Seismic Imaging Using Stacking Velocity Inversion (SVI) Technique

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Summary

The ultimate objective of the seismic imaging in exploration is to provide a reliable understanding of the shape and form of subsurface structures. Conventional imaging techniques uses an over simplified velocity model for depth conversion, i. e., simply extrapolation of the wave field which doesn't take into account the complexity of various geologic structures. Stacking velocity Inversion (SVI) provides a way to deal with this situation by deriving the interval velocity depth model with interpretative pause at each layer boundary. This derived interval velocity depth model plays a vital role in reconstruction of the wave field, i.e., Seismic Imaging. The technique has been applied on 2D-seismic data. The results show improvement in suppression of noises and better delineation of the horizons.

Introduction

Rapid advances have taken place in the application of seismic imaging technology. To resolve more difficult and structurally complex imaging problems, the depth imaging solutions have been developed. Since the depth migration strictly honors the accuracy of the input velocity model, so the building of an accurate interval velocity depth model is critical for depth imaging.

The concept of depth domain processing can be better understood through the basics of processing and inversion. Processing and inversion both are intended to estimate an earth model from seismic data nevertheless they differ in one fundamental respect, i.e., output domain. Processing yields an earth model in time, where as inversion yields an earth model in depth (Yilmaz, 2001).

This paper deals with interval velocity depth modeling and post-stack depth migration using stacking velocity inversion approach & the comparison of the results with time migrated and scaled to depth migrated section.

Theory & Methodology

Dix's conversion for interval velocity analysis do not hold accurately while processing complex structures (Habeebuddun, 2002). The stacking velocity inversion approach which is similar to stacking velocity analysis but uses the stacking velocity values as the representation of the data (a representation of move out curves), tackles this situation appropriately. The objective of SVI is to derive the interval velocity depth model from stacking velocities without assuming hyperbolic move out. The inputs to the SVI algorithms are stacking velocity picks & horizon interpretation in the time domain

To build a 'starting time model', interpretation is done along key horizons (across which significant velocity contrast is expected) making use of a priori information (from well data and surface geology where the situation permits). The process operates in layer stripping fashion (i.e. layer by layer from top to bottom). Within the selected range of interval velocities the application performs ray migration to depth and CMP ray tracing. For each velocity, the CMP travel time curve derived from CMP ray tracing is compared with a hyperbolic curve given by the stacking velocity, and calculates semblance which corresponds to the highest degree of matching. Once interval velocity for first layer is derived, ray migration to depth for this layer is performed. The same procedure is performed for subsequent layers, one by one up to the end of the section (Singh, et. al.2002).

Normally, structural interpretation is more readily done on time migrated data. For SVI, this interpretation needs to be ray migrated to the time domain (stack). Each horizon represents the base of the layer in this time model (Furniss, 2000). The input for depth domain processing using SVI technique is obtained by the conventional time domain processing.

In the present study, recording parameters used for input data are as follows:

Type of data	:	2D
Spread type	:	End on
Number of channels	:	96
Near Offset	:	175 m
Far Offset	:	1362.5 m
Group Interval	:	12.5 m
Shot Interval	:	12.5m
CMP Interval	:	6.25 m
Foldage	:	48
Sampling interval	:	2 ms
Data length	:	2500 msec

The raw seismic data are processed in time domain with the following processing sequence using FOCUS 5.2 software:

1. Trace editing
2. True amplitude recovery
3. Filtering
4. CMP sorting
5. Deconvolution
6. Velocity Analysis
7. NMO correction
8. Muting
9. Stacking
10. Migration (T-X Kirchoff migration)

Depth domain processing is carried out on GEODEPTH Paradigm software. During depth domain processing, the algorithm used for deriving the velocity depth model using stacking velocity inversion (SVI) is shown in Fig. 1. This velocity depth model is finally used for post stack depth migration using Kirchoff method.

