The Study of Static Correction for Seismic Data Acquired in Boulder Bed Areas of Pasighat (Arunachal Pradesh)

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Summary

Static correction has been a major challenge for seismic exploration particularly in geologically complex areas having boulder beds and mountains . Such areas are characterized by lateral velocity variation in the weathered zone . It has been observed from the first breaks of seismic monitor records showing distinct features of bending events of near offsets. Therefore, assuming equivalent medium with quadratic velocity variation in depth, an attempt has been made to derive proper static correction in order to apply on the seismic data acquired in Pasighat areas of Arunachal Pradesh.

The technique for quadratic velocity model for solving the raypaths bending at near offset and linear events (refraction) for the far offset arrivals has been used world wide. But the technique has been adopted for the first time in Pasighat area. Where acquiring seismic data in loose boulder beds has been increasingly difficult due to shot-hole drilling problems. Thereby the shot and receiver static has been calculated and used them in seismic data processing. Considerable improvement has been observed in seismic sections after the application of the method in the shallow events where as there is only marginal improvement in the deeper events.

Introduction

Oil India Ltd (OIL) has been carrying out seismic surveys since 1977 as part of its exploration activities in south of the river Brahmmaputra North East. Recently as part of its accelerated exploration programme OIL is conducting seismic surveys in the geologically and logistically complex areas of Pasighat and Manabum in Arunachal Pradesh.. The Pasighat area comes under thrust belt and logistically difficult area fully covered with boulders and loose sands where 2D seismic survey has been carried.

The exploratory efforts have been increased in Pasighat area by conducting seismic survey using the state-of-the-art technology equipment and about 100 GLKM of seismic data has been acquired. The static correction in such geologically complex and logistically difficult area has been a major problem for obtaining good seismic data. It has been observed from the seismic records that such areas are characterized by lateral velocity variation in the top top weathered zone. The first breaks of seismic monitor records show distinct features of bending events at near offsets. Therefore, assuming equivalent medium with quadratic velocity variation in depth, an attempt has been made to derive proper static correction for the seismic data acquired in Pasighat areas of Arunachal Pradesh.

The technique for quadratic velocity model for solving the raypaths bending at near offset and linear events (refraction) for the far offset arrivals has been used worldwide. In view of this the technique has been tried for the first time in Pasighat area on a 2D seismic line which shows relatively better S/N ratio than the other data acquired in the area where acquiring seismic data in loose boulder bed has been very increasingly difficult due to shot-hole drilling problems. The shot and receiver static has been calculated using this method and applied in processing of this line. Considerable improvement has been observed especially in the continuity of the shallow events.

Method for solving the quadratic velocity model

Earth is divided in several layers having lateral and vertical velocity variations. It assumed that Earth is homogeneous medium in shallow depth and as per conventional technique, velocity varies laterally and vertically due to presence of these layers having different velocities. Therefore the technique of quadratic velocity model is applied.

The general equation for continuous velocity model (Wei et al 2002)

$$V(z) = \sum_{n=1}^{N} a_n z^n$$

Where a is constant, z^n many layered and N is showing the multilayer velocity medium, this equation maybe used in to describe any types of continuous velocity model.

In reality, there is no stability in inversion with higher than two degree. Hence it can use the velocity model equation as given below.

$$V(x,z)= V(z)(1+ax+bx^2) \quad (1)$$

The quadratic equation for ray bending at near offset is:

$$T=a^1x + b^1x^2 \quad (2)$$

The linear first break arrivals at far offset can be written is:

$$T=T^2o+ a^2x \quad (3)$$

Where T^2o is an intercept time and a^2 is a slope or inverse of bedrock velocity

Assuming that the two intersect at offset x_o .

