Static Correction for Vibroseis Data over South Kharatar, Rajasthan, India-A Case History

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Summary

Since 1964, Oil & Natural Gas Corporation, is in continuous strive in oil exploration activities in Western Rajasthan. In the past, in different field seasons, its field parties carried out 2D Seismic surveys over the area. of Western Rajasthan. But in F.S 2003-04, first time in the history, its one of the Geophysical Party26, which is based at Jodhpur, carried out 3D seismic survey in Western Rajasthan. In the next field season also, party was asked to continue in the southern portion of the area. The area is under PEL of South Kharatar. After the discovery of CT#1 well in this area, it was necessitated to go for a 3D survey for detailed mapping of sedimentary structures of sub surface and delineation of small stratigraphic features.

The Rajasthan sedimentary province forms part of gentle westerly and northwesterly dipping eastern flank of Indus Shelf. Jaisalmer Basin is one of the four main structural elements of this province. Jaisalmer Basin is a late paleozic basin with Permian rocks resting unconformity over phylite and schists of doubtful proterzoic age.

Entire Jaisalmer Basin in Western Rajasthan covered by linear and sometimes steep sand dunes, which reaches height of around 120mts from the above the mean sea level. These dunes commonly trend in the NNE-SSW direction and appear to have been controlled primarily by the prevailing winds. These sand dunes causes large increase in the travel times of reflected events in seismic data, hence some care was taken while calculating statics in this area. This paper deals with how the statics were calculated and taken care for improving the data quality.

Introduction

Static corrections are time shifts applied to seismic traces to correct the reflection arrival times to the times which would have been observed if all sources and receivers had been located on a horizontal plane (or some other surface chosen as datum) with no weathering or low velocity material present . When static corrections have not been applied properly, errors in the structure are introduced, then resolution is reduced, and sections commonly mis-tie at line intersection.

This needs correct calculation of statics so that at the time of processing of land data, they lead to improved quality in subsequent steps, which in turn, impact the integrity, quality, and resolution of the imaged section.

Generally On- land, the situation is much more complicated because of the topography that may exist over the survey area and the need to remove the effect of rapid velocity changes in the near surface, or weathering layer.

Methodology

A detailed knowledge of the topography of the survey was in hand and generated contours & three dimensional picture through SURFER software over the entire area which was given broad idea where to conduct a SR survey,(See Figure-I) accordingly SR points were selected.

Strike direction of the most of sand dunes is in the north-south direction, hence maximum possible line lay out for SR is always kept in east –west direction which is also parallel to seismic line. This refraction survey with interval of 1 km planned over the entire survey area accordingly 173 SR points covered to determine the required velocities to enable the seismic data to be corrected to a defined datum. (Figure-2 of SR points covered). Initially grid kept at half a km for close monitoring of sub-surface, in later stage it was found that one km grid is found sufficient to have a similar picture of sub surface.

