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DATA PROCESSING REPORT

NGALIA BASIN REPROCESSING PROJECT

MARCH - NOVEMBER, 1991

NGALIA BASIN EP 15

NORTHERN TERRITORY

FOR

ONSHORE

digital exploration limi

(a digicon company)

DATA PROCESSING REPORT

NGALIA BASIN REPROCESSING PROJECT

MARCH - NOVEMBER, 1991

NGALIA BASIN EP 15

NORTHERN TERRITORY

FOR

MAGELLAN PETROLEUM AUSTRALIA LIMITED

LEVEL 10, 145 EAGLE STREET

BRISBANE QLD 4000

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DPR020A:KJF

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INTRODUCTION

The reprocessing project consisted of 4 different vintages of data, totalling approximately 795 kilometres. The 1964 and 1969 data was shot single fold using dynamite as the energy source. The 1971 data was shot both 6 and single fold-again using dynamite as the energy source. The 1981 data was shot 12 fold using vibroseis as the energy source.

Following is a list of the lines processed.

1981 12 Fold Data. Recorded by SSL - Source: Vibroseis

LINE	STATION RANGE	KMS.
NIO81 - 06	1174 - 996	8.90
NIO81 - 08	1001 - 1374	18.65
NIO81 - 10	996 - 1374	18.90
NIO81 - 12	1004 - 1174	8.50
NIO81 - 13	1018 - 1202	9.20
NIO81 - 14	1003 - 1215	10.60
NIO81 - 15	1004 - 1192	9.40
NIO81 - 15 A	1004 - 1158	7.70
NIO81 - 16	979 - 1085	5.30
NIO81 - 17	1001 - 1229	11.40
NIO81 - 17 A	1003 - 1245	12.10
NIO81 - 19	1004 - 1202	9.90
		130.55 kms

1971 6 Fold Data. Recorded by Austral United Geophysical Pty Ltd
Source: Dynamite

LINE	STATION RANGE	KMS.
NA	104 - 284	24.56
NAA	892 - 938	6.93
NBEX	1101 - 1207	14.84
NN	285 - 401	16.18
NP	3 - 103	13.97
NR	1053 - 1099	15.95
Z	673 - 762	15.91
		108.34

1971 Single Fold Data. Recorded by Austral United Geophysical P/L
Source: Dynamite

LINE	STATION RANGE	KMS.
NAEXT	483 - 504	17.71
NAB	802 - 817	12.88
NAD	945 - 964	10.98
NAE	966 - 989	19.32
NAF	848 - 857	8.05
NAG	1002 - 1014	10.47
NAH	1015 - 1027	10.47
NAI	1028 - 1040	10.47
NAJ	1052 - 1041	9.66
NB	577 - 614	30.59
NQ	443 - 417	21.74
NR	444 - 450	8.55
NS	459 - 463	40.25
	819 - 868	
NT	555 - 526	24.15
NW	869 - 890	17.71
QR	482 - 465	14.49
X	678 - 645	18.67
		286.16

1964 Single Fold Data. Recorded by Geophysical Associates Int.
Source: Dynamite

LINE	STATION RANGE	KMS.
1	1 - 100	40.20
2	132 - 375	48.01
6	407 - 439	13.27
		151.48

1969 Single Fold Data. Recorded by Bureau of Mineral Resources
Source: Dynamite

LINE	STATION RANGE	KMS.
A	1538 - 1621	46.20
F	2750 - 2798	26.40
H	3005 - 3026	13.75
O	6000 - 6058	31.90
		118.25

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PRODUCTION PROCESSING SEQUENCE

1. Reformat
2. True Amplitude Recovery
3. Trace Editing
4. Zero to minimum phase conversion filter
5. Deconvolution
6. Common Depth Point Gather
7. Datum Static Computation and Application
8. Velocity Analysis
9. Automatic Residual Static Computation and Application
10. Dip Moveout Correction
11. Normal Moveout Correction
12. Pre-stack Scaling
13. Common Depth Point Stack
14. Tau-P Filtering
15. Filtering
16. Post Stack Scaling
17. Migration (Finite Difference Method)
18. Display

Not all of these processing steps were applied to all vintages of data.

