Analytical Approach to Acquire 3D Seismic Data in Tidal Affected Areas- A Case History from Cambay Basin, India

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Summary

The paper presents an analytical approach adopted while acquiring data in a logistically difficult, tidal affected Olpad-Dandi area of Cambay Basin, India, which is quite important from the hydrocarbon exploration point of view. In the present scenario, the seismic data acquisition can no more be dealt with well defined conventional ways as the exploration areas are gradually limiting mainly to complex and critical terrains. So to deal with such situations a more analytical and flexible approach towards data acquisition is required which involves problem identification, problem analysis, searching solutions, using the best and achieving the goal up to the satisfaction of client.

Introduction

The Olpad-Dandi area of south Cambay Basin, India is surrounded from three sides i.e. North, East & South by prospective fields. Nearby Kim, Katpur, Kosamba and Olpad fields are hydrocarbon producers. (fig.1).

Though the area has been assessed as very important from the hydrocarbon point of view but the presence of Kim river in the area and also to its west coupled with other logistical constraints made the task of seismic data acquisition quite exasperating. Kim river is connected to Arbian sea and its course extends in the high tide period to such an extent that laying of seismic lines becomes a staggering task. Moreover during high tide time, the flow of water attains such a speed that nothing stands against that. The seismic 3D data acquisition in this area was carried successfully by adopting analytical and flexible approach to negotiate different problems and meticulous planning. As the exploration objective was to delineate the sand geometry of thin sands at different levels, the quality was not at all compromised at any stage and high frequency data has been acquired which led to the release of an exploratory location and is expected to prove its prospectivity on drilling.

Methodology

Before attempting 3D data acquisition in the area, lot of reconnaissance and desk work was carried out to tackle the impediments successfully at the time of actual operation. The following flow chart was actually put to practice

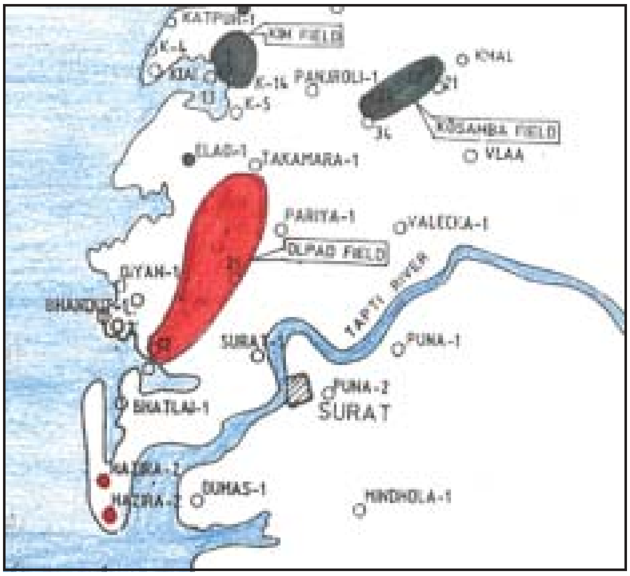


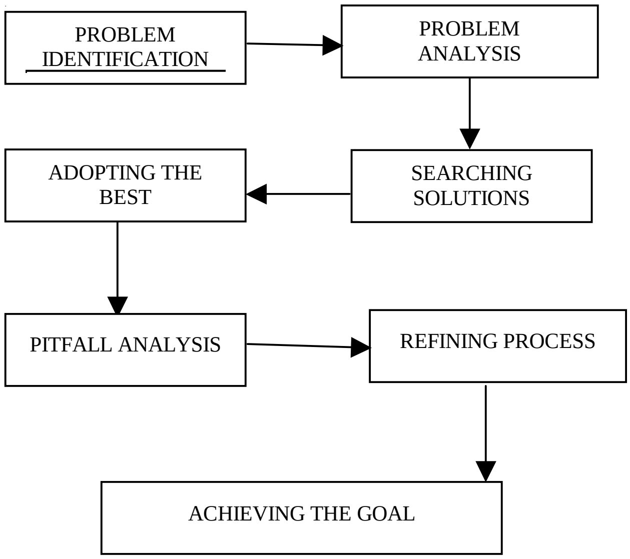
Fig. 1 : Study area

All of these concerned aspects were analysed and tackled systematically in right order by adopting the following strategies.

Problem identification

To acquire high frequency data across Kim river to resolve thin sands without data gap, firstly the problems requiring attention were summarized as under

- Inundation of water in major part of area during high tides and leaving swampy land after tide receded.
- Understanding of timing of tide cycle.



- Laying of seismic line across river/ marshy land around river
- Safety of men & materials.

