



## 3D Isotropic Prestack Depth Migration : A Case History of South Assam Shelf of Assam & Assam Arkan Basin

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### Summary

Exploration in Dhansiri Valley is very challenging because of the complex fault systems obscuring the imaging targets which are difficult to resolve in conventional time imaging processing techniques. This paper presents a case study of 3D seismic data covering North of Borholla to Merapani area of Dhansiri Valley characterized by intersecting fault system. The isotropic 3D PreSDM depth migration carried out on this dataset has resulted in improved imaging of subsurface consistent with geological setting. The depth migration has helped in better understanding of fault kinematics that could minimize exploration risk in the study area. We have used an iterative approach through global depth tomography for velocity depth model refinement before a final PreSDM

### Introduction

Depth imaging has brought a new dimension of clarity and quality of subsurface seismic images giving interpreter increased confidence in locating hydrocarbon traps in complex geological structures. PreSDM not only helps to minimize structural uncertainty and better definition of the reservoir, it also helps in understanding of petroleum system on a regional scale. Our study area falls in between North of Borholla and Merapani (Fig-1) of Dhansiri Valley of Assam and Assam Arakan Basin. The area has been covered by five seismic campaigns that has been recorded over a period of several years using a wide variety of acquisition geometries and parameters. In order to maximize the effectiveness of each exploratory well in multiple fault blocks with resultant complex structural bedding, it was decided to merge these 3D campaigns into a single dataset which simulates, what would have been produced had these been recorded by single seismic campaign and at the same time processed as a single dataset. The present paper lays emphasis on how PreSDM could accurately resolve the intricate fault system, so considerable care was taken in determining a detail interval velocity depth model through horizon based tomography.

### Geological Setting:

The Assam & Assam Arakan basin is a geological province in north eastern part of India (Fig-2). Dhansiri Valley is part of this basin. The basin has poly-phase deformational history ranging from Gondwana to Miocene age having complex fault system.

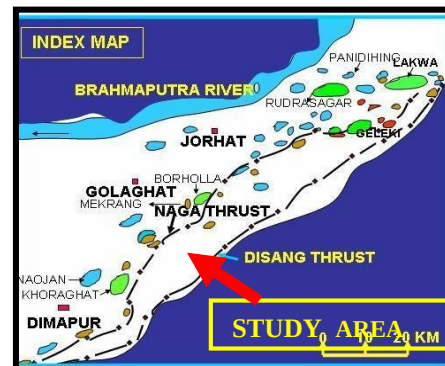


FIGURE -1 : Location map of the study area

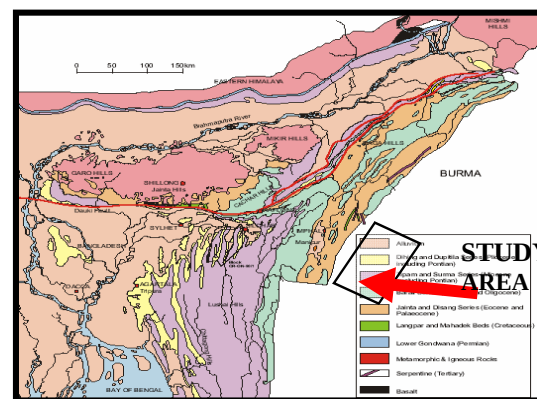


FIGURE -2 : Geological map of Assam & Assam Arakan Basin

Tectonic movement along Miocene thrusts has created major structural distortion of Paleogene rocks beneath.

