3D-2C Transition Zone Seismic Survey in Palk Bay, Cauvery Basin-A Case Study

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SUMMARY

To explore for hydrocarbons in the established plays of Nannilam & Bhuvanagiri Formations as the primary target and to establish new play in deeper Andimadam Formation in palk bay, 3D-2C seismic data was acquired during FS: 2013-14. Survey area consists of different logistics such as human habitat, fish ponds, river and back water, paddy fields, coconut gardens, railway track, highways and coastal belt. Seismic data acquisition in these types of logistically difficult area needs meticulous planning & implementation to achieve quality data and as well as very good time management.

The present paper describes the case study of the acquisition of 3D OBC seismic data in the transition zone (logistically challenging area) by deploying suitable state of art air gun, marine node based cables, three types of sensors (dual sensor in marine, geophone on land and marshy geophone on backwater) for shooting in the marine extended to backwater area along with the conventional land equipment. The paper presents how the geophysical and logistical challenges were overcome through the design of optimized acquisition parameters to achieve quality data.

Keywords*: Transition zone, 3D-2C, air gun and explosive, dual sensors, geophones & marshy geophones, quality of seismic data, backwater, OBC.*

INTRODUCTION

Palk bay shallow offshore is the extension of Ramnad sub basin into the offshore area. In Ramnad sub basin, 28 BCM of IGIP and 19 BCM of reserves in Nannilam & Bhuvanagiri plays have so far been established through five discovered gas fields. These established discoveries are mainly confined to NNE-SSW trending PE-PP fault and to south of E-W trending fault (Kanjirangudi) in four way closures. Major part of the PBS-1 structure is extending into offshore part. Based on the existing wide grid 2D data, four prospects have been identified along similar fault trends. These identified prospects have an upside potential of about 15 BCM of IGIP. However, these prospects need to be firmed up with good data set.

The area was earlier covered by 2D lines of two vintages. As these lines have been acquired in very shallow water-transitional areas (Maximum water depth 6-7m), the quality of data was not as desired. As such, the available lines render mapping of Andimadam very difficult.

To firm up the identified prospects & to explore for hydrocarbons in the established plays of Nannilam & Bhuvanagiri Formations as the primary target and to establish new play in deeper Andimadam Formation as secondary objective, 130 skm of ocean bottom cable (OBC) based 3D-2C data with larger offsets and smaller bin sizes has been acquired in Palk Bay shallow offshore area and coastal transition zone. The data thus acquired would enable perceiving the prospectively of the area in a seamless manner with the on land data.

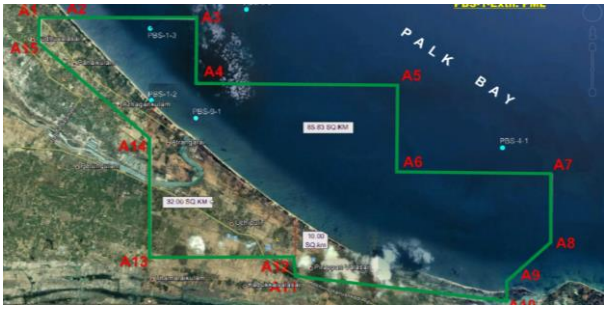

Fig.1: Showing the block diagram of survey area

OPERATIONAL AREA & CHALLENGES

The area where 3D-2C seismic data was to be acquired in the block consist of various logistic

features. On land portion the plantation of receiver lines over highway, railway track, highly populated human habitats, fish pond and navy camp was a challenging task. To keep charge at optimum depth also was challenging job since most of the land portion is mainly covered with loose sands .Proper care was taken to counter the collapse of shot holes and to keep charge at optimum depth (OD in the range of 25-30 meters decided by upholes survey & near surface models).

