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## Field statics estimation: A case history from North Assam Shelf, Assam, India

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### Summary

**Summary:** Complex near surface velocities and Elevation differences introduce irregular travel time delays. Static corrections are applied to seismic data to compensate for the effects of these variations. Success of statics estimation depends on the accuracy of the near Surface model. Uphole survey based modeling smoothens out the strong variations in the near surface. Often the statics estimated from the interpolation of discrete coarsely sampled uphole surveys lead to gross errors. Uphole times observed from the shot to shot indicates the high frequency variation of the near surface. The vertical times from the uphole surveys need to be reconciled with uphole times from the shot points to arrive at the near surface model. This approach takes the benefit of both high frequency and low frequency variation better and the field statics estimated will yield better results.

### Introduction

The 2D high resolution seismic survey was carried out during 2012-13 in the Teok area of North Assam Shelf of Assam. The Acquisition parameters were given in the table-1 and scheme of lines shown in fig-1. The data acquired with high dense receiver (single sensor with 10m group interval) and 86 fold. The objective of the survey is to map the prospects within Barail Coal-Shale (BCS) and Barail Main Sand (BMS) of Oligocene age and Tura & Sylhet formations of Eocene age and also to find out Syn-rift sediments (TWT 2800-3200ms). The major Jorhat fault is in the southern part of this area with West-East strike. The area consists of large scale tea gardens with gentle slope and there are not much of topographic variations. The near surface consists of mostly shaly sand and energy penetration and in general, the coupling conditions are good. Near surface studies were carried out using deep (~60-65m) uphole surveys at 2-Km interval and some shallow refraction surveys. Near surface modeling is done by interpolating the uphole surveys along the profile.

**Initial Observations:** Examination of supplied field static corrections at some locations revealed the inconsistency in the computed estimates. The plot of elevation and total statics also substantiated the incorrectness. Normally, at a

given location, the elevation with reference to the datum and the receiver static correction should have opposite trend (fig-2).

Table 1: Acquisition Parameters

Parameter	Value
Group Interval (m)	10
Shot Interval (m)	50
Charge depth	18-21m
Charge size	2.5 – 3.5 Kg
Number of Channels	860
Fold	86
Shooting geometry	Symmetric Split Spread
Min Offset (m)	5
Max Offset (m)	4295
Record Length	8 sec
Sample rate	2 ms
Instrument	IO Scorpion
Sensor	SVSM

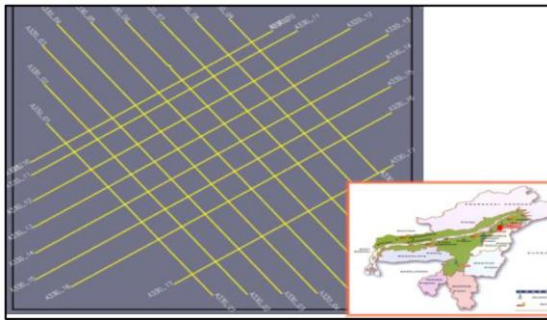


Fig 2: Elevation & Statics model

Comparison of CMP Stack with and without application field statics, indicated that the results without application field statics are found to be better. The continuity of shallower as well as deeper events was disturbed after applying field statics. It is also evident from the overlying graph of elevation and the total static correction above the CMP locations (fig 3). Statics are recalculated in two methods with available information for further processing.

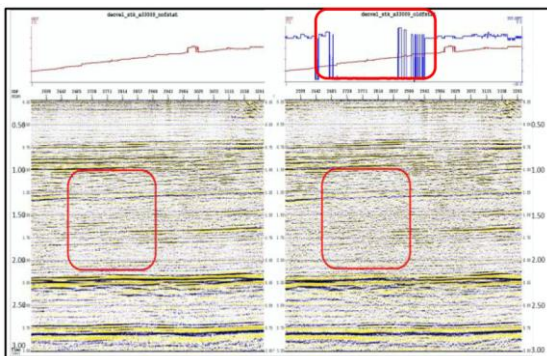


Fig 3: CMP stack without (left) and with (right) field statics.

## Methodology

1. **Single layer method:** Elevation statics involve the computation and removal of the effect of different source and receiver elevations. This involves bringing the source and receiver to a common datum. For this a replacement velocity for the material between the datum and the source or receiver is required. In the simplistic assumption, this material can be thought of a single layer rather than two or three layers. This is a quick but relatively inaccurate method.