PROCESSING

1. REFORMAT

The data from the field tapes were decoded and converted to Digicon's internal 9 track, trace sequential format for subsequent processing.

2. RESAMPLE

The data were resampled from 2 msec. to 4 msec. A 90 Hz high cut anti-alias filter of the Butterworth type is applied prior to resampling.

3. TRUE AMPLITUDE RECOVERY

The true amplitude recovery phase of seismic data processing included the following steps:-

a) Removal of Binary Gain (non-linear) which is applied to the data during recording.

b) Correction for 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 V T, where V is the seismic wave velocity and T is the two-way recorded time.

c) Correction for non-linear losses such as inelastic attenuation at geologic boundaries. This is an experimentally determined gain function and applied to each trace.

4. TRACE EDIT

This option is used on some records to zero noisy or wild traces which would not make a useful contribution to the stack. Information from the display reformatted field records, field monitor records and observers logs is combined to determine the editing table.

5. CONVERSION TO MINIMUM PHASE

A zero to minimum phase conversion filter was applied to the 1981 data using a filter designed from the amplitude and phase response curves for the source instruments.

6. DECONVOLUTION

Deconvolution is the process of designing and applying an inverse filter to remove the effects on the recorded data of the earth's filtering and distortion of the source wavelet characteristic. The deconvolution is accomplished by the application of one or more whitening filters designed from the auto-correlation of the data trace of the input records.

The filter is designed to whiten or broaden the frequency spectrum within a band pass having an allowable signal-to-noise ratio. By whitening the pass-band, the time transient is collapsed into a shorter interval thus providing finer delineation of the reflecting horizons.

On the 1969 and 1964 data a spike deconvolution filter, with an operator of 161 milliseconds was designed on data within a single window.

On the 1981 and 1971 data a wavelet deconvolution was used. This routine designs a single wavelet shaping filter to each field record in turn.

An estimate of the source wavelet is made after compensation for instrument, geophone and truncation effects. A filter is then designed, using a homomorphic approach, to shape this source wavelet to a specified desired output wavelet.

The advantage of this process over more conventional deconvolution operators is the replacement of each variable source wavelet with a stable, predictable output wavelet. This results in an overall improvement in character and continuity on the stacked seismic section.

7. COMMON DEPTH POINT GATHER

The seismic traces along a line are gathered into data sets on the basis of common reflection 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.

8. DATUM STATICS COMPUTATION

Three methods of datum static computation were used on the data. All statics were calculated to a datum of 580 m. The 1981 data used the statics computed by the field crew. It is assumed that some refraction type method was used in the calculation.

For the 1971 6 fold data statics were computed using Digicon's STATICM routine. The input consists of digitised first breaks from the production records. Geometry information is drawn from the data base and used with the input elevation listings to fully define the profile. Details of shot and receiver offsets, weathering velocity (Vo) and selected datum elevation are also provided.

The routine is iterative, and progressively adjusted first break times are submitted for updating of sub-weathering velocities (Vr) and delay times (Td) at each group location. Both of these are constrained by suitable smoothing filters to inhibit erratic variation.

After the final iteration, usually 3, the geophone statics (Tg) are computed as an elevation correction plus a weather correction as follows:-

$$Tg = -\left[\frac{E}{Vr} + K.Td\right]$$

Where $K = \sqrt{\dfrac{Vr - Vo}{Vr + Vo}}$

and E = elevation above datum

The shot correction (Ts) is obtained from:-

$$Ts = Tg - Tuh$$

For a surface source $Tuh = 0$

The weathering thickness (Wx) is computed as:-

$$Wx = \frac{Td \times Vo}{\cos\left(\text{arc}\sin \frac{Vo}{Vr}\right)}$$

The 1971 and 1969 single fold data used the uphole method.

