

Dynamic recovery planning in a highly urbanised area: A case study from Cambay basin

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Keywords

Recovery swath, Infill lines, Dynamic recovery, Seamless coverage.

Summary

The challenges in Seismic data acquisition are increasing day by day. Particularly for land seismic surveys, it has become indeed a very difficult task to have seamless coverage due to logistics and rapid urbanisation. Because of the logistic problems, it is becoming very difficult to place the seismic source and receivers on the pre-planned locations. The problem gets more severe where objective given for acquisition is very shallow. In such cases, proper recovery plans have to be made keeping objective of the survey in mind. Dynamic recovery is a term used when recovery and regular shooting are done simultaneously, which saves production time. This paper describes a case study of seismic data acquisition with shallow objective where, special recovery plans were made to overcome fold drop due to logistics and obstacles.

Introduction

A 3D seismic survey was carried out in the study area. The study area falls in the North-eastern part of the Jambusar-Broach tectonic block of South Cambay Basin and lies on the north eastern rising flank of Broach syncline (Fig 1: Location of study area). The area is logistically very challenging. There were large number of cultivated fields, which were being cultivated round the year and irrigated with the help of a number of tube wells and water canals. The wells and canals were connected with network of underground pipe lines for irrigation. The Northern most part of the area was highly urbanised with lots of industries. Apart from that, large number of villages with well-connected metal roads, traffic movement, and farm houses associated with number of tube wells, canals roads, railway track were major obstacles for seismic data acquisition. A map showing several logistic challenges is shown in fig 2.

Objective of the survey and Acquisition Geometry

The objective of survey was to bring out strati-structural prospects at Trap, Olpad & Ankleshwar Formation and to delineate fracture and their orientation for Trap level. The zone of interest in terms of two-way travel time was from 450ms -1200ms and in depth it was from 500m to 1300m.

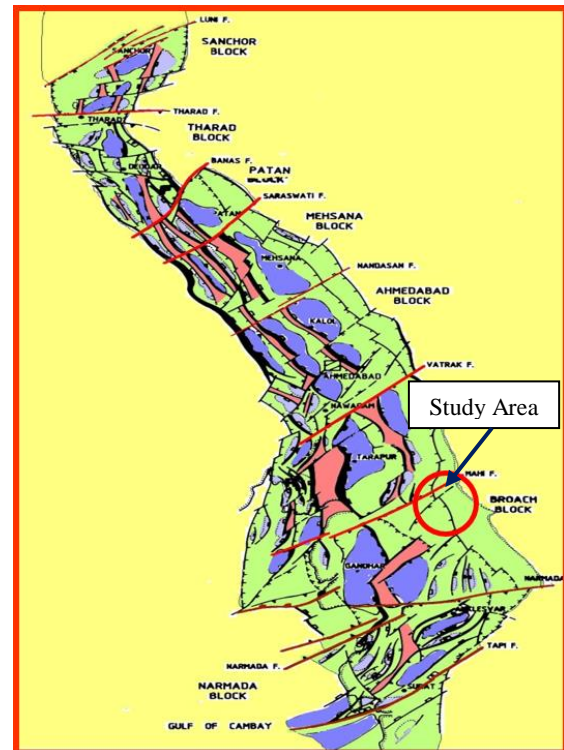


Figure 1: Location of study area.

Keeping the above objective in view, several geometries were analysed by generating their attributes through modelling. Parameters of final geometry (Table -1) and unit template are shown in figure 3.

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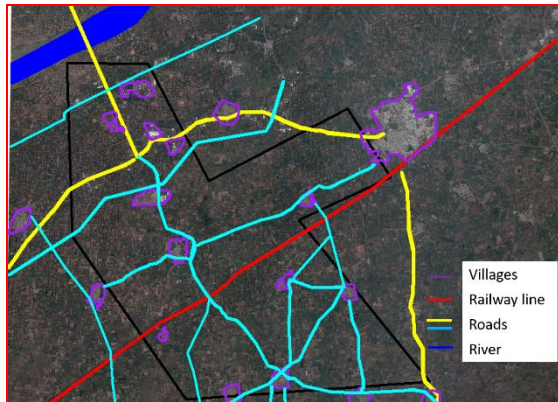


Figure 2: Logistic map of study area.

