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SHORTER GROUP INTERVALS IMPROVE SEISMIC DATA QUALITY ON THE ROMA SHELF, QUEENSLAND

G. R. Leamon and R. J. E. Parrott

Introduction

This paper presents the case history of Oil Company of Australia N.L.'s approach to improve seismic data quality in ATP 276P, a permit it has operated since 1980. The study area lies in the northern half of ATP 276P, and covers part of the Surat Basin and the Denison Trough. The main tectonic element in the area is the Roma Shelf (see Fig. 1). Seismic surveys were conducted previously using a dynamite source in 1980, 1983 and 1984.

The Problem

The region has a shallow sedimentary sequence (less than 700 milliseconds T.W.T.), is subject to severe ground roll (wavelengths 30 m to 65 m), and has high frequency static variations. Fair quality data has been obtained below 300 milliseconds but poor data above (which constitutes half the sedimentary sequence). Relatively large misties reduces confidence in subtle structural closures. The high cost of drilling shotholes sets a limit to the fold of CDP coverage. The 287 km 1985 seismic survey set out to alleviate the problems stated above without substantially increasing survey costs.

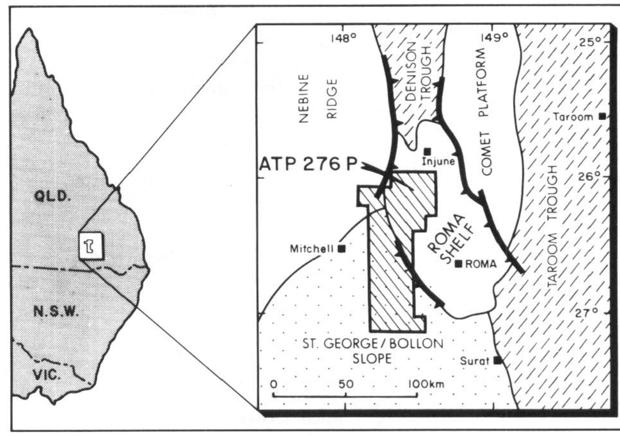

FIGURE 1
Location of study area.

The Method

Previous surveys had unsuccessfully tried to maintain a balance between cancelling ground roll in the field and recording shallow reflection data. For the 1985 survey a fundamental decision was made to rely on F–K filtering of ground roll rather than relying on array cancellation. This opened the way to shorten the group intervals and improve the quality of the shallow data. Table 1 compares the parameter changes. Group interval and station interval were both set at 10 m. The 10 m group interval was less than half the shortest wavelength of the ground roll observed on previous surveys, thus avoiding spatial aliasing. Ten metre group intervals enabled full fold coverage by 300 milliseconds using a 96 trace cable. Previous surveys were recorded with a 48 trace cable and 30 m group interval. The extra field effort in laying three times the number of groups was eased by reducing the number of geophones per group from twelve to six. Thus the 1985 survey had 18 geophones laid over 30 m (three groups) against the previous 12 geophones per 30 m group.

TABLE 1 Recording Parameters

Year	1983	1984	1985
CDP Coverage	600%	600% & 1200%	800%
Far Offset	750 m	750 m	485 m
Geophones	10Hz	10Hz	10Hz
Hole Depth	35 m	35 m	25 m average
Receiver Array	12 phones/20 m	12 phones/30 m	6 phones/10 m
Recording Channels	48	48	96
Sample Rate	2 millisecs	2 millisecs	2 millisecs
Source	Dynamite	Dynamite	Dynamite
Source Interval	120 m	120 & 60 m	60 m
Station Interval	30 m	30 m	10 m

Data Quality

Field monitor records from the 1985 survey showed more pronounced ground roll effects than for previous surveys. It was not until the data reached the processing centre that improved data quality became apparent. Fig. 2 is a comparison of two final stack seismic sections recorded over the same stretch of line and processed through the same sequence. The 1983 line is 6–fold with shothole depths of 35 m whereas the 1985 line is 8–fold with shothole depths of 19 m to 24 m. Both have a similar display trace spacing but the 1983 survey had a group interval of 30 m while the 1985 survey had a group interval of 10 m, hence the difference in total traces. It is apparent that the event resolution of the 1985 section is superior to the 1983 section.