Elevation values (E), uphole times (TUH) and depths (Ds) for each shot were input and interpolated for intervening station locations. Shot correction (Ts) and geophone corrections (Tg) were computed as follows:-

$$Ts = - \frac{E - Ds - Ed}{Vr}$$

$$Tg = - Ts - TUH$$

Where Vr represents the replacement velocity and Ed the elevation of datum.

After calculation, the shot and receiver statics are averaged to produce a mean static and a residual shot and receiver static, which is usually quite small. Subsequent processing is performed on data with only the residual components applied. Effectively the data is referenced to surface.

The mean static is applied to the data after the final filtering process to correct the data to the selected seismic datum of 580 meters.

All lines were tied back to the 1981 data as it was assumed that this data was the most reliable and the static corrections more accurate because of the multiplicity.

9. VELOCITY ANALYSIS (SVELFAN)

SVELFAN Velocity Analysis is an automatic production orientated technique designed to obtain stacking velocity RMS velocity information from seismic data in CDP gather form.

Based on pre-determined knowledge of the stacking velocities which might be expected in an area, a set of velocity ranges versus two-way reflection time is input to the program together with a number of consecutive CMP gathers, for each location at which a velocity study is required. Also input is a number, N, (usually 9 - 11, in this case 11), of velocity functions to be applied to the gathers.

The program takes the maximum and minimum functions as specified by the velocity ranges and times above, and evenly intersperses N-2 other functions between them. It applies these functions to the CMP-gathers which are subsequently stacked, filtered and displayed.

The VELFAN display consists of six parts:

a. The uncorrected central gather of the input group.
b. The central gather NMO corrected by the central velocity function.
c. The stacks formed by NMO-correcting, stacking and filtering the set of CMP gathers using the N functions.
d. A display of velocity versus reflection time showing the fan of N functions, and points of high coherence at preselected intervals, e.g. 50 milliseconds in this case.
e. A plot of relative coherence amplitude versus time.
f. A listing of velocities versus time of up to three velocities at any time level, based on coherence measurements.

For the 1971 and 1981 data the analyses were run over 21 depth points with 11 velocity functions forming the fan, and were run at approximately 2 km. intervals before automatic residual statics and 1 km. intervals after automatic residual statics. Time above mention was used on the mute fold data. On the single fold data constant velocity stacks were used.

10. RESIDUAL STATICS

The routine assumes that the static variation from trace to trace is caused by velocity and thickness variations in the low-velocity gathering layer. It further assumes that refined static corrections, based on statics computed from the reflection data itself, are desirable.

The automated statics analysis routine is conducted on NMO corrected gather records by utilizing all possible cross correlations between traces within and from adjacent depth points.

A dip model, representing the observed structure on one or more events within a specified gate or gates, is input to the program to facilitate dip correction within the set of CDP gathers being operated on. The model is interpreted from the previous stacked section in the processing sequence.

The process iterates automatically and makes separate estimations of residual normal moveout and dip, then computes a set of surface consistent residual statics for all shot and receiver locations. The appropriate residuals may be output on tape for application at a later stage, or stored in the data-base.

The following correlation processing controls are generally followed while estimating residual statics and have some data dependence:

a. Static limits (+/- 20 msec. for these data)
b. Damping factor to prevent matrix instability
c. Number of iterations (3 for these data)
d. The number of depth-points in the cross correlations. This was constant at 11, 9 and 7 through iterations 1, 2 and 3.

Residual geophone statics are applied in accordance with receiver surface location and residual shot statics with record or shot input sequence. Both are recorded in the appropriate trace headers.

For the 2nd pass automatic residual statics calculation a non surface consistent solution was determined. The following correlation processing control were used:

a. Static limits (+/- 4 msec.)
b. Number of iterations (1 for these data)
c. Number of depth-points used in the cross correlations (5 for these data)

11. DIP MOVEOUT CORRECTION (DMO)

The data was processed through Digicon's Kirchhoff dip moveout routine.