Problem analysis / searching solutions

To record high frequency data in the area, attribute analysis of suitable geometries was studied, closed grid uphole surveys were carried out, extensive charge / depth optimization was done To acquire 3D seismic data across Kim river the following aspects were analyzed and executed

- Understanding of tidal activities and their time cycle was the prime task for analysis. The data on tidal activities was collected from Metrological department, the data was validated after personal interaction with the villagers staying nearby. To validate the integrity of available data, people were deployed to monitor the activities, physically at chosen sites.
- Planned adoption of flip-flop operation between tidal affected and non-tidal affected zones.
- Boats were arranged. Expert swimmers were employed.
- Sufficient arrangement of Bamboos, ropes and inflated automobile tubes was done for crossing of ground electronics.
- Got fabricated iron stands specifically for the placement of SU's and PSU's
- Quality of equipments checked and maintained well

Adopting the best

After studying the tidal activities, monthwise tidal charts were prepared, which gave an idea of the level of tidal ferocity, their time duration and time of occurrence (fig.2)

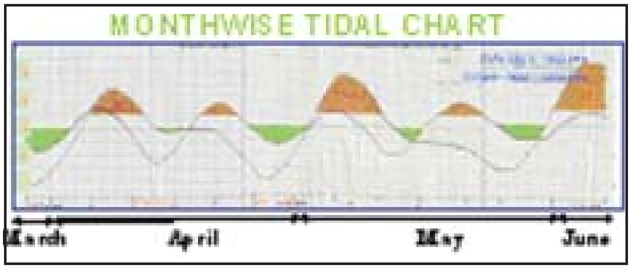


Fig. 2 : Monthwise tidal chart

It could be brought out that the operational period in the tidal affected zones is limited to only five days between full moon to new moon and another three days before the full moon making only eight days available during a month. So it was decided to approach these zones only for eight days during the month and to flip to other areas during other days of the month. Moreover, it could also be observed that only 3-4 hours during such a day remains available to carry out operation in those limited eight days of a month. So accordingly men and materials were kept alert and in readiness before starting operation by carrying out prior mock drills.

On the basis of fold tests on earlier acquired 2D data, it was concluded that 24 fold data will be good enough to achieve the desired geological objectives. After studying the attribute of different suitable geometries, 8 receiver line/ 8 shot per template swath geometry was adopted, this provides 28 fold data. The parameters of the adopted geometry have been shown in table I and the layout is displayed in fig. 3

Results of charge/depth optimization were analysed for their frequency contents. The charge giving

Table I

	Geometry	Orthogonal
1	Fold	28 (7 x 4)
2	No. of receiver lines	8
3	Receiver line interval (RLI)	120 m.
4	Shot point interval	120 m in-line 60m. x-line direction
5	No. of SPs per template	8

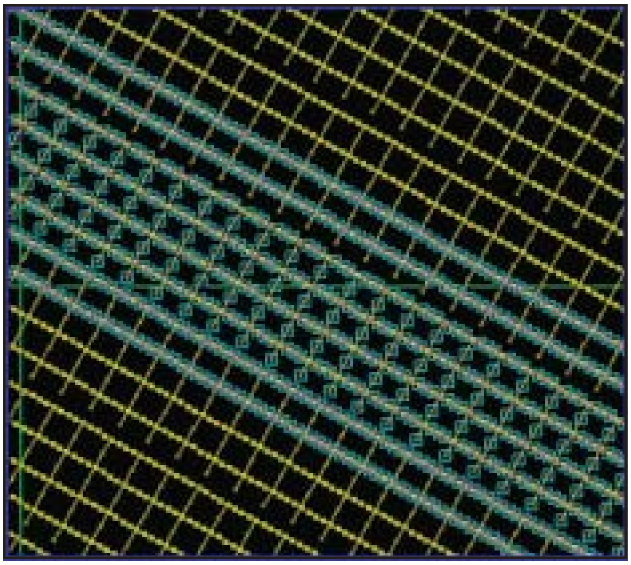


Fig. 3 : layout of geometry adopted

the best frequency band width was used for regular production work.

The result of close grid uphole surveys were critically analysed in the back drop of velocity, pulse signatures, lithologs etc. of different layers. Near surface models along inline and cross lines were prepared for the whole area to understand spatial behaviour of near surface layers.(fig. 4) When the layers of identical velocities were noticed at different depths, pulse signatures were given due weightage to arrive at best optimum depth. The check shots were taken along with regular production work also to ascertain the optimum depth and to refine it if not found giving desired results. Daily analysis of the data was carried out on Field Processing Unit (FPU) for its frequency content. These enabled corrective measures for maintaining quality. The obstacles encountered during acquisition were properly recovered after executing suitable recovery plans generated on FPU.