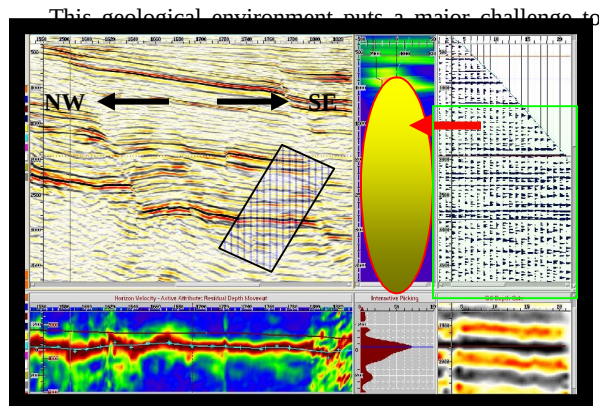


Figure-3 : Final tomography results showing diminished residual moveouts

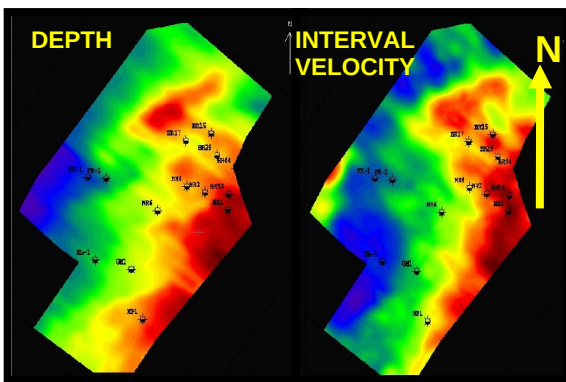


Figure-4 : Final depth and interval Velocity map at Barail level calibrated with well data

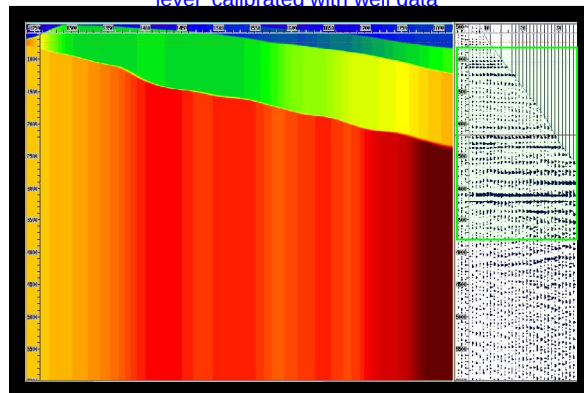
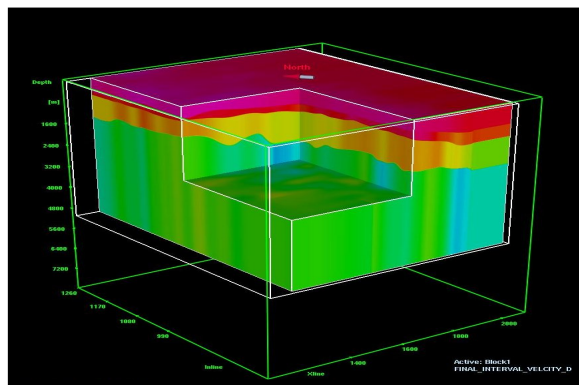


Figure -5 : velocity validation through flatness of events in depth gather at all levels



Structural style of Dhansiri Valley is characterized by major normal fault system trending northeast - southwest with significant displacement within Paleogene section. Crossfaults trending ENE-WSW are also observed in the area that offsets the older NE-SW trending faults. These fault sets have dissected major structures and play a major role in hydrocarbon entrapment.

## Velocity Depth Modelling Procedure

Proper velocity depth model to PreSDM can bring significant improvement in the seismic data quality in terms of resolution, continuity and proper structural positioning. We have adopted following methodology for velocity model building

Four geological formations corresponding to Namsang(Pliocene), Tipam(Miocene), Barail (Oligocene) and Sylhet(Eocene) have been chosen as units for velocity model building. Seismic velocities in these units are controlled by rock characteristics of formations.

As the seismic data from these old vintages has already been interpreted, so the existing interpretation was used as guide for horizon correlation in 3D time migrated volume for model building. In view of limited resolution of the seismic data it was difficult to pick time horizons, hence an iterative approach was adopted in interpreting the horizons to minimize errors in time, velocity and depth.

During horizon picking interpreter was involved to make the interpretation seamless and to ensure that the time migrated surfaces created are geologically plausible and consistent.

Horizon velocity field derived from rms velocity field was converted into interval velocities using Dix equation to get interval velocity maps along chosen horizons. Image ray based map migration technique was used to get depth surfaces for all horizons using interval velocity model.

