Static Correctons: Is it a Key Issue in Imaging Subsurface in Fold Belt?- A Case History in Langai Area, Assam Arakan Fold Belt

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Summary

In the complex of geological areas like fold belt with undulated topography, the data set required for modeling of the near surface is generally under sampled. The close grid up hole survey at each 1 Km is not sufficient to decipher the near surface model in such terrains. A closer sampling of up hole survey becomes uneconomical due to its drilling cost. To overcome this problem, authors adopted a new methodology of continuous shallow refraction (CSR) survey to map near surface model continuously. The efficacy of results of continuous shallow refraction survey (CSR) and its comparison with results of up hole survey at each 1 Km was compared by applying static corrections obtained by both surveys on 2D seismic data. The processed sections show that static corrections obtained using information of continuous shallow refraction survey gives better result in comparison to statics obtained through up hole survey.

Introduction

Seismic mapability of the cores of anticline is the greatest problem in Cachar fold belt of Assam Arakan Geosynclinal Basin which is in eastern part of India . The style of the deformation of the cores of Cachar is quite complex . The seismic data acquired in Cachar area of Assam Arakan fold belt do not give good image of subsurface particularly in the crest of the anticline whereas the flanks are relatively better imaged (Fig 1and Fig. 2) .The seismic data was aquired with large no. of channels (320 channels) with closer sampling, high fold and large offsets in the recent past. The mechanized potable drilling rigs are used for drilling the shot holes in order to get better penetration of seismic energy. However the efforts could not yield good image on the crest of anticline. These crestal portions are highly disturbed with thrusts and highly faulted. In such areas, along the anticlines, the near surface velocity changes rapidly and the Uphole surveys at an interval of 1km will give scanty information along the line. Therefore it requires interpolation of velocities to get continuous static correction at each shot point and receiver point. Wherever the high angle thrust and deeper information extend up to surface, UH surveys which are carried out at an interval of