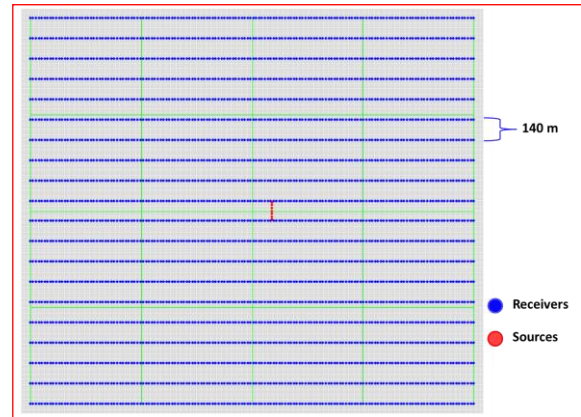


Fig 3: Unit Template

Acquisition Geometry Parameter

Bin Size	10 m x 10 m
Swath Geometry	Asy Split Spread
No of receivers per line	84 + 70
No of receiver lines	20
Total active channels/shot	3080 (154 x 20)
Receiver Interval	20 m
Receiver Line Interval	140 m
Shot Line Interval	140 m
Shot Interval	20 m
Shooting method	Orthogonal
Offset min	14 m
Offset max min	184m
Offset min max	1898m
Offset max	2173m
No. of shot / per template	7 Shots
Fold	110 (10x11)
Bearing	62° 06' 00"
swath roll over	1 Receiver line
Direction of swath rolls over	South to North
Aspect Ratio	0.86

Source Parameter

Charge type	Explosive
Charge size	2.5 Kg
Charge depth	Based on Near surface
Source pattern	Single

Recording Parameter

Recording Instrument	I/O System 4 (Scorpion)
Recording format	I/O SEG-Y
Low cut filter	Out
High cut filter	187.5 Hz
Notch filter	Out
Polarity	Normal
Record length	6.0 Sec
Sample rate	2 ms
Receiver	SVSM

Table-1: Parameter of Acquisition Geometry

Recovery Planning

As per the acquisition geometry, assigned area was to be covered with 108 swaths starting from swath no 11, which was in the southern part of the area. Planned shot-receiver layout and corresponding fold map is shown in figure 5 and figure 6 respectively. Up to swath 55, skipped shot were very less, however after that, study area was highly urbanised and industrialized due to which more than 30% of the planned shots were getting skipped. A map showing tube wells and other obstacle is shown in figure 4. In those areas, shot hole blasting was not at all possible due to safety reasons. Use of vibriosis was also not feasible. Actual shot receiver layout is shown in figure 7. It is evident that very limited locations were available to place the seismic source, however, with some proactive approach like advance detailed reconnaissance survey

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and horizontal layout of sensors using sand bags, planting receiver in those areas was possible. Since the target was very shallow, and available shot locations were sometimes kilometers apart, recovery techniques like forward/ reverse recovery, undershooting etc., wouldn't have yielded useful subsurface information. In that case, it was decided to place additional receiver lines (infill receiver lines) in between two planned line. The idea was to record useful offset as much as possible keeping shallow target zone in view.

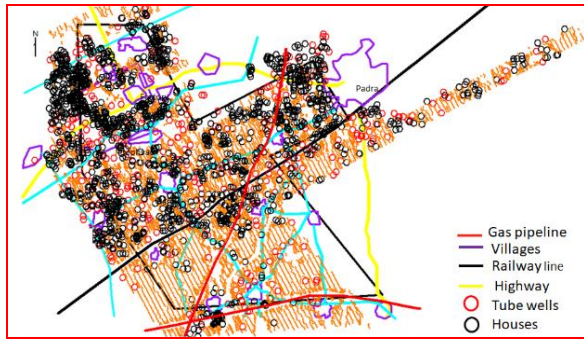


Figure4: map showing actual shot layout along with obstacles.

