P-304

Processing of Tripura's Fold Belt Data using Tomo-Statics and Investigation of Low Illumination Zones.

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Summary

Seismic data from the geologically complex fold belt area of Tripura is processed using first break based nonlinear refraction tomography for arriving at the near surface model (thereby statics).Horizon based rms velocities are picked directly from a set of constant velocity pre-stack time migrated sections. Migration is carried out from floating datum. Building up of interval velocity-depth model for PSDM begins with the inverted near surface model as the starting point and the model below this built layer by layer using sets of constant velocity pre-stack depth migrated outputs for picking of velocity. Results from this approach are presented and compared with the same obtained from conventional processing software. A high velocity hump in the inverted near surface model is investigated as a possible source of 'blank zone' in the data.

Keywords: *Refraction tomography, floating datum*

Introduction

Acquisition and processing of seismic data from the fold belt area of Tripura has always been a challenging task. Complex geology associated with a folded and faulted belt coupled with rapid topographic variations makes not only the estimation and application of statics a difficult problem, but makes velocity estimation and migration quite difficult. Apart from this, poor energy penetration in some areas leads to blank zones. However, recent developments in seismic data processing technology have led to significant improvement in imaging of such complex areas. In recent times, technology has been developed to address the specific problem of imaging of such complex areas.

A couple of 2D lines were processed using conventional processing approach of field statics, CMP sorting and migration from flat datum and compared with a processing approach that does away with CMP sorting and works entirely in the shot domain. Our aim was to make a critical analysis and comparison of the outputs from the two approaches. Apart from this, we investigated if the inverted near surface model itself could be one of the sources of low energy penetration in one of the zones. In the follwing sections, we describe briefly the methodology of the latter processing approach followed by presentation and discussion of the results.

Theory and/or Method

A near surface model is obtained from picked first breaks using nonlinear refraction tomography (Zhang and Tokzoz, 1998). Applying appropriate corrections, the data is then moved to a floating datum and subsequent processing carried out, in the shot domain, from the floating datum. After pre-stack processing of data, a set of constant velocity migrated image panels is generated from which rms velocity is directly picked in the next stage. This is then used to migrate the shot gathers from the floating datum using Kirchoff migration adapted for non-flat datum followed by static corrections to the seismic reference datum.

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If pre-stack depth migration needs to be performed, the image obtained from PSTM is demigrated to obtain the zero offset section. The same is subjected to post-stack depth migration using interval velocity depth model obtained from DIX conversion of rms velocity field in depth. The output from post-stack depth migration is then overlaid on the interval velocity depth model. A set of depth horizons with significant velocity contrast is then interpreted and the resulting model used as an initial model for subsequent layer based model updating via residual moveout analysis. An alternative approach is to start with the inverted near surface model and build the velocity model below this, layer by layer by generating sets of constant velocity pre-stack depth migrated panels & picking of horizons alternately.

Results and Discussion

Figure 1 shows the initial near surface model obtained from first break picks (used as an input to tomography) and the final inverted near surface model using nonlinear tomography (Zhang and Toksoz, 1998). Figure 2 shows PSTM stack obtained using the latest processing approach. The same may be compared with the stack obtained using conventional processing (Figure 3) i.e. field statics and processing from a fixed datum. There is a marked improvement in the section obtained using the non- conventional approach specially adapted for thrust belt processing.

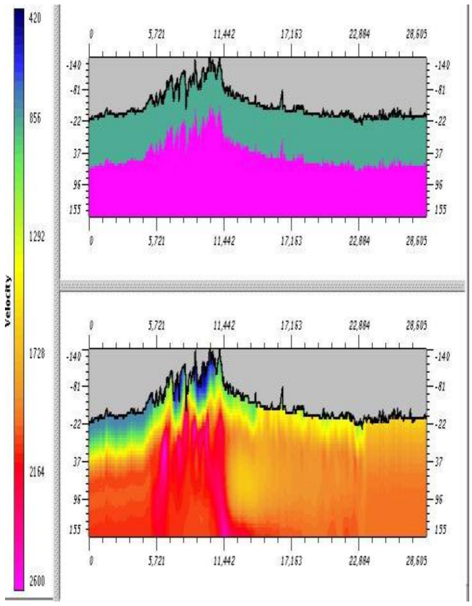

Figure 1 : Initial Near Surface Model (top) and Inverted Near surface Model (bottom).

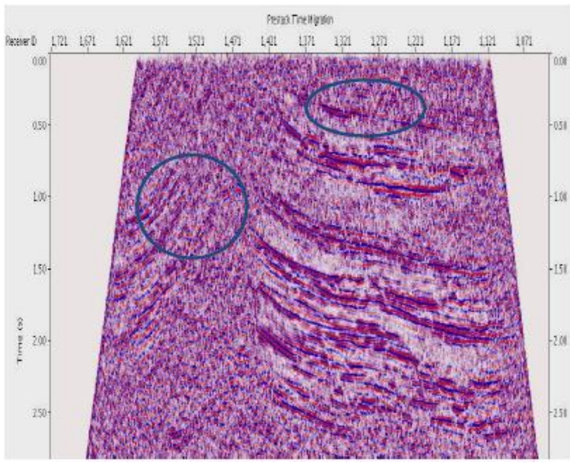

Figure 2: PSTM Stack using tomo-statics and floating datum processing(areas of improvement have been encircled).

