Processing the Blackfoot broad-band 3-C seismic data

Stan J. Gorek, Robert R. Stewart, and Mark P. Harrison

ABSTRACT

During early July, 1995, a large volume of 2-D three-component seismic data was acquired over the Blackfoot field east of Calgary. Acquisition details for this survey are provided in previous chapters. From the field, raw data on 3480 cartridges was sent to storage where it was also copied and consolidated into four 8mm tapes. Both formats are available to sponsors. The data was brought in-house to CREWES to be further merged and sorted into sets of 2Hz, 4.5Hz, 10Hz, and 10Hz array subsets. Each of these is on a single 8mm tape to provide an easier alternative access to sponsors.

Geometries, refraction and residual statics files, and velocity files were generated and quality control displays and stacks were obtained. These should provide useful inputs for further research by CREWES staff.

The data was also sent to an experienced contractor, Sensor Geophysical Ltd. and processed through complete conventional and converted wave flows.

INTRODUCTION

This report focuses on the contribution made by Sensor Geophysical Ltd. to provide a final processed dataset. It examines some of the characteristics of the raw data, outlines the processing flows used by the contractor, and highlights noise attenuation and converted wave techniques which were applied. In particular, an interesting implementation of f-k filtering is described, converted wave binning and stack are noted, and velocity determination for stack and migration is presented.

DATA ANALYSIS

Figures 1 and 2 illustrate the quality of the field recording. In general, all records are very comparable showing strong reflection energy on both vertical and radial components. Only low levels of wind noise and occasional indications of other surface noise are present. There is some evidence of increased contribution to signal energy in the broader band recording. The near offsets of field records are strongly contaminated by source noise and converted wave refraction energy on the radial component. This low velocity coherent energy severely obscures the signal to about one third of the spread length in the zone of interest on the radial recording and provides a challenge to data processing.

Rotation analysis demonstrated that useful signal was restricted to the radial component. Stacks of the 10Hz transverse component also indicated that further processing would provide no benefit

