



GEOLOGICAL SURVEY OF CANADA

OPEN FILE 1277

REFLECTION SEISMIC

SOFTWARE

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ENGINEERING SEISMIC REFLECTION SOFTWARE FOR THE APPLE MICROCOMPUTER

Over the last few years, the Geological Survey of Canada has been developing engineering seismic reflection software for the Apple microcomputer. This has been in conjunction with the development and testing of the optimum window and optimum offset techniques of shallow reflection profiling. There is now a fairly extensive library of routines that allows the user to interactively pick events from the screen for static corrections or for velocity analysis of either refraction or reflection events, to apply a digital automatic gain control and/or a series of gain tapers to the data, to shift individual traces in time, to apply normal-moveout-corrections for a given velocity-depth function, and to produce high-quality printer plots of 12-channel seismic records. These programs are efficient, easy to use, fully documented, and available without charge. They constitute a powerful tool for anyone who is involved in engineering seismic reflection work.

The processing is done on an Apple II+ or Apple IIe microcomputer (64 K of memory) with 2 disk drives. An Epson dot matrix printer (MX 100 or FX 100 series) is required for plotting the data. The software supports several different printer interface cards. The data can be transferred to disk storage from any of the major engineering seismographs and this requires a serial interface card. All components of the system are presently available for a total cost of less than \$3000 US. Thus, a rather minimal investment gives the user of an engineering seismic system with digital recording capacity a wide range of data processing and display capabilities.

Our computing facilities are designed to be transported and set up at the field office so that data can be transferred to disk and data quality be monitored on a daily basis. Our software execution time has proved to be efficient enough to keep up with data production. As a rule, a preliminary seismic section can be obtained at the field site for an initial interpretation. Being able to carry out most of the data processing in the field gives the geophysicist invaluable feedback for modification and execution of a survey plan.

Transfer Routine

The first step in the processing is to transfer the data from the seismograph to disk storage. Commercial transfer routines are available for the ABEM, BISON, NIMBUS and OYO engineering seismographs from the respective manufacturers. Purchase of this routine is the only non-hardware cost that has to be incurred.

Eight 12-trace records can be stored on one side of a disk. Each trace consists of 1024 samples of up to 10-bit data. In addition, all the essential recording parameters are saved in a header. All GSC software is designed to read data that has been stored in the format output by these routines.

System Requirements:

The following components are required to run the engineering seismic reflection software described below:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives
- Epson dot matrix printer (MX-100/FX-100)
- one of the following parallel printer interface cards:
 - Epson Type II
 - Grappler
 - Grappler+

The particular parallel interface cards listed are critical for the high-resolution printer plot routines COMMON OFFSET and VELOCITY ANALYSIS.

In addition to the components listed above:

- Apple Serial Interface card (A2L0008) or Super Serial card

is necessary to run the transfer.

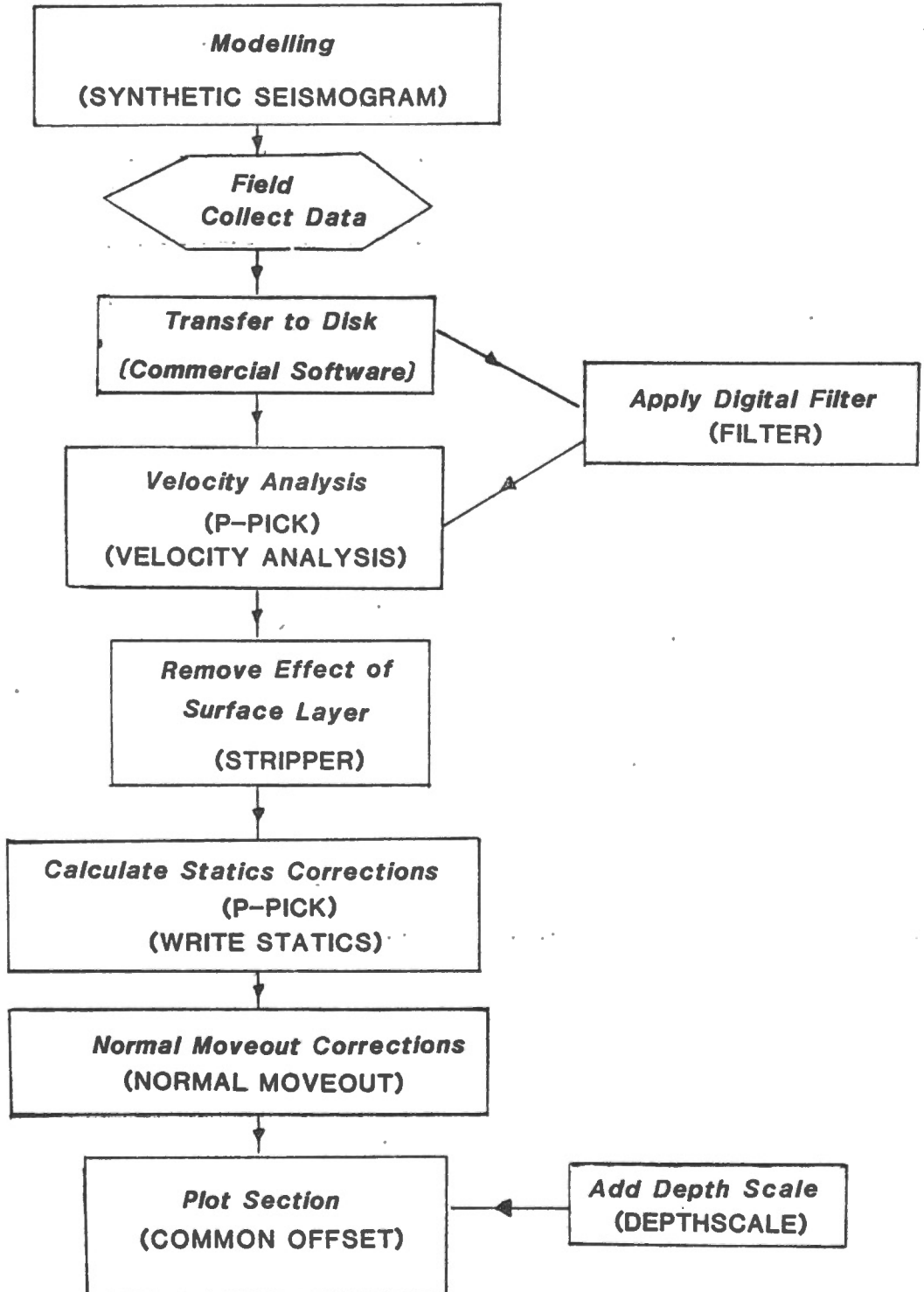
Processing and Documentation

On the following pages are flow diagrams describing the steps in processing Optimum Window and Optimum Offset data. The processing of an optimum offset section is illustrated with an example from Bangkok, Thailand.

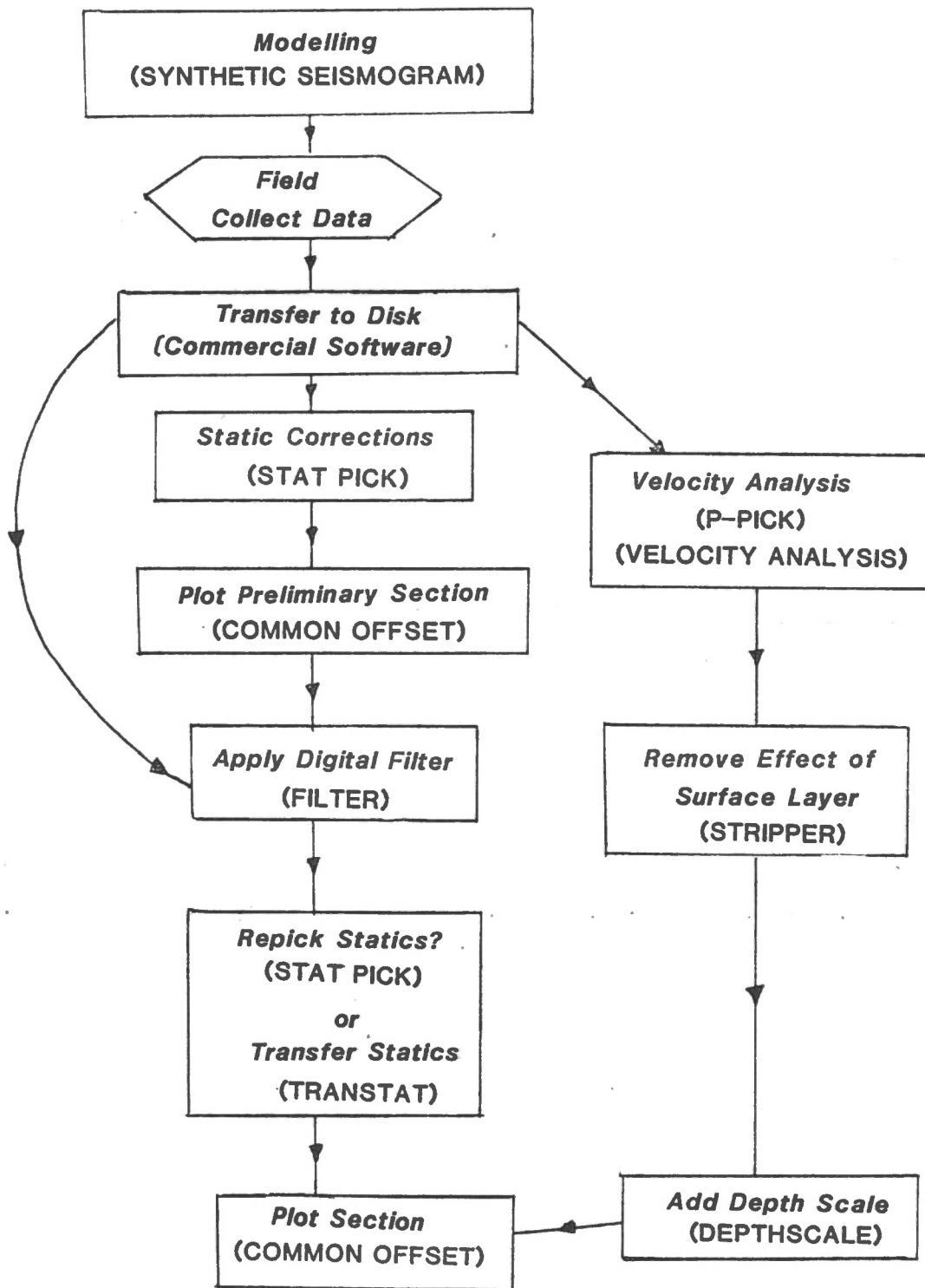
Full documentation of the following programs is included:

