whatsoever. On the other hand it is difficult to lay ones hands on a spectacular example, as the so-called field static values, when based on good input data must and will produce good quality data. It is not always the case that statistically improved refraction static values when applied will, improve the data everywhere. In some cases the improvement will be restricted only to a part of a section where, for various reasons, the more conventional methods will fail. A classic example is an area with more or less constant weathering conditions, but where a sudden and rapid change in these will very often lurk undetected; for example a buried river bed. We have an example of this nature, where the sections with applied uphole and statistically improved refraction statics are of equally good stack quality. The only difference between them is the outcoming message about the form and shape of the horizons. In this case the section with statistically improved refraction statics applied, shows a great improvement in accuracy especially at the long wavelength end of the static scale. This data provoked us into performing a modelling exercise, the objective of which was to create a subsurface that would produce a similar pattern of first breaks to the ones recorded in the field. The results of this modelling exercise will be presented.

Finally one more 'with and without' example will be presented. This time the example being restricted only to a part of a section, where the statistically improved refraction statics produced both better stack quality and greater accuracy this time mainly at the short wavelength end of the scale, opposite to the previous example where uphole field statics were used.

We believe that these two examples show the potential that is inherent in this method of statistically improved refraction statics, and that the method has proved itself in providing such good results.

A NEW VELOCITY FILTER FOR THE ATTENUATION OF COHERENT SEISMIC NOISE

V. Goebel and B. J. Evans

Introduction

A new method of wave modelling and phase velocity filtering in the FX domain is presented. A shot record is considered to be consisting of two models — one model is that of relatively slow velocity coherent noise whilst the other is of relatively fast velocity (reflected) waves. The process measures phase velocity as a function of frequency for each trace of a shot record. Then it produces the two separate models — one with only coherent noise present, the other with only reflected waves present. This has a clear application to shot records on which coherent noise has the same frequency content as reflected signal, and the process requires less computation than the equivalent FK methods.

FX Filtering

Consider a shot record to be the sum of slow and fast velocity events, with background noise. We may measure the dominant phase velocities of each event within a suitable frequency range. A cut-off velocity is then selected for filter design and application.

The minimum aperture for modelling is three traces, but model equations may be expanded to process any odd number of adjacent traces, provided the phase velocity is linear across the traces. This is to ensure that events may be summed within each model to represent a single composite vector at each frequency and spatial location. When used as a filter, the predicted or estimated wave is the sum of all wave types within a given velocity range.

The processing sequence is:

(i) Apply an F.F.T. to each trace in the gather, where $t_{in}(l,k) \overset{FFT}{\rightarrow} T_{in}(j,k)$.

(ii) Using the three trace model,

$$T_{in}(j,k\text{-}l) = A(j,k) \exp (i\ @\ [j,k]) + B(j,k) \exp (i(\#\ [j,k] - \&\ [j,k]))$$
$$T_{in}(j,k) = A(j,k) \exp (i\ @\ [j,k]) + B(j,k) \exp (i(\#\ [j,k]))$$
$$T_{in}(j,k+l) = A(j,k) \exp (1\ @\ [j,k]) + B(j,k) \exp (k(\#\ [j,k] + \&\ [j,k]))$$

Reflection model A is assumed to be stationary across three traces and phase @ [j,k] is constant. Surface wave model B(j,k) has linear velocity, and a phase change by & (j,k) from trace to trace.

(iii) Using exp (j,k) = cos x + i sin x, we may write the three trace model as six equations with three unknowns, or

$$\begin{bmatrix} 1 & \cos (\#-\&) & 0 \\ 1 & \cos \# & 0 \\ 1 & \cos (\#+\&) & 0 \\ & & \\ 0 & \sin (\#-\&) & 1 \\ 0 & \sin \# & 1 \\ 0 & \sin (\#+\&) & 1 \end{bmatrix} \begin{bmatrix} \mathrm{Re}\ (A \exp (i\ @)) \\ \\ \\ B\ (j,k) \\ \\ \\ I_m\ (A \exp (i\ @)) \end{bmatrix} = \begin{bmatrix} \mathrm{Re}\ (T_{in}(j,k-l) \\ \mathrm{Re}\ (T_{in}(j,k) \\ \mathrm{Re}\ (T_{in}(j,k+l) \\ \\ I_m\ (T_{in}(j,k-l) \\ I_m\ (T_{in}(j,k) \\ I_m\ (T_{in}(j,k+l) \end{bmatrix}$$

or $C_{6\times3}\ x_{3\times1} = r_{6\times1}$

(iv) To produce a square system, multiply by $CT_{3\times6}$ to produce CTCx=CTr. Thus, we have three equations with three unknowns, which we solve for x by Gaussian Elimination. The model output is x, i.e. reflection model A or surface wave model B.