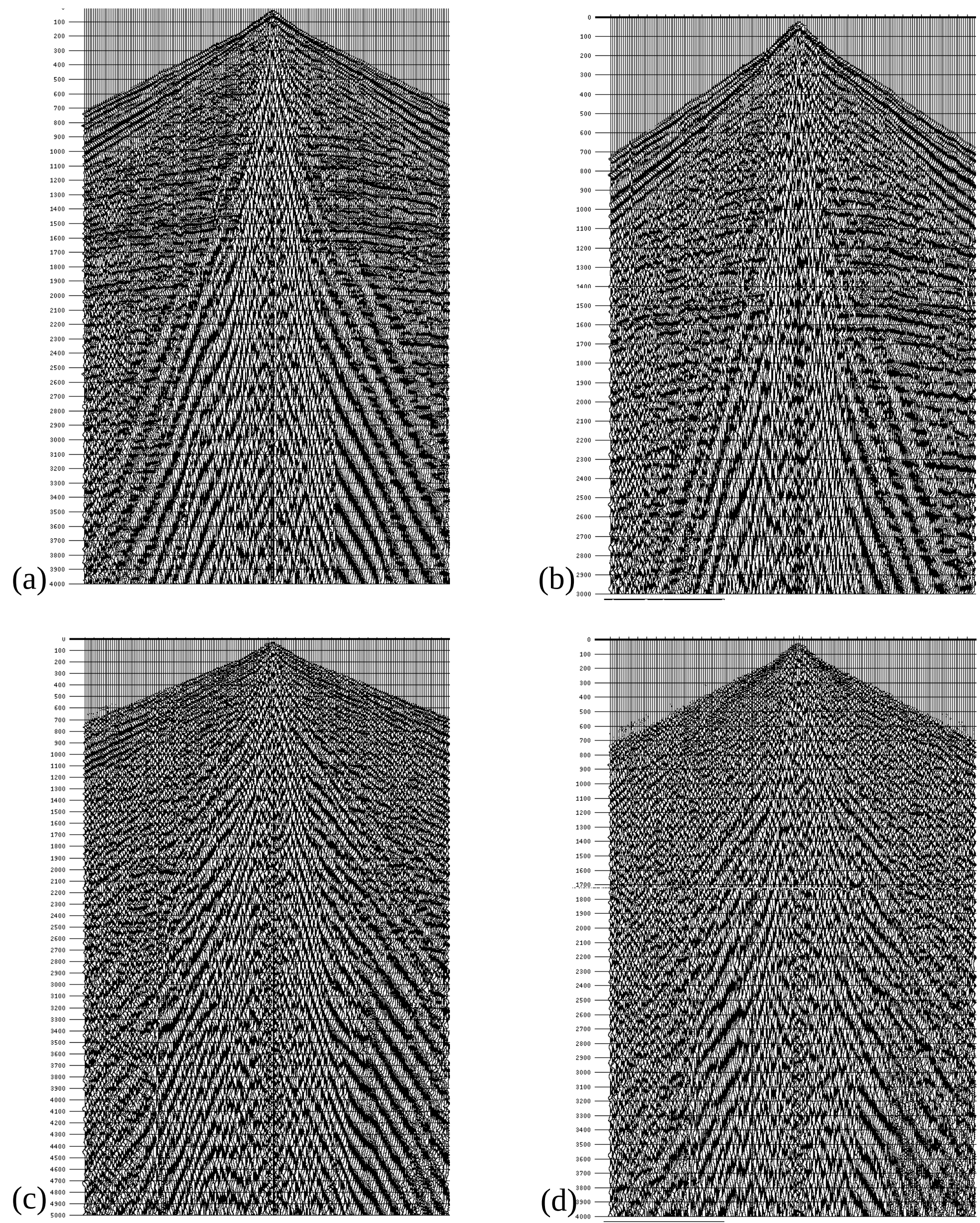

Fig. 1. Representative field records from a) 10 Hz array b) 10 Hz vertical c) 10 Hz radial d) 10 Hz transverse