The main benefits of including DMO in the processing sequence are:-

1. DIP-INDEPENDENT STACKING VELOCITIES

   Stacking velocities after DMO are dip-independent, allowing both horizontal and dipping reflectors to be stacked with the same RMS velocity ie. the RMS velocity associated with the horizontal event. Thus flat dip primary reflectors and step dip events (such as fault plane reflectors and diffraction limbs) may be optimum stacked at the same time.

2. REMOVAL OF REFLECTION POINT SMEAR

   Data recorded at a finite offset is transformed to zero offset thus eliminating reflection point smear. Time varying multi-channel filters applied in the common-offset domain laterally shift the reflection points to their zero-offset position.

12. NORMAL MOVEOUT (NMO) CORRECTION

This operation is performed assuming that the energy travels in a straight ray path and utilizes the following equation.

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

A space varying velocity function is utilized and the program computes a new space-varying function for each trace. By making floating point cubic interpolations between input control points, a high-fidelity NMO is output.

13. PRESTACK MUTING

The function of this process is to mute the very shallow long offset traces where the signal to noise ratio is extremely poor.

In particular, the disproportionate stretching of traces with decreasing velocity and increasing offset, following NMO correction, contributes significantly to the poor S/N ratio.

14. PRE-STACK SCALING

At this final stage of preparation of the trace it is assumed that each has been statics and NMO corrected to a simulated zero offset condition, on the datum plane, for the particular CDP. So that each may contribute equally over its full length, to the summed trace, a short gate (500 milliseconds) Automatic Gain Control was applied, before stacking, to ensure that all were at optimum level.

15. COMMON DEPTH POINT STACK

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

16. TAU-P FILTER

The migrated stacked data was input to the program which is a 2-D time space dip filter that has two non-linear signal estimation options available: coherence masking and dip balancing. The dip pass region given was ± 8.0 msec per trace and the unfiltered addback was 60% - 70 %.

17. FILTERING

Zero-phase digital filters were used in the filtering of stacked data. For intermediate processing, a time constant band-pass filter having a low-cut of 15 Hz and a high-cut of 80 Hz was used. On the final and migrated stacks a time variant filter was used.

18. POST STACK SCALING

A multi-gated balance was applied to the data after final filtering to bring the data to the desired amplitude level. The average absolute value (AABS) of the gate is computed and a scalar is applied to the centre point of the gate. This is repeated for each gate with the scalar interpolated between the gate centres.

19. MIGRATION (FINITE DIFFERENCE METHOD)

The lines were migrated using the finite difference wave equation technique with a layer thickness of 20 msec and migration velocity of 95% of the smoothed stacking velocities.

20. DISPLAY

The final display films were of a horizontal scale of 10 traces per cm and vertical scale was 20 cm per second.

The films were fitted with a side panel on the right hand side with a comprehensive tabulation of line, field and processing information. Along the top of the films data relating to actual location along the line is displayed. This includes datum statics and residual statics, line intersection details, uphole and well locations, surface elevation and R.M.S. velocity tables at their points of application. All films were in the wiggle trace-variable area mode, with timing lines every 100 milliseconds.

THE DATA PROCESSING SYSTEM

Digicon's installation in Brisbane is based on two Digital Equipment Corporation VAX 8650 computers, coupled with Digicon's Disco Seismic data Processing System.

The hardware configuration is flexible, with the Brisbane installation being one of many possible alternatives. Included in this establishment are twenty-five tri-density tape drives, disk storage of 6 gigabytes, five FPS array processors, two Numerix Vector processors, three Benson and one Versatic Electrostatic Plotters and twenty-six remote input/output terminals allowing multi-user, multi-functional interactive capability.

The 32-bit central processing unit and a 16 mega-byte capacity main memory enhances the scientific application of the VAX computers.

Plotting in a variety of modes is available through the on-line Benson plotters and a Geospace film plotter.

The Disco System (Digicon's Interactive Seismic Computer) is an extension of the Digicon Modular Seismic Data Processing System 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,
Digital Exploration Limited

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APPENDIX I

PROCESSING PARAMETER TESTS

The majority of the parameter tests were performed on line NI081-17.