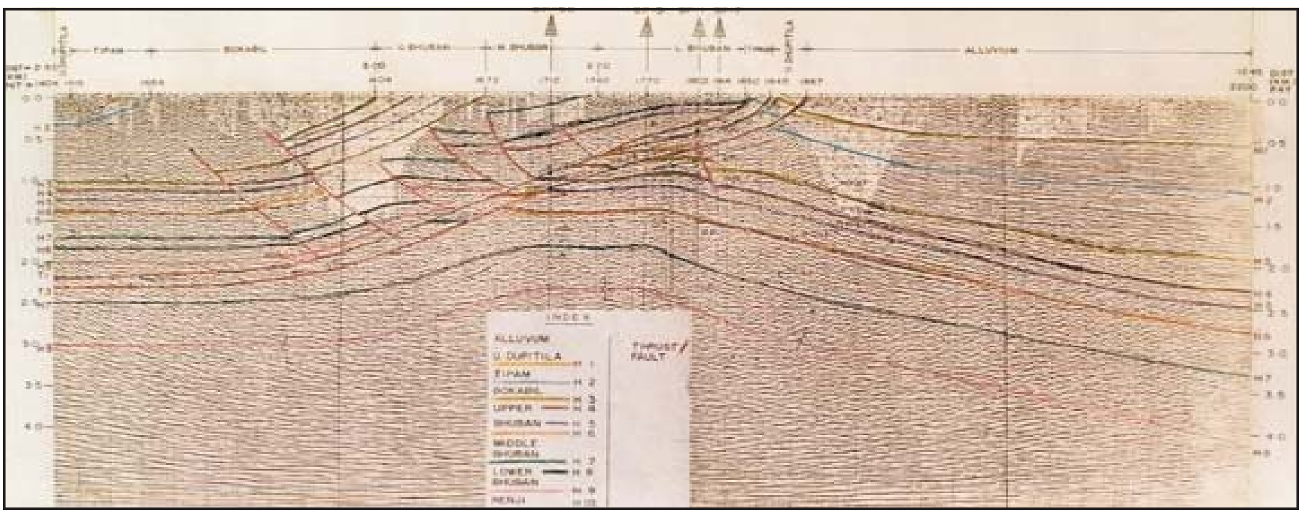

Fig.1 : Line A103-03 passing through Badarpur anticline

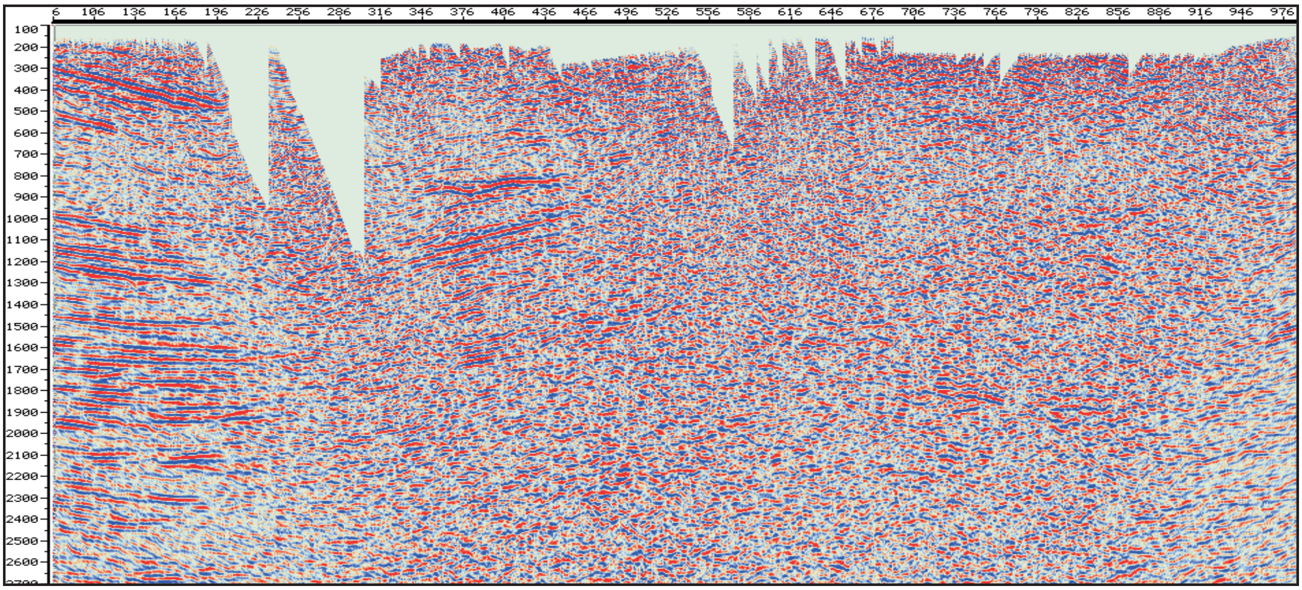

Fig. 2 : Line A147-02 passing through Langai anticline

1km cannot give adequate sampling of lateral velocity variations, thereby the static corrections become less accurate and cannot contribute for better imaging while processing.

However it is not possible to carry out UH survey at every shot / receiver point as it is very time consuming and expensive . The ability of the Geophysicist to estimate reliable velocity & residual static corrections depend on the quality of the input data and any necessary pre processing and data conditioning prior to this analysis. In the case of datum static corrections these errors can be minimized with suitable application of field statics and residual static corrections.

Datum static corrections are defined in terms of vertical travel through near surface layers. Corrections are applied to seismic data to compensate for the effects of variations in elevation, weathering thickness, weathering velocities. The objective is to determine the reflection arrival times which would have been observed if all measurements had been made on a (usually) flat plane with no weathering or low velocity medium (unconsolidated) present. Underlying the concept of static corrections is the assumption that a simple time shift of an entire seismic trace will yield the seismic record which would have been observed if the geophones had been displayed vertically downward to the reference datum.