(v) Thus, $T_{out}(j,k) \overset{FFT^{-1}}{\rightarrow} t_{out}(l,k)$.

Examples

1. During 1984, a low-fold 3-D seismic survey was performed by the Field Research Laboratory at WAIT, over Woodada gas field, North Perth Basin, WA. In-line and swath records were recorded using a 48 channel DFS IV, with a group interval of 30 metres. Swath recording used bunched geophone receiver groups, with a 500 gm anzite source at 1 metre depth. A 2 msec. sample rate used OUT filters (124 Hz anti-alias). For the shot record of Figure 1, there is a perpendicular offset to the nearest group of 175 metres. The near 24 traces are shown, with curved surface waves apparent at the near offsets. The high amplitude air blast (source at 1 metre) has been muted and all traces balanced.

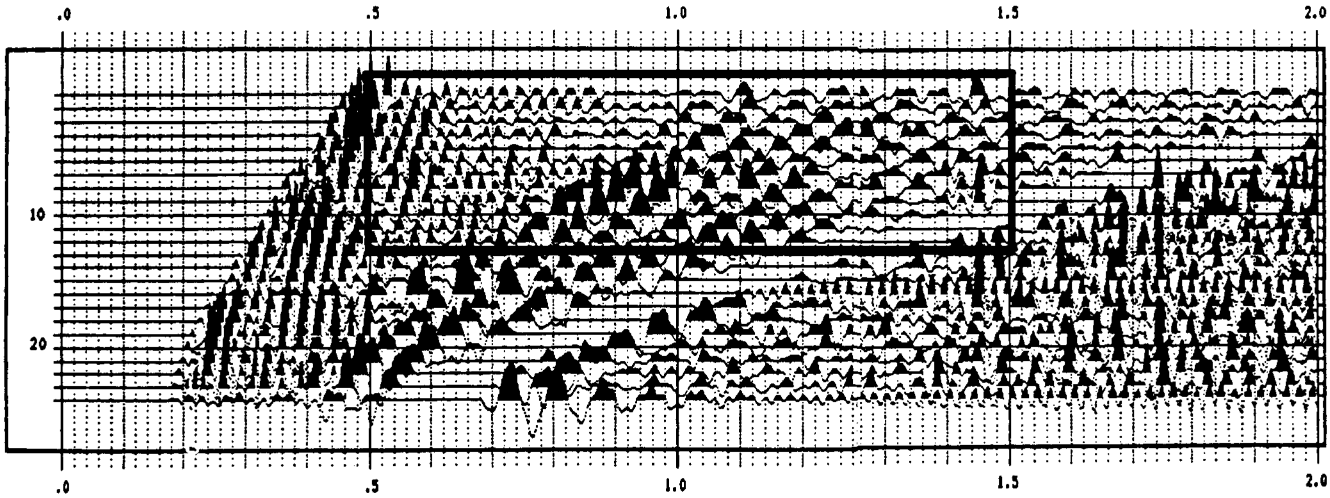

FIGURE 1
3-D shot record over Woodada gas field.

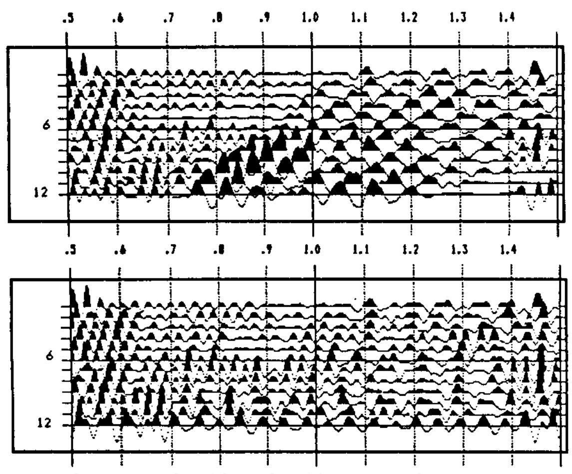

FIGURE 2A
12 trace input window of Woodada data.