A. The pre-stack tests used the shots at VP1065 and VP1191

1. Amplitude Recovery Tests

The raw shot record is measured for db level over 100 msec time gates from 0.10 secs to 4.00 msecs. A spherical divergence function is then applied to the shot record and the db level is measured again from the resultant display a gain function is then chosen if found to be necessary.

2. F-K Tests

Velocity filters were tested on the 2 shots. The velocity cuts tested were 833 m/sec, 555 m/sec and 416 m/sec.

3. Deconvolution Before Stack Tests

The following combinations of parameters were tested.

Spike; 0.1% white noise, 1 design gate, operator length 81 msec

Spike; 0.1% white noise, 1 design gate, operator length 121 msec

Spike; 0.1% white noise, 1 design gate, operator length 161 msec

Gap; 1.0% white noise, 1 design gate, operator length 121 msec, gate length 12 msec

Gap; 1.0% white noise, 1 design gate, operator length 121 msec, gate length 16 msec

Gap; 1.0% white noise, 1 design gate, operator length 121 msec, gate length 20 msec

Gap; 1.0% white noise, 1 design gate, operator length 121 msec, gate length 24 msec

Gap; 1.0% white noise, 1 design gate, operator length 121 msec, gate length 32 msec

Wavelet: 1 design gate, operator length 401 msec, output velocity 16 Hz to 60 Hz

4%, Filter Test

An octave bandpass filter test from 0 - 7.5 Hz to 90 - 180 Hz was run on the two shot records.

B. Stack Panels Tests VP 1090 - 1190 Line NI081 - 17

1. Deconvolution Before Stack

a. Spike Deconvolution with 161 msec operator, white noise 0.1%, single gate

b. Gap Deconvolution with 121 msec operator, white noise 0.1%, single gate, gap length 20 msec

c. Wavelet deconvolution with 401 msec operator, single gate output wavelet 16/60 Hz

2. Mute Tests

Mute tests using common offset stacks and increasing offset stacks were produced on data panels between VP's 1165 - 1180 and VP's 2310 - 2360.

3. Filter Tests

Filter test producing octave bandpass panels was run on a panel of data from VP 2300 - 2360

4. Coherency and Noise Tests

Coherency and Noise removal tests were performed on a panel of data from VP 2120 - 2320

5. Migration Tests

Migration tests using the finite difference method were run of data from VP 2120 to VP 2320. 80%, 90% and 100% of the smoothed stacking velocity field were tested.

One Line NR, VP 448 and VP 462 a similar set of pre stack tests were performed.

	FIELD TAPE	
	REFORMAT	
1ST BREAK DISPLAY FOR DIGITIZING	GAIN RECOVERY	
	PHASE CONVERSION FILTER	DISPLAY FOR QC
	RESAMPLE	
	DECONVOLUTION	
	CDP GATHER	
DATUM STATIC COMPUTATION	APPLY RESIDUAL COMPONENT	
	OF DATUM STATICS	INITIAL GATHER
	NMO	FIRST PASS VELOCITY ANALYSIS
	MUTE	
	STACK FILTER	
	SCALING	
	SCALING	
	DISPLAY - BRUTE STACK	
	NMO	VELOCITIES FROM (1)
	MUTE	
	FILTER	
	SCALING	
	1ST PASS, AUTO STATIC	
	COMPUTATION	
	APPLY 1ST PASS AUTO STATIC	
	NMO	VEL FROM (1)
	MUTE	
	SCALING	
	DMO	
	STACK	DMO GATHERS
	FILTER	
	SCALING	SECOND PASS VELOCITY ANALYSIS
	DISPLAY - DMO STACK	
	REMOVE 1ST PASS AUTO STATIC	
	NMO	
	MUTE	VEL FROM (2)
	FILTER	
	SCALING	
	2ND PASS AUTO STATIC COMPUTATION	
	APPLY 2ND PASS AUTO STATIC	
	NMO	
	MUTE	
	SCALING	VEL FROM (2)
UNFILTERED FINAL STACK	STACK	
	T.V. FILTER	
	SCALING	
	APPLY DATUM STATIC SHIFT TO DATUM	
	DISPLAY - FINAL STACK	

