



Seismic Expression over Tulumura anticline, Tripura

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Summary

Tulumura anticline which was geologically mapped way back in 1980's is geographically situated in Tripura foldbelt area of Assam and Assam-Arakan (A&AA) basin, India. This anticline is long, narrow and tight, trending mostly northeast direction is a result of late Pliocene movements. Gravity, Magnetic and aeromagnetic data is available over this structural feature whereas 2D Common Depth Point (CDP) surveys have been for the first time carried out by ONGC in 2006-07. Aeromagnetic data suggests an east-west trending geo-morphological high whereas the surface geology depicts north-south trending structure explains the thin skin tectonics. Tulumura anticline is of hydrocarbon interest because the east-west trending basement arch is believed to be extended up to Bangladesh where numerous gas fields are reported, through Tripura.

The area is seismically unfriendly and therefore poses a challenge to acquisition as well as processing geophysicist. It is well known that the acquisition reflection quality can not be judged from the shot records but the role of intelligent processing by removing the unwanted seismic energy from the record will show up the reflection quality. Therefore any traditional approach of processing will lead the processor to the state of disappointment.

In the present paper, a specialized processing approach is adopted to bring out the seismic expression of Tulumura anticline and the results are presented.

Introduction

The Tripura area constitutes a part of the Assam-Arakan geosyncline which mainly covers the states of Assam, northeastern frontier agency and, Nagaland and Manipur.

Tulumura anticline is situated in the southernmost of Tripura state in Belonia, Sabrum and Amarpur subdivisions of south Tripura district. Systematic geological mapping of Tulumura anticline was carried out in order to delineate the stratigraphy and structure of the exposed rock succession and collect other relevant information with a view to assess hydrocarbon potential of the structure.

The Tulumura anticline is a doubly plunging asymmetrical anticline with a gentle western limb and a steep faulted eastern limb. The crestal area of the fold the broad and gentle and this is succeeded to the east by a sharp genticulate flexure giving rise to a part-box structure. The anticline is about 40 km long and 18 km wide in its widest part (Fig.1).

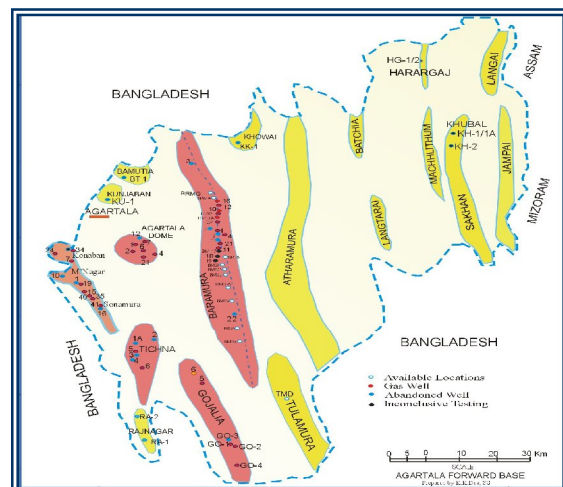


Figure 1: Location of Tulumura anticline trending NW-SE in the state of Tripura.



A longitudinal reverse fault called Tulumura fault hading west occurs in the eastern limb of the anticline. The throw of the fault is around 730 meters near the structurally highest part of the fold and diminishes gradually in eastern direction towards plunging ends.

Four gas shows have been reported in the crestal region of the Tulumura anticline. These gas occurrences combined with the closed doubly plunging nature of the anticline comprising a thick succession of sandstones and shales, lenticular nature of the sandstone bodies and the proximity of known hydrocarbon bearing structures in Bangladesh, call for extensive seismic surveys and drilling.

Apart from surface geological data, gravity-magnetic data is also available for the area. An airborne magnetic survey has been conducted in and around Tripura fold belt and a generalized basement configuration map has been prepared by KDMIPE, ONGC (Fig. 2). The iso-anomaly lines in the basement depth map reveal that the basement trends east-west direction in contradiction to Tulumura and other exposed structures in the area. This suggests that the basement is a geomorphologic high and the supra-basement structures are developed due to thin-skin tectonics.

