis was carried out on migrated gathers after merging of all blocks and manually picked by keeping consistency from one block to another as the lines are from shallow to deep. Velocity volume with these picks was prepared and smoothened which followed the horizon consistency

Migration: Finally, 3D prestack Kirchhoff's time migration of integrated volume with appropriate aperture using above velocity volume was fulfilled the objective of integration as the boundaries of individual blocks at the junctions were properly migrated and imaged.

Post stack Processing: At last, the post stack processing like Fxy decon & Spectral balancing were attributed to the volume. With spectral balancing, the band width of output volume was enhanced which was required to meet the objective of mapping the channel sands and fan complexes.

Results & Discussion:

- Since there were two blocks on either side to integrate with base block, therefore, two separate junctions with base block are discussed. The gathers before and after merging process along with the analysis for amplitude and spectrum for each junction justifies the merging process at **Fig-5** & **Fig-6**. Inline-2850 **(Fig-7)** & inline-4240 **(Fig-8)** are from junction of blocks B & C and blocks A & C respectively showing an overview before and after merge along with the final migrated output.

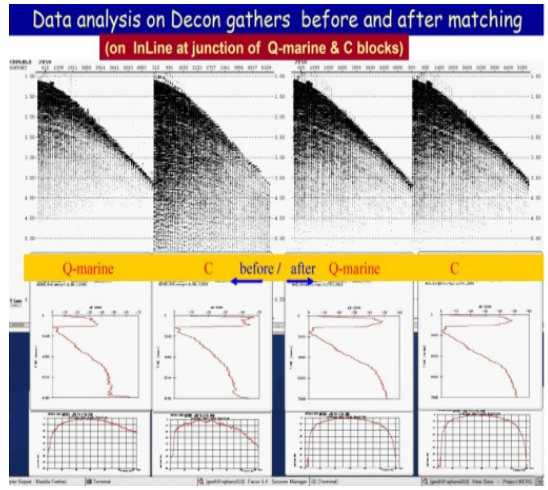

Fig5: Data analysis on Q-marine and C before & after merge

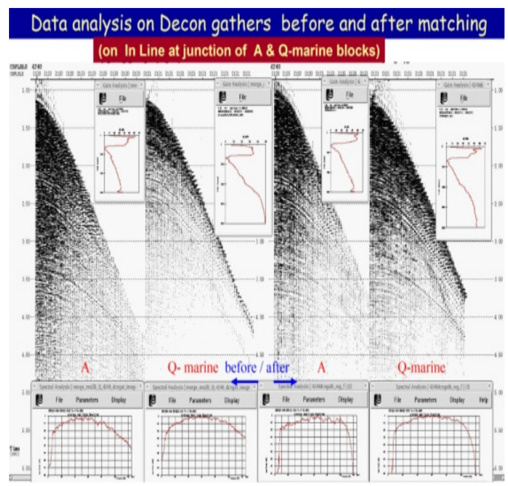

Fig6: Data analysis on Q-marine and A before & after merge

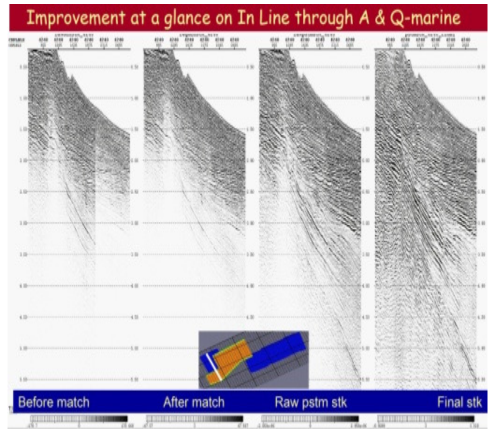

Fig7: Improvement on inline stepwise passing through blocks A & B (Q-marine)

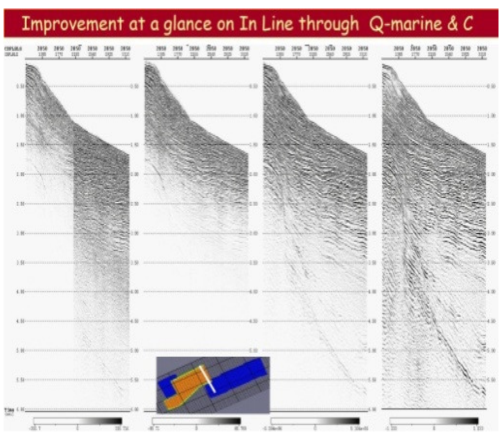

Fig8: Improvement on inline stepwise passing through blocks B (Q-marine) & C

- Amplitude and spectral analysis after integration for junction blocks in **Fig-9 & Fig-10** gives us the level of confidence for carrying out such attempts.

