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3D Seismic Survey in South Kadi- Balsar area with Special reference to Recovery Plan over Obstacles-A Case Study

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Summary

Over the years, ONGC has been carrying out Seismic surveys in towns and villages in different areas of Gujarat state and other areas in our country. From time to time, increasing populations and consequently expansion of the villages, towns, and presence of larger number of tube wells in comparison to the past has become a big task for the exploration & possesses a challenge to the organisation. In such conditions, to carry out seismic surveys in densely populated towns like Kadi,etc., requires meticulous & proper planning to recover such areas in order to get full image of the sub-surface.The value addition in the survey has been the innovative technique related to recovery programme undertaken by the crew to recover the foldage / offset losses due to skip of shots in the main towns like Kadi and in the areas with thick clusters of tube wells. The adopted recovery templates made it possible, with time / cost effective approach, to minimize the area characterized by low foldage / missing near offsets.

Introduction

Having an estimated prognosticated reserves of 2050MMT, Cambay basin has been very active in exploration since 1956. Area of operation is situated in Ahmedabad ,Cambay-Tarapur block. Due to findings of hydrocarbons in this area, the area has become more interesting and studies revealed the necessity of detailed 3D-survey in this area to find further structural /stratigraphic features.

This Challenging job was assigned to a departmental crew GP36 to carry out 3D seismic survey in South Kadi- Balsar area in Cambay Basin, Gujarat(India) during the Field Season 2010-11. Location of the study area shown in Fig.01.The objective of the survey was to *bring out strati-structural features in younger Cambay shale and detailing of south Kadi sands in older Cambay shale with zone of interest in the depth range of 1050 to 2500mts*. The survey was carried out by deploying state-of-the-art recording equipment (I/O system) and digital sensors (SVSM) as receivers. The survey was completed with stringent quality measures that resulted in good quality of data to the satisfaction of the client. Details of the above 3D seismic survey in this area are discussed with an emphasis on the special recovery programme to negotiate the foldage / offset losses due to skips of shots in the eastern part of the area where cluster of tube wells are present on particular swath and Kadi town.

Brief geology of the area

The study area (fig 01) is located in northern part of the Cambay basin. The basin is an intracratonic rift basin and is nearly north–south morpho tectonic trend in northern block and WSW- ENE trend in southern Narmada-Tapti block. The Cambay basin is devided into five tectonic blocks namely Sanchor-Patan, Mehsana-Ahmedabad, Tarapur-Cambay, Jambusar-Broach and Narmada-Tapti blocks(fig.02). In the Mehsana-Ahmedabad block, the hydrocarbon are known from sands in the Tarapur shale,Kolol fm ,Kadi formation, and older Cambay shale

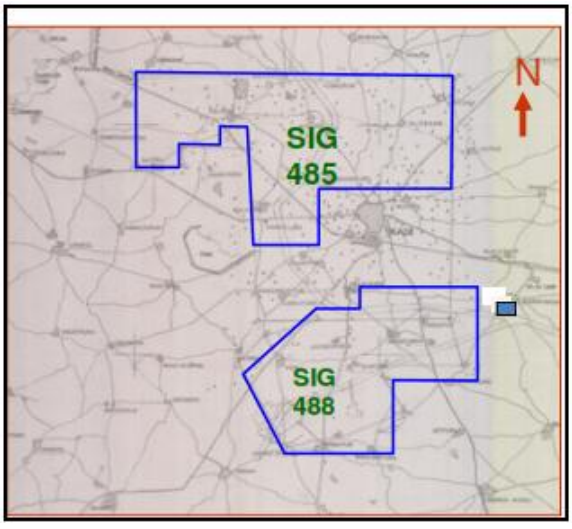

Fig.01 – Location map – Study area.

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The Early Eocene consists of two stratigraphic units: Cambay Shale and Kadi formations. The Cambay Shale is divided into two units – the Older Cambay Shale (the Lower) and the Younger Cambay Shale (the Upper) on the basis of a log marker (Neck Marker) – separated by an erosional unconformity. The Cambay Shale was deposited in a shallow marine environment. In the South Kadi field, hydrocarbon is encountered from the lenticular sand bodies within older Cambay shale and these sands are prolific producers.