Advance survey work in the northern part of the area was already done with which, a tentative fold map was prepared and areas of low fold were studied critically. In those areas, infill receiver lines were laid down along with regular lines. Shooting with infill lines and regular lines were done simultaneously to avoid any production loss due to extra infill lines.

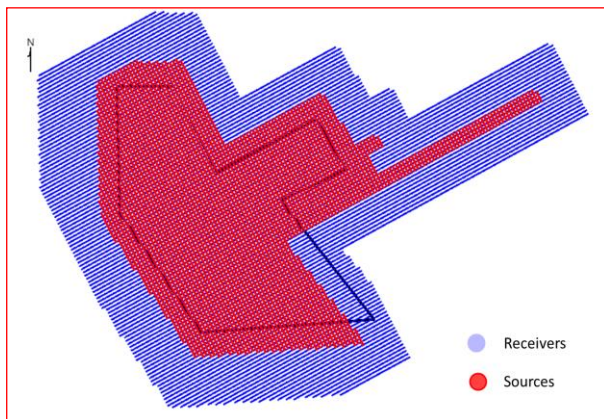


Figure5: Planned Shot-Receiver layout.



Figure6: Planned fold map.

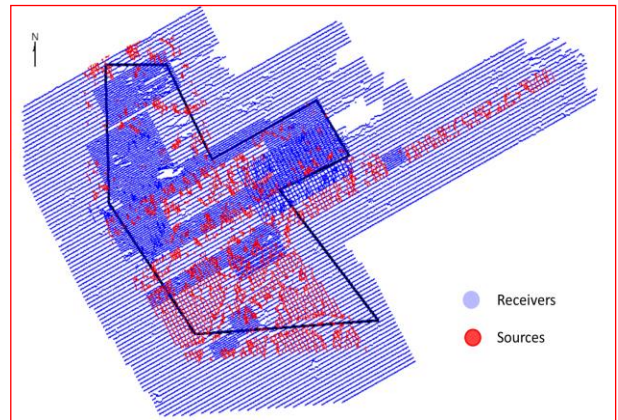


Figure7: Acquired Shot-Receiver layout.

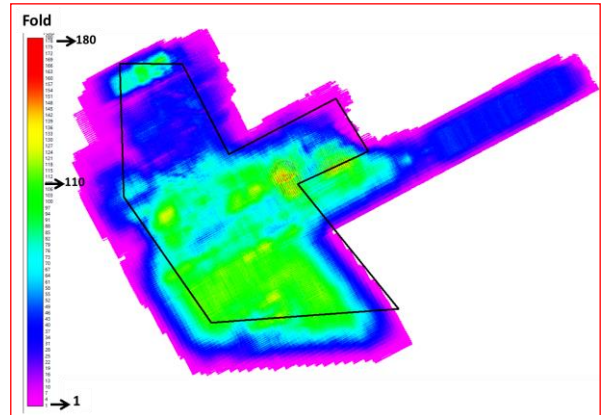


Figure8: Acquired fold map with infill receiver lines and recoveries.

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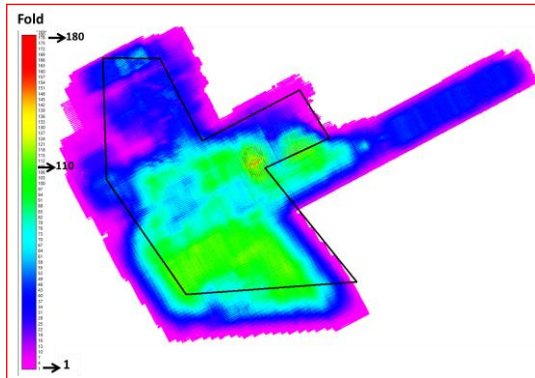


Figure9: Acquired fold map without infill receiver lines and recoveries.