COMMON OFFSET
ELOT
FILTER
NORMAL MOVEOUT
PARTIAL MOVEOUT
P-PICK
STAT PICK
SYNTHETIC SEISMOGRAM
VELOCITY ANALYSIS

PROCESSING OF OPTIMUM WINDOW DATA



PROCESSING OF OPTIMUM OFFSET DATA



PROCESSING OF OPTIMUM OFFSET DATA- STAGE 1

RAW DATA

- no AGC

- no smoothing

INITIAL GAIN .5

- no mute

- normal polarity

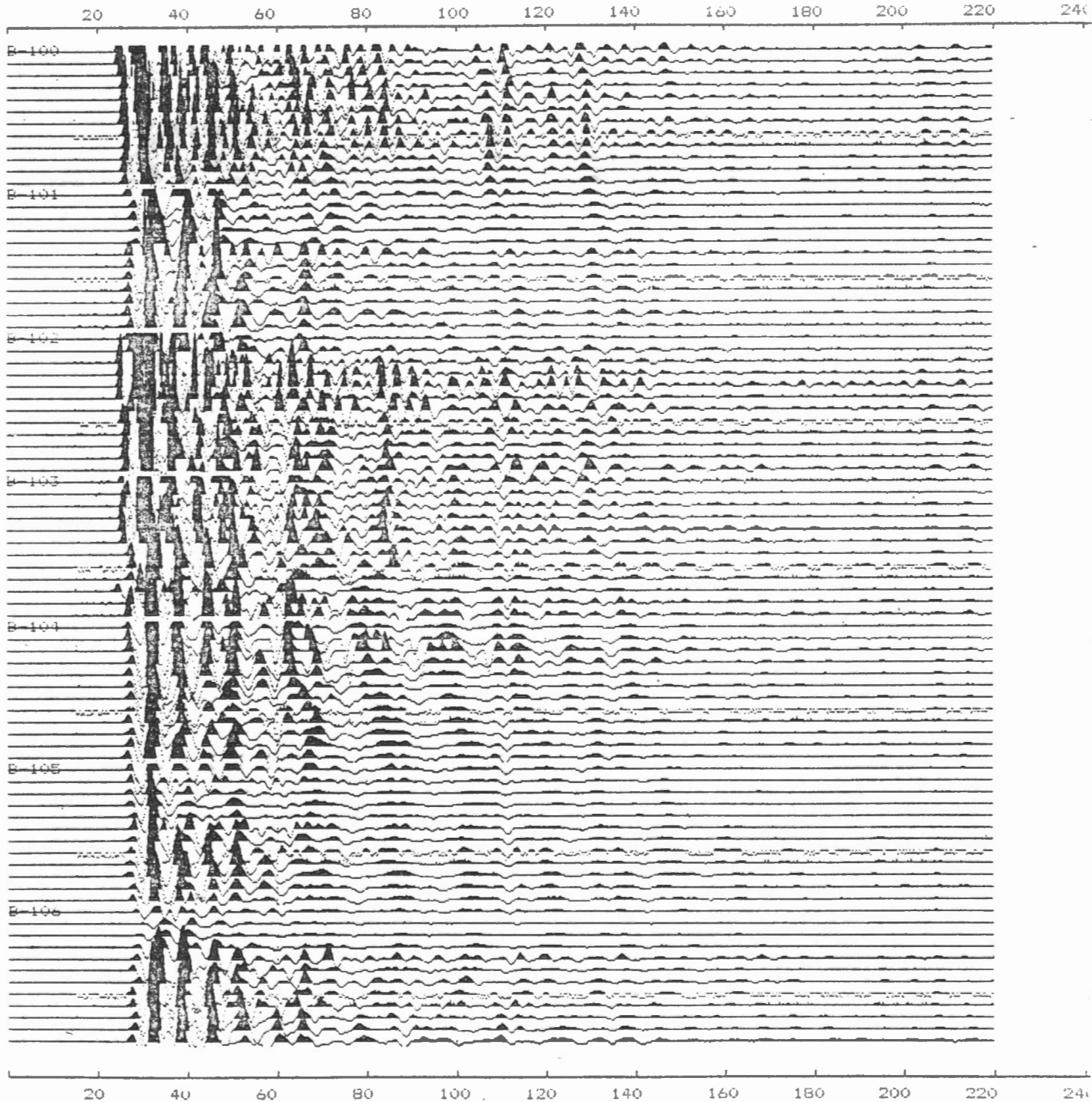
MUTE AT 0

- no gain tapers

TAP - 1 : 1 / 100

TAP - 2 : 1 / 200

TAP - 3 : 1 / 300



PROCESSING OF OPTIMUM OFFSET DATA- STAGE 2

- static corrections applied

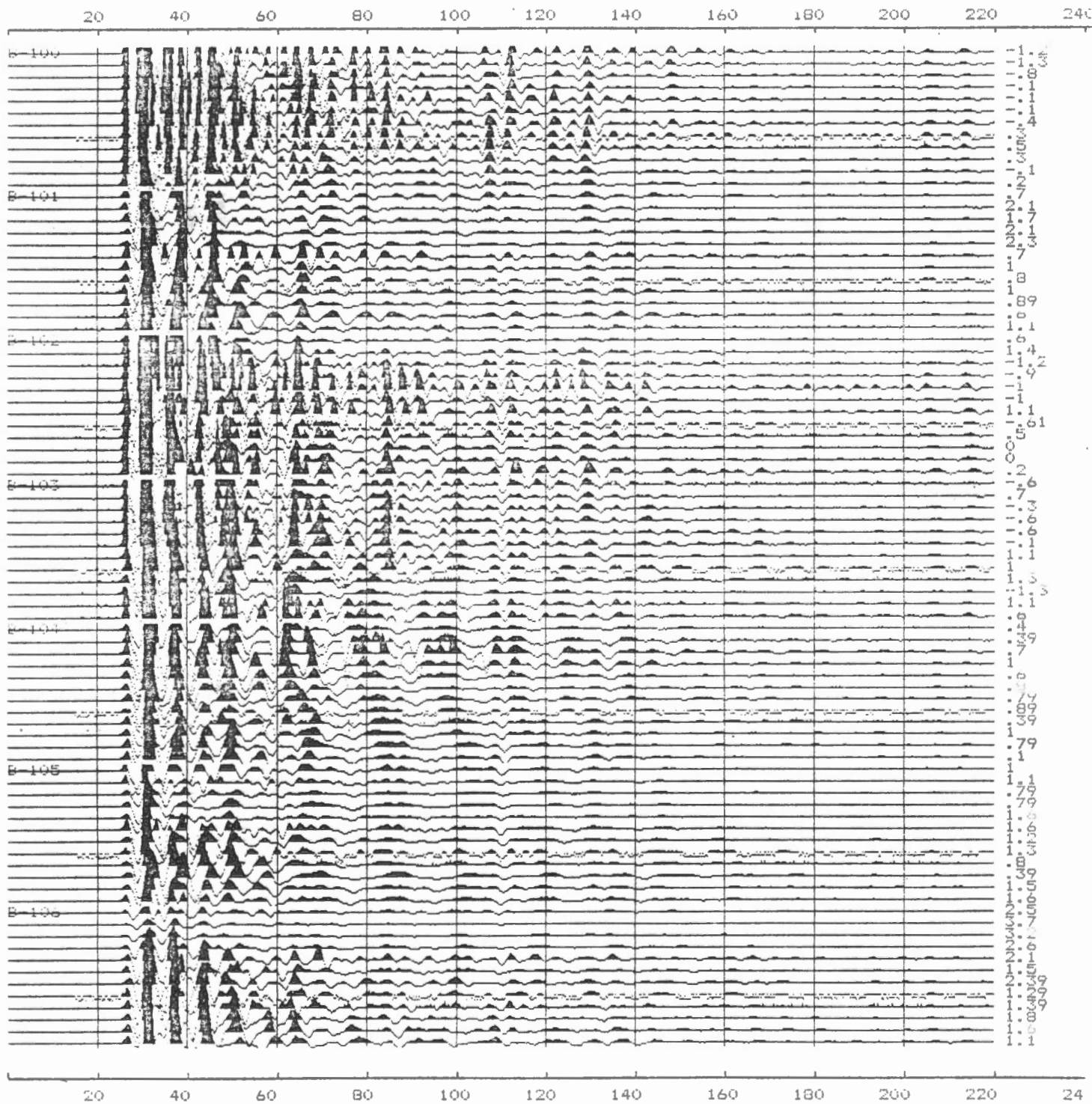
INITIAL GAIN .5

MUTE AT 0

TAP - 1 : 1 / 100

TAP - 2 : 1 / 200

TAP - 3 : .1 / 300



PROCESSING OF OPTIMUM OFFSET DATA - STAGE 4

WINDOW BEFORE 80

WINDOW AFTER 80

AGC CONSTANT 20

INITIAL GAIN .3

MUTE AT 0

TAP - 1 : 1 / 100

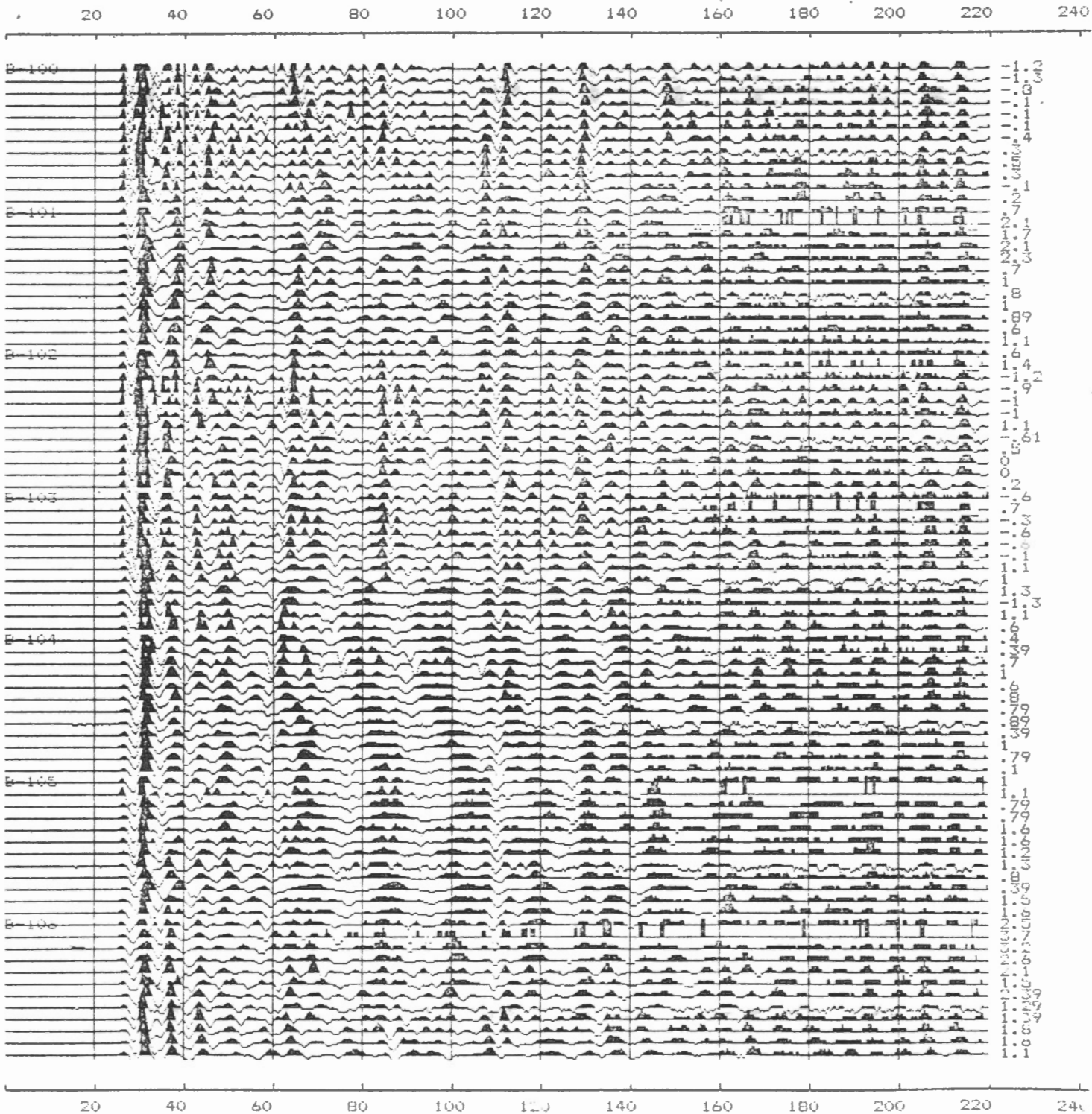
TAP - 2 : 1 / 200

TAP - 3 : 1 / 300

- static corrections applied

- AGC applied

- 3-point smooth



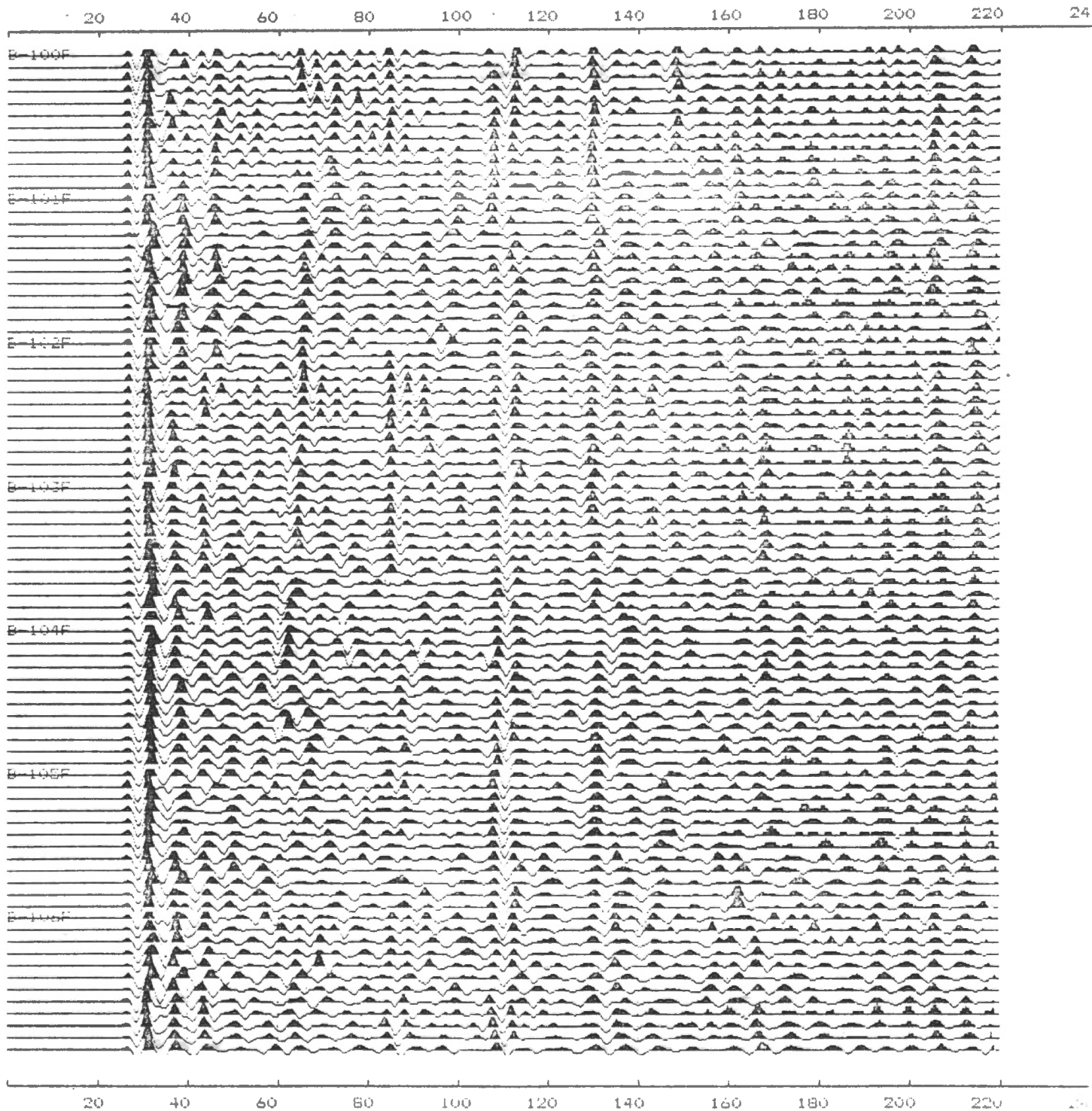
PROCESSING OF OPTIMUM OFFSET DATA - STAGE 5

WINDOW BEFORE 80
WINDOW AFTER 80
AGC CONSTANT 20
INITIAL GAIN .2

MUTE AT 0

TAP - 1 : 2 / 70
TAP - 2 : 1 / 800
TAP - 3 : 1 / 1600

- data filtered
- static corrections applied
- AGC applied
- 3-point smooth
- gain tapers applied



COMMON OFFSET

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives
- Epson dot matrix printer (MX 100/FX 100)
- one of the following parallel printer interface cards:

Epson Type II

Grappler

Grappler +

Program Description:

This is a high resolution printer plot routine designed primarily for producing common offset sections (hence the name), though any record(s) may be plotted. It allows the user to apply static corrections to the data, specify individual trace gains, apply an automatic gain control and/or gain tapers, mute the records to a given time, and choose between variable area or wiggle trace display. The full range of options is outlined below. A printer spooling routine allows one record to be printed while the next is being processed. The processing/printing time varies slightly but is of the order of 90 seconds/record. An example of the output produced by COMMON OFFSET is shown on page 21.

Execution:

- 1) Boot the appropriate program disk. A catalog of the files on the disk will be printed on the screen, with each file identified by a highlighted letter on the left hand side. The user selects the appropriate program simply by pressing the corresponding letter on the keyboard.

Three versions of the program COMMON OFFSET are listed on the screen:

COMMON OFFSET EPSON

COMMON OFFSET GRAP

COMMON OFFSET GRAP+

The user must select the program corresponding to the printer interface card in his/her Apple.

2) The following set-up is displayed on the screen:

```

<A> PRINTER SLOT          1  <ESC> EXIT
<B> DISPLAY STATICS      N
<C> TIME SCALE...AT START Y
<D>          ... AT END  Y
<E> NUMBER TIME SCALE    Y
<F> TIMING LINES         Y
<G> VARIABLE AREA        Y
<H> 3 POINT SMOOTHING    N
<I> REVERSE POLARITY     N
<J> AGC                   Y
<K> WINDOW BEFORE        80
<L> WINDOW AFTER         80
<M> AGC CONSTANT         20
<N> MUTE AT              0
<O> GAIN -               COMMON 1
<P> STATICS -           0
<Q> DIRECTION -         COMMON F
      GAIN TAPERS
<R> END ZONE 1 1         <S> TAPER  1
<T> END ZONE 2 800       <U> TAPER  1
<V> END ZONE 3 1600      <W> TAPER  1
<X> TRACE GAIN NORMALIZATION N
<Y> START TIME OF WINDOW 0
<Z>  END TIME OF WINDOW 1

```

This screen lists the plotting options that are available, and allows the user to make any changes that are desired before pressing to move to Step 3.

The keys through allow changes to be made to the corresponding lines <A> through <Z>.

Where a "Y" (yes) or "N" (no) is shown (lines through <J> and line <X>), pressing the letter corresponding to the line will cause the screen to be updated with the opposite value ("N" or "Y") displayed.

Where numerical values are shown (line <A> , lines <K> through <N> , <R> through <W> , <Y> and <Z>), pressing the letter corresponding to the line will move the cursor up to the line and allow the user to type in the desired value. Pressing will then cause the screen to be updated with the new value shown.

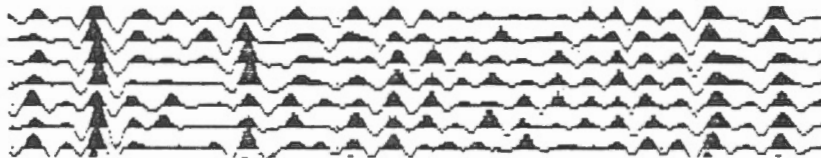
Lines <O>, <P> and <Q> toggle between two or three different options. These will be described below.

<A> PRINTER SLOT 1

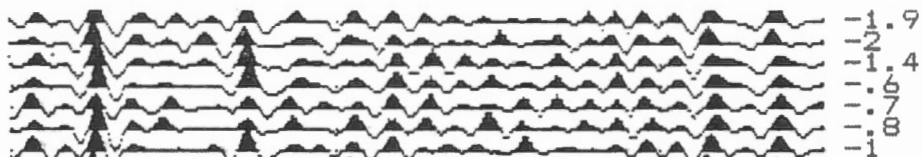
This line indicates the position of the printer interface card in the Apple. The card will generally be in SLOT 1 as shown above, but 1 through 7 are allowable values.

 DISPLAY STATICS N

The static corrections that have been applied will not be printed at the end of each trace if an "N" is displayed on line .



If a "Y" is displayed:



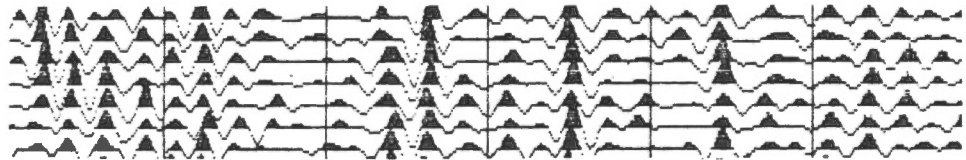
<C> TIME SCALE...AT START Y
 <D> ... AT END Y
 <E> NUMBER TIME SCALE Y

The user is given the option of printing a time-scale at the beginning and/or end of the plot, and of whether or not the timescale will be numbered.

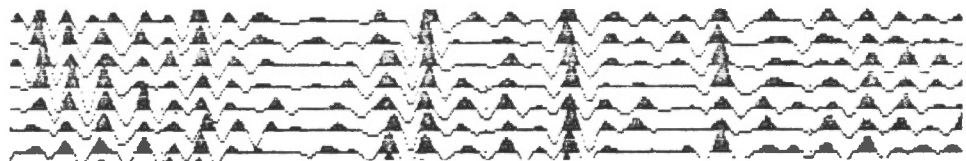
<F> TIMING LINES

Y

If "Y", timing lines will be printed across the record:



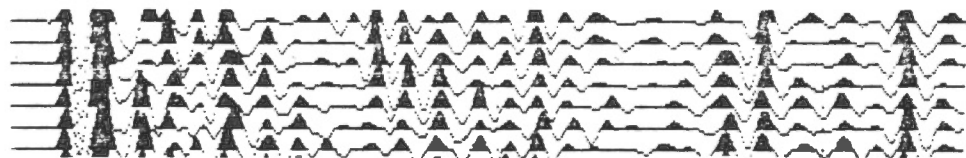
"N" will suppress these lines:



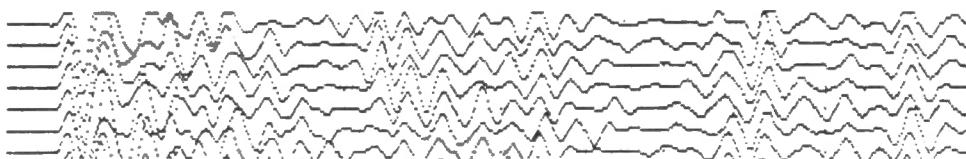
<G> VARIABLE AREA

Y

A "Y" indicates that the output plot is to be a variable area display:



An "N" will cause the output plot to be a wiggle trace display:

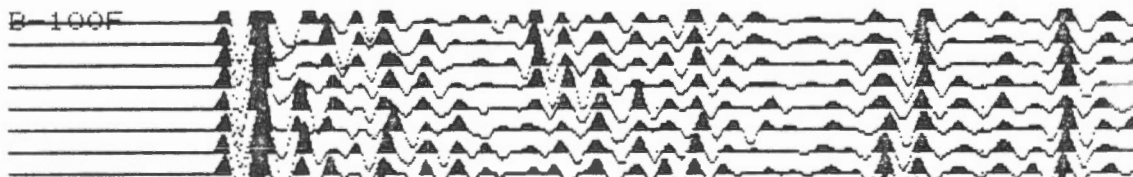


<H> 3 POINT SMOOTHING N

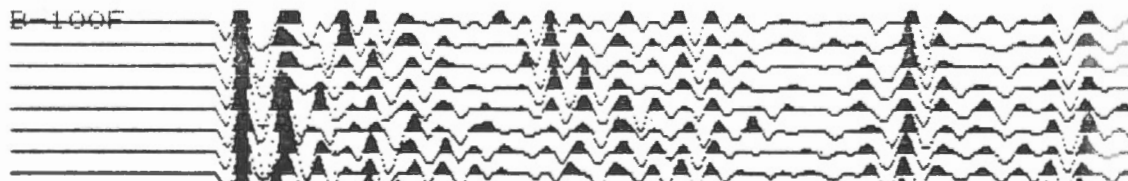
A running 3-point smooth may be applied to the data if desired. This acts as a high frequency filter.

<I> REVERSE POLARITY N

If a trace is normally plotted as follows:



it can be plotted "upside-down" if the user requests reverse polarity.



<J> AGC Y

The data may be plotted with an automatic gain control which is described below.

A "Y" indicates that the AGC is to be applied. The user must then check that the AGC parameters (lines <K> , <L> and <M>) are those desired.

An "N" indicates that no AGC will be applied. The values given in lines <K> , <L> and <M> are then irrelevant.

The automatic gain control adjusts the gain of each sample point individually. The user must specify the length of a running window (in number of sample points before and after the current point of interest) to be used for this calculation, as well as an AGC constant. The program calculates the sum of the absolute values of the amplitude of all the points in the window, and divides by the total number of sample points in the window to obtain an average value. The AGC gain factor for a given point is then

$$= \text{initial gain} \times \left(1 + \frac{\text{AGC constant}}{\frac{\sum |\text{amplitudes}|}{\# \text{ pts}}} \right)$$

(the initial gain is the value input in line <O>).

<K> WINDOW BEFORE

80

A typical value for this parameter is "80". However, the user may change this value by pressing , typing in the desired value, and then pressing .

<L> WINDOW AFTER

80

If desired this value may be changed as described above. If the WINDOW AFTER value is equal to the WINDOW BEFORE value, the running AGC window will be centred on the point of interest.

<M> AGC CONSTANT

20

A typical value for this parameter is "20", but it may be changed by pressing , typing in the desired value, and then pressing . Lower values will reduce the impact of the AGC.

<N> MUTE AT

0

The plotted data may be muted (zeroed) up to a given time (in milliseconds). If this feature is desired, press , type in the desired value, and press .

<O> GAIN -

COMMON 1

This line indicates whether the initial trace gains are all to be set to a common value or whether the user is to input them one at a time.

On start-up the initial trace gains are set to a common value of 1. To change this value, press . The line will now read:

<O> GAIN -

INDIVIDUAL

If line <O> is left this way, the user will be asked to input the initial trace gains for each record one by one in Steps 7 through 9.

Press again. The line will revert to "COMMON 1" with a blinking cursor over the cursor over the value "1". The user can type in the desired common initial trace gain and press . The screen will then be updated with the new value in line <O>.

<P> STATICS -

0

This line indicates whether static corrections are to be made, and if so, whether they are to be read from disk or input manually.

A "0" on this line indicates that no static corrections are to be made.

Press . The line will read

<P> STATICS -

DISK 2

with a blinking cursor over the value "2". This indicates that "STAT-" files are to be read from Disk 2. Press , or if desired, the "2" may be changed to a "1" before pressing RETURN .

If is pressed once more, the line will read

<P> STATICS - INDIVIDUAL

indicating that the user will input the static corrections manually in Step 11.

<Q> DIRECTION - COMMON F

This line indicates whether all the records are to be plotted in the same direction (F for forward, i.e., traces 1 through 12; R for reverse, i.e., traces 12 through 1), or whether the user will later specify the direction record by record.

<Q> DIRECTION - INDIVIDUAL

Press . The line will read

If line <Q> is left this way, the user will be asked to input the directions record by record in Step 16.

Press again. The line will revert to "COMMON F" with a blinking cursor over "F".

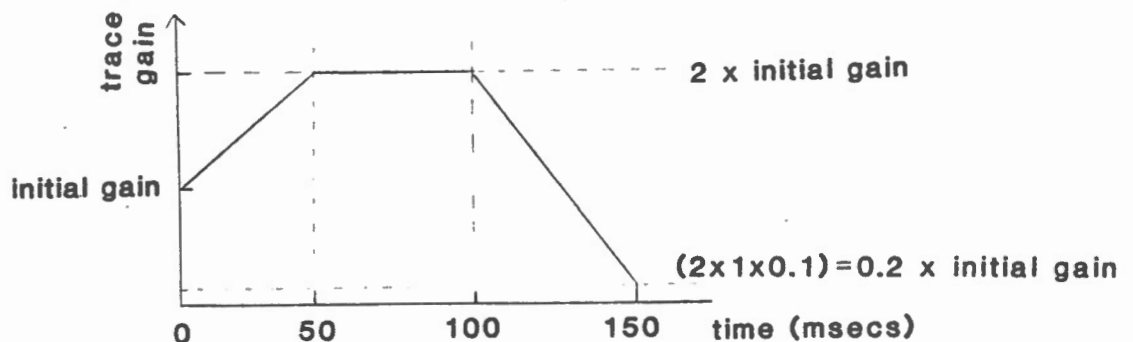
Press to accept "F", or type "R" and press to input the reverse direction for all records.

GAIN TAPERS

The data may be plotted with linear gain tapers within three user-specified windows. The user must specify the endpoints of three time windows (in msec) in lines <R>, <T>, and <V>, and the gain taper to be applied in each window in lines <S>, <U>, and <W>. The trace is zeroed after the end of the third window.

The values on start-up (all tapers = 1) mean that there is no variation in gain along the trace.

An example of the application of the gain tapers is shown below.



These gain tapers would be applied by modifying lines <R> through <W> to the following:

```
<R> END ZONE 1 50      <S> TAPER 2
<T> END ZONE 2 100   <U> TAPER 1
<V> END ZONE 3 150   <W> TAPER .1
```

For example, to change line <R>, press , type "50", then press .