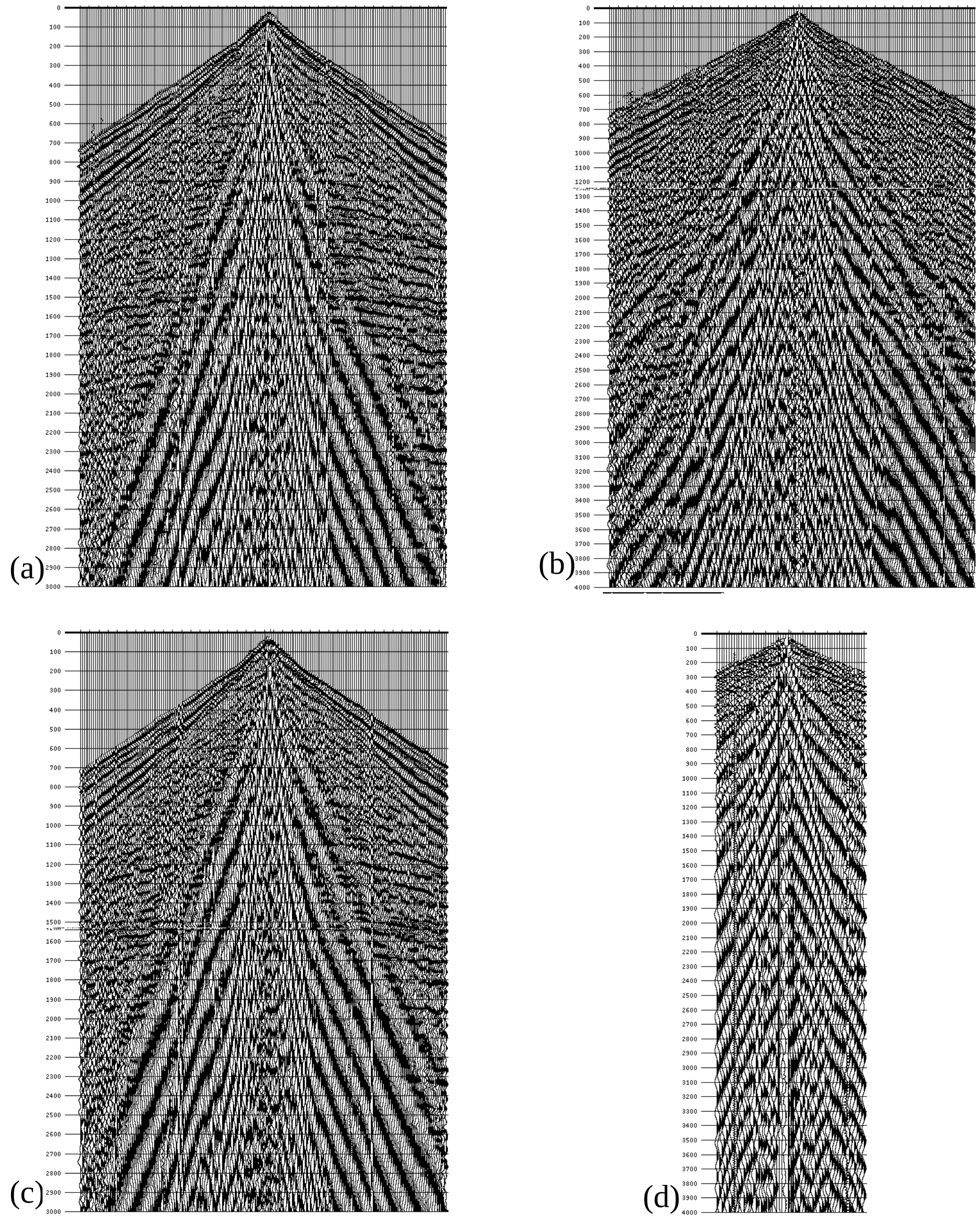

Fig. 2. Representative field records from a) 4 Hz vertical b) 4 Hz radial c) 2 Hz vertical d) 2 Hz radial

DATA PROCESSING

The vertical-component data were processed using the flow outlined in Figure 3. Within this flow, the combined effects of prestack surface consistent deconvolution and spectral whitening, and poststack spectral whitening plus f-x deconvolution contributed strongly to the final temporal resolution of the data. However the severe low frequency noise contamination needed to be dealt with before these could be used effectively.

It is worth noting that, within the primary flow, the f-k filter represents an interesting subflow shown in figure 5. The application of this filter to the NMO and static- corrected raw data, after iterating on processed data to obtain accurate velocities and statics, provided a much more representative input spectrum to subsequent deconvolution processes. Figure 6 illustrates the effectiveness of this procedure as applied to a shot record from the 10 Hz vertical dataset.

The converted wave data were processed using the flow outlined in Figure 4. Within this flow the noteworthy differences are the use of P-S asymptotic binning, CCP gather and converted wave stack. These procedures distribute traces into existing bins according to the location corresponding to that of the asymptote. Further time variant adjustments are made in the gather and stack processes.

Transparent to these flows, but significant to the final result, was the determination of a velocity field appropriate to converted wave stack and migration. The P-wave stacking (RMS) velocity field is modified using Vp/Vs information to satisfy depth-variant stacking requirements and to provide an initial function for converted wave velocity analysis. The P-wave migration interval velocity function is also converted to the converted wave migration interval velocity function using Vp/Vs ratios.

The final migrated results of these flows are shown in figures 7-13.