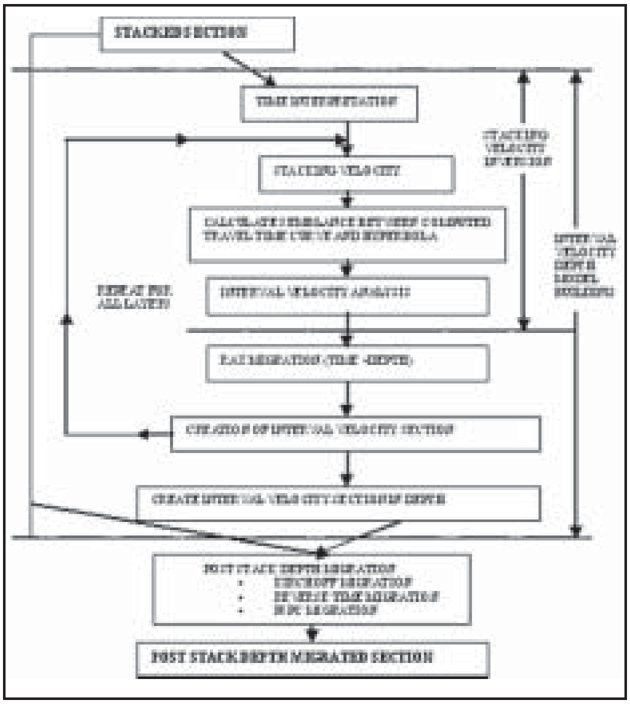

Fig. 1: Flow Chart of Post Stack Depth Migration Using Interval Velocity Depth Model through Stacking Velocity Inversion.

Discussion and conclusion

The diffraction and multiples which are major noises can be clearly seen after time domain processing on the stack section (Fig. 2). Once the stacking has been done, time migration is done with the stack input followed by T-X Kirchoff migration. The result of time migrated section (Fig. 3) shows the removal of migration smiles and diffractions to some extent. Now depth domain processing

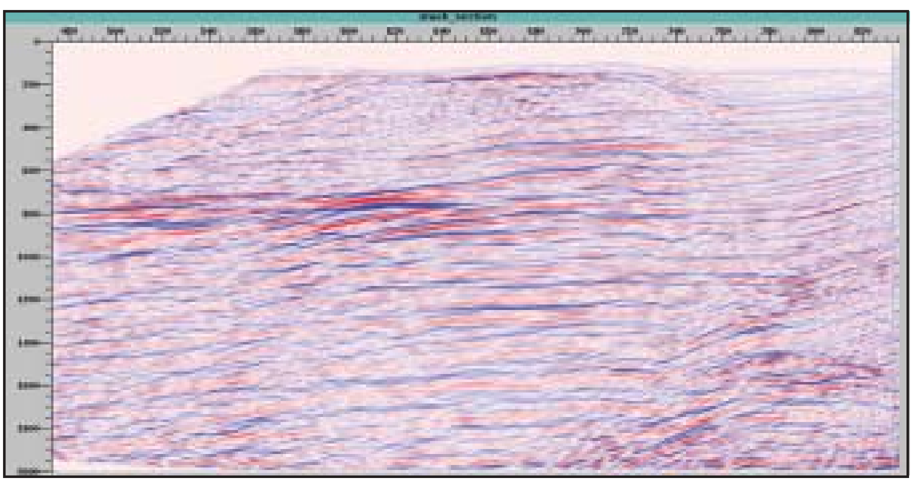

Fig. 2: Stack section

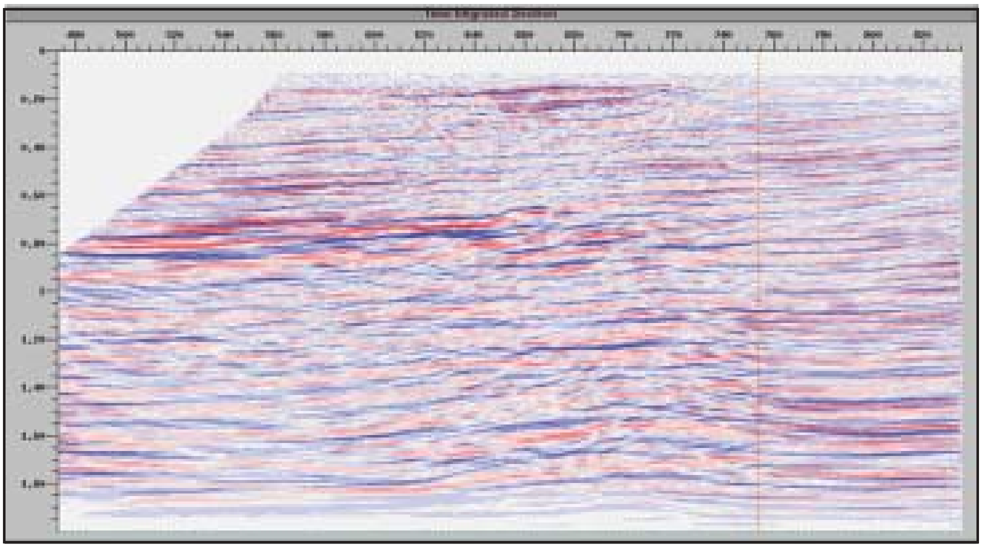

Fig. 3: Time migrated section using T-X Kirchoff Migration.

