EAGE

18

Pushing efficiency whilst maintaining data quality at Greater Endurance by advancing 3DHD wide-tow multi-source streamer acquisition

A. Merry[1], J. Northall[1], T. Kluever[2], M. Widmaier[2], K. Helgebostad[2]

[1] bp; [2] TGS

Summary

In 2022, bp and TGS acquired a wide-tow quad source 3D High Density (3DHD) streamer survey over the Endurance carbon store in licence CS001 and the prospective stores within the CS006 licence. An efficient wide-tow 3D configuration was used to obtain high resolution imaging for overburden integrity and reservoir characterization. The survey successfully delivered much higher near-offset fold than legacy hydrocarbon-focused surveys, improving imaging and resolution at all geological levels.

In 2025, bp and TGS, acquired the second 3DHD survey over Carbon Storage licence CS007. This paper outlines how this novel style of wide-tow quad-source acquisition has evolved from the 2022 to the 2025 configuration, details the relevant technical elements for large-scale 3DHD surveys, and suggests areas for future advancements.

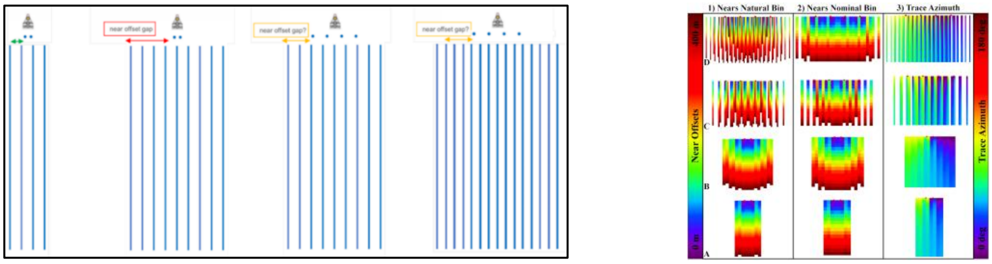
Pushing efficiency whilst maintaining data quality at Greater Endurance by advancing 3DHD wide-tow multi-source streamer acquisition

Introduction

In 2022, bp and TGS acquired a wide-tow quad source 3D High Density (3DHD) streamer survey over the Endurance carbon store in licence CS001 and the prospective stores within the CS006 licence. An efficient wide-tow 3D configuration was used to obtain high resolution imaging for overburden integrity and reservoir characterization. The survey successfully delivered much higher near-offset fold than legacy hydrocarbon-focused surveys, improving imaging and resolution at all geological levels (Cooper, 2022, Widmaier *et al.*, 2023, Tarasewicz, 2024). In 2025, bp and TGS, acquired the second 3DHD survey over Carbon Storage licence CS007. This paper outlines how this novel style of wide-tow quad-source acquisition has evolved from the 2022 to the 2025 configuration, details the relevant technical elements for large-scale 3DHD surveys, and suggests areas for future advancements.

Method

Many early 3D surveys in the UK North Sea used small streamer spreads and single or dual source configurations (Figure 1a, Geometry A). While providing good near offset coverage, they proved to be inefficient for covering large areas. Adding streamers (Geometry B) increased overall survey efficiency but reduced the spatial coverage of near offsets available for shallow imaging. In both cases, the towing arrangement introduced a significant inline offset between source and receiver which further limited near offset availability. Increasing the number of sources provides both the efficiency of a large streamer spread and the near offsets required for shallow imaging. In 2022, this concept was successfully applied using a wide-tow quad-source array with 9 streamers (Geometry C). In addition, the sources were towed over the streamer spread, further increasing the amount of near offset data. In 2025, this concept was further developed by utilising 15 streamers with wider source separation but narrower streamer spacing (Geometry D). This resulted in a 30% increase in sail-line spacing compared to the 2022 survey whilst preserving the abundance of near offsets available for shallow imaging.



