Pre Stack Imaging in Gobindpur Area, West Bengal Basin – A Case Study

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Summary

3D seismic data in Gobindpur was acquired to probe the hydrocarbon leads in the area. Existing 2D data was analyzed for optimal design of 3D survey keeping the Pre stack imaging scopes. Signal conditioning followed by Pre stack time migration of the acquired 3D data resulted in good quality image of the target zones in the Eocene -Paleocene section.

Introduction

Gobindpur area of West Bengal Basin falls in the Contai area (fig-1) in East Midnapore district of West Bengal. Positive hydro carbon indications in the area necessitated to the hydrocarbon potential through 3D seismics. One well W-1 falling in the area had produced gas @ 60m³/day from the Paleocene section confirmed the generation and migration of gaseous hydrocarbon as well as the availability of reservoir rock. In addition, oil shows were seen in another well (falling outside the limits of current 3D area, in the north western part) from Paleocene and Cretaceous sections. To ascertain the entrapment locale either in the down-dip or elsewhere 3D seismics was planned. The area had been covered earlier by 2D seismic data was thoroughly analyzed for optimization of 3D acquisition parameters. 3D survey design and recovery planning was carried out and structured to cover the Paleocene pay units encountered in the well. 3D seismic data was acquired in the year 2004-05 (fig-2 & 3). Though the required subsurface area was about 50 Sq.Km, the actual size increased to about 201 Sq.Km. after full migration aperture and full fold considerations.

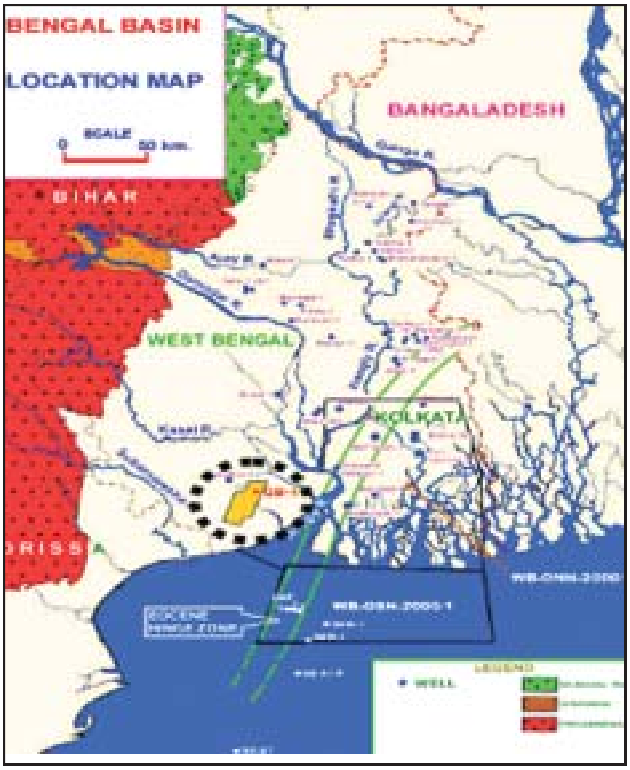

Fig.1: Location Map of Gobindpur area

Geology of the area

Indian part of Bengal basin encompasses an area of 57,000 sq.km of onland area and 33,700 sq.km. of offshore area. The basinal area is bounded by rocks of Indian shield to the north-west, Surma basin to the east, deeper Bay of Bengal to the south-southwest and Mahanadi basin to the southwest. The onland basinal area of Bay of Bengal is largely covered by Bengal Alluvium. Sediments ranging in age from Permo – Triassic to Recent had been reported in Bengal basin. Several wells were drilled for different hydro carbon prospects ranging from Paleocene to Miocene stages. Gondwanas are found in the graben parts and lie over the Archaen basement. Volcanics of Rajmahal traps of Cretaceous age overlie the Gondwanas. Arenaceous section of Bolpur formation belonging to Lower Paleocene overlies Rajmahal traps. Ghatal shales and lime stones of marine - shallow marine origin follow Bolpur formation. Jalangi formation, consisting of lime stones and shales belonging to Upper Paleocene age overlie the Ghatal formation. Monotonous

