U.S. GEOLOGICAL SURVEY MULTICHANNEL SEISMIC DATA

NATIONAL ENERGY RESEARCH SEISMIC LIBRARY
NERSL CD-ROM 1

D.R. Hutchinson U.S. Geological Survey, Woods Hole, MA 02543
D.J. Taylor U.S. Geological Survey, Denver, CO, 80225
F.N. Zihlman U.S. Geological Survey, Denver, CO, 80225

U.S. Geological Survey
Open-file Report 90-699

The text of this report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey editorial standards and nomenclature. Any use of trade names in this publication is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

November, 1990

NOTE: This open-file report consists of the text only from NERSL CD-ROM Disk 1. Copies of the CD-ROM are available through U.S. Geological Survey Open-File Report 92-289.

INTRODUCTION

This publication presents nine marine, digital seismic reflection multichannel profiles from the Atlantic East Coast, and seven lines from land surveys in southern New Mexico and Montana, together with location information, on a CD ROM. The software provided on the disk allows the seismic data to be displayed in black and white or color, at variable scales, and provides map graphics for display of line and line-segment locations.

MARINE SEISMIC DATA

In 1978, the USGS completed one phase of its seismic reflection studies of resource potential and environmental hazards on the Atlantic Outer Continental Shelf. Begun in 1973, these studies were mostly in response to leasing initiatives related to petroleum exploration. With the acquisition of multichannel lines 18 to 38 in 1978, nine of which are contained in entirety in this compilation, the total multichannel seismic coverage reached about 20,000 km, with a cross-shelf line-spacing of about 40 km, and several tie lines along parts or all of the margin (Folger and others 1979). This represents one of the densest multichannel seismic data sets that are publicly available from any continental margin on Earth. The nine lines presented here represent 2,285 km of data consisting of six dip lines and three strike lines across Georges Bank basin and the Long Island platform along the northeast U.S. Atlantic continental margin.

Georges Bank basin contains sedimentary rock that forms a seaward-thickening wedge deposited in one primary and several ancillary depocenters created when North America and Africa rifted apart in middle Mesozoic time (Schlee and Klitgord, 1988). The lines show images of features such as the thick wedge of Mesozoic and Cenozoic postrift deposits, the basement hinge zone, buried rift basins, the postrift unconformity, the paleoshelf edge, crystalline basement, oceanic basement, and occasional intracrustal and Moho reflections (Grow and others, 1983; Schlee and Klitgord, 1988; Klitgord and others, 1988). The dip profiles (lines 18, 19, 20, 21, 22, and 23) provide excellent images of the shallow basement platform at the landward end of each profile, the deep marginal sedimentary basins beneath the outer shelf, slope, and rise, and the deep ocean basin at the seaward end of each profile. Sediment thickness is in excess of 10 km in the depocenters and decreases to 0-5 km along the flanking basement platforms, such as the Long Island platform to the west of Georges Bank and the Gulf of Maine platform north of Georges Bank.

Two of the lines presented here have been the subjects of detailed studies. Line 19 across Georges Bank lies near two Continental Offshore Stratigraphic Test (COST) wells (Mattick and Libby-French, 1988) and has been used as a reference profile for the Georges Bank basin (Klitgord and others, 1982; Poag, 1982; Schlee and others, 1983; Schlee and Klitgord, 1988). Line 36 crosses the Long Island platform and illustrates several Triassic/Jurassic buried rift basins (Klitgord and Hutchinson, 1985; Hutchinson and others, 1986), numerous basement

structures, and an exceptionally well-imaged Moho reflection (Hutchinson and others, 1986; Phinney and others, 1986; Phinney and Roy-Chowhdhury, 1990).

Each of the marine multichannel profiles were collected and processed by Geophysical Services Inc. (GSI) under contract to U.S. Geological Survey. None of the data have been migrated. The acquisition and processing details for line 19 are given in Appendix 1. Details of the acquisition geometry and processing parameters for the other lines are given in the .SPN files in the directory DEMO on the CD ROM.