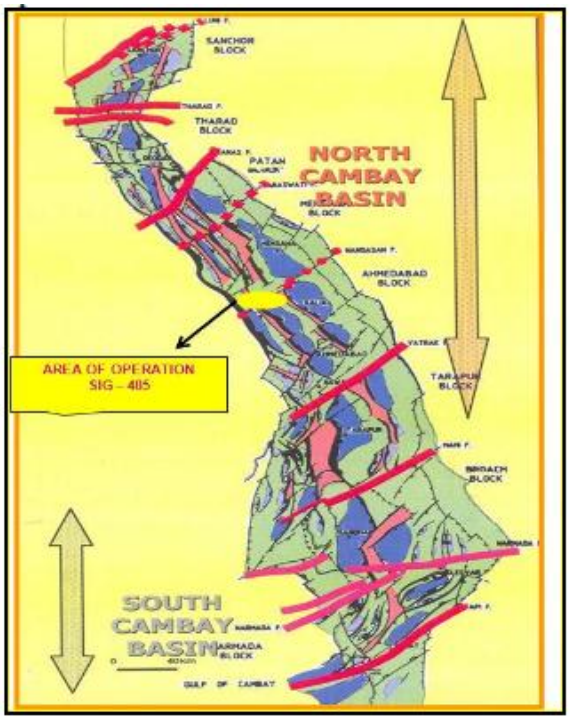

Fig 02: Tectonic Map of Cambay Basin

As revealed by exploration and development drilling the hydro- carbon entrapment is predominantly controlled by the presence of reservoir sands within the shale sequence and is therefore a stratigraphic reservoir. In spite of a large number of drilled wells, the sand distribution is difficult to resolve, because of its small thickness, multilayered and discrete occurrence.

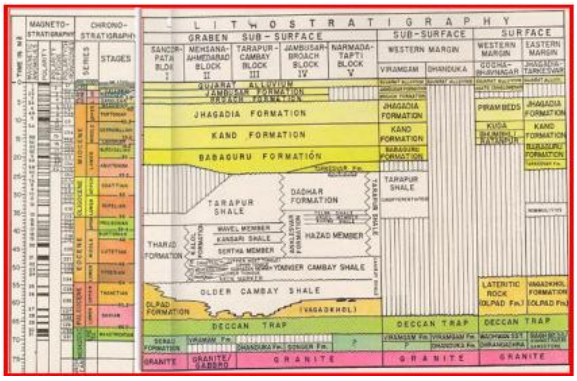

Fig:03 -Generalised Stratigraphy of Cambay Basin

Many wells of South Kadi, North Kadi, Linch and Viraj field fall in this area. South Kadi field is mainly producing from lower Kadi Sands A, B+, C, D, E & F within Older Cambay shale. North Kadi field is mainly producing from Kalol Sands. Generalized stratigraphy of Cambay basin is shown in Fig.03.

Methodology

With consideration of seismo-geological objectives, target, available inputs and economy, different geometries and attributes derived from MESA software. Out of which, one geometry of orthogonal with End-on was derived with a template consists of 1872 channels on 12 receiver lines (each line 156 channels) with a line interval of 260mts , shot interval of 20mts ,shot salvo to receiver lines with 78 shots per template, salvo interval of 260mts and receiver interval kept as 20mts. Swath geometry is shown in fig.04 Charge size of 5.0 Kg. was found to be optimal in this area based on experimental work. As the area was almost ground roll prone, a minimum offset of 130mts given from the shot point. Integrated analysis of near surface velocity, lithology and trace amplitudes were studied in order to arrive at the optimized shot hole depths.

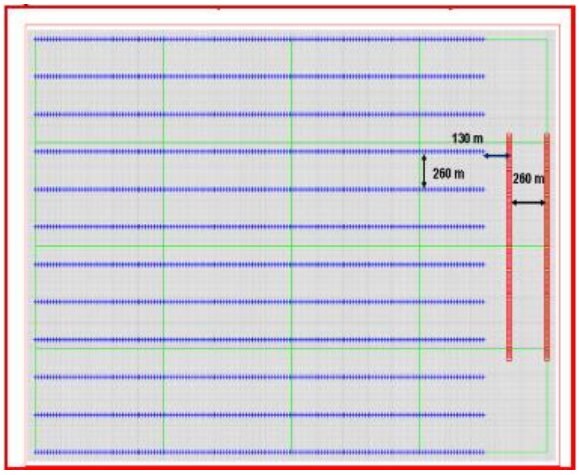

Fig.04 Swath geometry

Goal of modelling is to analyse the main geometric paramet for data acquisition ,like offsets, to meet the requirements. the available data were used to calculate the velocity, mai from VSP. To simulate the data acquisition the models w built from the surface to horizon of interest. Model on a inline shown in Fig 05 & Fig.05a which shows the sub surf varying with different velocity zones and its location in study area.

