



P 198

## Meaningful Seismic Data Acquisition in Gojalia, South Tripura, Assam Arakan Fold Belt: A Challenge.

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### Summary

*The area under study falls in Tripura, which in turn, is a part of the Assam-Arakan Fold Belt and geographically situated in the northeastern part of India. Tectonically, the Tripura region is characterized by a series of sub-parallel; elongated, doubly plunging, tightly folded asymmetrical anticlines arranged echelon and separated by wide, flat and more or less symmetrical open synclines. These folds are trending NNW-SSE to N-S direction and the intensity of folding increases from west to east, with progressively older rocks exposed in the anticlinal cores. Due to erosion of anticlinal folds and exposure of older formations, the surface is highly undulating. The dip of the beds is in general more than 45 degree. Most of the seismic energy is scattered and converted into noise, masking the subsurface reflections. This has been a major challenge in imaging the sub surface.*

*A 2-D campaign with fine spatial sampling was shot to get meaningful reflection events over Gojalia anticline. The data acquired from the current seismic investigation is showing better signal to noise ratio and continuity of reflectors in the anticlinal part from Upper and Middle Bhuban sequence at the depth of 600 m to 2500 m. This was achieved mainly through intellectual efforts by modeling and physical efforts by managing logistic problems.*

**Keywords:** 2D Seismic data acquisition, South Tripura, Assam Arakan Fold Belt

### Introduction

Gojalia anticline is one of the prominent hydrocarbon bearing structures in south western Tripura. Owing to steep dips, complex pattern of folding and faulting and rapid elevation variations coupled with lateral velocity variations, seismic wave propagation in this areas becomes too complex. Till date twelve exposed structures are identified, in Western Tripura. Commercial viable gas reserves have been established in seven prospects in Western Tripura within hydrostatic and transition pressure regimes in Bokabil, Upper Bhuban and Upper part of Middle Bhuban formations of Miocene age.

The objective of the recent campaign TR-71 was to acquire good quality seismic data to delineate structural and stratigraphic plays within Upper and Middle Bhuban sequence at the depth of 600 m to 2500 m (Two way time : 500 ms to 2000 ms). The anticlinal feature was not convincingly deciphered in the earlier data due to large

receiver group interval. 2-D lines in this campaign were planned and shot in Gojalia in South Tripura during field season 2012-13. The location map of acquired lines is shown in Figure 1. The study area is infested with thick vegetation, steep hillocks, valleys, rubber gardens and practically devoid of approach roads.

### Methodology

The survey was conducted by using the ION seismic data acquisition unit keeping record length at 5 sec, sampling rate at 2 ms, preamp gain settings at 0 dB with Notch filter OUT. The 2D profiles were around 8 km across the central part of Gojalia anticline with 1.6 km on either side of full fold boundary area as shown by dotted lines in Figure 1. The symmetric split spread shooting pattern was adopted during acquisition. Comparison of acquisition parameters with previous investigations is shown in Table1.

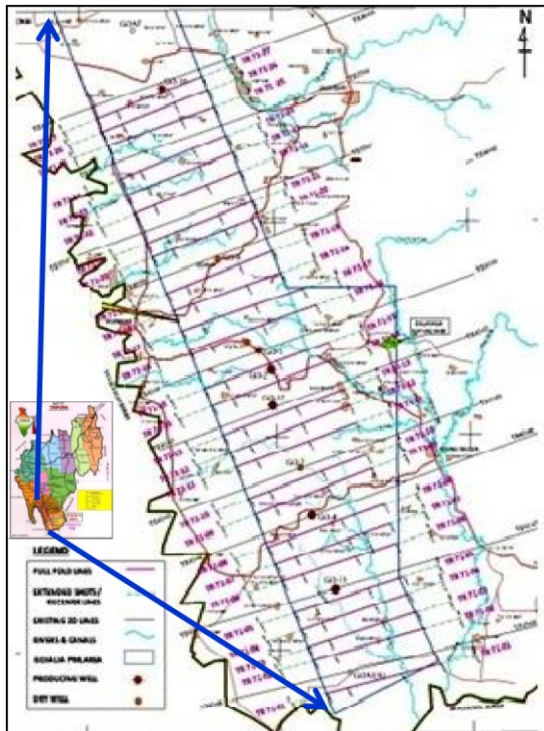


Figure 1: Location Map showing 2D lines in Study area

Parameters	TR-37 2000- 01	TR-40 2003- 04	TR-43 2004- 05	TR-71 2012-13
Spread Type	2D	2D	2D	2D
Shooting technique	SSS	SSS	SSS	SSS
Foldage	60	60	60	80
No. of Channels	240	240	240	640
Near off set (m)	100	100	100	5
Spread Length (m)	3075	6150	6150	3200
Group interval(m)	25	25	25	10
Shot interval(m)	50	50	50	40
Av. Shot depth(m)	17 36	15-30	15-35	22-40
Av. Charge size(kg)	2.5	2.5-5.0	2.5-10	5
Record Length(ms)	5000	5000	5000	5000

## Modeling by NORSAR

2D modeling was carried using NORSAR software to validate geometry parameters. Subsurface model of Gojalia anticline was generated using geological horizons of upper and middle bhuban as shown in figure 2. Ray trace model was generated for all shots in a profile as shown in figure 3. Ray trace models were generated for single shot on the top of anticline as well as on either side of the anticline structure as shown in figure 4. Synthetic seismogram shown in Figure 5 was prepared by using ray trace model for one shot at the top of anticline shows good reflections from apex and flank parts of upper and middle bhuban.

