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Imaging the shallow basin margin and deep basinal structures by executing two different 3-D Geometries simultaneously- A case study from Cambay Basin, India

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Summary

In areas where 3-D is required to bring out subsurface features extending from shallow basin margins (100-400 m) to deep basinal part (1000 to 3000 m), finalizing the 3-D seismic data acquisition geometries remains a problem for the field Geophysicists. If the geometry is focused on shallow prospects in basin margin side, the offsets are inadequate to illuminate the deeper prospects towards basinal part. If the geometry is focused at deeper parts, then majority of larger offsets are not required in basin margin and these unwanted larger offsets are muted at the time of processing and again few smaller offsets are left with the processor which are inadequate to properly resolve the thin pinching sand layers in basin margin. The problem is further complicated if limited field resources are required to be optimized. In India, tackling this problem assumes greater importance under New Exploration Licensing Policy (NELP) regime where operator has limited allotted time to acquire data in both shallow and deeper prospects in single project. The problem could be addressed properly by designing two different geometries – one focused at deeper prospects using larger bin size and another aimed at shallow margin area using smaller bin size. Then entire data is merged in larger bin size keeping uniform bin size & fold and simply restricting larger offsets towards shallow part of the area. This technique was applied successfully by Geophysical party No.15 of ONGC, India while acquiring 3-D seismic data in South Gamij area of Cambay basin, (India) during FS. 2008-09.

Introduction

The survey area lies on the Eastern rising flank of Cambay Basin and falls in Ahmedabad Tectonic Block of Cambay basin (Fig-01). The project area falls in and around Gamij field. Kalol and Chhatral reservoirs are main producers in this field. The area is characterized by N-S trending steeply dipping margin fault system with Westward dip. Paleogene units gradually pinch out towards east. Available 2-D seismic data is inadequate to map subtle features with confidence. The present survey is proposed to detail structural configuration of the area to identify reservoir distribution pattern in Kalol, Chhatral and Olpad sections. The zone of interest for basin margin area is at a depth of 380 – 1000 m (TWT : 400 -1000 ms) and for the Basinal deep area is at a depth of 1000 -2450 m (TWT : 1000-2200 ms). In view of the complexity of the fault systems in the basin margin area, a 3D seismic coverage is required for better structural definition and stratigraphic interpretation.

Methodology and data analysis

The project area (193 sq. km) was covered with 47 swaths (25 swaths in deep prospect area and 22 in shallow prospect area). Five swath Geometries were designed and analyzed by using GEOLAND software for acquiring data in South Gamij area. Since there were two

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areas, one with shallow objective and the other with deeper objective, the operational area was planned to be covered with two geometries. This principle adopted was aimed at utilizing all the offsets while processing the data. The Eastern part of the project area (Fig.2) consisting of the shallower prospect was covered with a bin size of 10 m X 20 m where as the Western part (deeper prospect) was covered with a bin size of 20 m X 20 m. with same no. of channels, half group interval resulted in restricting far offset to half of the far offset for deeper prospects details of the 3-D acquisition geometry used are shown in the following table 1.

Efforts were made to maintain uniform fold of 56 (56 in 20 X 20 bin and 28 + 28 =56 in 10 X 20 bin) through out the survey area. However there is redundancy of middle offsets in overlap region of the area, the redundancy can be addressed during processing. The fold map of the combined area is shown in Fig. 4. To eliminate the field errors during acquisition, first deeper prospect with Group interval 40 m was covered and then the continuation of swaths in basin margin side with group interval 20 m was covered Then entire data was merged in 20X20 m bin size to process the the data uniformly.