This definition leads to the concept of surface-consistent corrections i.e. corrections that are dependent on the location of the source or receiver but are independent of the source to receiver offset or time of the recorded data.

The implied assumption of vertical travel in the near surface layers works well in most of the areas, even though the ray paths are rarely vertical. Because the distance traveled in the near surface layer for the various ray paths are different, and as lateral in homogeneities are present, the velocity may not be the same as per Mike Cox (1999).

Variations in elevation and irregularities in the near surface properties create irregularities in the recorded wave field. Some times the datum static corrections do not compensate for the near surface conditions and can introduce misalignments in a common mid point (CMP) gather that are larger than the data without datum static corrections. It is preferable to compute the datum static corrections, providing sufficient basic field data such as from SR – survey with more sampling on continuous profile. Therefore the SR-survey data can be compensating the near surface conditions in such a highly undulated seismic profile.

While acquiring Seismic data in Langai area of Cachar fold belt, the seismic crew adopted continuous SR survey along one seismic line and static corrections were calculated using this data. These static corrections which are obtained without interpolation contributed substantially for improving the seismic data in the crestal portion. The authors explain the methodology and its application while carrying out seismic survey in Langai area.

Methodology

2D seismic data was acquired in Langai area of Assam Arakan Geosynclinal Basin during 2004-05 with an objective of imaging the subsurface with additional efforts. Before acquiring the seismic data, seismic modeling studies were carried out to optimize the GI, nos of channels, spread length etc. and finally 25m GI, 4000 for offset & 40 fold data were selected for acquiring the seismic data.

The satellite map (Fig. 3) over the Langai anticline clearly brought out the surface relief & topographic trends of the area which is directly related to the tectonic deformation of the region. The major portion of the area is covered with hilly terrain with steep slopes & dense jungles with bamboo, sal, gargan , banana trees and tea gardens. There are a number of rivers and swamps in the area. The area is highly undulated with hillocks/steep mounds like terrain and the elevation varies from 10 m to 155 m in general. Langai anticline is the southern most part of the anticlinorium of Cachar fold belt of Assam-Arakan Geosynclinal basin encompassing an area of about 400 sq. km. It is a doubly plunging, narrow, elongated, tightly folded anticline having N-S to NNE-SSW trend with steep limbs. Its eastern limb is dislocated by a prominent longitudinal reverse fault, which diminishes towards both the plunging ends. The anticline is bounded by Deo and Lalkhira syncline on the west and Isabil syncline on the eastern flank. The core of the anticline exposes Upper Bhuban formation. Younger formations like Tipam & Dupitilla are exposed on the flanks.

