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Some issues in 3D Pre stack Merging

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Summary

With the advancement in seismic data processing technology, pre stack merging of 3D vintages has come as a viable alternative to costly and time consuming reacquisition, which can provide a reasonably good integrated seamless data across prospects to meet the exploration time line. Here authors demonstrate that residual statics in a common super grid is superior to those determined in individual grid over the overlapping areas as there is no tapering of CDP fold in the super grid. New sets of Shot and Receiver point numbers are generated which are used for removing totally redundant traces from the super volume. This also removes 'tapering' in receiver gather in the overlapping area.

Introduction

Till recently, 3D onshore seismic campaigns in India were carried out over prospective geological features, identified mainly from large 2D surveys. The targets were localized covering limited area, largely because of resource constraints like hardware, cost and time. These small volumes were acquired in different seasons. As they are conceived and acquired in isolation, the surveys are different in terms of bin size, orientation, fold and azimuth. They were processed and interpreted independently.

As the exploration progressed, not only the original targeted prospects, but the areas in between them also become interesting. Interpretation across these assorted volumes is difficult and less confident because of the different processing parameters and poor data quality over the edges. Merging the datasets in post stack can not address many of these issues.

With the advancement in seismic data processing technology, reprocessing of seismic data particularly prestack merging and migration of existing 3D vintages has come as a viable alternative to costly and time consuming reacquisition and its processing. It can provide a reasonably good integrated seamless data across individual prospects. When the time is short to comply with the exploration licensing regulations, it is also possible to make use of the intermediate processed outputs from individual campaigns, like geometry merged gathers or conditioned gathers, for fast track merging and migration.

It is a common practice in prestack merge to pre processes the individual data sets in their respective grids before putting them in the common super grid. This ensures better QC, especially geometry data merging and data integrity, and efficient noise attenuation as the gathers are inherently regular in their specific grids. Surface consistent processors like deconvolution, amplitude corrections and residual statics based on stack optimization are also done in data's own grids. These conditioned cleaned gathers are matched for possible polarity, bulk time shifts, wave shape, frequency, phase and amplitude across individual data sets and re-gridded in the super grid. All these can be done in a fairly amplitude preserving manner. Migration of these gathers, after accounting for the irregularity in offsets, generally results in seamless integrated volume which can be interpreted with more faith and confidence.

In this study, authors demonstrate the improvement brought out by estimating residual statics on total data in the super grid over those estimated on individual data sets. Authors also suggest a way of uniquely assigning shot and receiver picket numbers for co located or nearly co located pickets irrespective of the data sets and original numbers.

The method

In a typical pre stack merge scenario there will be areas where two or three volumes overlap. Due to variations in

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survey geometries, orientations or naming conventions, co-located pickets will have different and uncorrelated numbers. It is extremely difficult to match the picket numbers of one data set to that of the other. Though there is in general an excess CDP fold in the overlapping area, the receiver gathers will have fewer traces and show tapering. This will remain the same even if the geometry merging is done in the common grid or super grid.

Here authors propose a way of uniquely renumbering the pickets in a Super Survey Grid in a surface consistent manner, where co-located or nearly co-located pickets from different data sets will have a single number. In a way, this can be seen as a reverse geometry merge.

Conventional geometry merging can be seen as header updating / transformation from Filed File- Channel Number pair to Shot Point (SP) - Receiver Point (RP) pair and further to Shot XY- Receiver XY coordinate pair. SP and RP are a combination of Shot Line- Shot Picket and Receiver Line - Receiver Picket respectively. These lines and picket numbering are with respect to an arbitrary survey grid origin with predetermined orientation and spacing. Though they are arbitrary in absolute terms, they are surface consistent, enabling computation based on them.

Here the Shot coordinate are transform back to Shot Line- Shot Picket pair with respect to a Super Survey Grid. This is very similar to CMP binning or gridding were mid point coordinates are transformed in to Inline and Crossline numbers. This involves a coordinate transformation (translation usually with rotation) and division into lines or pickets. Concatenating the two will give a unique point number. Receiver coordinates are also treated in a similar fashion giving receiver point number. Volume specific SP/RP numbers can also be generated, if required, by concatenating SP/RP numbers with the volume identification or index numbers.

Receiver gathers in the over lapping zones in the Super Survey Grid are now rich in traces and will not show any tapering. Vintage intermediate data, like geometry merged gathers or de-noised gathers, where SPs or RPs are inadvertently transcribed improperly or in completely (no compromise on coordinates) can also be used for prestack merging with surface consistent residual statics.

Redundancy removal:

Over lapping zones generally have redundant traces. Total redundant traces (both in offset and azimuth) can be easily identified as traces with same SP-RP pairs. Volume identification number can be used to keep the preferred trace and knock out the others.

Application and discussion:

The above approach was tried on a prestack merge project consisting of ten campaigns pertaining to KG basin, East Coast India. The pre processing like Geometry merging, de-noise, field statics application, gain recovery, deconvolution, amplitude balancing etc were done in the data's own grids.