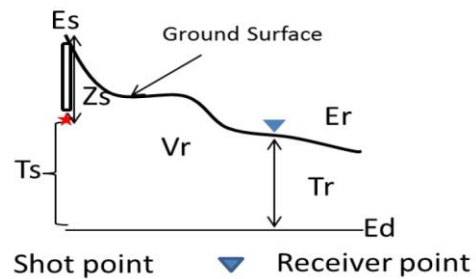


Fig 4a: Schematic diagram for elevation static

The Source static correction is given (fig-3) by

$$T_s = ((E_s - Z_s - E_d) / V_r) * 1000,$$

and the corresponding receiver correction is given by

$$T_r = ((E_r - E_d) / V_r) * 1000,$$

Hence the total static correction is  $T = T_s + T_r$

Here  $E_s$ ,  $E_r$  shot & receiver ground elevations,  $Z_s$  depth of shot with respect to surface,  $E_d$  datum elevation from mean sea level, and  $V_r$  is replacement velocity.

2. **Graphical method:** In another approach, instead of one layer velocity, Uphole times recorded in the immediate vicinity of the shot holes are used to calculate statics for more accuracy. For this, the uphole times observed at each shot point are plotted at the depths of the shot point picket and contouring the equal uphole times. At those shot point pickets where the uphole survey is also available, the uphole times need to be reconciled. Care must be taken to exclude erroneous uphole times. The methodology is explained in table -2 & fig-4c.

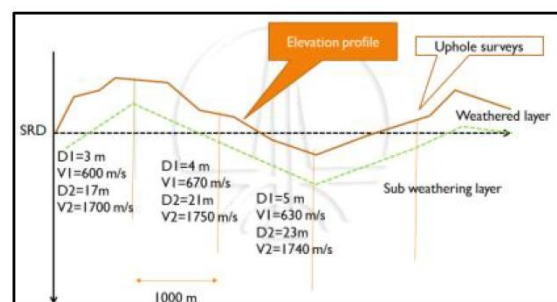


Fig-4b. Static correction estimation using linear interpolation of uphole survey data. High frequency variation of near surface is missed in this approach.

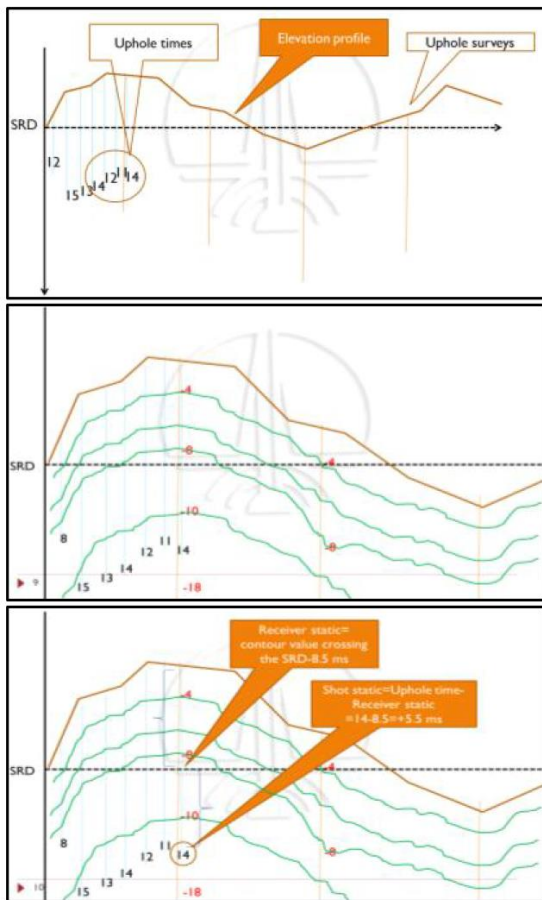


Fig-4c. Near surface modeling and statics estimation using uphole times and uphole surveys through reconciliation. Posting of picket elevations, charge depth and uphole times at depths of shot point pickets (top). Contouring the reconciled uphole times (middle). By reading the contour value at each picket at Seismic reference datum (SRD) as receiver static and shot static as the difference between the uphole time and the estimated receiver static (bottom).

### Study of the available data

With the available data, the estimated replacement velocity is 1600m/s for calculation of static corrections in the first method. The shot hole depth is varying from 21 to 25m. The near surface model estimated based on uphole surveys only is shown in fig-5. The elevation is varying in the range of 85 – 108m as depicted in fig-6. From uphole surveys weathering layer velocities are found to vary in the range of 600 to 1100m/s and subweathering layer velocities are in between 1300 to 1700m/s (fig-7 & 8).

For the second method, contour maps are generated with available uphole times at the shot hole depths and uphole surveys as explained in table-2 for receiver static

calculation. The fraction of shot depth and Uphole times give the average velocity at each shot point. This velocity is used to calculate the receiver statics and the subtraction of uphole time from receiver correction gives the shot static value.

Table-2. Static correction estimation using uphole times & uphole surveys.

