REPORT OF

DATA PROCESSING

1990 BASS STRAIT SEISMIC SURVEY

PERMIT T/14P, T/18P AND T/23P

VICTORIA, AUSTRALIA

for

SHELL COMPANY OF AUSTRALIA

SHELL HOUSE

1 SPRING STREET

MELBOURNE     NSW     3001

by

DIGITAL EXPLORATION LIMITED

(A DIGICON COMPANY)

54-56 BROOKES STREET

BOWEN HILLS   QLD   4006

C.R. HIGGS: SENIOR GEOPHYSICIST                    JULY 1990

DPR1007B: KJF

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OR- 0246C

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## 1.0 INTRODUCTION

During January through to March 1990, the Bass Strait Seismic Survey was
acquired by Halliburton Geophysical Services for the Shell Company of
Australia in the regions T/14P and T/18P, Bass Strait.

A total of 921.075 km of marine seismic data were processed for Shell
Company of Australia by Digital Exploration Limited from 26th February,
1990 to 20th April, 1990.

A detailed list of lines processed along with acquisition parameters
appears on Tables 5.1 and 5.2.

Client supervision was provided by Mr Martin Ecclestone for Shell Company
of Australia.  Initial QC meetings were held with the client's
representative at Digital Exploration Limited's Brisbane office and at
Shell Company of Australia's Melbourne office.

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## 2.0 2D PROCESSING SEQUENCE

### GENERAL DESCRIPTION

### 2.1 TRANSCRIPTION

The SEG-D recorded field tapes were transcribed to an internal 9-track trace sequential format prior to subsequent processing. No tape output of data was produced at this stage of processing.

### 2.2 RESAMPLE

Data recorded at 2 ms was resampled to 4 ms for processing. A minimum phase anti-alias filter (Butterworth 0/0-90/72 low pass) was applied prior to the resampling.

Examination of octave panel filter analyses of selected shot records showed that 4 ms processing was correct for the signal bandwidth.

### 2.3 STATIC CORRECTION

For this processing, a constant source/streamer depth correction was applied to reference the data to sea level using a water velocity of 1485 m/s. The standard gun delay was 51.2 ms. With a nominal gun depth of 6.5 m $\pm$ 0.5 and an average streamer depth of 8 m, a total correction of -41.5 ms was used.

### 2.4 TRACE EDIT

Trace and shot editing, where necessary, was applied using observer log information. Little editing was required, the data being exceptionally clean.

### 2.5 VELOCITY FILTER

This process is an F-K Butterworth dip filter applied via a 2D convolution in the X-T domain which offers substantially reduced "edge-effect" artifacts in the resulting filtered data. Passband dip limits can be interpreted from X-T shot data in order to best separate linearly travelling noise from signal energy and hence attenuate the noise. Noise with apparent velocity less than 1750 m/s. ($\pm$ 3.5 ms/trace at 12.5 m group interval) was attenuated.

Prior to F-K filtering, the shot records were pre-processed with a removeable AGC of gate length 400 msec.

### 2.6 ADJACENT TRACE SUM

The 300 channel shot data was reduced to 150 channel data by a application of 2:1 adjacent trace sum. Traces to be summed were prepared with differential NMO, before summing.

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## 2.7 SPHERICAL DIVERGENCE CORRECTION

The seismic trace suffers amplitude loss due to spherical spreading of the wave front as it is propagated downwards through the earth and reflected back to the surface. To correct for this each trace is multiplied by a scalar (VT), where V is the seismic wave velocity and T is the two-way recorded time.

The velocity/time function used for the spherical divergence correction was:-

| TIME (ms) | VELOCITY (m/sec) |
|-----------|------------------|
| 0 | 1500 |
| 100 | 1500 |
| 750 | 2200 |
| 1600 | 2400 |
| 2200 | 2700 |
| 2800 | 3000 |
| 3800 | 3700 |
| 5000 | 4500 |

## 2.8 SIGNATURE DECONVOLUTION (DEFLAT)

Deflat is an offset dependent, source consistent signature deconvolution. It is assumed that the total system wavelet can be decomposed into two wavelets, a short wavelet representing the smooth spectral shape and a relatively long wavelet representing the detail part of the spectrum. The short wavelet is whitened only in a user specified passband (in this case 8-90 Hz).