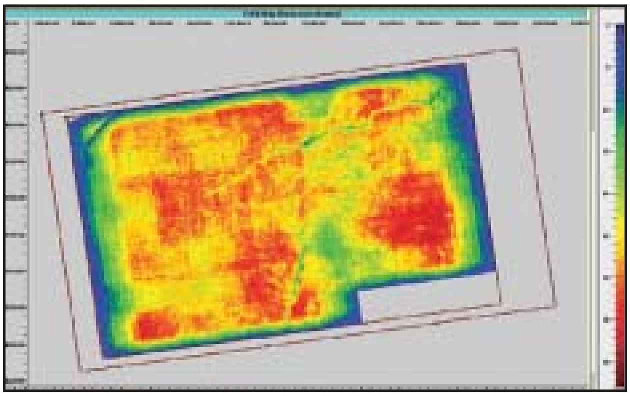

Fig.2 : Foldage map

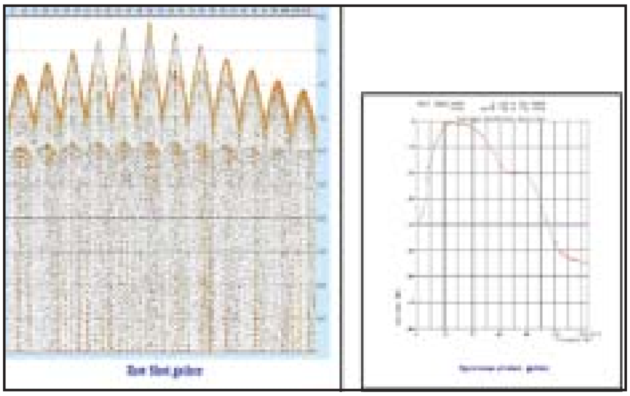

Fig.3 : Raw shot gather and the spectrum

limestones of Kalighat formation of Eocene age follow Jalangi formation. Hoogly shales (Lower Oligocene), Burdwan formation (Oligocene), Memari and Pandua formations (Miocene), Debagram formation (Pliocene – Pliestocene) and Bengal alluvium (Recent) complete the stratigraphic succession.

Objectives

Objectives of the 3D data are to decipher the extension of pay sands encountered in well Well#1 within the Jalangi formation (Eocene to Paleocene). This corresponds to a two way time window 2.0 – 2.6 s and depth range of 2500 - 3500 m.

Data acquisition parameters

- Group Interval : 50m
- Shot interval : 50m
- Bin size : 25 X 25m
- No. of Receiver lines : 12
- No. of receivers/line : 98
- No. of active #s/shot : 1176
- Receiver line interval : 300m
- Shot line interval : 350m
- Swath roll : 1800m
- Type of shooting : Orthogonal
- Multiplicity : 7X6 = 42
- Type of spread : Sym. Split
- Total shots : 10635
- Min. offset : 425m
- Max. offset : 3635m
- Direction of shooting : N – S
- Receiver line orientation : W – E
- Geophone array : Bunching
- Charge size : 1.0 -3.0 kg.
- Charge depth : 10-35m
- Record Length : 5 sec
- Sampling Interval : 2 ms
- Instrument : SN-408UL

Processing

Comprehensive workflow adopted for processing is given in fig-4. Broadly, the processing steps included standard signal conditioning techniques without affecting the relative amplitudes followed by pre stack time migration. The main features are as follows:

- Format Conversion
- Header Generation.
- Editing of bad traces.
- Initial velocity analysis on predictive decon gathers
- Gain recovery (V**2*T) using space variant velocity function.
- Inverse Q – filter tests
- Surface consistent deconvolution before stack tests and application.
- Surface consistent balancing
- Velocity analysis (500m * 500 m).
- Auto statics estimation I-pass.
- Auto statics estimation II-pass using external pilot.
- Initial RMS velocity volume creation.
- Initial Pre Stack Time Migration along velocity lines
- RMS velocity analysis on INMO’d PSTM gathers
- Final RMS velocity volume creation.
- Full migration aperture tests (3.5, 4.0, 4.5 and 5.0 km.)
- Geometric weight computation.
- Final Pre Stack Time Migration (Full aperture 5.0 km. at Two Way Time 2100 ms).
- Demultiple
- Random Noise attenuation
- Final mute selection and stacking of flattened PSTM gathers.

