EAGE

Efficient high-resolution acquisition using wide-tow double dual sources – a survey design study

Introduction

In recent years we have seen an increased application of wide tow source solutions in streamer acquisition. These designs combine improved near-offset coverage with efficiency (Widmaier et al., 2019). In this work, we describe an acquisition design for optimizing resolution at medium target depths whilst maintaining acquisition efficiency that wide tow triple source solutions achieve in deep water settings. The design uses a wide-tow double dual source. Its features and benefits will be demonstrated using a survey design study in the Central Graben area of the North Sea.

Survey design study

Figure 1a shows a legacy velocity model from the study area in the Central Graben in the North Sea. Many reservoirs in the region are located at the top of the chalk layer abetween1800-2500 m depth (the thin high velocity band stretching through the entire section), requiring high vertical and lateral resolution to resolve small scale reservoir details. Good near-offset coverage is key to resolution optimization. Below the chalk, salt diapirs with interbedded small sedimentary basins are overlaying the Rotliegend lithostratigraphic unit (located just above 6000 m on the left edge of Figure 1a)

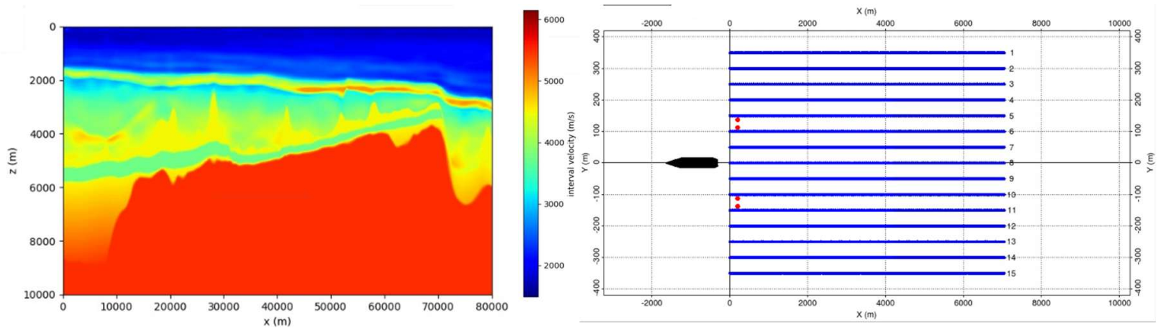
The area is characterized by shallow water with depths ranging from 40-80 m, making a classical streamer spread with narrow towed sources inefficient with geophysically sensible sailline separations in the order of 250-300 m, unless large near-offset coverage gaps are accepted at sailline boundaries. Wide-tow triple source geometries mitigate these near-offset coverage gaps, assuming no additional streamers are added, by distributing the near-offset traces evenly in the crossline direction. However, whilst the near offset coverage is improved, the first offset with all CMP lines covered at nominal crossline CMP line spacing is increased.

Alternatively, a classical approach of a narrow-tow dual source acquisition with a narrow streamer spread (appropriate for the water depth) can be taken as a base layout. In the study area, this leads to a layout with 10 streamers spaced 50 m, yielding a nominal crossline bin size of 12.5 m that allows to capture the necessary amount of spatial detail at about 2000 m target depth. Towing two dual sources in a wide-tow fashion (Figure 1b) effectively doubles efficiency of legacy streamer spreads while maintaining geophysically desirable characteristics of the small, dense streamer spread solution. The shallow primary target depth allows the maintaining of a shot point interval of 37.5 m per source: blended energy of shot N+1 falling on top of the Rotliegend layer which is well below the primary target depth. Figure 2 compares offset distributions of a wide-tow triple source configuration and the novel wide-tow double dual source solution. The wide-tow triple source configuration has 450 m coverage, whereas the wide-tow double dual source geometry is more efficient at 500 m coverage. The denser sampling of the near offsets with the wide-tow double dual source solution is evident.