<X> TRACE GAIN NORMALIZATION N

This is one means of normalizing variations in amplitude between traces. If invoked, this option will seek the maximum amplitude within a time window specified by the user and adjust the gain of the trace so that this maximum amplitude is equal for all 12 traces of the record.

A "Y" indicates that TGN is to be applied.

The user must then check that the start and end times of the window (lines <Y> and <Z>) are those desired.

An "N" indicates that no TGN will be applied.

The values given in lines <Y> and <Z> are then irrelevant.

If the user wished to normalize a record using an event between 100 and 130 msec, he/she would change lines <Y> and <Z> to read:

```
<Y> START TIME OF WINDOW 100
<Z>  END TIME OF WINDOW 130
```

NOTE - The program will not accept an end time that is less than the start time. Therefore it may be necessary to change line <Z> before line <Y>. To change line <Z>, press , type "130", then press .

3) TURN ON THE PRINTER AND PRESS RETURN

Check that the printer is turned on before pressing .

- 4) WHEN DIRECTORY APPEARS USE LETTER
TO SELECT FILE : <ESC> TO QUIT
INSERT SEISMIC DATA DISK IN
DRIVE 1 SLOT 6 AND PRESS RETURN

Remove the program disk from Drive 1 and
insert a data disk before pressing **RETURN**.
The upper two lines of this message is a help
menu for the following step.

- 5) A list of the data files on the disk in Drive 1 is shown on the screen with each
file identified by a letter on the left-hand side. For example:

```
A B-100  
B B-101  
C B-102  
D B-103  
E B-104  
F B-105  
G B-106
```

If no data files exist on the disk in Drive 1, a blinking cursor will appear in the
upper left-hand corner. Simply insert a data disk in Drive 1 and press **RETURN**.

NOTE - The program checks the directory and identifies binary files with a
length of 66 sectors as data files. Occasionally, a data file is
mistakenly listed in the directory as 0 sectors in length and therefore
will not be accessible by this program. See Helpful Hints for the means
to correct this situation.

The user may select any or all of the data files listed on the screen for
processing, in any order. A filename is entered simply by pressing the
corresponding letter. When all desired filenames have been entered, press **ESC**.

For example, from the list shown above the user may select the files B-103, and B-104 by pressing D and then E. Pressing ESC will indicate that these are the only two files to be processed.

- 6) The user is now given a chance to check that the correct filenames have been entered in the correct order.

B-103
B-104

OK? (Y/N)

If the list is correct, press Y.

If the list reads to be changed, press N.

The program will go back to Step 4.

- 7) If line <O> GAINS - of the set-up screen (Step 2) read "COMMON", then the program will skip to Step 9.

If line <O> read "INDIVIDUAL", the user must now input the initial trace gains record by record.

For each record input, the following message will appear:

B-103

ARE ALL TRACE GAINS EQUAL? (Y/N)

Press Y if a single value is to be input for the initial gain of the 12 traces of this record.

Press N if the initial trace gains are to be input individually. The program moves directly on to Step 8.

If Y has been pressed in response to the above question, the user will be asked to:

INPUT THE GAIN FOR ALL TRACES >

Enter the desired value and press .

The program will then go back to the start of this step for the next record that was input in Step 5. When the last record is reached, the program will move on to Step 9.

- 8) If the user has chosen to input the initial trace gains for a record individually, by pressing in response to the first question of Step 7, the following message will be displayed on the screen:

```
INPUT TRACE GAINS ONE/LINE
```

```
B-103
```

```
1      0
```

This shows the trace number and the current value of the initial gain for that trace. The user may accept the listed value by pressing , or change it by typing in a new value before pressing .

When 12 values have been entered, the user will be asked:

```
OK? (Y/N)
```

Press to start Step 8 for this record once again.

Press to accept the listed values and return to Step 7 to check the initial gains for the next record that was input in Step 5. When the last record is reached, the program will move on to Step 9.

- 9) As a final check the initial gains for the 12 traces of each record will be listed on the screen, one record at a time.

```
GAINS
B-103
1      .3
2      .3
3      .3
4      .3
5      .3
6      .3
7      .3
8      .3
9      .3
10     .3
11     .3
12     .3
```

```
OK? (Y/N)
```

The user may accept the values by pressing Y .

If any changes need to be made, press N . The program will go back to Step 8 and allow the user to modify the listed values as necessary.

When the initial gains for the record in question are accepted, the program moves back to Step 9 to continue checking the values for other records.

- 10) When the initial gains for all records have been checked by the user, the following message appears on the screen:

```
<ESC> RE-DO <RETURN> CONTINUE
```

Press ESC to return to Step 7. Press RETURN to continue.

- 11) If line <P> STATICS - of the set-up screen (Step 2) read "0", then the program will skip to Step 14.
- If line <P> read "DISK 1" or "DISK 2" then the program will move directly to Step 12.

If line <P> read "INDIVIDUAL", then the user must now input the static corrections manually. The following instruction will be displayed on the screen:

INPUT STATICS ONE/LINE

B-103

1 0

This shows the trace number and the current value of the static correction for that trace.

The user may accept the listed value by pressing , or change it by typing in a new value before pressing .

When 12 values have been entered, the user will be asked:

OK? (Y/N)

Press to start Step 11 for this record once again.

Press to move on to Step 14.

- 12) If line <P> of the set-up screen (Step 2) read "DISK 2" the following message will be displayed:

INSERT STATICS DISK IN
DRIVE 2 SLOT 6 AND PRESS RETURN

Make sure the disk with the appropriate "STAT-" files is in Drive 2 and press .

The program then reads the "STAT-" file for each record input in Step 5.

If line <P> read "DISK 1", the above step would involve Drive 1 instead of Drive 2.

13) CHECK DATUM TIMES FOR STATIC CORRECTIONS

B-103
25

The datum time in milliseconds is displayed on the screen for each record in turn. The user accepts this value by pressing , or may input a new value by typing it in before pressing . If a new datum time is input the static corrections will be recalculated

When all datum times have been accepted or revised by the user, the message:

OK? (Y/N)

will allow the user to repeat Step 13 if is pressed.

Press to continue on to Step 14.

14) The static corrections for traces 1 to 12 of each file in turn are listed on the screen as follows:

```

STATICS
B-103
1      -.6
2      .7
3      -.3
4      -.6
5      -.6
6      -.1
7      1.1
8      1
9      1.3
10     -1.3
11     1.1
12     .6

```

OK? (Y/N)

Press Y if the static corrections listed for the given file are correct. This step will then be repeated for the next file entered at Step 5.

Press N if a change must be made to any of the listed values. The values will then be listed trace by trace on the screen. The user may accept the correct values by pressing RETURN, or make any necessary changes by typing in the correct value before pressing RETURN.

- 15) When the static corrections for all records have been checked by the user, the message:

<ESC> RE-DO <RETURN> CONTINUE

appears on the screen. Press ESC to return to Step 11. Press RETURN to continue.

- 16) If line <Q> DIRECTION - of the set-up screen (Step 2) read "COMMON F" or "COMMON R", then the program moves directly to Step 17.

If line <Q> of the set-up screen read "INDIVIDUAL", then the following message will appear:

B-103

<F>ORWARD OR <R>EVERSE?

Press F if the record is to be plotted in the forward direction (i.e., traces 1 through 12).

Press R if the record is to be plotted in the reverse direction (i.e., traces 12 through 1).

This step will be repeated for all records entered in Step 5.

- 17) As a final check on the directions that the records are to be plotted, a list of all the records entered in Step 5 and their respective directions is displayed on the screen.

```
B-103      F
B-104      F

OK? (Y/N)
```

Press Y if these values are correct.

Press N to return to Step 16 and enter the directions record by record.

- 18) INSERT SEISMIC DATA DISK IN
DRIVE 1 AND PRESS RETURN.

After checking that the data disk is in Drive 1,
press RETURN.

- 19) The first record to be processed will be read from the disk in Drive 1, and the plotting parameters and timescale (if requested on line <C>, Step 2) will be printed on the printer. An example is shown below:

```
WINDOW BEFORE 80
WINDOW AFTER 80
AGC CONSTANT 20
INITIAL GAIN .3

MUTE AT 0

TAP - 1 : 2 / 50
TAP - 2 : 1 / 100
TAP - 3 : .1 / 150
```

In this case, an automatic gain control was applied to the records, as well as the gain tapers given in the example in Step 2 (line <R> through <W>).

Helpful Hints

1. If the program COMMON OFFSET is loaded in memory, it may be restarted after a **RESET** or after a normal exit by typing in the following lines:

```

] CALL-151          press RETURN
* 803G             press RETURN

```

If **RESET** was hit while the plotting was taking place, the printer should be turned off and on again before restarting the program.

2. To correct a directory that lists a data file as 00 sectors in length:

```

BLOAD      file name
UNLOCK     file name
DELETE     file name
BSAVE      file name, A$2004, L$40FB.
LOCK       file name

```


ELOT

System Requirements :

- Apple II (with 16K ram card), or Apple IIe
- monitor
- 1 disk drive
- Epson dot matrix printer (see note with Step 3)
- parallel printer interface card (Grappler or Epson type II) in SLOT 1

Program Description :

This program reads a data file from disk, prints out the header information on the printer, plots the record on the screen and then dumps the screen to the printer. The machine language graphics subroutines that are used to plot the record on the screen allow the user to display any desired portion of the record and to vary the individual trace gains.

Execution :

- 1) Boot the appropriate program disk. When the menu is displayed press E to select the program ELOT. This will load the machine language graphics subroutines into memory (BLOAD FAST PLOT 4/9/85) and then load and execute the basic routine ELOT (RUN ELOT 16/1/86).

- 2) INTERFACE

<E>PSON

<G>RAPPLER TYPE

SELECT :

Press **E** if the parallel printer interface in use is an Epson Type II.

Press **G** if the parallel printer interface in use is a Grappler or Grappler +.

- 3) <S>INGLE OR

<D>UBLE SIZE

SELECT :

Press **S** for single size output (see ELOT - Example of output 1, page 7).

Press **D** for double size output (see ELOT - Example of output 3, page 9).

Note - If only single size plots are desired, an MX 80/FX 80 printer can be used. The wide track MX 100/FX 100 printers are needed to accommodate the double size plots.

- 4) VARIABLE AREA? (Y/N) Press Y for record to be plotted in variable area display (see EPlot - Example of output 1, page 7).
Press N for record to be plotted in wiggle trace display (see EPlot - Example of output 2, page 8).

- 5) TURN PRINTER ON AND PRESS RETURN
Check that the printer is turned on and then press RETURN.

- 6) INSERT DATA DISK IN DRIVE 1
AND PRESS RETURN Remove program disk from Drive 1 and insert data disk before pressing RETURN.

- 7) At this point the catalog of the disk in Drive 1 is presented on the screen and the user is asked to:

INPUT NO OF RECORDS TO BE PLOTTED

Enter the desired number (N<20) and press RETURN.

- 8) INPUT RECORD NAMES ONE/LINE

The user must enter the input number (N) of record names, one per line, each entered by pressing RETURN.

9) CHECK RECORD NAMES

The input record names are printed out here one per line and the user is asked to check that they have been entered correctly.

OK? (Y/N)

Press Y if the names have been correctly entered. The first record is then read from the data disk in Drive 1.

Press N if a correction must be made.

The program will then return to Step 6.

10) The header information is listed out on the printer in the following form:

RECORD NO B-100X

SHOT OFFSET 15

DIRECTION W

GROUP INTERVAL 3

NO. OF STACKS 1

CHANNEL GAINS 1 TO 12 - 48 48 48 48 48 48 48 48 48 48 48 48

LOW CUT FILTER 300

HIGH CUT FILTER OUT

TIME DELAY 0

TIMESCALE 200

TAPE IDENT. NO. 12025100

11) The record is plotted on the screen with the following lines displayed below the plot:

USE : <- -> RET : ^I :ESC

V-SCALE

H-SCALE

ORIG

The first line is a help menu. It lists the keys (← , → , and RETURN) that can be used to change the:

V-SCALE - the trace gains.

H-SCALE - the portion of the record plotted.

ORIG - the starting point of the plot.

The help menu also lists the keys (**CTRL** **I**) that can be used to vary the gain of any individual trace (Step 13), and the **ESC** key which is used to indicate that no further changes to the display are required (Step 14).

- 12) The user can modify the screen display as many times as desired until he/she chooses to dump the screen to the printer. The changes can be effected as follows:

- (i) To change V-SCALE:

Press **RETURN** . A blinking cursor will appear beside the value of V-SCALE. Press **→** to incrementally increase V-SCALE. Press **←** to incrementally decrease V-SCALE. When the desired value is reached, press **RETURN** . The blinking cursor will then appear beside the value of H-SCALE.

- (ii) To change H-SCALE:

With the blinking cursor beside the value of H-SCALE the **→** and **←** keys may be used to increase or decrease H-SCALE. Allowable values are:

- 1 - all record displayed (every 4th sample point plotted).
- 2 - 1/2 record displayed (every 2nd sample point of chosen portion of record plotted).
- 4 - 1/4 record displayed (every sample point of chosen portion of record plotted).
- 8 - 1/8 record displayed (every sample point of chosen portion of record plotted).

When the desired value of H-SCALE is displayed, press **RETURN** . The blinking cursor will then appear beside the value of ORIG.

(iii) To change ORIG:

The value of ORIG is the starting sample point of the display and must have a value between 1 and 800. Values outside this range will not be accepted when RETURN is pressed. A value of 1 means that the data are plotted from the start of the record. A value of 513 means that the record is plotted from the midpoint of the recorded data.

When the values of V-SCALE, H-SCALE and ORIG have been changed as described above and RETURN is pressed to enter the ORIG value, the record is replotted on the screen with the new plotting parameters displayed below.

13) It is also possible for the user to change the gain of a trace individually.

Press the CTRL and I keys simultaneously (Note- ^ is used to represent the CONTROL key in the help menu displayed below the plot.)

The message

TRACE >

will appear at the bottom of the screen.

Type the number of the trace to be modified and press RETURN to enter. The single trace will then be displayed on the screen. Press RETURN. A blinking cursor will appear beside the value of V-SCALE. Press → to incrementally increase V-SCALE, or ← to incrementally decrease V-SCALE. When the desired value is reached, press RETURN. The trace will then be replotted on the screen with the new gain. Pressing RETURN once more will allow V-SCALE to be changed again if so desired.

CTRL I is a toggle command. If these two keys are pressed simultaneously at any point, the entire record will again appear on the screen. The displayed value of V-SCALE is that corresponding to trace 1.

The gain of any or all traces may be individually adjusted by repeating Step 13 as necessary.

- 14) When the screen plot is satisfactory, press . The message:

ARE THESE OK? (Y/N)

will appear below the plot, asking the user to confirm that no more changes are desired. If is pressed the help menu and the current values of V-SCALE, H-SCALE and ORIG are displayed below the plot and the user may make any further changes to these parameters that are necessary by repeating Steps 11 and/or 12. If is pressed, timing marks are plotted on the screen and the screen plot is dumped to the printer along with the times (in msec) corresponding to the tick marks (see EPLLOT - Examples of output 1 - 3, pages 7-9).

- 15) If more than one record was to be plotted (from Step 7), the next record will be read from the data disk in Drive 1 and the program returns to Step 10.

Helpful Hints:

1. If, for any reason, the computer has to be the user may start executing the program EPLLOT again by typing RUN and pressing . If was hit while the screen dump was taking place, it may be necessary to turn off the printer before restarting the program.
2. If the printer interface card is not in SLOT 1, change the value of PS in line 8 of the program to the appropriate slot number.
3. If you wish to read data from a disk in Drive 2, change the value of ID in line 8 of the program from 1 to 2. (Note that this will make Drive 2 the default drive after completion of the program).
4. The form feed that takes place after each record is plotted may be avoided by removing the statement PRINT CHR\$(12) from line 590.