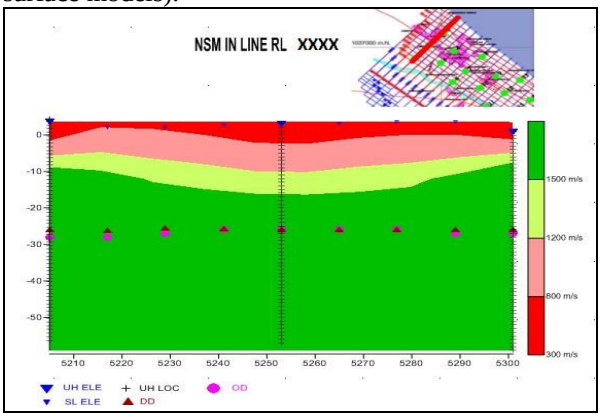

Fig.2a: Near Surface Model

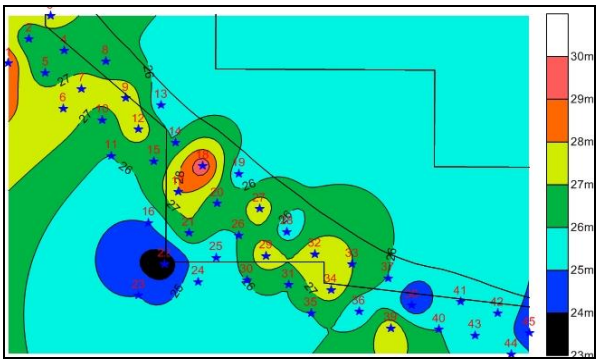

Fig. 2b: Land source optimum depth contour map

In marine portion the main challenges with logistics was due to the coral reef in shallow water area as shown in fig.3 where plantation of marine cable with catamarans (small boat) was a difficult task and data recovery in backwater area need good planning, data gaps in the seismic sections are unavoidable specially in near offset owing to large logistically difficult area and care was taken to maintain desired fold even in such circumstances by planning proper recovery shots.

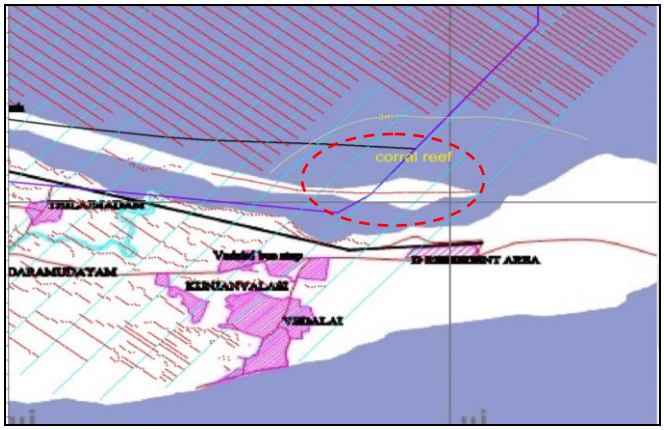

Fig.3: Backwater, island and coral reef portion of the block

OPERATIONS

Orthogonal geometry with 8 receiver lines for on-land swaths and 4 receiver lines for marine swaths were adopted. Catamarans were used to deploy seismic lines along the pre-plot lines, which was capable to hold up to 3 line km. of OBC cable. According to the statistics of work, it takes 15 minutes of time for deployment of the cable for the line length 1500 m and 40 minutes for recovering. These boats are able to work even in very difficult weather conditions as in the rough sea. Deployment of receiver lines in very shallow water was made with the help of boats Zodiak type. The auxiliary boats powered by outboard motors were used for recovery and deployment of transverse cables, battery changing, catamaran's crew exchange, cargo & people delivery from vessels & shore and preliminary depth measurement.

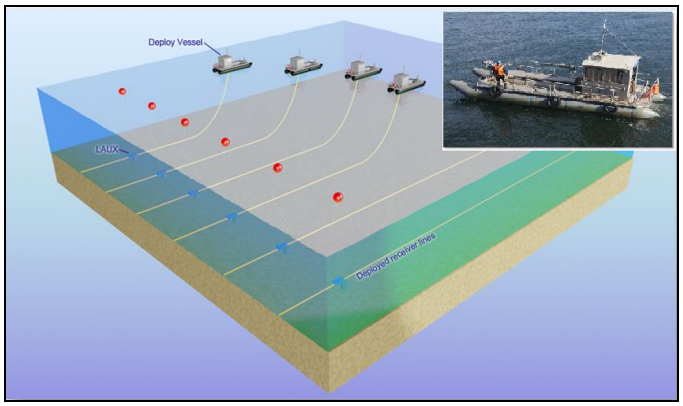

Fig. 4: Catamarans operation during plantation of OBC

Sercel made FDU with link cables were used in land part. Land & marine cables were connected by an adaptor

cable at the junction of land and water. SM24 geophone strings having 12 elements were planted in approximately one feet deep pit. Water was also poured in the pit falling in the sand patch.

Recording of seismic data

After the geometry check of receiver lines with pinging data, the shooting starts along the source lines in marine part by shooting vessel and recording of the seismic data is done at the recording unit UL-428 stationed at land. Loading of shot holes are done approximately at 12.00 hrs after receiving explosives form portable explosive magazine. Shooting of shot holes are done by four nos. of blaster unit and the data is recorded in the same recording unit used for marine data recording. Land shooting was carried out at day time and marine shooting during night time in general.