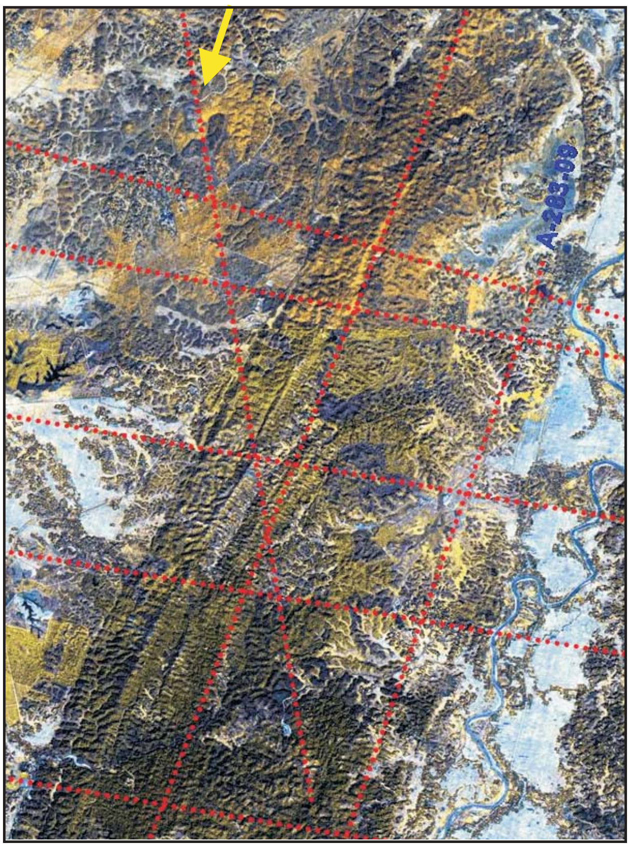

Fig. 3 : Satellite map of Langai in cachar area.

While carrying out seismic data along seismic line no 03, UH survey were carried out at nine places along the line and the Near Surface Model was prepared . Along this line Continuous Shallow Refraction (CSR) surveys were carried out with a spread length of 120 mts. Group interval is kept as 5 mts and total 24 groups are present in each spread. Schematic layout of CSR is shown in fig. 4. About 49 SR surveys were carried out along the line -03. The results of SR survey were processed with the help of Reflex Software and shown in fig 5b. Fig 5a shows the velocity information obtained through interpolation of UH survey data. Fig 5b shows the variations in near surface velocity when compared to fig 5a, because the velocities are interpolated in between uphole survey, whereas in CSR survey, the velocities are actually obtained at each picket interval. Fig 6a shows a part of weathering depth and elevation on line no. -03. The weathering depth obtained through UH survey and interpolated subsequently and the depth obtained through CSR survey do not show much variation. However in Fig 6b the weathering velocity obtained through the different processes give much variation and these variation shows / explain the ambiguities in static corrections. The SR survey throws more light on variations in near surface velocities effectively in comparison

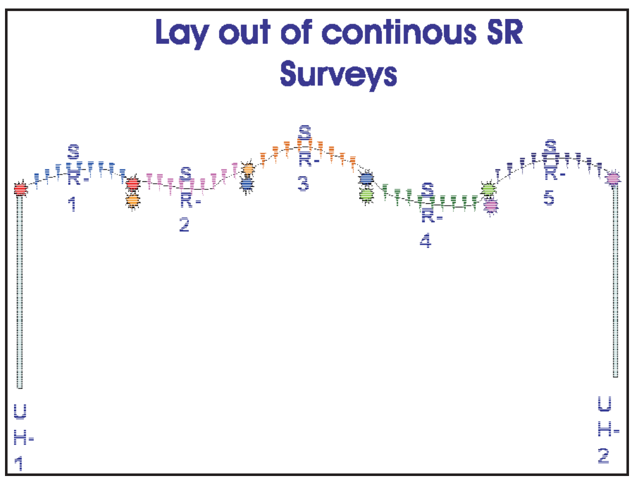

Fig. 4 : Schematic lay out of Continuous SR survey

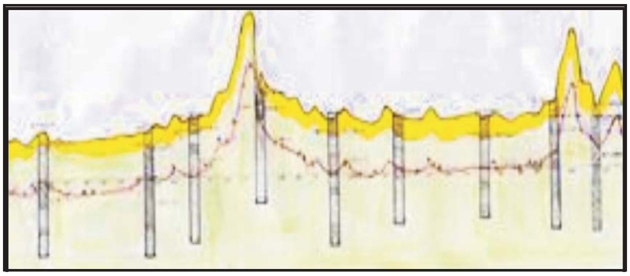

Fig. 5a : Near surface model along profile (UH survey)

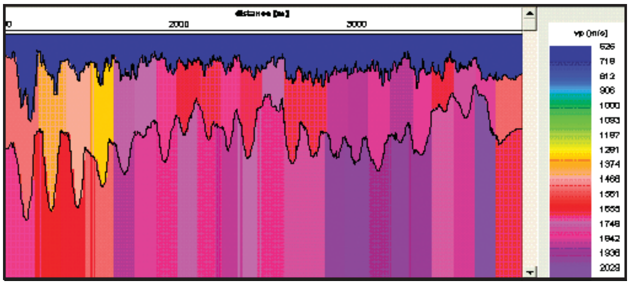

Fig. 5b : Near surface model along profile (CSR survey)