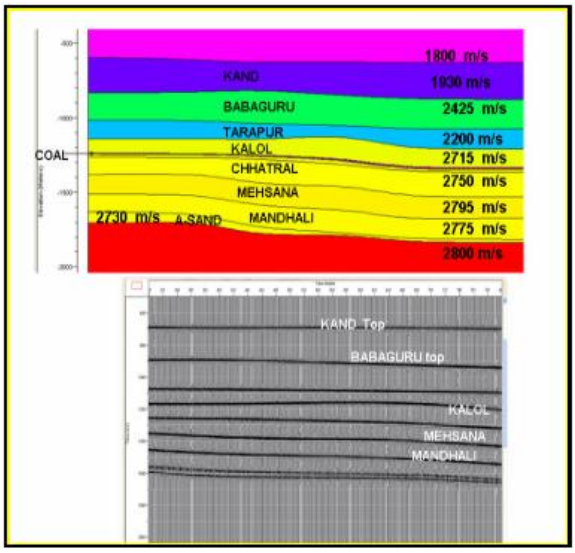

Fig: 05 -Sub Surface Model (W-E) on a particular inline

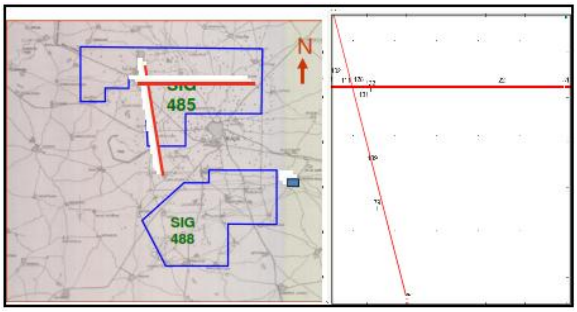

Fig: 05a-Location of Sub Surface Model (W-E)

Total eleven in-line models and 13 cross-line models were generated from 105 upholes. Due to near surface has very complex geology with varying velocities, many check shots were observed for reconfirmation of OD. Fig.06 shows complex near surface geology. Fig 07 shows confirmation from check shot.

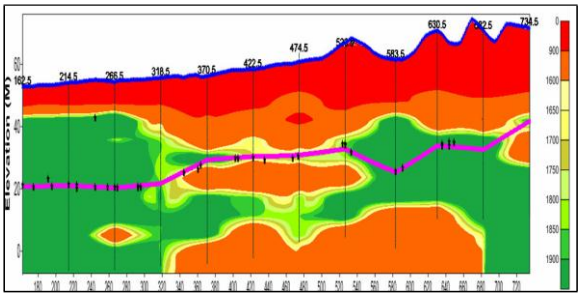

Fig 06. Near surface Inline model

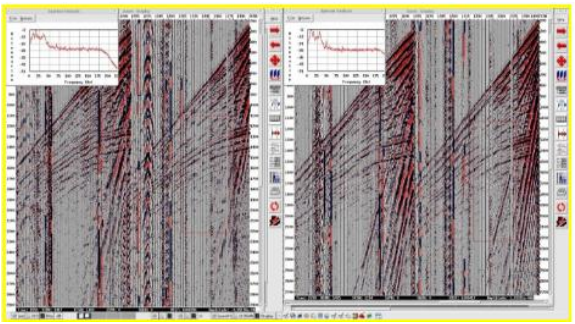

Fig 07. Check Shot

Recovery Programme

The assigned area consists of 86.28 Sq,kms and divided in two areas namely south Kadi—Balsar and Viraj (refer fig.01). Area Soth kadi-Balsar was covered in 5 swaths and

Viraj area was covered in 5 swaths. Operation of 3D survey carried out with swath roll over from North to South with 6 receiver lines overlap and shooting direction from West to East. In southern and eastern part of area Narmada main canal was cutting all the lines and having scattered cultivation of wheat and cotton. In this paper, recovery programme taken as example on Swath 03 of South Kadi-Balsar area due to disturbance on this swath is much higher with obstacles like roads,crop,canal and villages as shown in fig.08. This swath had 2213 shots in total (Fig.9a shows shot template before recovery). With this number of shots, if shooting takes place, by modelling it was found there will be lot of gap and might face with redundant foldage as shown in fig. 09b. Offset distribution and Azimuthal distribution is also not uniform as shown in Fig.9c and Fig.9d.