Depth and interval velocity maps (Fig-4) were used to create the interval velocity depth model, and initial PreSDM was carried out for updating the velocity depth model. Non-flatness of the events was observed in the depth gathers, so global approach was used to minimize the cumulative error coming from velocity and depth model.

Three iteration of 3D model layer based tomography was used to update the interval velocities and depth interfaces for each layer of the model. During each iteration the model was reviewed based on the imaging results. After final run of PreSDM, no residuals delays are left as can be observed in Fig-3. Depth gather show flatness of events as shown in Fig-3 and Fig- 5, signifying that a correct model based velocity depth volume as depicted in Fig-6 has been achieved in depth domain.

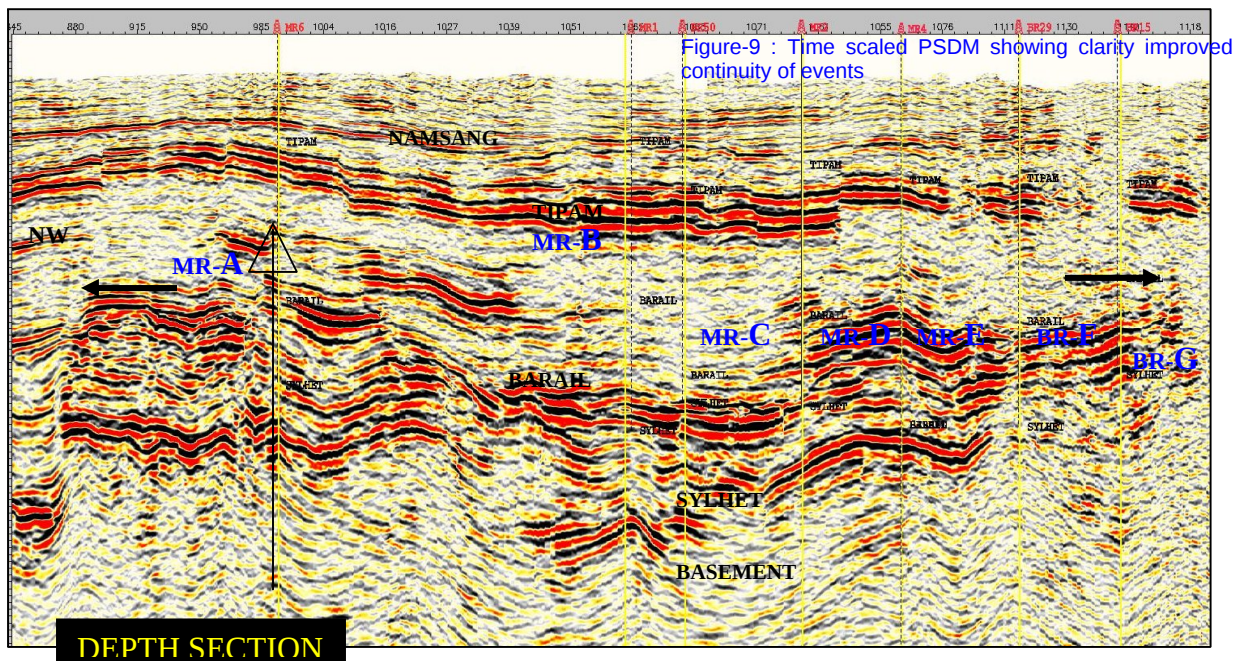


Figure-7 : A R.C line connecting wells showing the complexity of the structures.

