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Characteristics of Low Velocity Layer in Upper Assam Basin near Naga Thrust: A Brief Study

S. Saha*, A. Mandal, B. Borah and M. Gupta, *Oil India Ltd.*

Summary

Low velocity layer modelling is an integrated and vital part of seismic data processing and interpretation as it influences seismic reflection travel time. In this article, we tried to establish the nature of LVL near Naga thrust area of Upper Assam Basin. LVL survey data of different areas viz. Amguri, Sonari-Sapekhati-Namrup-Borhat and Jorajan are used to study the LVL nature (fig-1). In each area, we generated the elevation and velocity contour maps and tried to correlate between them. In most of the areas, we found the presence of three layers whereas some place exhibited the signature of a fourth layer.
The areas which are chosen for the purpose of this study are quite far from each other which made it challenging to correlate between them at the initial phase of the study.

Keywords: *LVL, Naga thrust, Amguri, Sonari-Sapekhati-Namrup-Borhat, Jorajan*

Introduction

Low velocity layers (LVL) or weathered layers are present on the uppermost layer of the crust near the surface up to a certain depth. It has a significant influence on seismic reflection travel time and hence influences seismic data processing & interpretation. The modelling of LVL aims to correct for the time shift necessary to nullify its effect on seismic data and bring the seismic data to a datum. Shallow refraction and uphole survey techniques are used to extract the information of shallow weathering layers.

In this article, the geometry and seismic characteristics of weathering layers at Upper Assam Basin along Naga thrust area, has been discussed. The shallow refraction and uphole data of different areas, along the Naga thrust, have been used. The low velocity layer data from Amguri, Namrup-Borhat- Sonari-Sapekhati and Jorajan areas were inspected thoroughly (fig-1). **The Intercept/slope** technique aided the interpretation and the CPS module of **Geo-Frame software** provided the contour plots required for analysis.

Surface Geology and Logistics

Areas from where the data are acquired are mainly around the northern foot hill regions of Naga hill. Naga hill trends NE to SW along the southern part of the Assam shelf separating Assam from Arunachal Pradesh. Naga Thrust belt is characterised by narrow, elongated and highly rugged surface topography about 20 to 25 km wide with steep slope and inaccessible terrain. Due to these variations in topography, it is always very challenging to acquire data in these regions and also this undulating topography plays a vital role in static in reflection seismic. In the map bellow, the red line indicates the trend of Naga Thrust belt.

Geophysicist, Oil India Limited, Duliajan, India
Sankhajit_saha@oilindia.in

Figure -1 : Map showing area around the Naga thrust (red line), area of study are marked (yellow blocks).

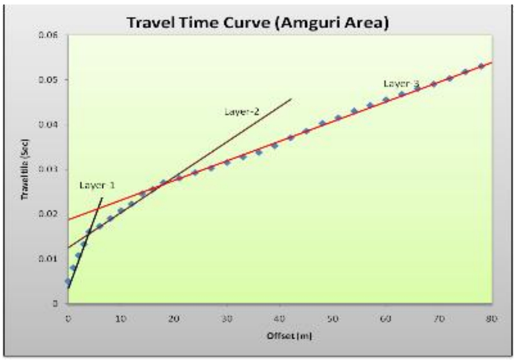


Figure-2: Travel time curve from refacrtion data for amguri showes three layers model.

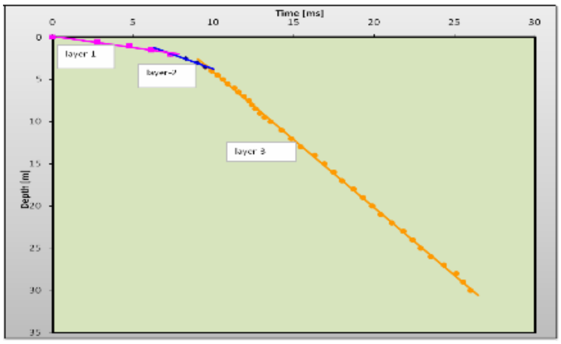
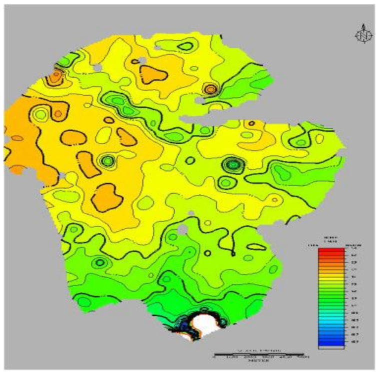


Figure-3: Uphole data indicates three layers model for Amguri area.