By ray path modelling , wherever shot could not be taken due to hindrance, that shot's mid point coverage was obtained by reversing the shot point location in such way that mid point of nearby trace path becomes farther mid point trace path and farther ray path becomes nearer one.

Accordingly back recovery for all such shots were planned prior to operation and shots taken without disturbing regular shooting. Fig.10a shows total taken after recovery.

Fig.08 . Google map in the area with swath 03 template

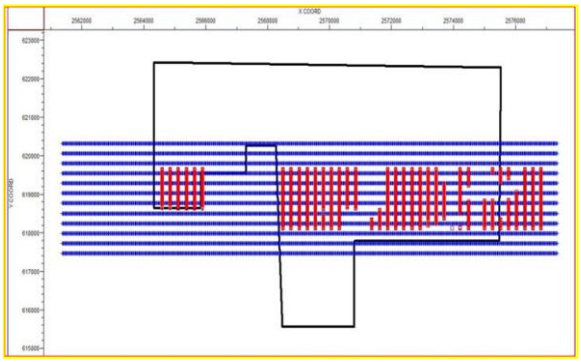

Fig. 09a:Shot Template of Swath 3 before recovery

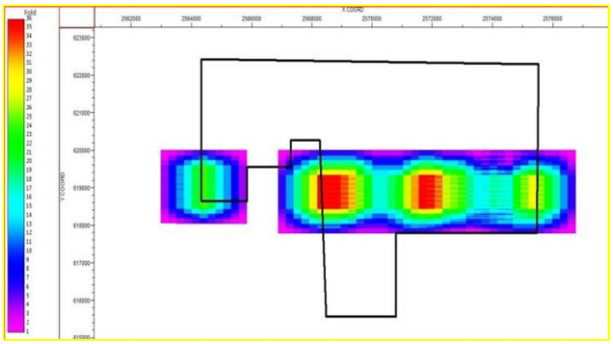

Fig.09b: Foldage map of Swath 3 before recovery

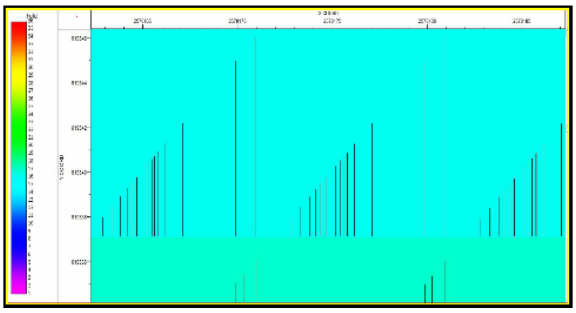

Fig. 09c:Offset distribution of Swath 3 before recovery

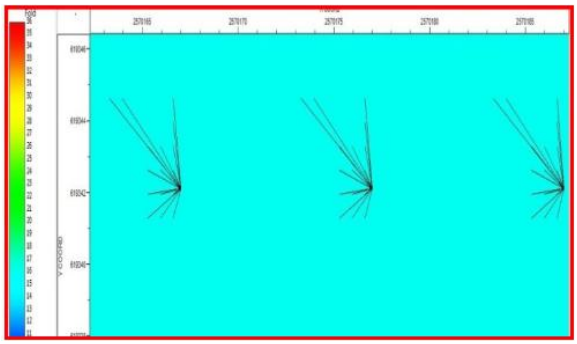

Fig. 9d : Azimuth distribution of Swath 3 before recovery

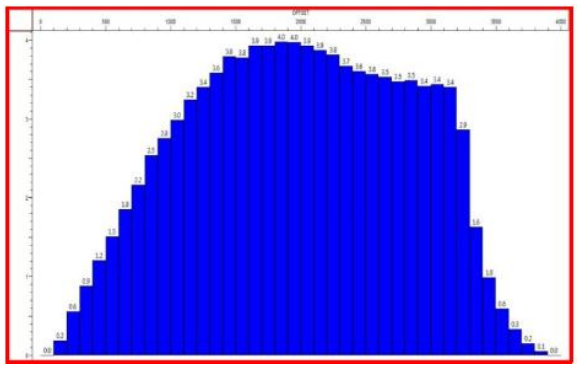

Fig.9e : Offset vs Trace %ge for Swath 3 before recovery

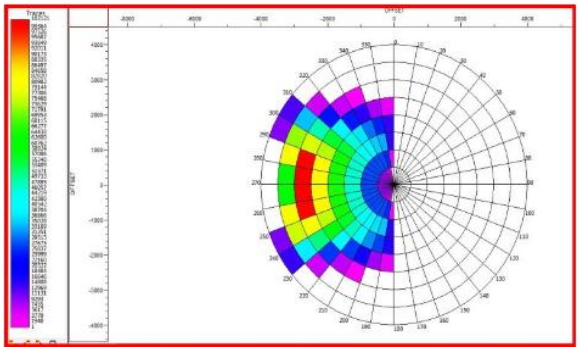

Fig.9f: Rose diagram Swath 3 before recovery

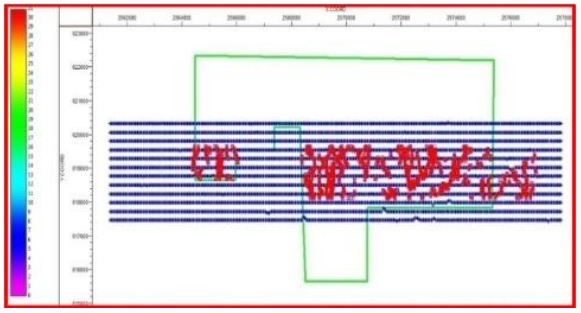