Boats, large bamboo structures and specially designed iron structures were used to lay seismic line. Heavy equipments were kept on inflated tubes and slide over swampy zones.

Pitfall analysis & refining process

By adoption of flip-flop technique, the data could be acquired in major part of the area by executing number of recovery plans and negotiating lot of problems, leaving a small patch of 700 m. width across the river. This patch always remains inundated with water. The flow of water is always very fast and its level rises to 8-10 ft., three to four times a day. The water encroachment is so fast that it gives no time to wind up the men and material from there. Even after the recede of water, the area becomes so swampy that nobody could even walk over that and crawling technique was adopted for approaching the shot pickets for loading and blasting.

Many unsuccessful attempts were made in the patch to lay eight receiver lines in the limited available operational hours, keeping safety of men and material in mind. By the time four or five receiver lines are laid water level used to start rising which warranted immediate wind up of men and material. Leaving the patch was creating a data gap in the prospective zone. Seeing no way to cover the area, four receiver line geometry with 32 shot template was studied for its attributes. The alternate geometry

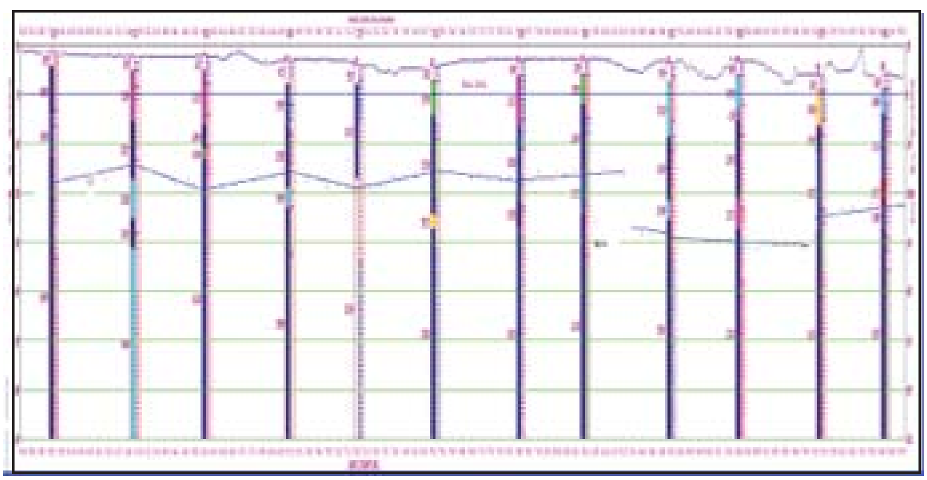


Fig. 4 : Near surface along one line

Fig. 5 : laying of seismic line in the area

provided similar foldage and acceptable offsets. The geometry was found suitable because laying of four receiver lines was somehow possible in limited operational hours. The shots were taken on both the banks of river by laying receiver line across the river. Layout of this geometry is shown in fig. 6 .

By adopting this revised geometry the subsurface under the river could be recovered with sufficient foldage.The coverage before and after the execution of recovery plan is shown in fig.7.

Even walking over the swampy areas, exposed after receding of the river, was not possible but by personal experiences of field crew, it could be observed that crawling was quite easier. So carrying of explosives, loading of shot points, laying of seismic lines was made possible by crawling over swampy zones.

