UNITED STATES DEPARTMENT OF THE INTERIOR

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Coal-seismic, desktop computer programs in BASIC; part 7: display and compute shear-pair seismograms

by

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ABSTRACT

Processing of geophysical data taken with the U.S. Geological Survey's coal-seismic system is done with a desk-top, stand-alone computer. Programs for this computer are written in the extended BASIC language utilized by the Tektronix 4051 Graphic System. This report discusses and presents five computer programs used to display and compute shear-pair seismograms.

INTRODUCTION

A shear pair is a set of two records taken along the same spread of detectors but with the shear-wave source struck in opposite directions. The pair of seismograms can be displayed in two ways: by superposing both records on one plot with coding used to identify the constituent records, or by summing the two records before display as a single record. If the two records are summed after reversing the polarity of one of them, then shear-wave arrivals tend to be enhanced; if the summing is done without reversal, then P-wave arrivals are emphasized. Examples of both procedures are presented in this report.

These data processing procedures were developed as part of the U.S. Geological Survey's coal-seismic system. The computer programs were written in an extended BASIC language developed by Tektronix, Inc. for use with their 4051 Graphic System. The programs require five pieces of Tektronix equipment: a 4051 Graphic System with a 32K-byte memory, a 4924 digital cartridge tape drive, a 4662 interactive digital plotter, a 4631 Hard Copy unit, and a Data Processing ROM. In addition, a special ROM (discussed in the last section) is used.

Figures 1 and 2 are screen copies of the two seismic records used to demonstrate shear-pair displays and computations. The records on figure 1 have not been processed beyond fixed-gain display; the records on figure 2 have been muted and normal-moveout (NMO) corrected. Programs used in the preparation of figures 1 and 2 also are used in the last section of this report within which the sum and difference procedures are described.

In the display of the uncorrected records, figure 1, the offset (O/S)--distance from the source point (SP) to the detector in meters--for each of the 12 traces of the record is listed in the left column; the position number (PN)--an odd number assigned to each detector position--is listed in the right column. Use of the position number in combination with the source point and line number allows numerical specification of each detector and subsurface (midpoint) position within a given prospect. Thus with a larger memory computer or a disc-storage unit, one could store and later retrieve each trace for processing such as common midpoint (CMP) or common offset.

Each 12-trace record (identified by an eight-digit header; for example: 13540031) is stored on a master data tape (MDT) identified by a five-character code name; for example, AR2UT. Each MDT can contain 10 records. The amplitude shown on the far right at the top of the display (Ampl=) is the value of a multiplier applied to the data before they are plotted at the indicated plot sample interval (SI).

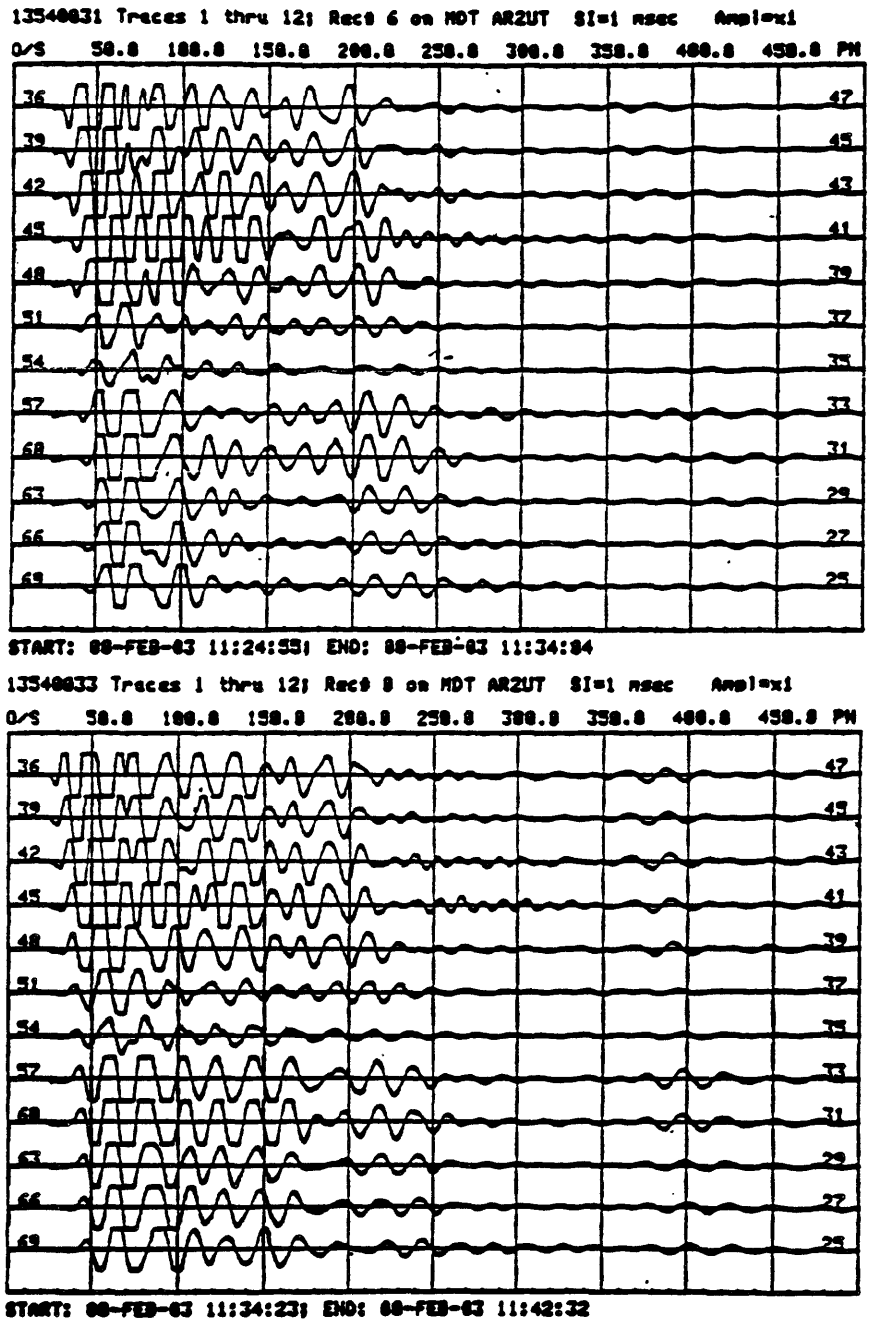

Figure 1. Copies of screen displays of the constituent shear-pair records with no processing other than fixed-gain display.

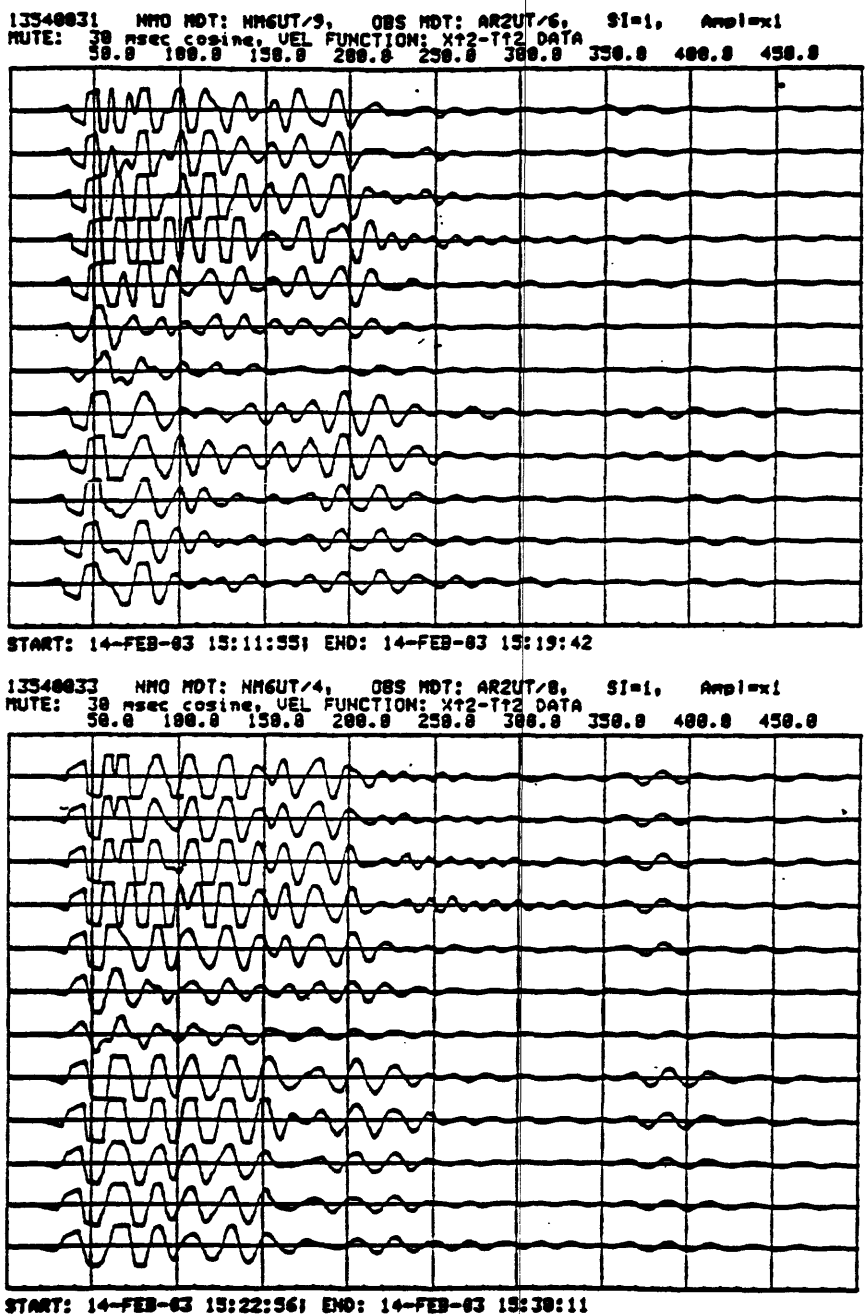

Figure 2. Copies of screen display of the two demonstration records with a 30-msec cosine-taper mute and NMO correction applied.

CODED WORK PLOT DISPLAYS

This section of the report gives examples of coded work plots of shear-pair seismograms. The quick-plot (hard copy display only) routine assumes data were acquired using a single-ended spread with 12 equally spaced detectors. Shown on figure 3 are the data entered (in boxes) and the plot produced by the coded work plot program for the unprocessed shear-pair records.

Because the two records of a shear pair may be on different MDT's, you must enter code names for both. You next choose the records that are to be displayed as the first and second ones. Traces of the first record of the shear pair are drawn with a solid line; traces of the second record are shown with a dashed line.

Although you must enter the trace offset and position number for traces 1 and 12, you have the option of plotting less than all 12 traces. The program also requires entry of the position number of the source point (SP). Given the position numbers of source point and detectors, the program computes and then displays subsurface position numbers (SS) in a column on the left side of the work plot. Offsets (O/S) and position numbers (PN) of each trace are listed in columns on the right side of the plot.

After entering the SP number, you are prompted to enter the type of source and detector types as T, R, or V; corresponding to transverse, radial, and vertical, respectively. The ordered pair of source/detector orientations is printed on the bottom line of the record display.

If you elect to multiply trace amplitudes by a constant, then this factor is applied to all traces. In the work plot program, the default condition is to display a shear pair with the polarity of the second record reversed; thus, the program applies a negative multiplier to the second record. If you want to see the second record without reversal, you must enter a minus amplitude multiplier for the second record in order to restore it to its original polarity.

With the work plot program you can elect to increase the sample interval; however, the plot sample interval must be an integral multiple of the original, the value of which is included in the header code. Each seismic record carries its own eight-digit header stored as the lead data block for each record on the magnetic tape. The header is coded as follows: first three numbers are the date, fourth number indicates the sample interval in msec (1=0.05, 2=0.1, 3=0.2, 4=0.5, 5=1.0, and 6=2.0), next two numbers are the delay in tens of msec, and the seventh value is the record number of the tape number shown as the eighth value. Thus in the example shown on figure 3, the sixth record stored on master data tape AR2UT was taken on the 135th day at a sample interval of 0.5 msec with a zero delay and it was the third record of the first tape taken on that day.

The bottom line on the record display tells us that the source was at source point (SP) 2 of wave test (WT) 1 and that the source position number was 69 along line 1 of the wave test. The date and time shown on this line appear only if your computer contains a clock.

