Short-Offset Processing of 3D Seismic Data: A Tool for Study of Sea Floor and to Identify Shallow Hazards - A Case History


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ABSTRACT: The study area, namely, west of Bassein lies in Heera-Bassein block of Western Offshore Basin. It is about 80 Km from Mumbai coast and at water depth ranging from 58 to 74 m. Bassein formation is the main producer. The main objective of the survey was to study the structural and stratigraphic features at the level of Heera, Bassein and Panna formations. The study pertains to short-offset processing to identify the shallow hazards by developing and optimizing processing flow on short-offset data up to 1.5s, which is a subset, derived from the 3D seismic data volume of the west of Bassein prospect. Rigorous Testing enabled to enhance signal bandwidth, which in turn, resulted in significant improvement in vertical resolution at the shallow level. The preliminary study of the short offset volume indicates few anomalous zones with higher amplitudes at shallow level. True amplitude preservation, Pre-Stack Time Migration, AVO and Seismic Inversion studies, etc., are planned for their precise characterization. Besides, the quick look of this processed output, i.e., short offset volume indicates a few locales for hydrocarbon at deeper levels, which may be a good target for future exploration.

INTRODUCTION

The study area namely west of Bassein is westward extension of main Bassein field in Heera - Bassein block of Western Offshore Basin (Fig. 1). It is about 80 Km from Mumbai coast. The water depth varies from 58 to 74 m. The bathymetry map is shown in Fig 4. Bassein Formation is the main producer.

3D seismic data has been acquired in the study area with the main objective to map the structural and stratigraphic features at the level of Heera, Bassein and Panna Formations.

During the course of data processing the idea of short offset processing was attempted to exploit the information contained within 3D data, which is ignored due to its inherent impact on routine workflow, the available data was conditioned to this objective.

OBJECTIVES

The main objectives of the study are

1. To develop & optimize the flow for short offset processing to identify shallow hazards.
2. To look for the anomalous zone which may be causative to shallow hazards.
3. To give a quick look of the data volume and identify the probable prospective features.

METHODOLOGY

The processing team made an effort to derive and analyze the information associated with the shallow level (0-500 ms) which is normally ignored due to its inherent impact on routine workflow and developed a methodology from the available 3D data. For this study, a subset with limited offset upto 1500 m was derived from the acquired full offset 3D data. Although the emphasis for parameter optimization was only in shallow zone (TWT 0-1500 ms) yet the flow was applied to full length, i.e., upto 3000ms.
This method provides a quick look of the features in the zone of interest at deeper level and to guide for optimizing the processing parameters. The Base map (fig.2) and the foldage map are shown in Fig 3. Some loss of foldage is due to obstruction of drilling rig in the area as . The acquisition and processing parameters are given below:

**Acquisition parameters**

- **Method**: Dual streamer / Dual source
- **Orientation**: West-East (269.054 deg)
- **Recording channels**: 288/368
- **Streamer separation**: 100m
- **Group Interval**: 25 m.
- **Streamer Depth**: 8.0m +/- 1.0m
- **Near offset**: 173 m, far offset: 3773m/4773 m
- **Shot Interval**: 50 m (25 m flip-flop)
- **Source Depth**: 6.0 +/- 1.0m
- **Gun Pressure/Volume**: 2000 PSI / 2538 Cubic Inch
- **Acquisition system**: TRIACQ 1.6
- **Recording Format**: SEGD 8015 Rev.2
- **Sample Interval**: 02 ms.
- **Record Length**: 6.0 s
- **LC filter/slope**: 3 Hz / 18 db/octave
- **HC LC filter slope**: 200 Hz / 200 db/octave

**Processing**

The processing of the data consists of two parts
1. From reformat to stack was carried on PGS-TENSOR.
2. Final migration on Geo-Depth (Paradigm).

- **Reformat**: SEG-D to PGS Tensor format
- **Offset**: 1500m
- **Statics**: 8ms
- **Instrument delay**: 48.07ms
- **Edit**
  - **Nav-merge**
  - **Spherical divergence correction**: V1.5 xt
  - **Deconvolution type**: spiking
  - **Operator length**: 200ms,
  - **Gap**: 2ms
  - **Pre Whitening**: .1
  - **Velocity analysis interval**: inline1000m, crossline 500m
- **NMO+ Stack**
  - **Filter**: 8-12-160-180 Hz
- **Random Noise Attenuation**: Fxy –deconvolution

**Migration on Geo-Depth**

3D Kirchoff migration (single pass),
- **Aperture**: 3000m
- **Filter**: 8-12-90-100 Hz
- **Balancing**: Single window

The processing flow for short offset processing is given in Fig 5.
Short-Offset Processing of 3D Seismic Data

The sample plots of raw record (shot gather), and the spectral analysis in different time window for the Raw & Decon outputs are given in Fig 6-9. Optimization of processing parameters enabled to enhance signal bandwidth (Fig. 10), which in turn, would result in significant improvement in vertical resolution at the shallower level.

The migrated section along line showing a high amplitude anomaly is given at Fig 11.
The areas for further study are identified and the signal conditioned cmp gathers were taken out corresponding to these zones considering the migration aperture. This data will be subjected to Pre Stack Time Migration, AVO, LMR, Seismic Inversion studies, etc., for the precise characterization of anomalous zones.

**OBSERVATIONS**

1. The data along Inline, Crossline and Time slices at every 4 ms was scanned for the whole area. The preliminary study of the short offset volume indicates a few anomalous zones with relative higher amplitudes at shallow level.

1. The quick look of the processed output, i.e., short offset volume indicates a few probable locales for hydrocarbon at deeper levels (Fig. 12-14) which may be a good target for future exploration.

1. The bathymetry and reflection strength of the event corresponding to sea bottom indicates the non-uniformity in the character of the surface.

**Figure 9:** Shot record after decon and frequency spectrum (0-500 ms)

**Figure 10:** Migrated sections along In line showing faults running upto the sea bottom

**Figure 11:** Time slices at shallow level (160ms and 280ms)

**Figure 12:** Migrated section along In line showing features at deeper level

**Figure 13:** Migrated section along Cross Line showing features at deeper level
The presence of faults in shallow zone - a few running right upto the sea bottom.

The method seems to be quite effective for the deepwater areas to assess the potential shallow hazards.

CONCLUSION

The preliminary study of the short offset volume indicates a few anomalous zones at shallow level with relatively higher amplitudes.

The sea bed seems to be quite uneven and heterogeneous in the study area.

The faults are observed in shallow zone and a few running right upto the sea bottom.

The method can be routinely applied for the deepwater prospects where ever 3D data is available for the identification of the shallow hazards.

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