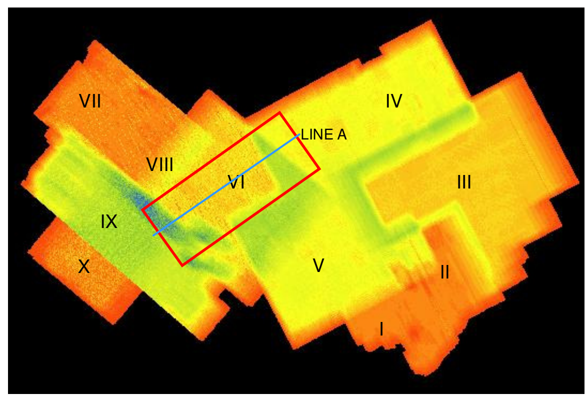
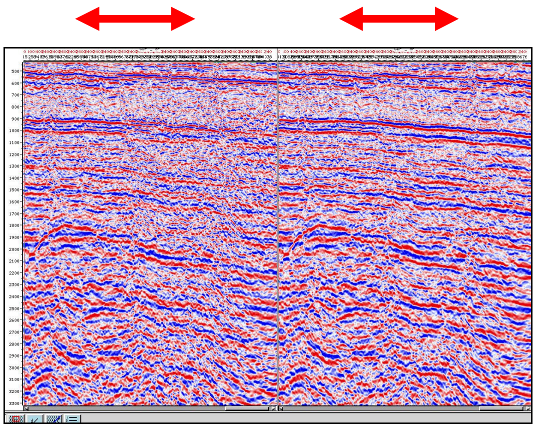
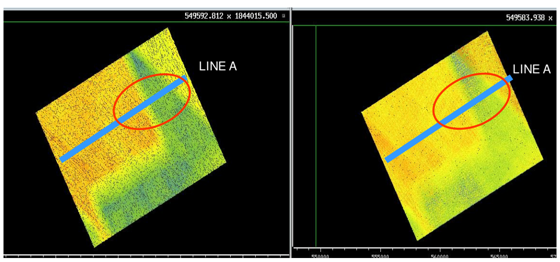


Fig. 1: Composite map showing different campaign



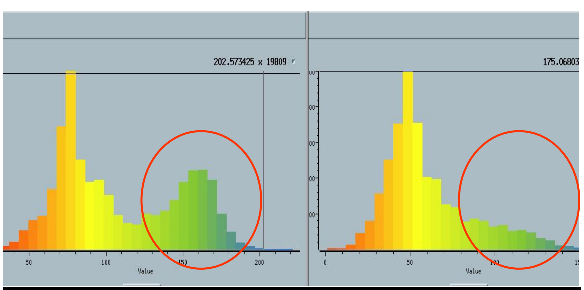
Individual Grid Super Grid

Fig. 2: A part of Line A passing through overlap zone



Before removal of traces After removal of traces

Fig. 3a: Fold map before and after removal of redundant traces



Before removal of traces After removal of traces

Fig. 3b: Histogram of Fold map before and after removal of redundant traces

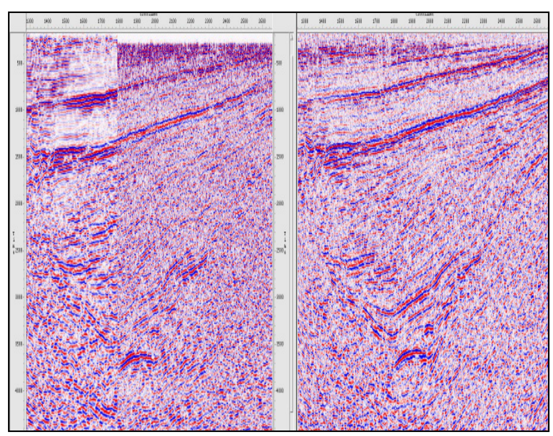
All the individual data sets were re-gridded in a super grid, encompassing the whole area, and after amplitude/frequency/wave shape matching. SP-RP numbers were reconstructed in a Super Grid.

Fig. 1 shows composite fold map of all ten different vintages which are input to pre stack merging. The red colour rectangle shows the area under study having overlap zones. This rectangle portion is only shown in Fig 3a for the demonstration of result.

Results of application of residual statics in the Super Grid vs. individual grids are compared as shown in the fig. 2. The application of residual statics in the Super Grid show improvement over the individual grid as the data is now seamless without tapering, in all respects.

Fig. 3a shows the fold map before and after removal of redundancy over an overlapping zone and the red circle demonstrates the effectiveness of this method. The average fold in the all the vintages is approximately 50-60. After pre stack merging of these volumes, the fold in overlap portions shoots up to 220 as shown in Fig. 3b. After application of redundancy method as mentioned above, the final fold is well within optimum limit.

After application of residual statics in super grid for all volumes and removal of totally redundant traces, i.e. having same RPs & SPs point, the final output of this merged volume provide a reasonably good integrated seamless data across prospects. Fig. 4 shows a comparison between Post stack & Pre stack merging.

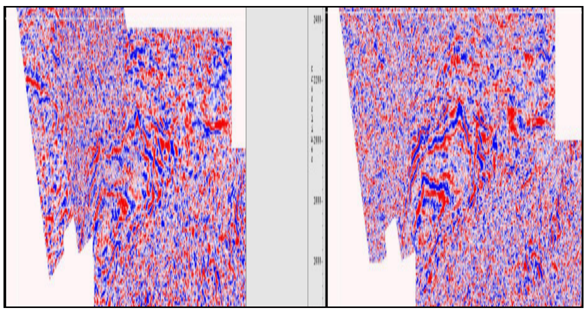


Post Stack Pre Stack

Fig. 4: A comparison of Post stack & Pre stack merging

Fig. 5 is similar comparison in time slice at 3160 ms and the improvement is visible. The synclinal feature is well developed in the target zone.

A more comprehensive prestack merge processing could include field statics re-estimation based on combined and seamless Near Surface Model, Noise attenuation in Receiver / Cross spread domain after redundancy removal and surface consistent amplitude correction in the Super Survey Grid.



Post Stack Pre Stack

Fig. 5: A comparison of Post stack & Pre stack merging (Time Slice 3160 ms)

Conclusion:

Survey picket numbers were renumbered using the shot and receiver coordinates in a surface consistent way in a Super Survey Grid, which were used for redundancy removal and residual statics estimation and correction. The results show considerable improvement in the output quality.

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