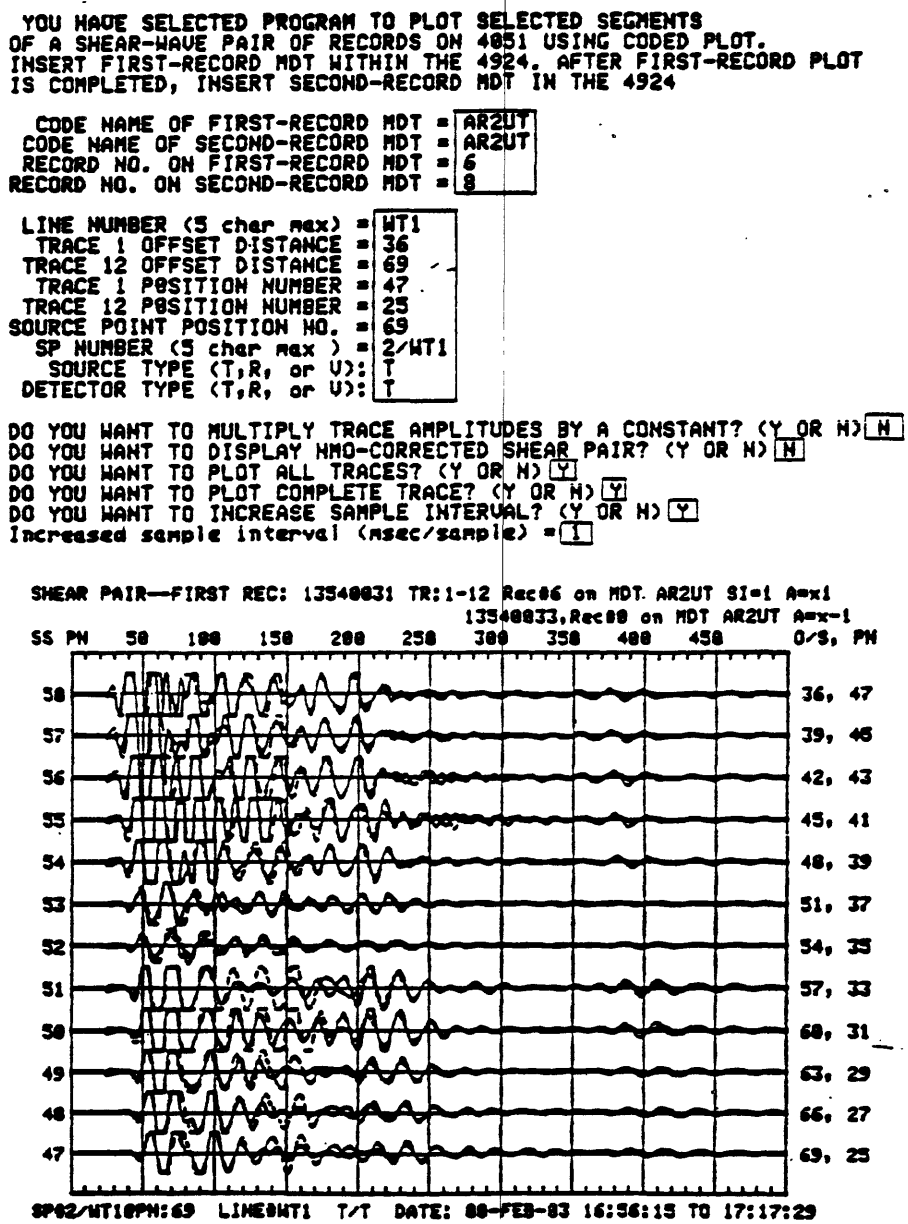

Figure 3. Information entered and coded work plot produced using the unprocessed demonstration records of figure 1.

Figure 4 shows an example of the data entered and the record produced by the coded work plot program after you have elected to display the NMO-corrected records of figure 2. With this quick-plot routine, you may select a trace-amplitude multiplier, but you are not given the choice of sample interval, traces, or trace length as these selections already have been made on the NMO-corrected record.

The shear-pair records of figure 3 and 4 clearly show the arrivals that are probably shear waves (those in phase or nearly in phase after reversal of polarity of one of the constituent records), and those arrivals that are most likely P-waves (those paired traces that interlace each other). Note that phase shifts do not always equal 0 or 180 deg, and that the second record may differ from the first record in aspects other than phase.

PLOTTER DISPLAY OF SHEAR-PAIR RECORDS

Using the programs of this report, shear-pair records can be displayed in two ways: 1. by making a hard copy of the results displayed on the screen (the quick plot), and 2. by using an interactive digital plotter (the final plot). Although it is approximately three times faster to plot and copy results from the screen than it is to make displays with the digital plotter, what one gains in speed, one loses in quality and versatility of display. With the screen display you are limited to one orientation and one size of lettering (72 letters per line); therefore, if you were to print all that you might like on a line, not enough room may be left to plot the data. The purpose of the work plot is to display the significant information and to do so in the quickest time. If you must enter three full screen displays of information before the plot is made, as is the case with the digital-plotter procedure, then the objective of a quick plot is defeated.

Figures 5a and 5b illustrate the information to be entered to produce the digital-plotter record on figure 6. Data for this example are the same as used on figure 3. For entering the 60-character plot identification, the cursor is positioned exactly 60 characters before the end of the line. As before, you enter the appropriate code names and record numbers of the shear-pair records to be plotted. The plot code menu lists five available plot modes. In this example, the first record is displayed using a high-density, variable-area presentation--code 2 on the menu. The second record uses the solid-line, wiggle-trace display mode--code 3 on the menu. When the high-density variable-area display is called, fill-in is done with vertical lines spaced at the sample interval; with the low-density, variable-density mode, a vertical fill-in line is drawn at every fifth sample-interval position.

Trace information for the first record is entered as shown on the bottom half of figure 5a. If you elect to use the same plot multiplier and plot code for all traces, then you will need to enter only the component code letters and SP-seismometer distances as shown by the boxed quantities.

Shown on figure 5b are the trace data for the second record and the entries to obtain the desired trace-time and plot sample intervals.

```
YOU HAVE SELECTED PROGRAM TO PLOT SELECTED SEGMENTS
OF A SHEAR-WAVE PAIR OF RECORDS ON 4851 USING CODED PLOT.
INSERT FIRST-RECORD MDT WITHIN THE 4924. AFTER FIRST-RECORD PLOT
IS COMPLETED, INSERT SECOND-RECORD MDT IN THE 4924

  CODE NAME OF FIRST-RECORD MDT = NM6UT
 CODE NAME OF SECOND-RECORD MDT = NM6UT
 RECORD NO. ON FIRST-RECORD MDT = 9
RECORD NO. ON SECOND-RECORD MDT = 4

 LINE NUMBER (5 char max) = WT1
  TRACE 1 OFFSET DISTANCE = 36
 TRACE 12 OFFSET DISTANCE = 69
  TRACE 1 POSITION NUMBER = 47
 TRACE 12 POSITION NUMBER = 25
SOURCE POINT POSITION NO. = 69
  SP NUMBER (5 char max ) = 2/WT1
   SOURCE TYPE (T,R, or V): T
 DETECTOR TYPE (T,R, or V): T

DO YOU WANT TO MULTIPLY TRACE AMPLITUDES BY A CONSTANT? (Y OR N) N
DO YOU WANT TO DISPLAY NMO-CORRECTED SHEAR PAIR? (Y OR N) Y
```

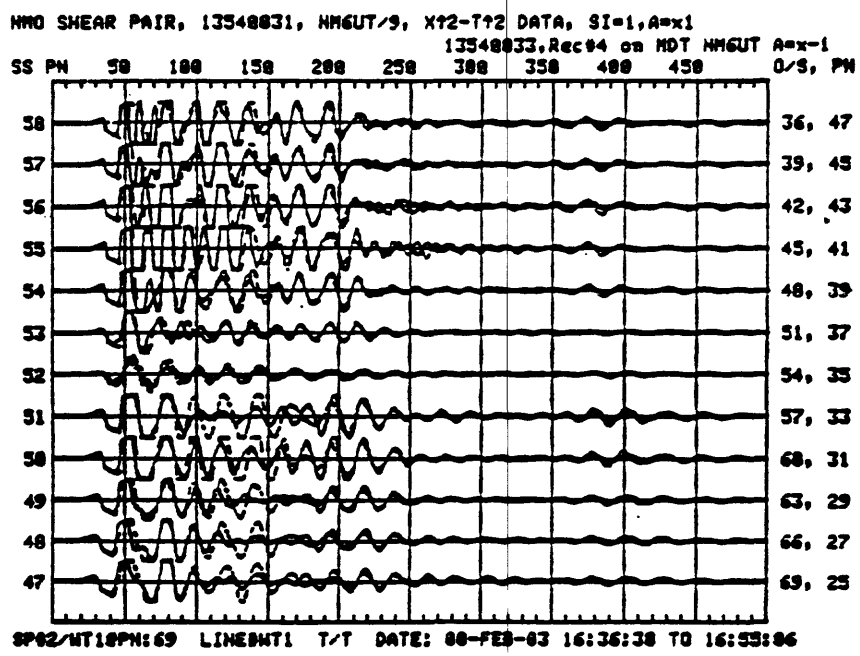

Figure 4. Information entered and coded work plot produced using muted and NMO-corrected demonstration records.

```
PROGRAM FOR FINISH PLOT OF 12-TRACE, SHEAR-PAIR

SET LEGAL-SIZE PAPER (8.5 X 14 in) AT LOWER-LEFT CORNER

WERE DETECTORS EQUALLY SPACED? (Y OR N) [Y]

DO YOU WANT NMO-CORRECTED DATA? (Y OR N) [N]

PLOT IDENT. NAME (60 characters max)=
          [W191 NEAR VERNAL,UTAH, SP-2(NSE), SPD 2 TO 9, AR2UT-REC:6&8]
 MDT code name of first record = [AR2UT]      Record number = [6]
MDT code name of second record = [AR2UT]      Record number = [8]

NOTE: IF MDT CODES DIFFER, WARNING BELL SOUNDS AT FINISH OF
FIRST PLOT AND NEW MDT NUMBER IS PRINTED AT LOWER,LEFT CORNER
OF SCREEN. TO CONTINUE, ENTER A "Y" AND THEN HIT RETURN KEY


PLOT CODE MENU
1: Low density VA
2: High density VA
3: Solid line wiggle trace
4: Short dash wiggle trace
5: Long and short dash wiggle trace

READY TO PROCEED? (Y OR N) [Y]


TRACE INFORMATION TABLE FOR FIRST RECORD
NUMBER OF BLOWS=[5]
WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) [Y]
Common amplifier gain (in multiples of 1 K)=[5]
DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) [Y]
Common plot multiplier=[1]
DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) [Y]
Common plot code=[2]

COMPONENT CODE (1 char): R=RADIAL, T=TRANSVERSE, V=VERTICAL

COMPONENT  SP-SEIS  AMPLIFIER   PLOT AMPL.  PLOT
(1 char.)   DIST.   GAIN(in K) MULT(-=REV)  CODE
    [T]      [36]        5           1         2
     T       [39]        5           1         2
     T       [42]        5           1         2
     T       [45]        5           1         2
     T       [48]        5           1         2
     T       [51]        5           1         2
     T       [54]        5           1         2
     T       [57]        5           1         2
     T       [60]        5           1         2
     T       [63]        5           1         2
     T       [66]        5           1         2
     T       [69]        5           1         2

READY TO PROCEED? (Y OR N) [Y]
```

Figure 5a. Copy of screen display showing the first group of data entered to produce the digital-plotter record on figure 6.

```
TRACE INFORMATION TABLE FOR SECOND RECORD
NUMBER OF BLOWS=5
WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) Y
Common amplifier gain (in multiples of 1 K)=5
DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) Y
Common plot multiplier=-1
DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) Y
Common plot code=3

AMPLIFIER   TRACE AMPL.   PLOT
GAIN(in K)  MULT(--REV)   CODE
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3
     5          -1          3

INSERT MDT AR2UT WITHIN THE 4924

READY TO PROCEED? (Y OR N) Y

FIRST-RECORD DATA WERE RECORDED WITH DELAY=0 & SI=0.5

DO YOU WANT COMPLETE TRACE-TIME INTERVAL? (Y OR N) Y

DO YOU WANT TO INCREASE SI? (Y OR N) Y
Increased SI(msec/sample)=1
```

Figure 5b. Copy of screen display showing the second group of data entered to produce the digital-plotter record on figure 6.

After making the entries shown on figure 5a and 5b, the digital-plotter display on figure 6 is produced.

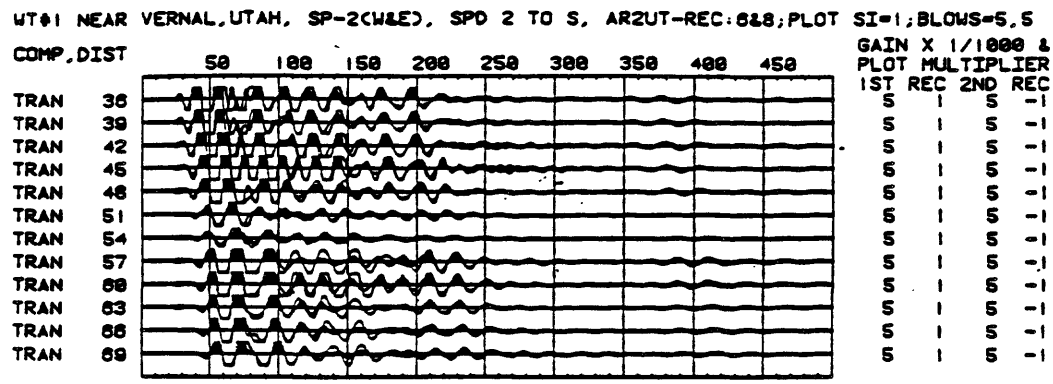

Figure 6. Digital-plotter display of the shear-pair record after entering the information shown on figures 5a and 5b.

Figure 7 shows the same shear-pair data as figure 6, except that the plot multiplier was increased from 1 to 2 and the plot was limited to show only those data in a window from 100 to 300 msec. Vertical lines

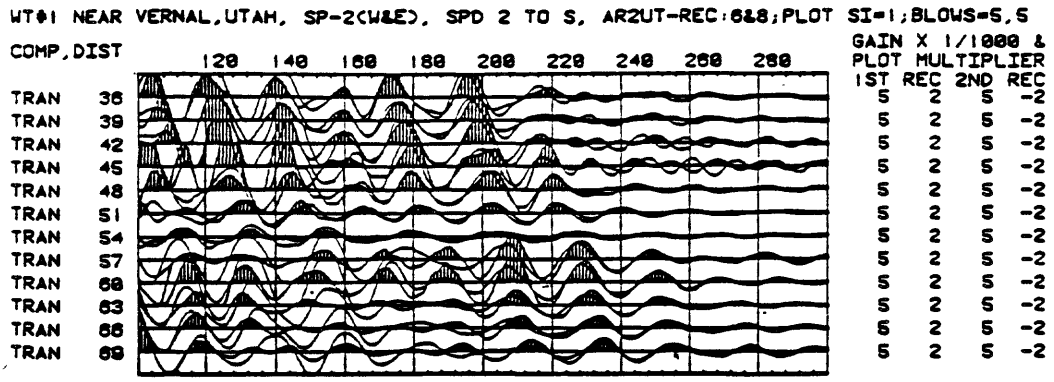

Figure 7. Digitial-plotter display of the shear pair record segment from 100 to 300 msec with amplitudes twice those shown on figure 6.

drawn in making the variable-area display of the first record of the shear pair are more distinctly shown on figure 7 than on figure 6 because the record on figure 7 has been stretched as a result of using the shorter window. The arrivals are shown in more detail in this display, and since vertical lines used to make the variable-area presentation are at the plot sample interval of 1 msec, these lines can be used as timing lines to guide the picking of trace times to the nearest half msec. Also, with the expanded-time-scale display, traces of the second record are not masked as they are when a more dense variable-area presentation is made. For a less-dense fill-in effect, select plot code 1.