(a) (b)

Figure 1 *(a): Geometry A (left), B (centre left), C (centre right), & D (right) acquisition configurations. Note that sail-line spacing increases from left to right, increasing survey efficiency. (b): Column 1: First 400m near offset for each survey on natural bin grids. Column 2: First 400m near offset on nominal bin grid 12.5 m x 12.5 m. Column 3: First 400m offset trace azimuth on natural bin grids.*

The distribution of near offset data for each geometry is shown in Figure 1b. Column 1 shows the distribution of the first 0 m - 400 m of near offsets using natural bins for each geometry A-D. Geometry A maintains small near offsets for each bin, but with limited coverage. Geometry B acquires a wider swath of data, but near offsets become larger. Geometries C & D provide a distribution of near offsets all the way out to the outer streamers across a wide swath. Column 2 shows the near offsets for each geometry binned on a nominal 12.5 m x 12.5 m bin. For geometries A and B, the near offset coverage and distribution is unchanged. However, for geometries C & D, the acquisition consistently provides small near offsets across the large swath. This is why wide-tow source acquisition is successful in delivering significantly improved shallow images whilst maintaining survey efficiency. The 2025 survey acquired using geometry D provides a wider swath of well populated near offset bins when compared to 2022 geometry C, increasing survey efficiency, but also an improved near offset population. This demonstrates the continued development of this acquisition method. Column 3 highlights one significant challenge. The source-receiver azimuth (0 deg -180 deg) of the first 400 m of near offsets varies in a stable manner for geometries A & B. However, for surveys C & D, azimuths alternate sharply between sublines. This introduces complexity when combining data into super bins.

Fast track images of the 2025 data (Figure 2) show that the larger spread continues to improve data quality whilst improving survey efficiency. Note that in parallel, advances in data processing, particularly challenges of shallow water (20m-90m), have also contributed improvement to the 2025 image compared to that from 2022 (Merry, 2025, Helgebostad, 2025).

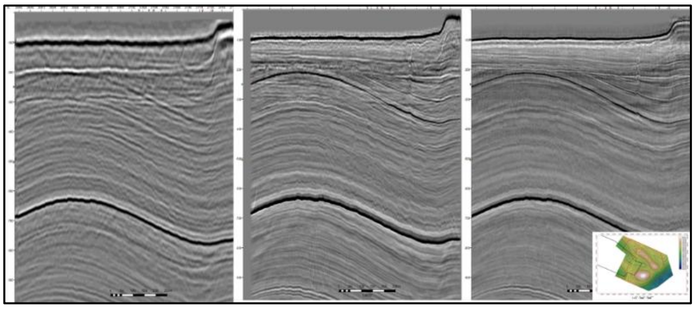


Figure 2 *Comparison of crossline from; legacy 3D survey acquired using geometry B (left); 2022 3DHD survey acquired with geometry C (centre); & the 2025 survey acquired with geometry D (right).*

Conclusions

The diluted and distributed nature of near offset for wide-tow configurations can be leveraged in data processing to provide efficient, high quality, 3D HR data. Nuance and challenges in processing continue to be addressed. Potential improvements could be made in the following areas to the 2025 acquisition:

- Adding additional sources and streamers to further increase productivity. Related operational challenges in shallow water and further dilution of fold need to be carefully scrutinized.
- Denser firing and self-simultaneous shooting will improve inline fold, alleviating challenges of fold dilution and improving data quality. This comes with its own pre-processing challenges.

Wide-tow multi-source acquisition continues to advance. Developments in the processing of this novel technique will help the industry steer its efforts for better quality and more efficient acquisition.

References

Cooper, C. [2022] High-resolution quad source acquisition over three CCS structures in the Southern North Sea. *Third EAGE Marine Acquisition Workshop, Oslo, Norway, 22-24 August 2022*.

Helgebostad, K.S., Oukili, J., Karlsen, T.K., Vaz, A., Merry, A. and Lawrance, D. [2025] Maximizing Resolution from HD3D Seismic Over the Greater Endurance CO2 Store Area, Southern North Sea, UK: 86th EAGE Conference and Exhibition 2025, Jun 2024, Volume 1, p.1-5

Merry, A., Smith, L., Tarasewicz, J., Lawrance, D., Vaz, A. and Nagra, N. [2025] Optimising Seismic Data Quality Across Multiple CO2 Storage Sites in the Greater Endurance Area, UK: 86th EAGE Conference and Exhibition 2025, Jun 2024, Volume 1, p.1-5

Tarasewicz, J., Merry, A., Gillespie, A., Lawrance, D. and Buchanan, S. [2024] Using 3DHR Seismic for Site Characterisation of the Endurance CO2 Store, Southern North Sea, UK: 85th EAGE Conference and Exhibition 2024, Jun 2024, Volume 1, p.1-5

Widmaier, M., Roalkvam, C., Orji, O. [2023] Advanced 3D Seismic Crossover Technologies Between Hydrocarbon Exploration, CCS Development, and Offshore Wind. *First Break*, 41 (11), 53-58.