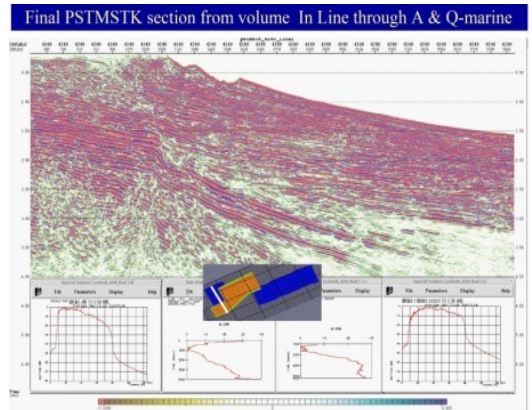

Fig9: Final migrated section of Inline passing thru A & B blocks

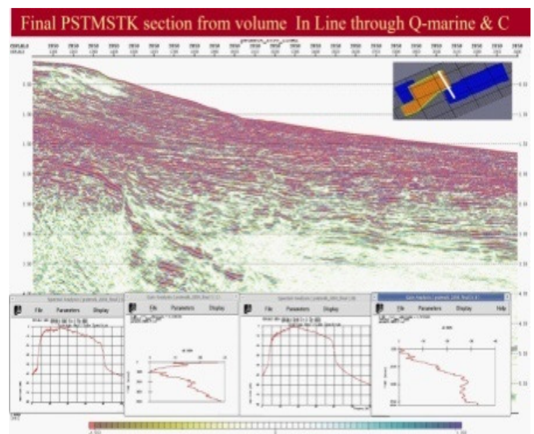

Fig10: Final migrated section of Inline passing thru B & C blocks

- **Fig-11** & **Fig-12** are the zoomed merged sections from junctions of blocks B & C and blocks A & B respectively which shows the seamless integration with base block.

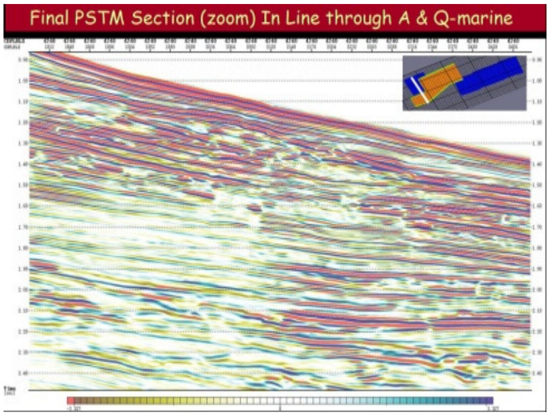

Fig11: Final migrated section of Inline passing thru A & B blocks (Zoom)

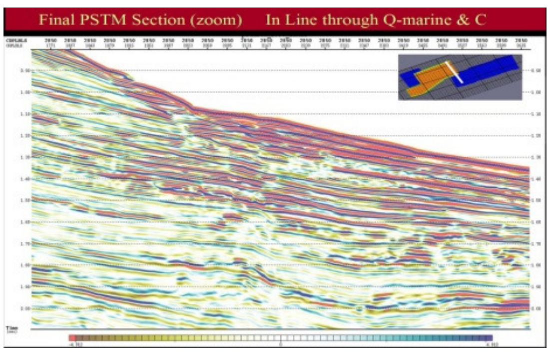

Fig12: Final migrated section of Inline passing thru B & C blocks (Zoom)

- Velocity section after precision velocity analysis in **Fig-13** shows the consistency of picking from one block to another block.

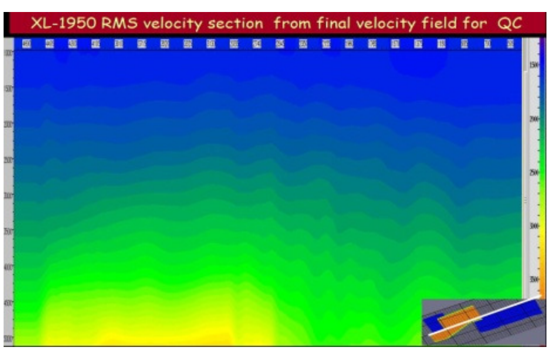

Fig13: Final Velocity section through XLine passing through blocks A, B & C

- The merged volume shows improvement and value addition with the earlier processed individual blocks even in the case of base volume of Block 'B'. The comparisons at **Fig-14, Fig-15 & Fig-16** are self explanatory.