LAND SEISMIC DATA

The land seismic data on this disk represent a sample set of data owned exclusively by the U.S. Geological Survey. The data were used in support of energy resource and seismic processing research projects within the Office of Energy and Marine Geology. The six Church lines are from southern New Mexico around the town of Church Rock. The Land 1 line runs north to south across the Montana/Wyoming state line near Alzada, Montana.

The Churth Rock lines were collected as part of a project to evaluate structures which may have influenced deposition of the uranium-bearing Jurassic upper Morrison Formation. The seismic survey helped to show that block faulting had caused an increase in thickness and sand content of the Morrison Formation's Westwater Canyon Member, which contains most of the deposits from the Church Rock Uranium district (Phelps and others 1986.)

The Church Rock lines were collected and processed by the Department of Geophysics, Colorado School of Mines under contract to the U.S. Geological Survey. The area of interest is rugged and thus the line locations were limited by access and topography. A total of 15 miles (24 km) of 12-fold Vibroseis seismic reflection data were acquired. The acquisition and processing parameters are given in Appendix 2.

The Montana profile, Land 1, was acquired as part of a hydrologic study of the Mississippian age Madison Limestone Formation. Characteristics of the seismic response from the Madison Limestone interval were examined to see if the presence of water in the formation could be predicted. A variety of seismic techniques, including down-hole vertical seismic profiling, showed that the presence of water could be inferred from seismic attributes (Ryder and others, 1981).

Seismograph Service Co. of Tulsa, Oklahoma acquired the Land 1 surface seismic reflection data in 1978. The data were processed by the U. S. Geological Survey on its Raytheon RDS 500 Phoenix I seismic data processing system using software from Seismograph Service Co. The acquisition and processing parameters are given in Appendix 3.

INSTRUCTIONS FOR DATA DISPLAY

OVERVIEW:

The seismic data may be displayed using the program SEGMENT included on the disk. SEGMENT may run on any PC having standard EGA, VGA, or extended VGA video cards (Orchid or Paradise types). Program performance is enhanced by having a math coprocessor installed. The coprocessor is automatically detected. All instructions are through menus or interactive keyboard commands. SEGMENT allows individual seismic lines to be selected from a data set and either "previewed", viewed at greater detail, have the EBCDIC header from the SEG-Y tape displayed or a text file containing field and processing parameters printed. The preview mode displays the seismic line selected as well as a shot point map of the data set with that particular line highlighted in a color different from others in that data set. The detailed mode uses four windows to display the data. These windows function as:

Window 1: Full Seismic Display - displays the entire line selected.
Window 2: Displays a color bar with which the users may interactively adjust the display colors.
Window 3: Displays the shot point map of the data set.
Window 4: Extended Seismic Segment Display - displays an enlargement of a user-designated portion of the Full Seismic Display.

All four windows may be positioned about the screen as desired by the user when each is initially displayed. After their location is selected they may not be moved during the duration of the data display. Windows 2, 3, and 4 may also be sized by the user at the same time they are being positioned on the screen.

The seismic data displayed in window 1 and 4 can be in black and white (positive amplitudes shaded) or color. For color displays, program start-up options allow the seismic traces displayed to be scaled to a mean rms value for the entire seismic line, an rms value calculated for each trace, or only those portions of each trace having an rms value falling between a specified range.

The color bar in window 2 allows interactive adjustment of the intensity, saturation, and hue of both the foreground and background of the seismic data displayed. This provides the user with a means to enhance features of the data as desired.

The shot point map shown in window 3 is displayed using a modified Plate Carree projection allowing a rapid graphical display. The seismic line selected for display is highlighted on the shot point map using a color different from the others in the shot point map window. The locations of the traces displayed from that seismic line are further emphasized by tick marks of a second color on the highlighted seismic line.

The data displayed in window 4 (the Extended Seismic Segment window) are a subset of the entire seismic line (the Full Seismic Segment) displayed in window 1 and are selected from window 1 using a "selection

box". The selection box appears as a small box placed upon the data displayed in window 1 and is sized proportionally to that of window 4. The selection box size and location may be changed interactively by the user. The data within the boundaries of the selection box are those which will be displayed in the Extended Seismic Segment window. The smaller the box the greater the resolution, or magnification, of the data displayed in the Extended

Seismic Segment window.