The record segment from 300 to 500 msec is shown on figure 8. Here individual trace multipliers have been selected so as to produce a record whose trace amplitudes are in better balance.

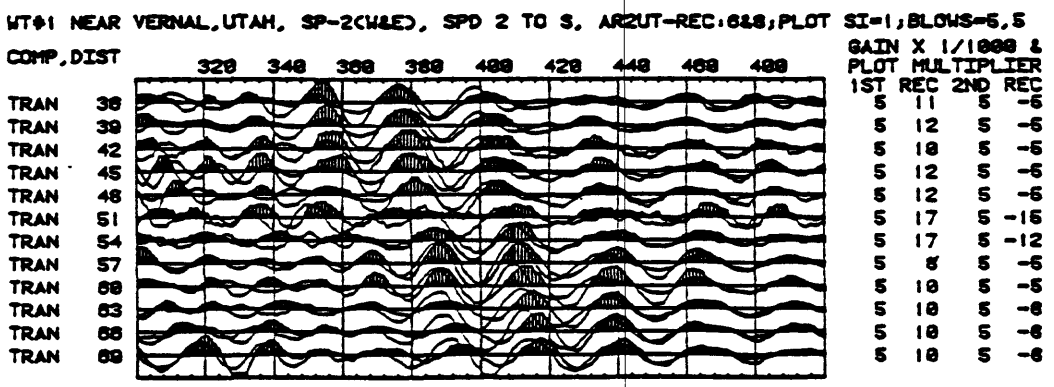

Figure 8. Digital-plotter display of the shear-pair record segment from 300 to 500 msec. Individual trace multipliers were selected to produce a better balance of trace amplitudes.

An example of information entered when detectors are unequally spaced and are not of the same type, such as when three-component seismometers are employed, is displayed on figures 9a and 9b. Graphic display units (GDU) with the digital plotter of this report are expressed in English units with 10 GDU = 1 inch.

After entering the information on figures 9a and 9b, the digital-plotter display on figure 10 is produced. To indicate that the three-component detectors are grouped at single positions, additional space is left between the three-trace sets. The last two entries on the top line of the digital-plotter display are the sample interval used on the plot (0.5 msec on fig. 10) and the number of impacts or blows against the shear-wave source for the first and second records respectively (BLOWS=5,5 on fig. 10).

Figure 11 is a copy of the screen display showing a NMO-corrected record displayed with the digital plotter. Here, in contrast to the work plot display, one may select the display window--50 to 450 msec in this example.

```
PROGRAM FOR FINISH PLOT OF 12-TRACE, SHEAR-PAIR

SET LEGAL-SIZE PAPER (8.5 X 14 in) AT LOWER-LEFT CORNER OF 4662 PLOTTER

WERE DETECTORS EQUALLY SPACED? (Y OR N) N
ESTABLISH RECORD SIZE AND TRACE POSITIONS ON PLOT
NOTE: WITH THE 4662 PLOTTER, 1 GRAPHIC DISPLAY UNIT (GDU) = 0.1 INCH

ENTER OUTER DIMENSIONS OF RECORD'S BORDER IN GDU'S
Upper border (must be <71) = 70
Lower border (must be =>0) = 2
 Left border (must be >14) = 15
Right border (must be <101)= 100

TRACE POSITION IN GDU'S
TRACE    VERT. POSITION
  1            64
  2            60
  3            56
  4            48
  5            44
  6            40
  7            32
  8            28
  9            24
 10             16
 11             12
 12              8

DO YOU WANT NMO-CORRECTED DATA? (Y OR N) N

PLOT IDENT. NAME (60 characters max)=
          ASSUMED 3-COMP RECORD PLOTTED WITH UNEQUALLY SPACED OPTION
 MDT code name of first record = AR2UT       Record number = 6
MDT code name of second record = AR2UT       Record number = 8

NOTE: IF MDT CODES DIFFER, WARNING BELL SOUNDS AT FINISH OF
FIRST PLOT AND NEW MDT NUMBER IS PRINTED AT LOWER,LEFT CORNER
OF SCREEN. TO CONTINUE, ENTER A "Y" AND THEN HIT RETURN KEY


PLOT CODE MENU
1: Low density VA
2: High density VA
3: Solid line wiggle trace
4: Short dash wiggle trace
5: Long and short dash wiggle trace

READY TO PROCEED? (Y OR N) Y
```

Figure 9a. Copy of screen display showing information entered when detector interval and type are not the same for all traces. Data entry is continued on the next page, figure 9b.

```
TRACE INFORMATION TABLE FOR FIRST RECORD
NUMBER OF BLOWS=5
WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) Y
Common amplifier gain (in multiples of 1 K)=5
DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) Y
Common plot multiplier=1
DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) Y
Common plot code=2

COMPONENT CODE (1 char): R=RADIAL, T=TRANSVERSE, V=VERTICAL

COMPONENT  SP-SEIS   AMPLIFIER   PLOT AMPL.   PLOT
(1 char.)   DIST.   GAIN(in K) MULT(--=REV)  CODE
    T        102         5           1         2
    R        102         5           1         2
    V        102         5           1         2
    T        105         5           1         2
    R        105         5           1         2
    V        105         5           1         2
    T        108         5           1         2
    R        108         5           1         2
    V        108         5           1         2
    T        111         5           1         2
    R        111         5           1         2
    V        111         5           1         2

READY TO PROCEED? (Y OR N) Y


TRACE INFORMATION TABLE FOR SECOND RECORD
NUMBER OF BLOWS=5
WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) Y
Common amplifier gain (in multiples of 1 K)=5
DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) Y
Common plot multiplier=-1
DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) Y
Common plot code=3

AMPLIFIER   TRACE AMPL.   PLOT
GAIN(in K)  MULT(--=REV)  CODE
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3
     5           -1         3

INSERT MDT AR2UT WITHIN THE 4924

READY TO PROCEED? (Y OR N) Y
FIRST-RECORD DATA WERE RECORDED WITH DELAY=0 & SI=0.5

DO YOU WANT COMPLETE TRACE-TIME INTERVAL? (Y OR N) N
Start record time=100
  End record time=200

DO YOU WANT TO INCREASE SI? (Y OR N) N
```

Figure 9b. Continuation of screen display showing information entered when detector interval and type are not the same for all traces.

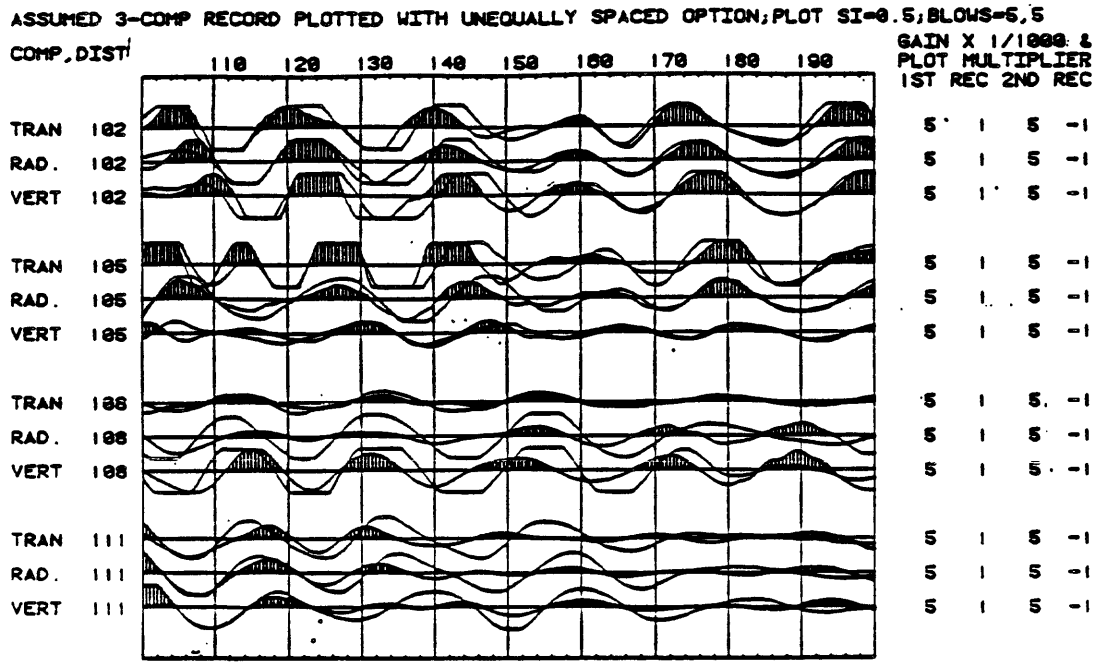

Figure 10. Digital-plotter display using data entered in figure 9.

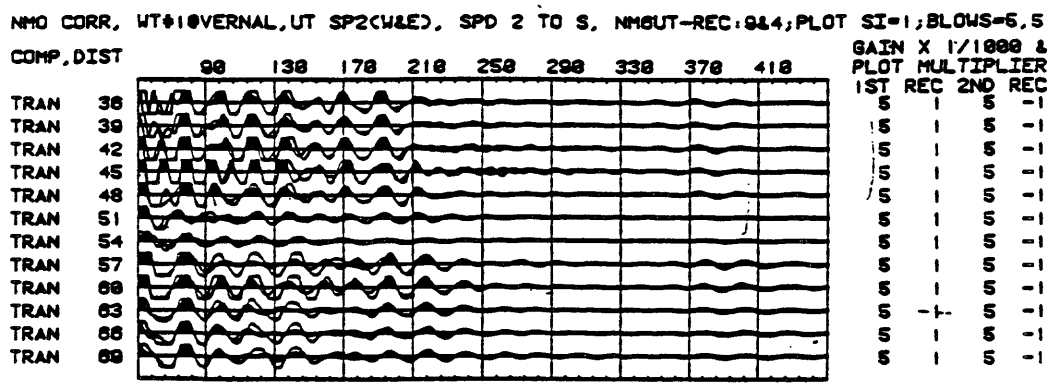

Figure 11. Digital-plotter display of record segment of NMO-corrected record.

COMPUTATION AND DISPLAY OF SUMMED OR DIFFERENCED RECORDS

A pure shear-wave source embedded in the surface of a layered medium of no dip will produce only SH (shear-horizontal) arrivals. Under these ideal conditions, the two constituent records of the shear pair should be completely out of phase with each other; that is, upward moving traces on one record should be mirrored by downward moving traces on the other record of the pair. If the two records of an ideal shear pair are summed, then complete cancellation will occur; if the polarity of the second record is reversed before the two records are summed, then the resulting record will have twice the amplitude of the first record. Let us term the record obtained by directly summing the two records of the shear pair a 'summed record', and term the record obtained by first reversing the polarity of one of the records and then summing a 'differenced record'.

One common method of emphasizing shear arrivals is to produce a differenced record from the shear pair. Conversely, the summed record can be used to enhance P-wave arrivals. Computer programs to perform this summing and differencing and to display the results are discussed and presented in this section of this report.

Figure 12 is a copy of the screen display showing information

```
PROGRAM TO PRODUCE SUMMED OR DIFFERENCED MDT

NOTE: INTERMEDIATE OPERATIONS REQUIRE THE USE OF A HOLDING
      TAPE WHICH MUST BE MARKED AS FOLLOWS:
      FIND 1, MARK 1,512
      FIND 2, MARK 24,3872

INSERT PRE-MARKED HOLDING TAPE IN 4951 AND FIRST RECORD MDT IN 4924
ARE YOU READY TO PROCEED? (Y OR N) Y

DO YOU WANT TO COMBINE NMO-CORRECTED MDT'S (Y OR N) N

CODE NAME OF  FIRST-RECORD MDT = AR2UT
CODE NAME OF SECOND-RECORD MDT = AR2UT
RECORD NO. ON FIRST-RECORD MDT = 6
RECORD NO.ON SECOND-RECORD MDT = 8
     CODE NAME OF SUM/DIFF MDT = SD1UT
 RECORD NUMBER ON SUM/DIFF MDT = 1

DO YOU WANT TO PRODUCE A SUMMED TRACE-BY-TRACE MDT? (Y OR N) Y
TRANSFER OF RECORD 6 (HEADER:13540031) TO HOLDING TAPE COMPLETED
TRANSFER OF RECORD 8 (HEADER:13540033) TO HOLDING TAPE COMPLETED

REMOVE PAIRED-RECORD MDT FROM 4924 AND INSERT S/D MDT
ARE YOU READY TO PROCEED? (Y OR N) Y

PROGRAM COMPLETED   START: 14-FEB-83 10:28:04  END: 14-FEB-83 10:32:04
```

Figure 12. Copy of screen display showing information entered to produce the summed shear-pair record: SD1UT/1.

entered to produce a summed shear-pair record (the P-wave enhanced, SH-diminshed record) stored as record 1 on MDT: SD1UT, (SD1UT/1). Figure 13 displays screen copies that show the information entered and the plot

```
PROGRAM TO QUICK-PLOT SELECTED CONTENTS OF MDT ON SCREEN
INSERT MDT WITHIN THE 4924
CODE NAME OF MDT = SD1UT
RECORD NO ON MDT = 1
DO YOU WANT TO CHANGE TRACE AMPL? (Y OR N) N
DO YOU WANT A PLOT OF ALL TRACES? (Y OR N) Y
ARE ALL DETECTORS EQUALLY SPACED? (Y OR N) Y
OFFSET TO TRACE  1 = 36
     PN OF TRACE  1 = 47
OFFSET TO TRACE 12 = 69
     PN OF TRACE 12 = 25
DO YOU WANT TO PLOT COMPLETE TRACE? (Y OR N) Y
DO YOU WANT TO INCREASE SAMPLE INT? (Y OR N) Y
Increased sample interval (msec/sample) = 1
```