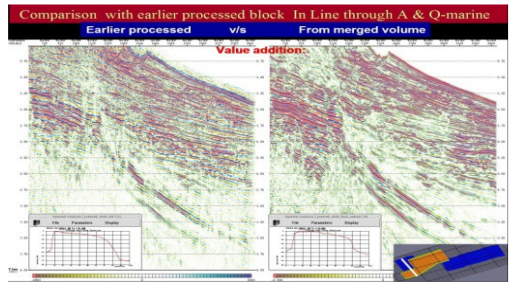

Fig14:Comparison of earlier section from block A with section from merged volume

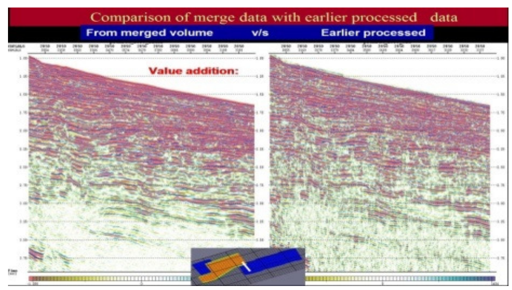

Fig15: Comparison of earlier section from block A with section from merged volume

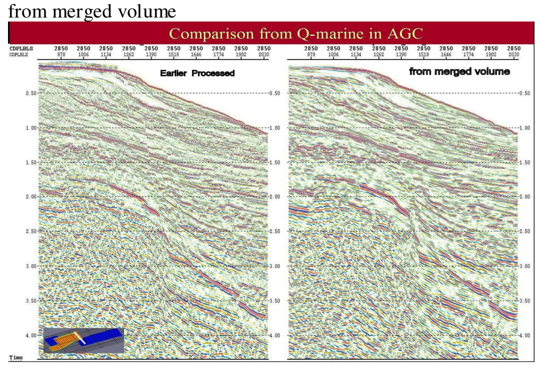

Fig16 Comparison of earlier section from block B with section from merged volume (in AGC)

- Time slice from final merged volume shows the consistency of attributes from one block to another at **Fig-17**.

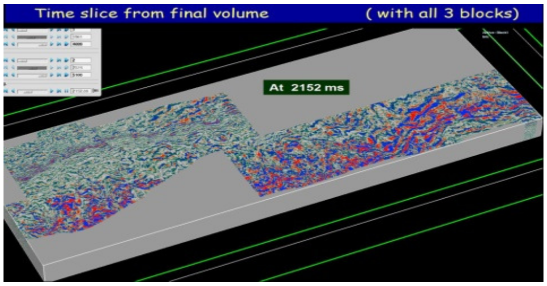

Fig17: Time slice at 2182 ms from final merged volume

- This merged volume preserved the high amplitude anomaly rather shows better delineation in one of the block as evident from **Fig-18**.

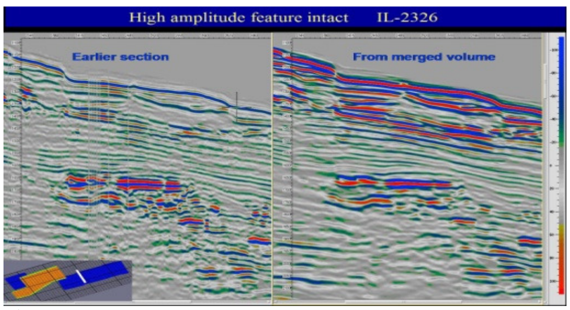

Fig18: High amplitude features are brought out in better way

Parameter	Area "A"	Area "B" Q-Marine	Area "C"
Type of shooting	Streamer mode	Q- marine	Streamer mode
Year of acquisition	2004-05	2006-07	2006-07
No of streamer	6	8	8
No of channels	1920	3840	1224
Near offset	275 M	125 M	155/215 M
Max Offset	6200 M	6200 M	5255/5300 M
Record Length	6 sec	8sec	8sec
Bin size	12.5*25	6.255*25	12.5*25
Fold	50/60	60	51
Line Direction (Degrees)	151/331	154.2/334.2	158/338
Recording filter	4/200Hz	3/200 Hz	3/206 Hz

Table-1: Broad variation in acquisition parameters

Conclusion:

1. The methodology adopted over processes for integration of independently acquired blocks with different technology and having high frequencies compared to other blocks, resulted to obtain the final merged volume with excellent continuity and consistency throughout the data volume.

2. These results give us the confidence to use the data not only for mapping the channel sands & fan complexes but also to make use of amplitude & sequence attributes to derive an appropriate geological model of entire field for further hydrocarbon exploration, as envisaged

3. It is evident from the final merged volume of three blocks which encouraged us that the Streamer datasets can be merged with high frequency Q-marine datasets.

4. The distinction of the junction of the prospects brought to zero error on final volume.

5. Features like high amplitude anomaly remained intact rather show better on the final merged volume.

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The views expressed here are those of the authors only and do not reflect the views of the Organization which they belong to.

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