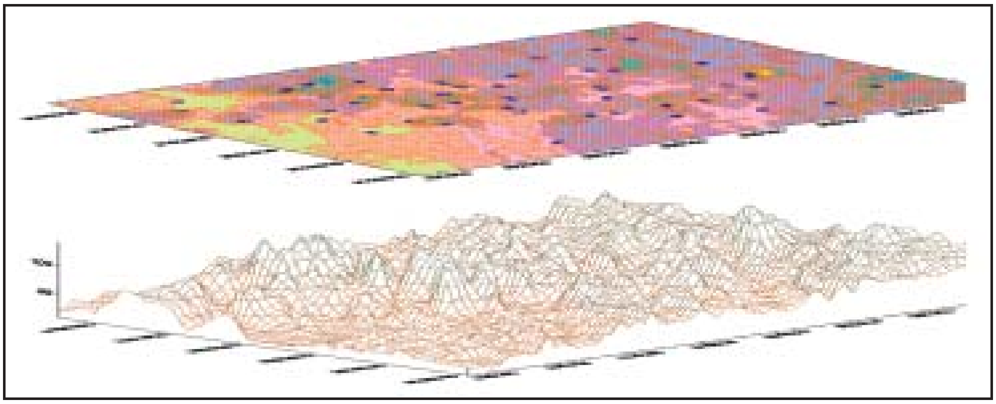

Fig. 1: General topography of the area

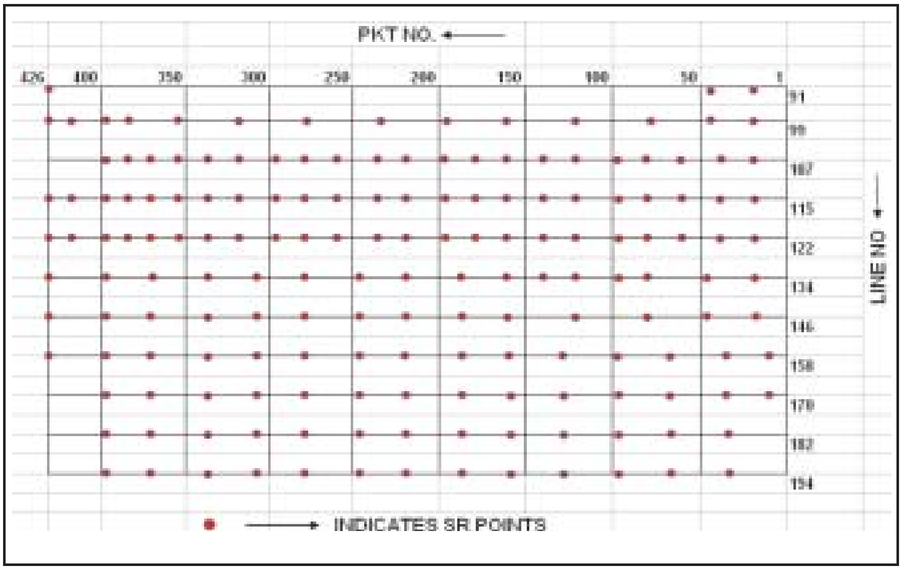

Fig 2. SR-points covered in the area

Cable Layout

A cable of 175mts was taken as it was expected weathering depth is not more than 40mts.Both the ends shorter group interval and in center highest group interval were kept. A single geophone at each location was used. Total of 24 geophones were taken for each spread.

With the layout as shown in fig-2 & 3 shots were taken at both the end of spread and the data was recorded with Bison seismic refraction unit. Then the first arrival timings were pickup manually for each shot record from the monitor records and subsequently computation made by plotting Time-distance(T-Z) plot. A sample of our data is made available in figure 4, 4a

Accordingly calculated the depth of 1st layer ie weathered zone and 2nd layer and velocity for all layers.

This velocity information from refraction survey allowed us a correction to be made to a specified datum.

For the seismic lines located between sand dunes, a depth model (fig:5 and fig:6) and velocity model first ,second, and third layers (Figure.7 to 8) generated from the calculated velocities for calculating field statics.

Data of all SR Points were considered as reference points, then first estimated the point on the bottom of the first layer where SR conducted by subtracting D1(weathered layer thickness at that point) from elevation. Like that all

Ch# 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21222324
Ch#

Sp1 ✷ •--•--•--•--•--•----•----•----•------•------•------•--------•-------•-------•------•-----•-----•-----•--•--•--•--•--• ✷ Sp2

5 5 5 5 5 5 8 8 8 12 12 12 15 12 12 12 8 8 8 5 5 5 5 5 5
Distance in mts

Fig. 3: Field layout for Shallow Refraction profile shown below in

Field parameters:
Number of channel :24 Channel spacing : Tapered (figure-3) Number of Geophones: Single Shot Depth : 1mt Charge Size : 125 grams
Number of shots : 2 Record Length : 1 sec.