Fig.10a :Shot Template of Swath 3 after recovery plan

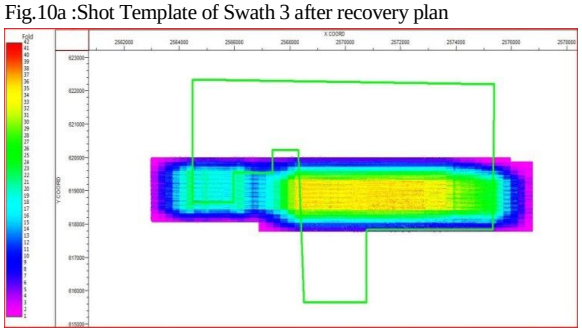

Fig.10b:Foldage map of Swath 3 after recovery

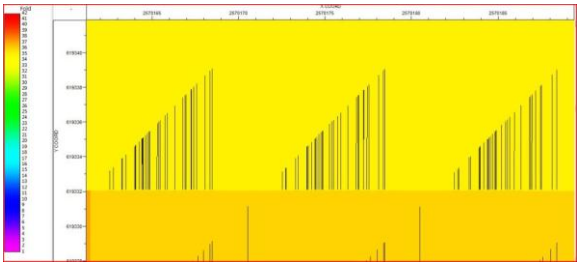

Fig.10c: Offset distribution of Swath 3 after recovery

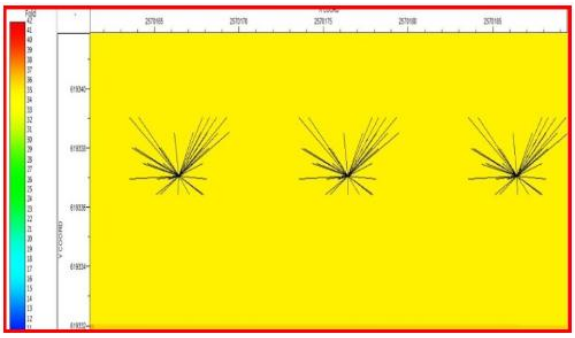

Fig. 10d : Azimuth distribution of Swath 3 after recovery

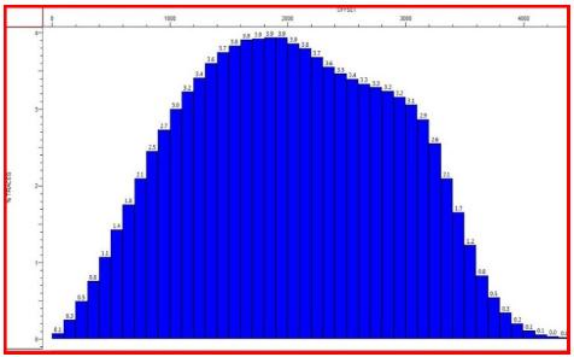

Fig.10e: Offset vs Trace %ge for Swath 3 after recovery

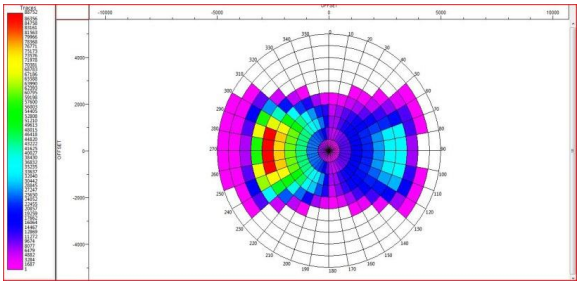

Fig.10f: Rose diagram Swath 3 after recovery

Fig.10b shows foldage uniformity and coverage after recovery. Fig.10c & 10d shows, offsets and azimuths even distribution in the recovery area and Fig.9e & 10e show Offset versus traces percentage before and after recovery

and Fig.9f & 10f shows rose diagram before and after recovery which confirms the success of the recovery programme. Fig.11a & 11b shows foldage map of full area before and after recovery in the area also confirms success.

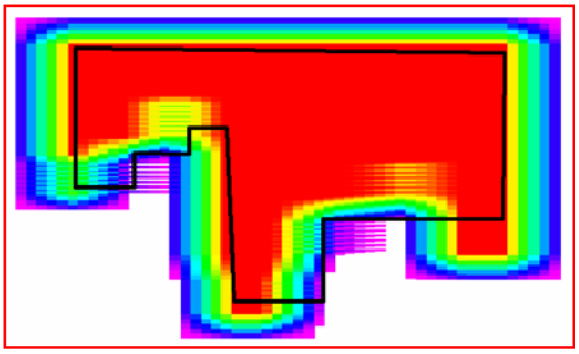

Fig 11a : Pre acquisition foldage over the given area.

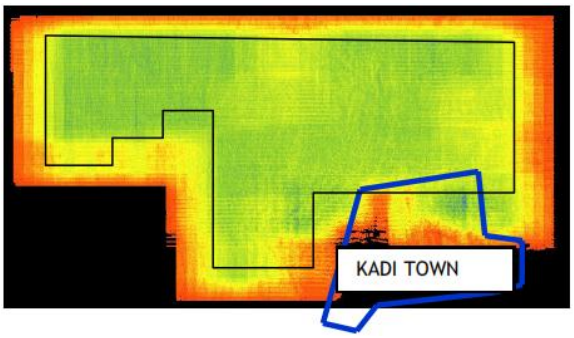

Fig 11b : Post acquisition foldage over the given area.