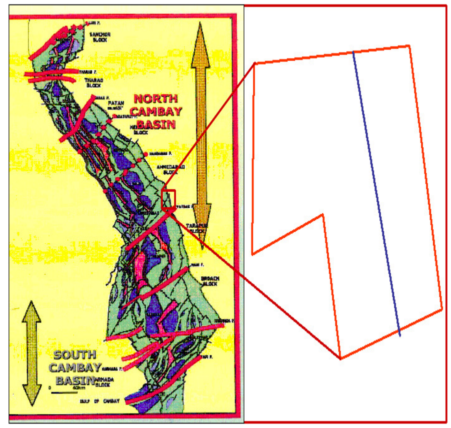


Fig.1 Location of study area

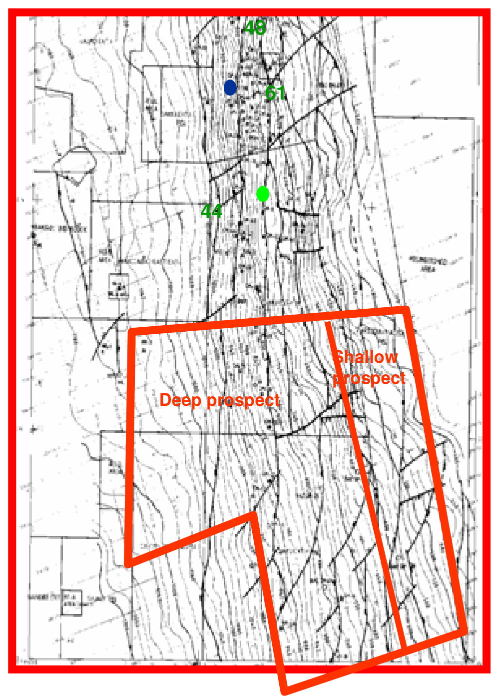


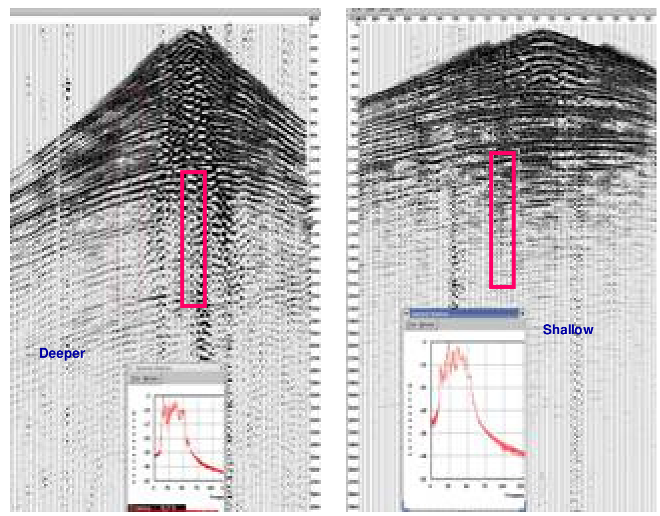
Fig.2 The project area is divided into shallow prospect in the east and deeper prospect in the west.

Parameters	Shallow Prospect	Deep prospect
Shooting geometry	Orthogonal ASS	Orthogonal ASS
No. of receiver lines	14	14
No. of channels per line	96 (60 + 36)	96 (60 + 36)
Total active channels	1344	1344
Group interval	**20 m**	**40 m**
Shot interval	40m	40m
Receiver Line interval	120 m	120 m
Shot Line interval	240 m	240 m
Spread length	1180 + 700 m	2360 + 1400 m
Far trace offset - inline / xline	1190m/ 1676 m	2380m/ 2880 m
Bin size	**10 m x 20 m**	**20 m x 20 m**
Foldage	28 + 28 = 56	56
Direction of shooting	West to east	West to east
Swath roll	South to North	South to North
Energy source	Dynamite	Dynamite

Table-1 Acquisition parameters for the two prospects (geometries)

Results and discussions

Eastern part of the area comprises of basin margin and sedimentary column is very shallow (less then 1.0 sec). The reflectors in the zone of interest were seen up to 1.6 sec and deeper events were seen in the Western part of the area up to 3.5 sec. Standouts of reflection events in the window of interest are good and frequency bandwidth is 10-60 Hz in general and upper limit normally observed is 50 ± 10 Hz. The recorded data of all the 47 swaths were loaded on Field Processing Unit (FPU), analyzed, geometry merged. Fig. 3 shows some raw record from different parts of the area. The recorded data were studied using FPU and processed upto Migration. Migrated stacks were generated for the whole data volume. Some of the processed sections generated on FPU are shown in Fig. 5, 6, & 7. Combined foldage map was generated for all the swaths (both shallow as well as deeper prospects) as shown in Fig. 4.



(a) (b)

Fig.3 Raw record from deep prospect area (a) and shallow Prospect area (b)

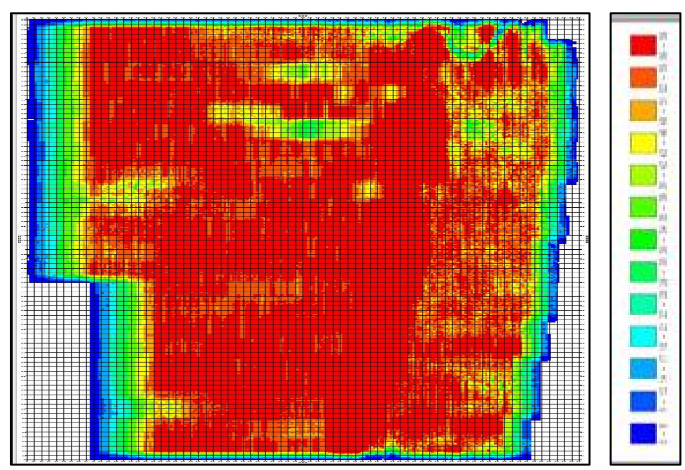


Fig.4 Fold map of combined area (both shallow & deep prospect)