FIGURE 2B
Woodada reflector model A output after FX filter.

Twelve traces were selected at an offset range and time in which events are linear. The event at 1.45 sec is considered to be the gas producing Caringynia limestone. The time window selected was 500 to 1500 milliseconds, the events in the region of 1.2 to 1.5 seconds being of major importance.

A cut-off velocity of 3000 metres per second, a frequency range of 10 to 30 Hz, and a 3 trace aperture were selected for filtering.

Figure 2(a) shows the 12 trace window used for the input data trace, on an expanded scale. Figure 2(b) shows the model A reflector output traces. Note that not only do the Caringynia reflections at 1.45 seconds have greater continuity, but reflected events at 1.1 and 1.3 seconds are also enhanced.

2. Shot record Figure 3 from Southern Colorado, was recorded with a group interval of 25 metres, and a linear array of 12 geophones evenly spaced over the group interval. The energy source was 2½ kg of dynamite at 25

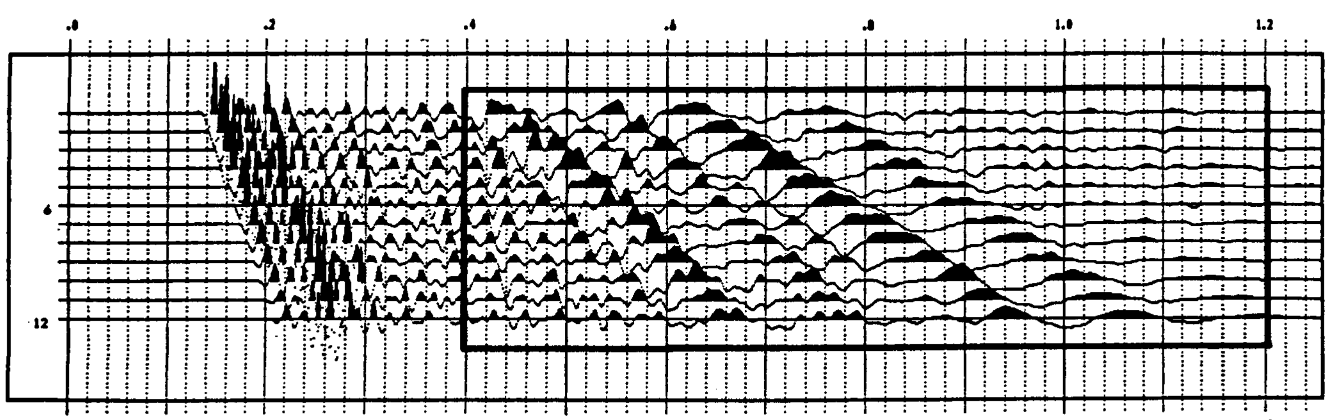

FIGURE 3.
2-D shot record from Southern Colorado.

metres depth, and a recording filter of 125 Hz. The zone of interest is from 800 to 1000 milliseconds.

12 traces from 400 to 1200 milliseconds were input, with a similar set of parameters as example 1. Input data has been bandpassed 10–100 Hz, and balanced. The output record indicates improved reflection continuity between 800 and 1000 milliseconds in Figure 4.

3. A similar shot record, Figure 5, from Northern Wyoming used a source of 4 vibrators, a sweep range of 10 to 120 Hz, and a 24 geophone uniform array spread over the group interval of 25 metres. The zone of interest was from 1200 to 1800 milliseconds.