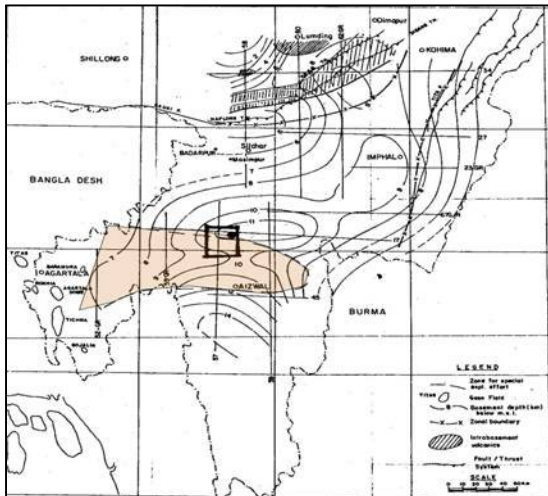


Figure 2: A generalized basement configuration map for the Tripura foldbelt area.

Two dimensional CDP surveys are carried out over the Tulumura anticline by Oil and Natural Gas Corporation Limited (ONGC) during 2006-07 (Fig.3). These CDP surveys are designed with the following parameters.

- Spread geometry: split spread 120+120
- No. of channels: 240
- Group interval: 25m
- Shot interval: 50m
- Geophone array type: Bunched
- Near offset: 100m

- Far offset: 3075m
- Foldage: 2*30
- Shooting direction: W-E on dip lines, N-S on strike lines
- Energy source: Explosive
- Record length: 6000 msec
- Sampling interval: 2000 micro seconds

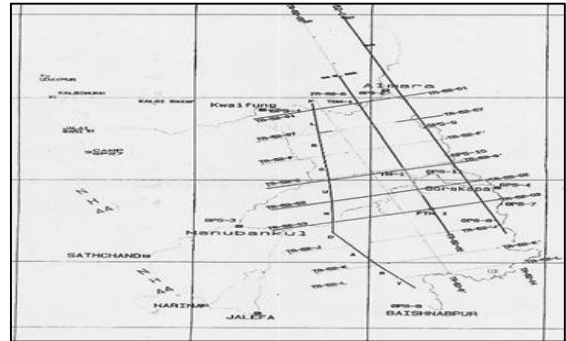


Figure 3: Location of 2D seismic lines that have been shot over the Tulumura anticline. E-W trending lines are dip lines and S-N lines are strike lines.

The record length and the far offset parameters should provide information about the basement at least on the strike lines. However, the present study is carried out to elicit the geometrical configuration of the Tulumura anticline and its role in the entrapment of hydrocarbons. The seismic acquisitions parameters are optimized in the field and goaded by the results of forward modeling (Fig.4).

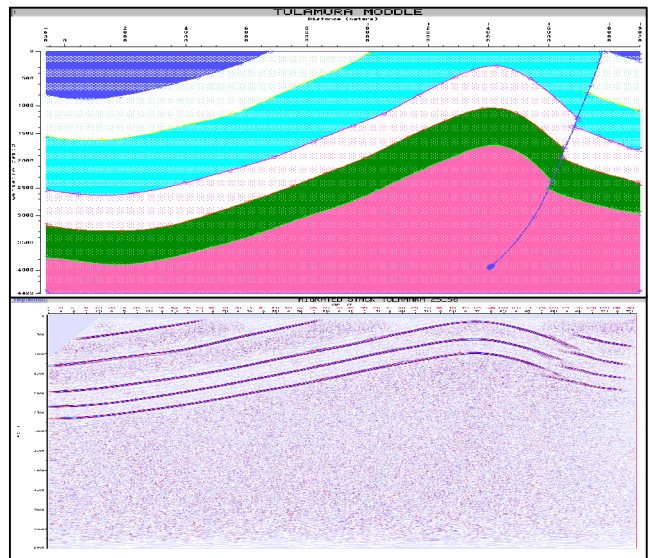


Figure 4: The proposed geological model over the Tulumura anticline and its image after migration obtained from forward modeling.



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Seismic Data Processing

Processing of seismic data acquired from foldbelt areas is not an unknown *mettre en doute* because the quality of seismic data depends on many factors including technical and non-technical matters. The acquisition geophysicist deems that any flaw in acquisition stage will be compensated during processing. In general, two types of data come from foldbelt areas. One is with poor S/N and this type of data can be handled with care by choosing appropriate noise attenuation algorithms and selectively applying them in different domains in the pre-stack stage to enhance the signal. Second is with in appropriate geometry which means that the S/N is not consistent along the seismic line and this varying degree of S/N poses threat to the processor to optimize the parameters of noise attenuation algorithms. Furthermore, the so called additional benefits that come from redundancy and dearth of proper offsets warrants any model based processing and if ignored, model based processing may cause artifacts in the data.