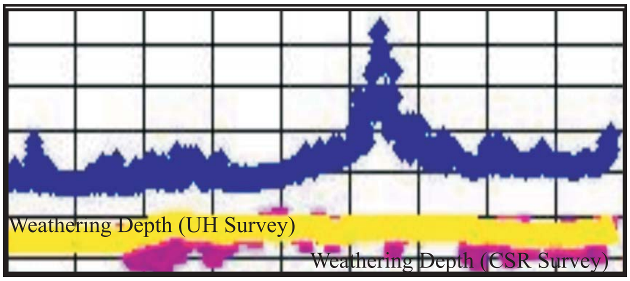

Fig. 6a : Weathering depth and Elevation along profile

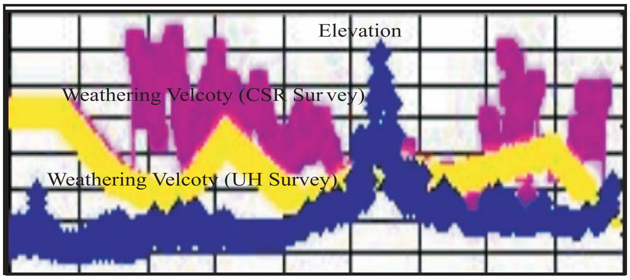

Fig. 6b : Near surface model along profile (CSR survey)

