Low-volume apparition sources: source trials from the Bass Strait

Simon Redfearn, Lorenzo Casasanta, Sergio Grion Shearwater Geoservices*
Jon Cocker, Beach Energy

Introduction

Towed-streamer blended acquisition using either overlapping or simultaneous sources is designed to deliver increased shot sampling and fold, enhanced resolution, and to optimize operational efficiency. During Q4 2021, several test lines of streamer data were acquired in the Australian Bass Strait to assess the impact of novel source configurations on data quality. In this abstract, we will focus on how reduced-volume source-array set-ups affect the recorded seismic data in terms of signal-to-noise ratio and usable bandwidth.

A baseline dataset was acquired using three conventional 2480in^3 source arrays in a flip/flop/flap triple-source configuration. The baseline is compared to two low-volume apparition triple-source test lines: the "large" apparition line uses three 340in^3 source arrays, whilst the "small" line uses three further reduced 140in^3 arrays. The other acquisition parameters are the same for all test lines. The sources are towed 100m apart. The shot-point interval is 8.33m with subsequent shots overlapping every 4s; underlapping energy from the previous shot was assessed and found to have a negligible impact on de-blended results. The apparition sources are fired quasi-simultaneously with periodic time delays of the order of a few milliseconds. The data are recorded by 12 streamers with 12.5m group spacing and 8km maximum offsets. Despite the lower source volume, we demonstrate that an apparition-enabled broadband processing sequence renders usable bandwidth comparable to the baseline survey at both ends of the frequency spectrum.

Apparition-enabled broadband processing

The three test lines' pre-processing sequence includes shot- and receiver-domain noise attenuation and natural random dither de-blending to remove the interference of the overlapping shot energy. The latter has been applied to the apparition data without damaging the underlying periodic modulated signal. State-of-the art receiver de-ghosting and shot-by-shot near-field-hydrophone-based source de-ghosting and de-bubble are now routinely applied to extend the bandwidth of conventionally acquired data. The same sequence is applied to apparition-blended seismic data with some changes to accommodate periodic time modulated signals. Since the sources are firing simultaneously, we apply receiver de-ghosting before apparition de-blending. Bubble energy is also removed prior to de-blending, as its modulated spatial variations are aliased and cannot be accurately separated into the individual shots during the de-blending process. The bubble is removed using a shot-by-shot operator derived from near-field hydrophone data as detailed in Casasanta et al., 2020. Apparition de-blending is then performed using a multidimensional sparse inversion algorithm to recover the full bandwidth of each source (Casasanta et al., 2021). The far-field source signatures obtained from the near-field hydrophones are also de-bubbled, de-blended and used in a shot-by-shot fashion to remove source-side ghost effects and un-aliased spatial source-array variations. Apparition de-blending noise sensitivity is higher at low frequencies and therefore can potentially be more detrimental for the low-volume sources investigated in this study.

Processing results

Figure 1 and 2 show the time-migrated processing results for the central cable after multiple attenuation for the baseline (left) and the apparition (center, right) low-volume source surveys. Upon inspection of the migrated stacks (Figure 1), the de-blended data have comparable quality, resolution and signal-to-noise ratio to the baseline survey. Further analysis of the octave panels in Figure 2 shows that upon apparition de-blending we can recover similar usable bandwidth to the baseline. Because of the use of significantly smaller volume sources, the low frequency end of the spectrum has a slightly elevated level of noise in the 2-4Hz band, but the signal strength is widely comparable in the 4-8Hz band.

Conclusions

This study demonstrated that lower volume apparition sources can be an environmentally and operationally viable choice. We have designed an apparition-enabled broadband processing sequence

capable of retrieving full usable bandwidth at both ends of the spectrum, particularly at the lower end, which is more noise prone from apparition de-blending.
The de-blended data has a comparable bandwidth to the baseline, despite the use of significantly smaller volume sources. When considered on a 2D test line, the data quality is comparable, but apparition offers the opportunity for better resolution in the crossline direction. In the examples shown, the extra shot points have been used to increase the stack fold instead.

References

Casasanta, L., Telling, R., and Grion, S. [2020], De-signature of apparition-blended seismic data: a North Sea example. *SEG Technical Program Expanded Abstracts*: 2888-2892.
Casasanta, L. and Grion, S. [2021], Multidimensional apparition de-blending through sparse inversion. *82nd EAGE Conference and Exhibition, Extended Abstracts*.