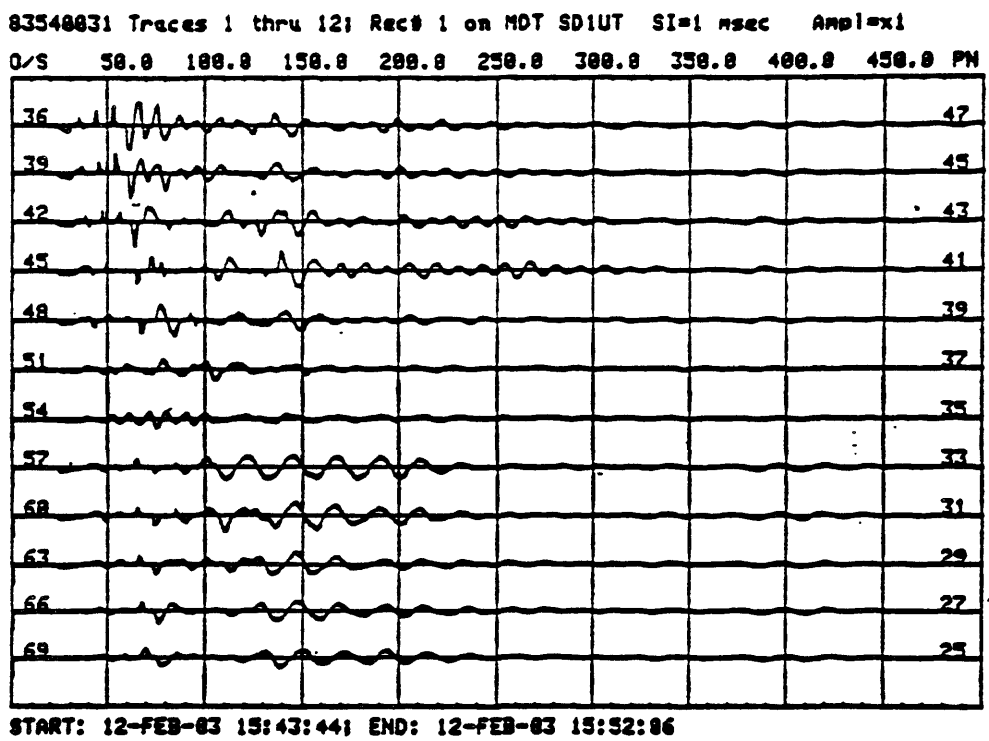

Figure 13. Copy of screen displays showing information entered and resulting plot using the summed shear-pair record: SD1UT/1.

produced using the record generated in the summing operation as illustrated on figure 12.

Figure 14 is a copy of the screen display showing information entered to produce a differenced shear-pair record (the SH- enhanced, P-wave diminshed record) stored as record 2 on MDT: SD1UT, (SD1UT/2).

```
PROGRAM TO PRODUCE SUMMED OR DIFFERENCED MDT

NOTE: INTERMEDIATE OPERATIONS REQUIRE THE USE OF A HOLDING
      TAPE WHICH MUST BE MARKED AS FOLLOWS:
      FIND 1, MARK 1,512
      FIND 2, MARK 24,3072

INSERT PRE-MARKED HOLDING TAPE IN 4051 AND FIRST RECORD MDT IN 4924
ARE YOU READY TO PROCEED? (Y OR N) Y

DO YOU WANT TO COMBINE NMO-CORRECTED MDT'S (Y OR N) N

CODE NAME OF  FIRST-RECORD MDT = AR2UT
CODE NAME OF SECOND-RECORD MDT = AR2UT
RECORD NO. ON FIRST-RECORD MDT = 6
RECORD NO.ON SECOND-RECORD MDT = 8
     CODE NAME OF SUM/DIFF MDT = SD1UT
 RECORD NUMBER ON SUM/DIFF MDT = 2

DO YOU WANT TO PRODUCE A SUMMED TRACE-BY-TRACE MDT? (Y OR N) N
YOU HAVE ELECTED TO PRODUCE A TRACE-BY-TRACE DIFFERENCE MDT
TRANSFER OF RECORD 6 (HEADER:13540031) TO HOLDING TAPE COMPLETED
TRANSFER OF RECORD 8 (HEADER:13540033) TO HOLDING TAPE COMPLETED

REMOVE PAIRED-RECORD MDT FROM 4924 AND INSERT S/D MDT
ARE YOU READY TO PROCEED? (Y OR N) Y

PROGRAM COMPLETED   START: 12-FEB-83 16:22:08; END: 12-FEB-83 16:56:51
```

Figure 14. Copy of screen display showing information entered to produce the differenced shear-pair record: SD1UT/2.

Figure 15 displays screen copies showing the information entered and the plot produced using the record (SD1UT/2) generated in the differencing operation as illustrated on figure 14. Comparison of figures 13 and 15 indicates that the dominant arrivals are shear waves.

Records produced by the sum and difference procedures (in the examples, those stored on MDT: SD1UT) carry an eight-digit header whose last seven digits are those of the header of the first record of the shear pair and whose first digit is an eight for the summed and a nine for the differenced record.

If sums or differences are to be made using a pair of NMO-corrected records, then information such as that shown on figure 16 is entered. The format for data entry is identical to that of previous examples--the questions are the same, but different responses are entered.

```
PROGRAM TO QUICK-PLOT SELECTED CONTENTS OF MDT ON SCREEN
INSERT MDT WITHIN THE 4924
CODE NAME OF MDT = SD1UT
RECORD NO ON MDT = 2
DO YOU WANT TO CHANGE TRACE AMPL? (Y OR N) N
DO YOU WANT A PLOT OF ALL TRACES? (Y OR N) Y
ARE ALL DETECTORS EQUALLY SPACED? (Y OR N) Y
OFFSET TO TRACE  1 = 36
     PN OF TRACE  1 = 47
OFFSET TO TRACE 12 = 69
     PN OF TRACE 12 = 25
DO YOU WANT TO PLOT COMPLETE TRACE? (Y OR N) Y
DO YOU WANT TO INCREASE SAMPLE INT? (Y OR N) Y
Increased sample interval (msec/sample) = 1
```

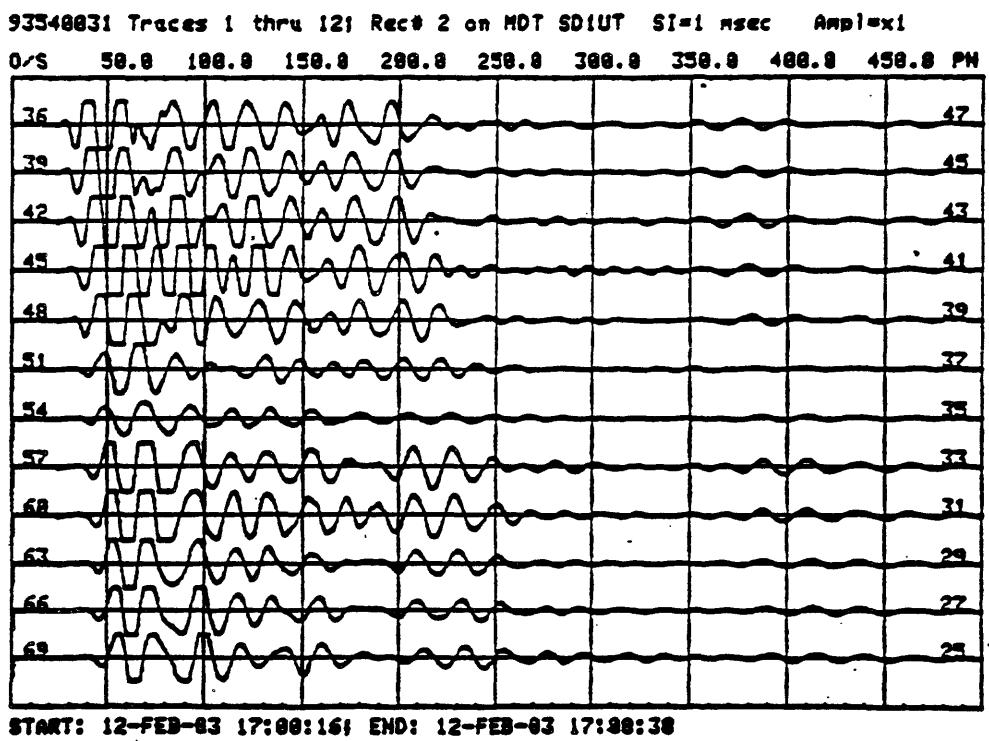

Figure 15. Copy of screen displays showing information entered and resulting plot using differenced record: SD1UT/2.

```
PROGRAM TO PRODUCE SUMMED OR DIFFERENCED (S/D) MDT

NOTE: INTERMEDIATE OPERATIONS REQUIRE THE USE OF A HOLDING
      TAPE WHICH MUST BE MARKED AS FOLLOWS:
      FIND 1, MARK 1,512
      FIND 2, MARK 24,3072

INSERT PRE-MARKED HOLDING TAPE IN 4051 AND FIRST RECORD MDT IN 4924
ARE YOU READY TO PROCEED? (Y OR N) Y

DO YOU WANT TO COMBINE NMO-CORRECTED MDT'S (Y OR N) Y

CODE NAME OF  FIRST-RECORD MDT = NM6UT
CODE NAME OF SECOND-RECORD MDT = NM6UT
RECORD NO. ON FIRST-RECORD MDT = 9
RECORD NO.ON SECOND-RECORD MDT = 4
     CODE NAME OF SUM/DIFF MDT = SD1UT
 RECORD NUMBER ON SUM/DIFF MDT = 3

DO YOU WANT TO PRODUCE A SUMMED MDT? (Y OR N) Y
TRANSFER OF RECORD 9 (HEADER:13540831) TO HOLDING TAPE COMPLETED
TRANSFER OF RECORD 4 (HEADER:13540833) TO HOLDING TAPE COMPLETED

REMOVE PAIRED-RECORD MDT FROM 4924 AND INSERT S/D MDT
ARE YOU READY TO PROCEED? (Y OR N) Y

PROGRAM COMPLETED   START: 14-FEB-83 13:34:33; END: 14-FEB-83 13:44:18
```

Figure 16. Copy of screen display showing information to be entered to produce a summed record: SD1UT/3 using NMO-corrected records.

Figure 17 displays screen copies that show the information entered and the plot produced using the record (SD1UT/3) generated in the summing operation illustrated in figure 16. Figure 18 shows a screen copy of the plot produced using the record (SD1UT/4) generated in differencing the two NMO-corrected records.

COMMENTS ON AND LISTINGS OF THE PROGRAMS

In order to put the programs of this report to work, you must know how to perform the following operations:

1. transcribe the programs into the computer,
2. store the programs on magnetic tape,
3. retreive the programs from magnetic tape,
4. enter information from the keyboard,
5. copy the screen display, and
6. make a display on the digital plotter.

These tasks are well documented in the computer's operator's manuals.

Four control characters (ones requiring the holding down of the control key as the letter is entered) are used in the programs: G (ring bell), K (move cursor up one line), L (erase screen and move cursor to the HOME position), and the RUB OUT (move cursor to the left margin and down one line). In the printed listing these control characters are shown as G_, K_, L_, and __, respectively.

To achieve maximum data packing on master data tapes, all record

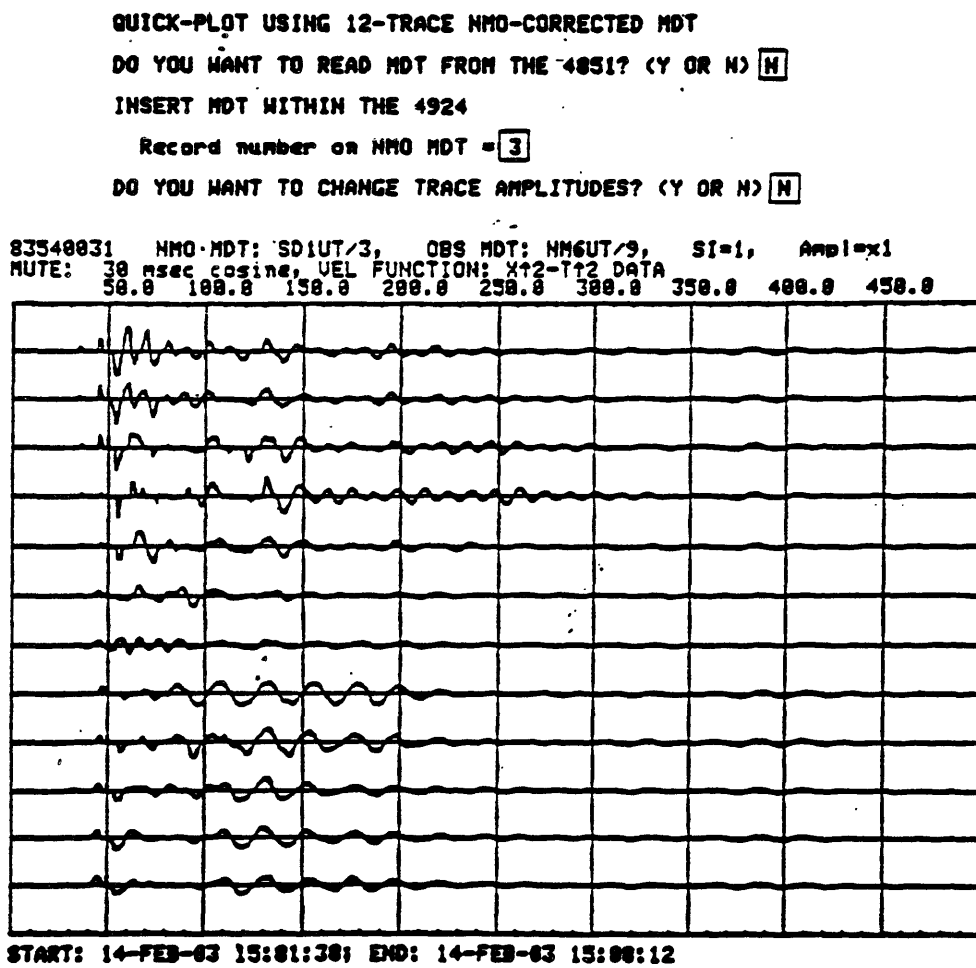

Figure 17. Copy of screen displays showing information entered and resulting plot using summed record SD1UT/3.