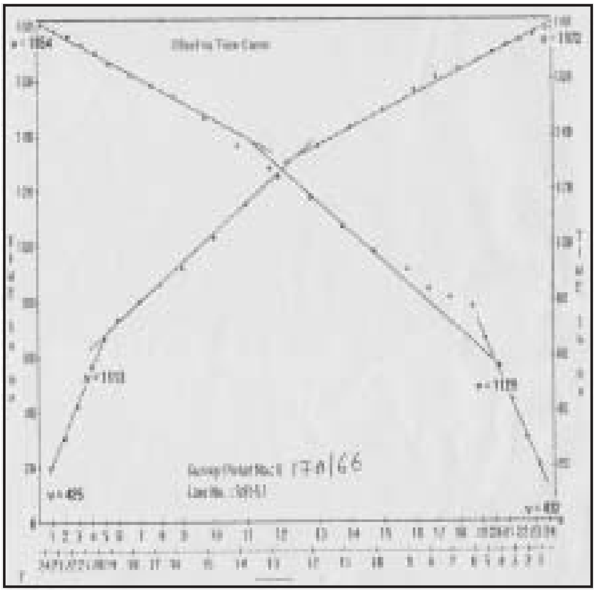

Fig. 4

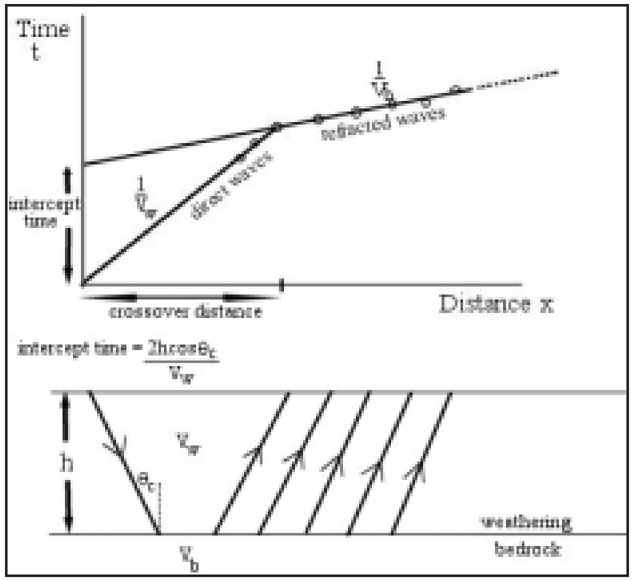

Fig. 4a

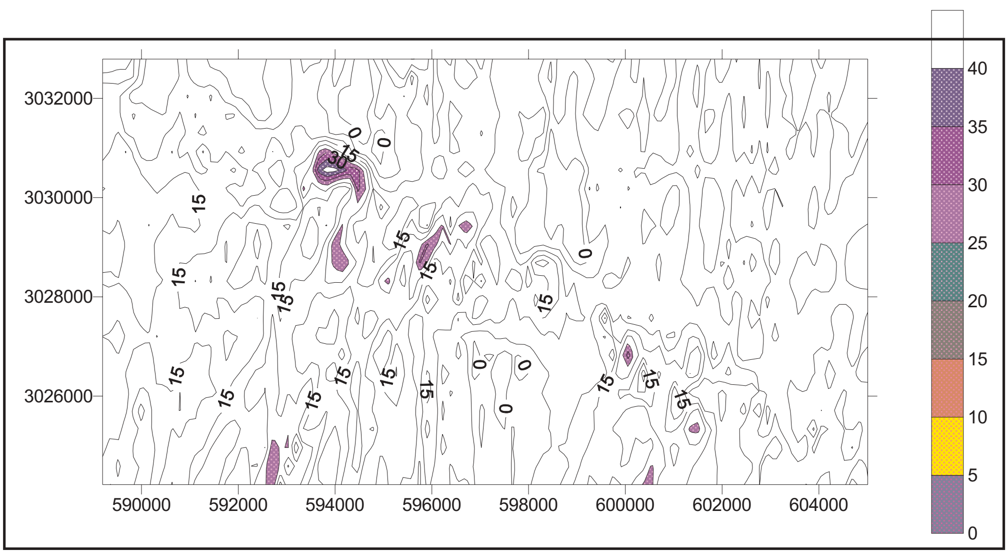

Fig. 5: Contours of weathered layer thickness

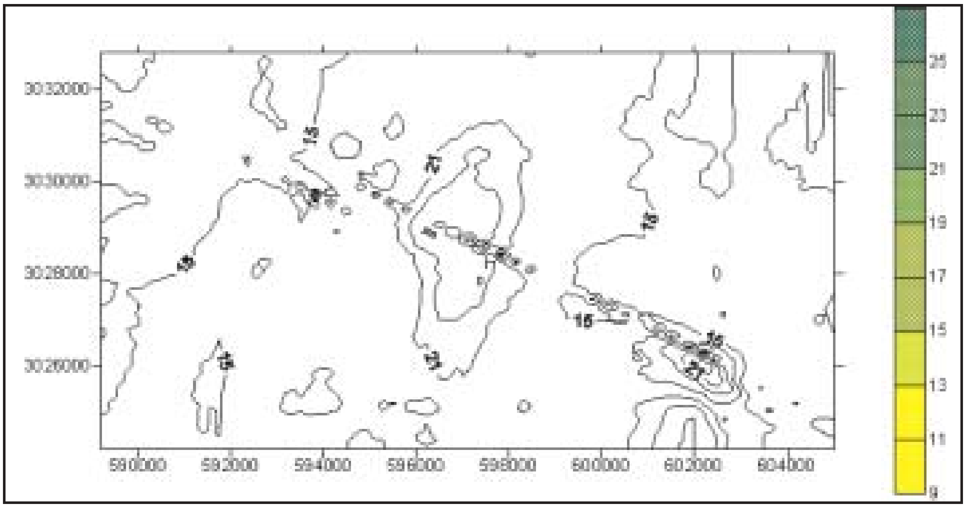

Fig. 6 : Contours of second layer thickness

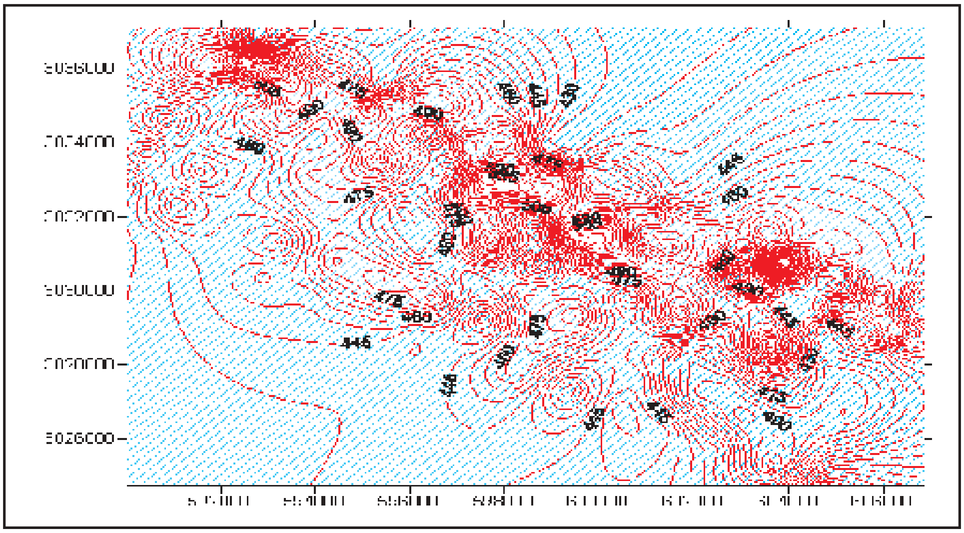

Fig. 7: Velocity model for weathered layer (1st layer)

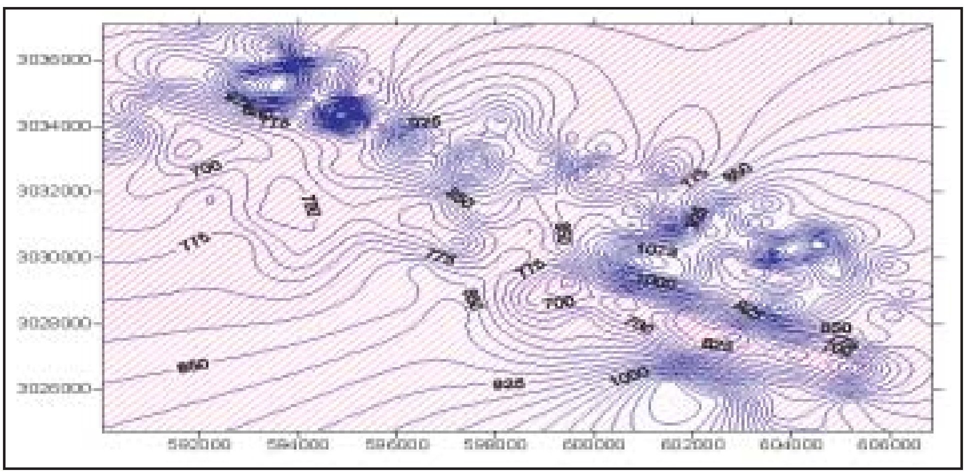

Fig. 8: Velocity model for 2nd layer

values taken wherever SR conducted. Then first layer determined. Bottom of the second layer smoothened by taking linear interpolation between SR points. Then at 70 mts an artificial layer created which cuts low velocity layer horizontally then makes three different layers. A line on which the SR conducted and variation of topography seen in fig.10

In this way, layer-1 ie thickness found and thereby calculated first time correction (To) by dividing thickness of first layer at corresponding shot/receiver points with velocity at that point. Here it is to be noted that velocities are also linearly interpolated. Time correction for all points on a line for the 2nd layer also found by dividing thickness of 2nd layer with velocity of that layer. Similarly, at 3rd layer timing correction (T2) calculated by dividing the 3rd layer thickness with the velocity of that layer which is generally highest velocity. Then calculated final static correction by adding all individual timing correction (ie T0+T1+T2).