APPENDIX II

LIST OF ARCHIVE TAPES

1. UNFILTERED, FINAL STACK UNFILTERED FINAL STACKS 1981
12 FOLD DATA 3.0 SECS @ 4 MSEC

LINE NO.	INPUT CDP	SEQUENTIAL COUNTER
NIO81 - 06	2371 - 2003	1 - 369
NIO81 - 08	2007 - 2772	370 - 1135
NIO81 - 12	2342 - 2015	1136 - 1463
NIO81 - 10	2772 - 1997	1464 - 2239
NIO81 - 13	2014 - 2397	2240 - 2623
NIO81 - 14	2424 - 2013	2624 - 3035
NIO81 - 15	2378 - 2015	3036 - 3399
NIO81 - 15A	2014 - 2310	3400 - 3696
NIO81 - 16	1964 - 2196	3697 - 3929
NIO81 - 17	2008 - 2452	3930 - 4374
NIO81 - 17A	2012 - 2484	4375 - 4847
NIO81 - 19	2393 - 1984	4848 - 5257

2. MIGRATED STACK, 1981 12 FOLD DATA 3.0 SECS @ 2 MSEC
TAPE NO. 2729

NIO81 - 06	2371 - 2003	1 - 369
NIO81 - 08	2007 - 2772	370 - 1135
NIO81 - 12	2342 - 2015	1136 - 1463
NIO81 - 10	2772 - 1997	1464 - 2239
NIO81 - 13	2014 - 2397	2240 - 2623
NIO81 - 14	2424 - 2013	2624 - 3035
NIO81 - 15	2378 - 2015	3036 - 3399
NIO81 - 15A	2014 - 2310	3400 - 3696
NIO81 - 16	1964 - 2196	3697 - 3929
NIO81 - 17	2008 - 2452	3930 - 4374
NIO81 - 17A	2012 - 2484	4375 - 4847
NIO81 - 19	2393 - 1984	4848 - 5257

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3. UNFILTERED FINAL STACKS 1971 6 FOLD 3.0 SEC @ 4 MSEC
TAPE NO. CDP 2746

LINE NO.	INPUT CDP	SEQUENTIAL COUNTER
NA	109 - 1141	1 - 733
NAA	3557 - 3764	734 - 941
NBEXT	4397 - 4840	942 - 1385
NN	1129 - 1612	1386 - 1869
NP	7 - 424	1870 - 2287
NR	14 - 490	2288 - 2764
Z	2681 - 3150	2765 - 3234

4. MIGRATED STACKS 1971 6 FOLD 3.0 MSECS @ 2 MSEC
TAPE NO. CPT 2730

LINE NO.	INPUT CDP	SEQUENTIAL COUNTER
NA	109 - 1141	1 - 733
NAA	3557 - 3764	734 - 941
NBEXT	4397 - 4840	942 - 1385
NN	1129 - 1612	1386 - 1869
NP	7 - 424	1870 - 2287
NR	14 - 490	2288 - 2764
Z	2681 - 3150	2765 - 3234

5. UNFILTERED FINAL STACKS 1971 SINGLE FOLD DATA 3.0 SECS @ 4 MSEC
TAPE NO. 2804

LINE NO.	INPUT CDP	SEQUENTIAL COUNTER
NAD	14 - 494	1 - 481
NAE	14 - 590	482 - 1058
NAF	14 - 254	1059 - 1299
NAH	14 - 326	1300 - 1612
NAI	14 - 326	1613 - 1925
NS	14 - 1326	1926 - 3238
NAEXT	14 - 542	3239 - 3767
NAB	14 - 398	3768 - 4152
NAG	14 - 326	4153 - 4465
NAS	14 - 392	4466 - 4754
NQ	14 - 662	4755 - 5403
QR	14 - 446	5404 - 5836
NB	14 - 921	5837 - 6744
NT	14 - 734	6745 - 7465
NW	14 - 542	7466 - 7994
X	14 - 830	7995 - 8811

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6. MIGRATED STACKS 1971 SINGLE FOLD DATA 3.0 SEC @ 2 MSEC
TAPE NO.