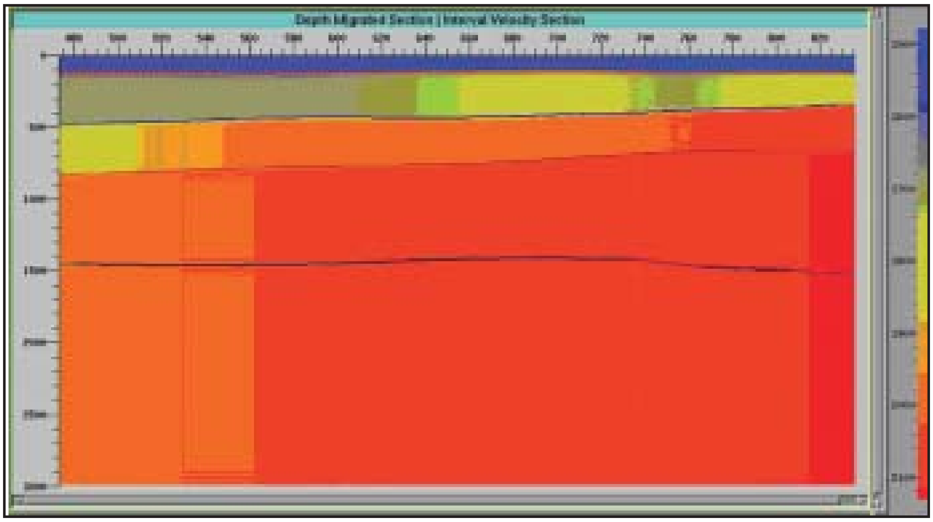

Fig. 4: Interval velocity depth section derived from SVI technique.

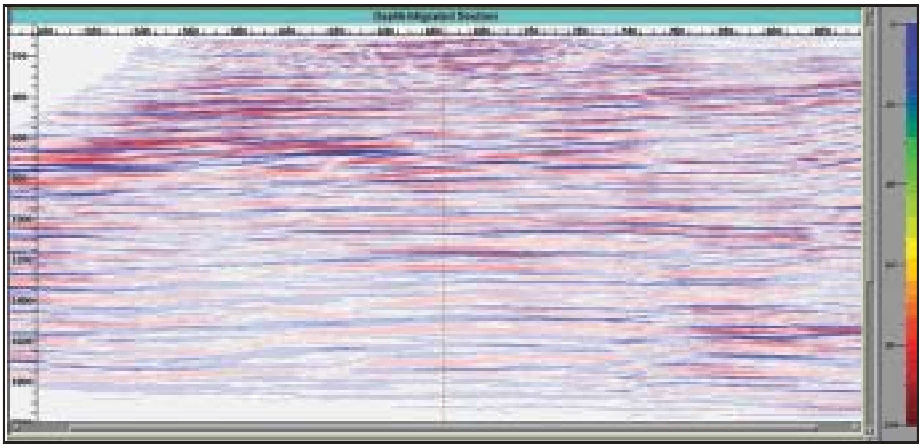

Fig. 5: Post stack depth migrated section using interval velocity depth model derived through SVI

is done using SVI technique and, interval velocity depth section is created (Fig. 4). The result of post stack depth migration shows that maximum diffractions are removed and migration smiles are reduced to good extent in comparison to time migrated section. Thus, post stack depth migrated section (Fig. 5) using interval velocity depth model derived from SVI presents the better image of the seismic data used for present study.

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References

Furniss, A., 2000, An integrated Prestack depth migration workflow using Model-Based velocity Estimation and Refinement: Geohorizons, 1, 4-17.

Habeebuddun, M., Balak, P.R., Pande, K.K., 2002, Post Stack depth Migration Using a velocity Model derived from Stacking velocity Inversion: A case study from a structurally complex area: In proceedings of the 4th Conference & exposition on Petroleum Geophysics, Mumbai, 498-505.

Singh, P.K., Gupta, A., Jha, N.N., Saxena, U.C., 2002, Stacking Velocity Inversion in Deep water 3D Prospect: A case study: In proceedings of the 4th Conference & exposition on Petroleum Geophysics, Mumbai, 467-470.

Yilmaz, O., 2001, Seismic data Analysis,SEG.