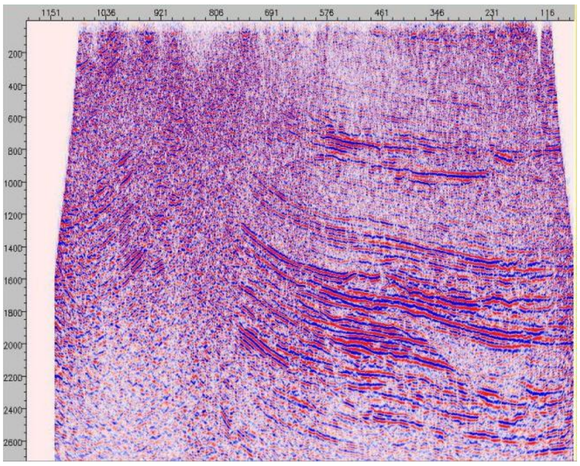

Figure 3 : PSTM Stack of the same line using conventional processing.

However, we see poor imaging of the top of the anticline even in the section processed with the latest approach. PSDM was carried out for a regional line in this area to see if we could better image the structure. Figure 4 and 5 show PSTM and PSDM (scaled to time) sections (using the unconventional approach) obtained for this line. We see that the problem of poor imaging of the top of the anticline remains.

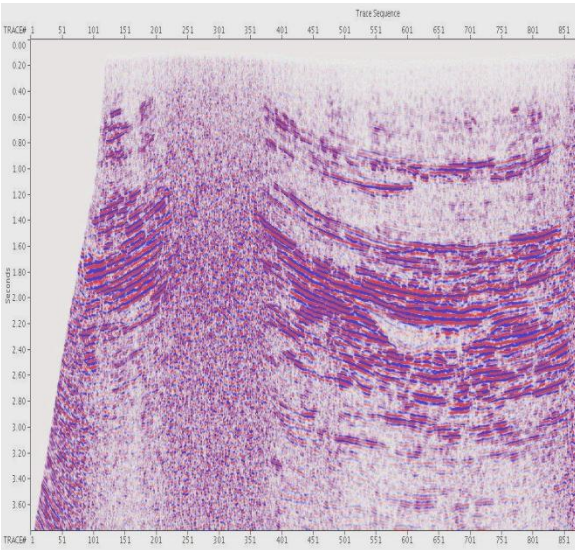

Figure 4 : PSTM section of the regional line.

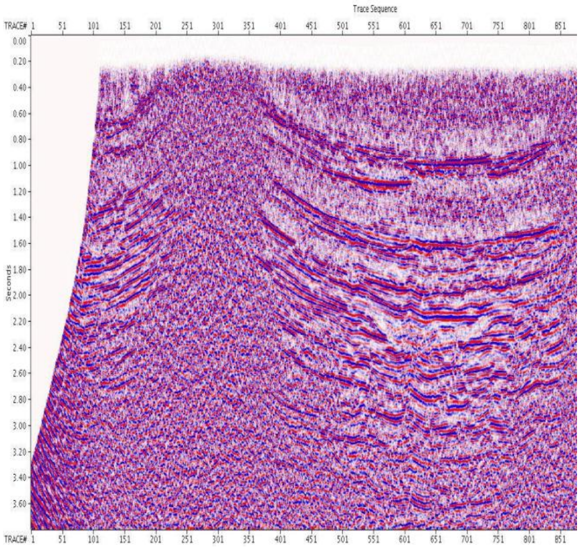

Figure 5 : PSDM section of the regional line scaled to time.

We now turn our attention to the near surface model and investigate this as a possible source of low energy penetration The inverted near surface model from nonlinear tomography has a high velocity hump just below the hillock on the surface. This near surface model was transported to modeling software, NORSAR, and response seen for a reflector introduced below the hump. The results are shown below.

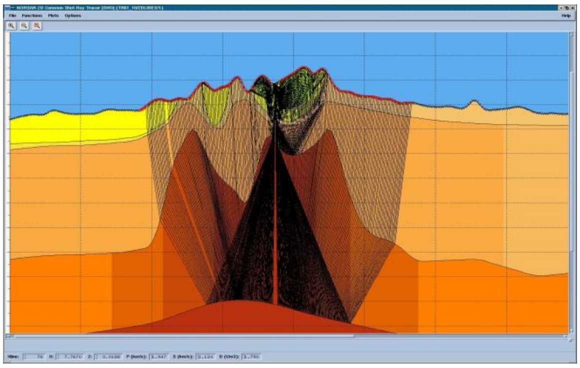

Figure 6 : Ray paths for a spread just above the hump in the inverted near suface model(reflector introduced below the hump is shown with an arrow).