DC			DA		
Range of values		Count in range	Range of values		Count in range
from	till		from	till	
-26	-24	0	-26	-24	0
-24	-22	0	-24	-22	0
-22	-20	0	-22	-20	0
-20	-18	0	-20	-18	0
-18	-16	0	-18	-16	0
-16	-14	0	-16	-14	0
-14	-12	3	-14	-12	2
-12	-10	11	-12	-10	15
-10	-8	35	-10	-8	50
-8	-6	50	-8	-6	71
-6	-4	113	-6	-4	123
-4	-2	196	-4	-2	163
-2	2	553	-2	2	558
2	4	143	2	4	152
4	6	100	4	6	79
6	8	60	6	8	73
8	10	42	8	10	31
10	12	13	10	12	3
12	14	1	12	14	0
14	16	0	14	16	0
16	18	0	16	18	0
18	20	0	18	20	0
20	22	0	20	22	0
22	24	0	22	24	0
24	26	0	24	26	0
26	28	0	26	28	0

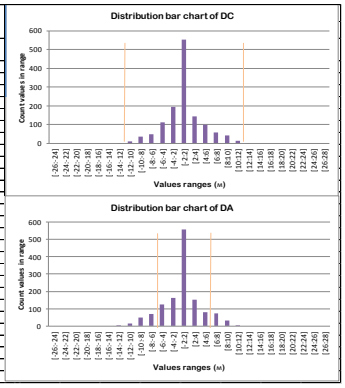

Table 1: Pinging data statistics from marine swath

Dual Sensor

The dual sensor consist of a Hydrophone and a Gimbal Mounting Geophone planted in the marine & the data collected by the sensors are recorded on separate channels. Cables with coupled FDU 428XL or FDU2S are available to operate with the dual sensor.

Fig. 5: Dual sensor OBC receiver

Parameter	Marine survey	Land survey
Bin size (m)	12.5X12.5	
Near offset (m)	18	
Far offset (m)	6977	7116
Nominal foldage	92	
Minimum accepted foldage	70	
Shot line interval (m)	150	300
Shot point interval (m)	25	
Receiver line interval (m)	450	
Receiver point interval (m)	25	
Template geometry	Central-Orthogonal	
No. of receiver lines in template	4	8
No. of receivers in template	2208	4416
Length of receiver pattern (m)	13775	
Inline receiver template Roll	6	12
Cross line receiver template Roll	2	1
Inline Source Roll	36	18
Cross line Source Roll	1	1
Length of shot line (m)	875	425
No. of shot lines moving template inline	1	1
No. of sources moving template cross line	36	18

Table2: Acquisition parameters

Source Parameter Used in the T-Z Survey

Parameter	Specification
Manufacturer and Type	G-Gun & mini G-Gun
Number of Sources	1
Sub-arrays	2 lines x 8 guns
Nominal Source Array Volume	1040 cu in
Nominal Operating Pressure	2000 PSI
Nominal Source Depth	2.5 m (If Bathymetry < 7m)
Peak to Peak	39.2
Primary/Bubble Ratio	25.8
Synchronization	b/w +/-1.0 ms
Sub-array Separation	5 m
Number of RGPS Units per Sub-array	1
Firing sensor type	Solenoid
Gun Controller	Bigshot
Navigation System	Gator (Concept System Ltd.)

Table 1: Air gun specification & source parameters

The quality control for each line was made for all the stages of data acquisition. The ambient noise levels, gun pressure/volume, quality during the shot, shot data, depths and navigation GPS, etc. on swath basis were studied.

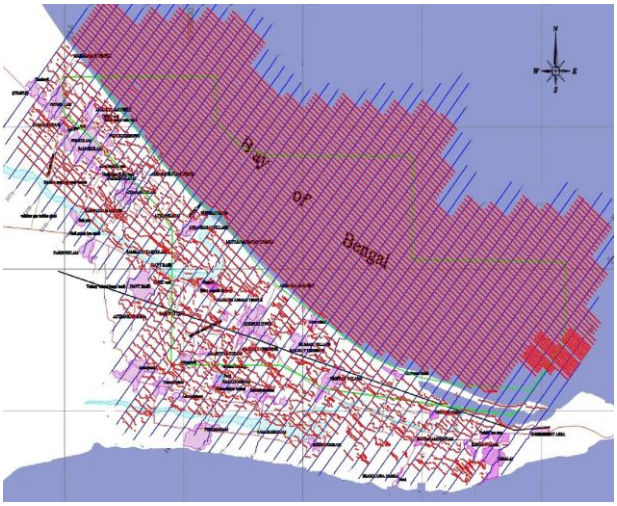

Fig. 6: Post plots of source & receiver layout

Pinging data statistics were checked before and after end of each swath production and found within specifications. Total 116 Recovery shots were planned in backwater land part and 81 recovery shots acquired in marine due to shallow water coral reef area to maintain the desired fold.