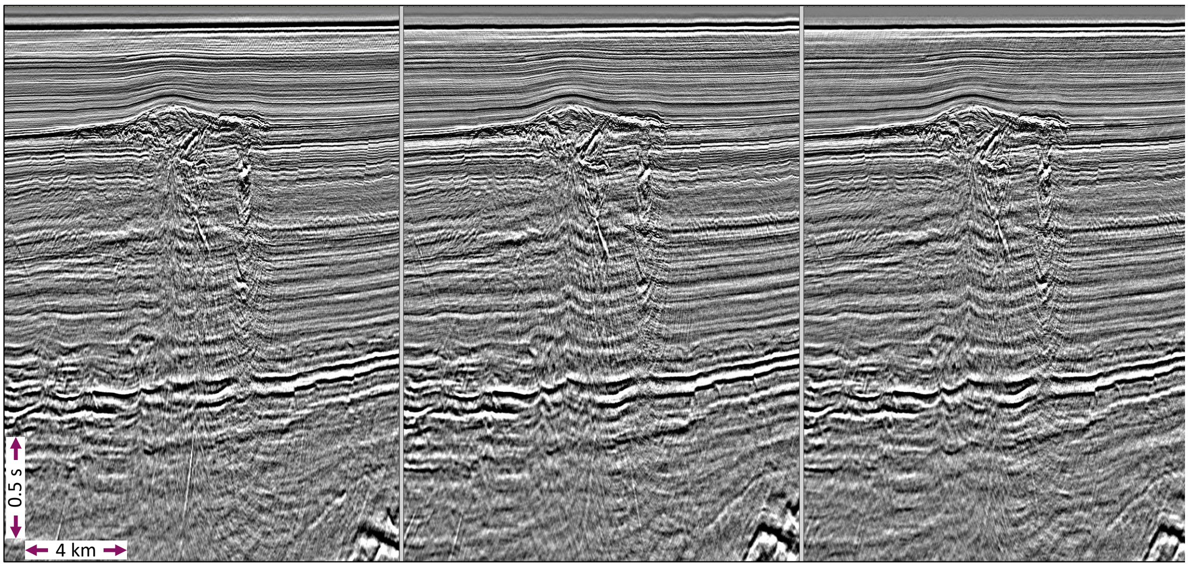

***Figure 1** Pre-stack time migrated stacks for the central cable: conventional 2480in^3 source (left) 340in^3 apparition triple-source (center) and 140in^3 apparition triple-source (right)*

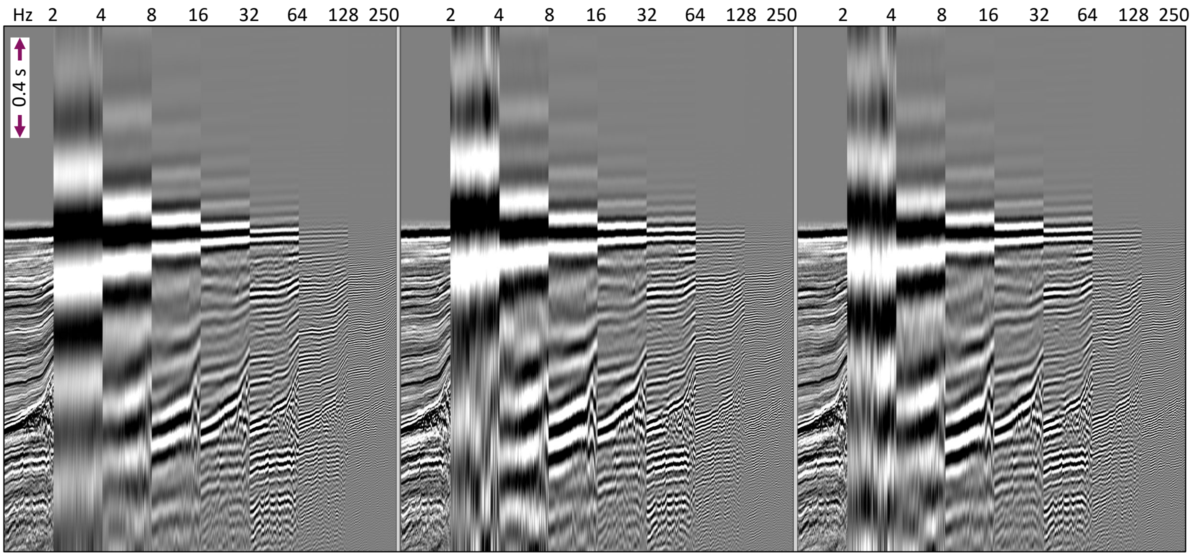

***Figure 2** Pre-stack time migrated stacks divided in frequency octave panels for the central cable: conventional 2480in^3 source (left) 340in^3 apparition triple-source (center) and 140in^3 apparition triple-source (right).*