RECORD NO B-100X

SHOT OFFSET 15

DIRECTION W

GROUP INTERVAL 3

NO. OF STACKS 1

CHANNEL GAINS 1 TO 12 - 48 48 48 48 48 48 48 48 48 48 48 48

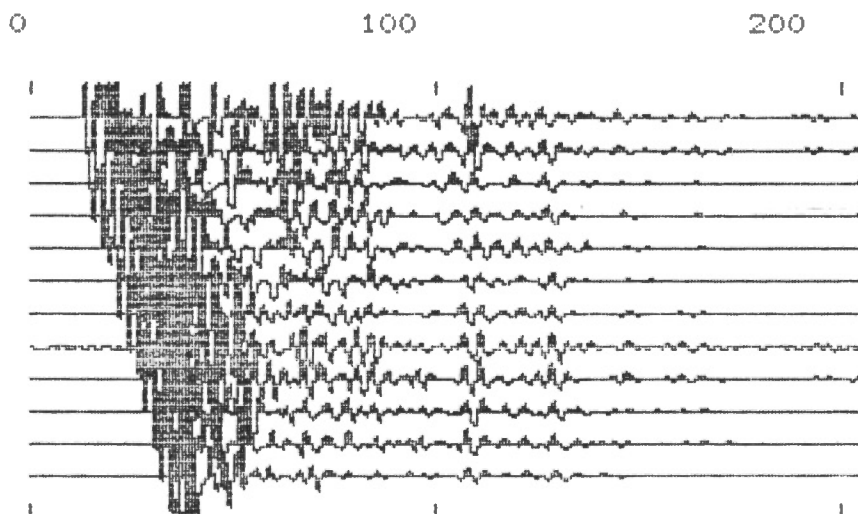
LOW CUT FILTER 300

HIGH CUT FILTER OUT

TIME DELAY 0

TIMESCALE 200

TAPE IDENT. NO. 12025100



single size output

variable area display

V-SCALE .3 H-SCALE 1 ORIG 1

RECORD NO B-100X

SHOT OFFSET 15

DIRECTION W

GROUP INTERVAL 3

NO. OF STACKS 1

CHANNEL GAINS 1 TO 12 - 48 48 48 48 48 48 48 48 48 48 48 48

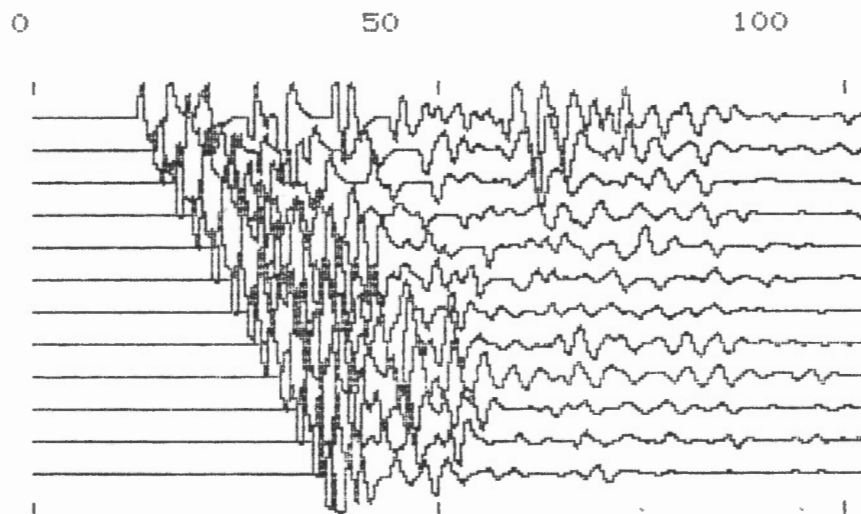
LOW CUT FILTER 300

HIGH CUT FILTER OUT

TIME DELAY 0

TIMESCALE 200

TAPE IDENT. NO. 12025100



single size output

wiggle trace display

V-SCALE .2 H-SCALE 2 ORIG 1

RECORD NO B-100X

SHOT OFFSET 15

DIRECTION W

GROUP INTERVAL 3

NO. OF STACKS 1

CHANNEL GAINS 1 TO 12 - 48 48 48 48 48 48 48 48 48 48 48 48

LOW CUT FILTER 300

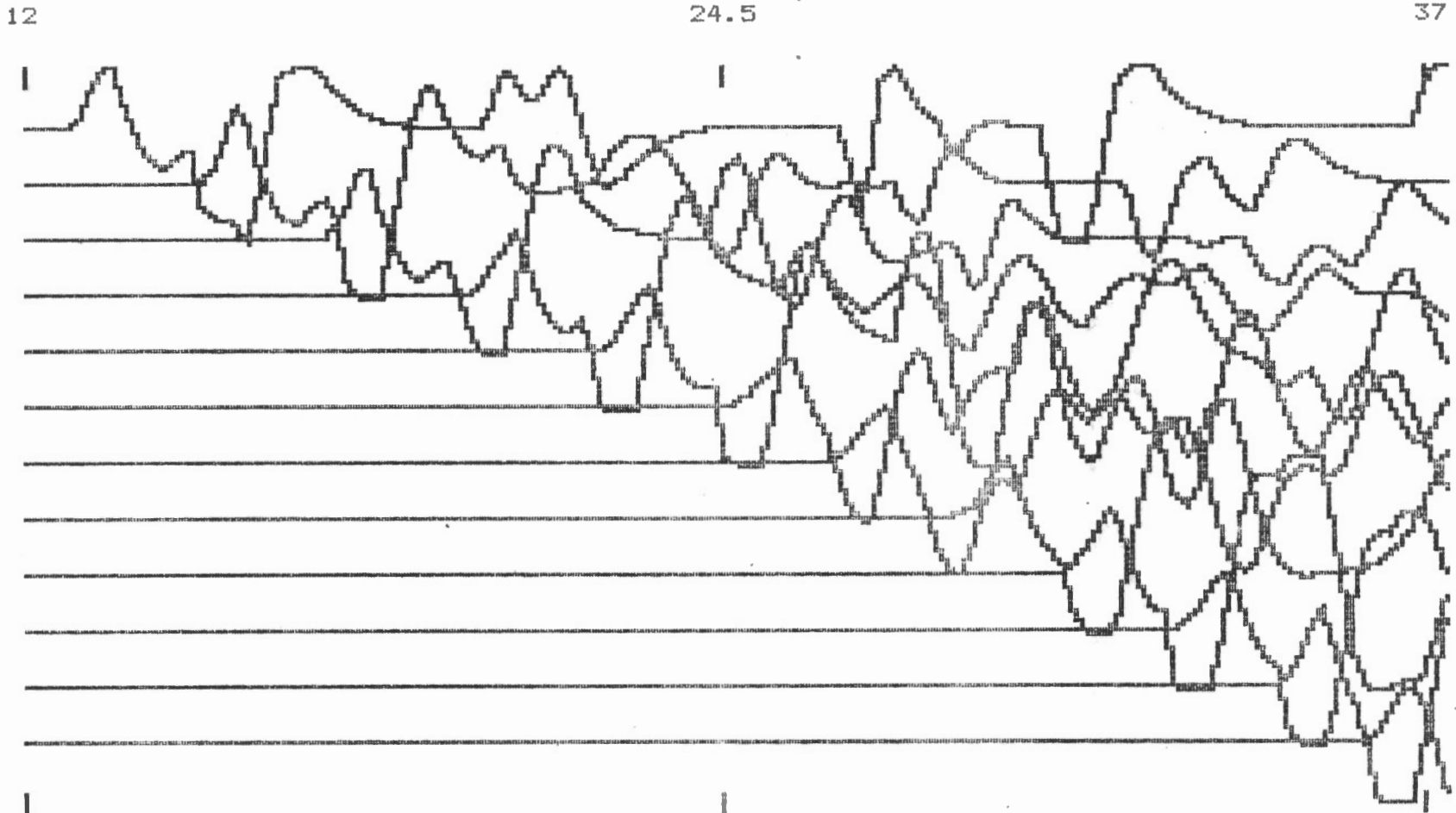
HIGH CUT FILTER OUT

TIME DELAY 0

TIMESCALE 200

TAPE IDENT. NO. 12025100

double size output
wiggly trace display
V-SCALE .2
H-SCALE 8
ORIG 61



FILTER

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives

Program Description:

This is a digital bandpass filtering routine. The user must specify the low and high frequency cutoff points (in Hertz) and rolloffs (in db/octave). The timescale of the data must also be input. With this information the shape of the filter in the frequency domain can be calculated.

A machine language Fast Fourier Transform (FFT) routine developed at the University of Saskatchewan is then used to transform each trace into the frequency domain, filter it, and transform it back into the time domain. The filtered records are saved on disk.

It requires approximately 10 minutes to filter a 12 channel record.

Execution:

- 1) Boot the appropriate program disk. When the menu is displayed press to select the FILTER program. This will load the machine language FFT subroutines into memory (BLOAD FFTPROCESSTRACE and BLOAD FFTFDF), and then load and execute the basic routine AUTO FILT 1.0 (RUN AUTO FILT 1.0).
- 2) INPUT LO CUT FREQ (HZ),ROLLOFF (DB/OCT)

The user must input the -3db cutoff frequency (in Hertz) for the low end of the bandpass filter, and the rolloff (in db/octave). These values should be separated by a comma. Press to enter.

Note - a value of 18 db/octave is suggested for the rolloff.

3) INPUT HI CUT FREQ (HZ), ROLLOFF (DB/OCT)

The user must now input the -3db cutoff frequency (in Hertz) for the high end of the bandpass filter, and the rolloff (in db/octave). These values should be separated by a comma. Press to enter.

4) INPUT TIMESCALE OF RECORDS
(50, 100, 200, 500, 1000 OR 2000 MSECS)

The user is asked to indicate the timescale of the records to be filtered (in milliseconds). The allowed values are listed. Press to enter. This value must be correct for the calculation of the desired bandpass filter.

5) CALCULATING FILTER ...

This message is displayed while the program calculates the filter in the frequency domain. This process takes approximately one minute.

6) NO. OF FILES

Enter the number of records (on one disk) that are to be filtered ($N \leq 8$). Press .

7) INPUT FILENAME

The filenames of the records to be filtered are requested one at a time. Type in the filename and press . This step is repeated N times where N is the number of files entered in Step 6.

- 8) SOURCE DISK DRV.1, TARGET DISK DRV.2
ANY KEY WHEN READY

Remove the program disk from Drive 1 and insert the data disk with the unfiltered records. Insert an initialized disk in Drive 2 for the filtered records. Press RETURN.

- 9) The first data file is read from the disk in Drive 1 and the filtering starts. The screen display will be of the following form:

```
FILTERING ... 200-500 HZ BP
              40/18//100/18
```

```
FILE 1 OF 8
TRACE NO. 00
```

Where 200 Hz was the low cutoff frequency entered in Step 2, and 500 Hz was the high cutoff frequency entered in Step 3. The line

```
40/18//100/18
```

indicates that the sample points in the frequency domain corresponding to 200 and 500 Hz are 40 and 100 respectively, and that the rolloff on both ends of the filter is 18 db/octave.

```
FILE 1 OF 8
```

indicates that 8 files are to be filtered, and that the program is currently filtering file 1. The number of traces that have been filtered is indicated on the last line. When all 12 traces have been processed:

```
TRACE NO. 000B0A090807060504030201
```


the filtered record is written to the disk in Drive 2 with an "F" appended to the filename. The program will then read the next record to be filtered from the disk in Drive 1. Step 9 will be repeated until all N files have been processed.

- 10) The program returns to Step 6 so that data files on another disk may be filtered. Make sure that these files all have the same timescale as that entered in Step 4.

The computer must be RESET to exit from the program.

Helpful Hints

1. Though the fact that a data file has been digitally filtered is indicated by an "F" at the end of the filename it is up to the user to keep track of the parameters of the filter that has been applied. Make sure that the cutoff frequencies and the rollofs are shown on the label of the filtered data disk.
2. Occasionally a filtered record will contain a zeroed trace. This can usually be corrected by refiltering the record with a slightly different filter.
3. If static corrections are to be made while plotting filtered records, it will be necessary to have "STAT-" files with an "F" appended to the filename. These "STAT-" files can be created by picking the filtered record using the program STAT PICK, or by rewriting "STAT-" files for the corresponding unfiltered records with the program TRANSTAT (see utility routines).

NORMAL MOVEOUT

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives

Program Description:

This program calculates the normal moveout corrections for an input velocity-depth function. The velocity function is defined by up to 20 intercept time/average velocity pairs, which must have been determined by a velocity analysis of the data using the programs P-PICK or VELOCITY ANALYSIS.

The normal moveout corrections can be applied to a series of multi-channel records. Static corrections may be made before the records are processed. The processed records are saved to disk, and may be plotted later using the program COMMON OFFSET. Examples of a synthetic record and some real data before and after normal moveout corrections have been applied are shown on page 10.

Execution:

- 1) Boot the appropriate program disk. A catalog of the files on the disk will be printed on the screen, with each file identified by a highlighted letter on the left hand side. The user selects the program NORMAL MOVEOUT 7.0 by pressing the corresponding letter on the keyboard (BRUN NORMAL MOVEOUT 7.0).
- 2) WHEN DIRECTORY APPEARS USE LETTER
TO SELECT FILE : <ESC> TO QUIT
INSERT SEISMIC DATA DISK IN
DRIVE 1 SLOT 6 AND PRESS RETURN

Remove the program disk from Drive 1 and insert a data disk before pressing **RETURN**. The upper two lines of this message is a help menu for the following step.

- 3) A list of the data files on the disk in Drive 1 is shown on the screen with each file identified by a letter on the left-hand side. For example:

```
A B-100X
B B-101X
C B-102X
D B-103X
E B-104X
F B-105X
G B-106X
```

If no data files exist on the disk in Drive 1, a blinking cursor will appear in the upper left-hand corner. Simply insert a data disk in Drive 1 and press **RETURN**.

NOTE - The program checks the directory and identifies binary files with a length of 66 sectors as data files. Occasionally, a data file is mistakenly listed in the directory as 0 sectors in length and therefore will not be accessible by this program. See Helpful Hints for the means to correct this situation.

The user may select any or all of the data files listed on the screen for processing, in any order. A filename is entered simply by pressing the corresponding letter. When all desired filenames have been entered, press **ESC**.

For example, from the list shown above the user may select the files B-102X and B-106X by pressing **C** and then **G**. Pressing **ESC** will indicate that these are the only two files to be processed.

- 4) The user is now given a chance to check that the correct filenames have been entered in the correct order.

```
B-102X
B-106X
```

OK? (Y/N)

If the list is correct, press **Y**.

If the list needs to be changed, press **N**.

The program will go back to Step 2.

5) ZERO STATICS? (Y/N)

If no static corrections are to be made to the records before the normal moveout corrections, press Y. The program moves to Step 10 which allows the user to accept or modify the zero values.

If static corrections are to be made, press N.

6) READ STATICS FROM DISK? (Y/N)

Press N if the static corrections are not on disk and are to be input manually.

If the static corrections are on disk as "STAT-" files, press Y. ****Note**** these "STAT-" files are not the output of STAT PICK! See Helpful Hints for a discussion of this point. The program jumps to Step 8.

7) If the user has chosen to input the static corrections manually (Step 6), the following instruction will be displayed on the screen.

INPUT STATICS ONE/LINE

B-102X
1 0

This shows the trace number and the current value of the static correction for that trace. The user may accept the listed value by pressing RETURN, or change it by typing in a new value before pressing RETURN.

When 12 values have been entered, the user will be asked:

OK? (Y/N)

Press N to start Step 7 for this record once again.

Press Y to move on to check the static corrections for the next record.

When this step is completed for the last record entered at Step 3, the program moves to Step 11.

- 8) INSERT STATICS DISK IN
DRIVE 2 SLOT 6 AND PRESS RETURN

Make sure the disk with the appropriate "STAT-" files is in Drive 2 and press .

The program then reads the "STAT-" file for each record input in Step 3.

- 9) CHECK DATUM TIMES FOR STATIC CORRECTIONS

B-102X
20

The datum time in milliseconds is displayed on the screen for each record in turn. The user accepts this value by pressing , or may input a new value by typing it in before pressing . If a new datum time is input the static corrections will be recalculated.

When all datum times have been accepted or revised by the user, the message:

OK? (Y/N)

will allow the user to repeat Step 9 if is pressed. Press to continue on to Step 10.

- 10) The static corrections for traces 1 to 12 of each file in turn are listed on the screen as follows:

```

B-102X
1      -.6
2      .7
3      -.3
4      -.6
5      -.6
6      -.1
7      1.1
8      1
9      1.3
10     -1.3
11     1.1
12     .6

```

OK? (Y/N)

Press Y if the static corrections listed for the given file are correct. This step will then be repeated for the next file entered at Step 3.

Press N if a change must be made to any of the listed values. The values will then be listed trace by trace on the screen. The user may accept the correct values by pressing RETURN, or make necessary changes by typing in the correct value before pressing RETURN.

- 11) When the static corrections for all records have been checked by the user, the message:

```
<ESC> RE-DO <RETURN> CONTINUE
```

appears on the screen. Press ESC to return to Step 5. Press RETURN to continue.

- 12) The first data file is read from the disk in Drive 1.

LOADING B-102X

This is to allow the program access to header information (e.g. source offset, geophone spacing, timescale, and time delay) that is necessary for the calculation of the normal moveout corrections.

- 13) ENTER INTERCEPT TIME/AVERAGE VELOCITY

MAXIMUM 20 PAIRS - T = 0 TO STOP
 T(0) = 0 V(0) =

The user must now enter the velocity function needed to compute the normal moveout corrections. This information is requested as intercept time/average velocity pairs. The values are requested one at a time. Intercept time values should be in milliseconds; velocity values should be in m/msec (or ft/msec). Press to enter each value. Enter an intercept time of 0 to indicate that all necessary information has been input.

The intercept time/average velocity information can be obtained from an analysis of the records using the programs P-PICK or VELOCITY ANALYSIS.

When a T value of 0 has been entered, the message:

OK? (Y/N)

appears. Press to start Step 13 once again. Press to indicate that the input values are correct.

- 14) The program now computes the normal moveout corrections for the given velocity function. This process takes about 20 seconds if a single velocity is entered, but may take considerably longer if many intercept time/average velocity pairs are input.

- 15) The normal moveout corrections are now applied to the data file in memory. As each trace is processed a number is displayed on the screen.

123456789ABC

indicates that the entire record has been processed.

- 16) INSERT DISK FOR NMO IN DRIVE 2

Make sure that an initialized data disk is in Drive 2 and press .

- 17) SAVING NMO.B-102X

This message is displayed while the processed record is saved on the disk in Drive 2. The normal - moveout corrected record is identified by the prefix "NMO.".

If more than one file has been entered in Step 3, the program will read the next file from the disk in Drive 1 after the above save is complete. It checks that the timescale, source offset, and geophone spacing of this record matches that of the first record. If so, the normal moveout corrections are applied and the corrected record can again be saved to disk (Steps 15-17). If there is a discrepancy between these parameters of this record and the one for which the normal moveout corrections were calculated, the program returns to Step 13 and the user must input the velocity function again.

18) DO YOU WISH TO DO MORE FILES? (Y/N)

Press **Y** to return to Step 2 and enter another series of filenames. For this rerun of the program, Step 13 will be skipped if the timescale, source offset and geophone spacing of the records remains unchanged.

Press **N** to exit from the program.

Helpful Hints

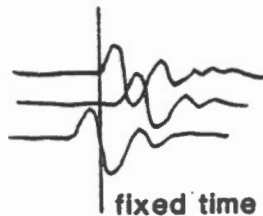
1. If the program NORMAL MOVEOUT 7.0 is loaded in memory, it may be restarted after a **RESET** or after a normal exit by typing in the following lines:

```

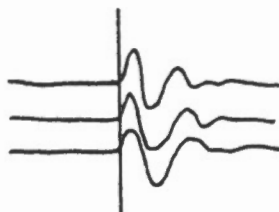
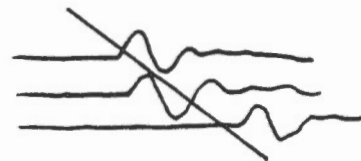
]CALL-151      press RETURN
*803G         press RETURN
    
```

2. The user may wish to apply static corrections to the records before the normal moveout corrections to compensate for time variations due to a low velocity layer at the surface. These are not the static corrections that are output by the program STAT PICK which are discrepancies between the time of arrival and a fixed time. The static corrections needed for this routine are the discrepancies between the first arrivals and an expected time corresponding to the first arrival velocity and the moveout between traces (see below).

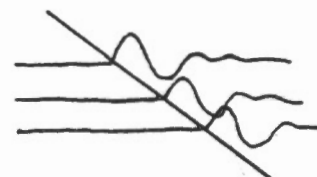
COMMON OFFSET RECORD



MULTI-CHANNEL RECORD



AFTER STATIC CORRECTIONS

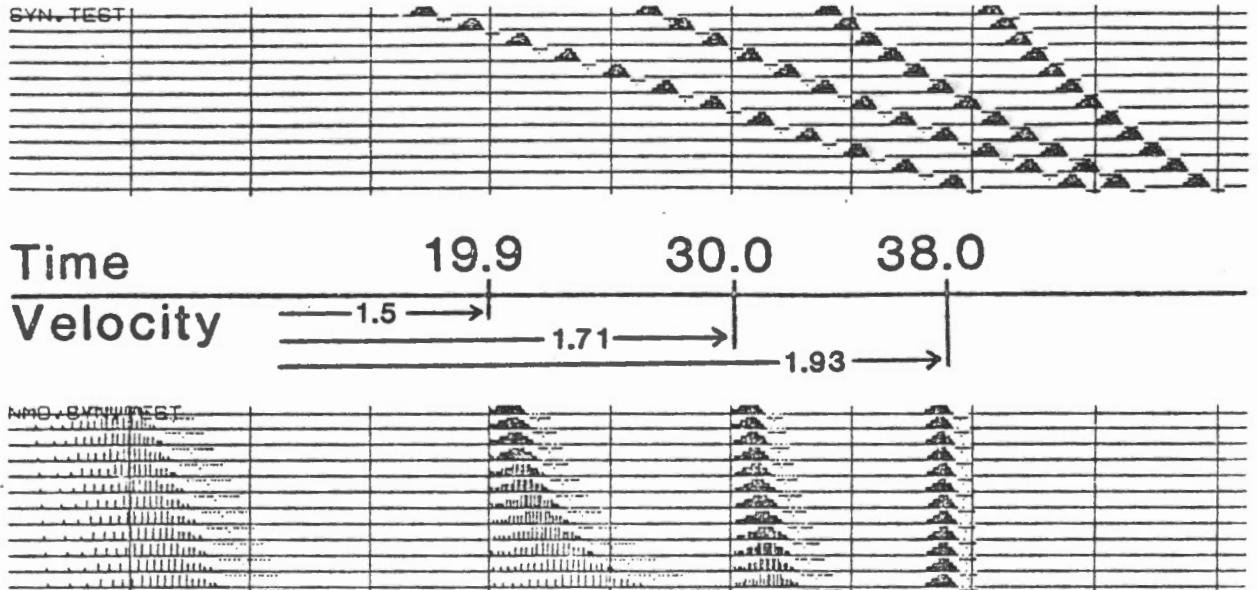


The user may create the "STAT-" files required for NORMAL MOVEOUT by picking the first arrivals with P-PICK, calculating the static corrections needed to align the traces to the least-squares line through the picked points, and inputting these values to a "STAT-" file using the utility routine WRITE STATICS.

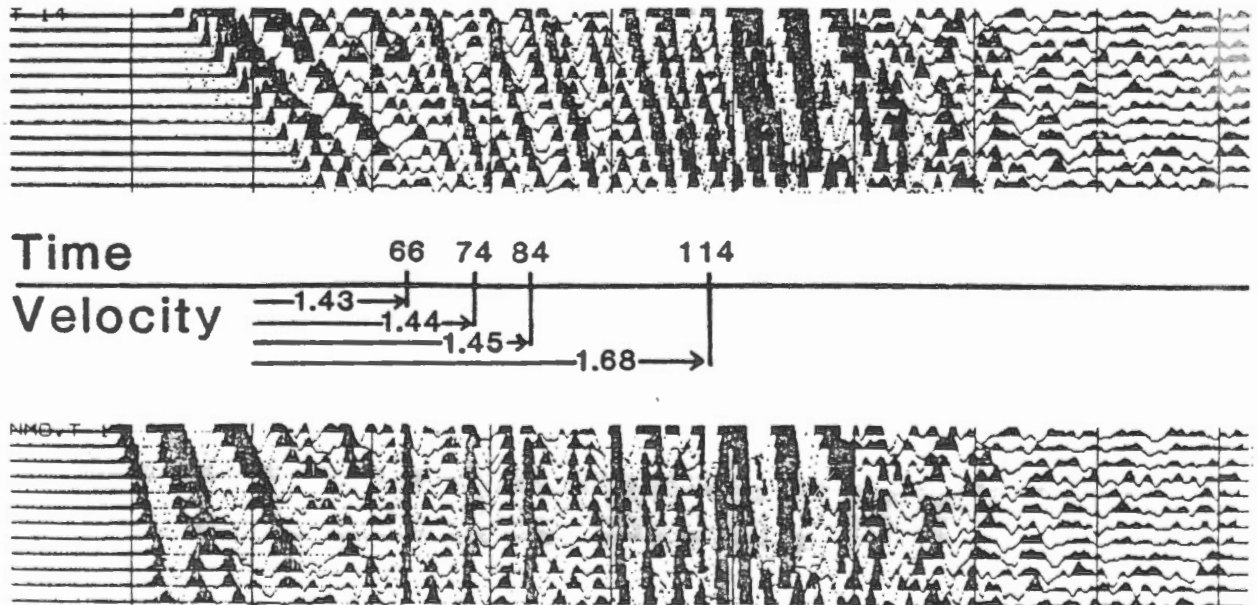
3. To correct a directory that lists a data file as 00 sectors in length:

BLOAD	file name
UNLOCK	file name
DELETE	file name
BSAVE	file name, A\$2004, L\$40FB
LOCK	file name

Normal Move Out (Synthetic)



Normal Move Out



PARTIAL MOVEOUT

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives

Program Description:

This program calculates the "partial" moveout corrections for an input velocity-depth function. "Partial" as opposed to "normal" moveout corrections shift the points of a trace in time to correspond to the response at a different source offset (which is not zero, as would be implied by "normal" moveout corrections). Partial moveout corrections can be applied to one or a series of common offset records. The program allows the user to match two sections that were initially recorded with different offsets.