The combination of the long wavelet operator and the band limited short wavelet operator gives us a new minimum phase operator that has relatively flat spectrum outside the passband. Phase distortion due to frequencies outside the user specified passband can be removed deterministically by designing a dephasing filter derived from a user input estimate of the source wavelet. This estimate is derived from information from phase and amplitude response curves of the instruments. Shot and receiver de-ghosting is included in the dephasing filter.

N.P    Both permit areas had design gates as follows:-

NEAR OFFSET          FAR OFFSET
0 - 4100 ms          2900 - 4500 ms

Application gate was applied over whole trace.

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## 2.9  TIME VARIANT EQUALISATION (ORE-CDPSUM)

Single gated functions were used pre CDPSUM.  For both permits T/14P and T/18P, the window used is given by:

| NEAR TRACE (ms) | FAR TRACE (ms) |
|---|---|
| 250 - 3500 | 2500 - 4500 |

## 2.10  COMMON DEPTH POINT GATHER

The seismic traces along a line are gathered into data sets on the basis of common mid point.  The offsets, surface and sub-surface co-ordinates and shot sequence numbers are annotated in the trace headers for use in the subsequent processing.  Data was gathered using the maximum acquisition fold for the different surveys.

## 2.11  VELOCITY ANALYSIS (INITIAL INTERPRETATION)

"VELFAN" velocity analysis is an automatic production orientated technique designed to obtain RMS velocity information from seismic data in CDP gather form, the gather sets chosen at 4.0 km intervals.

Based on pre-determined knowledge of the stacking velocities which might be expected in an area, a set of 9 velocity ranges versus two-way reflection time is input to the program, together with 11 consecutive CDP gathers for each location where a velocity analysis is required.

The program takes the maximum and minimum functions as specified by the ranges and time above, then evenly intersperses "n-2" other functions between them in equal increments on NMO.  It then applies these functions, stacks and filters the data.

The VELFAN display consists of six parts.

1.  The uncorrected central gather of the input group.

2.  The central gather NMO corrected by the fifth velocity function with the appropriate pre-stack mutes overplotted.

3.  The stacks formed by NMO correction, stacking and filtering the set of CDP gathers using the "n" functions.

4.  A display of velocity versus reflection time showing the "n" functions and points of high coherence at preselected time intervals, eg. 100 milliseconds.  Each point has a dip bar indicator overplotted showing the highest coherence dip present.

5.  A plot of relative coherence amplitude versus time.

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6.  A listing of velocities versus time of up to three velocities at
    any time level, based on coherence measurements.

The velocity analyses were run over 11 depth points with 9 velocity
functions.  The velocity limits and knee points of the 1st and 13th
velocity functions are user defined.  The 7 intermediate functions
are determined within the program on a basis of constant moveout at
each time "knee point".  The central velocity function is
approximated from a regional velocity.

## 2.12  MULTIPLE SUPPRESSION (PMULT)

Digicon's PMULT uses Radon filters to improve signal to noise ratio
by pre-stack multiple suppression.

The Radon transform uses parabolic curvature measurements of both
primary and multiple data.

This Radon transform record is defined by zero-offset time and
zero-offset curvature.  By applying a velocity function which will
impart negative curvature to primary events and positive curature to
multiple events, the Radon transform can separate (with greater
precision than a Fourier transform) primary and multiple events.
With the positive curvature events edited within the Radon transform
record, the inverse transform to X-T domain show an excellent
multiple suppression.

Within a range of -100 ms to +350 ms (measured at the far offset) 20
paraboles were used to define the curvature of events.  The velocity
function applied to the data uses 90% of the initial velocity field.

## 2.13  DIP MOVEOUT COMPENSATION (DMO)

DMO processes are designed to give dipping events on non-zero offset
traces an adjustment such that these events will stack coherently at
the flat-dip stacking velocity function.  This is achieved by
performing a partial migration before stack.