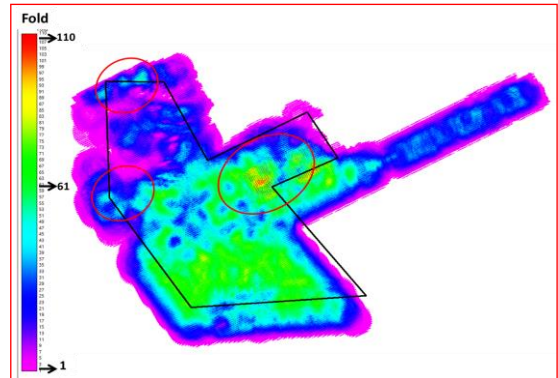


Figure12: Acquired fold map within zone of interest (500m to 1300m) with infill receiver lines and recoveries.

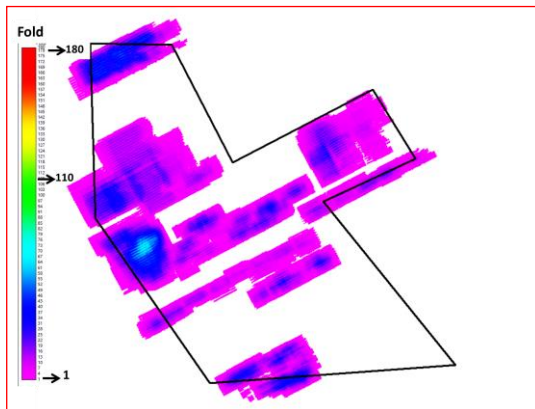


Figure10: Fold contribution only due to infill receiver lines and recovery.

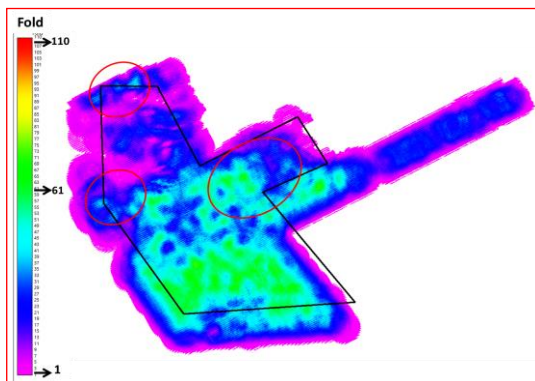


Figure11: Acquired fold map within zone of interest (500m to 1300m) without infill receiver lines and recoveries.

Value Addition:

The recovery program has added value to the acquired data. Acquired fold map of the study area is shown in figure 8. The fold map that would have been obtained without any recovery is also shown in figure 9. Fold generated only due to recovery program is shown in figure 10, which clearly shows the usefulness of recovery program. Fold map within the zone of interest i.e. from 500m to 1300 m with and without recovery is shown in figure 11 and figure 12 respectively, which indicates that the recovery program has added fold within zone of interest as well. Figure 13 and 14 represent rose diagram for planned and acquired geometry. Similarly figure 15 and figure 16 show offset distribution for actual and acquired geometry. Improvement can also be seen on brute stack which is shown in figure 17 and 18.

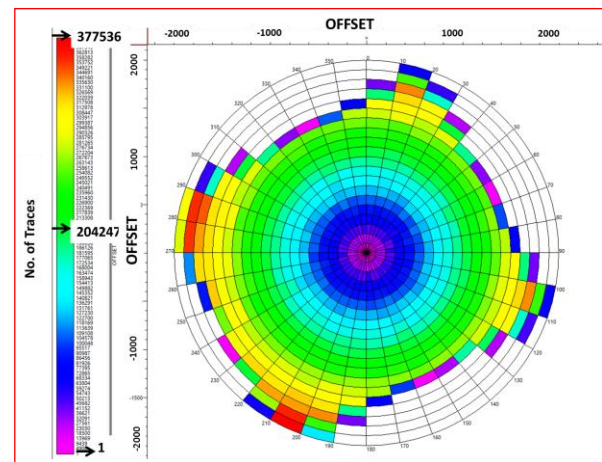


Figure13: Rose diagram for planned geometry.