The velocity function required to calculate the corrections is defined by up to 20 intercept time/average velocity pairs, which must have been determined by a velocity analysis of records from the area using the programs P-PICK or VELOCITY ANALYSIS.

Static corrections may be applied to the records before processing. The processed records are saved to disk, and may be plotted later using the program COMMON OFFSET.

Execution:

- 1) Boot the appropriate program disk. A catalog of the files on the disk will be printed on the screen, with each file identified by a highlighted letter on the left hand side. The user selects the program PARTIAL MOVEOUT 7.0 by pressing the corresponding letter on the keyboard (BRUN PARTIAL MOVEOUT 7.0).
- 2) WHEN DIRECTORY APPEARS USE LETTER
TO SELECT FILE : <ESC> TO QUIT
INSERT SEISMIC DATA DISK IN
DRIVE 1 SLOT 6 AND PRESS RETURN

Remove the program disk from Drive 1 and insert a data disk before pressing **RETURN**. The upper two lines of this message is a help menu for the following step.

- 3) A list of the data files on the disk in Drive 1 is shown on the screen with each file identified by a letter on the left-hand side. For example:

```
A B-100
B B-101
C B-102
D B-103
E B-104
F B-105
G B-106
```

If no data files exist on the disk in Drive 1, a blinking cursor will appear in the upper left-hand corner. Simply insert a data disk in Drive 1 and press .

NOTE - The program checks the directory and identifies binary files with a length of 66 sectors as data files. Occasionally, a data file is mistakenly listed in the directory as 0 sectors in length and therefore will not be accessible by this program. See Helpful Hints for the means to correct this situation.

The user may select any or all of the data files listed on the screen for processing, in any order. A filename is entered simply by pressing the corresponding letter. When all desired filenames have been entered, press .

For example, from the list shown above the user may select the files B-100 and B-105 by pressing and then . Pressing will indicate that these are the only two files to be processed.

- 4) The user is now given a chance to check that the correct filenames have been entered in the correct order.

```
B-100
B-105
```

OK? (Y/N)

If the list is correct, press .

If the list needs to be changed, press .

The program will go back to Step 2.

5) ZERO STATICS? (Y/N)

If no static corrections are to be made to the records before the partial moveout corrections, press Y. The program moves to Step 10 which allows the user to accept or modify the zero values.

If static corrections are to be made, press N.

6) READ STATICS FROM DISK? (Y/N)

Press N if the static corrections are not on disk and are to be input manually.

If the static corrections are on disk as "STAT-" files, press Y. The program jumps to Step 8.

7) If the user has chosen to input the static corrections manually (Step 6), the following instruction will be displayed on the screen.

INPUT STATICS ONE/LINE

```
B-100
1      0
```

This shows the trace number and the current value of the static correction for that trace. The user may accept the listed value by pressing RETURN, or change it by typing in a new value before pressing RETURN.

When 12 values have been entered, the user will be asked:

OK? (Y/N)

Press N to start Step 7 for this record once again.

Press Y to move on to check the static corrections for the next record.

When this step is completed for the last record entered at Step 3, the program moves to Step 11.

- 8) INSERT STATICS DISK IN
DRIVE 2 SLOT 6 AND PRESS RETURN

Make sure the disk with the appropriate "STAT-" files is in Drive 2 and press .

The program then reads the "STAT-" file for each record input in Step 3.

- 9) CHECK DATUM TIMES FOR STATIC CORRECTIONS

B-100
25

The datum time in milliseconds is displayed on the screen for each record in turn. The user accepts this value by pressing , or may input a new value by typing it in before pressing . If a new datum time is input the static corrections will be recalculated.

When all datum times have been accepted or revised by the user, the message:

OK? (Y/N)

will allow the user to repeat Step 9 if is pressed. Press to continue on to Step 10.

- 10) The static corrections for traces 1 to 12 of each file in turn are listed on the screen as follows:

```

B-100
1      -.6
2      .7
3      -.3
4      -.6
5      -.6
6      -.1
7      1.1
8      1
9      1.3
10     -1.3
11     1.1
12     .6

```

OK? (Y/N)

Press Y if the static corrections listed for the given file are correct. This step will then be repeated for the next file entered at Step 3.

Press N if a change must be made to any of the listed values. The values will then be listed trace by trace on the screen. The user may accept the correct values by pressing RETURN, or make necessary changes by typing in the correct value before pressing RETURN.

- 11) When the static corrections for all records have been checked by the user, the message:

```
<ESC> RE-DO <RETURN> CONTINUE
```

appears on the screen. Press ESC to return to Step 5. Press RETURN to continue.

- 12) The first data file is read from the disk in Drive 1.

LOADING B-100

This is to allow the program access to header information (e.g. source offset, timescale, and time delay) that is necessary for the calculation of the partial moveout corrections.

- 13) OFFSET IS 30
NEW OFFSET >

The offset for the data file just read from disk is shown. The user must input the offset for the partial moveout corrected record in metres (or feet). Press .

- 14) ENTER INTERCEPT TIME/AVERAGE VELOCITY

MAXIMUM 20 PAIRS - T = 0 TO STOP
T (0) = 0 V (0) =

The user must now enter the velocity function needed to compute the partial moveout corrections. This information is requested as intercept time/average velocity pairs. The values are requested one at a time. Intercept time values should be in milliseconds; velocity values should be in m/msec (or ft/msec). Press to enter each value. Enter an intercept time of 0 to indicate that all necessary information has been input.

The intercept time/average velocity information can be obtained from an analysis of multichannel records from the area using the programs P-PICK or VELOCITY ANALYSIS.

When a T value of 0 has been entered, the message:

OK? (Y/N)

appears. Press to start Step 14 once again. Press to indicate that the input values are correct.

- 15) The program now computes the partial moveout corrections for the given velocity function. This process takes a few seconds.
- 16) The partial moveout corrections are now applied to the data file in memory. A "1" is displayed on the screen.
- 17) INSERT DISK FOR PMO IN DRIVE 2
AND PRESS RETURN

Make sure that an initialized data disk is in Drive 2 and press RETURN.

- 18) SAVING PMO.B-100

This message is displayed while the processed record is saved on the disk in Drive 2. The partial - moveout corrected record is identified by the prefix "PMO.", and the source offset in the header of the new record is the value input in Step 13.

If more than one file has been entered in Step 3, the program will read the next file from the disk in Drive 1 after the above save is complete. It checks that the timescale and source offset of this record matches that of the first record. If so, the partial moveout corrections are applied and the corrected record can again be saved to disk (Steps 15-17). If there is a discrepancy between these parameters of this record and the one for which the partial moveout corrections were calculated, the program returns to Step 13 and the user must input the new offset and velocity function again.

19) DO YOU WISH TO DO MORE FILES? (Y/N)

Press Y to return to Step 2 and enter another series of filenames. For this rerun of the program, Steps 13 and 14 will be skipped if the timescale and source offset of the records remains unchanged.

Press N to exit from the program.

Helpful Hints

1. If the program PARTIAL MOVEOUT 7.0 is loaded in memory, it may be restarted after a RESET or after a normal exit by typing in the following lines:

J CALL-151	press	<input type="checkbox"/> RETURN
*803G	press	<input type="checkbox"/> RETURN

2. To correct a directory that lists a data file as 00 sectors in length:

BLOAD	file name
UNLOCK	file name
_DELETE	file name
BSAVE	file name, A\$2004, L\$40FB
LOCK	file name

P-PICK

System Requirements:

- Apple II (with 16 K ram card) or Apple IIe
- monitor
- 1 disk drive
- optional printer (no restrictions on type of printer or printer interface card)

Program Description:

This program plots a record (or any portion of it) on the screen and allows the user to pick a point on each trace with a keyboard-controlled cursor. A least-squares fit of the time-distance (T-X) values is then made to determine either the refraction velocity and time intercept (T-X analysis), or the average velocity down to a reflector and its corresponding time intercept ($T^2 - X^2$ analysis). The velocity and time intercept can be output to a printer. The T-X values can also be printed out and/or saved to disk.

Execution:

- 1) Boot the appropriate program disk. When the menu is displayed press to select the program P-PICK. This will cause the machine language graphics subroutines to be loaded into memory (BLOAD FAST PLOT 4/9/85) and then will load and execute the basic routine P-PICK (RUN P-PICK 19/1/86).

- 2) ENTER SLOT FOR PRINTER - 0 FOR NONE

The program is asking for the number of the slot with the printer interface card. If no printer is available or needed, press . This will direct all output to the screen rather than a printer. Generally, the printer interface card will be in SLOT 1. If this is the case, press . Any value from 0 to 7 will be accepted.

- 3) INSERT DATA DISK IN DRIVE 1
AND PRESS RETURN

Remove program disk from Drive 1 and insert a data disk before pressing RETURN.

- 4) A list of all the data files on the disk in Drive 1 will be printed on the screen. Each file is identified on the left with a letter - A through H (ie. to a maximum of 8 data files/disk). The record to be plotted can be selected by pressing the corresponding letter.

For example:

```
A B-100X
B B-101X
C B-102X
D B-103X
E B-104X
F B-105X
G B-106X
```

The record B-100X can be selected simply by pressing A.

If no data files exist on the disk in Drive 1, no list will be printed on the screen and a blinking cursor will appear in the upper left corner. Press any key. A message:

```
NO FILE ENTERED - PRESS ANY KEY
```

will appear. Press any key to return the program to Step 3.

NOTE - The program checks the directory and identifies binary files with a length of 66 sectors as data files. Occasionally, a data file is mistakenly listed in the directory as 0 sectors in length and therefore will not be accessible by this program. See Helpful Hints for the means to correct this situation.

- 5) The selected record is read from the disk in Drive 1 and plotted on the screen. A blinking cursor (I) appears partway along the first trace. The following lines appear beneath the plot:

```

USE H J K L I M : <- -> RET : ^I ^S ESC.
V-SCALE          H-SCALE          ORIG
TRACE            TIME

```

The first line is a help menu. It first lists the keys (H, J, K, L, I, M) that are used to control the cursor. Then the keys , and are shown. These keys are used to change the:

V-SCALE	- the trace gains
H-SCALE	- the portion of the record plotted
ORIG	- the starting point of the plot

The help menu also lists the keys () that can be used to vary the gain of any individual trace (Step 8), the keys () that are used to skip a trace where no pick is to be made (Step 9), and the key which is used to indicate that the cursor is properly placed and a time pick is to be made for the trace (Step 7).

- 6) The user can modify the screen display as many times as desired, and at any time during the picking process, so that the events to be analysed are shown as clearly as possible. The changes can be effected as follows:

- (i) To change V-SCALE:

Press or . A blinking cursor will appear beside the value of V-SCALE. Press to incrementally increase V-SCALE. Press to incrementally decrease V-SCALE. When the desired value is reached, press . The blinking cursor will then appear beside the value of H-SCALE.

(ii) To change H-SCALE

With the blinking cursor beside the value of H-SCALE the and keys may be used to increase or decrease H-SCALE. Allowable values are:

- 1 - all record displayed (every 4th sample point plotted).
- 2 - 1/2 record displayed (every 2nd sample point of chosen portion of record plotted).
- 4 - 1/4 record displayed (every sample point of chosen portion of record plotted).
- 8 - 1/8 record displayed (every sample point of chosen portion of record plotted).

When the desired value of H-SCALE is displayed, press . The blinking cursor will then appear beside the value of ORIG.

(iii) To change ORIG:

The value of ORIG is the starting sample point of the plot, and must have a value between 1 and 800. Values outside this range will not be accepted when is pressed. A value of 1 means that the data are plotted from the start of the record. A value of 513 means that the record is plotted from the midpoint of the recorded data.

When the values of V-SCALE, H-SCALE and ORIG have been changed as described above and is pressed to enter the ORIG value, the record is replotted on the screen with the new plotting parameters displayed below the record.

NOTE - It is possible to temporarily lose control of the cursor, if, when replotting the record as described above, the cursor is "too far" outside the portion of the record displayed. If this happens, the Apple will beep and a blinking cursor will be displayed beside the TRACE number at the bottom of the screen. Press and simultaneously. This will move the cursor onto the screen.

- 7) Once the event to be picked is displayed satisfactorily on the screen (Step 6), the cursor can be used to pick a point in time on any traces desired. The trace for which the time pick is made is shown on the bottom line. If no time pick is to be made for that trace it can be skipped (Step 9). The keys:

```

      I
    H J K L
      M
  
```

are used to control the cursor. **H** moves the cursor 5 points to the left, **J** moves it 1 point to the left, **K** moves it 1 point to the right, **L** moves it 5 points to the right. **I** and **M** will move the cursor 1 point up or down, respectively. The time value corresponding to the position of the cursor is beside TIME on the bottom line and is updated every time the cursor is moved to the left or right.

When the cursor is at the desired position, press **ESC**. This will save the time value corresponding to the cursor position for that trace and move the cursor down to the next trace. Repeat this step until all traces have been picked or skipped (Step 9). The program then moves to Step 10).

- 8) It is possible to display only the trace to be picked on the screen and to change the gain (V-SCALE) of this trace only.

Press the **CTRL** and **I** keys simultaneously. (Note- ^ is used to represent the CONTROL key in the help menu displayed below the plot).

The single trace will be plotted on the screen with the help menu, plotting parameters, trace number, and time corresponding to the cursor position displayed at the bottom of the screen.

CTRL I is a toggle command. If these two keys are pressed simultaneously at any point, the entire record will again appear on the screen.

If desired the individual trace gain can be changed as follows:

Press or (it may be necessary to press the key twice). A blinking cursor will appear beside the value of V-SCALE. Press to incrementally increase V-SCALE, or to incrementally decrease V-SCALE. When the desired value is reached, press . The trace will then be replotted on the screen with the new gain.

These steps may be repeated as necessary until the desired gain level is reached:

When the trace is satisfactorily displayed on the screen and the cursor has been properly positioned using the H, J, K, L, I and M keys, press . This will save the time value corresponding to the cursor position for that trace, move the cursor down to the next trace and replot the entire record on the screen.

- 9) If no pick is to be made on a given trace, press the and keys simultaneously. (Note - ^ is used to represent the CONTROL key in the help menu displayed below the plot). The cursor will then move down to the next trace. No time value is saved for the trace that was skipped.

- 10) Once all the traces have been picked or skipped, a message:

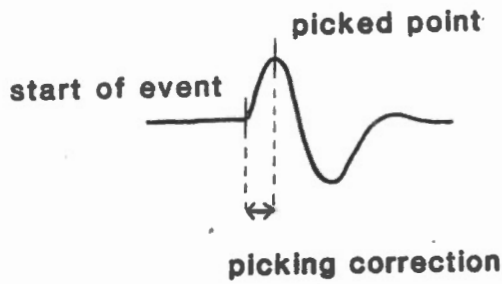
ARE THESE OK? (Y/N)

appears at the bottom of the screen. If the picks are not satisfactory, press . This will return the program to Step 6 with the cursor positioned at the pick previously made for trace 1. Each pick may be accepted by pressing , or changed by moving the cursor with the cursor-control keys before pressing (see Steps 7-9).

When all picks are satisfactory, press in response to the above message.

- 11) ENTER PICKING CORRECTION IN MS

The user may now enter a time in milliseconds that is to be subtracted from all the picked times. This is to allow a correction to be made for the estimated difference between the picked points and the start of the event (see below).



If no correction is required, enter \emptyset and press **RETURN** , or simply press **RETURN** .

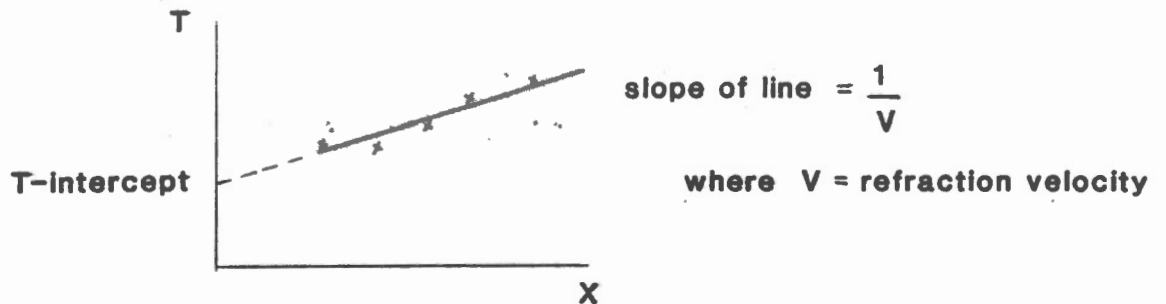
12) REFLECTION (0) OR REFRACTION (1) ?

Press \emptyset if a reflection event has been picked.

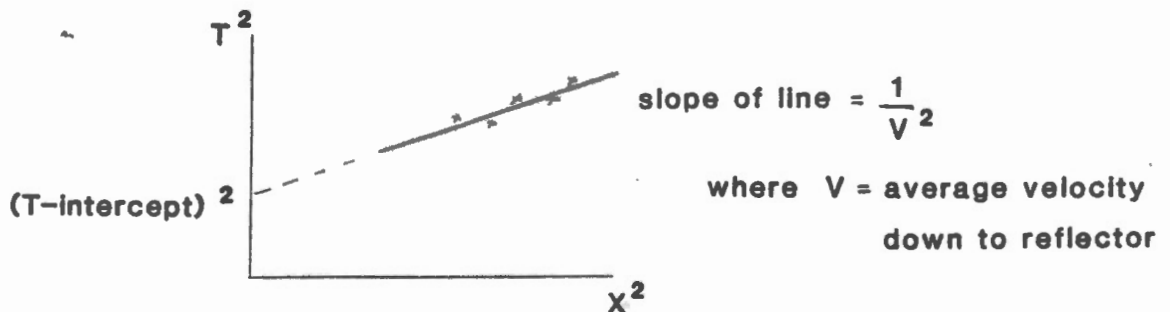
Press 1 if a refraction event has been picked.

At this point a least-squares fit of the time distance values is made according to the interpretation of the picked events:

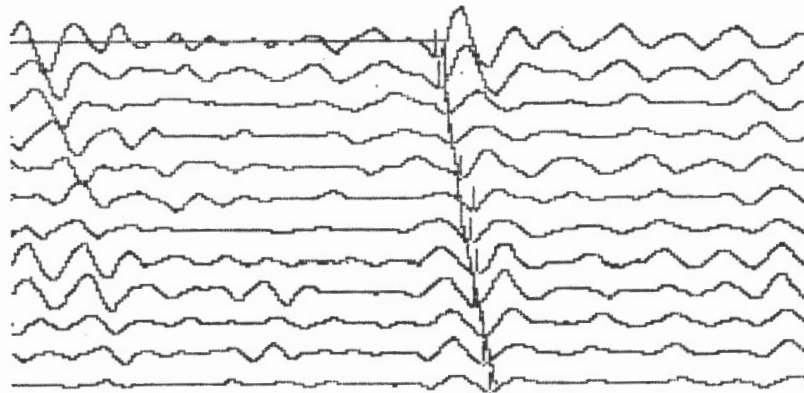
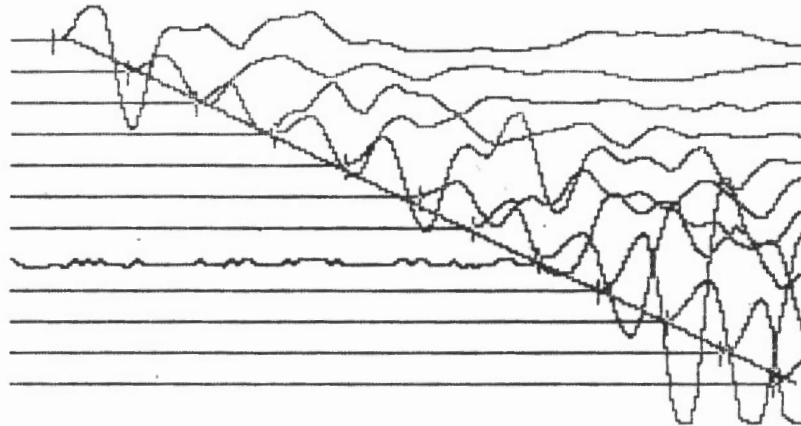
(i) For a refracted event:



(ii) For a reflected event:



The best fit straight line (refraction) or hyperbola (reflection) is plotted on the screen. Examples are shown below.