$$a^1x_o + b^1x^2_o =T^2o+a^2 x_o \quad (4)$$

$$T^2o= a^1x_o + b^1x^2_o - a^2 x_o \quad (5)$$

After Solving the Equations (4) & (5), we have derived the following

$$T^2o=-b^1x^2_o$$
$$a^2 = a^1 + 2b^1x_o$$

Computation of first break

- Pick the first break precisely from seismograph.
- Plot a time vs offset graph.
- Analysis of quadratic curve for bending of ray path at near offset.
- The quadratic equation for near offset can be written as.
  $T=a^1x + b^1x^2$
- Linear first break at far offset from refracted arrivals can be written as.
  $T=T^2o+ a^2x$
  Where To be the intercept time and a^2 is the inverse of bedrock velocity V_b as in case of refracted static correction.
- Calculated the intercept time from linear first break at far offset.
- Computed the velocity of weathering layer V_o from the quadratic curve at near offset and velocity of sub weathering layer V_1 calculated from refracted arrivals at far offset.
- After calculating V_o, V1 and T_o, depth of weathering layer z_o is determined.

Computation of static

When velocity model is generated and the shot and receiver static can be calculated.

Shot and receiver static calculated with the help of this formula

$$t^s_i = \frac{e_i - d_i - e_d}{V1}$$

$$t^r_i = \int_0^{z0i} \frac{dz}{Vo} + \frac{e_i - z_o - e_d}{V1}$$

Where e_i, z_o, e_d are the datum elevation, depth of weathering layer and surface elevation i^{th} position of station.

For application of this technique, one seismic line PSG-10 in Pasighat area has been selected and utilized by using the conventional as well as proposed method. The raw data contained full of noise and ground rolls. This data has been processed with conventional as well as proposed method.

Results and discussion

It has been observed that after the application of the statics computed by this method, there was improvement in the continuity of the shallow events.

Figure 1 and 3 shows the conventional statics computed by the normal LVL method and Figure 2 and 4 shows the statics computed from the quadratic velocity model for source and receivers respectively The conventional receiver statics show a more scattered trend both at high and low elevations (Figure 3). While, on the other hand, the receiver statics calculated by new method show a smoother trend at low elevation. Similarly the points

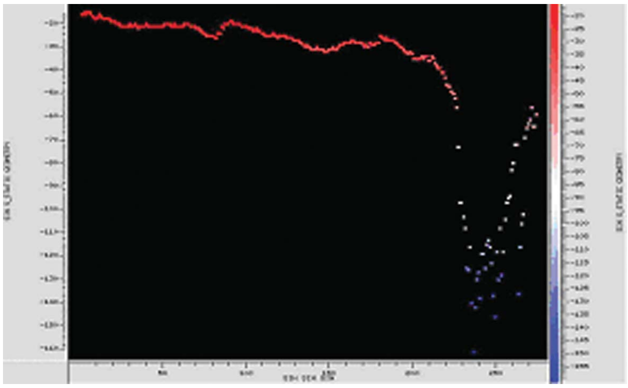

Fig.1 Shows the Source Statics calculated from Conventional Method.

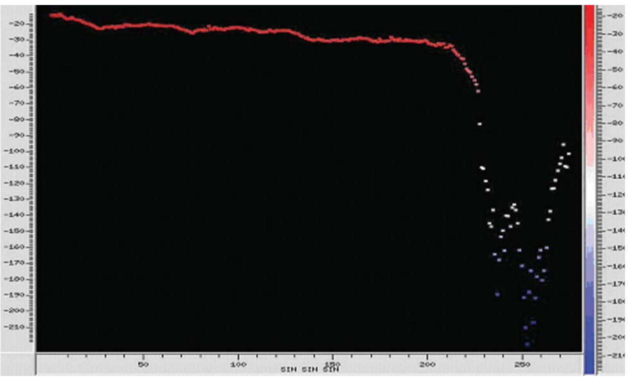

Fig.2 Shows the Source Statics calculated from Quadratic Velocity Model.