- On a mm graph paper plot the profile with distance along X-axis and Depth along Y-axis (with vertical exaggeration)
- Plot the elevation profile with respect to Seismic reference datum
- Mark the shot hole depths at each shot picket ('-')
- Place the uphole time value near the ('-') symbol
- Also plot the uphole survey data ( $v_1, d_1, v_2, d_2$  and depth vs vertical time) at appropriate depth intervals at the uphole survey locations
- Try to reconcile the uphole times with uphole survey depth-vertical time values at the shot depth points
- Contour the uphole times with an interval of 2-ms along the profile
- Read the contour value crossing the seismic reference datum at each picket. This is the Receiver static correction at that picket
- Subtract the uphole time value from the receiver static correction. This is the shot static correction

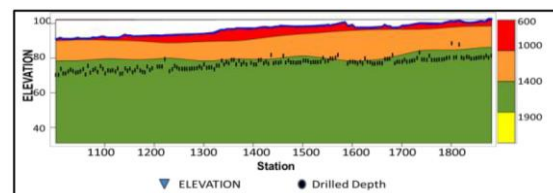


Fig 5: Near surface model of Line 09

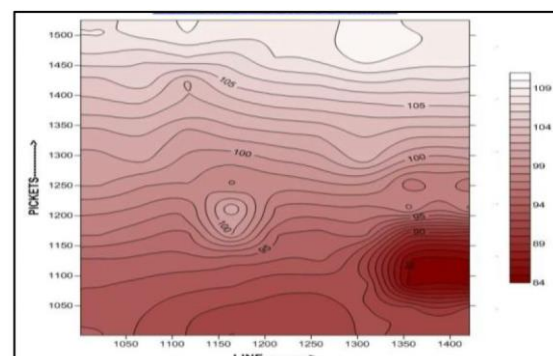


Fig 6: Elevation contour map

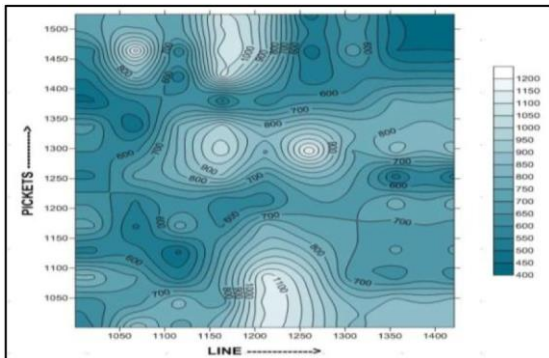


Fig 7: Weathering layer velocity contour map

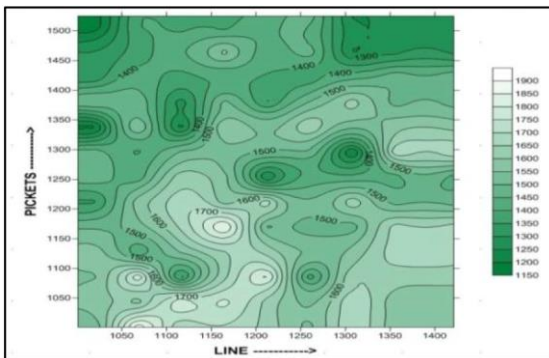


Fig 8: Sub-Weathering layer velocity contour map

### Observations & Results

With the above two approaches calculated statics are applied to the data and compared the sections. Calculated receiver statics model shown in fig-9. The stacked sections have shown in fig-10, fig11, and fig-15 demonstrate the improvements after correcting the statics.