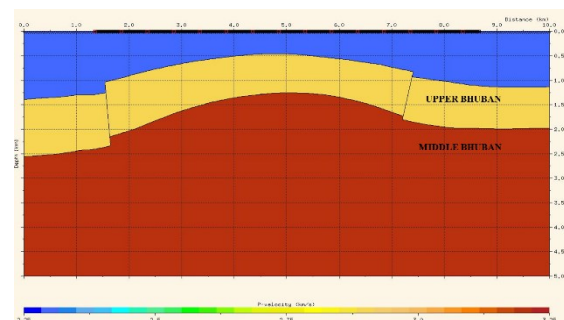


Figure 2: Model used for Ray tracing.

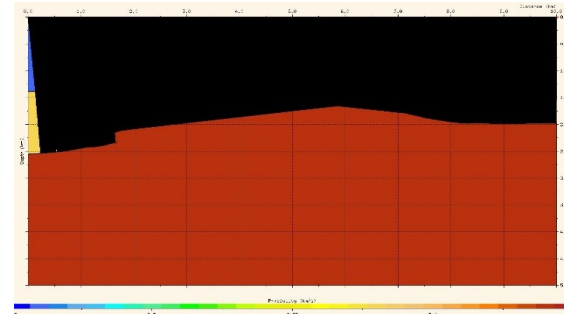


Figure 3: "Ray Trace Model for all shots in a profile".

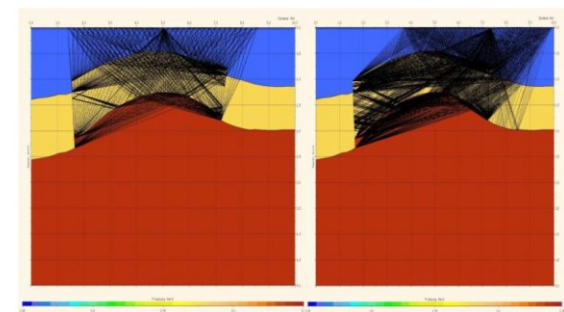


Figure 4: "Ray Trace Model for Single shots on either side & top of the anticlines".

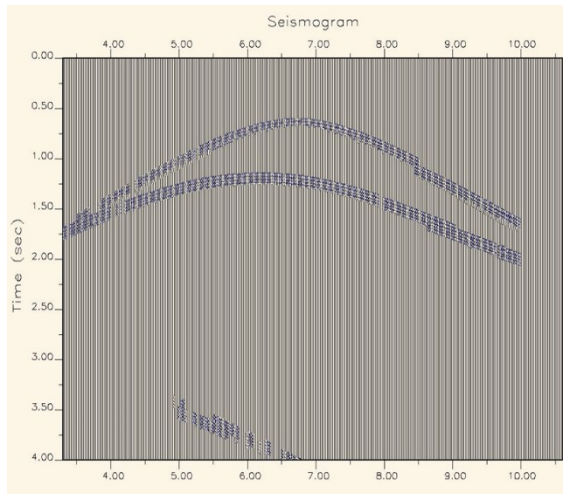


Figure 5: Synthetic seismogram for single shot on the top of anticline.

### Logistic challenges in study area

Sharp and sudden variations in elevation of the order of 15-150 m encountered at several places in the operational area (Figure 6). Steep changes in elevation within 10-20 m distance caused difficulty in planting receivers because of steep gradients. Operational area was full of thick and dense vegetation and big trees. Only two approach roads in the area of operation. Stacking of line was very slow and tedious due to steep and abrupt variations in ground elevations and was possible only after making the path by clearing the vegetation. Head load operations was only option for carrying of ground electronics to lay lines and carrying equipment for drilling shot holes. Dense vegetation posed problems in signal communication. Secluded zone/less sunlight limited the operational time for safety reasons. In addition to the above problems, rubber plantations are coming up in a big commercial way in the area in the last few years and the plantation area is spreading day by day and the plantations at places were in long continuous stretches which made it very difficult to acquire seamless data without skips.

Geophone plantations in pits was checked and ensured for proper coupling regularly in the field. Shot hole depths decided on the basis of up-hole survey and shot point locations were physically checked by field crew to ensure quality. Day's operations were planned in such a way that field work started early in the morning and completed before sunset for safety of men and materials because of secluded zones. Recovery shots were taken where ever possible to minimize data gaps.



Figure 6: Glimpse of logistic challenges.

The near surface models (NSM) were prepared using uphole data and elevation data. The NSM maps of Line 20, 21, 22 and 25 are shown in Figure 7. It was observed that there are huge elevations changes along the profiles in the operational area. Hence, conventional processing approach could not yield good results in this area. So, a different data acquisition and processing approach was adopted which worked well and the imaging quality improved considerably in the top part of the anticline structure.

