7th International Conference & Exposition
on Petroleum Geophysics

"HYDERABAD 2008"

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Value Addition from Reprocessing of Seismic Data: An Analysis of Some of the Case Histories

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Summary

Whenever the geological objectives are not met with the available processed data, the interpreters would like to get reprocessed the same data rather than to acquire data a fresh. Since the processing cost and time is much-much less than acquisition cost and time, it is prudent to get reprocessed of seismic data for improvement. A new lead and discovery at different/deeper level in a well provide new opportunity to the interpreter to re-look the data. Looking with another angle may require the re-processing of data with different objective. This is necessitated by the fact that advanced techniques aimed at enhancing the signal-to-noise ratio and frequency of the data available now might not have existed in the industry at that time which is seeing very rapid growth in the techniques in seismic data processing. Sometimes, the data is acquired in different campaigns and this usually results in apparent differences in the quality of the processed output. Integrated interpretation requirements necessitate the use of seismic data of similar quality and therefore the data may require reprocessing of whole data with uniform optimum processing parameters. Reprocessing of seismic data carried out using state-of-the-art processing techniques usually show an overall significant improvement in terms of reflection detail and frequency or in specific zones if the reprocessing effort is focused on specific targets

The basic reason for improving imaging by reprocessing is obviously advancement in processing technology, better conditioning of data rigorous editing, multiple attenuation, surface noise attenuation, closely spaced velocity analysis and prestack migration over previously processed data.

An analysis of different 2D re-processing projects undertaken at processing centre during last four years shows appreciable improvement in imaging quality over earlier processed data. Since, acquisition cost of acquiring the data is many times the processing cost, the value addition obtained through re-processing encourage to extract maximum information from the data through re-processing before acquiring the data a fresh.

Introduction

The role of seismic data in understanding the subsurface is increasing enormously due to vast coverage in comparatively shorter time with fair degree of confidence and therefore it is seen as the first choice among geoscientists engaged in hydrocarbon exploration and exploitation. The raw seismic data is baked through seismic processing and interpretation to achieve the ultimate values of seismic exploration. Seismic data processing involves a sequence of logical steps through which the data is passed through and for each of these steps there exist a multitude of different approaches. It is very important that a processor is well versed with the software implementations, its inherent assumptions, advantages and limitations so that he takes proper care to preserve the integrity of the data. With the advancement of the computer technology and processing algorithm, it has become possible to extract more and more information from the seismic data.

Reprocessing is generally rewarded with a much higher fidelity image of the subsurface than brought out during processing. Testing and optimization of processing parameters is time consuming and endless jobs. Time constraints and interpreters choice makes it limited and finite duration so that product is delivered on time with in line to client's desire. Wide temporal bandwidth, better spatial resolution, better S/N ratio, strong continuity and also a good match to well information are the objective of the processors. However, it appears that there is no unique way to process a particular seismic dataset correctly. There may be as many unique ways to process the data correctly as many times it is get processed. It has been rightly said that: "No matter who we get to process our data, there is probably someone else out there who can improve on it…. to a degree". (Jack Bauska, 1998)

Why Reprocessing

Reprocessing appears to be a wasteful expenditure and seems to be duplication of effort. Reprocessing may strain manpower and resources, requiring more QC, more interpretation, more data handling and additional computer resources like disk space etc. Despite these concerns, compelling reasons for re-processing of data are:

1. **Objective not met:** The quality obtained during processing is not up to the mark. The end product is not meeting the desired objective and therefore it is subjected to re-processing.
2. **Different/Deeper Objective:** The data got processed with different objective appropriate at that time. With the new lead and discovery in the area in different depth/target, the data may be subjected to re-processing to bring out the details at new target depth.
3. **Pre-stack/Post Stack Merging:** With the acquisitions of more data in adjoining area or in the same area (with new parameters or type) the whole of data may be subjected to re-processing. The pre-stack or post stack merging of different volumes may also require re-processing of the data. Data may also be subjected to re-processing with the new parameters due to analysis/QC of new monitor survey in 4D seismic.
4. **New techniques:** With the innovations of new techniques and processing steps which are more suitable to tackle the problem in the area, the data may be subjected to re-processing.
5. **Up-gradation at processing centre:** The processing centers is equipped with another software and is supposed to be more appropriate to seismic data for a given geographic area/sub-surface condition of the area.
6. **Getting Older and Wiser:** Processing skill, experience and knowledge of that area of the processors may be different. The past performance on one type of data does not guarantee similar quality in the future.