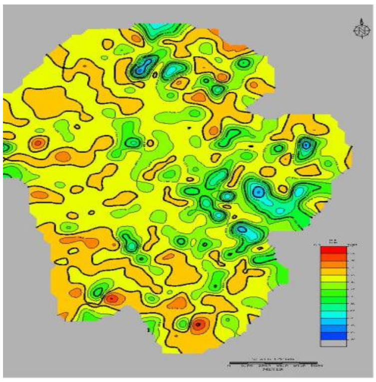


(a)

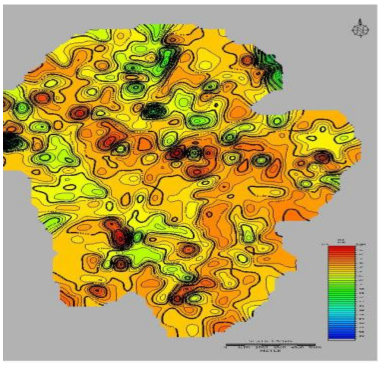
Interpretation results

Amguri

In Amguri area both the refraction and up hole data were acquired in a grid pattern. The refraction data of about 512 points and uphole data of about 132 points are used in this study. The refraction as well as uphole data indicates that the uppermost layer comprises predominantly of two layers (fig- 2,3). The upper one demonstrates velocity ranging from 250 m/s to 638 m/s with a thickness varying from 1.4 m to 8.8 m. The thickness varies from place to place with alterations in elevation. The lower one shows velocity ranging from 758 m/s to 3230 m/s and the thickness varies from 2.8 m to 11.3 m, though the thickness information is not continuous. The refraction data indicates the presence of a not-so-clear third layer at some places with a variation in velocity from 1359 m/s to 2576 m/s with differences in elevation. The Uphole data, however, gives information about the third layer quite well at each survey point and also, we get some information about the presence of a fourth layer. Figure-4a, 4b and 4c illustrate the elevation and velocity contours of the area.



(b)

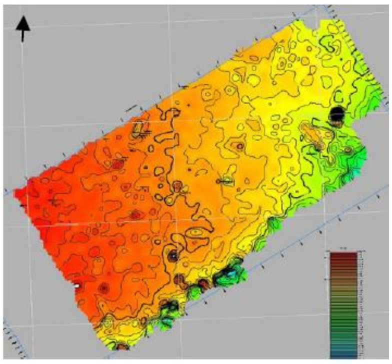


(c)

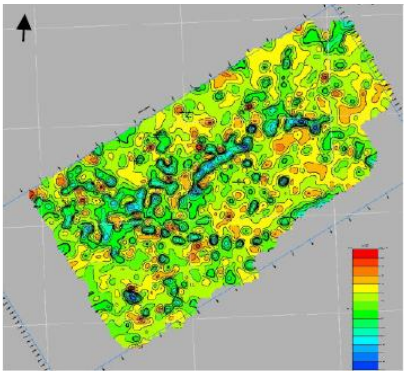
Figure-4: Elevation and thickness contouring of Shallow weathered layers in Amguri area, (a) elevation contour of the area, (b) velocity contour for first layer, (c) velocity contour for second layer.

Sonari-Sapekhati-Namrup-Borhat

LVL data that were acquired from Sonari, Sapekhati, Namrup, Borhat and their surrounding areas, also shows evidence about the presence of the three layers. Refraction data were studied from these areas. The variation in elevation in this area is quite large and it varies from 100 m to 157 m. The velocity of uppermost layer varies from 188 m/s to 854 m/s and the thickness varies from place to place, ranging from 1 m to 15 m. The second layer is showing large velocity variation from 505 m/s to 2134 m/s and the maximum thickness of the layer at some places goes up to 20 m. The third layer exhibits maximum velocity around 3227 m/s. The elevation contour map (figure: 5a) demonstrates that as we go away from the Naga thrust towards north, the elevation decreases.



(a)



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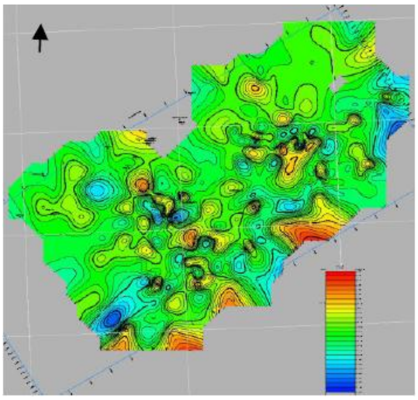
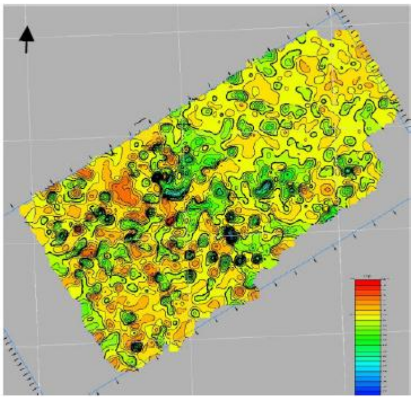