- 13) If a printer is available (step 2), the record name, header number, calculated time-intercept and velocity are printed out in the following form:

B-100R	12025102	REFRACTION T-INT = 3.568	VEL= 1.422
B-100X	12025100	REFLECTION T-INT = 107.172	VEL= 1.721

The upper line corresponds to the refraction record displayed in Step 12, while the lower line corresponds to the reflection record shown there.

The time-intercept is given in milliseconds; the velocity in ft/msec or m/msec. If no printer is being used, the calculated time-intercept and velocity appear on the screen below the picked record.

14) PRINT T-X DATA? (Y/N)

Press N to move directly to Step 15.

Press Y if a list of the T-X values is desired. The record will be cleared from the screen and a list of X values on the left and the corresponding T values (in msec) on the right will be printed on the screen (and printer if available). 12 sets of values will appear corresponding to traces 1 to 12, but zeroes will appear for any trace that was skipped.

3	5.1
6	7.5
9	9.7
12	12.2
15	14.5
18	16.9
21	18.6
24	20.7
27	22.6
30	24.8
33	26.5
36	28.2

15) STORE T-X DATA ON DISK? (Y/N)

Press N to move directly to Step 17.

Press Y to indicate that you wish to save the T-X data on disk.

16) INSERT T-X DISK IN DRIVE 1
AND PRESS RETURN

Make sure the appropriate disk is in Drive 1 and press RETURN. A file called TX - (record name) will be saved on this disk. It consists of a number giving the total number of picked values (ie., if 2 traces were skipped this number would be 10) and then the list of X and T values.

NOTE - because of the automatic naming of this data file, only one set of T-X values per record can be saved to disk.

A message:

TRANSFER TO DISK COMPLETE

tells the user that the save has been executed properly.

17) CONTINUE ON THIS RECORD? (Y/N)

Press N to move to Step 18.

Press Y to go back to Step 6. The user can now pick any other event of interest on the record.

18) The program returns to Step 3 so that other records may be picked by the user. The Apple must be RESET to exit from the program.

Helpful Hints

1. If, for any reason, the computer has to be RESET, the user may start executing the program P-PICK again by typing RUN and pressing RETURN.
2. To correct a directory that lists a data file as 00 sectors in length:

BLOAD	file name
UNLOCK	file name
DELETE	file name
BSAVE	file name, A\$2004, L\$40FB
LOCK	file name

STAT PICK

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 2 disk drives
- optional printer (no restrictions on type of printer or printer interface card)

Program Description:

This program plots a common offset record (or any portion of it) on the screen and allows the user to pick the first arrival on each trace with a keyboard-controlled cursor. The picked events are lined up on the screen and the user is given the option of making any necessary corrections to the original picks. The time values are calculated with respect to a datum (input by the user), and these "static corrections" can be printed out and/or saved on disk in the format that is required by the high-resolution printer plot routine (COMMON OFFSET).

Execution:

- 1) Boot the appropriate program disk. When the menu is displayed press to select the program STAT PICK. This will load the machine language graphics subroutines into memory (BLOAD FAST PLOT 4/9/85) and then load and execute the basic routine STAT PICK (RUN STAT PICK 21/1/86).
- 2) INSERT DATA DISK IN DRIVE 1
AND PRESS RETURN

Remove program disk from Drive 1 and insert a data disk before pressing .
- 3) A list of all the data files on the disk in Drive 1 will be printed on the screen. Each file is identified on the left with a letter - A through H (i.e., to a maximum of 8 data files/disk). The record to be plotted can be selected by pressing the corresponding letter.

For example

```
A B-100
B B-101
C B-102
D B-103
E B-104
F B-105
G B-106
```

The record B-100 can be selected simply by pressing **A**.

If no data files exist on the disk in Drive 1, no list will be printed on the screen and a blinking cursor will appear in the upper left corner. Press any key. A message:

```
NO FILE ENTERED - PRESS ANY KEY
```

will appear. Press any key to return the program to Step 2.

Note - the program checks the directory and identifies binary files with a length of 66 sectors as data files. Occasionally a data file is mistakenly listed in the directory as 0 sectors in length and therefore will not be accessible by this program. See Helpful Hints for the means to correct this situation.

- 4) The selected record is read from the disk in Drive 1 and plotted on the screen. A blinking cursor (I) appears partway along the first trace. The following lines appear beneath the plot.

```
USE H J K L I M : <- -> RET : ^I ^S ESC
V-SCALE          H-SCALE          ORIG
TRACE           TIME
```

The first line is a help menu. It first lists the keys (H, J, K, L, I, M) that are used to control the cursor. Then the keys **←**, **→** and **RETURN** are shown.

These are used to change the:

V-SCALE	- the trace gains.
H-SCALE	- the portion of the record plotted.
ORIG	- the starting point of the plot.

The help menu also lists the keys (**CTRL** **I**) that can be used to change the plotting parameters of an individual trace (Step 7), and the **ESC** key which is used to indicate that the cursor is properly placed and a time pick is to be made for the trace (Step 6).

- 5) The user can modify the screen display as many times as desired, and at any time during the picking process, so that the first arrivals are shown as clearly as possible. The changes can be effected as follows:

(i) To change V-SCALE:

Press **←** or **→**. A blinking cursor will appear beside the value of V-SCALE. Press **→** to incrementally increase V-SCALE. Press **←** to incrementally decrease V-SCALE. When the desired value is reached, press **RETURN**. The blinking cursor will then appear beside the value of H-SCALE.

(ii) To change H-SCALE:

With the blinking cursor beside the value of H-SCALE the **→** and **←** keys may be used to increase or decrease H-SCALE. Allowable values are:

- 1 - all record displayed (every 4th sample point plotted).
- 2 - 1/2 record displayed (every 2nd sample point of chosen portion of record plotted).
- 4 - 1/4 record displayed (every sample point of chosen portion of record plotted).
- 8 - 1/8 record displayed (every sample point of chosen portion of record plotted).

When the desired value of H-SCALE is displayed, press **RETURN**. The blinking cursor will then appear beside the value of ORIG.

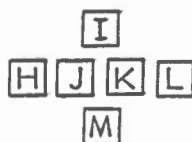
(iii) To change ORIG:

The value of ORIG is the starting sample point of the plot, and must have a value between 1 and 800. Values outside this range will not be accepted when **RETURN** is pressed. A value of 1 means that the data are plotted from the start of the record. A value of 513 means that the record is plotted from the midpoint of the recorded data.

When the values of V-SCALE, H-SCALE and ORIG have been changed as described above and **RETURN** is pressed to enter the ORIG value, the record is replotted on the screen with the new plotting parameters displayed below the record.

NOTE -It is possible to temporarily lose control of the cursor, if, when replotting the record as described above, the cursor is "too far" outside the portion of the record displayed. If this happens, the Apple will beep and a blinking cursor will be displayed beside the TRACE number at the bottom of the screen. Press **CTRL** and **S** simultaneously. This will move the cursor onto the screen.

- 6) Once the first arrivals are displayed satisfactorily on the screen (Step 5), the cursor can be used to pick a point in time on each trace in turn. The trace for which the time pick is to be made is shown on the bottom line. The keys:



are used to control the cursor. **H** moves the cursor 5 points to the left, **J** moves it 1 point to the left, **K** moves it 1 point to the right, **L** moves it 5 points to the right. **I** and **M** will move the cursor 1 point up or down, respectively. The time value corresponding to the position of the cursor is beside TIME on the bottom line and is updated every time the cursor is moved to the left or right.

When the cursor is at the desired position, press **ESC**. This will save the time value corresponding to the cursor position for that trace and move the cursor down to the next trace. Repeat this step until all traces have been picked. The program then moves to Step 8.

- 7) It is possible to display only the trace to be picked on the screen and to change the plotting parameters of this trace only.

Press the **CTRL** and **I** keys simultaneously (Note - ^ is used to represent the CONTROL key in the help menu displayed below the plot).

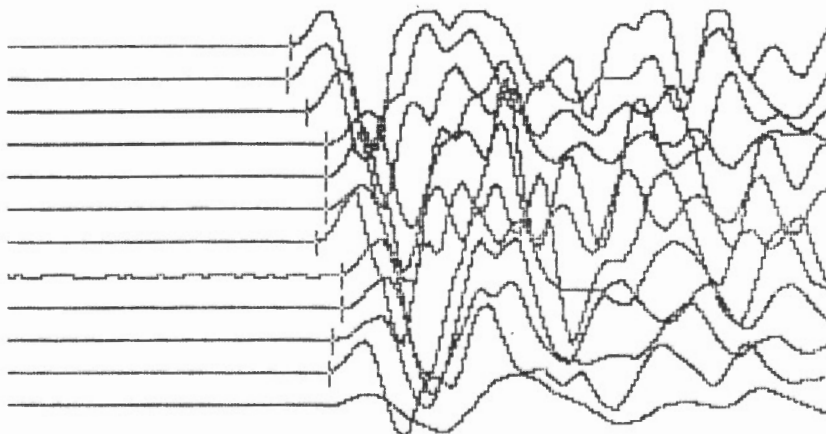
The single trace will be plotted on the screen with the help menu, plotting parameters, trace number, and time corresponding to the cursor position displayed at the bottom of the screen.

CTRL I is a toggle command. If these two keys are pressed simultaneously at any point, the entire record will again appear on the screen.

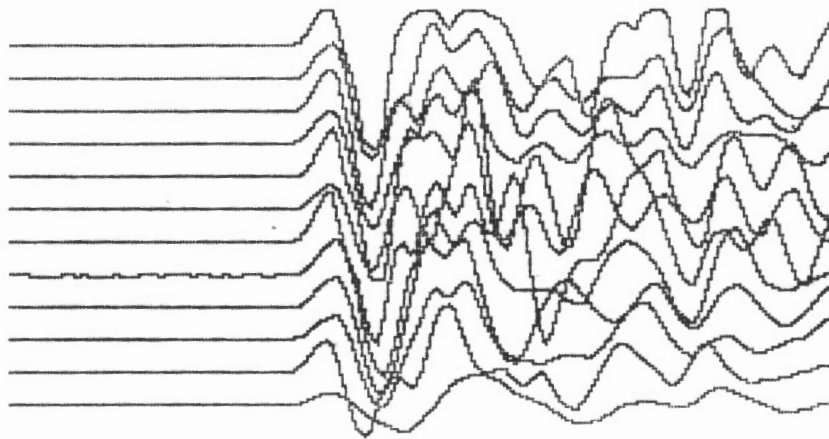
The plotting parameters of the single trace may be changed by following the instructions given in Step 5.

When the first arrival of this trace is clearly displayed, position the cursor using the H, J, K, L, I and M keys, and then press **ESC**. This will save the time value corresponding to the cursor position for that trace, move the cursor down to the next trace, and replot the entire record on the screen.

- 8) Once all the traces have been picked:



The record is replotted with the picked values lined up:



and the message:

ARE THESE OK? (Y/N)

appears at the bottom of the screen. If the picks are not satisfactory, press N. This will return the program to Step 6 with the cursor positioned at the pick previously made for trace 1. Each pick may be accepted by pressing ESC, or changed by moving the cursor with the cursor-control keys before pressing ESC (Steps 6 and 7). When all picks are satisfactory, press Y in response to the above message.

- 9) The record is removed from the screen and the picked time values are listed in the following form:

PICKED TIMES FOR RECORD B-100

TRACE NO	TIME (MSEC)
1	23.7
2	23.6
3	24.2
4	24.9
5	24.8
6	24.8
7	24.5
8	25.2
9	25.4
10	25.2
11	24.9
12	25

INPUT STATIC DATUM (MSEC)

The user is asked to input a datum time (in msec). This is the time at which the picked points will be lined up on the section plots that are output by the printer plot routine COMMON OFFSET. Generally, a convenient time close to the picked values is chosen. For example, in the case above, the user might enter the value 25 and press .

- 10) The "static corrections" are then calculated with respect to this datum and displayed on the screen as follows:

STATIC CORRECTIONS FOR B-100
DATUM = 25 MSEC

TRACE NO	TIME (MSEC)
1	-1.3
2	-1.4
3	-.8
4	-.1
5	-.2
6	-.2
7	-.5
8	.2
9	.4
10	.2
11	-.1
12	0

DO YOU WANT A PRINTOUT? (Y/N)

Press to obtain a copy of this on the printer.

Press to move on to Step 11.

- 11) STORE DATA ON DISK? (Y/N)

Press to move directly on to Step 13.

Press to indicate that you wish to save these values on disk.

- 12) INSERT STATICS DISK IN DRIVE 2
AND PRESS RETURN

Make sure the appropriate disk is in Drive 2 before pressing . A file "STAT - (record name)" will then be saved on this disk.

- 13) PICK ANOTHER RECORD? (Y/N)

Press to exit from the program.

Press to return to Step 2. The user can now pick the first arrivals on another record.

Helpful Hints

1. If for any reason, the computer has to be , the user may start executing the program STAT PICK again by typing RUN and pressing .
2. To correct a directory that lists a data file as 00 sectors in length:
 - BLOAD filename
 - UNLOCK filename
 - DELETE filename
 - BSAVE filename, A\$2004, L\$40FB
 - LOCK filename
3. Since 8 data files completely fill a disk, leaving no room for the corresponding "STAT-" files, and the "STAT-" files themselves are small, it is usually convenient to reserve a disk exclusively for the "STAT-" files for a given line or project. This separate disk is used in Drive 2 when plotting common offset sections with the routine COMMON OFFSET.

SYNTHETIC SEISMOGRAM (SYNVA)

System Requirements:

- Apple II (with 16 K ram card), or Apple IIe
- monitor
- 1 disk drive
- Epson dot matrix printer (MX 100 or FX 100)
- parallel printer interface card (Grappler type or Epson Type II) in SLOT 1

Program Description:

This program plots a 12-channel synthetic seismogram for a given horizontally-layered subsurface model. The user must input the number of layers in the model, and the velocity and thickness of each layer. The user is also asked for the source offset, spacing between geophones and the length of record to be plotted. Refraction and/or reflection events can be plotted one at a time, and the synthetic seismogram may be dumped to the printer at any time.

An arbitrary pulse is used to create the synthetic seismogram. The seismogram shows where the given refracted and/or reflected events occur in time, but no attempt is made to model the attenuation of seismic energy.

Execution:

- 1) Boot the appropriate program disk. When the menu is displayed press **Z** to select the program SYNTHETIC SEISMOGRAM (RUN BIN. SYNVA).
- 2) The user is then asked to identify the type of parallel printer interface card that is in SLOT 1 of the computer.

INTERFACE

<E>PSON

<G>RAPPLER TYPE

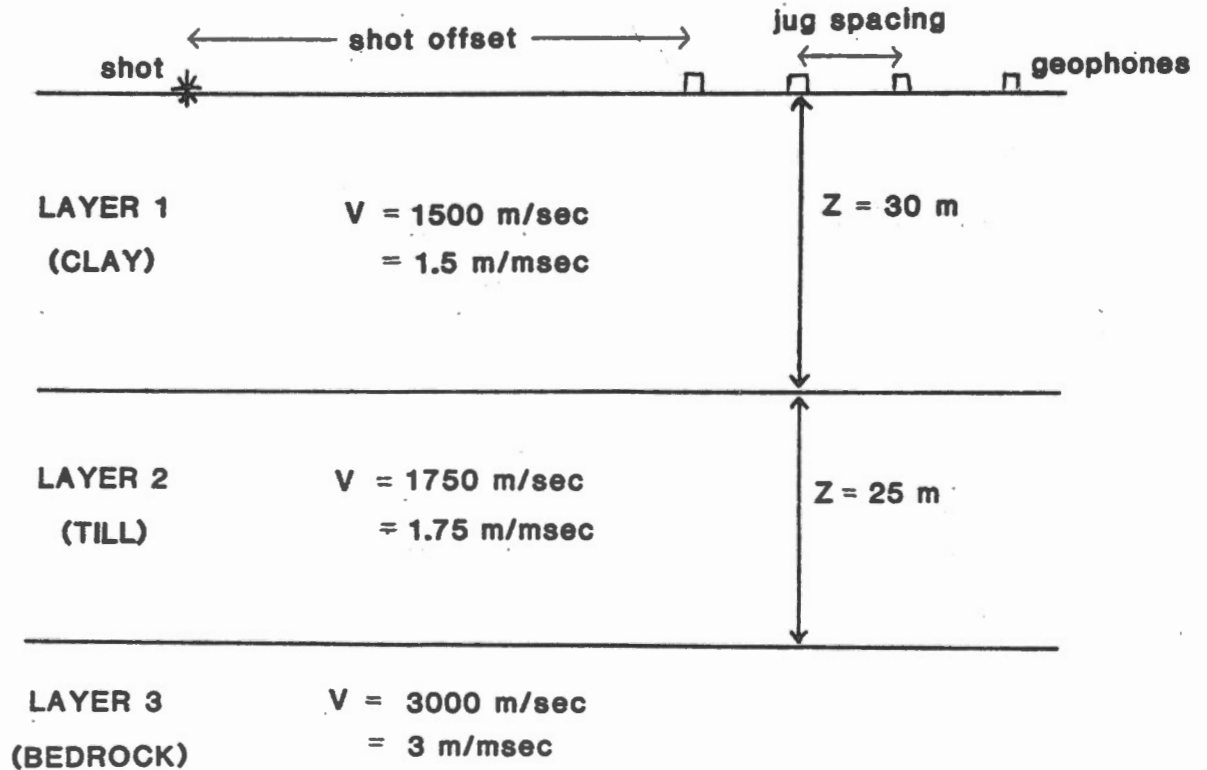
SELECT :

Press **E** if the parallel printer interface card in use is an Epson Type II.

Press **G** if the parallel printer interface card in use is a Grappler or Grappler +.

SYNTHETIC SEISMOGRAM (SYNVA) - 2

- 3) Before running the program, the user must decide on the model to be input and on the set-up parameters (i.e. source offset, geophone spacing, record length, etc.). An example is given here and will be used to illustrate the following steps:



- 4) INPUT NUMBER OF LAYERS

Enter number of layers ($N < 11$) in subsurface model, and press . For the example given in Step 3, the user would enter a "3" and press .

5) INPUT V AND Z FOR LAYER 1

Enter velocity of layer 1 (i.e. surface layer) in m/msec (or ft/msec), and the thickness of the layer in m (or ft). The two values should be separated by a comma. For the example given in Step 3, the user would type "1.5, 30" and press .

- 6) Step 5 is repeated N times where N is the number of layers (Step 4). For the example given in Step 3:

INPUT V AND Z FOR LAYER 2

The user would type "1.75, 25" and press .

INPUT V AND Z FOR LAYER 3

The user would type "3, 10" and press . The value of Z for the lowermost layer in the model is arbitrary, but a value must be entered.

7) INPUT JUG SPACING

Enter the spacing between geophones in metres (or feet) and press (see diagram in Step 3).

8) INPUT SHOT OFFSET

Enter the distance between the source and the first geophone in metres (or feet) and press (see diagram in Step 3).

- 9) INPUT TIME SCALE (MSECS)
(50,100,200,500, OR 1000)

Enter the desired record length in milliseconds.
The allowed values are listed. Press .

- 10) INPUT START TIME IN MSECS

Enter the time delay in milliseconds between the
shot and the start of the synthetic seismogram.
Press .