The main aim of all the re-processing is to get more clear and reliable picture of sub-surface. However, the quality of the final image is limited by following important variables:

1. S/N ratio is area specific: Geographic location of the data set determines signal to noise ratio of the processed data. The influence of near surface conditions, topography and sub-surface structure has a bearing on the data quality. Some areas are renowned for bad data quality while others are seismic friendly area.
2. Acquisition parameters and survey design: No processing techniques can overcome the error made during acquisition.
3. Software or Hardware limitations: Processing systems and algorithm differences in various packages either limit or enhance ultimate quality. Hardware limitations may also have a bearing especially for large 3D survey.
4. Human factors: Processors' skill, QC and time constraints affect the quality of the finished product.
5. Processing steps and available techniques: Testing and optimization of processing parameters is time consuming and endless jobs. Time constraints and interpreters choice makes it limited and finite duration so that product is delivered on time with in line to client's desire.
6. Unnoticed error: Some error may be committed unknowingly and are not got noticed by the processors/tape operators.

The re-processing cannot enhance the quality of data limited by the first two factor i.e. difficulties associated with survey location and acquisition parameters or survey design. However, it can partially compensate for problems or differences in processing systems and processor skills. With availability of new tools/ techniques for enhancement of S/N ratio will definitely improve the quality of re-processed data. Processor carrying out the re-processing is generally equipped with the earlier processed section and processing steps/flows/parameters used during processing. These are valuable information and bench marked if used without getting biased from it. There are remote chances of committing the same error in reprocessing which got unnoticed during processing the data earlier.

Acquisition And Processing Cost Comparison

Acquisition of seismic data requires an expenditure of the order of crore. Almost a hundred of hands of people deployed in the fields control the quality of data acquired. The time required is also typically a year or so. The entire data sets are handled by the two hands of a processor or more. The cost of processing is much less than processing cost. The time involved in the processing is of the order of couple of months. The processing cost is varying between approximately 400 to 1600 Rs. per Line Kilometer (LKM) for 2D data re-processed at the centre. The table 1 shows the cost and volume of 2D data processed at the center and also depicted in the graph shown in figure 1& 2. It is evident that acquisition cost of seismic data is much more than processing cost.

Table: 1 Processing Cost and Volume of 2D data re-processed

Year	Cost (Rs. per LKM)	2D data re-processed (LKM)
2003-2004	1092.66	12161.33
2004-2005	403.72	9473.346
2005-2006	848.07	9043.4075
2006-2007	1629.25	14046.6785

