DATA PROCESSING REPORT

BLUE ENERGY

2007 COBALT 2D SEISMIC SURVEY

ATP 854P
SURAT BASIN
QUEENSLAND

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Integrated Seismic Technologies

Disclaimer

This report has been prepared in good faith and with all due care and diligence. It is based on the seismic and other geophysical data presented and referred to, in combination with the author's experience with the seismic technique, and as tempered by the geological and stratigraphic evidence presented in various forms and through discussions with client representatives.

As such, the report represents a collation of opinions, conclusions and recommendations, the majority of which remain untested at the time of preparation. In the light of these facts it must be clearly understood that Velseis Processing Pty. Ltd., its proprietors and employees cannot take responsibility for any consequences arising from this report.

Table of Contents

Introduction

Velseis Processing Pty. Ltd. processed approximately 85 kilometres of 2D land seismic data for Blue Energy from December 2007 to March 2008. The data had been acquired by Terrex Seismic.

Line summary for processed lines

Line Name	Vintage	Group Interval	Shot Interval	First SP	Last SP	Length (km)
07COB-01	Cobalt	15.0	15.0	266	1500	18.51
07COB-02	Cobalt	15.0	15.0	233	1300	16.01
07COB-03	Cobalt	15.0	15.0	242	800	8.37
07COB-04	Cobalt	15.0	15.0	200	764	8.46
07COB-05	Cobalt	15.0	15.0	200	1482	19.23
07COB-06	Cobalt	15.0	15.0	200	1160	14.40
Total						84.98

Acquisition Parameters

Vintage	**2007 Cobalt**
Acq Company	Terrex
Date Acquired	2007
Sample Rate (ms)	2
Record Length (ms)	4000
Group Int (m)	15
Shot Int (m)	15
Spread Description	Symmetrical Split Spread
Geophone	10Hz
No. of Groups	260
Geophone array	6 phones over 15 m
Filter	Half Nyquist (Linear phase)
Near Offset (m)	7.5
Far Offset (m)	1942.5
Source Type	Vibroseis
Sweep frequencies (Hz)	6-110
Sweep duration (ms)	10000
Number of sweeps per source point	1
Number of vibes	3
Move-up (m)	0
Distance pad to pad (m)	12.5
CDP Fold	130

Parameter Testing

For tests applied to shotrecords, FFID 3124 was used. For tests on the basis of stacked sections, line 07COB-04 was used.

Initial Frequency Tests

A set of narrow bandpass filters were applied to obtain an initial estimate of the frequency range of useful reflection energy. The tests were applied to raw shotrecords. Additionally, spectral analysis was performed on selected windows of the records and stacks to aid these decisions.

On the basis of these tests, the following bandpass filter was designed, for use during the early phase of processing.

0ms-900ms: 6-10-100-110 Hz
1100ms-4000ms: 3-6-50-60 Hz

Spherical Divergence Tests

Spherical divergence correction tests were applied to raw shotrecords in order to determine which spreading equation to use: 1/distance or 1/(t*v^2).

Additionally, the exponential correction constant was tested. The options tried were 0 dB/s, 2 dB/s, and 4 dB/s.

The 1/(t*v^2) spreading equation was chosen, with 2dB/s exponential gain.

F-K and Airblast Filter Tests

There was significant low speed linear noise present in the raw records. Various F-K fan filters were applied in order to choose optimum parameters.

Firstly, the following F-K fan filters tests were applied to raw shotrecords:

1/ None
2/ F-K 200m/s-5Hz, 3000m/s-40Hz
3/ F-K 200m/s-5Hz, 4000m/s-40Hz
4/ F-K 200m/s-5Hz, 5000m/s-40Hz
5/ F-K 200m/s-5Hz, 5000m/s-50Hz
6/ F-K 200m/s-5Hz, 5000m/s-60Hz
7/ F-K 200m/s-2Hz, 5000m/s-50Hz
8/ F-K 100m/s-5Hz, 5000m/s-50Hz

On the basis of these tests, the following parameters were chosen: bottom speed 100m/s, bottom frequency 5Hz, top frequency 50Hz. An airblast filter was also tried prior to F-K filter, and was found to give better results than the F-K filter alone.