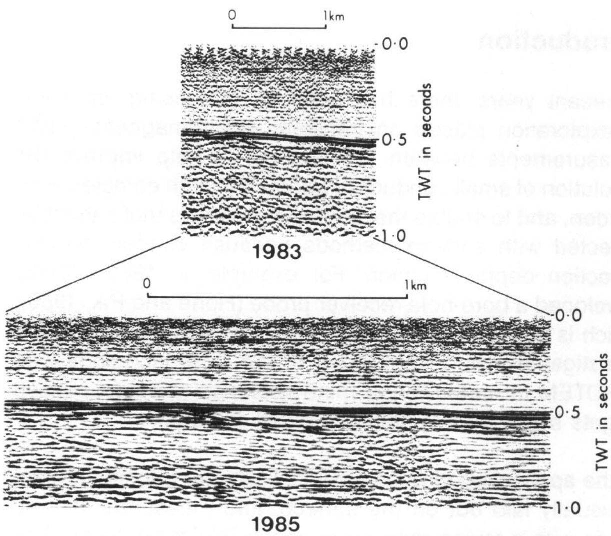

FIGURE 2
Stack comparisons. Group intervals were 30 m in 1983 and 10 m in 1985.

Processing

Where did the improved data quality come from? Figs 3, 4 and 5 are a comparison at various stages of processing of two shot records that contributed to their respective stacked sections in Fig. 2. Both were recorded at the same location but in opposite directions. The mirror image of the 1983 record has been displayed to show the same orientation as the 1985 section.

Fig. 3 compares two demultiplexed records. The 1985 record is swamped by coherent noise which appears to be less severe but partially aliased on the 1983 record. First breaks are much clearer on the 1985 record. Fig. 4 compares the records after gain recovery and signature deconvolution (Digicon process). Deconvolution was more effective on the 1985 record. Note that the 1983 record has three legs to the reflector at 0.5 seconds whereas the 1985 record has only two legs. Fig. 5 shows the records after F–K filtering. Ground roll appears to have been entirely removed from the 1985 record whereas the 1983 record retains some noise. These records are typical examples.

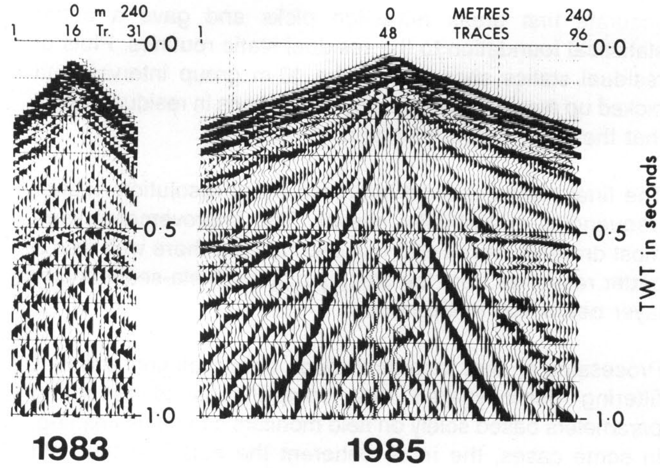

FIGURE 3
Demultiplexed records.

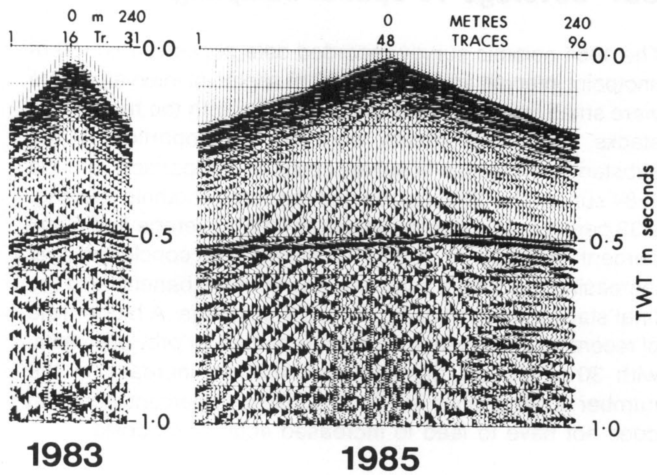

FIGURE 4
Records after gain recovery and deconvolution.

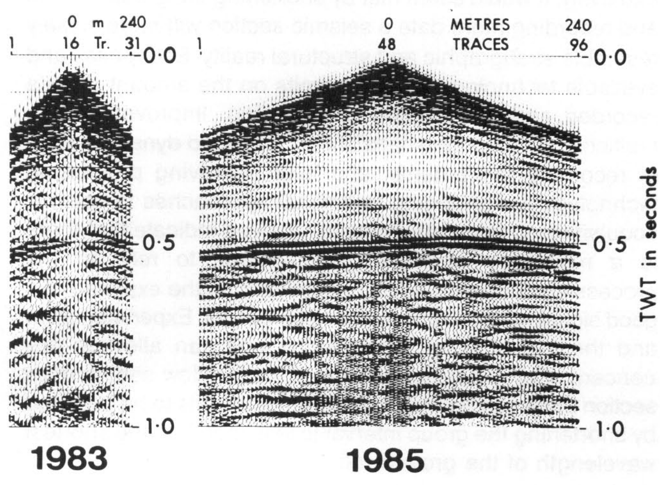

FIGURE 5
Records after deconvolution and F–K filtering.