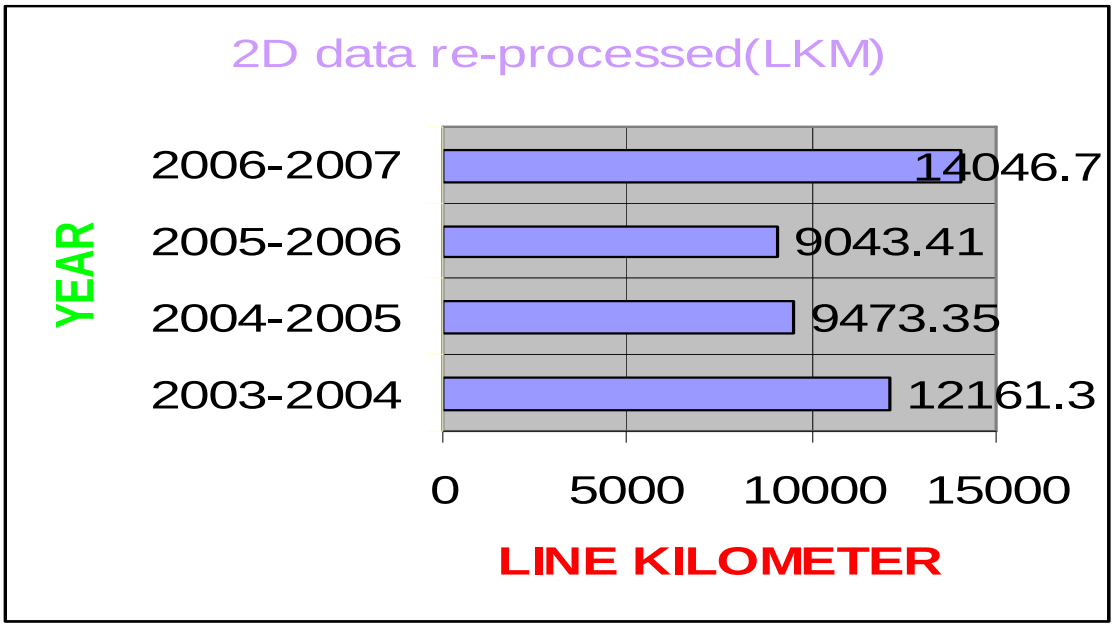

Figure 1: 2D data volume re-processed during last four year

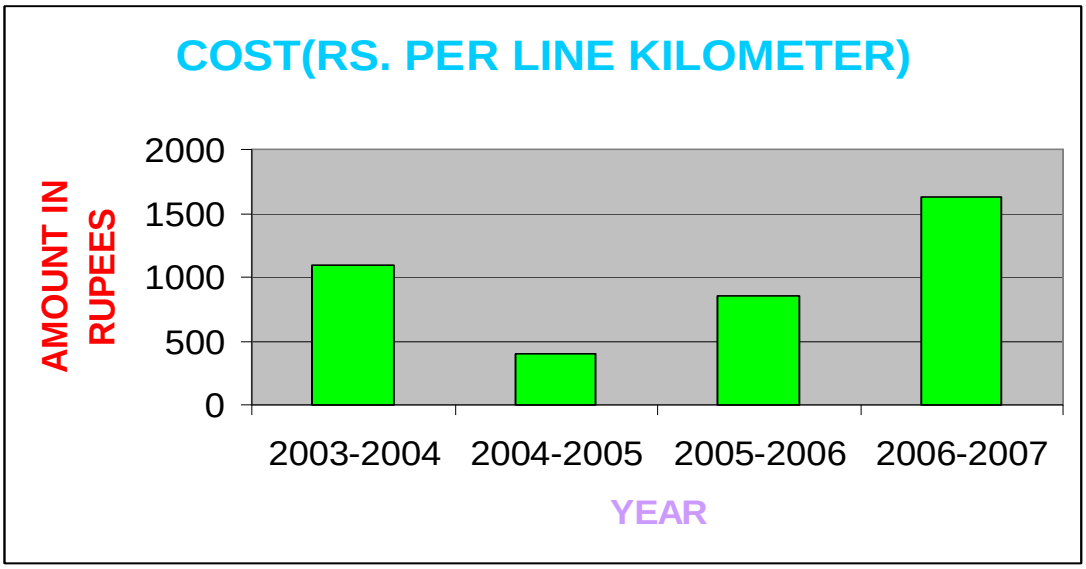

Figure 2: Processing cost (cost per line Kilometer) during last four years

Value Addition From Reprocessing

A total of about 32 projects having a volume of 33824.76 LKM 2D have been re-processed during the analysis period. The improvement in imaging quality is observed in most of the projects because of better conditioning of data like rigorous editing, multiple attenuation, surface noise attenuation, closely spaced

velocity analysis. Pre-stack time migration is carried for improving imaging. However, it is not like that the improvement is observed in all the cases of reprocessing projects. Some of the projects show either similar imaging quality as earlier processed data or the re-processing has not been able to obtain desired objective. This may be due to quality of data acquired or over-expectation from the data.