PROGRAM FUNCTION:

Shown below are the steps used to display the data using SEGMENT. Steps 1, 2, 3, and 13 apply to both preview and detailed display modes. The remaining steps describe the detailed mode only.

1) Start-up

Set the default directory to "DEMO" on the CD-ROM. SEGMENT may execute in either EGA, VGA, or extended VGA by starting it with one of the following commands:

Segment /(video option) /(display option)

The current video options are:

/E	EGA resolution
/V	VGA resolution
/X	extended VGA (256 colors)

The current seismic trace display options are:

/m	scale each trace to an average rms value calculated for the entire seismic line (Default start-up option)
/t	scale each trace to an average rms value calculated for that trace.
/p <low><high>	display only that portion of each trace whose rms values fall within the range of the 2 to the <low> and <high> exponents.

2) Select Display Mode

At the prompt select either "p" for preview mode, "v" for detailed viewing, "h" (EBCDIC header display to screen), and "s" (print text file of field/processing data). Select "x" to stop program execution. Press <enter> after selecting the mode desired.

Currently, the preview option will preview all lines that have been processed at production time. The detailed mode will display only those lines with complete data sets on the CD-ROM.

3) Select A Line for Display

The seismic lines available for viewing are displayed in a menu box. Select the seismic line desired by moving the highlight bar up or down using the keyboard up and down arrow keys. When the desired seismic line is highlighted press the <INSERT> (<INS>) key to select it.

4) Position the Full Seismic Display Window

After selecting a seismic line, the first window to appear is the Full Seismic Segment display window (window 1). It may be moved about the screen using the keyboard arrow keys but may not be sized. Pressing the "+" will make it move quicker in response to the arrow keys. Pressing "-" will make it move slower. After it has been placed in the desired position press <ENTER>. The entire seismic line is now displayed.

5) Position the Color Bar Window

After the data has been displayed in window 1, the color bar appears (window 2). The color bar may be moved about the screen in the same manner as described for the Full Seismic Segment window. The color bar window may also be made larger or smaller by pressing "h" (higher), "s" (smaller), "w" (wider), or "n" (narrower). After it has been placed in the desired position and sized properly press <ENTER>. At this time the menu appears allowing the user to change the intensity, hue, and saturation of the display colors (see Changing the Current Screen Display Colors, Step 9 below). After selecting and changing the color parameters desired, highlight the "Exit" option and press <ENTER> to exit the menu.

6) Position the Shot Point Map

After placing the color bar window and exiting the color change menu, the Shot Point Map window appears (window 3). This window may be moved about the screen in the same manner as described above. It may be changed in size by pressing "l" (larger) or "s" (smaller). After it has been placed in the desired position and sized properly press <ENTER>.

7) Position the Extended Seismic Segment Window

After placing the shot point map, the Extended Seismic Segment window appears (window 4). This window may be moved about the screen and sized in the manner described above for the color bar window.. After it has been placed in the desired position and sized properly press <ENTER>.

8) Select the Data to Display in the Extended Seismic Window

After the Extended Seismic Segment window has been placed and sized, the selection box appears on the Full Seismic Segment display (window 1). The initial size of the selection box will be proportional to the size selected for the Extended Seismic Segment window. The selection box may be moved about the seismic data displayed in window 1 using the keyboard arrow keys. It may be sized by pressing "l" (larger) or "s"

(smaller) with the size changing relative to the upper left corner (not center) of the box. Making the box smaller increases the resolution, or "magnification", of the data to be displayed. The rate at which the box size changes in response to the "l" or "s" commands is controlled by pressing either the "-" (smaller rate of change) or the "+" (greater rate of change) keys. This is similar to the procedure discussed in step 4 (Position the Full Seismic Segment Window). When the selection box encloses an area of interest press <ENTER> and the data selected will be displayed in the Extended Seismic Segment window (window 4). While the data is being displayed, the location of the shots will be highlighted with white tick marks on the appropriate line in the shot point map window. As soon as all the data has been displayed in the Extended Seismic Segment window the user may again move and size the selection box to select another area of interest for display. This process may be repeated as often as desired until the user exits the program.