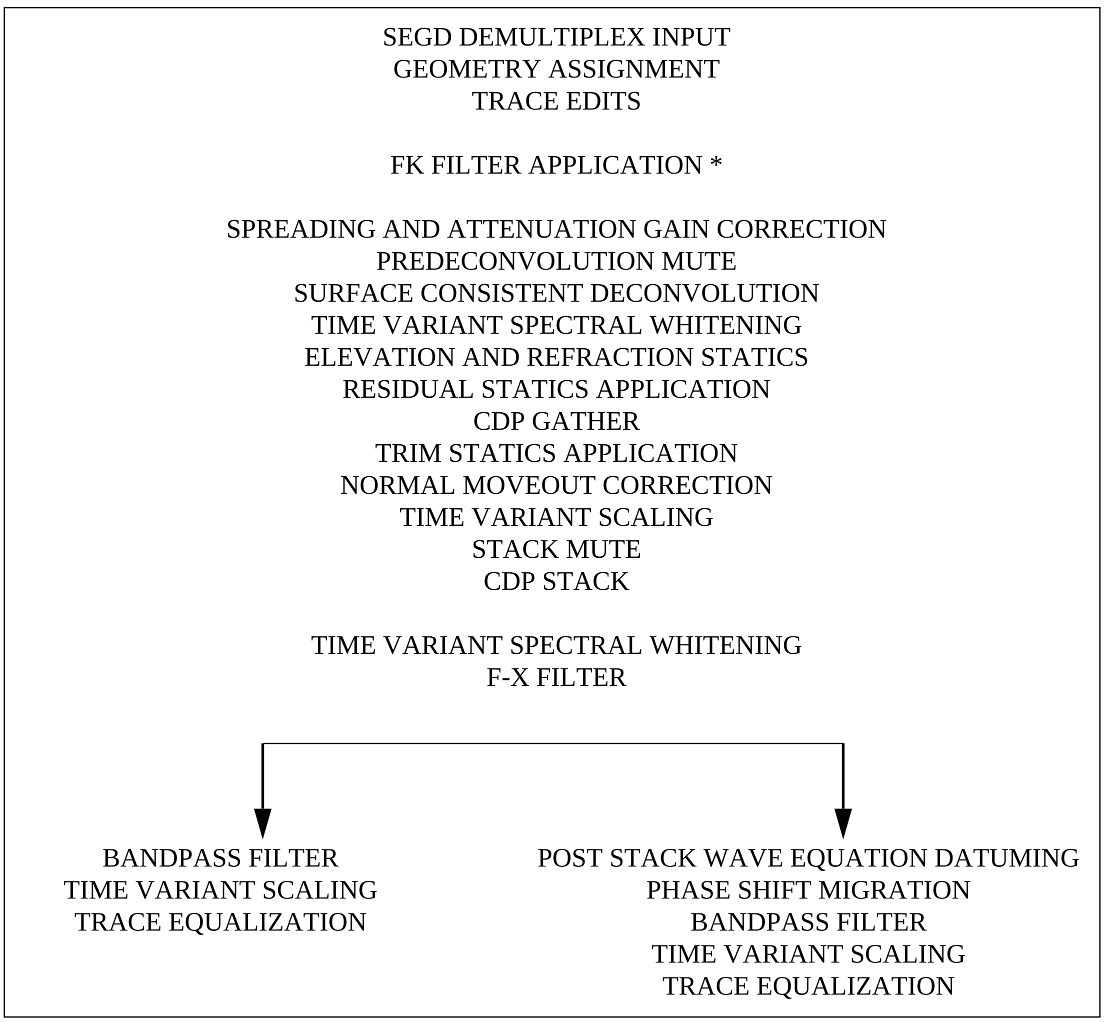

Fig. 3. Vertical processing flow

SEGD DEMULTIPLEX INPUT
GEOMETRY ASSIGNMENT
P-S ASYMPTOTIC BINNING
REVERSE POLARITY OF TRAILING SPREAD
TRACE EDITS

FK FILTER APPLICATION *

SPREADING AND ATTENUATION GAIN CORRECTION
SURFACE CONSISTENT DECONVOLUTION
TIME VARIANT SPECTRAL WHITENING
ELEVATION AND REFRACTION STATICS
RESIDUAL STATICS APPLICATION
TRIM STATICS APPLICATION
CCP GATHER
NORMAL MOVEOUT CORRECTION
TIME VARIANT SCALING
STACK MUTE
CONVERTED WAVE STACK

TIME VARIANT SPECTRAL WHITENING
TRACE EQUALIZATION
F-X FILTER

BANDPASS FILTER
TIME VARIANT SCALING
TRACE EQUALIZATION

ADJUST TO FLOATING DATUM
WAVE EQUATION DATUMING
PHASE SHIFT MIGRATION

BANDPASS FILTER
TIME VARIANT SCALING
TRACE EQUALIZATION

Fig. 4. Radial processing flow

ELEVATION AND REFRACTION STATICS
APPLY RESIDUAL STATICS
NORMAL MOVEOUT CORRECTION
ADJUST TO FINAL DATUM
AUTOMATIC GAIN COMPENSATION
FK FILTER APPLICATION
AUTOMATIC GAIN REMOVAL
MOVE TO FLOATING DATUM
INVERSE NORMAL MOVEOUT CORRECTION
REMOVE REMAINING STATICS