Value addition obtained through re-processing of 2D seismic data is described below for some of the case histories:

Example-A:

The dataset-A pertains to the marine data of Kerala – Konkan block of West Coast, India. Most of the available sections in this area were having average quality. The PSTM was to be carried out for better placement of faults and delineation of structural/strati-structural features. Figure 3 shows the comparison of PSTM image obtained through re-processing and earlier processed sections processed earlier. The frequency spectrums of these sections are shown in figure 4. Re-processed section shows better fault delineation and co-relatable events at deeper level.

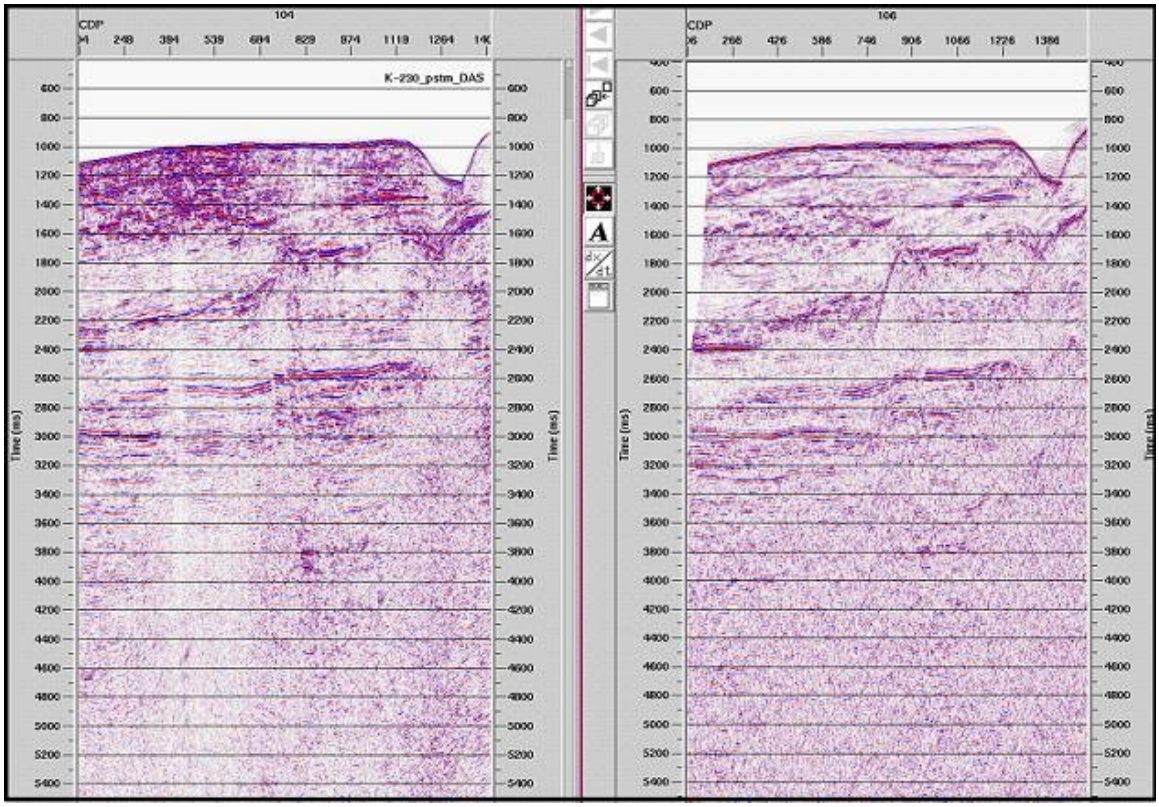

Figure 3: Comparison of PSTM section (a) and earlier processed section (b)