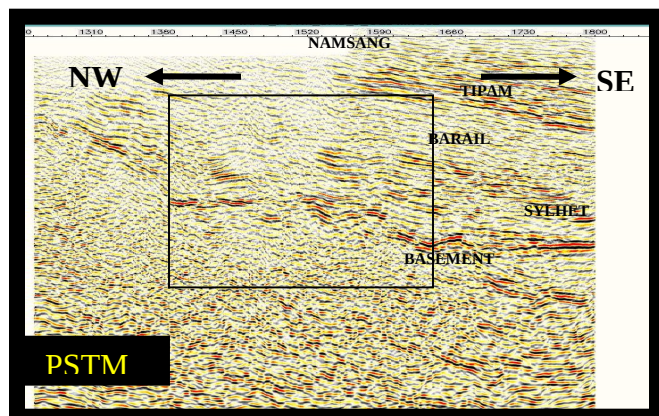
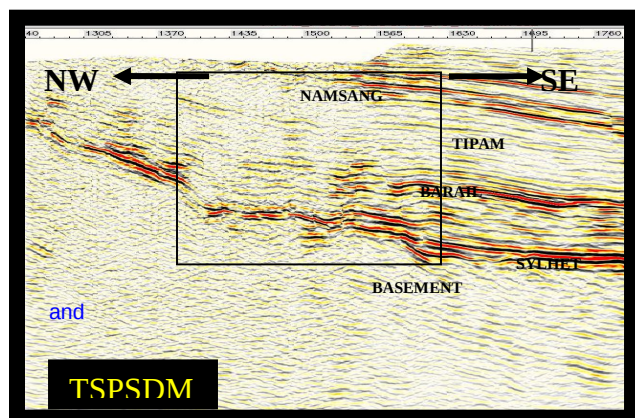


Figure-8 : PSTM inline section indicating poor continuity of the events.



## PreSDM Results and Observations :

The main focus of PreSDM was to accurately resolve the intricate fault system which has eluded conventional time domain processing. Examples as shown in Fig-9 & Fig-11 clearly indicates that 3D PreSDM section both in inline and cross-line direction shows a greater coherency and much higher image quality, compared to 3D PSTM sections as depicted in Fig-8 and Fig-10 which show lack of continuity and distortion of events.

It is also observed from Fig-9 and Fig-11, that definition of the fault blocks and the improved continuity of the events within fault blocks have been enhanced in PreSDM section.

A reconstructed section connecting the wells MR-A, MR-B, MR-C, MR-D, MR-E, BR-F and BR-G (Fig-7) indicate that the area is highly faulted with intersecting faults dividing structure into numerous fault blocks. This structural pattern has influenced hydrocarbon distribution in Dhansiri Valley.

Time slices generated at Tipam, Barail and Sylhet levels as depicted in Fig-12, Fig-13 and Fig-14 show that faults are better resolved, less noise contaminated images and better focused in PreSDM in comparison to PSTM. This has helped in accurate mapping of fault system at different levels.



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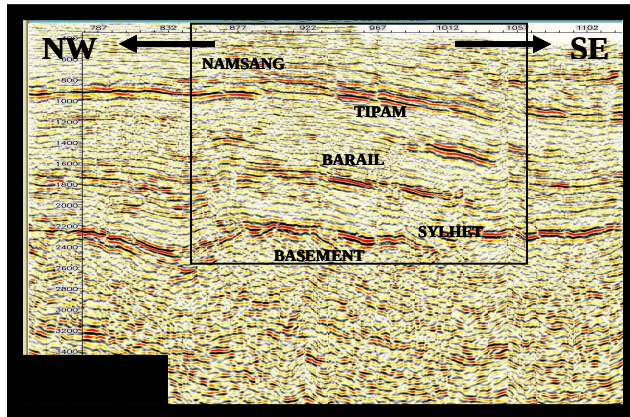


Figure-10 : PSTM, crossline section showing poor resolution of the events, and also faults are not clearly defined. There is a significant degradation of reflector continuity at all levels.

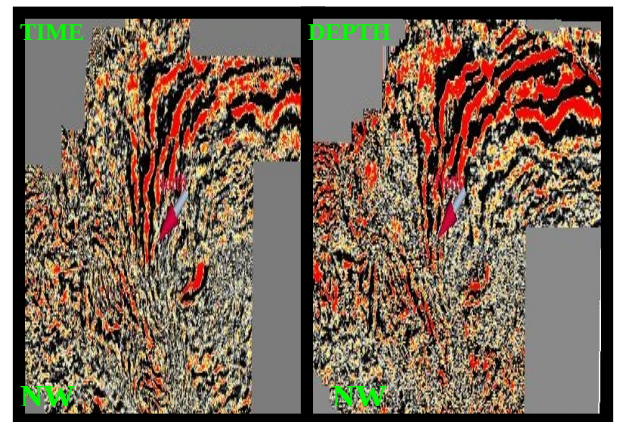


Figure-12 Comparison of Time slice and depth Slice at Tipam level.