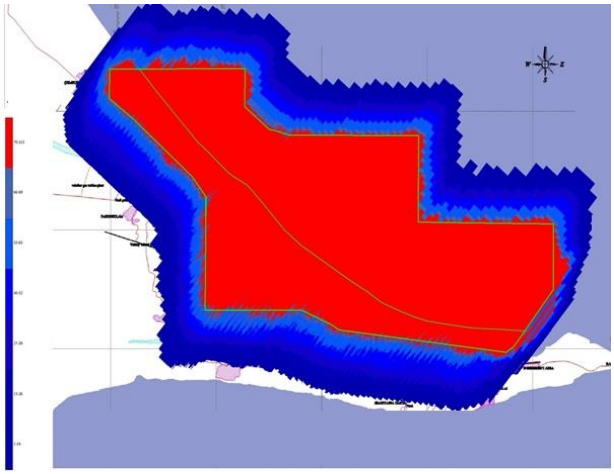

Fig. 7a: Final foldage map for all offset range of 0-6500m

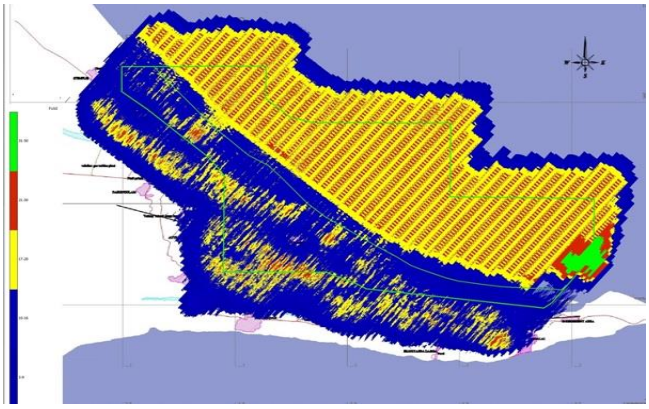

Fig. 7b: Foldage map for offset range 0-1625m

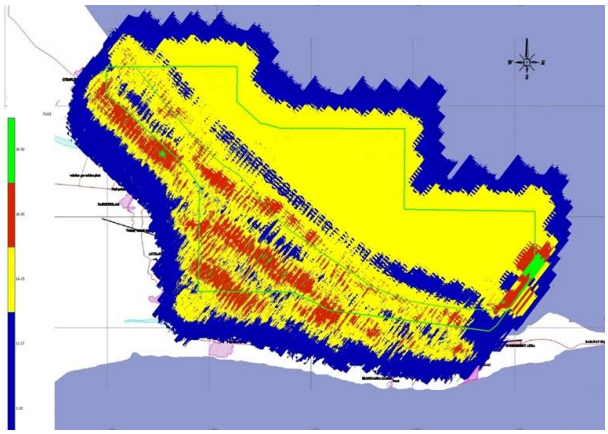

Fig. 7c: Foldage map for offset range 1625-3250m

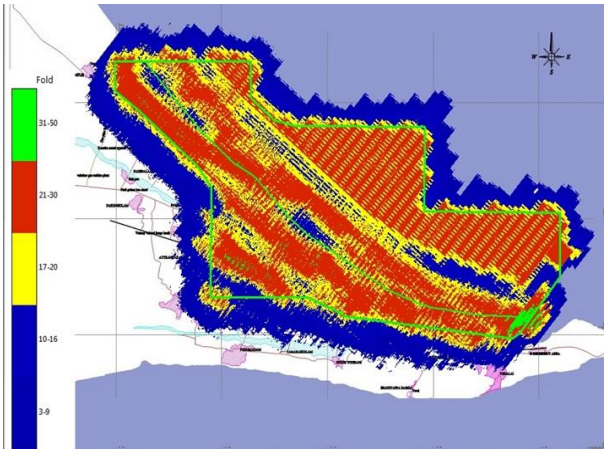

Fig. 7d: Foldage map for offset range 3250-4875m

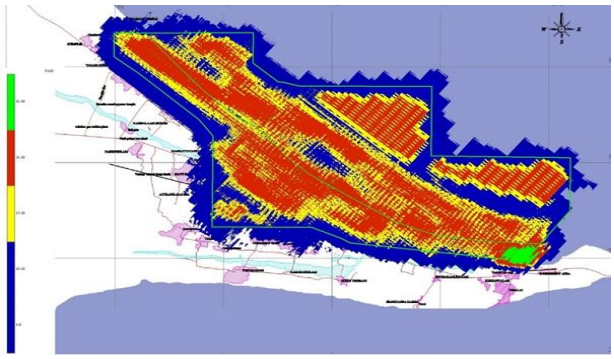

Fig. 7e: Foldage map for offset range 4875-6500m

RESULTS

Meticulous planning helped to acquire 70 fold 3D data in 130 SKM area. The acquired data after completion of each swath was stacked in the field for QC purpose. Data quality here is constrained by various difficult field logistics but still even under such circumstances foldage map and seismic section is good and events (2 -2.5 sec) visible on the section. Although the results is not very encouraging after processing in terms of seamless data in shallow water level but the data will help to study near deeper play Andimadam.

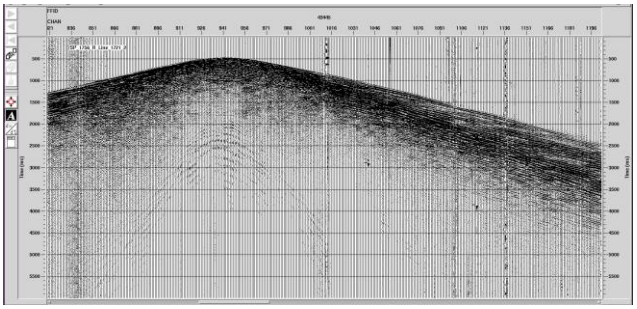