The final decision on the top speed of the F-K fan filter was made on the basis of 1st pass residual statics stacks. Stacks were created using the following F-K fan filter options prior to deconvolution:

1/ Null
2/ F-K filter, 100m/s-5Hz,4000m/s-50Hz
3/ F-K filter, 100m/s-5Hz,5000m/s-50Hz
4/ F-K filter, 100m/s-5Hz,6000m/s-50Hz

The 6000m/s option was preferred.

Deconvolution tests

Deconvolution tests were performed to determine the optimum parameters. The comparison was made on the basis of convolved shot gathers, and also on residual statics stacks. The following deconvolution options were viewed:

1/ Surface consistent spiking deconvolution, 80ms operator
2/ Surface consistent spiking deconvolution, 120ms operator
3/ Surface consistent spiking deconvolution, 160ms operator
4/ Surface consistent spiking deconvolution, 120ms operator, with spectral whitening
5/ Surface consistent spiking deconvolution, 160ms operator, with spectral whitening

For both sets of lines, surface consistent spiking deconvolution with 120ms, followed by spectral whitening, was preferred.

NMO Mute Tests

NMO mute tests were performed. Comparison was based on the effect of the mute on deconvolved, moved out gathers, and on 1st pass residual statics stacks.

The following percentage stretch mutes were tested: 10%, 15%, 20%, 25%, 30%, 35% and 40%.

Although useful reflection energy was visible past the 35% stretch, the phase character of the far offsets differed from the near. A 30% mute was ultimately chosen.

CDP Trim Tests

Tests were performed to determine an optimum maximum shift to be allowed in the application of CDP trim statics. A gate length of 800ms was used.

The maximum shift values that were tested were 4ms, 8ms, 12ms.

12ms was chosen for all cases.

Pre-stack AGC Tests

Tests were performed to determine an optimum pre-stack AGC. The comparison was performed on the basis of CDP trim statics stacks.

The options tested were 100ms, 200ms, 500ms, and 1000ms.

200ms was preferred.

Migration Tests

Tests were performed to select an optimum velocity scale and maximum dip to be used in migration.

The velocity scales tested were 95%, 97.5%, 100% and 102.5%. 100% velocity scale was chosen.

The maximum dip values tested were 50 degrees and 70 degrees. The 50 degree maximum dip value was chosen.

Post-stack AGC Tests

Post-stack AGC tests were performed, in order to choose an optimum operator length and blend ratio. The AGC was applied after bandpass filter, on both cdp trim stacks and migrated stacks. The following options were viewed.

1/ No post-stack AGC
2/ AGC, 200ms operator
3/ AGC, 500ms operator
4/ AGC, 1000ms operator
5/ AGC, 500ms operator, blended in 1:1 ratio with non-AGC data
6/ AGC, 500ms operator, blended in 1:2 ratio with non-AGC data

AGC with 500ms operator was chosen.

Post-stack Eigenvector Filter Tests

An optimum eigenvector filter pass range was chosen, by applying various filters to the migrated stack, as follows:

1/ No eigenvector filter
2/ Eigenvector filter, 0-10% pass range
3/ Eigenvector filter, 0-15% pass range
4/ Eigenvector filter, 0-20% pass range
5/ Eigenvector filter, 0-30% pass range

0-20% pass range was chosen.

Processing Sequence

Reformat

Input data was reformatted to ProMAX internal data format.

Trace Edit

Bad and noisy traces were removed from shot records interactively.

Geometry

Geometry information was assigned to trace headers. Information assigned to each trace includes source, receiver and CDP location along with offsets and CDP fold.

The coordinates are referenced to GDA-94, Zone 55.

Static Computation

Refraction statics were calculated from first break picks, using a datum elevation of 500m and a replacement velocity of 3000m/s.

Minimum Phase Filter

A minimum phase filter was applied.

Gain Recovery

A spherical divergence correction was applied to all lines. The spherical spreading factor used is [1/time*velocity^2], with an exponential correction of 2 dB/s.