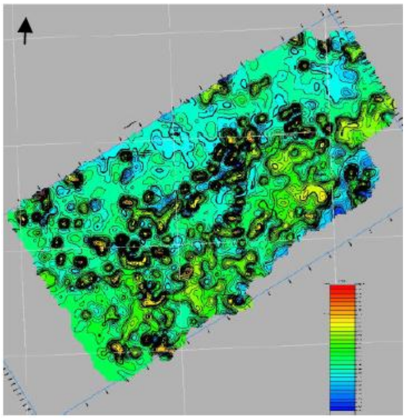
(c)

Figure-5: Elevation and thickness contouring of Shallow weathered layers in Namrup-Borhat area, (a) elevation contour of the area, (b) thickness contour for first layer, (c) thickness contour for second layer.

Figure: 5 (b) and (c) display the thickness distribution of first and second layers respectively. The thickness map of first layer shows certain pattern, particularly at the middle portion of the map. A narrow band of the thicker portion of the layer trends approximately SW-NE direction. It may be correlated with the subsurface deformation but extensive study and information is necessary. Figures: 6a, 6b and 6c show velocity distribution of all the three layers. If we see the velocity and thickness contour map simultaneously for the first layer, it could be observed that the narrow zone with closely spaced contours in the velocity map shows velocity difference from its surrounding area. In the second layer sharp velocity variation in local scale can be seen.



(a)



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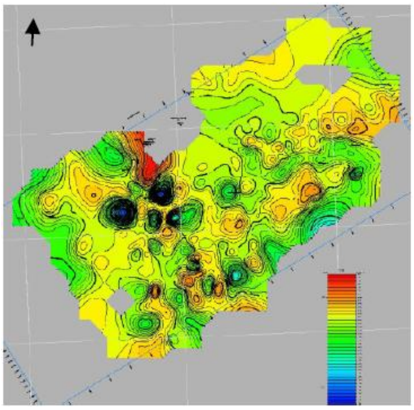

(c)

Figure-6: Velocity contouring of all three Shallow weathered layers in Namrup-Borhat area, (a) velocity contour for first layer, (b) velocity contour for second layer, (c) velocity contour for third layer.

Jorajan

In Jorajan area, Uphole data was analysed for the on-going study. The Uphole data of about 179 points are used in this study. The Uphole data designate that the uppermost layer comprises of two layers (fig-7). The upper one shows velocity ranging from 211 m/s to 900 m/s with a thickness varying from 4.0 m to 12.00 m. The thickness once again is non-unique with elevation changes. The lower one shows velocity ranging from 1071 m/s to 2700 m/s. No information could be revealed about the thickness of the layer.

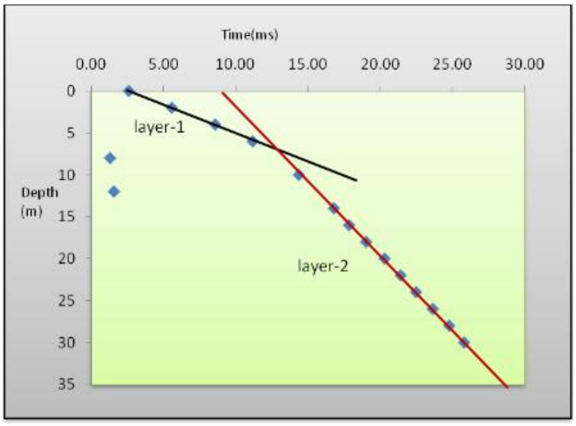

Figure-7: Depth time curve from uphole for Jorajan shows two layes model.

Conclusion

In all the three areas, LVL study distinctly illustrates the presence of three layers in the topmost part of the subsurface. Among them two layers are well mapped. The velocity- thickness map of all the layers in each area shows significant variations, both in local as well as regional scale. For further analysis, more information is required. We had encountered a number of obstacles during our study of LVL data of these areas. As the selected study areas are separated too large a distance, larger even on a regional scale, it would not be an intelligent idea to interpolate the subsurface LVL properties between these areas. So before moving further, we need to acquire sufficient information to fill the data gap. We may have to obtain core samples and then do the analysis to get the lithological characteristics of the low velocity layer along the thrust. As LVL has substantial impact on seismic reflections, we will have to think seriously about these issues. Although this work is in the preliminary stage, it gives a brief picture of LVL characteristics near Naga thrust area (fig-1).

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