- 11) REFRAC-R REFLEX-F PRINT-P END-E

The user is now asked to identify the seismic event he/she wishes to plot on the synthetic seismogram. The user may also choose to dump the screen to the plotter at this point, or to exit from the program.

Press to indicate that a refraction event is to be plotted. The program moves to Step 12.

Press to indicate that a reflection event is to be plotted. The program moves to Step 13.

Press for a screen dump to the printer. The model parameters will first be listed out in the following forms:

```

MODEL PARAMETERS
LAYER 1          V= 1.5          Z= 30
LAYER 2          V= 1.75        Z= 25
LAYER 3          V= 3
JUG SPACING 5
SHOT OFFSET 20
START TIME 0 MSECS
TIMING LINES 10 MS INTERVALS

```

Examples of the printer output are shown on pages 9 and 10. On completion of the screen dump the program returns to Step 11.

Press **E** to exit from the program. If another run is to be made, type RUN and press **RETURN**. The program starts again at Step 2.

- 12) The user must now input information on the refraction event he/she wishes to plot.

INPUT REFRACTOR LAYER NO

Enter the number of the layer along the top of which the refracted wave travels and press **RETURN**. If \emptyset is entered the program jumps to Step 14.

INPUT NO OF RAY SEGMENTS
DOWN TO THE REFRACTOR

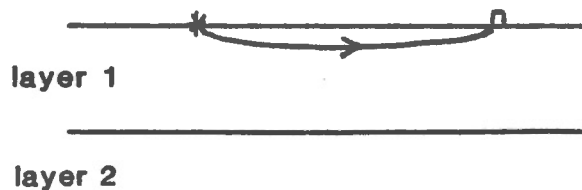
Enter the number of layers through which the wave travels before it hits the refractor layer and press **RETURN**.

INPUT WAVE CODE DOWN TO REFRACTOR
ONE NUMBER AT A TIME

Enter the number of each layer that the wave travels through on its down-going path, pressing **RETURN** after each entry.

Some examples will help to illustrate the required inputs.

- (i) Refraction example - the "direct" wave.

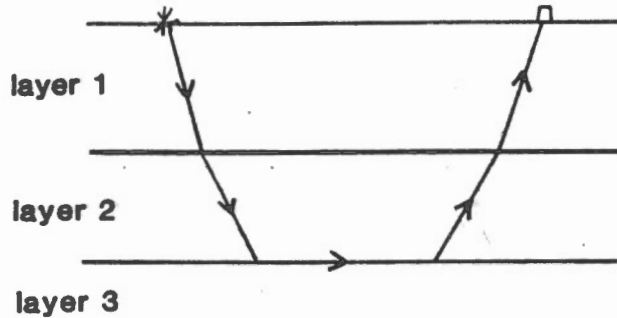


Refractor layer no = 1

No of ray segments down to refractor = \emptyset

Wave code down to refractor = \emptyset

- (ii) Refraction example - refraction from bedrock for model given in Step 3.



Refractor layer no = 3

No of ray segments down to refractor = 2

Wave code down to refractor = 1, 2

When the required information on the refraction event has been entered, the synthetic seismogram is plotted on the screen, one trace at a time, with this refraction event added to it. Note - no pulse will be plotted until the critical distance is reached. The program then returns to Step 11 to allow the user to add other events to the synthetic seismogram if so desired.

- 13) The user must now input information on the reflected event he/she wishes to plot.

FOR REFLECTION INPUT NO OF RAY SEGMENTS
IN DOWN-GOING AND UP-GOING RAY

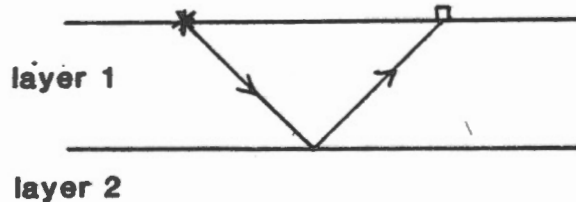
Enter the total number of ray segments along the path from shot to geophone and press **RETURN**. If a 0 is entered the program jumps to Step 14.

INPUT WAVE CODE
ONE NUMBER AT A TIME

Enter the number of the layer through which each ray segment passes in order, starting at the shot. Press **RETURN** after each entry.

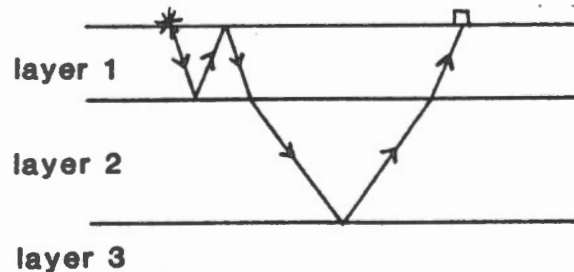
Some examples will help to illustrate the required inputs:

- (i) Reflection example - reflection from top of till for model given in Step 3.



No of ray segments in down-going and up-going rays = 2
Wave codes = 1, 1

- (ii) Reflection example - "peg-leg" reflection



No of ray segments in down-going and up-going rays = 6
Wave codes = 1, 1, 1, 2, 2, 1

When the required information on the reflection event has been entered, the synthetic seismogram is plotted on the screen one trace at a time with this reflection event added to it. The program then returns to Step 11 to allow the user to add other events to the synthetic seismogram if so desired.

- 14) If a \emptyset has been input at the beginning of Step 12 or 13, the user will be given a chance to start another model, to plot out the synthetic seismogram plotted on the screen, or to return to Step 11.

DO YOU WANT TO TRY ANOTHER MODEL? (Y/N)

Press Y to go back to Step 4.

Press N and the following message will appear :

DUMP SCREEN TO PRINTER? (Y/N)

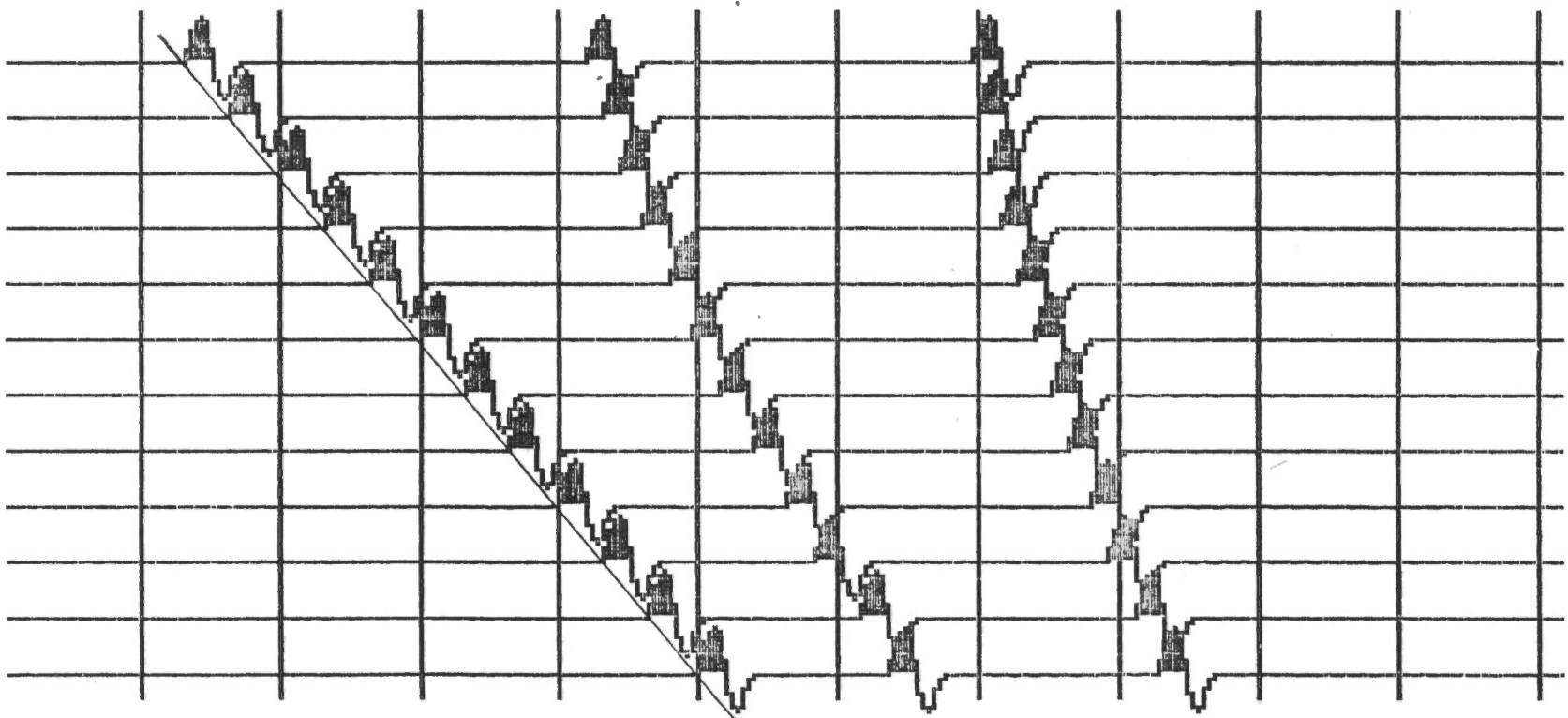
Press Y to obtain a printer output (see examples on pages 9 and 10) of the current screen display. The program then returns to Step 11.

Press N to move directly to Step 11.

Helpful Hints:

1. After exiting from the program or after a RESET, the program may be restarted by typing RUN and pressing RETURN. If the computer was RESET while a screen dump was in progress it may be necessary to turn the printer off and on again to reset the printer parameters.
2. BIN. SYNVA is a compiled version of the Applesoft routine SYNVA. SYNVA can be run if necessary, though the screen plotting will be very slow. Line 10 (LOMEM : 16384) should be deleted from SYNVA before attempting to run this routine (RUN SYNVA).

MODEL PARAMETERS
 LAYER 1 V= 1.5 Z= 30
 LAYER 2 V= 1.75 Z= 25
 LAYER 3 V= 3
 JUG SPACING 5
 SHOT OFFSET 20
 START TIME 0 MSECS
 TIMING LINES 10 MS INTERVALS



REFRACTION REFLECTION REFLECTION
 "DIRECT" WAVE FROM LAYER 2 FROM LAYER 3

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MODEL PARAMETERS

LAYER 1 V= 1.5 Z= 30

LAYER 2 V= 1.75 Z= 25

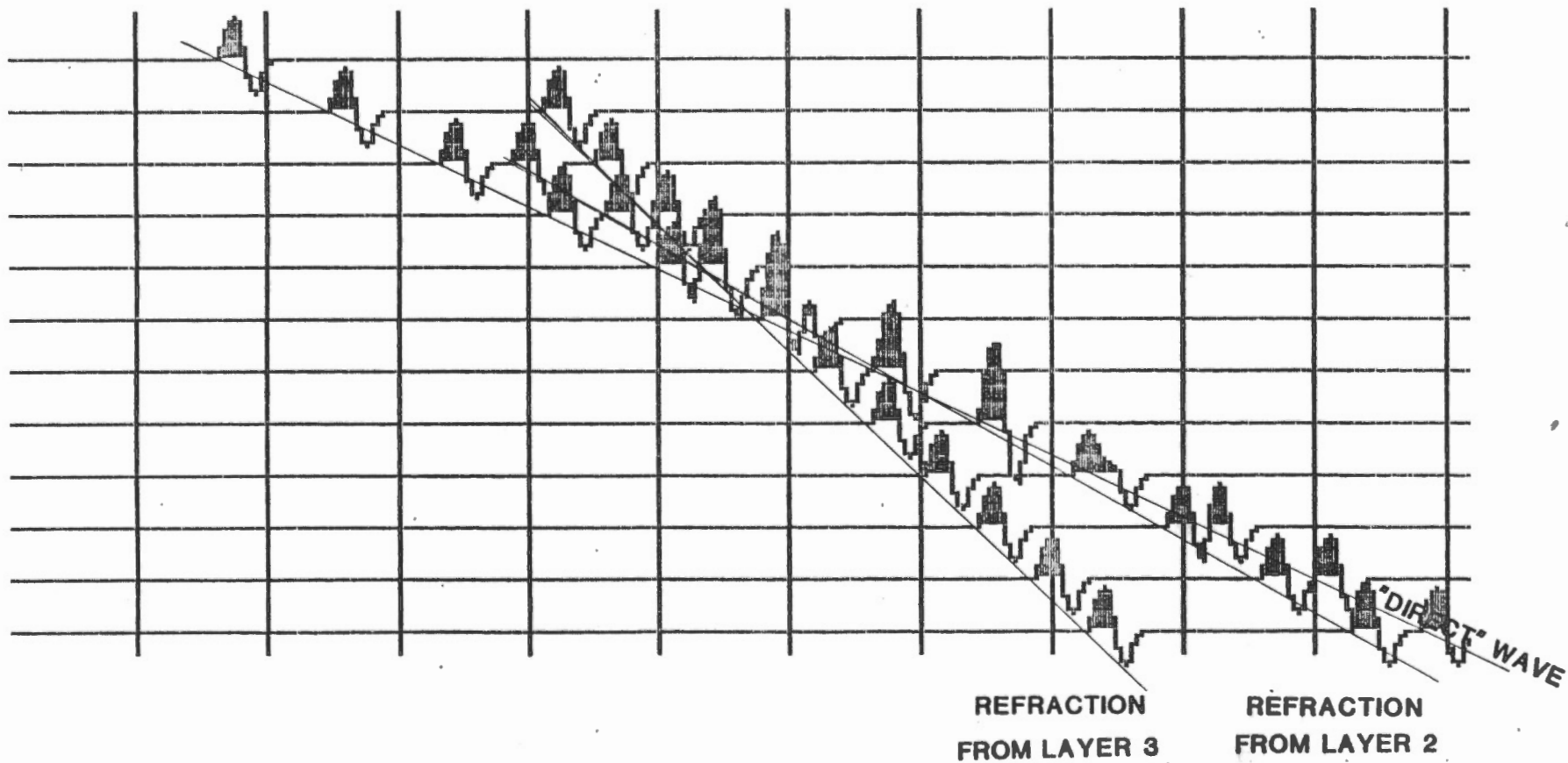
LAYER 3 V= 3

JUG SPACING 25

SHOT OFFSET 50

START TIME 0 MSECS

TIMING LINES 20 MS INTERVALS



VELOCITY ANALYSIS

System Requirements:

- Apple II (with 16K ram card), or Apple IIe
- monitor
- 2 disk drives
- Epson dot matrix printer (MX 100/FX100)
- one of the following parallel printer interface cards:
 - Epson Type II
 - Grappler
 - Grappler +

Program Description:

This program plots a processed multi-channel record after it has had normal moveout (NMO) corrections applied. The record is processed and plotted over and over again for a series of input NMO velocities. Up to 8 records (1 disk full) may be processed consecutively. The printer output can then be used to determine the average velocity down to any reflected events on the records.

The high-resolution plotting routine is similar to that used in COMMON OFFSET. The plotting options include variable area or wiggle trace display, automatic gain control and different gain tapers in three user-specified windows.

An example of the output produced by VELOCITY ANALYSIS is shown on page 19.

Execution:

- 1) Boot the appropriate program disk. A catalog of the files on the disk will be printed on the screen, with each file identified by a highlighted letter on left hand side. The user selects the appropriate program simply by pressing the corresponding letter on the keyboard.

Three versions of the program VELOCITY ANALYSIS are listed on the screen:

VELOCITY ANALYSIS EPSON
 VELOCITY ANALYSIS GRAP
 VELOCITY ANALYSIS GRAP +

The user must select the program corresponding to the printer interface card in his/her Apple.

2) WHICH SLOT FOR THE PRINTER? >

The user must input the number (1-7) corresponding to the slot in which the printer interface card is plugged. (Generally this will be "1"). Press .

3) TURN ON THE PRINTER AND PRESS RETURN

Check that the printer is turned on before pressing .

4) REVERSE POLARITY? (Y/N)

The user has the option to plot all traces with reverse polarity. For example if the traces were normally plotted as follows:



they would be plotted "upside down":



if the user requested reverse polarity. Press
 or as desired.

5) SAME VELOCITY RANGE FOR ALL RECORDS? (Y/N)

A series of up to 8 records (1 disk full) can be processed consecutively. If the user chooses the same NMO velocities for all records, by pressing Y in response to the above question, a series of records can be processed and printed with no user input necessary.

Press N to indicate the different records will use a different series of NMO velocities.

6) PLOT A TIME SCALE

...AT BEGINNING OF PLOT? (Y/N)

Press Y if a time scale is to be plotted before the first record is plotted.

Press N for no time scale.

...AT END OF PLOT? (Y/N)

Press Y if a time scale is to be plotted at the end of the section.

Press N for no time scale.

NUMBER THE TIME SCALE? (Y/N)

Press Y if the time (in milliseconds) corresponding to the tick marks on the time scales(s) are to be printed out.

Press N for no numbers to be printed.

PLOT TIMING LINES? (Y/N)

Press Y for timing lines to be drawn across the record(s). The option is recommended for VELOCITY ANALYSIS because it provides reference straight lines which are useful when determining the correct normal moveout velocities.

Press N for no timing lines.

7) TIME SCALE - START Y
 END Y
 SCALES NUMBERED Y
 TIMING LINES Y

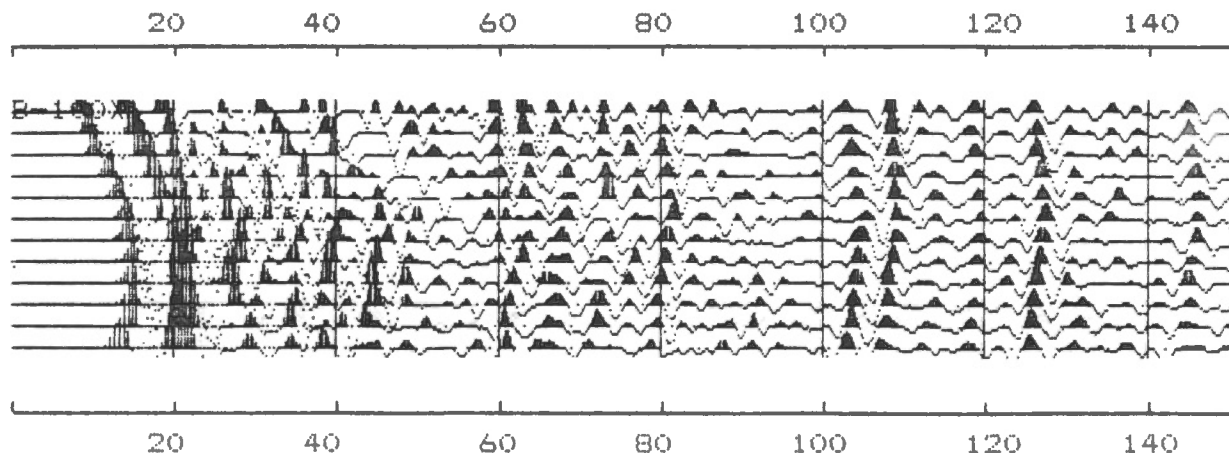
OK? (Y/N)

At this point the user is given an opportunity to check that the entries made in Step 6 were correct.

Press Y to continue.

Press N to return to Step 5.

An example of a record plotted with numbered time scales and timing lines is shown below:



8) ENTER TIME SCALE >

Input the record length in milliseconds (i.e. 50, 100, 200, 500, 1000 or 2000) and press .

9) ENTER TIME DELAY >

Input the time delay on the record (in milliseconds) and press .

10) MUTE AT >

The processed data may be muted up to a given time (in milliseconds). Input the desired value, (0 if no mute is desired) and press .

11) OK? (Y/N)

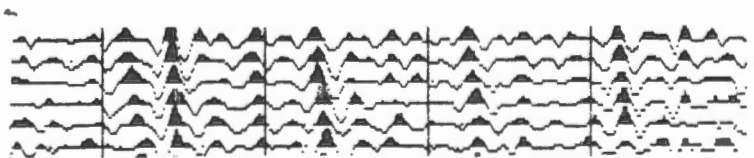
The user now has an opportunity to check that the entries made in Steps 8 through 10 are correct.

Press to continue.

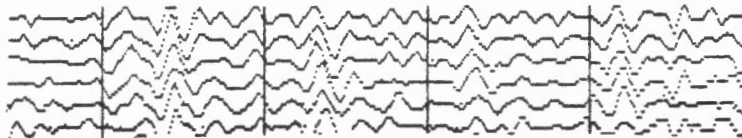
Press N to return to Step 8.

