File

INTERNAL DOCUMENT

I.O.S.

Improved digitisation and computer plotting of Mk. II Pop-up Bottom Seismograph (PUBS) Data.

by C.E. Davies

I.O.S. Internal Document No. 54

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey, GU8 5UB.
(042-879-4141)

(Director: Dr. A. S. Laughton)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051-652-2396)
(Assistant Director: Dr. D. E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823-86211)
(Assistant Director: M.J. Tucker)

Improved digitisation and computer plotting of Mk. II Pop-up Bottom Seismograph (PUBS) Data.

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Improved Digitisation and Computer Plotting of MARK II Pop-UP Bottom Seismograph (P.U.B.S.) Data

1. Introduction

A new replay system was designed to replace the Mk I replay system for reasons outlined below:

A. To increase the speed of replay. Whereas the old system replayed data at the same speed at which it was recorded, the new system replays at four times recording speed.

B. A clock displaying the PUBS time at recording was incorporated into the design. This enabled rapid and accurate positioning of the section of tape to be digitised, instead of the slower operation involved when listening for the shots with headphones and positioning the tape by hand.

C. In order to improve the digitising of airgun data, two thumb-wheel switches were incorporated. One switch is set to the airgun firing period and the other to the number of seconds, within that period, which need to be digitised. There was no such selection in the old system, airgun data was digitised continuously and the necessary data "window" selected later by fortran programming.

D. The MK II replay system was designed to be more compact and has just the one replay unit in contrast with the several units of the MK I system.

2. Digitisation

The CAMAC PDP11/05 Work Station is used to digitise analogue PUBS data from ¼" magnetic "data" tapes and to create CAMAC magnetic tapes which can be read by the Honeywell computer.

2.1 The Replay System

Six channels are recorded on the PUBS tape - three orthogonal geophones (X,Y,Z), a hydrophone, a clock and a flutter compensation channel.

The PUBS tape is replayed on a Sony TC-377 tape deck with a special Branch and Applebee 6-track replay head. The tape recorder also houses 6 pre-amplifiers which amplify signals from the head.

2.2 The Replay Unit

The amplified F.M. signals from the tape recorder are de-modulated in the replay unit. This comprises five identical demodulators for the hydrophone, the three geophones and flutter compensation channels. The clock channel is demodulated in a slightly different circuit which gives a Cmos compatible output.

By inverting and then summing the output of the flutter compensation channel with the data channels it is possible to reduce the effects of variations in replay speed of the tape recorder.

The pulse-width-encoded demodulated clock signal is decoded in the replay clock to give the number of hrs, mins, and 10 sec pulses. The PUBS number and lay number are also encoded on the clock channel. (Fig. 1).

The analogue outputs from the data demodulators may be filtered and are then level shifted (Fig. 2) in adjustable amplifiers (called the d.c. offset) so they are compatible with the input to the CAMAC system which digitises the data.

The demodulated clock signal is used in the interrupt unit to generate pulses for the CAMAC which initiate and terminate each digitisation sequence. The $10H_Z$ pulses of the clock are multiplied by a phase locked loop to separately produce 100 pulses/second. As replay is four times record speed, the CAMAC therefore samples at 400 pulses/second.

2.3 Setting up Procedure

1. Ensure the replay system is wired up correctly i.e. as shown in Fig. 3.

2. Set the thumb wheel switches. For airgun data a 120 sec. "PERIOD" (usually) with a 30 or 40 sec "MARK". For explosion data a 60 sec "MARK" with any "PERIOD" greater than this e.g. 70 sec.

3. Set the filter: The sampling rate of 100 samples/sec. requires an anti-aliasing low pass filter of 50 H_Z. However since replay is four times recording speed, a filter of 200 H_Z is required.

4. For both airgun and explosion data the switch on the interrupt unit is set to "single shot" (S.S.). During the first digitising sequence of an airgun series the switch is set to "normal" (N).

5. The data tape is positioned on the tape recorder and the CAMAC tape loaded on the SE data 8000 tape unit with the write-permit ring fitted. The tape unit is put "ON LINE".

6. Check the following CAMAC modules are present:

ADC 9070

TELETYPEWRITER V24 7061	Station positions must be specified on the CONFIG tape
MAGNETIC TAPE CS0042	
DMA EC369	
2 DUAL INPUT REGISTERS 9069A	

Note: Above units correct until August 1979.