As shown in the figure.11 wherever elevation of topography is below artificial layer (ie 70mts below) then the calculation of statics is followed in the conventional way.

All the seismic lines were recorded on 70 channel with end on shooting pattern and group interval 40mts with 5-station gap ie 200mts as shot line interval, for getting the inline foldage seven. Shot interval is 80mts and receiver

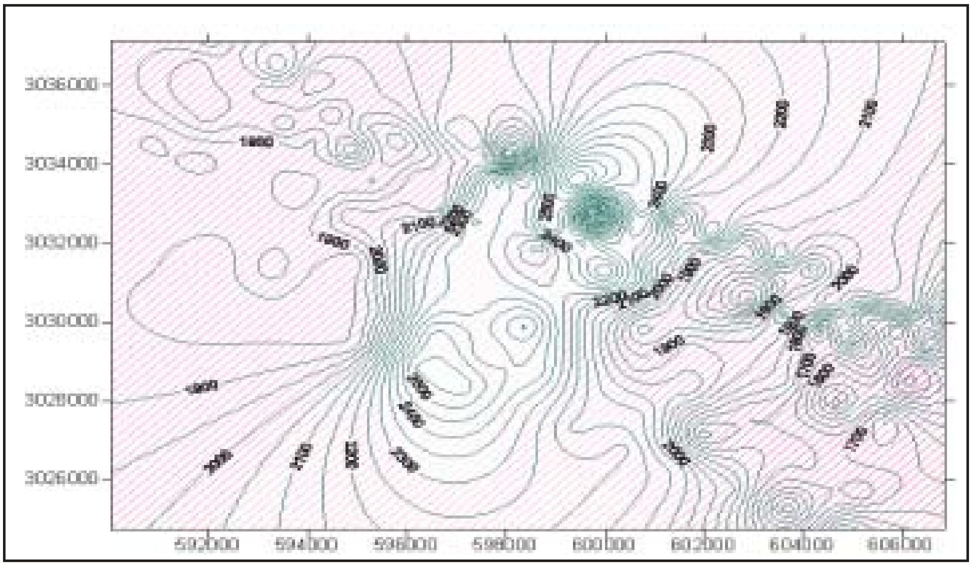

Fig. 9: Velocity model for 2nd layer.

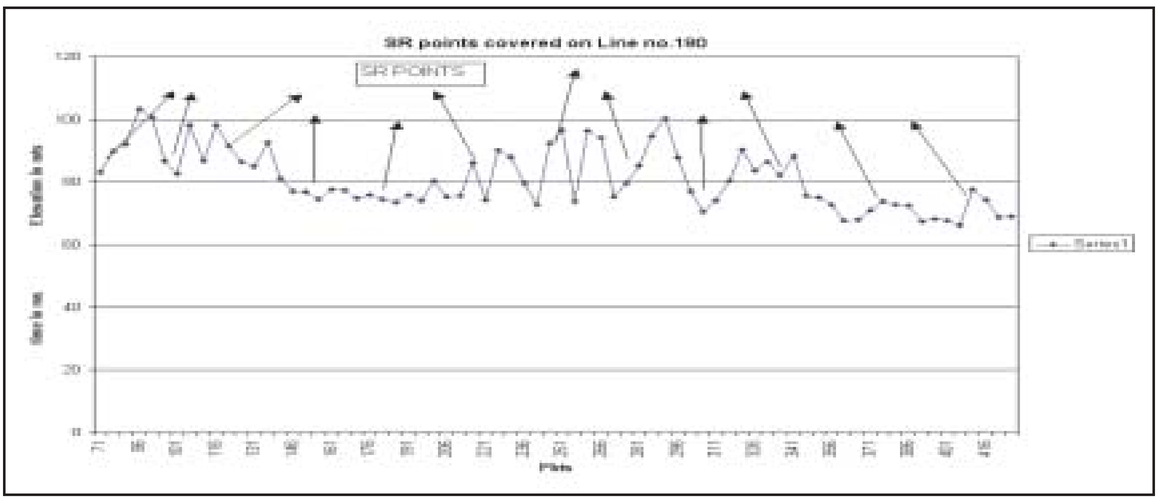

Fig. 10: Topgography model with covered SR points.