9) Changing the Current Screen Display Colors

In step 5 or after steps 1 - 8, the current foreground and background colors may be changed by pressing "c" (foreground) or "b" (background). Be sure that "Num Lock" is off on the keyboard. The color attributes which may be changed are:

Hue	- that property of color normally described as red, green or blue.
Saturation	- the absence of white in a color.
Intensity	- the absence of black in a color (equivalent to the brightness).
Reset	- reset the display colors to the initial settings.
Grey Scale	- Grey scale display with positive amplitudes shaded.

The display colors may be changed as often as desired after Step 8.

Foreground

Pressing "c" will re-display the color menu. To change a color use the arrow keys to highlight either "Hue", "Saturation", "Intensity", "Reset", or "Black and White" and press <ENTER>. The number pad is used to change the item selected in the following method:

Color Bar

	Left	Center	Right	
positive	1	(6) 2	3	positive
negative	7	(4) 8	9	negative

The numbers "1" and "7" control the positive and negative changes in the left portion of the color bar, "2" and "8" the positive and negative changes in the center portion and "3" and "9" the changes in the right portion. The changes made are displayed interactively in both the data and the color bar. Numbers "4" and "5" will allow changing the negative adjustment in the center. Note that particular combinations of hue, saturation, and intensity will yield 2-color images (for example, blue and white) that provide an alternative to the black and white option. These may also be manipulated to display negative amplitudes (left side of the color bar) rather than positive amplitudes (default setting). When all desired changes have been made, press <ENTER> and the color bar menu is again displayed. Another attribute may be selected or the user may highlight the "Exit" option and press <ENTER> to exit the color change menu.

Background

Pressing "b" allows the background color to be changed. The brightness and darkness of red, green, and blue are controlled on the number pad as follows:

	Red	Green	Blue	
brightness	1	2	3	brightness
darkness	7	8	9	darkness

Press <ENTER> when all desired changes have been made.

10) Side Panel Display

After the data have been displayed (steps 1- 8), the "side panel" text describing the field and processing history may be displayed by pressing "S".

11) Shot Point (Trace) Numbers

After the data have been displayed (steps 1 - 8), the traces displayed in the Extended Seismic Segment Window may be labeled with their shot point numbers by pressing "L".

12) Printing the Display

After the data have been displayed (steps 1 - 8), they may be printed by pressing "p". Currently the production system is set up to print on a NEC P2200 dot matrix printer but may be modified to print to any printer desired.

13) Program Exit

After the data have been displayed, pressing <ESC> will return the user to the startup menu described in Step 2. Selecting "x" will halt program execution and return the user to the operating system prompt.

DESCRIPTION OF FILES ON CD-ROM

There are three directories on the CD-ROM: DATA, NAV, AND SOURCE.

DATA: The DATA directory contains files in a format that optimize data display and manipulation for program SEGMENT:

.VAL: These files contain a modified SEG-Y file converted to PC floating point format. The format is modified SEG-Y because only the amplitudes are preserved, not the reel-header or data-header information.

.RMS: These files contain the root-mean-square calculations for each trace in the line. These are the data that get plotted in the "Extended Seismic Section Plot".

.VPT: These files contain EGA/VGA summary plots for each line which are used in the plots of "Full Seismic Section" on EGA/VGA terminals.

.XPT: These files contain extended VGA summary plots for each line which are used in the plots of "Full Seismic Section" on extended VGA terminals.

.MAP: These are individual map files used for highlighting individual lines.

.SPN: These files contain side-panel information that is ordinarily displayed with paper copies of the seismic data.

.LBL: These files contain information that is needed to plot and reconstruct the SEG-Y data, such as block size and number of traces.

.HDR: These files contain all of the header information from the SEG-Y format. This includes the first 3600 bytes of the file and the first 240 bytes of each trace block.

NAV: This directory contains the navigation records for the shot points by line number.

