Large-scale seismic acquisition in congested, shallow water areas: observations from modern OBN data in the Gulf of Mexico

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Abstract

Academic and research use of ocean bottom node (OBN) seismic technology has been around for several decades. Commercial applications, however, have only been used since 2004. The first OBN acquisition projects were in the deep water Gulf of Mexico where dense infrastructure made streamer acquisition impractical.   As an alternative the industry quickly adopted OBN acquisition to provide the long offset, full azimuth, high quality and repeatable data necessary for production seismic and 4D analysis. Recently the benefits of deep water OBN technology has been extended to shallow water where high speed deployment methods, very large channel counts and blended source technology have enabled the acquisition of cost effective, large scale multi-client surveys suitable for production and exploration in a mature, highly obstructed area like the Gulf of Mexico shelf.

Introduction

The geologic and imaging objectives of a seismic survey are met by all azimuth, long offset, high fold and dense subsurface sampling that are requirements of new imaging and noise reduction technologies. In lightly obstructed, deep water settings modern streamer vessels, with wide azimuth cable configurations, generally meet the geologic and imaging objectives of oil and gas operators. The Gulf of Mexico shelf, however, is a heavily explored, densely obstructed and shallow water area. Acquiring optimal seismic data coverage around man-made obstructions (rigs, platforms, jetties, catch basins etc.), natural hazards (reefs, islands, submerged sand bars etc.) and operational hazards (shipping lanes, recreational boating, fishing zones, near shore currents etc.) is challenging. Large-scale seismic acquisition that economically satisfies the requirements of late-stage field development and deeper pool exploration requires an acquisition system capable of operational efficiency, flexibility and accessibility amongst infrastructure.   Ocean bottom node (OBN) acquisition has clear advantages over streamer and other ocean bottom seismic (OBS) systems in this environment.

Improving OBN Productivity

Figure 1 is an example of a large scale OBN survey design that is characterized by:

1. All resources working at all times
2. Source effort and receiver effort in balance
3. Large receiver area that minimizes repeated shots and effectively utilizes blended acquisition
4. Minimal start up and ramp down

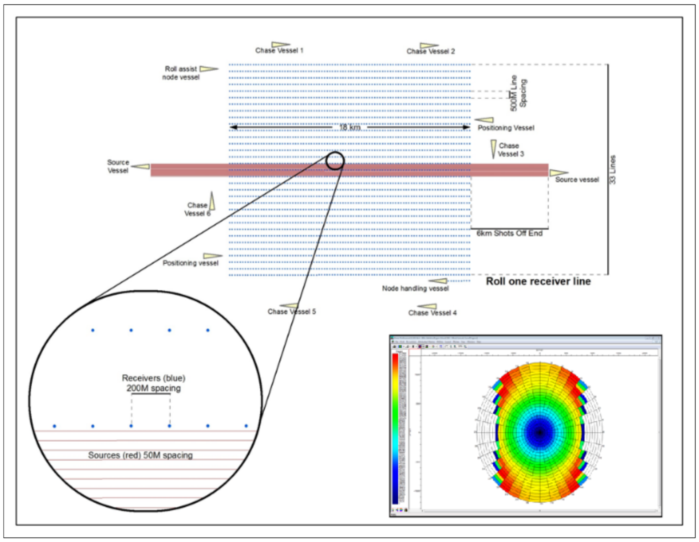

Figure 1 - *An OBN acquisition design known as the "I pattern". This design efficiently produces high fold, full azimuth data.*

Blended acquisition is the key technology that allows efficient acquisition of large scale OBN surveys. In conventional marine acquisition the time interval between successive shots are large enough to avoid interference in time. With blended acquisition multiple source vessels operate in a completely independent fashion. The multiple sources are shot in an overlapping fashion on a pre-determined random spacing. Waiving the constraint of no interference leads to improved productivity since more sources can be used in a given time period. Deblending is the procedure of recovering the data as if they were acquired in the conventional unblended way.[1] Figure 2 is an example of data before and after the deblending process.