LINE NO.	INPUT CDP	SEQUENTIAL COUNTER
NAD	14 - 494	1 - 481
NAE	14 - 590	482 - 1058
NAF	14 - 254	1059 - 1299
NAH	14 - 326	1300 - 1612
NAI	14 - 326	1613 - 1925
NS	14 - 1326	1926 - 3238
NAEXT	14 - 542	3239 - 3767
NAB	14 - 398	3768 - 4152
NAG	14 - 326	4153 - 4465
NAS	14 - 392	4466 - 4754
NQ	14 - 662	4755 - 5403
QR	14 - 446	5404 - 5836
NB	14 - 921	5837 - 6744
NT	14 - 734	6745 - 7465
NW	14 - 542	7466 - 7994
X	14 - 830	7995 - 8811

7. UNFILTERED FINAL STACK 1969 SINGLE FOLD DATA 3.0 SECS @ 2 MSEC
TAPE NO. 2776

TRAVERSE A	14 - 2030	1 - 2017
TRAVERSE F	25 - 1190	2018 - 3183
TRAVERSE H	14 - 638	3184 - 3808
TRAVERSE O	14 - 1430	3809 - 5225

8. MIGRATED STACK 1969 SINGLE FOLD DATA 3 SEC @ 2 MSEC
TAPE NO.

TRAVERSE F	25 - 1190	1 - 1166
TRAVERSE H	14 - 368	1167 - 1791
TRAVERSE O	14 - 1430	1792 - 3208
TRAVERSE A	14 - 2030	3209 - 5225

9. UNFILTERED FINAL STACKS 1964 SINGLE FOLD DATA 3 SEC @ 4 MSEC
TAPE NO. 2777

L1	14 - 2414	1 - 2401
L2	14 - 3374	2402 - 5762
L6	14 - 1574	5763 - 7323

10. MIGRATED STACKS 1964 SINGLE FOLD DATA 3 SECS @ 4 MSEC
TAPE NO. 2774

L1	14 - 2414	1 - 2401
L2	14 - 3374	2402 - 5762
L6	14 - 1574	5763 - 7323

APPENDIX III

The following is a list of shot records used to process the 1964 and 1969 data. The tape numbers noted are the numbers on the transcribed field tapes.

Also listed is the shift in milliseconds applied to the data to correct for zero time errors. This time was calculated from the shot reocrd displays and is an approximation only. The data was tied back to more recent vintages of data where intersections occured.

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
L1	3	1	- 300 msec	1
L1	3	3	- 300 msec	2
L1	3	6	- 300 msec	3
L1	3	10 - 12	- 300 msec	4 - 6
L1	3	14	- 300 msec	7
L1	3	16	- 300 msec	8
L1	3	18	- 300 msec	9
L1	3	20 - 22	- 300 msec	10 - 12
L1	3	24 - 27	- 300 msec	13 - 16
L1	3	29 - 32	- 300 msec	17 - 20
L1	3	35	- 300 msec	21
L1	3	37 - 38	- 300 msec	22 - 23
L1	3	40	- 300 msec	24
L1	3	42 - 46	- 300 msec	25 - 29
L1	3	49	- 300 msec	30
L1	3	52	- 300 msec	31
L1	3	54	- 300 msec	32
L1	3	63	- 300 msec	33
L1	3	67 - 70	- 300 msec	34 - 37
L1	3	72 - 73	- 300 msec	38 - 39
L1	4	74 - 100	- 300 msec	40 - 66
L1	4	102 - 135	- 300 msec	67 - 100

