Improvement of Signal/Noise Ratio and Fault Imaging with Full 3D Prestack Kirchoff Time Migration: A Case Study from Upper Assam

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Summary

The importance of seismic data in hydrocarbon exploration is realized by the extent to which the subsurface information can be derived during the data interpretation. To achieve this objective seismic data processing should aim at improving the S/N ratio so that a good seismic section can be produced for a meaningful interpretation of the subsurface geological features such as structural highs and lows, faults, pinch-outs etc. which are of paramount importance in hydrocarbon exploration. It is often seen that conventional processing is not always sufficient to bring out clearly certain subtle features of interest in oil exploration. In this paper, the results of Kirchoff Prestack Time Migration process which was carried out over a 3D data is presented. The results have shown a very good improvement (when compared with the conventional post stack migration process) in the fault imaging as well as mapping the horst/graben features and the associated structures for the Eocene reservoirs in OIL's operational areas in Upper Assam.

Introduction

The study area is one of the major oil fields within the operational areas of Oil India Limited in Upper Assam basin (Figure 1). These areas of Upper Assam-Arakan basin has undergone a series of extensive tectonism from the time of rifting and drifting phase in Cretaceous period till the major tectonic event of evolution of basement ridge and Himalayas during Miocene period. These various phases have led to severe faulting and thrusting of the basin where major oil findings are located. Most of the identified oil traps are found to be horst graben related closures from the deep Eocene reservoirs of about 3500-4500 m depth. The conventional 2D/3D basic processing which normally includes Dip Move Out and Post stack time migration may not be enough to image these subtle features and the answer to this problem may be full Prestack time migration (PSTM). It may be mentioned here that PSTM can accurately image the subsurface in areas of strong structural dips with relatively little change in lateral velocity. The method is also very successful when the sedimentary structure is relatively flat as it improves the reflection quality as diffractions which interfere with primary reflections are collapsed before stack since the lateral resolution is increased as the PSTM process shrinks the Fresnel zone very effectively. This is main reason why PSTM process has become more or less part of the basic processing sequence in the Petroleum industry. It may be mentioned here that even PSTM process may not be very effective where there is a strong change in velocity both vertically and laterally which was normally observed in thrust fold belt areas and the only answer to such a problem is Prestack Depth migration. The results of the present study have shown that Full 3D PSTM has not only improved the fault imaging and the mapping of the associated closures, but it has also shown significant improvement in the lateral resolution of the different subsurface layers especially at the Eocene level.

Results and disucssion

The data was processed with the latest version of the ProMAX 3D software on an 8 CPU SGI Origin 3900 Server in Oil India Ltd's processing centre at Duliajan, Assam. The 3D data set used for this study was acquired with 6 line swath geometry with 50% trace line overlap. The trace line interval was 300 m and the shot lines were perpendicular to the trace lines with 100 m as the shot interval. The bin size was 50 X 25 meters. Primary velocity analysis was initially carried out at 2 X 2 km grid and a QC stack was run with these velocities. After the computation and application of the residual statics a second pass velocity analysis were carried out at 1 X 1 km grid and the same was further carried at 0.5 X 0.5 km grid after the Dip Move out correction in the Post stack time migration sequence and Prestack Time migration sequence respectively. The velocities were smoothed and the data was stacked and migrated using Finite Difference post stack time migration and prestack time migration was done using Kirchoff