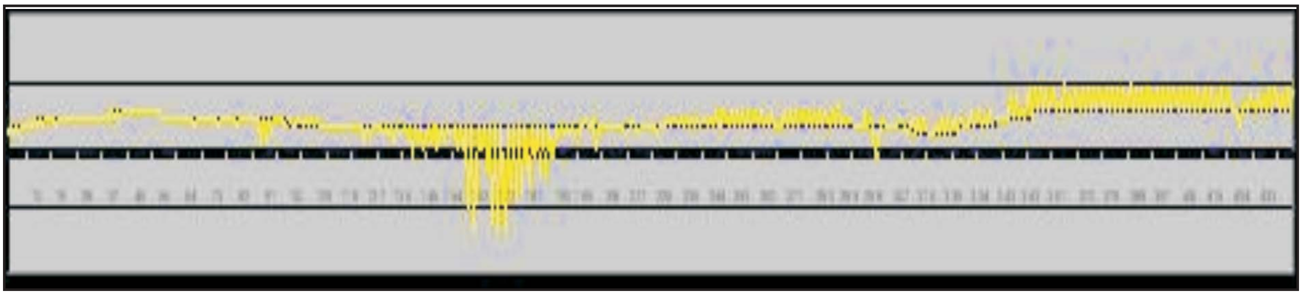

Fig. 7a : Static corrections obtained through UH survey

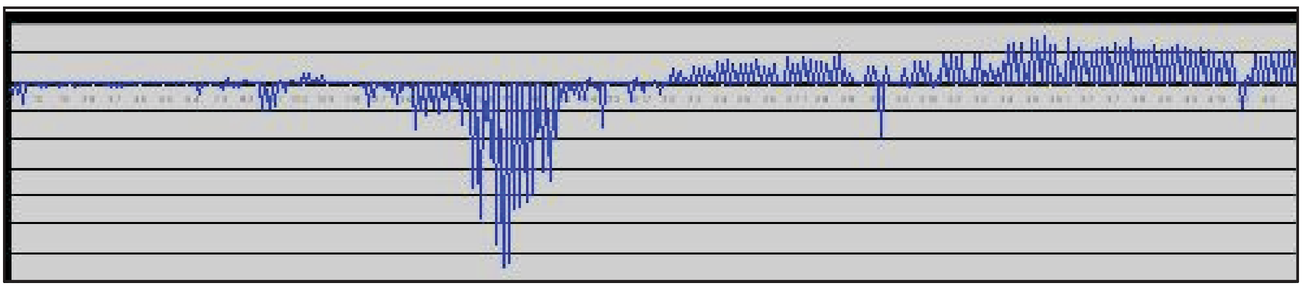

Fig. 7b : Statics obtained through CSR survey

to UH survey due to its closer spatial sampling. The static corrections obtained through these two different processes are shown in Fig 7a and 7b. Shot static corrections obtained through SR surveys (Fig 7b) are smaller than static corrections obtained through UH surveys (Fig 7a). The differences are quite evident. The line was processed initially with static corrections obtained through UH surveys and later with statics obtained through SR surveys. Fig 8a shows the stack section processed with statics obtained through UH survey and Fig 8b shows the stack section with statics obtained through CSR surveys. When compared to section Fig 8a and 8b the deeper events are clearly seen, the faults are also can be confidently mapped in this section.