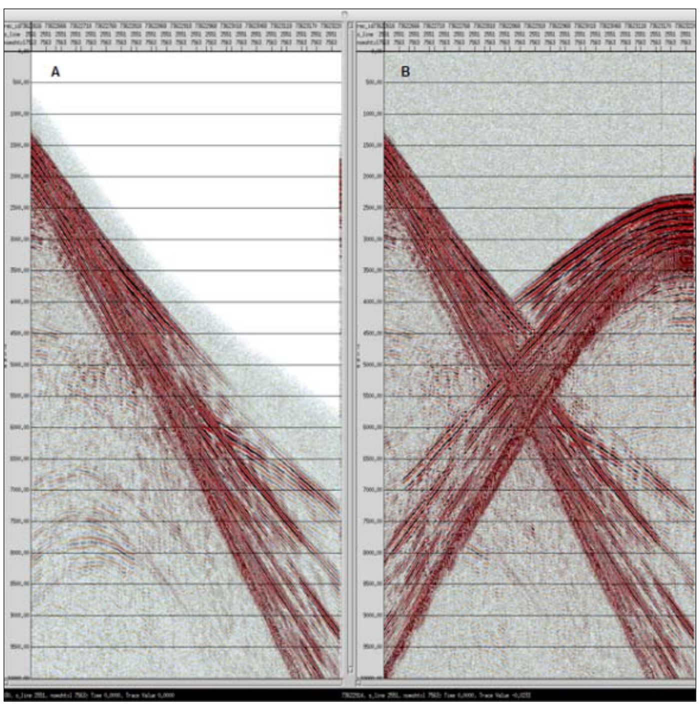

Figure 2 - *Common source records (A) After deblending. (B) Before deblending.*

Gulf of Mexico Shelf Data Examples

Production from the Gulf of Mexico Shelf include a variety of regions and play types from the Cenozoic through the less drilled Mesozoic. Shelf operators have recently pursued deeper Miocene reservoirs and applied technology such as short leg laterals to increase production and recover unswept reserves. Both cases require optimal seismic data to reveal new opportunities.

Consideration in acquisition design must be given to satisfying the requirement of advanced derivative products and attributes that can reduce risk and when combined with known geologic data or analogues to provide new opportunities. Legacy data may not provide the subsurface statistics to support proper application of quantitative interpretation technologies such as amplitude analysis, pre-stack data analysis (AVO and elastic inversion), azimuthal velocity analysis that impact both structural imaging and direct detection of geologic parameters (e.g. fractures and stress fields). Additionally, OBN acquisition provides converted wave data that is unavailable from streamer acquisition.

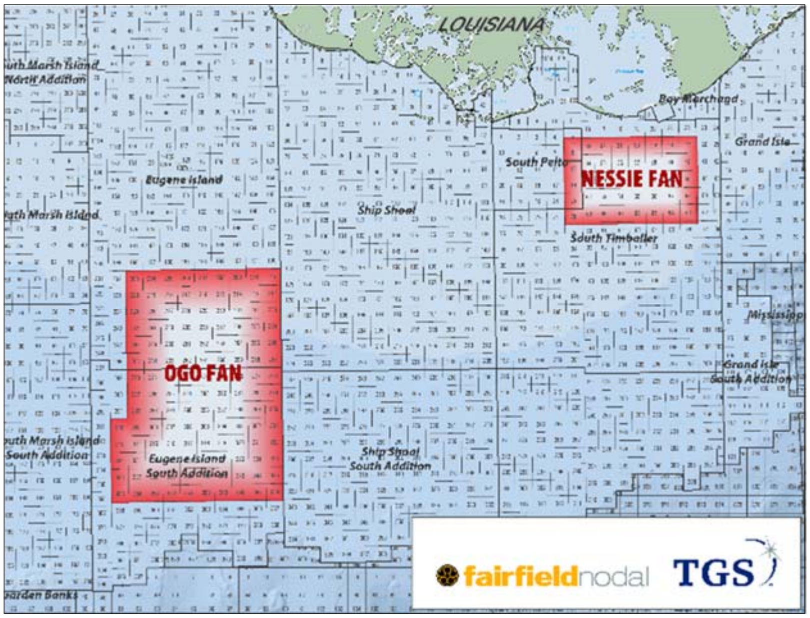

Figure 3 *- Location map of the full azimuth nodal data from the Gulf of Mexico.*

