RESULTS OF A 3D HI-RESOLUTION VIBROSEIS ACQUISITION TRIAL. IN THE COOPER BASIN.

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INTRODUCTION

The 3D acquisition geometry utilised in the Cooper Basin has remained relatively unchanged for the past 14 years, due largely to the efficient and cost effective method employed. Significant changes and progress have been made over these years in data processing, ensuring the seismic data have achieved the respective project objectives. However, with changing targets, greater emphasis on stratigraphic plays and the need for attribute analysis it is clear that processing techniques applied to the data have reached their limit and consequently the acquisition needs to yield better data.

This paper covers the results of an acquisition trial conducted in the Cooper Basin. The primary objective was to determine the effort required to image or better image certain shallow poor reflectors such as the oil bearing Hutton formation, through improved noise reduction by better spatial sampling. The secondary objective was to improve offset distribution to enable greater data regularisation for near and far offset traces. This in turn would improve the effectiveness of the migration process and consequently the robustness of the PSTM gathers for attribute analysis.

ACQUISITION

The parameters for the conventional survey were 40m group and 80m source interval, 320m receiver and source line spacing, consisting of 8 receiver lines of 96 receiver groups per line. This gives an effective fold of 24 with an in-line offset of 1900m and a cross-line offset of 1240m, and an aspect ratio of 1:1.5. The hi-resolution trial was recorded with 10m source and receiver interval with a maximum in-line offset of 4800m and a cross-line of 4480m. This was subsequently cut back to 3200m full azimuth in processing, giving an effective fold of 100. For the comparisons with the conventional data the offset was again reduced to 2200m, giving an effective fold of 50.

PROCESSING

The processing was carefully controlled to ensure observed differences were a result of acquisition changes and not differences in processing. 3D-FK filtering was applied to both data sets and obviously the coherent ground roll was better attenuated on the hi-res data. Inherently there were differences in the PSTM parameterisation, namely, the hi-res was 5 X 5m bins in and 10 X 10m bins out, whereas the conventional was 20X40 in and out. Careful consideration was given to offset binning such that there were minimal trace voids in each offset bin. The offset binning is shown in Table 1.

As the two main changes to the acquisition parameters, were source and receiver interval and full versus narrowish azimuth. These differences needed to be isolated in processing. Additionally the hi-res was also decimated at the field tape stage to simulate 20 X 20m and 40 X 40m group intervals. Gather and stack comparisons were made as tabulated in Table 2.

Table 1 Offset Bins

Bin #	Offset	Offset Range	Range
1	130	0-260	260m
2	360	261-460	200m
3	560	461-660	200m
4	730	661-800	140m
5	840	801-880	80m
6	920	881-960	80m
7	1000	961-1040	80m
Etc	Etc	Etc	Etc
24	2360	2321-2400	Max Conventional
Etc	Etc	Etc	Etc
33	3080	3041-3120	80m
34	3160	3121-3200	Max Processed Hi-Res

Table 2 Gather and Stack Comparisons

Comparison #	Group/Source Interval	Aspect Ratio (Azimuth)
1	10 X 10m	1:1 (Full)
2	10 X 10m	1:1.5 (Narrowish)
3	20 X 20m	1:1 (Full)
4	20 X 20m	1:1.5 (Narrowish)
5	40 X 40m	1:1 (Full)
6	40 X 40m	1:1.5 (Narrowish)
7	40 X 80m	Conventional 1:1.5