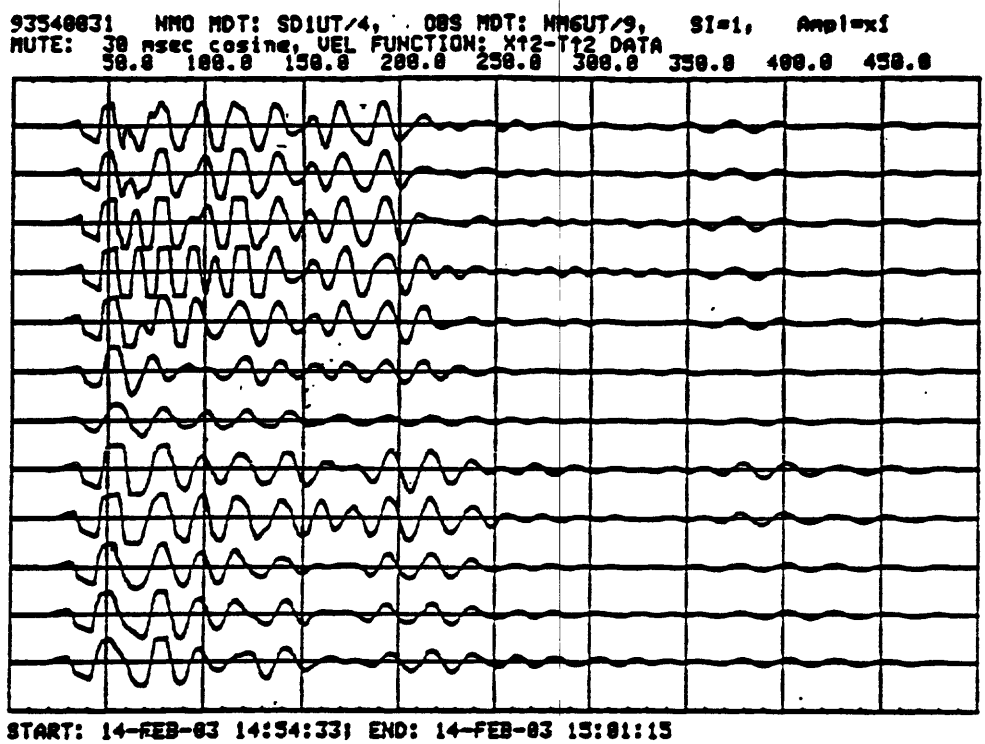

Figure 18. Copy of screen display showing plot produced using the differenced record SD1UT/4.

data are stored as three-byte hexadecimal values. A specially designed ROM is used to convert MDT (master-data-tape) data from hexadecimal to digital values and later to convert digital values to hexadecimal prior to storing them on a master data tape. The occurrences of these ROMs can be recognized in the programs by the statements of the form: CALL "HEXDEC",B$,V,LEN (B$),3 (where B$ is the string variable containing data in hexadecimal and V is the array containing the data in decimal), and CALL "DECHEX",B$,V,1001,3 (where 1001 is the size of the V array).

If your computer does not contain a clock, you must either replace the time statements (for example, CALL "TIME",A$) by a REMARK statement and then remove all references to time-term string variables in various print statements, or you must enter the start and end times using statements (inserted in the appropriate places) such as illustrated below:

```
1000 PRINT "START TIME = ";
1002 INPUT A$
2000 PRINT "END TIME = ";
2002 INPUT B$
```

PROGRAM LISTING FOR SHEAR-PAIR CODED WORK PLOT

```
100 PRINT "L_ YOU HAVE SELECTED PROGRAM TO PLOT SELECTED SEGMENTS"
110 PRINT "OF A SHEAR-WAVE PAIR OF RECORDS ON 4051 USING CODED PLOT. "
120 INIT
130 DIM A$(18), B$(3005), C$(18), G$(1), H$(10), I$(3), L$(4)
140 DIM M$(7), N$(7), P$(5), Q$(5), R$(1), S$(4)
150 DIM V(1002)
160 DATA 1, 6, 115, 6, 92, 1, 1, -1, 1, 1, 1
170 READ B0, C0, C1, D0, D1, N, K2, K3, Q1, Q2, S3
180 CALL "TIME", A$
190 PRINT "G_G_G_INSERT FIRST-RECORD MDT WITHIN THE 4924. AFTER FIRST-";
200 PRINT "RECORD PLOT"
210 PRINT "IS COMPLETED, INSERT SECOND-RECORD MDT IN THE 4924"
220 PRINT "__ CODE NAME OF FIRST-RECORD MDT = ";
230 INPUT N$
240 PRINT " CODE NAME OF SECOND-RECORD MDT = ";
250 INPUT M$
260 PRINT " RECORD NO. ON FIRST-RECORD MDT = ";
270 INPUT R1
280 PRINT "RECORD NO. ON SECOND-RECORD MDT = ";
290 INPUT R2
300 DIM P1(12), P2(12), X(12)
310 PRINT "__ LINE NUMBER (5 char max) = ";
320 INPUT Q$
330 PRINT "  TRACE 1 OFFSET DISTANCE = ";
340 INPUT X(1)
350 PRINT " TRACE 12 OFFSET DISTANCE = ";
360 INPUT X(12)
370 X3=(X(12)-X(1))/11
380 PRINT "  TRACE 1 POSITION NUMBER = ";
390 INPUT P1(1)
400 PRINT " TRACE 12 POSITION NUMBER = ";
410 INPUT P1(12)
420 P3=(P1(12)-P1(1))/11
430 PRINT "SOURCE POINT POSITION NO.  = ";
440 INPUT P4
450 PRINT "  SP NUMBER (5 char max ) = ";
460 INPUT P$
470 D$=" "
480 PRINT "   SOURCE TYPE (T, R, or V): ";
490 INPUT S$
500 PRINT " DETECTOR TYPE (T, R, or V): ";
510 INPUT R$
520 S$=S$&"/"
530 S$=S$&R$
540 FOR J=2 TO 11
550 X(J)=X(J-1)+X3
560 P1(J)=P1(J-1)+P3
570 NEXT J
580 FOR J=1 TO 12
590 P2(J)=0.5*(P4+P1(J))
600 NEXT J
610 PRINT "__DO YOU WANT TO MULTIPLY TRACE AMPLITUDES BY A CONSTANT?";
620 PRINT " (Y OR N) ";
630 INPUT G$
640 IF G$="N" THEN 700
650 PRINT " Trace-amplitude multiplier for first record = ";
660 INPUT K2
670 PRINT "Trace-amplitude multiplier for second record = ";
680 INPUT K3
690 K3=-K3
```

```
700 PRINT "DO YOU WANT TO DISPLAY NMO-CORRECTED SHEAR PAIR? (Y OR N) ";
710 INPUT G$
720 IF G$="N" THEN 760
730 Q2=2
740 DIM O$(7),U$(17),V$(35)
750 GO TO 840
760 PRINT "DO YOU WANT TO PLOT ALL TRACES? (Y OR N) ";
770 INPUT G$
780 IF G$="Y" THEN 840
790 PRINT "At what trace is plot to begin? ";
800 INPUT N1
810 PRINT "  At what trace is plot to end? ";
820 INPUT N2 ,
830 GO TO 860
840 N1=1
850 N2=12
860 N3=N2-N1+1
870 N4=512*(N3+1)
880 GOSUB 1620
890 IF Q2=1 THEN 920
900 GOSUB 3090
910 GO TO 1130
920 GOSUB 1720
930 PRINT "DO YOU WANT TO PLOT COMPLETE TRACE? (Y OR N) ";
940 INPUT G$
950 IF G$="Y" THEN 1010
960 PRINT "  At what record time is plot to begin? ";
970 INPUT T1
980 PRINT "    At what record time is plot to end? ";
990 INPUT T2
1000 GO TO 1030
1010 T1=L
1020 T2=L+T3
1030 PRINT "DO YOU WANT TO INCREASE SAMPLE INTERVAL? (Y OR N) ";
1040 INPUT G$
1050 IF G$="N" THEN 1130
1060 PRINT "Increased sample interval (msec/sample) = ";
1070 INPUT S2
1080 S3=S2/S1
1090 IF S3-INT(S3)=0 THEN 1150
1100 PRINT "ERROR! SELECTED INCREASED S. I.  NOT INTEGRAL MULTIPLE"
1110 PRINT " OF ORIGINAL S. I. --CHOOSE ANOTHER VALUE"
1120 GO TO 1060
1130 S2=S1
1140 S3=S2/S1
1150 L1=1
1160 L2=1
1170 L3=4
1180 L4=S3
1190 PRINT
1200 PAGE
1210 MOVE 0,100
1220 GOSUB 1910
1230 IF Q2=2 THEN 1260
1240 J1=3*(T1-L)/S1+1
1250 J2=3*(T2-L)/S1+1
1260 J3=J2-J1+3
1270 J4=(J2-J1)*S1/S2+3.0001
1280 N5=INT(J4/3)
1290 N6=INT(N5/L3)
1300 D4=D2/(N3+1)
```

```
1310 D5=D1-D4
1320 GOSUB 2040
1330 WINDOW 0,N5-1,-N4,N4
1340 VIEWPORT C0,C1,D0,D1
1350 D5=N4-1024
1360 FOR M=F1 TO F2
1370 GOSUB 2170
1380 GOSUB 2350
1390 NEXT M
1400 IF Q1=2 THEN 1540
1410 WINDOW 0,130,0,100
1420 VIEWPORT 0,130,0,100
1430 MOVE 0,96.5
1440 IF M$=N$ THEN 1480
1450 PRINT "G_G_G_READY FOR SECOND RECORD? (Y OR N) ";
1460 INPUT G$
1470 IF G$="N" THEN 1450
1480 R1=R2
1490 GOSUB 1620
1500 MOVE 64,96.5
1510 PRINT " ";H$;",Rec#";R2;" on MDT ";M$;" A=x";K3
1520 Q1=2
1530 GO TO 1330
1540 CALL "TIME",C$
1550 C$=SEG(C$,11,8)
1560 WINDOW 0,130,0,100
1570 VIEWPORT 0,130,0,100
1580 MOVE 0,2
1590 PRINT "G_G_G_SP#";P$;"@PN:";P4;"  LINE#";Q$;"  ";S$;"  DATE: ";
1600 PRINT A$;" TO ";C$
1610 END
1620 REM *** SUB: FIND AND RETRIEVE HEADER FILE
1630 F1=R1*12+N1-11
1640 F2=R1*12+N2-11
1650 F3=R1*12-10
1660 FIND @2:F3
1670 IF Q2=1 THEN 1700
1680 READ @2:H$,U$,N$,O$,V$,N5,R0,S1,T1,T2
1690 RETURN
1700 READ @2:H$
1710 RETURN
1720 REM *** SUB: DECODE HEADER FILE
1730 I$=SEG(H$,4,1)
1740 L$=SEG(H$,5,2)
1750 S1=VAL(I$)
1760 L=VAL(L$)*10
1770 GO TO S1 OF 1780,1800,1820,1840,1860,1880
1780 S1=0.05
1790 GO TO 1890
1800 S1=0.1
1810 GO TO 1890
1820 S1=0.2
1830 GO TO 1890
1840 S1=0.5
1850 GO TO 1890
1860 S1=1
1870 GO TO 1890
1880 S1=2
1890 T3=1000*S1
1900 RETURN
1910 REM *** SUB: LABEL, PLOT BORDER AND TICKMARKS
```

```
1920 IF Q2=1 THEN 1960
1930 PRINT "NMO SHEAR PAIR,  ";H$;",  ";N$;"/";R1;",  ";V$;
1940 PRINT ",  SI=";S1;", A=x";K2
1950 GO TO 1980
1960 PRINT "SHEAR PAIR--FIRST REC:  ";H$;"  TR:";N1;"-";N2;"  ";
1970 PRINT "Rec#";R1;"  on MDT ";N$;"  SI=";S2;"  A=x";K2
1980 MOVE 0,D1+1
1990 PRINT "SS PN"
2000 GOSUB 2480
2010 MOVE C1+1,D1+1
2020 PRINT "O/S,  PN"
2030 RETURN
2040 REM *** SUB: PRINT SUBSURFACE PN'S, OFFSETS, AND PN'S
2050 IMAGE 3D
2060 IMAGE 3D,",",3D
2070 FOR J=N1 TO N2
2080 MOVE 0,D5-1.3
2090 PRINT USING 2050:P2(J)
2100 MOVE C0,D5
2110 DRAW C1,D5
2120 MOVE C1+0.5,D5-1.3
2130 PRINT USING 2060:X(J),P1(J)
2140 D5=D5-D4
2150 NEXT J
2160 RETURN
2170 REM *** SUB: FIND, RETRIEVE, CONVERT AND SCALE DATA
2180 FIND @2:M
2190 IF M=F3 THEN 2230
2200 READ @2:B$
2210 IF Q2=2 THEN 2280
2220 GO TO 2270
2230 IF Q2=1 THEN 2260
2240 READ @2:H$,U$,N$,O$,V$,N5,R0,S1,T1,T2,B$
2250 GO TO 2280
2260 READ @2:H$,B$
2270 B$=SEG(B$,J1,J3)
2280 V=0
2290 IF Q1=1 THEN 2310
2300 K2=K3
2310 CALL "HEXDEC",B$,V,LEN(B$),3
2320 V=V-511
2330 V=K2*V
2340 RETURN
2350 REM *** SUB: PLOT TRACES
2360 MOVE 0,D5
2370 RMOVE 0,V(1)
2380 IF Q1=1 THEN 2410
2390 GOSUB 2870
2400 GO TO 2460
2410 K=1
2420 FOR J=1 TO N5-1
2430 K=K+S3
2440 RDRAW 1,V(K)-V(K-S3)
2450 NEXT J
2460 D5=D5-1024
2470 RETURN
2480 REM *** SUB: DRAW BORDER AND PLOT TICKMARKS
2490 C2=C1-C0
2500 C3=C2/50
2510 D2=D1-D0
2520 D3=0.5*D2
```

```
2530 MOVE C0,D1
2540 RDRAW C2,0
2550 RDRAW 0,-D2
2560 RDRAW -C2,0
2570 RDRAW 0,D2
2580 GOSUB 2600
2590 GO TO 2720
2600 REM *** SUB: TICKMARKS AND TIME LINES
2610 FOR J=1 TO 10
2620 FOR K=1 TO 4
2630 RMOVE C3,0
2640 RDRAW 0,-B0
2650 RDRAW 0,B0
2660 NEXT K
2670 RMOVE C3,0
2680 RDRAW 0,-D3
2690 RDRAW 0,D3
2700 NEXT J
2710 RETURN
2720 MOVE C0,D0
2730 D3=-D3
2740 B0=-B0
2750 GOSUB 2600
2760 REM *** LABEL TIME LINES
2770 IMAGE 3D
2780 MOVE C0+C2/10-4.1,D1+1
2790 T4=(T2-T1)/10
2800 PRINT USING 2770:T1+T4
2810 FOR K=2 TO 9
2820 RMOVE C2/10,0
2830 PRINT USING 2770:T1+K*T4
2840 NEXT K
2850 RETURN
2860 END
2870 REM *** SUB: PLOT SECOND RECORD USING CODED-TRACE DISPLAY
2880 L=1
2890 FOR J=1 TO N6
2900 FOR I=1 TO L1
2910 L=L+S3
2920 RDRAW 1,V(L)-V(L-S3)
2930 NEXT I
2940 L=L+L4
2950 RMOVE L2,V(L)-V(L-L4)
2960 FOR I=1 TO L2
2970 L=L+S3
2980 RDRAW 1,V(L)-V(L-S3)
2990 NEXT I
3000 L=L+L4
3010 RMOVE L2,V(L)-V(L-L4)
3020 NEXT J
3030 L=L-S3
3040 FOR K=L TO N5
3050 L=L+S3
3060 RDRAW 1,V(L)-V(L-S3)
3070 NEXT K
3080 RETURN
3090 REM *** SUB: CONDITION FOR NMO DISPLAY
3100 DELETE B$,V
3110 DIM B$(3*N5+2),V(N5+1)
3120 J1=1
3130 J2=3*N5-2
3140 RETURN
```