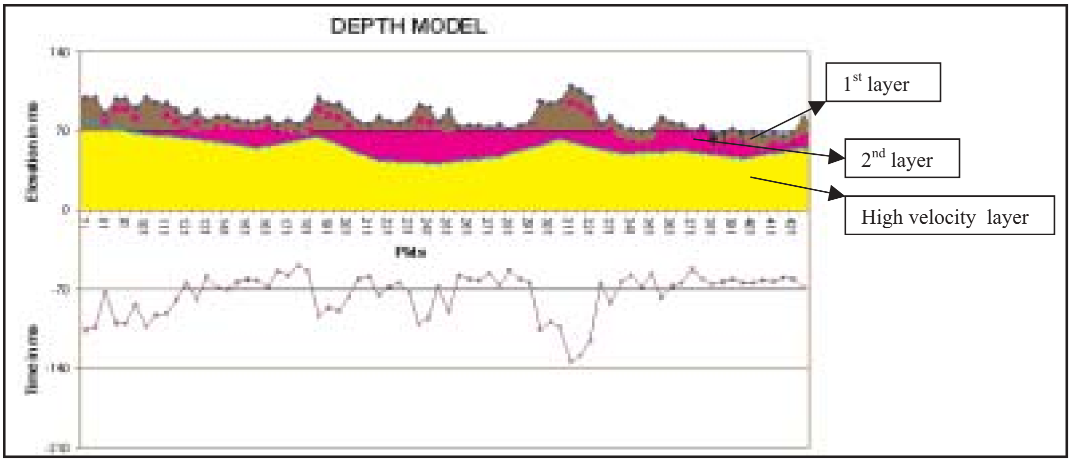

Fig.11 : Depth model Layer-1, Layer-2, Layer-3.

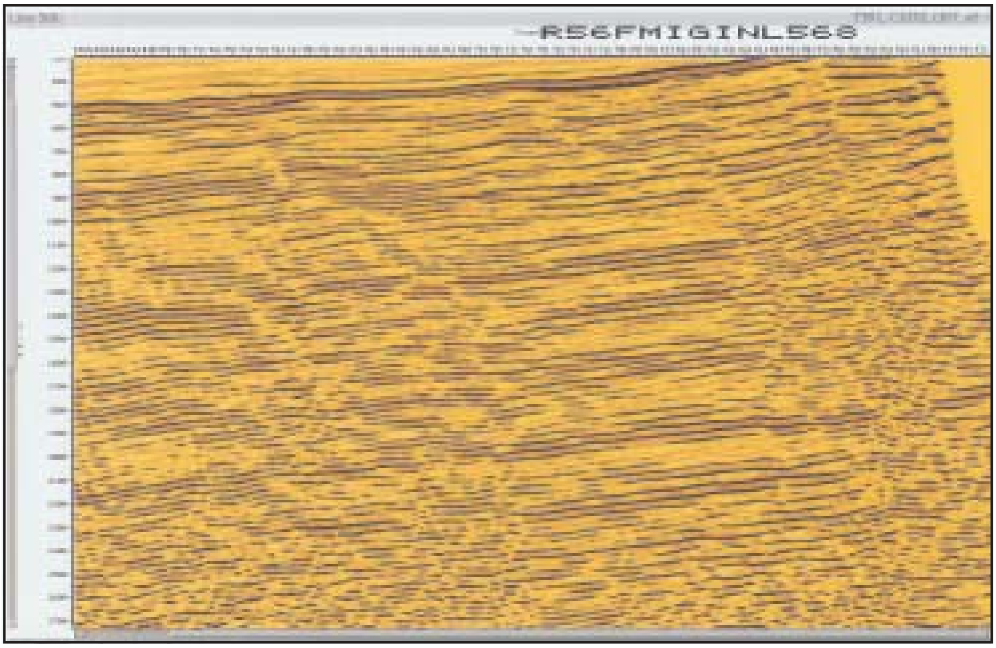

Fig.12 Seismic section of In-line on Swath 08

line interval is 160mts, so that cross line foldage as 6 and total foldage achieved is 42.

The data was processed with f-k filtering and sample section of one of the inline shown in fig.12

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