The overall benefits of DMO may be summarised as:-

a)  Organisation of many velocity trends (due to dip dependence of
    stacking velocity) on to a single velocity function at the same
    spatial location.

b)  Lateral invariance of the stacking velocity function in the
    presence of dip after DMO.  This leads to more useful velocity
    information after DMO for post-stack migration and/or depth
    conversion.

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c)  Improved signal/noise ratio as more signal energy may be stacked within a single velocity panel and reflector point dispersal for non-zero offset traces is removed.

DMO processing was applied to all data in the project.

## 2.14  GAIN CORRECTION

The inelastic attenuation of wave front energy with increasing travel time was corrected for by an exponential gain function.  The same gain function was used for both areas T/14P and T/18P.

| TIME (ms) | TOTAL GAIN |
|-----------|------------|
| 300 - 3300 | +18 dB |

## 2.15  POST DMO VELOCITY ANALYSIS

The second stage of velocity analysis was run using the gather records with both ZMULT and DMO applied.  Prior application of ZMULT enabled a more accurate analysis of primary velocity values now that the multiple energy interference had been attenuated.  Application of DMO on the final gathers also enabled a more accurate velocity and analysis now that the variations in velocity due to conflicting dips were largely removed.

Post DMO velocity analyses were run at 1.5 km intervals.  Parameters used were similiar to the initial VELFAN displays.  Differences included an increased dip search range from +/- 5 ms per trace to +/- 7 ms per trace and a slightly changed velocity fan shape to encompass the more accurately known velocity range.

Approximately, half the velocity analyses were supplied on VELFAN paper plots and the remainder interpreted on Digicon's "Sun" workstation.  Final velocities were picked using these two methods by Shell Company of Australia's representative.

## 2.16  NORMAL MOVEOUT (NMO) CORRECTION

NMO correction is performed to account for the difference in two-way time between traces recorded from different offsets.

$$(T \text{ record})^2 = (T \text{ corrected})^2 + \left(\frac{(X \times 1000)}{(VRMS)}\right)^2$$

A space varying velocity function is utilised and the program computes a new space-varying function for each trace by making floating point cubic interpolation between input control points, to produce a high fidelity NMO output.

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## 2.17  DECONVOLUTION BEFORE STACK

Predictive deconvolution using one gate with differing gap lengths
was tested for this prestack processing phas.  Predictive
deconvolution was preferred at this point for its ability to remove
short period multiple reverberations such as water bottom multiples
without modifying the main wavelet shape.  Time variant predictive
deconvolution using one gate for design and application was chosen.
Operator design and application was on a trace by trace basis.

## 2.18  PRE-STACK MUTING (OUTER)

An outer trace mute was applied to delete the shallow long offset
traces, where the signal/noise ratio is poor.  The excessive
stretching of traces with decreasing velocity and increasing offset
by the NMO correction, contributes significantly to the poor
signal/noise ratio.

## 2.19  COMMON DEPTH POINT STACK

After the completion of prestack muting and scaling, the CDP data
sets, which are corrected for the final velocity, are summed
algebraically.  The resultant amplitude, of each sample in the summed
trace, is divided by the number of live samples contributing to the
summation of produce the final unfiltered stacked sample.

## 2.20  TIME VARIANT BANDPASS FILTER

The stacked data, were filtered with a time varying series of zero
phase bandpass filter operators.  The optimum bandwidth for
increasing time is determined by examination of the useable signal
bandwidth on displays of octave range filtered stack panels from 5/60
- 10/60 Hz/dB/octave through to 90/60 - 120/60 Hz/dB/octave.

## 2.21  TIME MIGRATION AFTER STACK

All lines in both percent areas were migrated with the Kirchhoff
algorithm.  This migration uses the principle that any reflector is
considered as a superposition of point scatterers.  Each point
scatterer will, in the X-T plane, appear as an event with hyperbolic
moveout.  Kirchhoff migration sums along each hyperbolic path all
data on the path back to its apex, with correct phase and amplitude.

The theoretical hyperbolic path of point scatterers is limited
in practice by muting in X-T domain the hyperbolic trajectory.  Also
limited is the number of traces that the hyperbola is allowed to
span.