PROGRAM LISTING FOR SHEAR-PAIR FINISHED PLOT

```
100 PRINT "L__PROGRAM FOR FINISH PLOT OF 12-TRACE, SHEAR-PAIR"
110 INIT
120 PRINT "__SET LEGAL-SIZE PAPER (8.5 X 14 in) AT LOWER-LEFT CORNER"
130 DATA 15,95,20,55,24,1,1,1,1,1,1,1,5,2,25
140 READ C1,C2,D1,D2,N9,Q1,Q2,Q3,Q4,Q5,S3,K3,K4
150 DIM A$(3005),B$(11),C$(17),G$(1),H$(10),I$(3)
160 DIM L$(4),M$(7),N$(7),P$(62),U$(50),V$(6)
170 DIM D9(N9),G9(N9),K9(N9),P9(N9),Y9(N9)
180 PRINT "__WERE DETECTORS EQUALLY SPACED? (Y OR N) ";
190 INPUT G$
200 IF G$="N" THEN 230
210 GOSUB 4120
220 GO TO 240
230 GOSUB 4210
240 C3=C2-C1
250 D3=D2-D1
260 A1=D3/13
270 B$="COMP,DIST"
280 C$="GAIN X 1/1000 &"
290 PRINT "__DO YOU WANT NMO-CORRECTED DATA? (Y OR N) ";
300 INPUT G$
310 IF G$="N" THEN 340
320 Q1=2
330 DIM O$(7),R$(17),S$(37)
340 IF Q2=1 THEN 370
350 MOVE 0,0
360 PRINT
370 PRINT "__PLOT IDENT. NAME (60 characters max)="
380 PRINT "              ";
390 INPUT P$
400 PRINT " MDT code name of first record = ";
410 INPUT M$
420 PRI "K_                                                    Record number = ";
430 INPUT R6
440 R1=12*R6-10
450 PRINT "MDT code name of second record = ";
460 INPUT N$
470 PRI "K_                                                    Record number = ";
480 INPUT R7
490 R2=12*R7-10
500 PRINT "__NOTE: IF MDT CODES DIFFER, WARNING BELL SOUNDS AT FINISH OF"
510 PRI "FIRST PLOT AND NEW MDT NUMBER IS PRINTED AT LOWER LEFT CORNER"
520 PRI "OF SCREEN.  TO CONTINUE, ENTER A ""Y"" AND THEN HIT RETURN KEY__"
530 GOSUB 3780
540 GOSUB 3860
550 GOSUB 2360
560 GOSUB 2970
570 REM *** READ HEADER ON FIRST RECORD
580 PRINT "G_G_G___INSERT MDT ";M$;" WITHIN THE 4924"
590 GOSUB 3860
600 J=1
610 R3=R1
620 IF Q1=1 THEN 710
630 REM *** READ HEADER ON NMO MDT
640 FIND @2:R3
650 READ @2:H$,R$,N$,O$,S$,N5,R0,S1,T5,T6
660 T3=T6-T5
670 L=0
680 PRINT "L__FIRST NMO RECORD BEGAN AT ";T5;" AND ENDED AT ";T6;" WITH";
690 PRINT " SI=";S1
700 GO TO 740
710 GOSUB 1820
720 PRINT "G_G_G_L__FIRST-RECORD DATA WERE RECORDED WITH ";
730 PRINT "DELAY=";L;" & SI=";S1
740 PRINT "__DO YOU WANT COMPLETE TRACE-TIME INTERVAL?";
750 PRINT " (Y OR N) ";
760 INPUT G$
770 IF G$="Y" THEN 830
780 PRINT "Start record time=";
790 INPUT T1
800 PRINT "  End record time=";
```

```
810 INPUT T2
820 GO TO 850
830 T1=L
840 T2=L+T3
850 REM *** SELECT PLOT SI
860 PRINT "__DO YOU WANT TO INCREASE SI? (Y OR N) ";
870 INPUT G$
880 IF G$="N" THEN 930
890 PRINT "Increased SI(msec/sample)=";
900 INPUT S2
910 S3=S2/S1
920 GO TO 940
930 S2=S1
940 J1=3*(T1-L)/S1+1
950 J2=3*(T2-L)/S1+1
960 J3=J2-J1+3
970 N5=INT(J3/3)
980 DIM V(N5)
990 GOSUB 1230
1000 FOR J=1 TO 12
1010 R9=R3+J-1
1020 GOSUB 2030
1030 GOSUB 2190
1040 NEXT J
1050 IF N$=M$ THEN 1070
1060 GOSUB 3910
1070 R3=R2
1080 IF Q1=1 THEN 1120
1090 FIND @2:R3
1100 READ @2:H$, R$, N$, O$, S$, N6, R0, S1, T5, T6
1110 GO TO 1130
1120 GOSUB 1820
1130 FOR J=13 TO 24
1140 R9=R3+J-13
1150 GOSUB 2030
1160 GOSUB 2190
1170 NEXT J
1180 WINDOW 0,130,0,100
1190 VIEWPORT 0,130,0,100
1200 MOVE @1:150,100
1210 PRINT "G_G_G___PROGRAM COMPLETED"
1220 END
1230 REM *** SUB: PLOT NAME, BORDER, TICKMARKS, AND TRACE PARAMETERS
1240 PRINT @1,17:K3,K4
1250 MOVE @1:0,D2+6
1260 PRINT @1:P$;" PLOT SI=";S2;" BLOWS=";N1;", ";N2
1270 MOVE @1:0,D2+2
1280 PRINT @1:B$
1290 MOVE @1:C2+2*K3,D2+3
1300 PRINT @1:C$
1310 MOVE @1:C2+2*K3,D2+3-K4
1320 PRINT @1:"PLOT MULTIPLIER"
1330 MOVE @1:C2+2*K3,D2+3-2*K4
1340 PRINT @1:"1ST REC 2ND REC"
1350 MOVE @1:C1,D2
1360 RDRAW @1:C3,0
1370 RDRAW @1:0,-D3
1380 RDRAW @1:-C3,0
1390 RDRAW @1:0,D3
1400 MOVE @1:C1,D2
1410 M1=0.4
1420 M2=0.5*D3
1430 GOSUB 1490
1440 MOVE @1:C1,D1
1450 M1=-M1
1460 M2=-M2
1470 GOSUB 1490
1480 GO TO 1610
1490 FOR J=1 TO 10
1500 FOR K=1 TO 4
1510 RMOVE @1:C3/50,0
1520 RDRAW @1:0,-M1
```

```
1530 RDRAW @1:0,M1
1540 NEXT K
1550 IF J=10 THEN 1600
1560 RMOVE @1:C3/50,0
1570 RDRAW @1:0,-M2
1580 RDRAW @1:0,M2
1590 NEXT J
1600 RETURN
1610 MOVE @1:C1+C3/10-1.3*K3,D2+0.8
1620 T4=(T2-T1)/10
1630 PRINT @1:T1+T4
1640 FOR K=2 TO 9
1650 RMOVE @1:C3/10,0
1660 PRINT @1:T1+K*T4
1670 NEXT K
1680 REM *** PLOT O/S, COMP, AND TRACE GAIN
1690 IMAGE 4A,5D
1700 IMAGE 2X,3D,X,3D
1710 IMAGE 4(X,3D)
1720 FOR J=1 TO 12
1730 MOVE @1:0,Y9(J)-K4*11/32
1740 V$=SEG(U$,J*4-3,4)
1750 PRINT @1: USING 1690:V$,D9(J)
1760 MOVE @1:C1,Y9(J)
1770 RDRAW @1:C3,0
1780 MOVE @1:C2+K3,Y9(J)-K4*11/32
1790 PRINT @1: USING 1710:G9(J);K9(J);G9(J+12);K9(J+12)
1800 NEXT J
1810 RETURN
1820 REM *** SUB: FIND, RETRIEVE, AND DECODE HEADER FILE
1830 FIND @2:R3
1840 READ @2:H$
1850 I$=SEG(H$,4,1)
1860 L$=SEG(H$,5,2)
1870 S1=VAL(I$)
1880 L=VAL(L$)*10
1890 GO TO S1 OF 1900,1920,1940,1960,1980,2000
1900 S1=0.05
1910 GO TO 2010
1920 S1=0.1
1930 GO TO 2010
1940 S1=0.2
1950 GO TO 2010
1960 S1=0.5
1970 GO TO 2010
1980 S1=1
1990 GO TO 2010
2000 S1=2
2010 T3=1000*S1
2020 RETURN
2030 REM *** SUB: FIND, RETRIEVE, CONVERT AND SCALE DATA
2040 FIND @2:R9
2050 IF R9=R3 THEN 2090
2060 READ @2:A$
2070 IF Q1=2 THEN 2130
2080 GO TO 2130
2090 IF Q1=1 THEN 2120
2100 READ @2:H$,R$,N$,O$,S$,N6,R0,S1,T5,T6,A$
2110 GO TO 2130
2120 READ @2:H$,A$
2130 A$=SEG(A$,J1,J3)
2140 V=0
2150 CALL "HEXDEC",A$,V,LEN(A$),3
2160 V=V-511
2170 V=K9(J)*V
2180 RETURN
2190 REM ***SUB: PLOT TRACES
2200 WINDOW 0,N5-1,-1024,1024
2210 VIEWPORT C1,C2,Y9(J)-A1,Y9(J)+A1
2220 MOVE @1:0,V(1)
2230 IF P9(J)>2 THEN 2270
2240 REM *** PLOT USING VA
```

```
2250 GOSUB 3990
2260 RETURN
2270 IF P9(J)<4 THEN 2310
2280 REM *** PLOT USING BROKEN LINE
2290 GOSUB 3480
2300 RETURN
2310 REM *** PLOT USING SOLID LINE
2320 FOR K=S3+1 TO N5 STEP S3
2330 RDRAW 0,1:S3,V(K)-V(K-S3)
2340 NEXT K
2350 RETURN
2360 REM *** SUB: ENTER TRACE INFORMATION FOR FIRST RECORD
2370 PRINT "L_TRACE INFORMATION TABLE FOR FIRST RECORD"
2380 PRINT "NUMBER OF BLOWS=";
2390 INPUT N1
2400 PRINT "WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) ";
2410 INPUT G$
2420 IF G$="N" THEN 2470
2430 PRINT "Common amplifier gain (in multiples of 1 K)=";
2440 INPUT G1
2450 Q5=2
2460 G9=G1
2470 PRINT "DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) ";
2480 INPUT G$
2490 IF G$="N" THEN 2540
2500 Q3=2
2510 PRINT "Common plot multiplier=";
2520 INPUT K8
2530 K9=K8
2540 PRINT "DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) ";
2550 INPUT G$
2560 IF G$="N" THEN 2610
2570 PRINT "Common plot code=";
2580 INPUT P8
2590 P9=P8
2600 Q4=2
2610 PRINT "__COMPONENT CODE (1 char): R=RADIAL, T=TRANSVERSE, V=";
2620 PRINT "VERTICAL__"
2630 U$=""
2640 PRINT "COMPONENT  SP-SEIS  AMPLIFIER   PLOT AMPL.   PLOT"
2650 PRINT "(1 char.)   DIST.    GAIN(in K) MULT(-=REV)  CODE"
2660 FOR J=1 TO 12
2670 PRINT "     ";
2680 INPUT V$
2690 IF V$="R" THEN 2730
2700 IF V$="T" THEN 2750
2710 V$="VERT"
2720 GO TO 2760
2730 V$="RAD. "
2740 GO TO 2760
2750 V$="TRAN"
2760 U$=U$&V$
2770 PRINT "K_                ";
2780 INPUT D9(J)
2790 PRINT "K_                          ";
2800 IF Q5=1 THEN 2830
2810 PRINT G9(J)
2820 GO TO 2840
2830 INPUT G9(J)
2840 PRINT "K_                                  ";
2850 IF Q3=1 THEN 2880
2860 PRINT K9(J)
2870 GO TO 2890
2880 INPUT K9(J)
2890 PRINT "K_                                          ";
2900 IF Q4=1 THEN 2930
2910 PRINT P9(J)
2920 GO TO 2940
2930 INPUT P9(J)
2940 NEXT J
2950 GOSUB 3860
2960 RETURN
```

```
2970 REM *** SUB: ENTER TRACE INFORMATION FOR SECOND RECORD
2980 PRINT "L_TRACE INFORMATION TABLE FOR SECOND RECORD"
2990 PRINT "NUMBER OF BLOWS=";
3000 INPUT N2
3010 PRINT "WAS SAME AMPLIFIER GAIN USED ON ALL TRACES? (Y OR N) ";
3020 INPUT G$
3030 IF G$="N" THEN 3100
3040 PRINT "Common amplifier gain (in multiples of 1 K)=";
3050 INPUT G2
3060 FOR K=13 TO 24
3070 G9(K)=G2
3080 NEXT K
3090 Q5=2
3100 PRINT "DO YOU WANT THE SAME PLOT MULT ON ALL TRACES? (Y OR N) ";
3110 INPUT G$
3120 IF G$="N" THEN 3190
3130 Q3=2
3140 PRINT "Common plot multiplier=";
3150 INPUT K8
3160 FOR K=13 TO 24
3170 K9(K)=K8
3180 NEXT K
3190 PRINT "DO YOU WANT THE SAME PLOT CODE ON ALL TRACES? (Y OR N) ";
3200 INPUT G$
3210 IF G$="N" THEN 3290
3220 PRINT "Common plot code=";
3230 INPUT P8
3240 FOR K=13 TO 24
3250 P9(K)=P8
3260 NEXT K
3270 Q4=2
3280 PRINT "__AMPLIFIER   TRACE AMPL   PLOT"
3290 PRINT "GAIN(in K)  MULT(-=REV)  CODE"
3300 FOR J=13 TO 24
3310 PRINT "    ";
3320 IF Q5=1 THEN 3350
3330 PRINT G9(J)
3340 GO TO 3360
3350 INPUT G9(J)
3360 PRINT "K_                ";
3370 IF Q3=1 THEN 3400
3380 PRINT K9(J)
3390 GO TO 3410
3400 INPUT K9(J)
3410 PRINT "K_                                ";
3420 IF Q4=1 THEN 3450
3430 PRINT P9(J)
3440 GO TO 3460
3450 INPUT P9(J)
3460 NEXT J
3470 RETURN
3480 REM *** SUB: CODED-TRACE PLOT
3490 L1=1
3500 L2=1
3510 IF P9(J)=4 THEN 3540
3520 L1=4
3530 L2=2
3540 L3=(L1+3*L2)*S3
3550 N6=INT(N5/L3)
3560 L4=L2*S3
3570 N=1
3580 FOR M=1 TO N6
3590 FOR I=1 TO L1
3600 N=N+S3
3610 RDRAW @1:S3, V(N)-V(N-S3)
3620 NEXT I
3630 N=N+L4
3640 RMOVE @1:L4, V(N)-V(N-L4)
3650 FOR I=1 TO L2
3660 N=N+S3
3670 RDRAW @1:S3, V(N)-V(N-S3)
3680 NEXT I
```

```
3690 N=N+L4
3700 RMOVE @1:L4,V(N)-V(N-L4)
3710 NEXT M
3720 N=N-S3
3730 FOR K=N TO N5-S3
3740 N=N+S3
3750 RDRAW @1:S3,V(N)-V(N-S3)
3760 NEXT K
3770 RETURN
3780 REM *** SUB: PLOT CODE MENU AND PLOTTER SELECTIONS
3790 PRINT "__PLOT CODE MENU"
3800 PRINT "1: Low density VA"
3810 PRINT "2: High density VA"
3820 PRINT "3: Solid line wiggle trace"
3830 PRINT "4: Short dash wiggle trace"
3840 PRINT "5: Long and short dash wiggle trace"
3850 RETURN
3860 REM *** SUB: READY?
3870 PRINT "__READY TO PROCEED? (Y OR N) ";
3880 INPUT G$
3890 IF G$="N" THEN 3870
3900 RETURN
3910 REM *** SUB: READY?
3920 WINDOW 0,130,0,100
3930 VIEWPORT 0,130,0,100
3940 MOVE 0,4
3950 PRINT "G_G_G_";N$;"?";
3960 INPUT G$
3970 IF G$="N" THEN 3940
3980 RETURN
3990 REM *** SUB: VA PLOT
4000 IF V(1)<0 THEN 4030
4010 RDRAW @1:0,-V(1)
4020 RDRAW @1:0,V(1)
4030 FOR K=S3+1 TO N5 STEP S3
4040 RDRAW @1:S3,V(K)-V(K-S3)
4050 IF V(K)<=0 THEN 4100
4060 IF P9(J)=2 THEN 4080
4070 IF K/5-INT(K/5)<>0.2 THEN 4100
4080 RDRAW @1:0,-V(K)
4090 RDRAW @1:0,V(K)
4100 NEXT K
4110 RETURN
4120 REM *** SUB: EQUALLY SPACED TRACE PLOT POSITIONS
4130 A1=(D2-D1)/13
4140 A2=D2
4150 FOR K=1 TO 12
4160 A2=A2-A1
4170 Y9(K)=A2
4180 Y9(K+12)=A2
4190 NEXT K
4200 RETURN
4210 PRINT "SET RECORD SIZE AND TRACE POSITIONS--NOTE: 1 GDU=0.1 INCH"
4220 Q2=2
4230 PRINT "__DIMENSIONS OF RECORD BORDER IN GRAPHIC DISPLAY UNITS (GDU)"
4240 PRINT "Upper border (must be <71) = ";
4250 INPUT D2
4260 PRINT "Lower border (must be =>0) = ";
4270 INPUT D1
4280 PRINT " Left border (must be >14) = ";
4290 INPUT C1
4300 PRINT "Right border (must be <101)= ";
4310 INPUT C2
4320 PRINT "__TRACE POSITION IN GDU'S"
4330 PRINT "TRACE    VERT. POSITION"
4340 FOR J=1 TO 12
4350 PRINT "  ";J;"              ";
4360 INPUT Y9(J)
4370 Y9(J+12)=Y9(J)
4380 NEXT J
4390 RETURN
```