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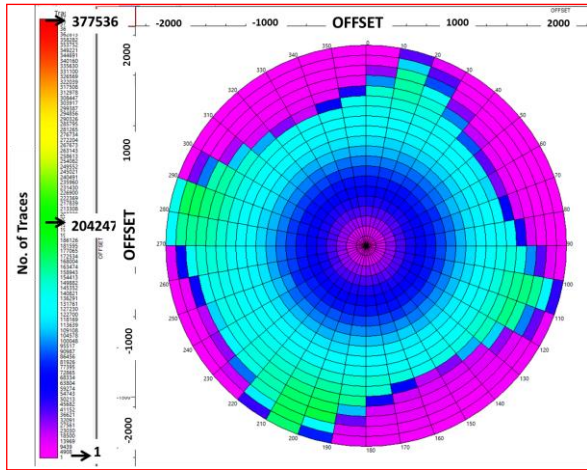


Figure 14: Rose diagram for acquired geometry.

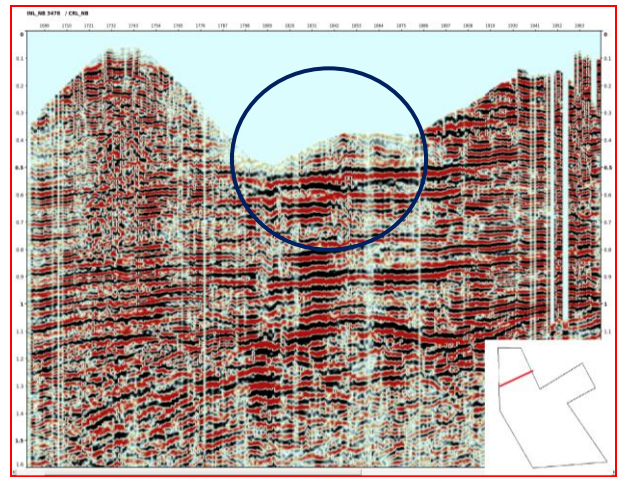


Figure 17: Brute stack without recovery along inline 3478.

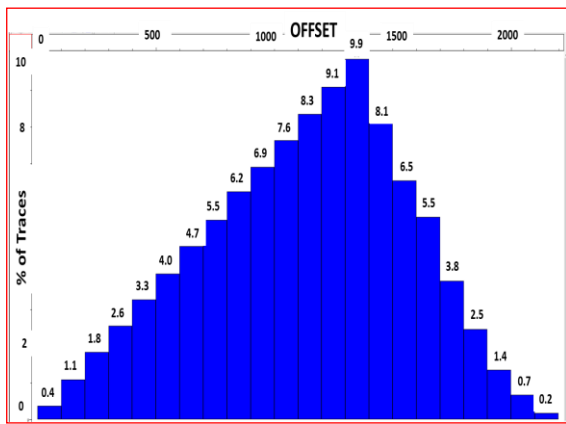


Figure 15: offset distribution for planned geometry

Time slice of final processed output (PSTM) is shown in figure 19 and 20. Time slice at 300 ms shows that there is still some data gap in the northern part of area. However, these data gaps are not there on time slices of 500 ms.

Seamless coverage on time slices indicate that the recovery program coupled with advance processing techniques has certainly added value to the final output data volume.