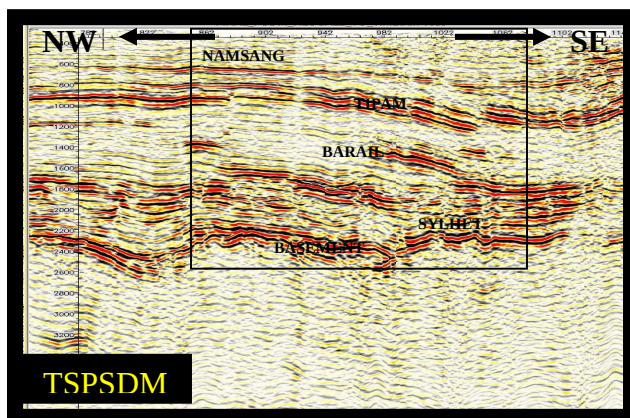


Figure-11 : Time scaled PSDM, crossline section showing improved definition of the fault blocks. Reflector continuity is interpretable.

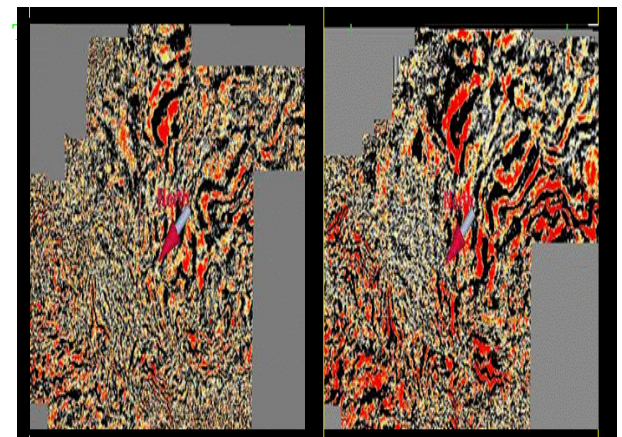


Figure-13 Comparison of Time slice and depth Slice at Barail level

## Conclusions:

The Paper highlights how PreSDM interpretive processing has resulted in significant improvement in definition of faults and proper positioning of subsurface structures in tectonically complex geological setup. Depth conversion is improved applying velocity estimation technique coupled with map migration ultimately reducing geological risk. PreSDM data has helped in identification of prospective area in Sylhet, Barail and Bokabil formations. The paper also demonstrates that constrained seismic derived velocities (by geological knowledge of the area) and addition of available well control has generated superior velocity model for depth conversion and spatial positioning of faults has improved compared to PSTM data.

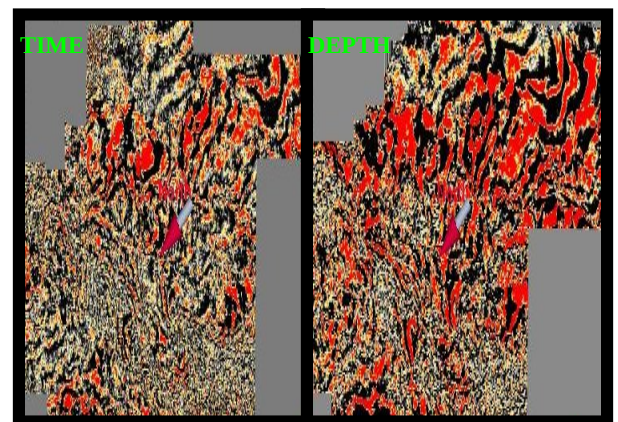


Figure-14 Comparison of Time slice and depth Slice at Sylhet level.



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