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
L2	6	244 - 220	- 300 msec	132 - 108
L2	5	219 - 213	- 300 msec	107 - 101
L2	6	245 - 273	- 300 msec	133 - 161
L2	7	333 - 334	- 300 msec	162 - 163
L2	7	336	- 300 msec	164
L2	7	337 - 360	- 300 msec	221 - 244
L2	8	423 - 437	- 300 msec	325 - 339
L2	9	438 - 473	- 300 msec	340 - 375

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
L6	9	507 - 497	- 300 msec	407 - 397
L6	9	495 - 488	- 300 msec	396 - 389
L6	9	486 - 481	- 300 msec	388 - 383
L6	9	480 - 474	- 300 msec	382 - 376
L6	9	508	- 300 msec	374
L6	9	509 - 540	- 300 msec	408 - 439

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
TRAVERSE A	10	1 - 4	- 520 msec	1538 - 1541
TRAVERSE A	10	6	- 520 msec	1542
TRAVERSE A	10	5	- 520 msec	1543
TRAVERSE A	10	9 - 23	- 520 msec	1544 - 1558
TRAVERSE A	23	47	- 105 msec	1559
TRAVERSE A	23	49	- 105 msec	1560
TRAVERSE A	23	51	- 105 msec	1561
TRAVERSE A	23	53 - 55	- 105 msec	1562 - 1564
TRAVERSE A	23	57	- 105 msec	1565
TRAVERSE A	23	65	- 105 msec	1566
TRAVERSE A	23	67	- 105 msec	1567
TRAVERSE A	23	66	- 105 msec	1568
TRAVERSE A	24	115 - 110	- 105 msec	1569 - 1574
TRAVERSE A	24	106 - 105	- 105 msec	1575 - 1576
TRAVERSE A	24	102 - 99	- 105 msec	1577 - 1580
TRAVERSE A	24	97	- 105 msec	1581
TRAVERSE A	24	98	- 105 msec	1582
TRAVERSE A	24	96 - 83	- 105 msec	1583 - 1596
TRAVERSE A	24	108 - 109	- 105 msec	1597 - 1598
TRAVERSE A	23	68 - 71	- 105 msec	1599 - 1602
TRAVERSE A	23	73 - 81	- 105 msec	1603 - 1611
TRAVERSE A	24	116 - 119	- 105 msec	1612 - 1615
TRAVERSE A	24	121	- 105 msec	1616
TRAVERSE A	24	26 - 31	- 520 msec	1617 - 1622

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
TRAVERSE F	14	45 - 60	- 520 msec	2750 - 2765
TRAVERSE F	14	63 - 83	- 520 msec	2766 - 2786
TRAVERSE F	14	85	- 520 msec	2787
TRAVERSE F	14	87	- 520 msec	2788
TRAVERSE F	14	89 - 90	- 520 msec	2789 - 2790
TRAVERSE F	14	92	- 520 msec	2791
TRAVERSE F	14	95	- 520 msec	2792
TRAVERSE F	14	97 - 102	- 520 msec	2793 - 2798

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
TRAVERSE H	15	1 - 6	- 520 msec	3001 - 3006
TRAVERSE H	15	30	- 490 msec	3007
TRAVERSE H	15	8 - 9	- 520 msec	3008 - 3009
TRAVERSE H	15	32 - 33	- 490 msec	3010 - 3011
TRAVERSE H	15	12 -	- 430 msec	3012
TRAVERSE H	15	13 - 14	- 515 msec	3013 - 3014
TRAVERSE H	15	15 -	- 490 msec	3015
TRAVERSE H	15	16	- 430 msec	3016
TRAVERSE H	15	17 - 18	- 500 msec	3017 - 3018
TRAVERSE H	15	20	- 500 msec	3019
TRAVERSE H	15	22 - 23	- 490 msec	3020 - 3021
TRAVERSE H	15	25 - 29	- 490 msec	3022 - 3026

LINE NO.	TAPE NO.	FFID	SHIFT	SHOT POINT
TRAVERSE O	20	1 - 11	- 520 msec	6000 - 6010
TRAVERSE O	20	13 - 60	- 520 msec	6011 - 6058