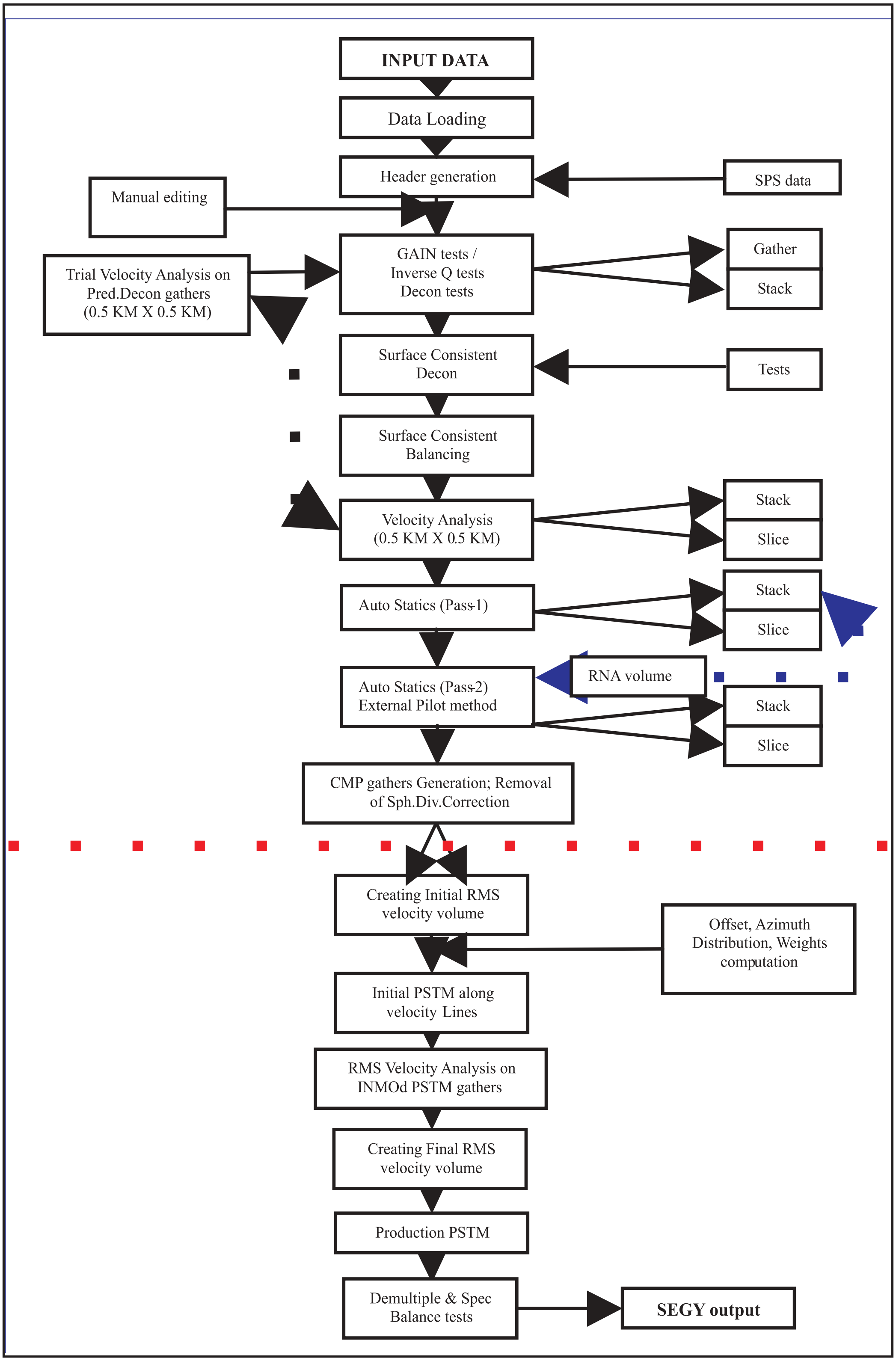

Fig.4: Processing workflow

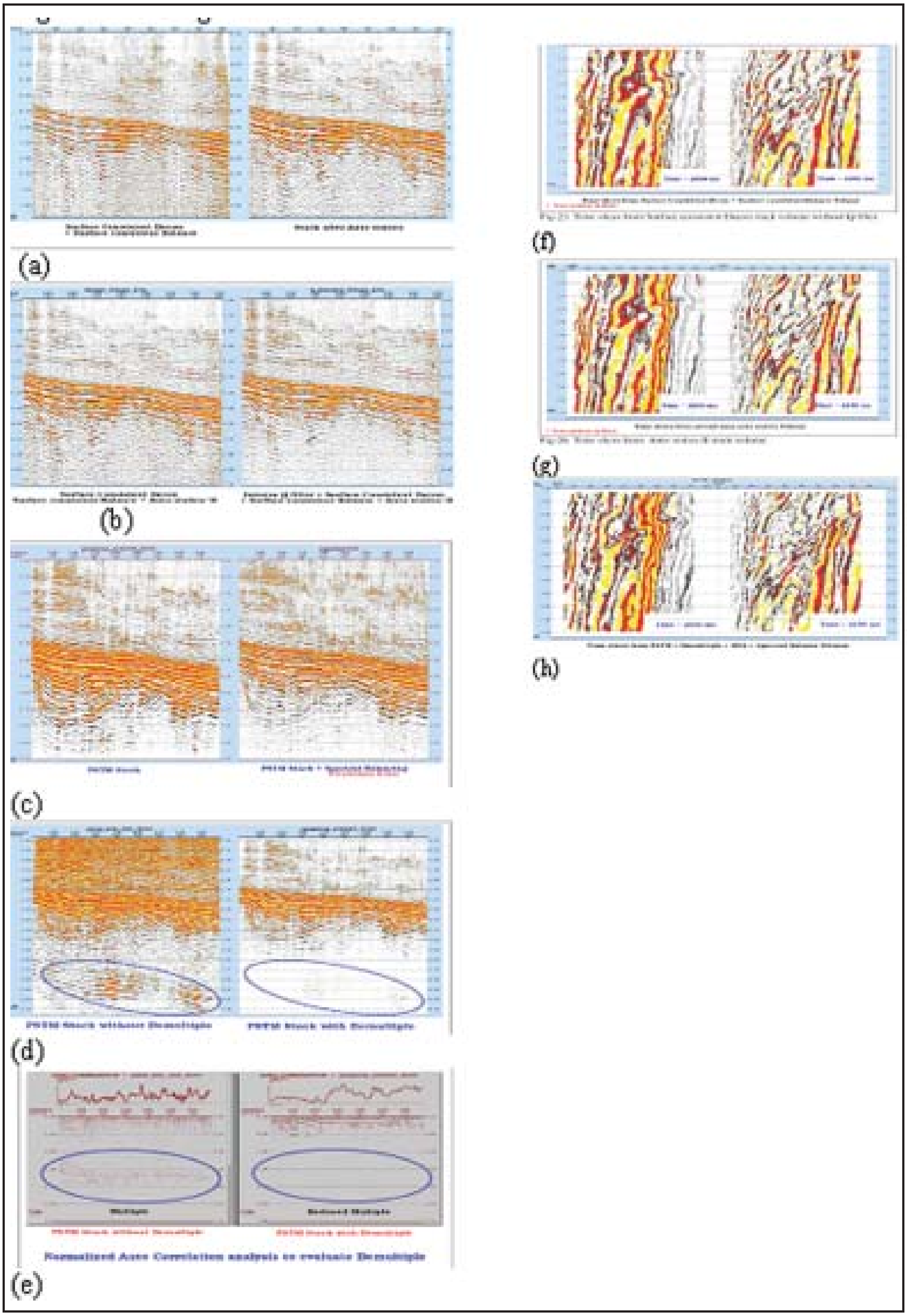

Fig.5 Comaparison of stacks after surf.cons.decon (a), auto statics (b), Inverse Q, Pre Stack Time migration (c), demultiple (d). Normalized auto correlation (e) shows reduction of multiple energies. Inverse Q-filter did not add value. The time slices after surf.cons.decon (f), auto statics (g) and Pre Stack Time migration (h).

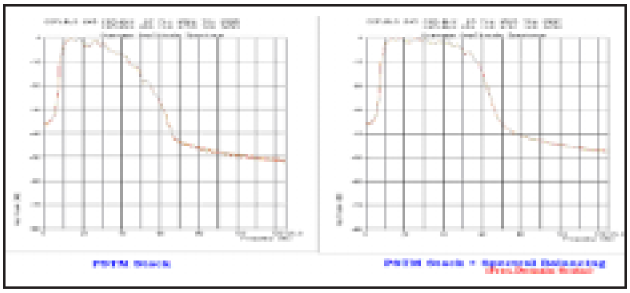

Fig.6 : Final spectra

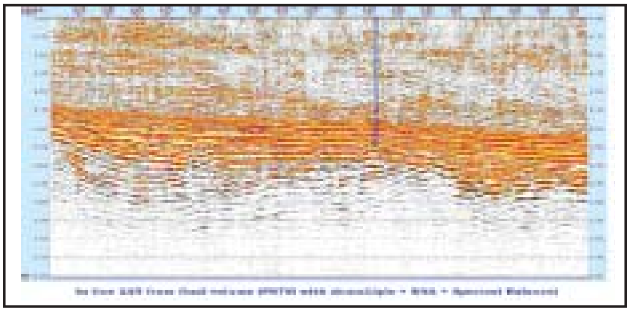

Fig.7 : Inline section thru the well

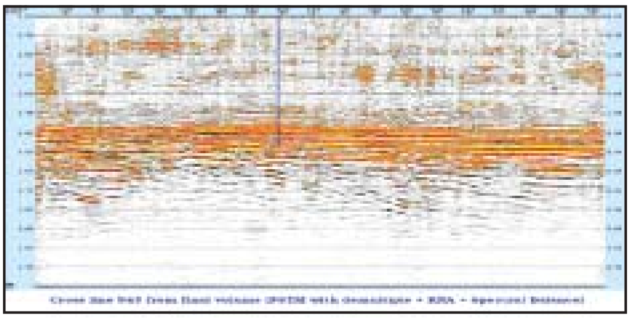

Fig.8: Crossline section thru the well

- Spectral balancing tests and application

Conclusions

3D seismic data in Gobindpur was acquired after analyzing the existing data and following appropriate geometrical considerations. In general, the acquired data quality is fairly good (fig-3). This facilitated signal conditioning in a logical way. Stage wise quality control at every step of processing resulted good quality data for input to migration. Inverse Q filter application was analyzed in detail and no significant improvements were seen in the Eocene – Paleocene section (fig-5b). First pass auto statics yielded better results (fig-5a) and second pass auto statics (fig-5b, g) could bring in only marginal improvements. Pre stack time migration of de-gained auto statics gathers with trace weights resulted in well imaged gathers. Demultiple followed by random noise attenuation of PSTM gathers further improved the gathers for stacking (fig-5d, e). Spectral balancing of PSTM stack using frequency domain scalars found to be optimal for post migration resolution enhancement (fig-5c,h, 6-8).

Acknowledgements

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Views expressed in this paper are that of the author(s) only and may not necessarily be of ONGC.

References

Mangaraj, B.K. et al, 2005, Signal conditioning and Pre Stack time migration of Gobindpur 3D data, unpublished ONGC report.