Fig.8: Raw shot gather of explosive source at land

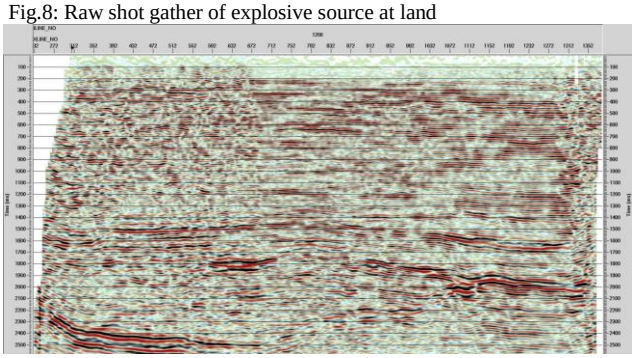

Fig. 9: Inline stack section

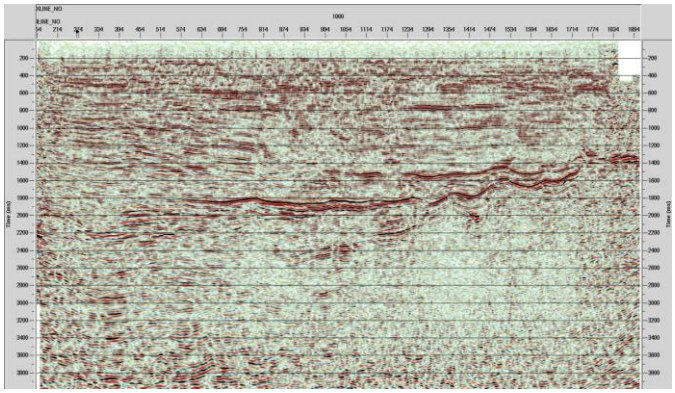

Fig. 10: Cross line stack section

CONCLUSIONS

Acquiring transition zone 3D-2C seismic data with in a logistically challenging area has been successfully completed in continuous supervision of ONGC. For negating the logistics, meticulous planning was made for acquiring full fold data with appropriate recovery plan. These include plantation of marshy geophone in fish pond and backwaters, trust hydrophone in surf zone, extra shots at island portion and extra source line in marine portion near coral reef.

ACKNOWLEDGEMENTS

The authors express their sincere thanks to all the members of Geophysical Services, Mumbai for their valuable suggestions & guidance during operation and analysis of the data. The authors express their deep sense of gratitude to ONGC Ltd. for providing technical & infrastructural support to carry out the above work.

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