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This is done to reduce computation time and also to limit the
migration of noise in data with poor signal/noise ratio in deeper
data. Small aperture width, however will cause suppression of
steeply dipping events.

Kirchhoff migration allows for a spatially varying velocity field.
Best results are obtained using smoothed, slowly varying RMS
velocities.

## 2.22   TIME VARIANT EQUALISATION (POST STACK)

A multi-gated function with overlapping measurement windows was used
for the final display. Average amplitude levels are measured within
the windows and a scalar is computed that will bring the measured
level to 0 dB (2   is reference 0 dB on DISCO). The resultant scalar
multipliers are interpolated linearly to provide the final amplitude
curve that is applied to the data on a per trace basis.

The time windows used are listed below:

| GATE START TIME (ms) | GATE END TIME (ms) |
|---|---|
| 100 | 600 |
| 500 | 1000 |
| 900 | 1500 |
| 1400 | 1900 |
| 1800 | 2300 |
| 2200 | 2700 |
| 2600 | 3100 |
| 3000 | 3500 |
| 3400 | 3900 |
| 3800 | 4300 |
| 4200 | 4700 |

## 2.23   FINAL DISPLAY

All Final Stacks and Migrated Stacks were displayed on film at a
horizontal scale of 1:25,000 and vertical scale of 3.75 in per
second.

The films were fitted with a side panel on the left hand side with a
comprehensive tabulation of line, survey and processing information
and a location map. Displayed above the data were shot point
locations, line intersection details, R.M.S. and interval velocity
tables with their points of application. All films were in wiggle
trace variable area mode, with timing lines every 100 milliseconds.

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For both areas T/14P and T/18P, shotpoints were annotated at centre of source array.

Field polarity was maintained throughout processing for both areas. Final display polarity for all sections was reversed, ie. a black peak on the display represents positive compression.

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## 3.0 PARAMETER TESTING

General parameter testing for the Bass Basin Survey was done on line BS90B-05. Additional testing for migration was done on line BS90A-17.

Certain of the processing parameters were specified by Shell Company of Australia prior to general testing. These were:

a) application of K-F shot domain implementation with 100% taper, in conjunction with application of restorable AGC of 400 ms gate length.

b) a 2:1 adjacent trace sum applied to shot data.

c) application of spherical divergence using a trace scalar of VT. The regional velocity function was supplied by Shell Company of Australia.

d) application of signature deconvolution (DEFLAT) using specified parameters as follows:-

|      |                            |          |
|------|----------------------------|----------|
| i)   | Output zero phase wavelet  | = 8 - 90Hz |
| ii)  | Operator length            | = 400 ms |
| iii) | White noise                | = 0.1%   |
| iv)  | No. of operators           | = 4      |

e) application of single gate trace equalise before stack.

With the above parameters specified, phase I processing to the output of initial gathers was completed.

Phase II processing required testing for:

a) Multiple removal
b) DMO
c) Final TAR gain

## MULTIPLE REMOVAL

The limited offset brute stack (offsets 0 - 1000 ms) showed considerable multiple interference from the near surface data down to 1.4 secs. Strong multiple events were seen to the 5.0 second record limit.

Three programs, ZMULT, PMULT and QZM were chosen for testing for multiple attenuation.

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## QZM

QZM removes multiples having a well defined velocity function. When the data is NMO corrected with the multiple velocity function, multiple energy will be flattened and can be rejected. The degree of rejection will depend upon the accuracy of the defined multiple velocity function and the length of a spatial filter, a longer filter more precisely rejecting a given set of multiple events.

Because of the sparse initial velocity sampling of 4 km if was decided not to use QZM as a production tool, due to the uncertainty of the velocity trends of the multiple events.

## ZMULT

ZMULT is a K-F domain multiple attenuation program, utilising the X-T separation of primary and multiple energy when NMO corrected. ZMULT applies a reject filter to the K-F transform of NMO overcorrected gather records. Multiple energy with small positive to large positive residual moveout up will be attenuated. Multiple energy close to K=0 in the K-F domain will not be attenuated.
The NMO overcorrection applied to the test line BS90B-01A was a constant 90% of the primary velocity field.