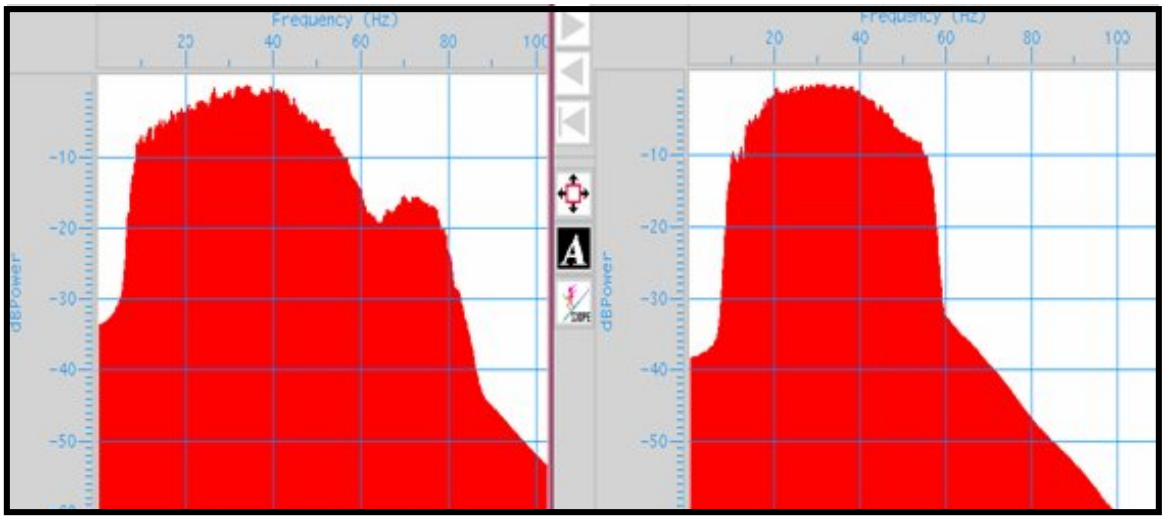

Figure 4: Comparison Frequency Spectrum of PSTM section (a) and earlier processed section (b)

Example-B:

Dataset - B pertains to Western Offshore Basin, West Coast, India acquired by departmental vessels during 1990s. The updip pinchout limit of sands within Panna Formation towards northern part is expected to be prospective and needs integration and detailed mapping. The PSTM is carried out on the dataset and comparison with earlier processed section shows appreciable improvement in target zone. Figure-5 and 6 show comparison of re-processed and earlier processed section and their frequency spectrums.