RESULTS

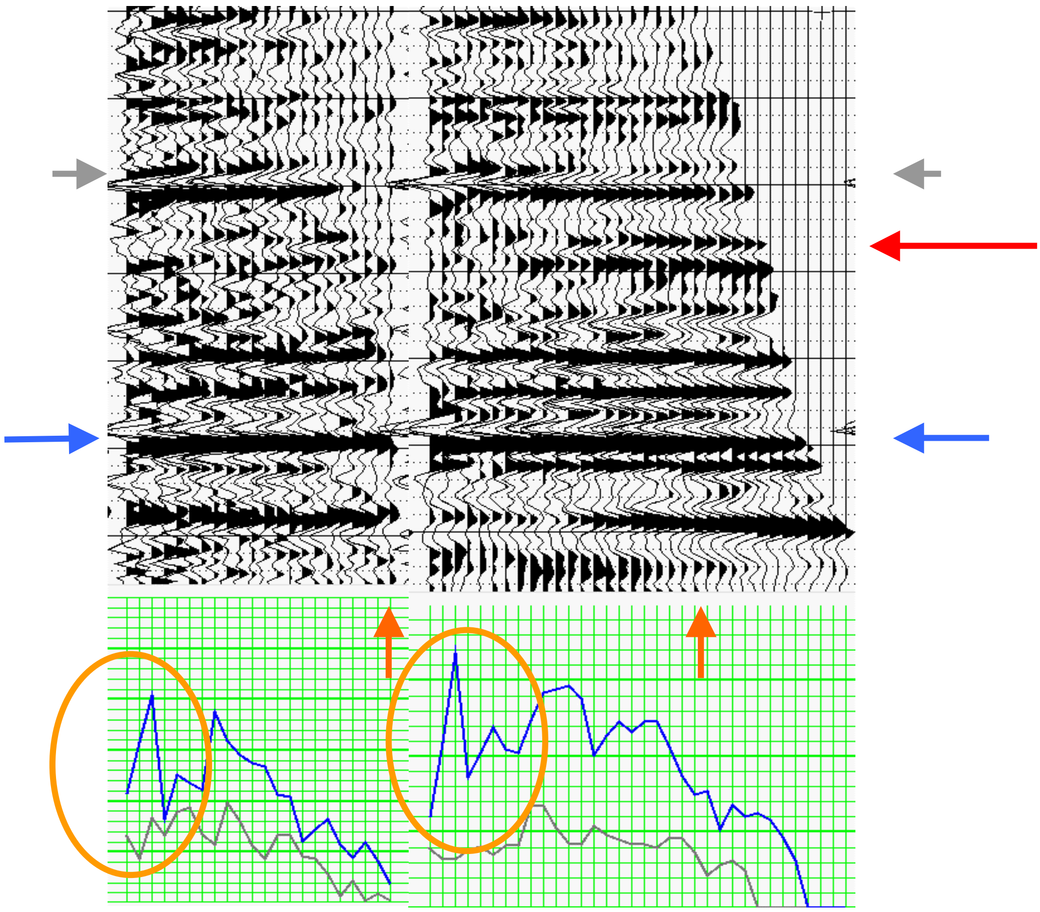
Figure 1 shows a conventional PSTM gather compared with the equivalent hi-res PSTM gather. The offset of 2200m has been indicated on both gathers by an orange arrow. It can be clearly seen that the hi-res has a far higher signal to noise ratio than the conventional acquisition. It can also be seen that the AVO response of the Patchawarra (blue) and the Birkhead (grey) on the near traces of both gathers is similar and still affected by noise. Although the Hutton is not shown on the AVO curve it is indicated on the gather by a red arrow.

When the hi-res is constrained to the same aspect ratio as the conventional acquisition, then differences become less apparent, refer to Figure 2. This indicates the full azimuth is giving the benefit rather than the finer sampling.

Similarly when a full azimuth simulated 40 X 40m group and source interval is compared with the 10 X 10m full azimuth, differences are less apparent, refer to Figure 3.

From the gathers it can be concluded that the signal to noise ratio is improved marginally by finer sampling of the geophone and source interval, however the full azimuth (1:1 aspect ratio) gives a far greater lift to the signal to noise ratio.

Figure 1
Conventional Acquisition   Hi-Res Acquisition



It is interesting that the stack data does not show a similar improvement to that exhibited by the gathers. This amply illustrates the power of the stack to attenuate noise and enhance signal.

In conclusion, significant improvement to the signal to noise ratio can be achieved at the CMP gather stage by acquiring full azimuth. Although finer sampling of source and receiver intervals does improve the S/N ratio it is minor compared to full azimuth. From a cost perspective, full azimuth can be achieved with a small cost increase, whereas finer sampling significantly increases the acquisition costs.

It should be cautioned that significant azimuthal anisotropy exists in the Cooper Basin, as was presented by Djamaludin & Brew at the 2003 Adelaide ASEG conference. It was shown that not only did amplitudes change significantly with azimuth, but time differences of the order of 10msec were common between the axis of strong and weak anisotropy.