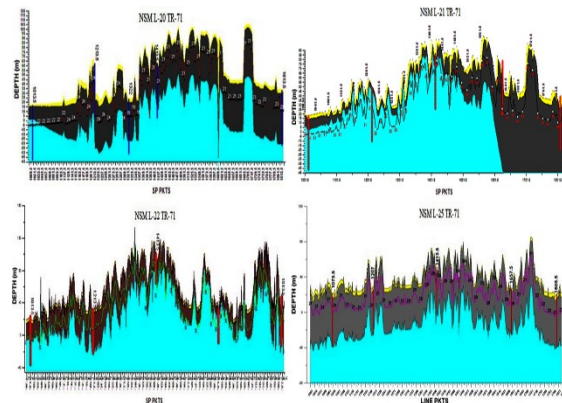


Figure 7: Near surface models of different profiles showing the degree of variations in shot point elevations in the area.

### Results and Discussion

The data was acquired using Lambert conic conformal –1 parallel projection with zero datum. One processed seismic section from the current investigation (TR-71-21) has been shown along with nearby processed line acquired

previously (TR-37-07) for comparison of the results (Figure 8). This PSTM section TR-71-21 shows continuous and meaningful reflections along the Gojalia anticline from Upper and Middle Bhuban sequence at the depth of 600 m to 2500 m (Figure 9). Previous seismic investigations in this area were not able to delineate the structural features effectively (Figure 10). Comparing the seismic section of recent profile with a nearby profile of earlier investigation, it is observed that the earlier data quality was not good enough to clearly decipher the events in the anticlinal part of the area. It might be attributed to the fact that earlier data, acquired with coarser spatial sampling and less foldage was not able to achieve the desired results in flanks and crestal part of the anticline.

The data acquired in the current investigation shows remarkable improvement in vertical and horizontal resolution particularly in the zone of interest as shown in PSTM section in Figure 9. The outcome of the recent study will be extremely useful for designing suitable acquisition parameters in future, in the tectonically complex areas.



Figure 8: Locations of compared lines TR37-07 & TR71-21.

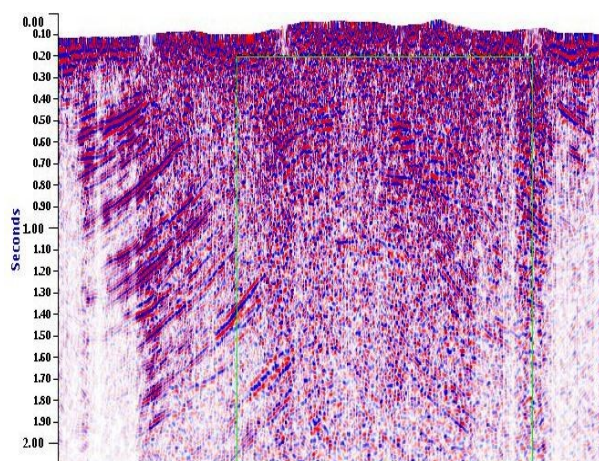


Figure 09: PSTM section of Line no: 21 of TR71.

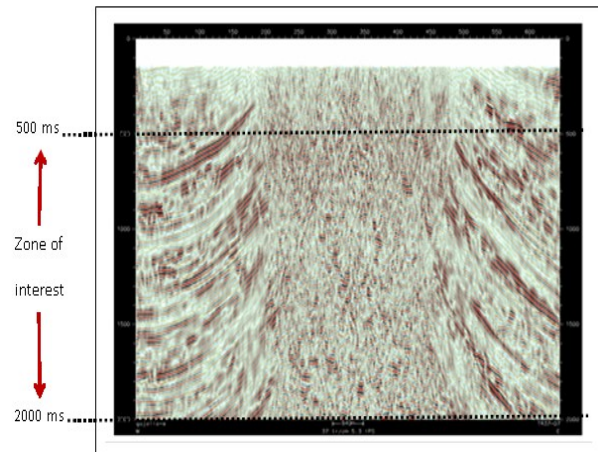


Figure 10: PSTM section of Line no: 07 of TR37.

## Conclusions

In the current Investigation of TR-71, 2D profiles were acquired in between old existing profiles of Investigations TR-37, TR-40 and TR-43. In recent campaign modeling study carried out before data acquisition has helped in field parameter fixation and this has resulted in improving the subsurface image. Closer geophone group interval of 10 m was used in the current campaign compared to the 25 m and 40 m in the earlier investigations. Foldage was also increased to 80 compared to earlier vintage range of 40 to 60. Team Geophysical Party No-09 put all efforts in acquiring meaningful and good quality data in spite of the increased logistic challenges in the area.

The data shown above from the current investigation is showing better signal to noise ratio and continuity of reflectors in the anticlinal part. The efforts put by the crew should definitely result in better delineation of further hydrocarbon reserves in the prospect.

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Views expressed in this paper are that of the author(s) only and may not necessarily be that of ONGC.

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