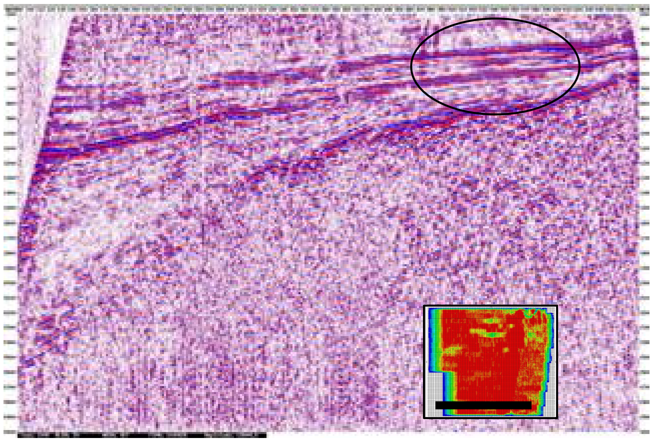


Fig5. Decon stack along a line (MLIN-34) (shallow & deep prospect combined)

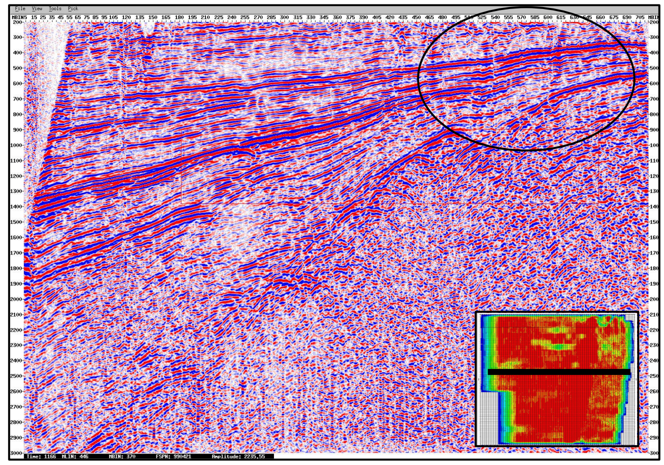


Fig.7 Final stack from 3D line

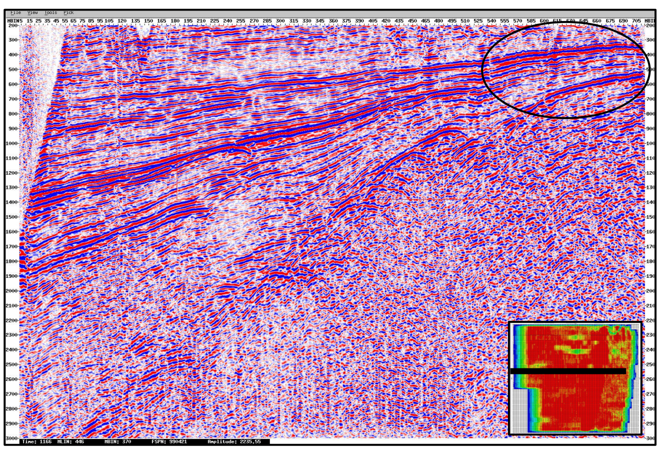


fig. 6 final stack along a CMP line in combined prospect

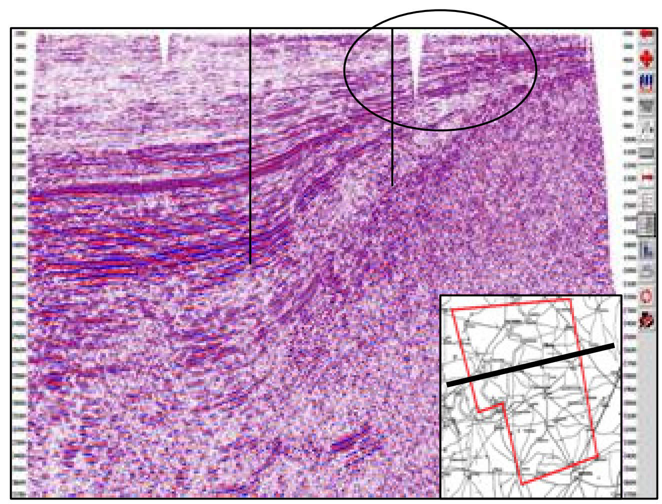


Fig. 8 Migration stack of a previous 2D line

Conclusion

The processed sections shown in figures5, 6, 7, and 8 clearly indicates that the sub-surface features towards basin margin side are well resolved. If the section in fig. 9 which was prepared from data acquired with single geometry, is compared with figures 5, 6, 7, & 8 the features in shallow margins are much better in fig. 5, 6, 7, & 8, it can be concluded that if basin margin area, data has to be acquired with smaller bin size and in deeper basinal parts, data has to be acquired with larger bin size. These two data sets can be acquired in single field season and can be processed in one go with uniform bin size. This technique will definitely help in delineating complete features of the basin from basin margin to deeper basinal parts. Apart from delineating the structural features in basin margins, this technique can economize the field operations.

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