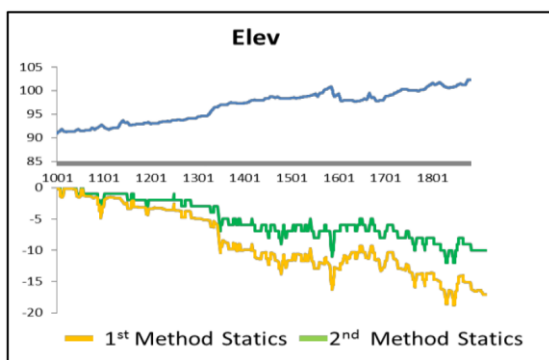


Fig 9: Elevation and different receiver statics

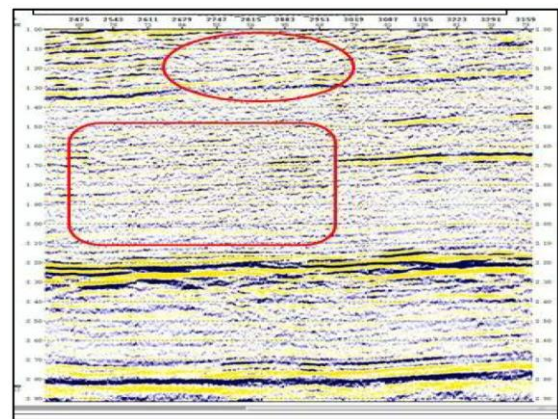


Fig-10: CMP Stack with erroneous filed statics

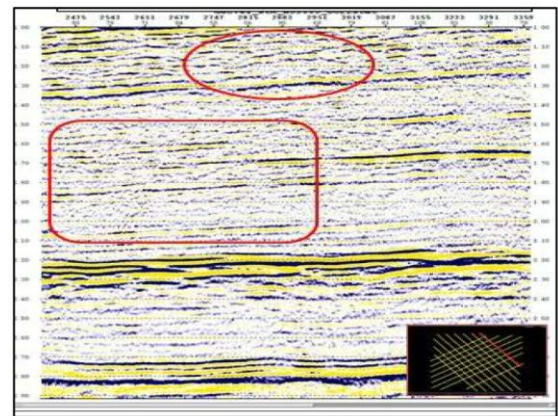


Fig-11: CMP Stack with Corrected statics

In figures-12 to 14, it has been observed the impact of static corrections in shallower zones in the semblance. After applying corrected statics the semblance has been easily distinguishable for better velocity picking in shallower zones.

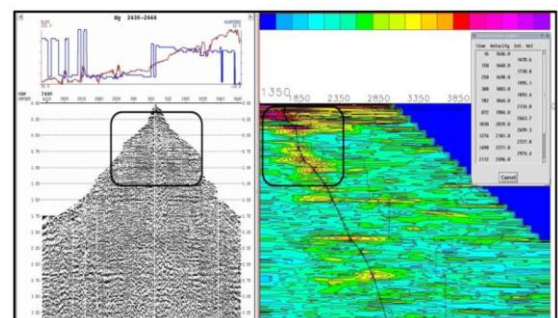


Fig-12: Velocity analysis on gather with earlier statics

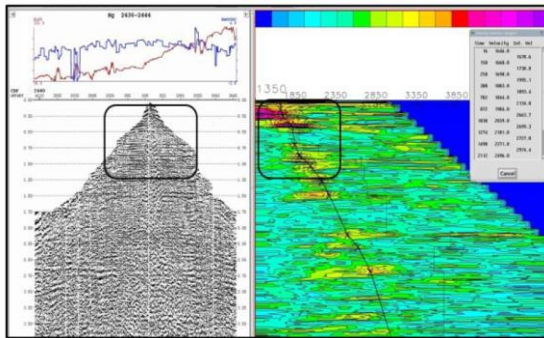


Fig 13: Velocity analysis on gather with first method statics

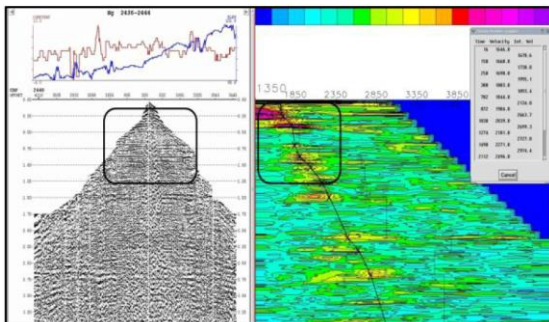


Fig 14: Velocity analysis on gather with Second method statics

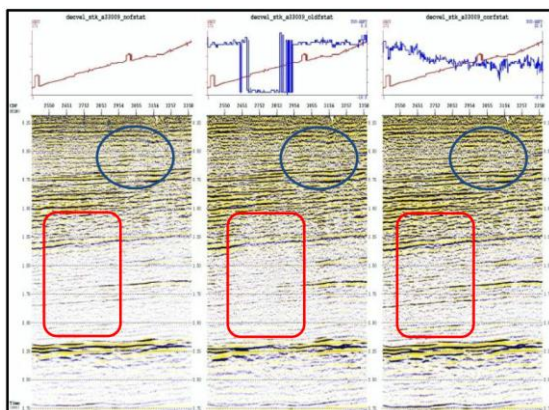


Fig 15: Comparison of CMP Stacks without statics, with Earlier & new statics calculated in second method

## Conclusions

Estimating the field static corrections from the near surface model based on coarsely sampled uphole surveys would only provide the low frequency variation. This would miss fast variations as seen in the uphole times at each shot point picket. Errors in statics so computed can be identified based on simple thumb calculations and based on single layer approaches. Contouring the uphole times observed at each and every shot point and reconciling with uphole surveys the estimated near surface model would derive the

benefits of the low frequency uphole survey data and the high frequency uphole times.

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*Views expressed in this study are of the authors only and do not reflect those of ONGC.*

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