Fig. 5. F-k filter processing sub-flow

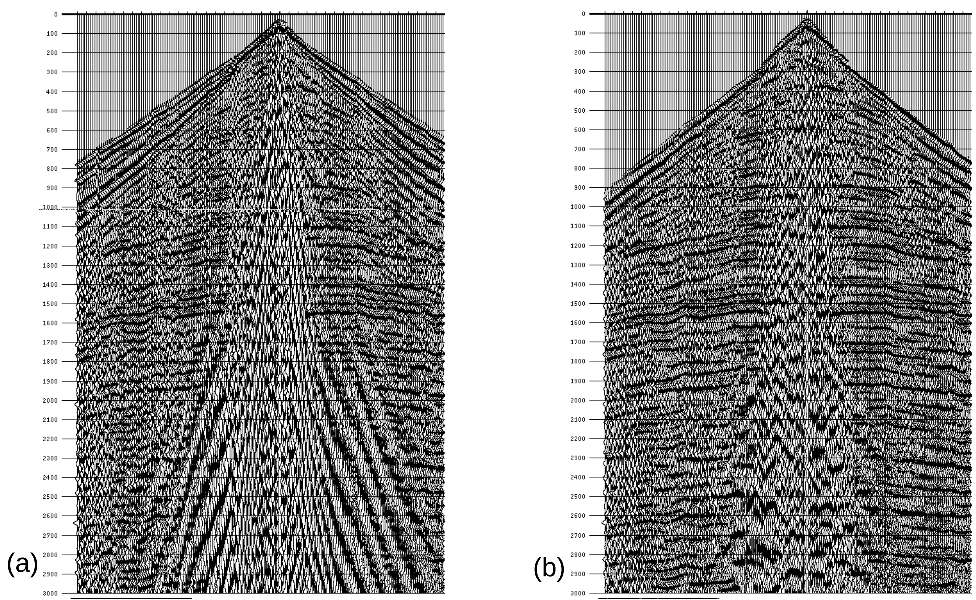

Fig. 6. F-k filter sub-flow a) input and b) output

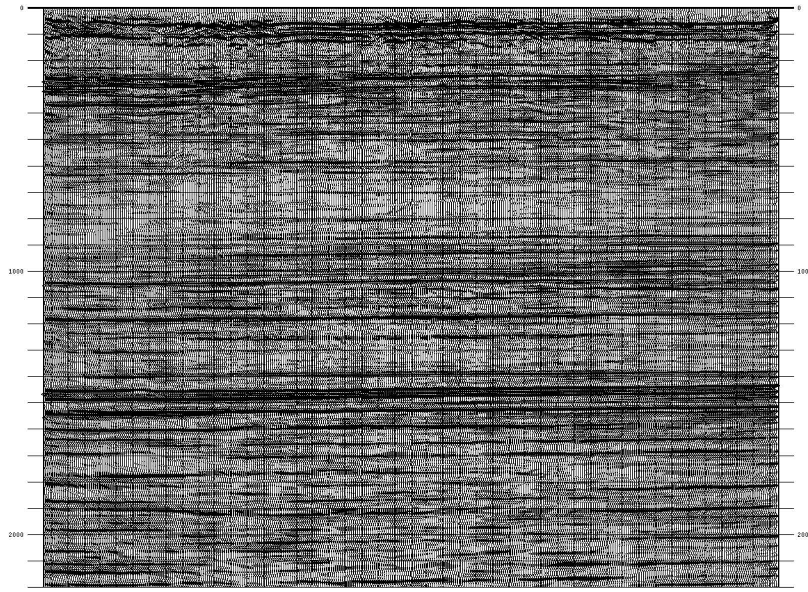

Fig. 7. Final migrated stack of 10 Hz vertical

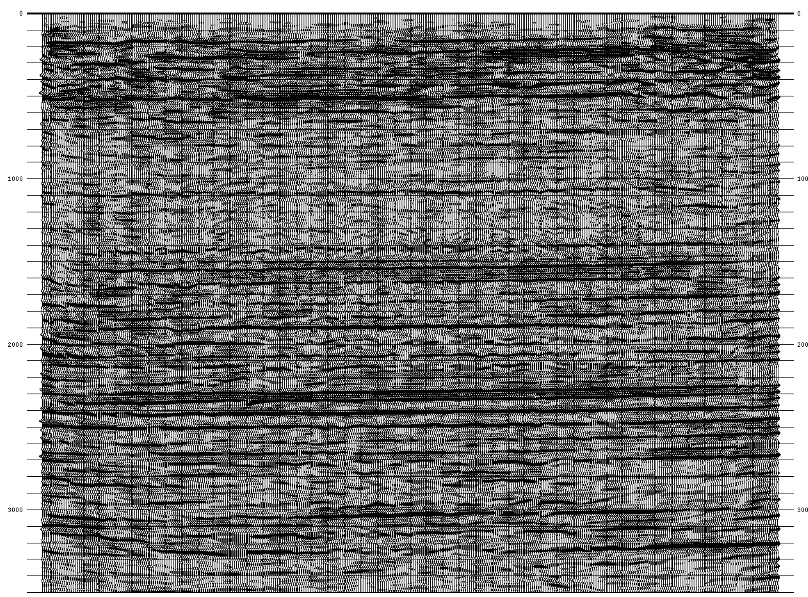

Fig. 8. Final migrated stack of 10 Hz radial

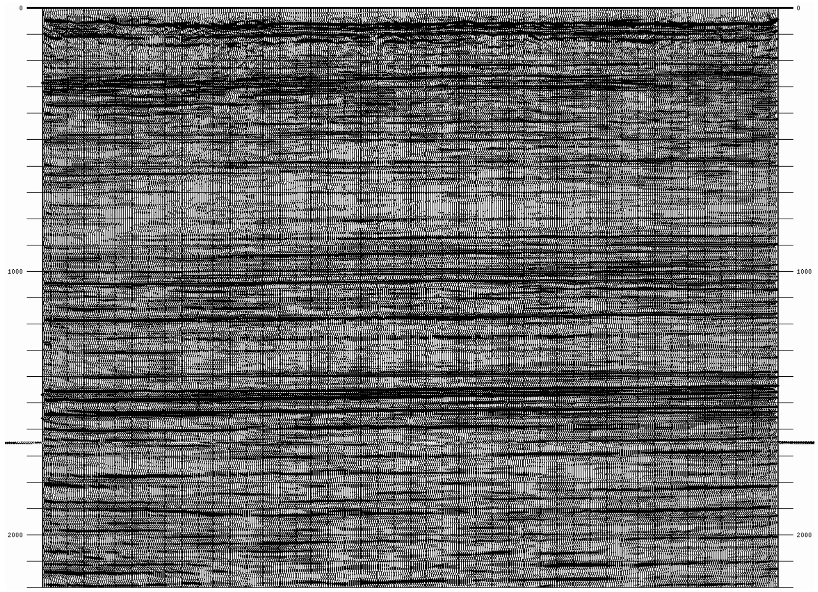

Fig. 9. Final migrated stack of 4 Hz vertical