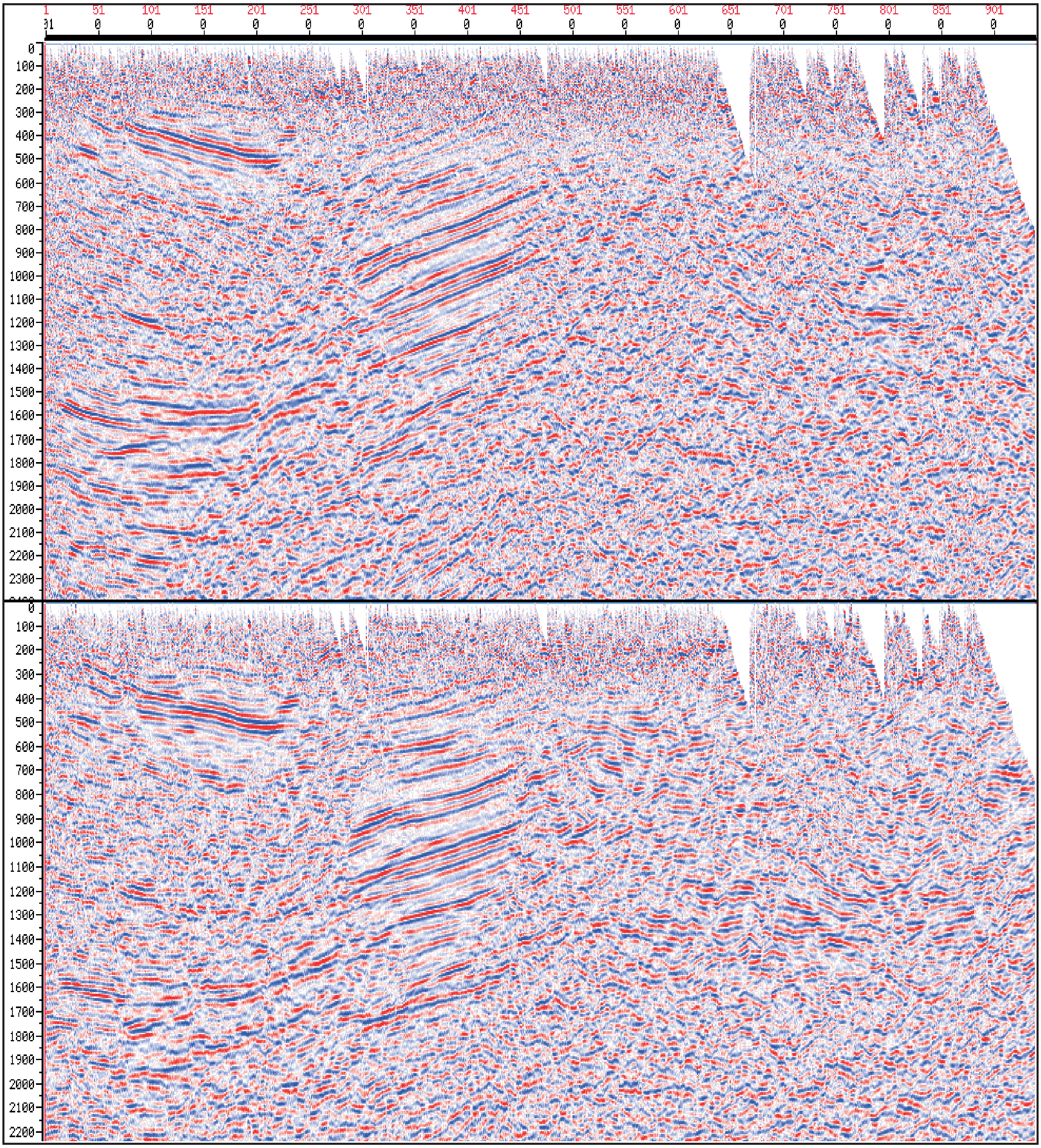

Fig. 8a(above) : Processed with statics obtained through UH survey & **Fig. 8b :** Processed with statics obtained through CSR survey

Conclusions

UH-survey and SR- survey seismic methods are key elements of the geometry for constructing near- surface modeling for evaluating the optimum depth (OD), weathering thickness (Dw), weathering velocity (Vw), sub-weathering velocity (Vsw), for the purpose of applying static corrections in processing for getting better seismic sections.

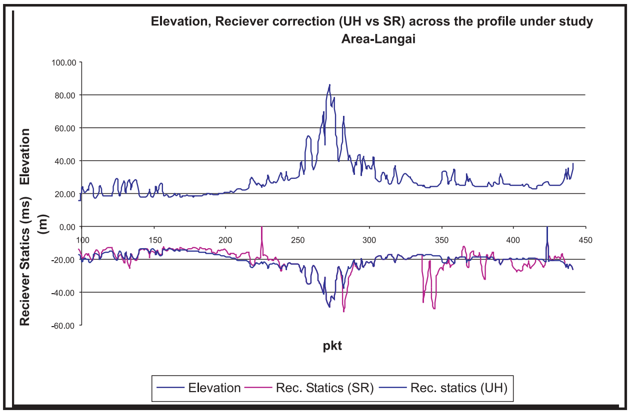

Fig. 9

Both UH & SR methods must be used in seismic field for the above purpose.SR method is a clear choice for solving certain types of problems like drilling difficulties like hard formation, hilly terrain and highly undulated area. Moreover velocity information is obtained at each picket.

Using more number of channels in SR studies, with continuous sampling of the profile or area employing minimum spacing of receivers (say 2m) accurate static corrections can be achieved which is very essential in undulated terrain. Such an exercise would yield a better stack response in such areas.

After analyzing the results of SR and UH, SR data sets add to the Uphole data sets to get more information from almost all the pickets. So this is an additional advantage on an area related to undulation and hard formation.

1. UH-survey results are under sampled and more interpolation is required for static correction in highly undulated area.
2. UH-drilling (50-60m) is very difficult in hard formation and more expensive.
3. SR-survey results are more/ closely sampled and no interpolation is required for static correction in highly undulated area.

Iherefore, it is concluded that SR-survey techniques adds additional information in highly undulated terrain and hard formation area. SR-survey gives more sampled data for accurate static correction in processing for better seismic stack.

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References

Choudhury, H.K. Sept 2004, Project report on 2D seismic survey in Badarpur area (unpublished), ONGC

Choudhury, H.K. Sept 2005, Project report on 2D seismic survey in Langai area (unpublished), ONGC

Dean A.Keiswalter, Don W.Steeples, A field investigation of source parameters for the sledgehammer.

Mike Cox, Static corrections for seismic reflection surveys. SEG publication

Robert W.Lankston, High Resolution Refraction Data Acquisiton and interpretation.