PROGRAM LISTING FOR COMPUTATION AND STORAGE OF SUMMED OR DIFFERENCED RECORDS

```
100 PRINT "L_PROGRAM TO PRODUCE SUMMED OR DIFFERENCED (S/D) MDT"
110 PRINT "__NOTE: INTERMEDIATE OPERATIONS REQUIRE THE USE OF A HOLDING"
120 PRINT "       TAPE WHICH MUST BE MARKED AS FOLLOWS:"
130 PRINT "       FIND 1, MARK 1,512"
140 PRINT "       FIND 2, MARK 24,3072"
150 INIT
160 DIM A$(18),C$(18),G$(1),H$(11),I$(10),J$(11),M$(7),N$(7),S$(7)
170 DATA 1001,2,1,1
180 READ N,F4,Q1,Q2
190 CALL "TIME",A$
200 PRINT "G_G_G___INSERT PRE-MARKED HOLDING TAPE IN 4051 AND FIRST RECORD";
210 PRINT " MDT IN 4924"
220 GOSUB 1620
230 PRINT "__DO YOU WANT TO COMBINE NMO-CORRECTED MDT'S (Y OR N) ";
240 INPUT G$
250 IF G$="N" THEN 270
260 Q2=2
270 PRINT "__CODE NAME OF  FIRST-RECORD MDT = ";
280 INPUT N$
290 PRINT "CODE NAME OF SECOND-RECORD MDT = ";
300 INPUT M$
310 PRINT "RECORD NO.  ON FIRST-RECORD MDT = ";
320 INPUT R1
330 PRINT "RECORD NO. ON SECOND-RECORD MDT = ";
340 INPUT R2
350 PRINT "      CODE NAME OF SUM/DIFF MDT = ";
360 INPUT S$
370 PRINT " RECORD NUMBER ON SUM/DIFF MDT = ";
380 INPUT R3
390 F5=12*R3-10
400 PRINT "__DO YOU WANT TO PRODUCE A SUMMED MDT?";
410 PRINT " (Y OR N) ";
420 INPUT G$
430 IF G$="N" THEN 450
440 GO TO 470
450 PRINT "YOU HAVE ELECTED TO PRODUCE A DIFFERENCED MDT"
460 Q1=2
470 REM *** TRANSFER PAIRED DATA TO HOLDING TAPE
480 GOSUB 560
490 PRINT "G_G_G___REMOVE PAIRED-RECORD MDT FROM 4924 AND INSERT S/D MDT"
500 GOSUB 1620
510 REM *** COMPUTE AND TRANSFER TO S/D MDT
520 GOSUB 1030
530 CALL "TIME",C$
540 PRINT "G_G_G___PROGRAM COMPLETED   START: ";A$;"  END: ";C$
550 END
560 REM *** SUB: TRANSFER PAIRED-RECORD DATA TO HOLDING TAPE
570 GOSUB 710
580 DIM B$(N*3+2),V1(N),V2(N)
590 V1=0
```

```
600 V2=0
610 GOSUB 800
620 R1=R2
630 F4=3
640 IF M$=N$ THEN 670
650 PRINT "G_G_G___INSERT SECOND RECORD MDT IN 4924"
660 GOSUB 1620
670 GOSUB 710
680 J$=H$
690 GOSUB 800
700 RETURN
710 REM *** SUB: FIND AND RETRIEVE HEADER FILE
720 F3=R1*12-10
730 FIND @2:F3
740 IF Q2=1 THEN 780
750 DIM O$(7), R$(17), V$(37)
760 READ @2:H$, R$, N$, O$, V$, N, R0, S1, T5, T6
770 GO TO 790
780 READ @2:H$
790 RETURN
800 REM *** SUB: READ THEN TRANSFER DATA TO HOLDING TAPE
810 FIND @2:F3
820 IF Q2=1 THEN 850
830 READ @2:H$, R$, N$, O$, V$, N, R0, S1, T5, T6, B$
840 GO TO 860
850 READ @2:H$, B$
860 FIND F4
870 IF Q2=1 THEN 910
880 WRITE H$, R$, N$, O$, V$, N, R0, S1, T5, T6, B$
890 CLOSE
900 GO TO 930
910 WRITE H$, B$
920 CLOSE
930 FOR J=1 TO 11
940 FIND @2:J+F3
950 READ @2:B$
960 FIND F4+J*2
970 WRITE B$
980 CLOSE
990 NEXT J
1000 PRINT "TRANSFER OF RECORD "; R1; " (HEADER:"; H$; ") TO HOLDING TAPE";
1010 PRINT " COMPLETED"
1020 RETURN
1030 REM *** SUB: COMPUTE AND TRANSFER TO S/D MDT
1040 FIND 2
1050 IF Q2=1 THEN 1080
1060 READ @33:H$, R$, N$, O$, V$, N, R0, S1, T5, T6, B$
1070 GO TO 1090
1080 READ @33:H$, B$
1090 CALL "HEXDEC", B$, V1, LEN(B$), 3
1100 FIND 3
1110 IF Q2=1 THEN 1140
1120 READ @33:J$, R$, N$, O$, V$, N, R0, S1, T5, T6, B$
1130 GO TO 1150
```

```
1140 READ @33:J$,B$
1150 CALL "HEXDEC",B$,V2,LEN(B$),3
1160 GOSUB 1360
1170 J$=SEG(H$,2,7)
1180 IF Q1=1 THEN 1210
1190 I$="9"&J$
1200 GO TO 1220
1210 I$="8"&J$
1220 K1=0
1230 GOSUB 1500
1240 FOR K=2 TO 12
1250 K1=K1+1
1260 FIND 2*K
1270 READ @33:B$
1280 CALL "HEXDEC",B$,V1,LEN(B$),3
1290 FIND 2*K+1
1300 READ @33:B$
1310 CALL "HEXDEC",B$,V2,LEN(B$),3
1320 GOSUB 1360
1330 GOSUB 1500
1340 NEXT K
1350 RETURN
1360 REM ** SUB: COMPUTE SUMS OR DIFFERENCES
1370 IF Q1=1 THEN 1420
1380 FOR J=1 TO N
1390 V2(J)=V1(J)-V2(J)
1400 NEXT J
1410 GO TO 1450
1420 FOR J=1 TO N
1430 V2(J)=V1(J)+V2(J)
1440 NEXT J
1450 V2=0.5*V2
1460 V2=INT(V2)
1470 IF Q1=1 THEN 1490
1480 V2=V2+512
1490 RETURN
1500 REM ** SUB: TRANSFER TO S/D MDT
1510 CALL "DECHEX",B$,V2,N,3
1520 FIND @2:F5+K1
1530 IF K1>0 THEN 1590
1540 IF Q2=1 THEN 1570
1550 WRITE @2:I$,R$,S$,N$,V$,N,R1,S1,T5,T6,B$
1560 GO TO 1600
1570 WRITE @2:I$,B$
1580 GO TO 1600
1590 WRITE @2:B$
1600 PRINT @2,2:
1610 RETURN
1620 REM ** SUB: READY TO PROCEED?
1630 PRINT "ARE YOU READY TO PROCEED? (Y OR N) ";
1640 INPUT G$
1650 IF G$="N" THEN 1630
1660 RETURN
```