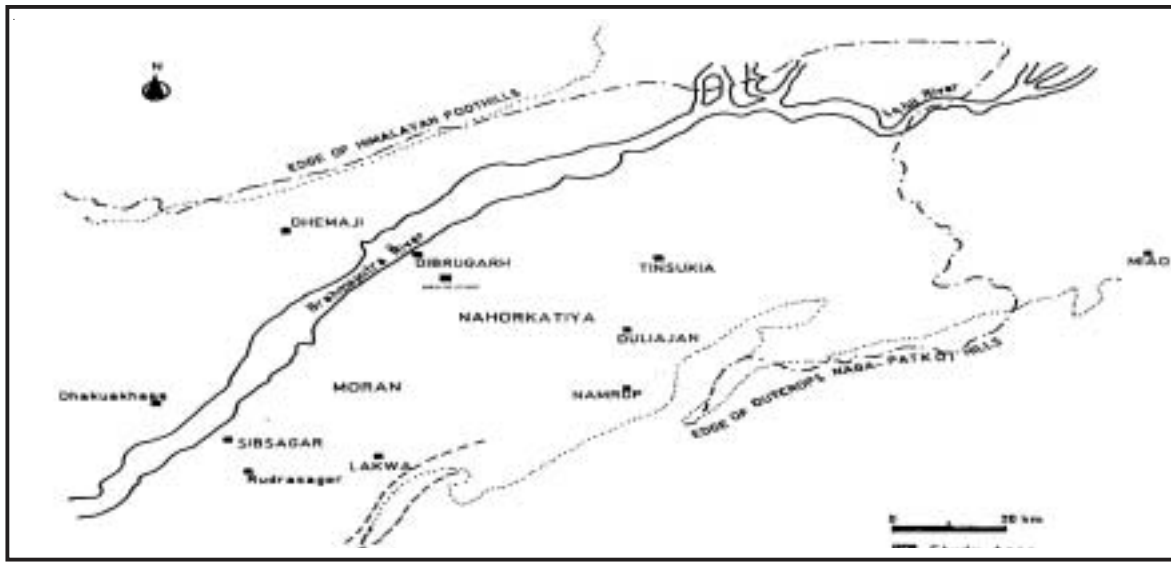

Fig.1 : Location map showing the area of study.

Prestack time migration and stacked respectively. The processing flows for Post stack time migration and Prestack time migration were shown in Figures 2 and 3 respectively.

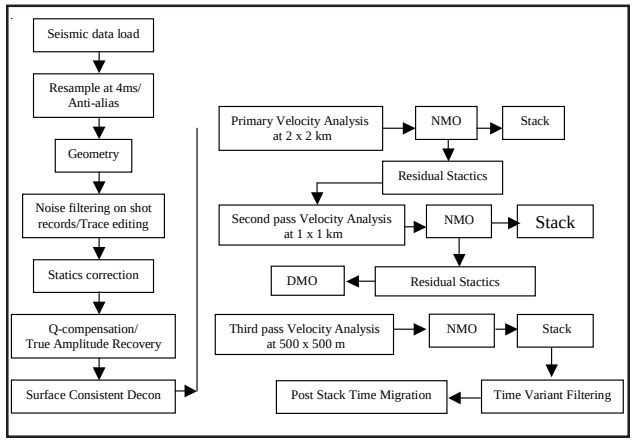

Fig.2 : Processing Sequence for the Post stack time migration

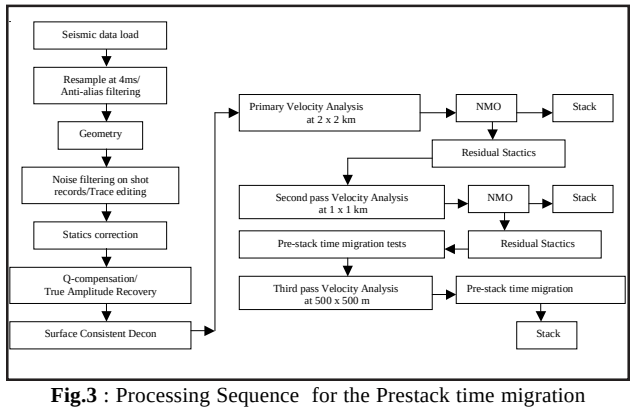

Fig.3 : Processing Sequence for the Prestack time migration

The Post stack time migrated sections of Inline 20 and inline 100 were shown in figures 4 and 6 respectively. The corresponding Prestack time migrated sections were shown for the same inlines in figures 5 and 7 respectively. A close examination of the Prestack time migrated data shows considerable improvement both laterally and vertically as compared with that of the earlier post stack time migrated data. With the newly processed data the horst and graben features which are very important from oil accumulation point of view have come up very clearly and can be mapped with a higher degree of confidence than the earlier processed data. The faults can now be seen more clearly and can be easily extended from Miocene to Eocene. The diffractions have also collapsed to a large extent improving the lateral resolution also.

Conclusions

As mentioned above the 3D PSTM process has shown considerable improvement in data quality both laterally and vertically which will certainly enable the interpreter in identifying the subtle features associated with the horst and graben features at the Eocene levels and below. The overall improvement is observed mainly in the continuity of reflections, fault definition and spatial and temporal resolution. From the 3D PSTM processed sections shown above, it can be seen that there is a marked improvement in the continuity of reflectors close to Prangs and LK+TH of Palecocene/Eocene age and Barail Argillaceous group of Oligocene age. The application of 3D PSTM to this 3D data