## PMULT

For this prospect PMULT was tested using a velocity field of 90% of the initial velocity function. The number of parabolic intervals was 20.

Tests were conducted with PMULT scanning the data through a time range of -100 ms to +200 ms (measured on the far trace) and -100 ms to +350 ms. The larger range of -100 ms to +350 ms ws chosen.

The multiple attenuation program PMULT was chosen for production data.

## DIP MOVEOUT TESTS (DMO)

Two algorithms K-F and Kirchhoff implementation, were tested on the line BS90B-01A with the chosen multiple attenuation program PMULT, already applied.

The K-F algorithm using 90 Hz high cut and 12.5m. trace interval (no summation) was chosen. The test displays showed little difference: the K-F method was chosen largely for its inherent benefits of least wavelet distortion when compared with the Kirchhoff method.

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TRUE AMPLITUDE RECOVERY TESTS

On line BS90B-04, using CDP gather records with DMO applied, TAR gain tests were performed.  A series of exponential gains of 3 dB/sec, 4 dB/sec, 5 dB/sec, and 6 dB/sec over a time range of 0.3 - 3.3 sec were displayed and for each range a graphical display of dB vs. time was plotted.  From these displays an exponential gain of 6 dB/sec over 0.3 - 3.3 sec. was chosen.

STACK PANEL TESTS (PHASE II PROCESSING)

Deconvolution before Stack Tests.

Testing was conducted on line BS90B-05, s.p. 1165 - 1265.  Using 200 CDP of prestack data, the following tests were were performed, after application of the processing sequence to DMO gather stage:

a)  No predictive deconvolution before stack

b)  Predictive deconvolution (36 ms gap, 360 ms operator length)

c)  Predictive deconvolution (48 ms gap, 360 ms operator length)

d)  Predictive deconvolution (64 ms gap, 360 ms operator length)

All predictive deconvolution used a single design gate vis:-

| OFFSET (m) | TIME (ms) |
|---|---|
| 100 | 150 - 2800 |
| 3800 | 2800 - 4700 |

The application gate was whole trace.  A gap deconvolution of 48 ms gap and 360 ms operator length was chosen.

OUTER MUTE TESTS

Line BS90B-05 S.P. 1190 - 1240 was used to display a series of 15 stack panels, each stack panel having a 250 m increase in offset range.

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The panels were displayed with the following offsets stacked and filtered:

| PANEL | OFFSET RANGE |
|-------|--------------|
| 1 | All offsets |
| 2 | 100 - 300 |
| 3 | 100 - 550 |
| 4 | 100 - 800 |
| 5 | 100 - 1050 |
| 6 | 100 - 1300 |
| 7 | 100 - 1550 |
| 8 | 100 - 1800 |
| 9 | 100 - 2050 |
| 10 | 100 - 2300 |
| 11 | 100 - 2550 |
| 12 | 100 - 2800 |
| 13 | 100 - 3050 |
| 14 | 100 - 3300 |
| 15 | 100 - 3550 |

These stack panels and the gathers record displays of VELFANS on this line were used to determine the mute used vis:-

| OFFSET (m) | TIME (msec) |
|------------|-------------|
| 125 | 20 |
| 550 | 300 |
| 3850 | 2800 |

Note:
The multiple attenuation program PMULT does not require the use of inner trace mute.

TIME VARIANT FILTER TESTS

Line BS90A-17, S.P. 1340 - 1540 was used in an octave panel bandpass filter analysis. This, in conjunction with Shell Company of Australia's in house analysis of unfiltered stack data from this line, resulted in the following time variant filter:

| TIME (sec) | PASSBAND/SLOPE (dB/Oct) |
|------------|-------------------------|
| 0.0 - 1.0 | 8/18 - 75/72 |
| 2.0 | 8/18 - 65/72 |
| 3.0 | 8/18 - 55/72 |
| 5.0 | 8/18 - 50/72 |

This filter was used in both permit areas.