PROGRAM LISTING FOR QUICK PLOT OF DATA STORED ON A MASTER DATA TAPE

```
100 PRINT "L__PROGRAM TO QUICK-PLOT SELECTED CONTENTS OF MDT ON SCREEN"
110 INIT
120 DIM A$(18), B$(3005), C$(18), G$(1), H$(11), I$(1), L$(2), N$(5)
130 N=1
140 CALL "TIME", A$
150 PRINT "G_G_G___INSERT MDT WITHIN THE 4924"
160 PRINT "__CODE NAME OF MDT = ";
170 INPUT N$
180 PRINT "__RECORD NO ON MDT = ";
190 INPUT R
200 PRINT "__DO YOU WANT TO CHANGE TRACE AMPL? (Y OR N) ";
210 INPUT G$
220 K2=1
230 IF G$="N" THEN 260
240 PRINT "Trace-amplitude multiplier = ";
250 INPUT K2
260 PRINT "__DO YOU WANT A PLOT OF ALL TRACES? (Y OR N) ";
270 INPUT G$
280 IF G$="Y" THEN 340
290 PRINT "At what trace is plot to begin? ";
300 INPUT N1
310 PRINT "  At what trace is plot to end? ";
320 INPUT N2
330 GO TO 360
340 N1=1
350 N2=12
360 N3=N2-N1+1
370 GOSUB 2110
380 F1=R*12+N1-11
390 F2=R*12+N2-11
400 F3=R*12-10
410 REM ** FIND, RETRIEVE, AND DECODE HEADER FILE
420 FIND @2:F3
430 READ @2:H$
440 I$=SEG(H$, 4, 1)
450 L$=SEG(H$, 5, 2)
460 S1=VAL(I$)
470 L=VAL(L$)*10
480 GO TO S1 OF 490, 510, 530, 550, 570, 590
490 S1=0.05
500 GO TO 600
510 S1=0.1
520 GO TO 600
530 S1=0.2
540 GO TO 600
550 S1=0.5
560 GO TO 600
570 S1=1
580 GO TO 600
590 S1=2
600 T3=1000*S1
610 PRINT "__DO YOU WANT TO PLOT COMPLETE TRACE? (Y OR N) ";
620 INPUT G$
630 IF G$="Y" THEN 690
640 PRINT "  At what record time is plot to begin? ";
650 INPUT T1
660 PRINT "and at what record time is plot to end? ";
670 INPUT T2
```

```
680 GO TO 710
690 T1=L
700 T2=L+T3
710 PRINT "__DO YOU WANT TO INCREASE SAMPLE INT? (Y OR N) ";
720 INPUT G$
730 IF G$="N" THEN 810
740 PRINT "Increased sample interval (msec/sample) = ";
750 INPUT S2
760 IF S2/S1-INT(S2/S1)=0 THEN 820
770 PRINT "ERROR! SELECTED INCREASED S. I. NOT INTEGRAL MULTIPLE"
780 PRINT " OF ORIGINAL S. I. --CHOOSE ANOTHER VALUE"
790 GO TO 740
800 GO TO 820
810 S2=S1
820 MOVE 0,0
830 PRINT
840 C2=130
850 D1=4
860 D2=92
870 D3=D2-D1
880 PAGE
890 GOSUB 1090
900 J1=3*(T1-L)/S1+1
910 J2=3*(T2-L)/S1+1
920 J3=J2-J1+3
930 J4=(J2-J1)*S1/S2+3.0001
940 N4=INT(J4/3)
950 D4=D3/(N3+1)
960 D5=D3-D4+D1
970 I=N1-1
980 FOR M=F1 TO F2
990 I=I+1
1000 DELETE Z
1010 DIM B$(3005),V(1001)
1020 GOSUB 1260
1030 GOSUB 1410
1040 NEXT M
1050 CALL "TIME",C$
1060 MOVE 0,0
1070 PRINT "G_G_G_START: ";A$;"  END: ";C$
1080 END
1090 REM *** SUB: LABEL, PLOT BORDER AND TICKMARKS
1100 PRINT "L_";H$;" Traces ";N1;" thru ";N2;"  Rec# ";R;" on MDT ";
1110 PRINT N$;"  SI=";S2;" msec   Ampl=x";K2
1120 GOSUB 1650
1130 IMAGE 3D.D
1140 MOVE 0,D2+1
1150 PRINT "0/S"
1160 MOVE C2/10-2.34,D2+1
1170 T4=(T2-T1)/10
1180 PRINT USING 1130:T1+T4
1190 FOR K=2 TO 9
1200 RMOVE C2/10,0
1210 PRINT USING 1130:T1+K*T4.
1220 NEXT K
1230 MOVE 126,D2+1
1240 PRINT "PN"
1250 RETURN
1260 REM *** SUB: FIND, RETRIEVE, CONVERT AND SCALE DATA
```

```
1270 FIND @2:M
1280 IF M=F3 THEN 1310
1290 READ @2:B$
1300 GO TO 1320
1310 READ @2:H$,B$
1320 B$=SEG(B$,J1,J3)
1330 V=0
1340 K3=M2/512
1350 K1=K2*K3/(N3+1)
1360 CALL "HEXDEC",B$,V,LEN(B$),3
1370 V=V-511
1380 V=K1*V
1390 V=V+D5
1400 RETURN
1410 REM *** SUB: PLOT TRACES
1420 S3=S2/S1
1430 MOVE 0,D5
1440 K5=C2/(N4-1)
1450 DELETE B$,H$,N$,Z
1460 DIM Z(2*N4)
1470 Z(1)=0
1480 Z(2)=V(1)
1490 K7=0
1500 FOR J=3 TO 2*N4-1 STEP 2
1510 K7=K7+K5
1520 Z(J)=K7
1530 K=S3*0.5*(J-1)+1
1540 Z(J+1)=V(K)
1550 NEXT J
1560 PRINT X(I)
1570 PRINT @32,20:Z
1580 DRAW 130,D5
1590 MOVE -123,D5
1600 PRINT P(I)
1610 MOVE 130,D5
1620 DRAW 0,D5
1630 D5=D5-D4
1640 RETURN
1650 REM *** SUB: PRINT BORDER AND TICKMARKS
1660 C3=C2/50
1670 DIM B(300)
1680 B=D2
1690 M1=0.4
1700 M2=D3/2
1710 M3=D2-M1
1720 M4=D2-M2
1730 B(1)=0
1740 C4=0
1750 FOR K=3 TO 291 STEP 6
1760 C4=C4+C3
1770 B(K)=C4
1780 B(K+2)=C4
1790 B(K+3)=M3
1800 B(K+4)=C4
1810 NEXT K
1820 B(297)=C2
1830 B(299)=C2
1840 B(300)=D1
```

```
1850 FOR K=30 TO 270 STEP 30
1860 B(K)=M4
1870 MOVE 0,D2
1880 NEXT K
1890 PRINT @32,20:B
1900 DELETE B
1910 DIM B(300)
1920 B=D1
1930 B(1)=C2
1940 C4=C2
1950 FOR K=3 TO 291 STEP 6
1960 C4=C4-C3
1970 B(K)=C4
1980 B(K+2)=C4
1990 B(K+3)=M1+D1
2000 B(K+4)=C4
2010 NEXT K
2020 FOR K=30 TO 270 STEP 30
2030 B(K)=M2+D1
2040 NEXT K
2050 B(297)=0
2060 B(299)=0
2070 B(300)=D2
2080 PRINT @32,20:B
2090 DELETE B
2100 RETURN
2110 REM *** SUB: SPECIFY OFFSETS AND POSITION NUMBERS
2120 DIM X(N2),P(N2)
2130 X=0
2140 P=0
2150 IF N3=1 THEN 2350
2160 PRINT "__ARE ALL DETECTORS EQUALLY SPACED? (Y OR N) ";
2170 INPUT G$
2180 IF G$="N" THEN 2350
2190 PRINT "OFFSET TO TRACE  ";N1;" = ";
2200 INPUT X(N1)
2210 PRINT "    PN OF TRACE  ";N1;" = ";
2220 INPUT P(N1)
2230 PRINT "OFFSET TO TRACE ";N2;" = ";
2240 INPUT X(N2)
2250 PRINT "    PN OF TRACE ";N2;" = ";
2260 INPUT P(N2)
2270 X1=(X(N2)-X(N1))/(N3-1)
2280 P1=(P(N2)-P(N1))/(N3-1)
2290 IF N2=N1+1 THEN 2340
2300 FOR J=N1+1 TO N2-1
2310 X(J)=X(J-1)+X1
2320 P(J)=P(J-1)+P1
2330 NEXT J
2340 RETURN
2350 PRINT "TRACE NUMBER   OFFSET   POSITION NUMBER"
2360 FOR J=N1 TO N2
2370 PRINT "       ";J;"           ";
2380 INPUT X(J)
2390 PRINT "K_                                    ";
2400 INPUT P(J)
2410 NEXT J
2420 RETURN
```

PROGRAM LISTING FOR QUICK PLOT OF NMO-CORRECTED DATA STORED ON A MDT

```
100 PRINT "L__QUICK-PLOT USING 12-TRACE NMO-CORRECTED MDT"
110 INIT
120 DIM A$(18), B$(3005), C$(18), G$(1), H$(18), I$(1), L$(2), M$(17)
130 DIM N$(7), O$(7), V$(35), B(300)
140 DATA 130, 0, 4, 92, 1, 0, 4, 13, 33
150 READ C2, C4, D1, D2, K2, M1, N3, U
160 C3=C2/50
170 D3=D2-D1
180 D4=D3/N3
190 D5=D2-D4
200 CALL "TIME", A$
210 PRINT "__DO YOU WANT TO READ MDT FROM THE 4051? (Y OR N) ";
220 INPUT G$
230 IF G$="N" THEN 260
240 PRINT "G_G_G___INSERT MDT WITHIN THE 4051"
250 GO TO 280
260 U=2
270 PRINT "G_G_G___INSERT MDT WITHIN THE 4924"
280 PRINT "__ .Record number on NMO MDT = ";
290 INPUT R
300 PRINT "__DO YOU WANT TO CHANGE TRACE AMPLITUDES? (Y OR N) ";
310 INPUT G$
320 IF G$="N" THEN 350
330 PRINT "Trace-amplitude multiplier = ";
340 INPUT K2
350 F3=R*12-10
360 F2=R*12+1
370 F1=F3
380 REM ** FIND, RETRIEVE, AND DECODE FIRST TRACE OF RECORD
390 FIND @U:F3
400 READ @U:H$, M$, N$, O$, V$, N0, R1, S1, T1, T2
410 S2=S1
420 D3=D2-D1
430 GOSUB 540
440 K3=C2/(N0-1)
450 DIM Y(N0), Z(2*N0)
460 FOR M=F1 TO F2
470 GOSUB 680
480 GOSUB 820
490 NEXT M
500 CALL "TIME", C$
510 MOVE 0, 0
520 PRINT "G_G_G_START: "; A$; "  END: "; C$
530 END
540 REM ** SUB: LABEL, PLOT BORDER AND TICKMARKS
550 PRINT "L__"; H$; "   NMO MDT: "; N$; "/"; R; ",    OBS MDT: "; O$; "/"; R1; ",  ";
560 PRINT "  SI="; S2; ",    Ampl=x"; K2
570 PRINT "MUTE: "; M$; ", VEL FUNCTION: "; V$
580 GOSUB 1010
590 IMAGE 3D.D
600 MOVE C2/10-2, 34, D2+1
610 T4=(T2-T1)/10
620 PRINT USING 590:T1+T4
630 FOR K=2 TO 9
640 RMOVE C2/10, 0
650 PRINT USING 590:T1+K*T4
660 NEXT K
670 RETURN
680 REM ** SUB: FIND, RETRIEVE, CONVERT AND SCALE DATA
690 FIND @U:M
700 IF M=F3 THEN 730
710 READ @U:B$
720 GO TO 740
730 READ @U:H$, M$, N$, O$, V$, N0, R1, S1, T1, T2, B$
740 V=0
```

```
750 K3=M2/512
760 K1=K2*K3/N3
770 CALL "HEXDEC", B$, V, LEN(B$), 3
780 V=V-511
790 V=K1*V
800 V=V+D5
810 RETURN
820 REM *** SUB: PLOT TRACES
830 S3=S2/S1
840 MOVE 0, D5
850 DIM Z(2*N0)
860 Z(1)=0
870 Z(2)=V(1)
880 K7=0
890 FOR J=3 TO 2*N0-1 STEP 2
900 K7=K7+K5
910 Z(J)=K7
920 K=S3*0.5*(J-1)+1
930 Z(J+1)=V(K)
940 NEXT J
950 PRINT @32,20:Z
960 DRAW 130, D5
970 MOVE 130, D5
980 DRAW 0, D5
990 D5=D5-D4
1000 RETURN
1010 REM *** SUB: PRINT BORDER AND TICKMARKS
1020 B=D2
1030 M2=D3/2
1040 M3=D2-M1
1050 M4=D2-M2
1060 B(1)=0
1070 FOR K=3 TO 291 STEP 6
1080 C4=C4+C3
1090 B(K)=C4
1100 B(K+2)=C4
1110 B(K+3)=M3
1120 B(K+4)=C4
1130 NEXT K
1140 B(297)=C2
1150 B(299)=C2
1160 B(300)=D1
1170 FOR K=30 TO 270 STEP 30
1180 B(K)=M4
1190 MOVE 0, D2
1200 NEXT K
1210 PRINT @32,20:B
1220 DELETE B
1230 DIM B(300)
1240 B=D1
1250 B(1)=C2
1260 C4=C2
1270 FOR K=3 TO 291 STEP 6
1280 C4=C4-C3
1290 B(K)=C4
1300 B(K+2)=C4
1310 B(K+3)=M1+D1
1320 B(K+4)=C4
1330 NEXT K
1340 FOR K=30 TO 270 STEP 30
1350 B(K)=M2+D1
1360 NEXT K
1370 B(297)=0
1380 B(299)=0
1390 B(300)=D2
1400 PRINT @32,20:B
1410 DELETE B
1420 RETURN
```