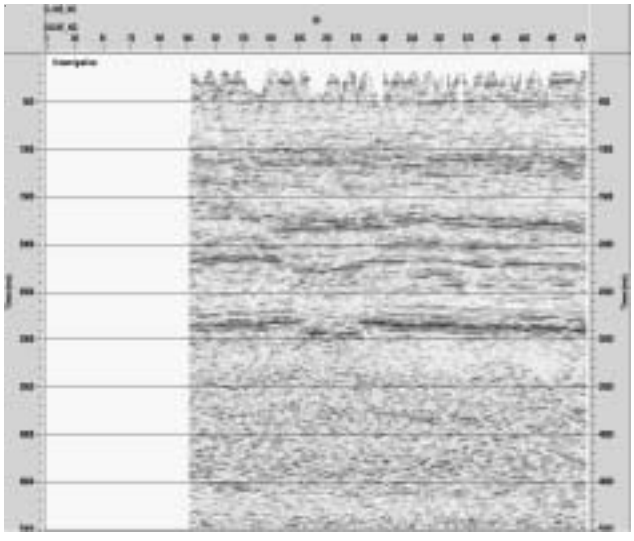

Fig.4 : Post stack time migrated section of inline 20

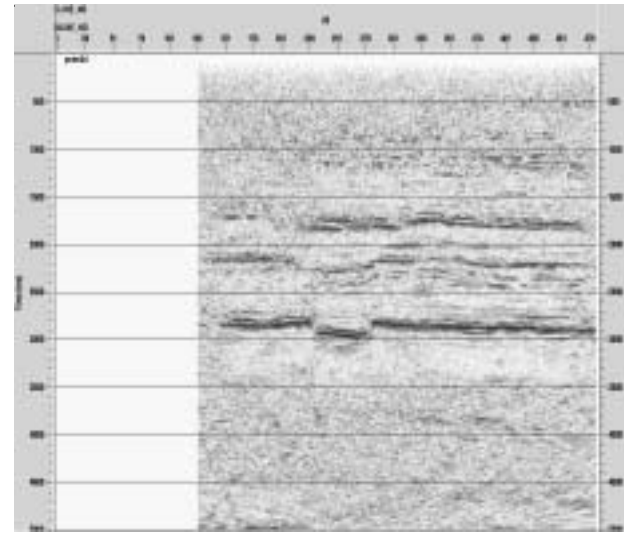

Fig. 5 : Prestack time migrated section of inline 20

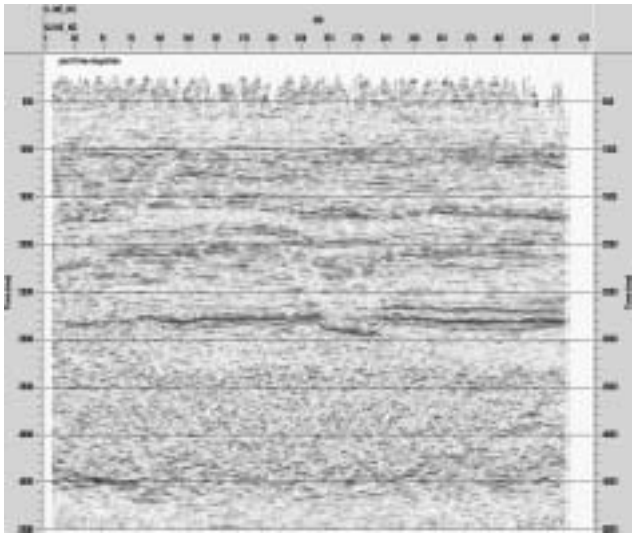

Fig. 6 : Post stack time migrated section of inline 100

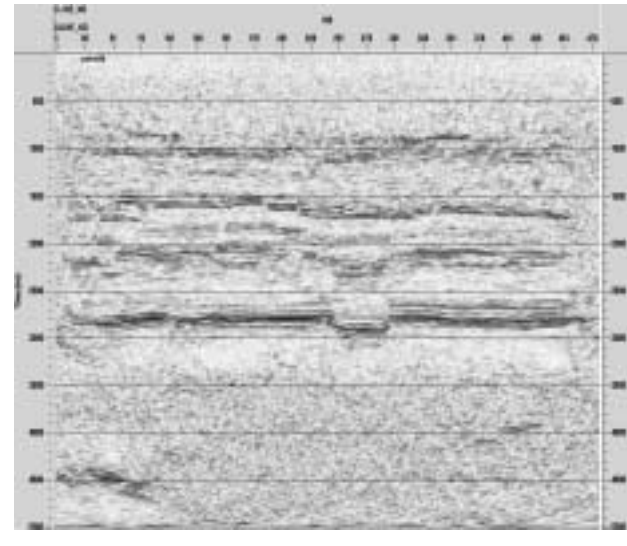

Fig. 7 : Prestack time migrated section of inline 100

set has shown considerable improvement in the fault definition especially near the horst and graben features. The overall improvement of the data quality should help in the interpretability of the depositional environment, reservoir facies etc.

References

Evans p. (1964) The tectonic framework of Assam. J. Geol. Soc. Of India,5:80-96

ProMAX reference manual.