12) VARIABLE AREA PLOT? (Y/N)

Press for output to be in variable area display - see below:



Press N for output to be in wiggle trace display - see below:



13) TRACE GAIN NORMALIZATION? (Y/N)

This is one means of normalizing variations in amplitude between traces. If invoked, this option will seek the point with the maximum amplitude within a time window input by the user, and adjust the gain of the trace so that this maximum amplitude is equal for all 12 traces in the record.

Press Y to indicate that trace gain normalization is to be applied. The user must then input the start and end times of the window (see below).

Press N to move directly to Step 13.

START TIME OF TGN WINDOW >

Enter the desired time (in msec) and press RETURN.

END TIME OF TGN WINDOW >

Enter the desired time (in msec) and press RETURN. The program will not accept a time less than the START TIME.

OK? (Y/N)

Press Y if the entries made above were correct.

Press N to input the START and END TIME again.

14) IS AGC TO BE APPLIED? (Y/N)

The processed data may be plotted with an automatic gain control which is described below.

Press Y to indicate that the AGC is to be applied. The user must then input the AGC parameters described below.

Press N to move directly to Step 15.

The automatic gain control adjusts the gain of each sample point individually. The user must specify the length of a running window (in number of sample points before and after the current point of interest) to be used for this calculation, as well as an AGC "constant". The program calculates the sum of the absolute values of the amplitude of all the points in the window, and divides by the total number of sample points in the window to obtain an average value. The AGC gain factor for a given point is then

$$= \text{initial gain} \times \left(1 + \frac{\text{AGC constant}}{\frac{\sum |\text{amplitudes}|}{\# \text{ pts}}} \right)$$

(the initial gain is the value input in Steps 20-23)

WINDOW BEFORE >

Enter the desired value and press RETURN .

A typical value is "80".

WINDOW AFTER >

Enter the desired value and press .

Again a typical value is "80". If the WINDOW BEFORE value is equal to the WINDOW AFTER value, the running window is centred on the point of interest.

AGC CONSTANT >

Enter the desired value and press .

A typical value is "20". Lower values will reduce the impact of the AGC.

OK? (Y/N)

Press if the entries made above were correct.

Press to input the window lengths and AGC constant again.

15) 3 POINT SMOOTHING? (Y/N)

A running 3-point smooth may be applied to the data.

Press to invoke this option.

Press for no smoothing to be applied.

16) VARIABLE AREA Y
TRACE GAIN NORM. N
AGC Y
SMOOTH Y

OK? (Y/N)

At this point the user has an opportunity to check that the entries made in Steps 12 through 15 were correct.

Press to continue.

Press to return to Step 12.

17) GAIN TAPERS TO BE USED? (Y/N)

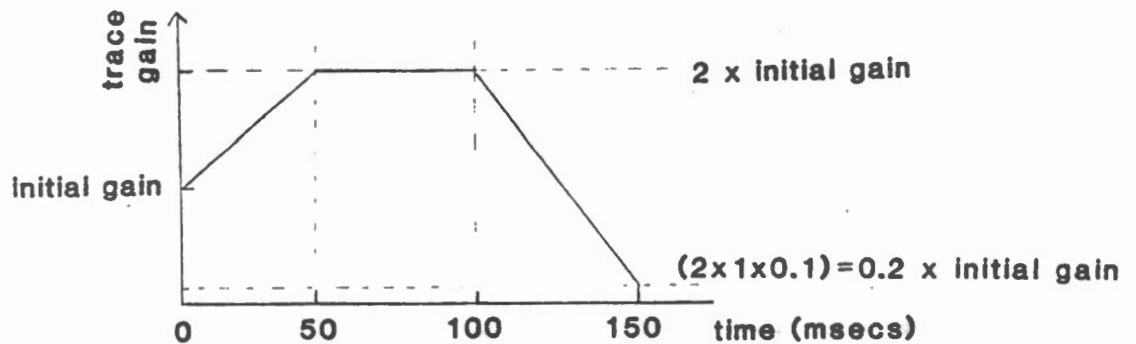
The data may be plotted with linear gain tapers within 3 user-specified windows.

Press to indicate that gain tapers are to be applied. The user must then input the information of the positions of the three windows and the corresponding gain tapers are requested.

Press to move directly to Step 18.

The user must specify the end points of three time windows (in msec) and then the gain taper to be applied in each window. The trace is zeroed after the end of the third window. The values input for the end points of the first two windows must be within the time scale + time delay input in Steps 8 and 9.

An example is shown below:



Window 1	0 - 50 msecs	gain taper 1 = 2
Window 2	50 - 100 msecs	gain taper 2 = 1
Window 3	100 - 150 msecs	gain taper 3 = 0.1

If the above gain tapers were desired, then, in response to the message:

THREE GAIN TAPER ZONES ALLOWED

TIME BOUNDARY BETWEEN ZONES 1 & 2 >

the user would type "50" and press ;

TIME BOUNDARY BETWEEN ZONES 2 & 3 >

the user would type "100" and press ;

TIME BOUNDARY OF END >

the user would type "150" and press .

OK? (Y/N)

If all three times were entered correctly, press

.

Press to enter time boundaries again.

The user is now asked to enter the gain taper for each window. For the example given above:

GAIN TAPER OF ZONE 1 >

the user would type "2" and press ;

GAIN TAPER OF ZONE 2 >

the user would type "1" and press ;

GAIN TAPER OF ZONE 3 >

the user would type "0.1" and press .

OK? (Y/N)

If all three gain tapers were entered correctly, press Y.

Press N to enter the gain tapers again.

- 18) WHEN DIRECTORY APPEARS USE LETTER
TO SELECT FILE : <ESC> TO QUIT
INSERT SEISMIC DATA DISK IN
DRIVE 1 SLOT 6 AND PRESS RETURN

Remove the program disk from Drive 1 and insert a data disk before pressing RETURN.

The upper two lines of this message is a help menu for the following step.

- 19) A list of the data files on the disk in Drive 1 is shown on the screen with each file identified by a letter on the left-hand side. For example:

```
A B-100X  
B B-101X  
C B-102X  
D B-103X  
E B-104X  
F B-105X  
G B-106X
```

If no data files exist on the disk in Drive 1, a blinking cursor will appear in the upper left hand corner. Simply insert a data disk in Drive 1 and press RETURN.

NOTE: The program checks the directory and identifies binary files with a length of 66 sectors as data files. Occasionally, a data file is mistakenly listed in the director as 0 sectors in length and therefore will not be accessible by this program. See Helpful Hints for the means to correct this situation.

The user may select any or all of the data files listed on the screen for processing, in any order. A file name is entered simply by pressing the corresponding letter. When all desired filenames have been entered, press .

For example, from the list shown above the user may select the files B-100X, B-103X, and B-106X by pressing , and then . Pressing will indicate that these are the only three files to be processed.

- 20) The user is now given a chance to check that the correct filenames have been entered in the correct order.

B-100X
B-103X
B-106X

OK? (Y/N)

If the list is correct, press .

If the list needs to be changed, press .

The program will go back to Step 18.

- 21) SAME INITIAL GAIN FOR ALL TRACES? (Y/N)

Press to indicate that the initial gain for all traces of all the input records is to be given a common value. The user will be asked to input the common gain (see below).

Press if the user wishes to input different initial trace gains for the input records. The program moves directly to Step 22.

INPUT COMMON INITIAL GAIN >

Enter the desired value and press .

The program moves directly to Step 24.

- 22) For each record input, the following message will appear:

B-100X

ARE ALL TRACE GAINS EQUAL? (Y/N)

Press Y if a single value is to be input for the initial gain of the 12 traces of this record.

Press N if the initial trace gains are to be input individually. The program moves directly on to Step 23.

If Y has been pressed in response to the above question, the user will be asked to:

INPUT THE GAIN FOR ALL TRACES >

Enter the desired value and press RETURN. The program will then go back to the start of this Step for the next record that was input in Step 19. When the last record is reached, the program will move on to Step 24.

- 23) If the user has chosen to input the initial trace gains for a record individually, by pressing N in response to the first question of Step 22, the following message will be displayed on the screen:

INPUT TRACE GAINS ONE/LINE

B-100X

1 0

This shows the trace number and the current value of the initial gain for that trace. The user may accept the listed value by pressing RETURN, or change it by typing in a new value before pressing RETURN.

When 12 values have been entered, the user will be asked:

OK? (Y/N)

Press N to start Step 23 for this record once again.

Press Y to accept the listed values and return to Step 22 to check the initial gains for the next record that was input in Step 19. When the last record is reached, the program will move on to Step 24.

- 24) As a final check the initial gains for the 12 traces of each record will be listed on the screen, one record at a time.

```
B-100X
1      .3
2      .3
3      .3
4      .3
5      .3
6      .3
7      .3
8      .3
9      .3
10     .3
11     .3
12     .3
```

OK? (Y/N)

The user may accept the values by pressing Y.

If any changes need to be made, press N. The program will go back to Step 23 and allow the user to modify the listed values as necessary. When the initial gains for the record in question are accepted, the program moves back to Step 24 to continue checking the values for other records.

- 25) When the initial gains for all records have been checked by the user, the following message appears on the screen:

```
<ESC> RE-DO <RETURN> CONTINUE
```

Press ESC to return to Step 21. Press RETURN to continue.

- 26) INSERT SEISMIC DATA DISK IN
DRIVE 1 SLOT 6 AND PRESS RETURN

After a final check that the data disk is in Drive 1,
press .

- 27) B-100X
START VELOCITY >

The user must input the lowest NMO velocity that is
to be applied to the record indicated. This velocity
should be in m/msec (or feet/msec).

Press .

END VELOCITY >

The user must input the highest NMO velocity to be
applied (again in m/msec, or feet/msec). Press

.

STEP SIZE >

Enter the desired step size, that is, the increase in
NMO velocity between reprocessing of the record.
This value should also be in m/msec (or ft/msec).

Press .

OK? (Y/N)

Press if the above values have been entered
correctly.

Press to repeat Step 27.

- 28) The first record to be processed will be read from the disk in Drive I, and the plotting parameters and timescale (if requested in Step 6) will be printed on the printer. An example is shown below:

WINDOW BEFORE 80

WINDOW AFTER 80

AGC CONSTANT 20

INITIAL GAIN .3

MUTE AT 0

TAP - 1 : 2 / 50

TAP - 2 : 1 / 100

TAP - 3 : .1 / 150

In this case, an automatic gain control was applied to the records, as well as the gain tapers given in the example in Step 17.

- 29) Each trace of the record is processing one at a time. A counter on the screen keeps track of the trace number. For example:

PROCESSING 6

indicates that trace 6 is being processed (A, B, and C refer to traces 10, 11 and 12 respectively).

Once the record is processed for the start velocity, a printer spooling routine allows the printing of the output for one NMO velocity value while the record is being processed for the next velocity.

- 30) When the processing and printing of one record is complete the program returns to Step 28 if the velocity range for all records is the same (Step 5), or else to Step 27 where the user must input the desired velocities and step size for the next record.

When all records input in Step 19 have been processed the following message appears:

DO YOU WISH TO CONTINUE

...WITH THE SAME PARAMETERS? (Y/N)

Press Y to return to Step 18. The user may then enter more files to be plotted with the parameters originally input in Steps 4-17.

Press N if more records are to be processed, but changes in the plotting parameters (e.g. gain tapers, AGC) are necessary.

...WITH DIFFERENT PARAMETERS? (Y/N)

Press Y to return to Step 8.

Press N to exit from the program.

HELPFUL HINTS

1. If the program VELOCITY ANALYSIS is loaded in memory, it may be restarted after a or after a normal exit by typing in the following lines:

]	CALL-151	Press	<input type="text" value="RETURN"/>
	*803G	Press	<input type="text" value="RETURN"/>

2. To correct a directory that lists a data file as 00 sectors in length:

BLOAD	file name
UNLOCK	file name
DELETE	file name
BSAVE	file name,A\$2004,L\$40FB
LOCK	file name

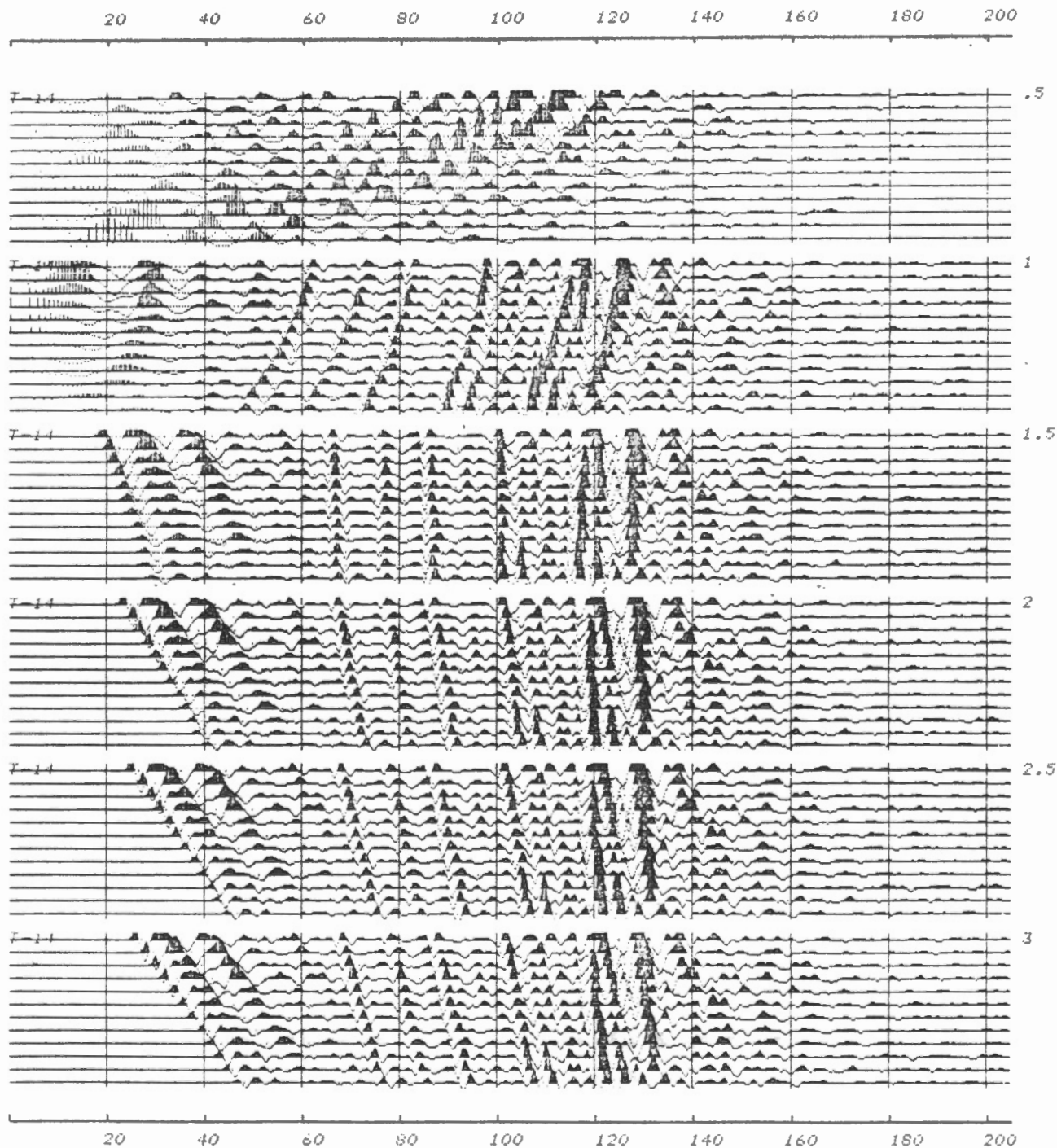
INITIAL GAIN .5

MUTE AT 0

TAP - 1 : 1 / 100

TAP - 2 : 1 / 200

TAP - 3 : 1 / 400



Programmer's Guide to Machine Language Graphics Routines

The EPLOTT, P-PICK, and STAT PICK routines have been written in a hybrid form. That is, they are BASIC programs that call machine language subroutines for segments that require speed.

The purpose of this section is to describe the BASIC/machine language interface to enable the user to better understand the programs and also to write his/her own programs that utilize these routines.

There are two types of calling mechanisms used:

i) USR

ii) &

Both of these calling mechanisms require that the user supply the addresses for the routines to the memory locations set up for this purpose (vectors). For the USR routine the vector is at 11, 12 (hex B, C), and for the & routine at 1014, 1015 (hex 3F6, 3F7). In general, the user pokes the routines addresses to these vectors.

Since our routines are at 37120 (hex 9100) for & and 37123 (hex 9103) for USR we use:

```
POKE 1014, 0 : POKE 1015, 145 for &
```

and

```
POKE 11, 3 : POKE 12, 145 for USR
```

(Note that we have poked hex 00 hex 91 for & and hex 03 hex 91 for USR into the vectors - $37120/256 = 145$).

The USR routines are used to obtain header values and are simply used by a statement such as:

```
TS = USR(6)
```

The '6' is an argument that is used to tell the routine what header variable is required - e.g.

0 - Shot Offset; 1 - Stack; 2 - Group Interval; 3 - Hi Cut Filter; 4 - Lo Cut Filter
5 - Time Delay; 6 - Time Scale; 7 to 18 - Gains for channels 1 to 12

In this (see 32000)

$$\text{FN HG}(I) = ((I = 0) + (I = 1) + (I = 3) * 2) * (I + 1) + (I = 2) * (I * 2)$$

which is interpreted as follows:

If an expression such as $(a = b)$ appears on the right side of the 'assignment' = sign it takes on the value 0, if $(a = b)$ i.e. false and 1 if $(a = b)$ true. Hence,

$$\text{FN HG}(0) = (1 + 0 + 0) * (1) + 0 = 1$$

$$\text{FN HG}(1) = (0 + 1 + 0) * (2) + 0 = 2$$

$$\text{FN HG}(3) = (0 + 0 + 0) * (3) + (1) * (4) = 4$$

$$\text{FN HG}(3) = (0 + 0 + 1 * 2) * 4 + 0 = 8$$

In a similar fashion

$$\begin{aligned} \text{FN VG}(I) = & (I < 9) * (I + 1) * .01 + (I > 8) * (I < 18) * (I - 8) * .1 \\ & + (I > 17) * (I < 37) * (I - 16) * .5 \end{aligned}$$

gives

$$\text{FN VG}(0) = 1 * 1 * .01 + 0 + 0 = .01$$

$$\text{FN VG}(1) = 1 * 2 * .01 + 0 + 0 = .02$$

$$\text{FN VG}(8) = 1 * 9 * .01 + 0 + 0 = .09$$

$$\text{FN VG}(9) = 0 + 1 * 1 * 1 * .1 + 0 = .1$$

$$\text{FN VG}(10) = 0 + 1 * 1 * 2 * .1 + 0 = .2$$

$$\text{FN VG}(17) = 0 + 1 * 1 * 9 * .1 + 0 = .9$$

$$\text{FN VFG}(18) = 0 + 0 + 1 * 1 * 2 * .5 = 1.0$$

$$\text{FN VG}(19) = 0 + 0 + 1 * 1 * 3 * .5 = 1.5$$

$$\text{FN VG}(20) = 0 + 0 + 1 * 1 * 4 * .5 = 2.0$$

$$\text{FN VG}(36) = 0 + 0 + 1 * 1 * 20 * .5 = 10.0$$

The & routines allow more flexibility and are used for the plotting routine and by the cursor drawing routine.

The syntax for plotting is:

```
& H PLOT (arg1, arg2, arg3, arg4, arg5)
```

where

arg1 is the trace number

- if arg1 = 0 all traces are plotted
- if $1 \leq \text{arg1} \leq 12$ - then only the specified trace is plotted
- if arg1 < 0 or arg1 > 12 - SYNTAX ERROR

arg2 is the location of the vertical gain for trace 1.

- the gains are stored segmentally in an integer array. If the array value is 256 the gain is 1, 128 \Rightarrow .5, 64 \Rightarrow .25, 512 \Rightarrow 2, 1024 \Rightarrow 4, 384 \Rightarrow 1.5, etc.

arg3 is the horizontal scaling

- 1 - every 4th pt is displayed
- 2 - every 2nd pt is displayed
- 4 - every pt is displayed
- 8 - every pt is displayed twice.

arg4 is the location of the starting point for trace 1

- the starting point is also stored in an integer array and is restricted to being between 1 and 800

arg5 is the variable area flag

- if arg5 = 0 wiggle trace
- if arg5 = 1 variable area

For example (see 31000)

```
& H PLOT (TR, GN%(0), FN HG(HS), OG%(0),0).
```