SOURCE: This directory contains the source code for the programs SEGMENT and SEGYDISK. SEGMENT was compiled with Microsoft C 5.1 using the compiler command:

```
cl/AL segment.c vimage2 graphlib
```

The program SEGYDISK is included to reassemble the SEG-Y data into a SEG-Y disk file if desired by the user. On the CD-ROM, the seismic data have been converted from IBM format (most significant byte first) to IEEE format (reversed byte format). The conversion from IBM to IEEE

makes processing time more efficient: for traces containing 3000 points, as most marine lines do, reformatting a trace for display on a PC and computing the root mean square amplitude value for plotting takes about 0.6 seconds, or more than one hour for lines which contain up to 6000 traces, as many of the marine lines do. It is not practical to preserve the original SEG-Y data for input to the program SEGMENT.

Because the IEEE format is capable of more precision than the IBM format, no information is lost in reformatting from IBM to IEEE. The original SEG-Y data can, therefore, be reconstructed if desired. To facilitate this, the SEG-Y information that is not used in program SEGMENT is stored in the .HDR files (EBCDIC reel header 3200 bytes long, the binary reel header 400 bytes long, and each trace header 240 bytes long). The header information is copied verbatim from the original SEG-Y input tapes and follows standard SEG-Y conventions with the exception that in the trace headers, the shot point information is stored as integers in bytes 189-190 on the marine lines and bytes 17-20 on the land lines.

To reconstruct the SEG-Y file of marine line 22 onto hard disk in the directory 'seismic', enter:

```
segydisk atlan_22 c:\seismic\
```

where 'atlan_22' is the name of the line being reconstructed and 'c:\seismic\' is the destination disk and path.

ACKNOWLEDGEMENTS

This CD ROM could not have been produced without the programming expertise and perseverance of Dr. Russell Ambroziak, for whom we are indebted. We thank Chris Polloni and Bill Dillon for their suggestions for improving data display and presentation in various phases of this project.

If you have any questions about the program operation or source code call Russ Ambroziak at 703-648-6168 in Reston, VA. Questions about the seismic processing should be referred to Dave Taylor at 303-236-5744 in Denver, CO.

REFERENCES

Folger, D.W., Dillon,W.P., Grow, J.A., Klitgord, K.D., and Schlee, J.S., 1979, Evolution of the Atlantic continental margin of the United States, in Talwani, M., Hay, W., and Ryan, W.B.F., eds., Deep drilling results in the Atlantic Ocean: continental margins and paleoenvironmnet: American Geophysical Union Maurice Ewing Series 3, Washington, D.C., p. 87-108.

Grow, J.A., Hutchinson, D.R., Klitgord, K.D., Dillon, W.P., and Schlee, J.S., 1983, Representative multichannel seismic profiles over the U.S. Atlantic margin, in Bally, A.W., edl, Seismic expression of Structural Styles: American Association of Petroleum Geologists Studies in Geology Series no. 15, v. 2, p. 2.2.3-1 to 2.2.3-19.

Poag, C.W., 1985, Depositional history and stratigraphic reference section for central Baltimore Canyon trough, in Poag, C.W., ed., Geologic Evolution of the United States Atlantic margin: New York, Van Nostrand Reinhold Co., p. 217-264.

Ryder, R.T., Balch, A.H., Lee, M.W., And Miller, J.J, 1981, Processed and Interpreted U.S. Geological Survey Seismic Reflection Profile and Vertical Seismic Profile, Carter County, Montana and Crook County, Wyoming: U.S. Geological Survey Oil and Gas Investigations Chart, Number OC-115.

Schlee, J.S., and Fritsch, J., 1983, Seismic stratigraphy of the Georges Bank basin complex, offshore New England, in Watkins, J.S., and Drake, C.L., eds., Studies in Continental Margin Geology: American Association of Petroleum Geologists Memoir 34, p. 223-251.

Schlee, J.S., and Klitgord, K.D., 1988, Georges Bank basin: a regional synthesis, in Sheridan, R.E., and Grow, J.A., eds., The Geology of North America, v. I-2, The Atlantic Continental Margin: U.S.: Geological Society of America, p. 243-268.