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POST STACK SCALING TESTS

Various equalisation windows were tested on Bass Basin data.  Tested were:

a)  Single gate 300 - 5000 msec

b)  Multi gate (broad time window)

·c)  Multi gate (narrow time window)

The following multi gate equalisation window was chosen for both permit areas:

| GATE TIME START (msec) | GATE TIME END (msec) |
|---|---|
| 100 | 600 |
| 500 | 1000 |
| 900 | 1500 |
| 1400 | 1900 |
| 1800 | 2300 |
| 2200 | 2700 |
| 2600 | 3100 |
| 3000 | 3500 |
| 3400 | 3900 |
| 3800 | 4300 |
| 4200 | 4700 |

TIME MIGRATION AFTER STACK

Finite difference and Kirchhoff algorithms were tested.  The input data was line BS90A-17, filtered with the final stack time variant filter, using 4 msec sample rate.

FINITE DIFFERENCE MIGRATION

A layer thickness of 20 msec was used for FD migration tests.  The final velocity field was modified in the three tests.  Tested were 100% of smoothed stack velocity , 95% of smoothed stack velocity and 90% of smoothed stack velocity.

FD migration using 100% of smoothed stack velocity was chosen for further comparison testing with the Kirchhoff algorithm, also using 100% of smoothed stack velocity.

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The aperture muting for the Kirchhoff migration was as follows:

| OFFSET (m) | TIME (msec) |
|---|---|
| 100 | 0 |
| 500 | 400 |
| 1125 | 800 |
| 3750 | 2000 |

The migrations with the Kirchhoff algorithm was clearly superior in deliniating unconformity surfaces and fault plane structure and was used in production.

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## 4.0 THE DATA PROCESSING SYSTEM

Digicon's installation in Brisbane is based on one Digital Equipment
Corporation's VAX 8650 computer and one 11/780 computer.  A brief
description of the computers and peripheral devices is as follows:

| Main Processing System | | VAX 1 | VAX 2 |
|---|---|---|---|
| 1. Computer System | : | 8650 | 11/780 |
| | : | 32 bit central processing unit with total of 32 remote input/output terminals allowing multi-user, multi-functional interactive capability | |
| Capacity (virtual memory) | : | 32 MB | 16 MB |
| Operating System | : | DISCO | DISCO |
| 2. Array Processors (FPS 100) | : | 3 units | 2 units |
| Array Processors (NMX 432) (high performance floating point array processor) | : | 1 unit | 1 unit |
| 3. Disk Storage System | : | 3 units | 6 units |
| Capacity (each unit) | : | 1.2 GB | 300 MB |
| 4. Magnetic Tape Drives | : | 15 units | 9 units |
| Density | : | 800 BPI, 1600 BPI and 6250 BPI | |
| 5. Line Printer | : | 1 unit | 1 unit |
| 6. Display System | : | Benson/Versatec electrostatic plotters. (resolution: 200 dots/inch) 2 units 36" plotter 1 unit 22" plotter | |
| | : | 1 unit geospace film plotter (resolution: 508 dots/inch) | |
| 7. Digitiser | : | 2 units summagraphic digitising tables | |

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- 1 unit tektronix graphics terminal and one hardcopy unit

- 2 units off-line ammonia printer

The DISCO system (Digicon´s interactive seismic computer) is an extension of the Digicon´s modular seismic data processing developed over many years. Being modular, the system is completely flexible allowing complete user control of the number and sequence of operations performed in any job.  The DISCO seismic monitor assembles the selected modules in the specified order and controls the processing run.
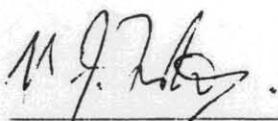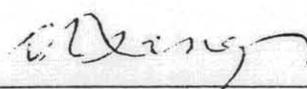
Respectfully submitted
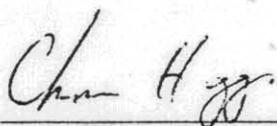
Chris Higgs
PROJECT GEOPHYSICIST