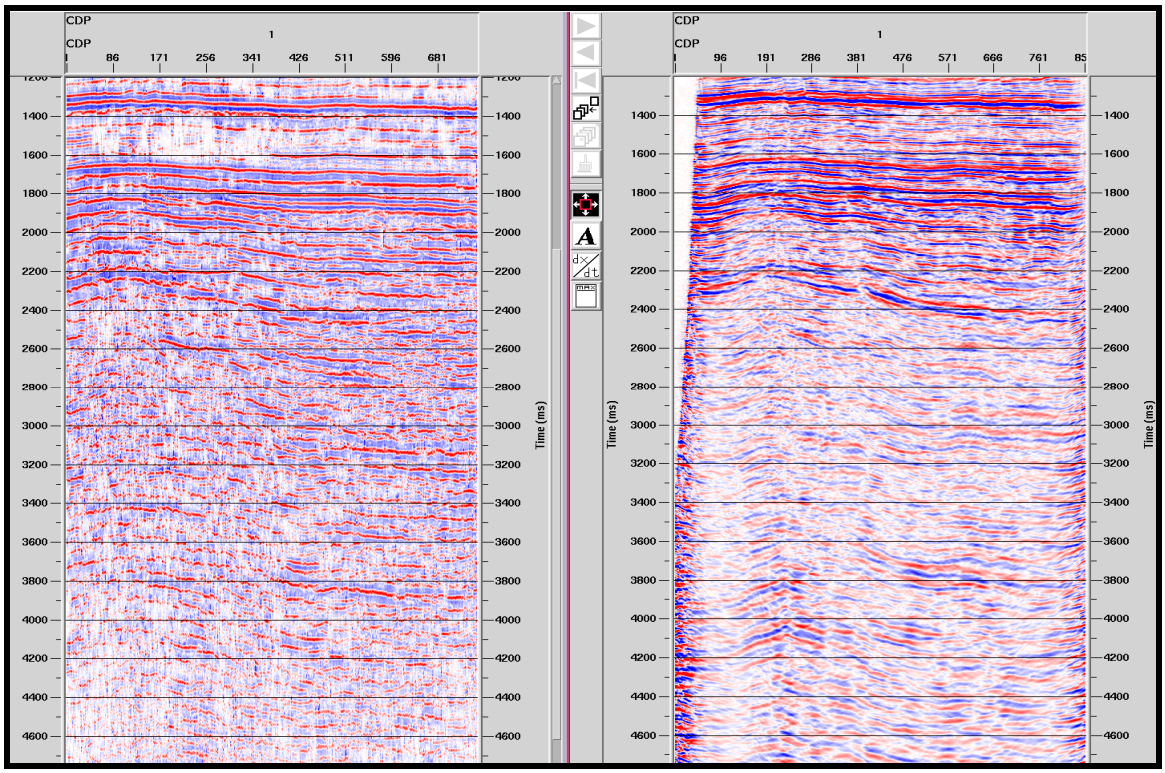

Figure-5: Comparison of earlier processed section and reprocessed PSTM Image

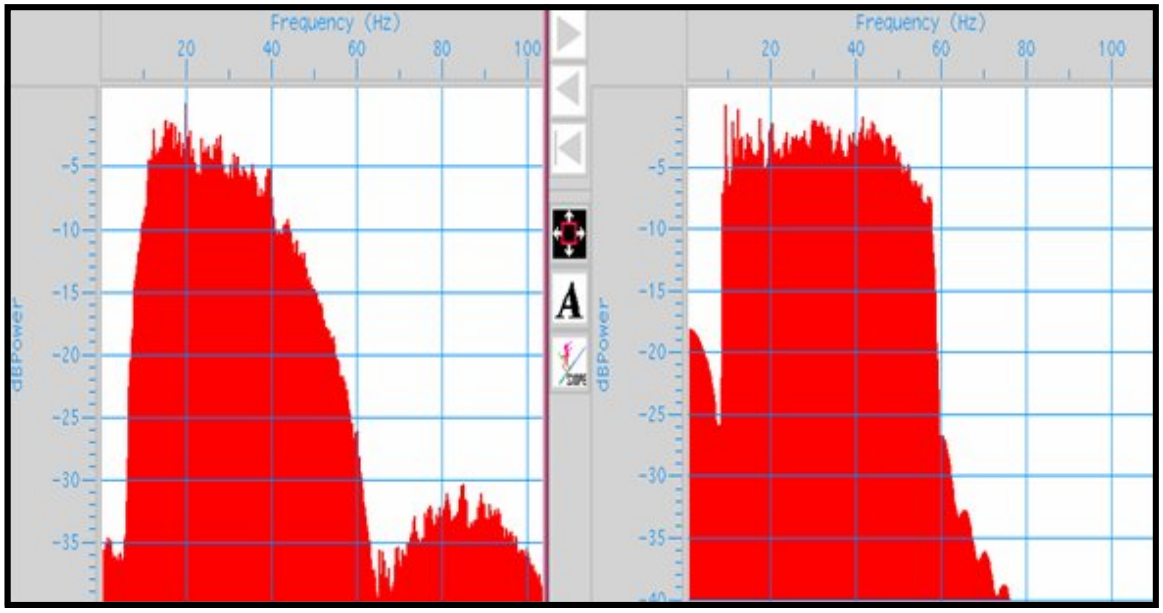

Figure-6: Frequency spectrum: Earlier processed section and reprocessed PSTM Image

Example-C:

The dataset-C pertains to the land data of Damoh-Jabera area of Vindhyan Basin. The area has very high velocity right from the surface. The data was acquired with the objective of evaluating the structure high against Damoh fault and exploring the Wedge out/pinch out prospect within Kajrahat Limestone in North and North West of Jabera structure. Figure 7 shows appreciable improvement in continuity and resolution of events within targets zone (1000-2200ms).