Example

The CDP data acquired over Tulumura anticline surprisingly fall into a third category which is a hybrid type of one and two explained above. However, attempts are made to process the data in order to output a meaningful seismic expression to make it consistent with the proposed geological model. Albeit, all the dip and strike lines are processed, a couple of dip lines are presented for this study.

Processing is started with application of geometry, field statics and gain corrections. Spikes in the data and sluggish amplitudes are removed by automatic editing routines. At this stage, the difference sections are produced and examined to care for the signal. One dimensional wavelet transform is used to suppress the ground roll. Surface consistent amplitude and deconvolution processes are applied on the data. A second pass noise attenuation is carried out to attenuate any possible unwanted reinforcement of noise during the deconvolution process. Velocity analysis is carried out for Normal Moveout (NMO) correction. After designing a proper NMO stretch mute, the CMP gathers are stacked to produce a seismic image. At this stage only patchy reflections are seen on the eastern side of the line. Several iterations of surface consistent residual static corrections and velocity analyses helped to improve the data. Kirchhoff migration, F-K migration, F-X migration and Wave-equation migration are tested on the stack after Dip Moveout (DMO) corrected data. All migration algorithms worked more or less in the same way but failed to produce a cleaner expression. DMO velocities are perturbed for various percentages and used during migrations but did not help. It is found that coherent energy getting aligned in the deeper part of the section below the Tulumura anticline which has no correlation with

the reflection pattern seen near the structure. The dipping events below the structure look to be against the dips of the structure. It is found that the migration route through DMO did not produce fairly a noise-free image (Figs. 5 and 6.). Pre stack Time and Depth migration are also failed in a different way for the reasons already explained in the abovementioned lines.

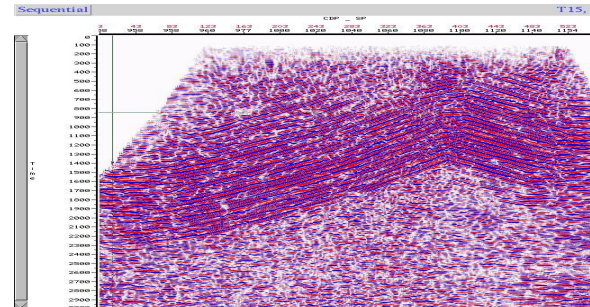


Figure 5: Seismic section along a dip line over Tulumura anticline. F-X migration is carried out on the data. Imaging is reasonably good except near the fault zone on the eastern side.

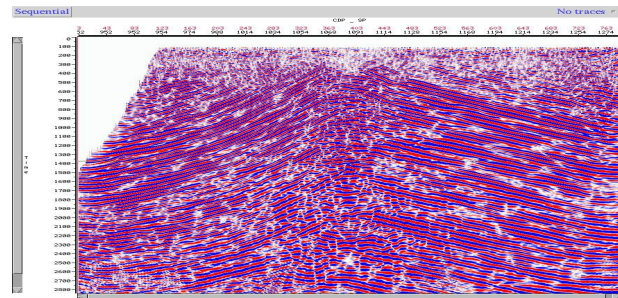


Figure 6: Seismic section along another dip line showing good imaging.

In the present work, to obtain a better image of Tulumura anticline, a slightly different processing flow is adopted from that of customary flow in which DMO is replaced with FK migration algorithm. The processing flow follows like, after residual static corrections, common offset planes are generated and each common offset plane is migrated with a constant velocity using post stack FK migration algorithm which should improve the steep dip conditions near the fault zone. To obtain a constant velocity for FK migration, multi panel velocity tests are carried out. The stacked output is then migrated using finite difference solution of the wave equation algorithm which should migrate dips up to 45 degrees with a smooth velocity field obtained after DMO. This process produced an image that is more reasonable and consistent with the existing geological model.



Discussion and Conclusion

For several reasons, the data come from foldbelt areas will be of noisy. For the case of two dimensional CDP surveys, coarse sub-surface sampling, the out of plane reflections, scattering of reflection energy, approximating 3D body to a 2D body, not considering the lateral dips cause difficulties during processing. This case history suggests that a different thinking and slightly un-customary processing flows yield reasonable imaging of foldbelt structures.

References

Ganguly, S., Ahuja, A.D., and Bhasin, A.L., 1971, Geology of Tulamura anticline, Tripura, compiled report of field season 1969-70 and 1970-71. ONGC, Dehradun, 1971.

Operational Report of seismic surveys conducted in Tulamura area, Tripura, by GP27, ONGC, MBA Basin, Kolkata, 2006-07.

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