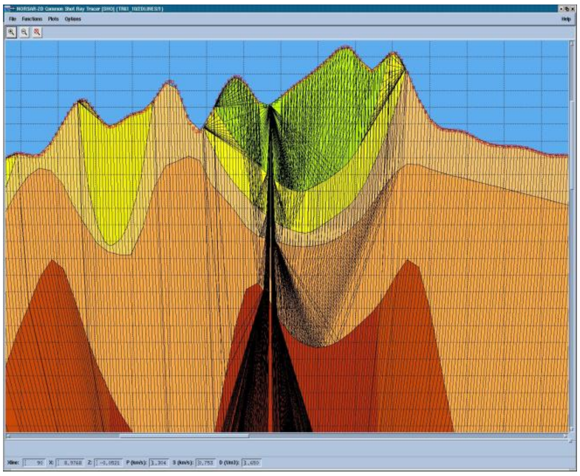

Figure 7 : Zoomed version of Figure 6.

Figures 6 and 7 show that, for the given spread, a very narrow band of rays contributes to the energy recorded on the surface. This is due to the high amount of ray bending caused by the near surface high velocity hump.

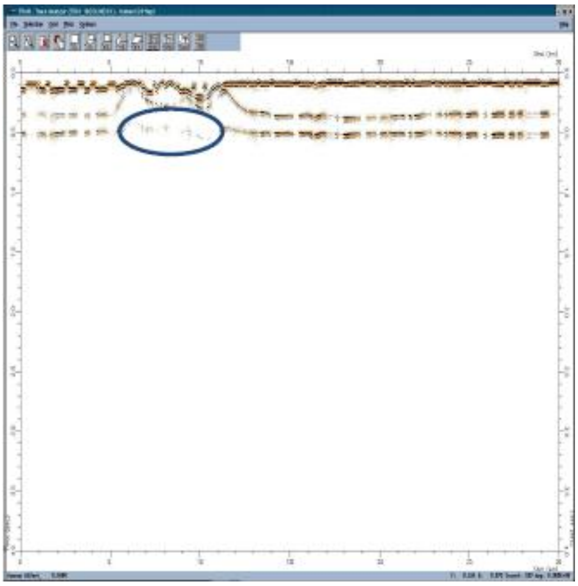

Figure 8 : Recorded section at 40 m offset shows poor reflector strength below the high velocity hump.

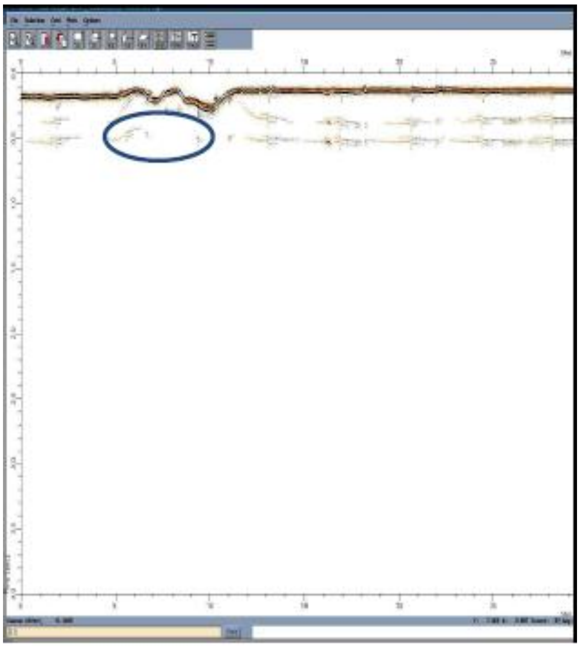

Figure 9 : Further weakening of reflector strength is seen at 160 m offset (Encircled zones show weaker relative strength).

Figures 8 and 9 show strength of reflector below the near surface hump at offsets of 40 m and 160 m. We see low strength below the hump even at 40m offset and still weaker strength at an offset of 160 m. Note that it is the relative amplitude that is important i.e. the amplitude below the hump compared to the amplitude on the sides, which is low in both the cases. So, the near surface is indeed one of the factors contributing to the 'blank zone' seen in the figures above. This is, however, not the only factor. A fault, with a large throw, present in the area is also expected to contribute to the low energy penetration in this zone—investigation of this effect is not within the scope of the paper.

Conclusions

Sections processed using tomo-statics and floating datum processing, along a dip line, from the geologically complex fold belt area of Tripura, have been compared with sections obtained from other softwares, employing field statics and a conventional approach to migration. Results clearly show superiority of the former approach. The inverted near surface model, obtained from nonlinear refraction tomography has a high velocity, high dip hump which is shown to be one of the factors contributing to the low illumination zone seen in the section.

References

Zhang, J. and Toksoz Nafi, M., 1998, Nonlinear refraction traveltime tomography; Geophysics, 63, 1726-1737.

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