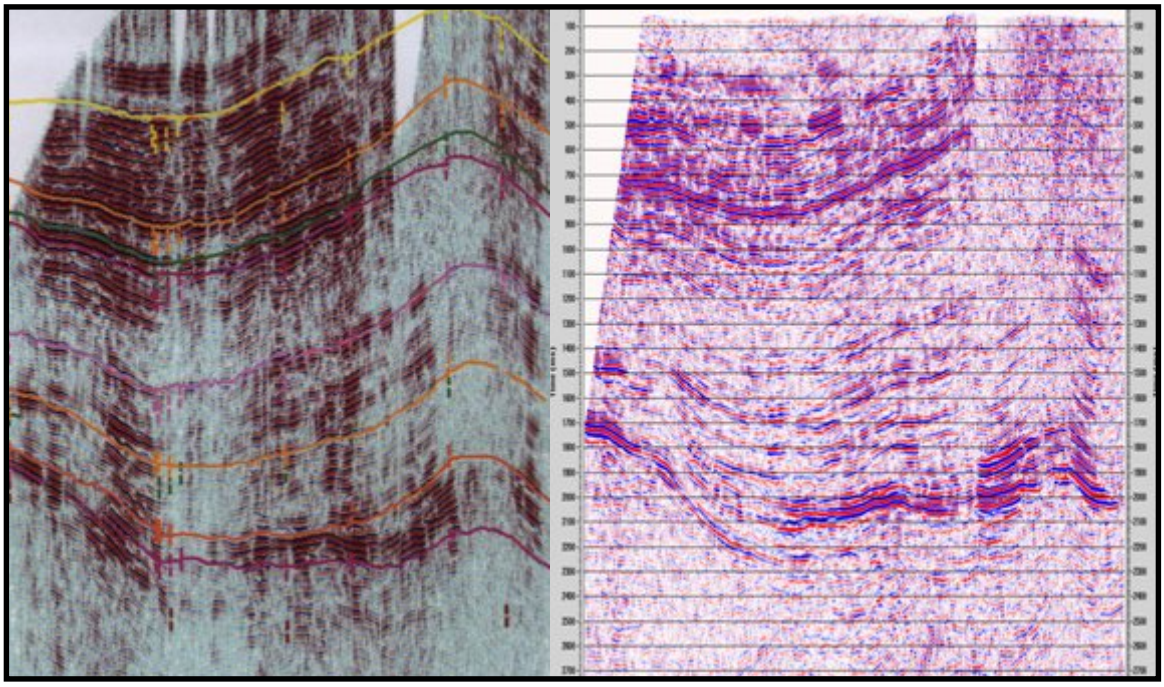

Figure 7: Comparison of Earlier processed section with re-processed PSTM image.

Conclusion

The analysis of the re-processing projects of 2D seismic data undertaken during last four years at processing centre show that re-processing had added value to the data in most of the projects. The improvement obtained in quality of data may be attributed to different factors but success ratio and degree of improvement suggests that the re-processing is fruitful exercise to be undertaken. The high imbalance in the cost and time of the processing and acquisition of data conclude that re-processing/dual processing may be carried in all the cases.

Reference

Jack Bauska, 1998, Double vision for interpreters: Case Histories showing the value of dual processing for 3-Dsurveys, The Leading Edge, November, 1998

Acknowledgement

Authors are grateful to Director (Exploration), Oil and Natural Gas Corporation Limited, India for providing the necessary facilities to carry out this work and permission to publish this work.