The overall quality of brute stacked data of swath-03, which was maximum affected by the skips, and swath 05 near Kadi town has also improved to a good extent after application of the recovery program as far as reflection strength & continuity were concerned (fig.12). Entire data volume processed by RCC,Baroda.

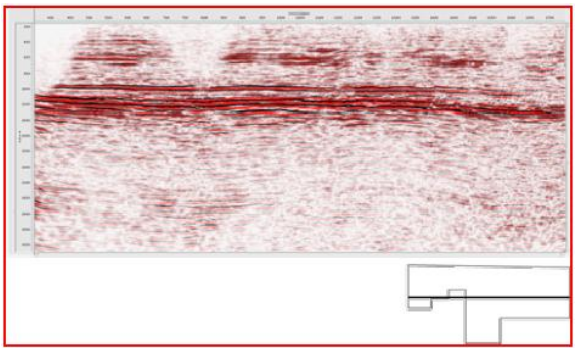

FIG. 12: Seismic Section_ PSTM_InLine 621

Conclusion

The acquisition of 3D seismic data in South Kadi area could be completed successfully to the satisfaction of the client and without any cost / time overrun. The application of the special recovery programme, thereby, compensating for the lost foldage / offset / azimuth will definitely add value to the final processedndata volume.

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References

Operational report on 3D seismic survey in of SIG-485, -ONGC Unpublished report

Book on “Oil & Gas Exploration and Production in India” by Dr.VK. Rao,Yogesh Garg.

2.VSP operational report of S.Kadi-22,41,111, 118,11128,132-ONGC Unpublished report

VSP operational report of S.Kadi-17,79,86,131,139. -ONGC Unpublished report