APPENDIX 1 - LINE 19 ACQUISITION AND PROCESSING

U.S.G.S. OFFSHORE EAST COAST 1978

DIRECTION SHOT = 149 DEGREES

ACQUISITION

FIELD PARTY	:	2912	
VESSEL	:	M/V CARINO	
DATE SHOT	:	MAY - NOV 1978	
ENERGY SOURCE	:	AIR GUNS	
RECORDING INSTRUMENTS	:	DFS IV	
RECORDING FILTERS LOW	:	8 HZ. 18 DB/OCT	
HIGH	:	62 HX. 72 DB/OCT	
SAMPLE RATE	:	4 MSEC.	
RECORD LENGTH	:	12 SECONDS	
MULTIPLICITY	:	24 FOLD	
STREAMER LENGTH	:	2400 METER 48 TRACE	
STREAMER DEPTH	:	13 METER AVERAGE	
SOURCE DEPTH	:	6.4 METERS	
AIR GUN CAPACITY	:	2000 CU. IN	: 2000 CU. IN
INLINE SHOT OFFSET	:	322 METERS	
ANTENNA TO SOURCE OFFSET	:	57 METERS	
GROUP CENTER INTERVAL	:	50 METERS	
SHOTPOINT INTERVAL	:	50 METERS	

Hutchinson, D.R., Klitgord, K.D., and Detrick, R.S., Jr., 1986, Rift basins of the Long Island platform: Geological Society of America Bulletin, v. 97, p. 688-702.

Hutchinson, D.R., Grow, J.A., Klitgord, K.D., and Detrick, R.S., 1986, Moho reflections from the Long Island platform, eastern United States, in Baraganzi, M., and Brown, L.D., eds., Reflection Seismology: The Continental Crust: American Geophysical Union Geodynamics v. 14, p. 173-187.

Klitgord, K.D., and Hutchinson, D.R., 1985, Distribution and geophysical signatures of early Misozoic rift basins beneath the U.S. Atlantic continental margin, in Robinson, G.R., Jr., and Froelich, A.J., eds., Proceedings of the Second U.S. Geological Survey Workshop on the Early Mesozoic basins of the eastern United States: U.S. Geological Survey Circular 946, p. 45-53.

Klitgord, K.D., Hutchinson, D.R., and Schouten, H., 1988, U.S. Atlantic continental margin: structural and tectonic framework, in Sheridan, R.E., and Grow, J.A., eds., The Geology of North America, v. I-2, The Atlantic Continental Margin: U.S.: Geological Society of America, p. 19-55.

Klitgord, K.D., Schlee, J.S., and Hinz, K., 1982, Basement structure, sedimentation, and tectonic history of the Georges Bank basin, in Scholle, P.A., and Wenkam, C.R., eds., Geological Studies of the COST Nos. G-1 and G-2 Wells, United States North Atlantic Outer Continental Shelf: U.S. Geological Survey Circular 861, p. 160-186.

Mattick, R.E., and Libby-French, J., 1988, Petroleum geology of the United States Atlantic continental margin, in Sheridan, R.E., and Grow, J.A., eds., The Geology of North America, v. I-2, The Atlantic Continental Margin: U.S.: Geological Society of America, p. 445-462.

Phelps, W.T., Zech, R.S., and Huffman Jr., A.C., 1986, Seismic Studies in the Church Rock Uranium District, Southwest San Juan Basin, New Mexico,in,Turner-Peterson, C.E., Santos, E.S., And Fishman, N.S., ed., A Basin Analysis Case Study: The Morrison Formation Grants Uranium Region New Mexico: Am. Assoc. of Petroleum Geol. Studies in Geology, Number 22, p. 145 - 159.

Phinney, R., 1986, A seismic cross section of the New England Appalachians: the orogen exposed, in Baraganzi, M., and Brown, L.D., eds., Reflection Seismology: The Continental Crust: American Geophysical Union Geodynamics v. 14, p. 157-172.

Phinney, R.A., and Roy-Chowdhury, K., 1989, Reflection seismic studies of crustal structure in the eastern United States, in Pakiser, L.C., and Mooney, W.D., eds., Geophysical Framework of the Continental United States: Geological Society of America Memoir 172, p. 613-653.