Final stacks with 10 m group intervals showed better static resolution than final stacks with 30 m group intervals. The 300% increase in the spatial sampling facilitated more accurate first break refraction picks and gave a better statistical foundation to the residual static routines. Plots of residual statics showed that the 10 m group interval data picked up many high frequency fluctuations in residual statics that the 30 m group interval data missed.

The final stacks showed improved event resolution, higher frequencies and smaller misties. The improvements were most dramatic above 300 milliseconds but there was also a better response from the steeply dipping meta-sedimentary layer below 700 milliseconds.

Processing of shot records through deconvolution and F–K filtering demonstrated that comparisons of recording parameters based solely on field monitors can be misleading. In some cases, the more coherent the noise on the field record, the better the signal on the F–K processed record.

CDP Coverage vs Spatial Sampling

The 1984 seismic survey recorded data at twelve-fold (60 m shotpoint interval) and six-fold (120 m shotpoint interval). There were small improvements to data quality with the higher fold stacks but improvements were not in proportion to the substantial increases in survey costs. In comparison with the 1984 survey, the 1985 survey had the same shothole spacing, a 33 percent reduction in maximum CDP coverage and a 300 percent increase in spatial sampling. We concluded that increasing the spatial sampling was far more beneficial to the final stack than increasing the CDP coverage. A higher rate of recording in 1985, with 10 m groups, than for previous years, with 30 m groups, demonstrated that an increase in the number of geophones laid (in this case a 50 percent increase) does not have to lead to increased acquisition costs.

Conclusion

Intuitively, it would seem that by shortening the group interval and recording more data a seismic section will more closely resemble stratigraphic and structural reality. Economics and available technology have set limits on the amount of data recorded and the method of recording. Improvements in multichannel recording capabilities, extended dynamic range of recording instruments, and ever improving processing technology are changing traditional approaches to seismic acquisition. Comments we have received indicate that there is a resistance amongst geophysicists to rely on the processing centre for noise cancellation at the expense of a good signal to noise ratio on the field monitor. Experimentation and the use of a field processing unit can alleviate this concern. Our experience is that, for a shallow sedimentary section there can be major processing benefits to be obtained by shortening the group interval to less than half the shortest wavelength of the ground roll.

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UNDERGROUND AND DOWN-HOLE TRANSIENT ELECTROMAGNETIC MODELLING

S. K. Lee and G. Buselli

Introduction

In recent years, there has been an increasing emphasis in exploration placed on transient electromagnetic (TEM) measurements beneath the surface, to help improve the resolution of small conductive targets beneath complex overburden, and to enable the detection of targets that cannot be detected with surface methods because of their intrinsic detection depth limitation. For example, in 1980, CSIRO developed a bore-hole receiver probe (Hone and Pik, 1980), which is now in routine commercial use and, in 1985, KIER investigated a new application of the TEM technique with SIROTEM in underground mine workings to detect missed targets below known bodies (Lee *et al.* 1986).

In the application of underground TEM, the transmitter loop is usually laid out on the surface, and measurements are made with a roving receiver in accessible mine drives. The application of underground and down-hole TEM enables the response of a conductive target deeper than 400 m to be detected.

At CSIRO, an analogue modelling project is being carried out to study the underground TEM response in three-dimensional space. Three-component measurements are made with plate-like targets of varying depth, dip angle, thickness and conductivity. In this study, the underground and down-hole response of single and multiple targets covered by overburden is being examined.

Optimum Transmitter Loop Size and Position

As a guide to the optimum transmitter loop size and position to use in analogue modelling, an investigation was carried out with program OZPLTE (Raiche, pers. comm.). Figure 1 summarizes the results obtained for the vertical (Z) component of the response measured at a delay time of 0.49 ms. The TEM response, expressed as a percentage of that obtained with a square 600 m loop, is plotted as a function of target depth and loop size for three target dip angles, 0, 45 and 90°.

For a target at a depth d of 200 m or less, there is an optimum loop size smaller than a 600 m loop. However, for a target deeper than 200 m, a maximum response is usually obtained for a loop size of 600 m or greater. For example, with a