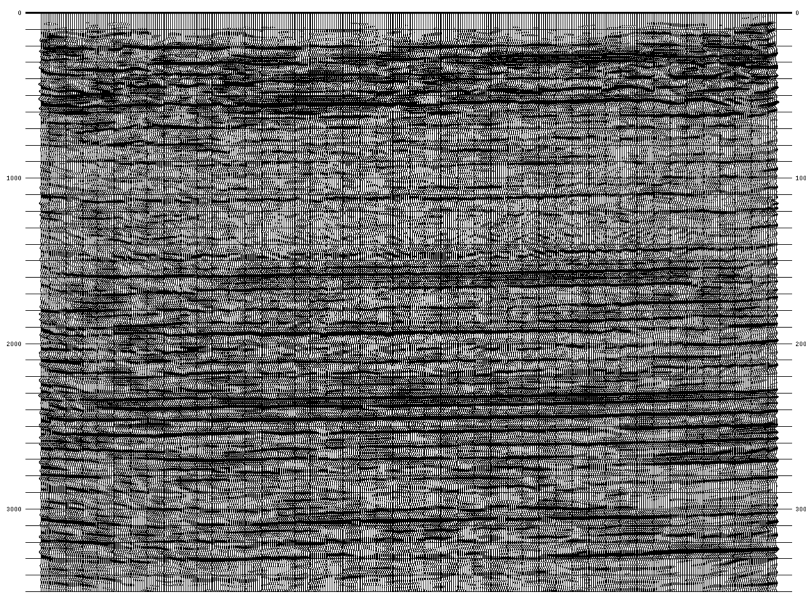

Fig. 10. Final migrated stack of 4 Hz radial

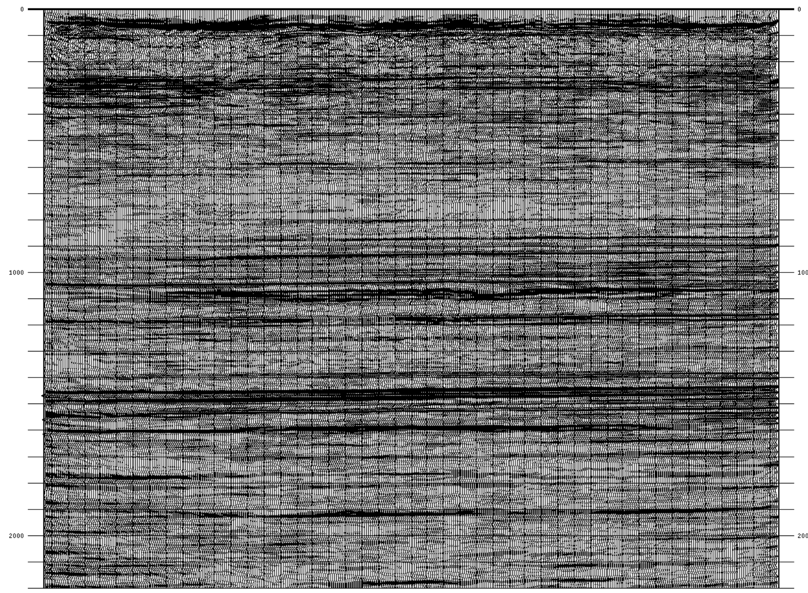

Fig. 11. Final migrated stack of 2 Hz vertical

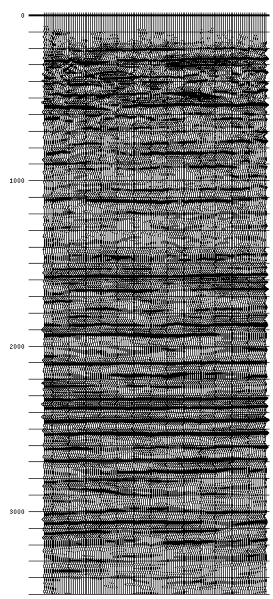

Fig. 12. Final migrated stack of 2 Hz radial

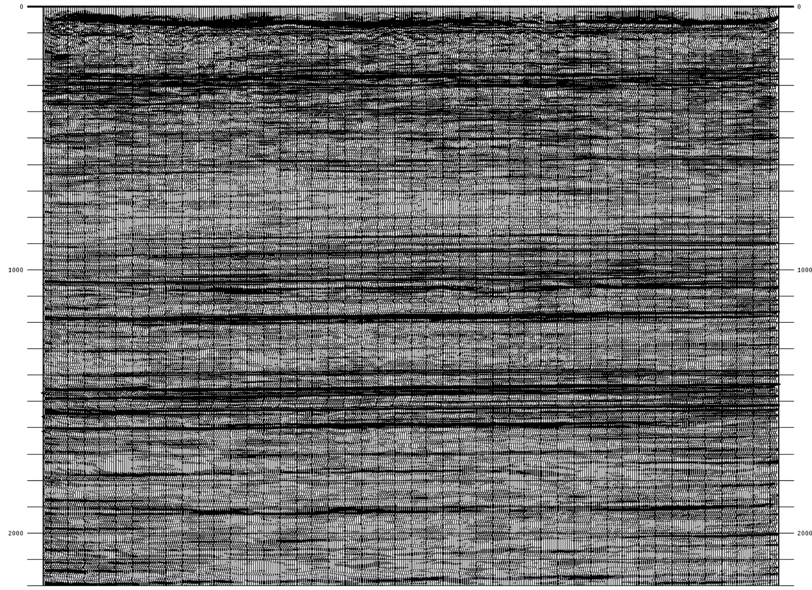

Fig. 13. Final migrated stack of 10 Hz vertical array

CONCLUSION

Multicomponent data has been acquired and prepared for further processing and analysis. The data displays characteristic challenges to multicomponent processing while providing sufficient signal to evaluate the results.

The data has been successfully processed in a reasonable time frame through flows incorporating converted wave processing. These processes will be made available in the next release of the Advance Geophysical ProMAX package.