Deconvolution

Surface consistent spiking deconvolution was applied to all lines.

A 120ms operator length was used. The white noise level applied was 0.1%.

Spectral Whitening

Spectral whitening was applied to all traces.

The parameters were as follows:

Operator length:	250ms
Number of panels:	8
Extent of zero padding:	25%
Spectrum:	6-110 Hz

F-K DMO

F-K DMO was applied, using absolute offset binning. The DMO stretch factor used was 0.6.

Velocities Analysis (Final Pass)

Velocities were picked again on DMO gathers at a regular interval of 50 CDPs.

Normal Moveout

An NMO correction was applied to the data using velocities picked on the first DMO volume. A 30% stretch mute was used.

Dynamic corrections are applied to the data using the following formula.

$$TX^2 = T0^2 + X^2/V^2$$

TX = time at offset X
T0 = time at zero offset
X = offset of the trace
V = velocity at time T

CDP Trim Statics

Trim statics application is the process of aligning traces within a gather by correlating them with a pilot trace, then applying appropriate shifts to each trace. Traces with a required shift greater than a pre-set maximum value are killed.

The pilot trace came from the DMO stack created with DMO velocities, and a maximum shift was 12ms.

Gain

An AGC with a 200ms operator length was applied after move out.

CDP Stack

Add traces within a common midpoint gather. The post stack trace was scaled by the square root of the sum of fold for each sample in the trace.

Pre-migration FX Deconvolution

Prior to migration, FX deconvolution was applied to reduce the level of noise. A horizontal window of ten traces and a time window of 500ms were used.

Steep Dip Explicit Time Migration

Steep Dip Explicit Time Migration was applied using a velocity scale of 100%, and a maximum dip of 50 degrees.

F-X Deconvolution

A Wiener Levinson F-X deconvolution was applied, using a 10 trace horizontal window and a 500ms vertical window.

Eigenvector Filter

An eigenvector filter with a pass range of 0-20% and a horizontal window width of 120 traces was applied.

Final Bandpass Filter

A time-varying Ormsby zero phase bandpass filter was applied to the data to remove high and low frequency noise.

The filter parameters used for the migrated and final stacks were as follows:

Time (ms)	Corner Frequencies (Hz)
0-900	20-30-100-110
1100-5000	10-20-50-60

Gain

An AGC with an operator length of 500ms was applied.

Display

Migrated and final stacks are displayed at a spacing of 20 CDPs per cm, and a vertical scale of 20 cm per second. Displayed with the traces are Shotpoint and CDP annotation, velocity information and fold.

Archiving

A compact disc (CPCD-881) has been produced, containing the following for all six lines of this survey:

IN SEG-Y FORMAT:

Unfiltered Final Stacks
Unfiltered Migrated Stacks
Filtered Final Stacks
Filtered Migrated Stacks

IN CGM FORMAT:

Filtered Migrated Stacks

IN ASCII FORMAT:

DMO stacking velocities
Migration interval velocities
Source and receiver refraction statics
Source and receiver residual statics

The CD also contains this report in PDF format.

Additionally, a set of DVD's (DVD-485) has been produced, containing the DMO gathers in CDP order, with CDP trim statics and fractional statics applied, moved out with DMO velocities and muted with 30% stretch mute.

Appendix

These data were processed by Velseis Processing Pty. Ltd., Brisbane, Australia.

Velseis Processing utilizes ProMAX 2D/3D processing software. This is a totally interactive system allowing the user to view data processing at each stage, producing a final result of the highest quality.

The software executes on a quad processor Sparc 20 Sun workstation and a 32 node, dual CPU/node Linux cluster. Data is viewed via X terminals networked to the main system, each terminal has a high definition monitor to enable accurate representation of the digital data in pixel form.

Plots were generated via a 300 dpi laser plotter. This was used to generate paper plots for QC purposes as well as the ability to provide final filmed copies.

Velseis Processing is committed to offering a premium product, the software development undertaken by ProMAX resulting in processing algorithms that are state of the art.