Typical seismic vessels have an inventory of 6 strings to build sources from. Moving from three to four sources reduces each source to a single string. Figure 3 compares a standard dual-string source with 3280 cu.in. and a single-string source with 1420 cu.in. at the primary target depth (left) and at the Rotliegend level (right). Even though the transition from three to four sources requires reduction from two to single string sources, significant bandwidth is predicted to be above the raw, single trace noise level acceptable according to typical streamer acquisition specifications (red line in Figure 3).

Conclusions

A novel wide-tow double dual source solution effectively doubles the efficiency of a legacy streamer spread in the shallow water areas of the Central Graben in the North Sea, whilst maintaining a small crossline bin size and a high trace density for high resolution imaging of medium depth targets. The solution is as efficient as geometries typically deployed in deeper water areas of the Norwegian Continental Shelf.



(a) (b)

Figure 1 *(a) Representative velocity model in the survey modelling area. The chalk layer is the high velocity zone starting at 1700 m depth on the right. (b) Sketch of the wide-tow double dual source layout with 15 streamers spaced 50 m.*

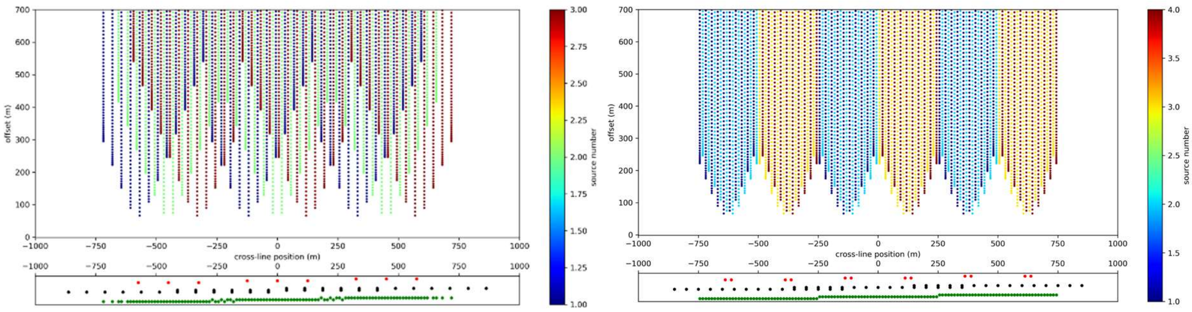


Figure 2 *Offset distribution for 12x75m wide-tow triple source solution (125 m source separation) and 15x50m wide-tow double dual source solution (250 m between dual source centers). Source numbers are color-coded.*

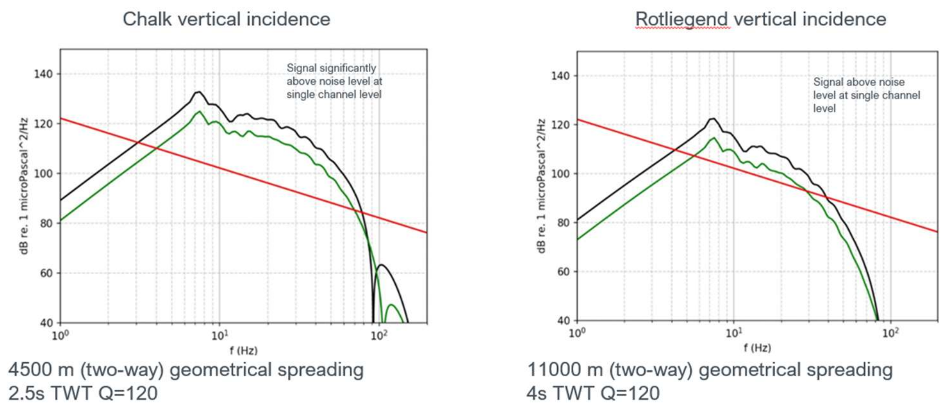


Figure 3 *Vertical farfield signature spectra of a 3280 cu.in. dual-string source array (black) at 8 m depth and a 1420 cu.in. single-string source array (cyan) at 7 m depth vs . representative single trace streamer noise level (red) at the primary target level (left) and the maximum depth of interest (right).*

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References

Widmaier, W., O'Dowd, D., and Roalkvam, C. [2019] Redefining Marine towed-streamer acquisition, *First Break,* **37**, 57 – 62.