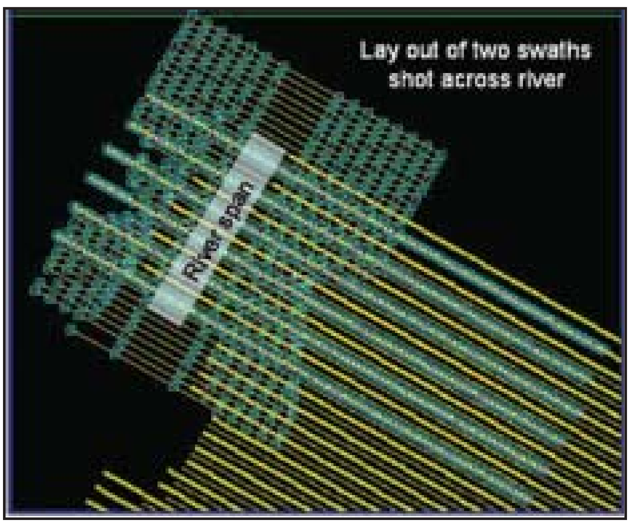


Fig. 6 : Layout of geometry used across river

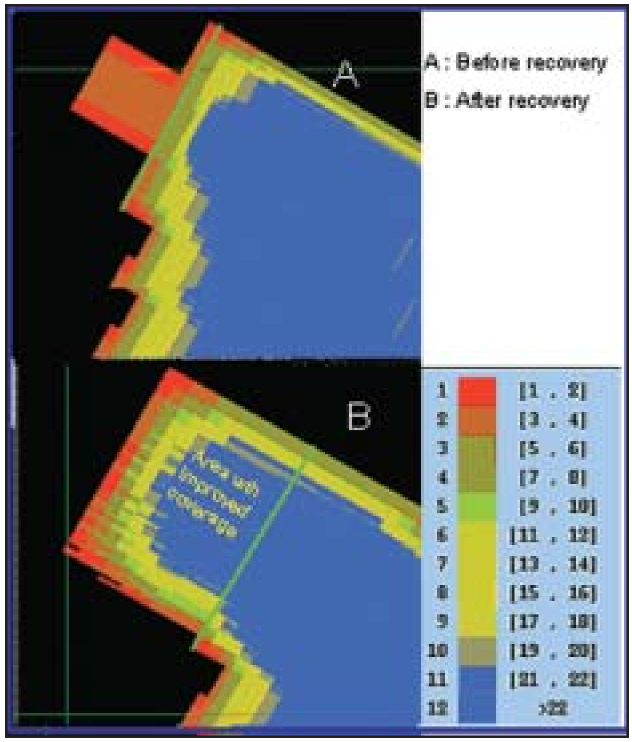


Fig. 7 : Coverage before and after recovery across river

Achieving the goal

Though the area was ridden with tough impediments, good quality data could be acquired without any data gap in such a challenging area without any loss to men and materials by analytical approach. The seismic section of a line falling in the area has been shown in fig. 8.

The frequency content of the data acquired is very good which helped in achieving the goal of resolving the thin sands (fig. 9). An exploratory location could be generated on the data acquired and possible positive results of the drilling may further boost up the morale of the team which carried out such a challenging task with great zeal by adopting suitable strategies.

Conclusions

Seismic data acquisition can no more be dealt with well defined conventional ways as the exploration areas are gradually limiting to complex and critical terrains. It requires something different from conventional work execution styles. The area under discussion was a smoldering example of such a situation and searching the means through conventional ways could probably leave the area

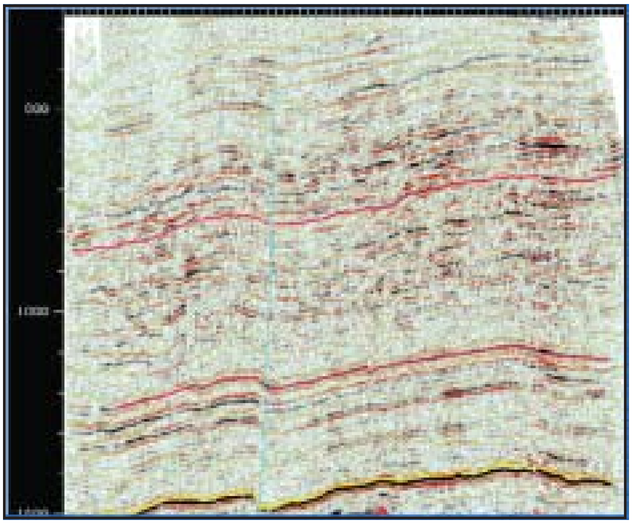


Fig. 8 : Seismic section of line falling in the area

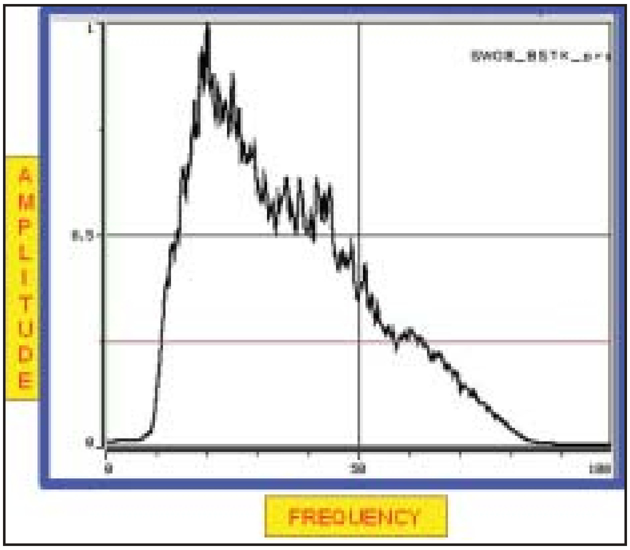


Fig. 9 : Frequency content of data acquired

unexplored. Understanding the exploration significance of the area, a more analytical approach towards data acquisition was adopted, tools were sharpened, strategies were defined / refined and goals were achieved.

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