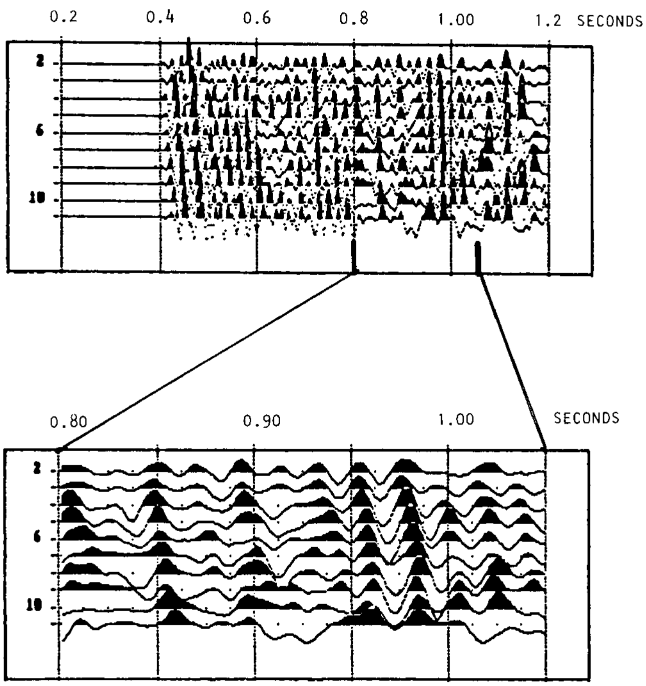

FIGURE 4A
Southern Colorado reflector model A after FX filtering.

FIGURE 4B
Expanded scale of model A.

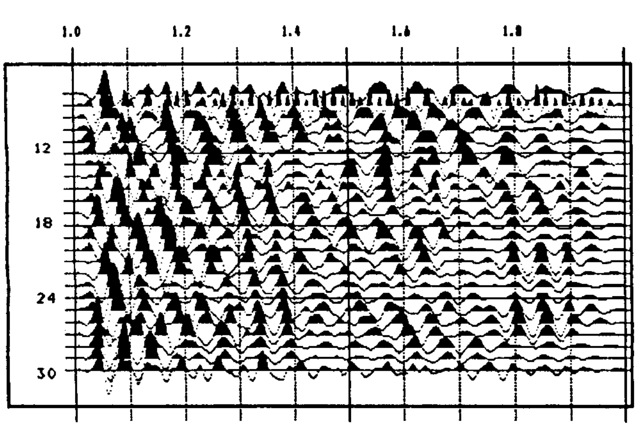

FIGURE 5
2-D vibroseis record from Northern Wyoming.

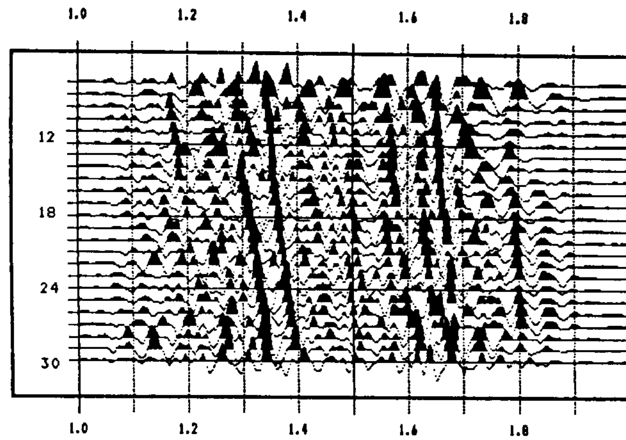

FIGURE 6
Northern Wyoming reflector model A after FX filtering.

A 5 trace aperture was used with a 10 to 80 Hz bandpass filter. After filtering, strong events are more clearly in evidence in Figure 6.

Conclusions

A method of phase velocity measurement and filtering in the FX domain has been demonstrated on seismic field records. The method shows promise for modelling near-surface and reflected waves. It is useful where variable shot azimuth data is recorded, where conventional geophone arrays are ineffective. It is therefore ideal for enhancing signal-to-noise ratios, where other methods have proven fruitless.

THE GEOPHYSICAL DEVELOPMENT OF THE JABIRU FIELD

P. D. Grant

Introduction

The Jabiru field, located within AÇ/L1 off the N.W. coast of Australia was discovered in August 1983 by BHP Petroleum and its co-venturers when the wildcat well Jabiru-1A intersected a 57 metre gross hydrocarbon column within sandstones of Jurassic age. The structure lies within the Jabiru Turnstone horst, one of a series of parallel horsts trending N.E./S.W. on the eastern side of the Cartier Trough (Fig. 1).

Geophysical History

The original well (Jabiru-1A) was drilled on seismic line 8026–15 (Fig. 2), recorded as part of the two surveys shot in