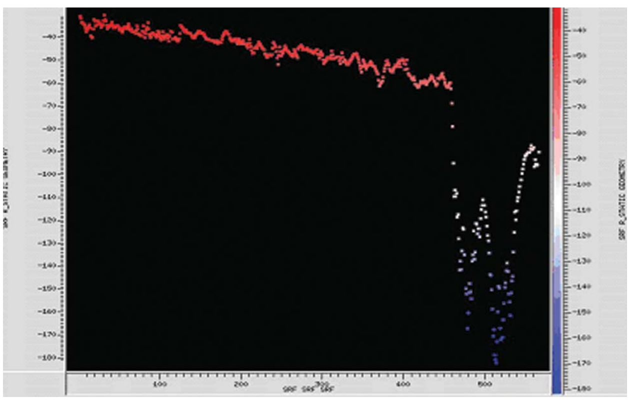

Fig.3 Shows Receiver Static calculated from Conventional Method.

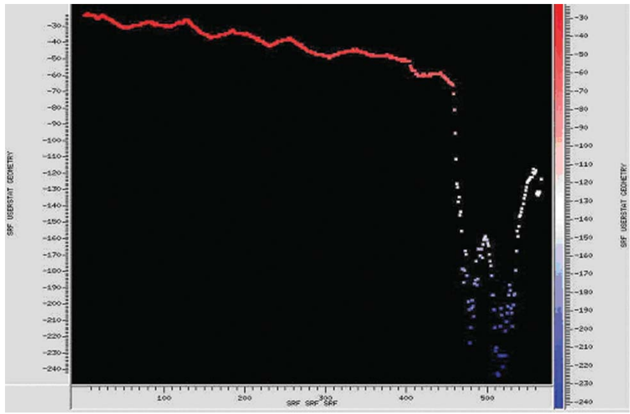

Fig.4 Shows Receiver Static calculated from Quadratic Velocity Model.

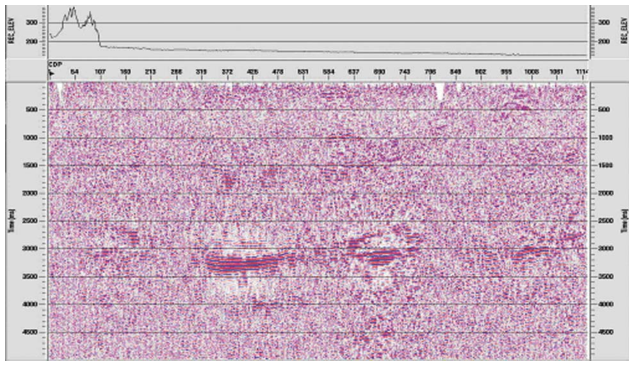

Fig.5 Shows Stack Section derived by using Conventional Statics Method

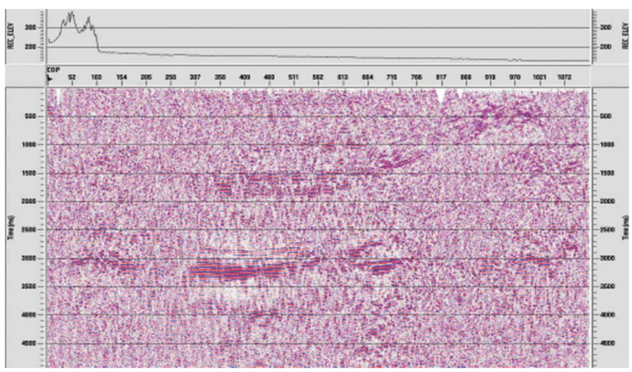

Fig.6. Shows Stack Section derived using New Statics derived by using Quadratic Velocity Method

are more aligned to give a better trend at higher elevation (Figure 4).

Figures 5 and 6 shows the sections processed with the conventional statics and new method respectively. The migrated sections of the same were shown in Figs 7 and 8 respectively. A close examination of the sections processed with the new statics vis-à-vis the earlier section has shown considerable improvement in the S/N ratio especially in the shallow horizons around 1500 ms.

Conclusion

The source and receiver statics have improved to a much better extent using the quadratic velocity model. In the areas like Pasighat, drilling of shot holes is big problem, being a tedious practice due to presence of boulder bed and loose sand. Thus this tool of calculating source and receiver statics, using quadratic velocity model along with careful application of the residual statics can improve the S/N ratio especially the shallow events and also the deeper events marginally.

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