Depth migration of 3D seismic data from NorthEast India

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SUMMARY

3D seismic processing has become a well established tool in the search for oil and gas deposits. 3D depth migration of data provides a high resolution image of the subsurface geological structures. In this paper we show application of 3D depth migration algorithm to a seismic data set from North-East India. An implicit ω-x depth migration algorithm is used for this purpose and was implemented in a parellel computing environment. The data was migrated first with a velocity model derived from DMO stacking velocities. For the next iteration the well log information was included into the velocity model. The migrated results show the accuracy of depth migration algorithm in imaging complex structures.

INTRODUCTION

Depth migration is a key step in imaging of the underground geological structures. It is specially useful in geologically complex areas where there are strong lateral velocity variations. The 3D seismic prospect analysed in the paper has sevaral thrust faults, unconformities and strong lateral velocity variations. This is an excellent data set for testing 3D migration algorithm. The first part of the paper gives a description of the depth migration method. Next we describe the geology of the area. Then the depth migration of the data set is discussed. Finally we show the interpretation of the data set, followed by discussion and conclusions.

3D DEPTH MIGRATION IN ω-x DOMAIN

3D Depth migration is a key step in obtaining an undistorted subsurface profile from seismic data, and is very important to petroleum industry which devotes a large fraction of its computational resources to this process. The main difficulty in migration is to make an input velocity model. A seismic processing geophysicists first starts by making a velocity model based upon DMO stacking velocities. Then the migrated output is examined and the model is modified. If some well information is available inthe area then some constarints are introduced. The model is modified in an iterative manner. Several weeks is not an unusual time for obtaining a satisfactory image, self-consistent image.

In this paper we have used a 65 degree approximation to the dispersion relation. The coefficients of this approximation are derived by solving an optimization problem. The diffraction term resulting from this approximation is a second order differential equation, which is solved by using a Crank-Nicolson implicit finite-difference scheme. The thin lens term which is essential for depth migration and to correct for the lateral velocity variation is solved analytically. The absorbing boundary conditions are used on the sides of the model. The migration is carried out in frequency-space domain and is both compute and I/O intensive. A onepass approach based upon the splitting of the migration operator is used for downward extrapolation.

The 3D poststack depth migration algorithm in implemented on PARAM OpenFrame parallel computer, using PVM (Parallel Virtual Machine) parallel programming environment. PARAM OpenFrame developed by C-DAC, comprises of 16 SUN Ultra2 processors, connected by a fast ethernet switch. The machine is capable of delivering a peak performance of 6.4 Gflops. The migration algorithm in ω-x domain is inherently parallel in terms of frequencies. A data parallel implementation distributes the number of frequencies to be migrated amongst the available processors. The efficiency and speed is achieved by overlapping computations and communications.

GEOLOGY OF THE AREA

Khoraghat field of North-East India is a part of the Dhansiri Valley of Assam-Arakan basin. It is a north-south trending tertiary basin bounded on the east by thrust fault and on the west by hills. The basement has a number of fault blocks forming distinct highs and lows.

There are a number of wells drilled in the area.

DEPTH MIGRATION OF 3D DATA SET

Figure 1 shows the CDP location map of the 3D seismic prospect. The following table shows the parameters of the migrated data volume. For one iteration the user time required on 16 CPUs was around 2 hours and 5 minutes.

No. of CDPs in each line	400
No. of Lines	201
No. of samples in each trace	2000
Sampling interval	0.002 sec
CDP spacing	25 m
Cross Line spacing	50 m
No. of Depth Steps	400
Depth Step size	10 m

At first the data was migrated with a velocity model derived from the DMO stacking velocities. Next the depth model was modified with the help of velocity logs. A five percent reduction in velocity was necessary for obtaining correct depths to the horizons observed in wells.

DISCUSSION AND CONCLUSIONS

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