Poag, C.W., 1982, Stratigraphic reference section for Georges Bank basin; depositional model for New England passive margin: American Association of Petroleum Geologists, v. 66, p. 1021-1041.

PROCESSING

TRUE AMPLITUDE RECOVERY	:	GAIN REMOVAL ALPHA = 5.0 DB/SEC. T1 = 0 T2 = 4.5 SEC.
TIME VARIANT DECONVOLUTION	:	DEPTHS 0-137 M. - 3 400 MSEC. FILTERS DEPTHS 138-244 M. - 2 400 MSEC. FILTERS DEPTHS OVER 244 M. - 3 200 MSEC. FILTERS
TIME VARIANT SCALING	:	GATE LENGTH 500 MSEC. UNITY AND 2 TO 1 FAR TO NEAR OFFSET SCALERS START TIME = WB
VELOCITY ANALYSIS	:	VELSCAN VELOCITY ANALYSIS SCATTERGRAMS AT 3 KM. INTERVALS
NORMAL MOVEOUT CORRECTIONS	:	VELOCITY ANNOTATION ON SECTION HEADING
OPTIMUM TRACE MUTING		
FIRST BREAK SUPPRESSION	:	VARIABLE
COMMON DEPTH POINT STACK	:	48 FOLD
TIME VARIANT FILTERING	:	TIME(MS+WB) FILTER(HZ) 0 15 - 45 3000 12 - 30 5000 8 - 25
TIME VARIANT SCALING	:	GATE LENGTH = 200 MSEC. START TIME = WB UNITY SCALERS

APPENDIX 2 - CHURCH ROCK LINES ACQUISITION AND PROCESSING

ACQUISITION

Source Type	: Single Vibrator 13-ton Litton Model 311
Source Spacing	: 220 ft.
Number of Sweeps per shot	: 10
Sweep Frequency	: 10 - 80 Hz. upsweep
Sweep Duration	: 14 seconds
Number of Recording Channels	: 48
Receiver Spacing	: 110 ft.
Record Length	: 16 seconds
Sample Rate	: 4 milliseconds
Lo-Cut Filter	: None
Hi-Cut Filter	: 83 Hz, anti-aliasing
Notch Filter	: 60 Hz
Receiver Spread	: Split Straddle
Source Location	: Between channels 24 and 25
Source to Spread Distance	: 110 ft
Fold	: 12

PROCESSING ORDER

Demultiplex	: 1
Cross Correlation	: 2
Gain Recovery	: 3
Vertical Sum	: 4
Diversity Stack	: 5
CMP Sort	: 6
Field Statics	: 7
Amplitude Recovery	: 8
First Break Mute	: 9
Deconvolution	: 10
Filter	: 11,17,21
Velocity Analysis	: 12,14
Residual Statics	: 13,15
NMO	: 16
Mute	: 18
Coherency Weighted Stack	: 19
Wave Equation Migration	: 20
Dip Filter	: 22
Display	: 23

APPENDIX 3 - MONTANA DATA ACQUISITION AND PROCESSING

ACQUISITION

Source Type	: Vibroseis (4)
Number of Sweeps per shot	: 16
Source Spacing	: 110 ft.
Sweep Frequency	: 56 - 14 Hz. downsweep
Sweep Duration	: 14 seconds
Number of Recording Channels	: 48
Receiver Spacing	: 110 ft.
Record Length	: 18 seconds
Sample Rate	: 4 milliseconds
Receiver Spread	: Split Straddle
Source Location	: Between channels 24 and 25
Source to Spread Distance	: 9 stations across the source
Fold	: 12

PROCESSING ORDER

Demultiplex, Edit, Sum	: 1
Cross Correlation	: 2
Geometry, Datum Statics	: 3
Scale	: 4,18
Filter	: 5,7,14
Deconvolution	: 6
Velocity Analysis	: 8,11
NMO, Mute	: 9,12
Residual Statics	: 10
Stack	: 13
Migration	: 15
Datum Correction	: 16

^Z^@^@^@^@^@^@^@^@^@^@^@^@^@