Sami M Khan
MARINE PROCESSING MANAGER

Nigel J Fisher
TECHNICAL SERVICES MANAGER

Bimal R Banerjee
GENERAL MANAGER

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## 5.1 LIST OF LINES PROCESSED
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| LINE NO. | S.P. RANGE | NO. OF KMS | PERMIT |
|---|---|---|---|
| BS90A - 01 | 1001 - 1391 | 9.775 | T/14P |
| * BS90A - 02 | 1001 - 1845 ⎫ | | T/14P |
| * BS90A - 02A | 1761 - 2221 ⎬ | 39.275 | T/14P |
| * BS90A - 02C | 2141 - 2571 ⎭ | | T/14P |
| BS90A - 03 | 1001 - 2503 | 37.575 | T/14P |
| BS90A - 04 | 1001 - 2602 | 40.05 | T/14P |
| BS90A - 05 | 1001 - 1462 | 11.55 | T/14P |
| BS90A - 06 | 1001 - 1673 | 16.825 | T/14P |
| BS90A - 07 | 1001 - 1476 | 11.90 | T/14P |
| BS90A - 08A | 1001 - 2238 | 30.95 | T/14P |
| BS90A - 09 | 1001 - 1558 | 13.95 | T/14P |
| BS90A - 10 | 1001 - 1747 | 18.675 | T/14P |
| BS90A - 11 | 1001 - 2340 | 33.50 | T/14P |
| BS90A - 12 | 1001 - 2570 | 39.25 | T/14P |
| BS90A - 13 | 1001 - 1476 | 11.90 | T/14P |
| BS90A - 14A | 1001 - 1680 | 17.0 | T/14P |
| BS90A - 15A | 1001 - 1477 | 11.925 | T/14P |
| BS90A - 16 | 1001 - 1715 | 17.875 | T/14P |
| BS90A - 17 | 1001 - 2054 | 26.35 | T/14P |
| BS90A - 19 | 1001 - 1492 | 12.30 | T/14P |
| BS90A - 21 | 1001 - 2471 | 36.775 | T/14P |
| BS90A - 23 | 1001 - 1879 | 21.975 | T/14P |
| BS90A - 25 | 1001 - 1855 | 21.375 | T/14P |
| BS90A - 27A | 1001 - 1999 | 24.975 | T/14P |
| BS90A - 29 | 1001 - 2005 | 25.125 | T/14P |
| BS90A - 31 | 1001 - 2604 | 40.10 | T/14P |
| BS90A - 33 | 1001 - 2007 | 25.175 | T/14P |
| * BS90A - 35 | 1001 - 1437 ⎫ | | T/14P |
| * BS90A - 35A | 1341 - 1942 ⎬ | 10.925 | T/14P |
| BS90A - 37 | 1001 - 1939 | 23.475 | T/14P |
| BS90A - 39 | 1001 - 2047 | 26.175 | T/14P |
| BS90A - 41 | 1001 - 1956 | 23.90 | T/14P |
| BS90A - 43 | 1001 - 1799 | 19.975 | T/14P |
| BS90A - 45 | 1001 - 1802 | 20.05 | T/14P |

* PROCESSED AS COMBINED LINE FROM REFORMATING STAGE

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| LINE NO. | S.P. RANGE | NO. OF KMS | PERMIT |
|----------|------------|------------|--------|
| BS90B - 01A | 1001 - 1857 | 21.425 | T\18P |
| BS90B - 02 | 1001 - 1876 | 21.90 | T\18P |
| BS90B - 03 | 1001 - 1999 | 24.975 | T\18P |
| BS90B - 04 | 1001 - 2275 | 31.875 | T\18P |
| BS90B - 05 | 1001 - 1591 | 14.775 | T\18P |
| *BS90B - 07 | 1001 - 1738 | 18.10 | T\18P |
| *BS90B - 07A | 1651 - 1937 | 7.175 | T\18P |
| **BS90B - 09 | 1001 - 1321 | 7.775 | T\18P |
| **BS90B - 09A | 1231 - 1573 | 6.55 | T\18P |
| BS90B - 11 | 1001 - 1574 | 14.35 | T\18P |
| BS90B - 13 | 1001 - 1755 | 18.875 | T\18P |
| BS90B - 15 | 1001 - 1581 | 14.525 | T\18P |