Figure 2

Simulated 40 X 40m Narrow Azimuth | Hi-Res 10 X 10m Narrow Azimuth

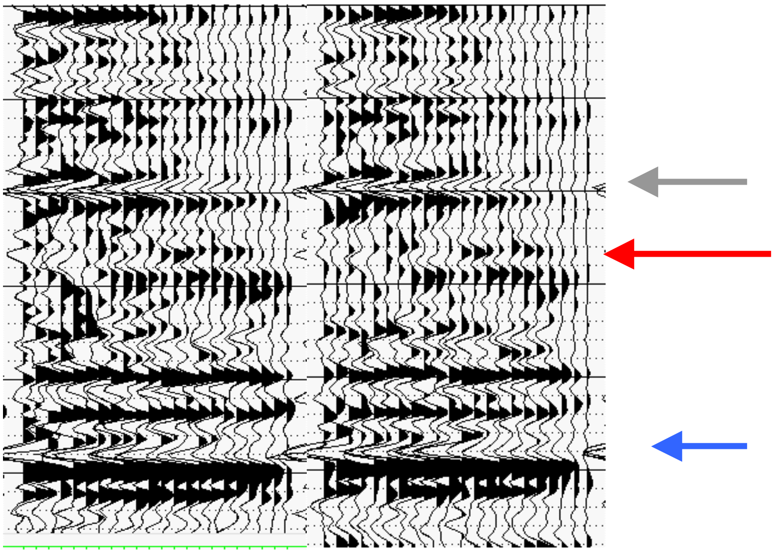
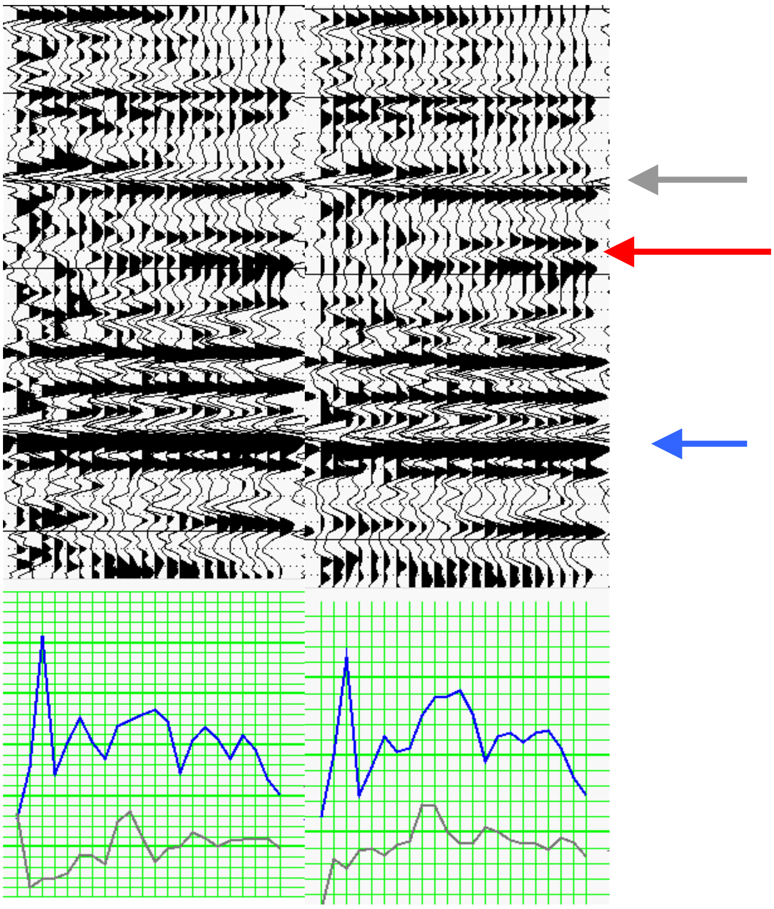


Figure 3

Simulated 40 X 40m Full Azimuth | Hi Res 10 X 10m Full Azimuth



ACKNOWLEDGEMENTS

The authors thank Santos Ltd, Beach Petroleum and Origin Energy for allowing the presentation and publication of this material.