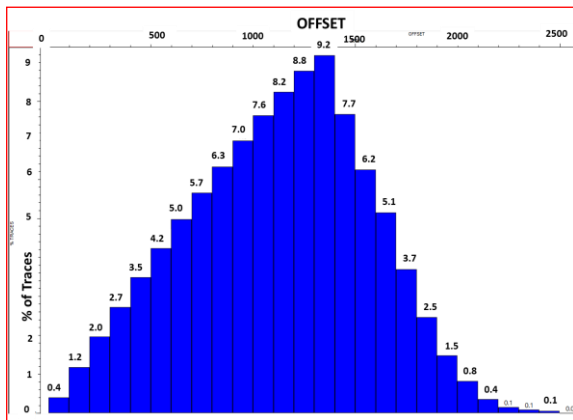


Figure 16: offset distribution for acquired geometry.

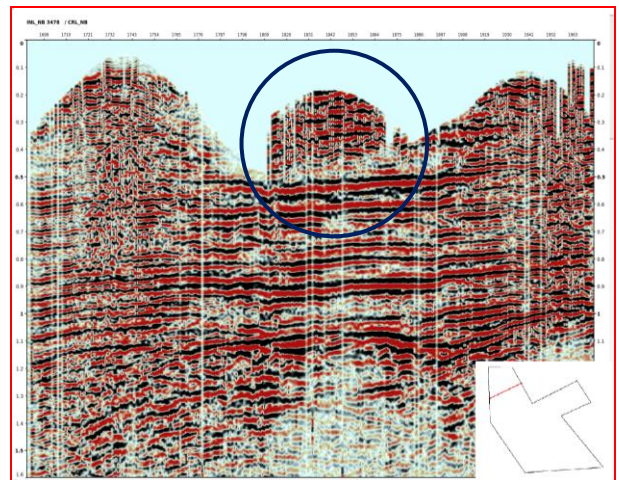


Figure 18: Brute stack with recovery along inline 3478.

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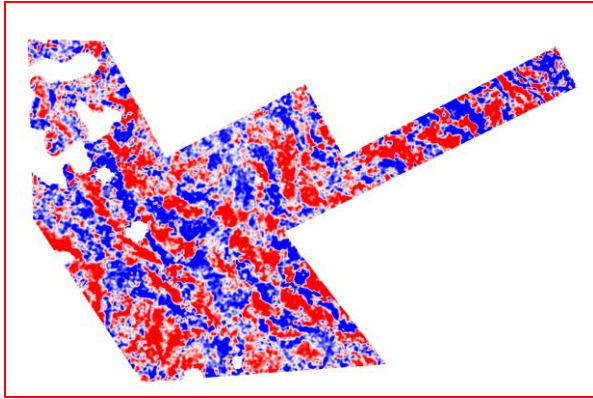


Figure19: Time slice at 300ms (Courtesy 3D-3C Processing Group)

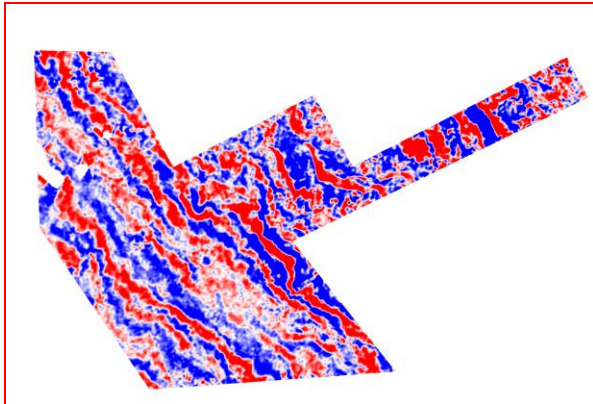


Figure20: Time slice at 500ms (Courtesy 3D-3C Processing Group)

Challenges

Dynamic recovery with infill lines posed many challenges during the data acquisition. Unlike regular lines which were laid down in advance, infill receiver lines were laid down in real time along with survey work on daily basis. Near industrial areas, cultural noise was also a problem.

Conclusion

The recovery plan to recover useful offset has added value to the final processed data volume. The acquired data together with the help of advance processing techniques like 3D/4D regularisation has provided seamless coverage in zone of interest.

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