131 blocks of multiclient long offset, full azimuth node (FAN) data was completed in November, 2015 in the EI protraction of the Gulf of Mexico Shelf (Figure 3). The FAN Ogo data over-shoots earlier vintage narrow azimuth OBC acquisition. Figure 4 is a comparison of co-located lines from both surveys. Early observations from the processed data in comparison to historical underlying OBC NAZ data shows significant image quality uplift potentially revealing new development and exploration opportunities. TTI RTM and TTI Kirchhoff migrations, as well as sub stacks will greatly benefit from the increased fold and subsurface sampling that FAN data provides.

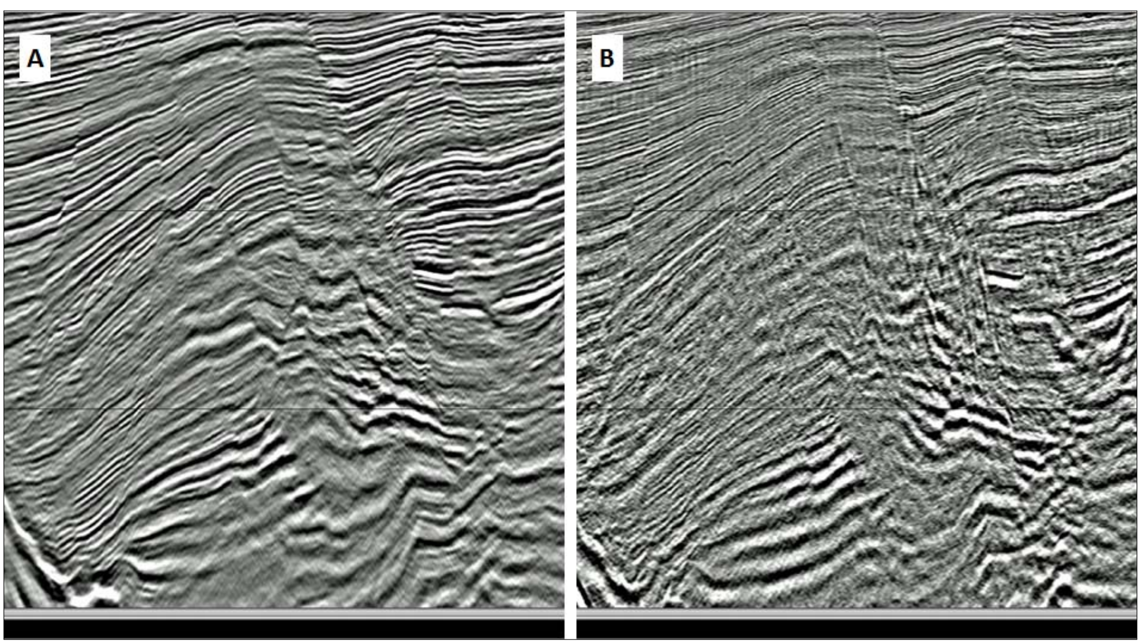

Figure 4 *- Co-located lines from (A) Full azimuth nodal data and (B) Narrow azimuth OBC legacy data. Note the clear difference in image quality. Both lines were migrated with the same velocity model.*

Conclusions

Ocean bottom nodes have delivered high quality full azimuth 3D data on a large scale in the congested waters of the Gulf of Mexico shelf. By employing large receiver spreads, new geometries and blended source acquisition OBN seismic provides cost effective seismic data that can be used at all stages of field development and revitalize exploration in mature basins.

References

1. Doulgeris, P., Mahdad, A., Blacquiere, G., 2011, Iterative separation of blended marine data: discussion on the coherence pass filter: SEG Annual Meeting Abstracts.