*   PROCESSED AS COMBINED LINE FROM REFORMATING STAGE
    TOTAL KMS OF LINE BS90B - 07/07A = 23.425

**  PROCESSED AS COMBINED LINE FROM REFORMATING STAGE
    TOTAL KMS OF LINE BS90B - 09/09A = 14.325

DPR1007D: KJF

## 5.2  SEISMIC PROGRAM ACQUISITION PARAMETER

Recorded by  :  Halliburton Geophysical Services
Vessel       :  M. R. Pacific Titan

| STREAMER PARAMETERS | SPECIFICATION |
|---|---|
| Dual or Single | Single |
| Groups/Streamer | 300 |
| Streamer Spread | N/A |
| Group Interval | 12.5 mtr |
| Streamer Offset | 100 mtr |
| Streamer Depth | 8 mtr |
| Nominal Depth Interval | 300 mtr |
| Streamer Tracking (Yes/No) | Yes |
| Nominal Compass Interval | 300 mtr |
| Feather Angle | 10 Deg Max |

| INSTRUMENT PARAMETERS | |
|---|---|
| Sample Interval | 2 ms |
| Record Length | 6 secs |
| Hi-cut Filter | 128 Hz/72 dB/Octave |
| Lo-cut Filter | 8 Hz/ 18 dB/Octave |

| SOURCE PARAMETERS | |
|---|---|
| Array Volume | 2180 Cu In |
| Array Depth | 6.5 mtr |
| Array Length | 14 mtr |
| Array Spread | 3 x 10 mtr |
| Array Formation | Parallel |
| Number of Strings | 4 |
| Nominal Pressure | 1850 psi |

| NAVIGATION PARAMETERS | |
|---|---|
| Shotpoint Interval | 25 mtr |
| Line Begin Extension | -7 SP |
| Line End Extension | +7 SP |
| Primary Navigation | Argo/Syledis |
| Secondary Navigation | Satellite |
| Spheroid | A.N.S. |
| Semi Major Axis | 6378160 |
| Reciprocal Flattening | 298.25 |
| Mag Dec (Correction) | 11.9 deg E |

DPR1007B: KJF

5)  CFT 1502 = Raw Final Stack

6)  CFT 1506 = Raw Migrated Stack

| FILE NO. | LINE NO. | CDP RANGE | SPT RANGE |
|---|---|---|---|
| 1 | BS90A-11 | 1849/2002-4676 | 1001-2338 |
| 2 | BS90A-12 | 1849/2002-5136 | 1001-2568 |
| 3 | BS90A-13 | 1849/2002-2948 | 1001-1474 |
| 4 | BS90A-14A | 1849/2002-3356 | 1001-1678 |
| 5 | BS90A-15A | 1849/2002-2950 | 1001-1475 |
| 6 | BS90A-16 | 1849/2002-3426 | 1001-1713 |
| 7 | BS90A-17 | 1849/2002-4104 | 1001-2052 |
| 8 | BS90A-19 | 1849/2002-2980 | 1001-1490 |
| 9 | BS90A-21 | 1849/2002-4938 | 1001-2469 |
| 10 | BS90A-23 | 1849/2002-3754 | 1001-1877 |
| 11 | BS90A-25 | 1849/2002-3706 | 1001-1853 |

7)  CFT 1514 = Raw Final Stack

8)  CFT 1519 = Raw Migrated Stack

| FILE NO. | LINE NO. | CDP RANGE | SPT RANGE |
|---|---|---|---|
| 1 | BS90A-27A | 1849/2002-3994 | 1001-1997 |
| 2 | BS90A-29 | 1849/2002-4006 | 1001-2003 |
| 3 | BS90A-31 | 1849/2002-5204 | 1001-2602 |
| 4 | BS90A-33 | 1849/2002-4010 | 1001-2005 |
| 5 | BS90A-35A | 1849/2002-3879 | 1001-1940 |
| 6 | BS90A-37 | 1849/2002-3874 | 1001-1937 |
| 7 | BS90A-39 | 1849/2002-4090 | 1001-2045 |
| 8 | BS90A-41 | 1849/2002-3908 | 1001-1954 |
| 9 | BS90A-43 | 1849/2002-3594 | 1001-1797 |
| 10 | BS90A-45 | 1849/2002-3600 | 1001-1800 |

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