7. Switch on CAMAC system

8. Load the system with CATY V2.0 from floppy disc as follows:

(i) Ensure crate, disc drive and PDP are switched on, and PDP is switched to HALT

(ii) Place system disc in drive 0

(iii) Set '157600' in BCD on PDP sense switches and press LOAD ADDRESS

(iv) Lift PDP HALT switch

(v) Set all sense switches down and press START

When bootstrap loads the keyboard prompts for program name.

(vi) Type CT12RØ

(vii) Type C2RØP1

(viii) Type NEWBRY

(ix) Enter Ø to continue

Caty 2.0 1/1/79 appears on the Visual Display Unit (V.D.U.)

9. Enter the following subroutines:-

! SR CONFIG

! SR MAGTV3

! SR BUFBTM

! SR KEYINS

! SR FINDFI

Place disc RBW ØØ1 in drive 1 and depending on the data to be digitised, one of four main programs is loaded.

! RD1 EXP1 for explosion data (hydrophone channel only)

! RD1 EXP3 for explosion data (3 geophone channels)

! RD1 AIR1 for airgun data (hydrophone channel only)

! RD1 AIR3 for airgun data (3 geophone channels)

10. Decimal numbers can be obtained (as the default option is octal) by typing ! DC.

11. ! RUZ will start the program, and if the program was loaded correctly, ENTER COMMAND S,R,L,F or Z appears.

(If not, the main program is cleared by !NE; !NS will clear the main program and the subroutines).

S is the "setting up" command, and when entered, the program asks for the MAX SIGNAL AMPLITUDE IN MILLIVOLTS. 5000 is entered. The program uses this to calculate the number of millivolts per step in the A to D conversion process (2.5 mv).

R is the "run" command, and the program requests
ENTER HEADER INFORMATION, TERMINATING WITH NULL LINE.

L will give a list of the contents of the data files on the CAMAC tape.

F is used for locating the required file number. When F is entered, the CAMAC tape is automatically rewound (or positioned) to the start and the program asks ENTER FILE NO. The reply causes the tape to be positioned at the start of this file and again the system asks for S,R,L,F or Z to be entered.

Z is a command to erase whatever has been written on the CAMAC tape.

A tape header is written at the start of each new CAMAC tape, (See Fig. 4) and is used for labelling and identifying purposes only. The next file is called the "dummy file" and must contain at least one interrupt pulse, it cannot be left blank as this would mark theend of data, S, 5000 and R are entered in sequence again, but now a file header must be written to the tape. For airgun data, only this one file header is written and it contains the initial shot number of the series. For explosion data a file header is written before each shot is digitised. Details of information contained in the file headers are shown in Fig. 5. Columns 77-80 are used to specify the "gain" of the hydrophone (i.e. that signal which after passing through a one tenth attenuator, gives the maximum undistorted signal at the modulator input. For the hydrophone, the multiplier in column 24 is set to "one". When digitising the geophones, columns 77-80 specify the lowest geophone gain (expressed as the product of signal amplifier and modulator gains) and the multipliers in columns 24, 30 and 36 set the correct gain for the other geophones. For example, if the vertical geophone (z) had a gain of 1000 and the other two had gains of 500, "0500" would be in columns 77-80, "two" in column 24 and "one" in columns 30 and 36. When the header has been entered RETURN is pressed twice (i.e. to include the null line) and the program is "READY TO START".

2.4 Digitising explosions

The PUBS time (to the nearest minute) of the explosion is located on the tape using the digital clock and the oscilloscope display is used to obtain the approximate arrival time of the water wave. The PUBS tape is rewound a few turns (corresponding to about 10 to 20 seconds of PUBS time as required) restarted and then the "START" button on the interrupt unit is pressed to signal the beginning of the digitising period (N). This period may contain the water wave arrival, and must contain the preceding ground wave arrivals. A calculation can be done to find the approximate time between the ground wave and water wave arrivals and if possible the digitising period will contain both these. The "START" button should only be pressed when the red 10 sec period dot on the clock display is not lit. An oscillomink record (paper speed 25 mm/sec) is made of each shot with the exact period of digitisation marked on the record. When the N sec period is completed the program will display the number of scans it received; - this should be 100 x M x N (viz N secs at 100 samples/sec, M = number of channels) and will ask for another command. The S, V = 5000, R and file header procedure is then repeated for each shot to be digitised. The closing down procedure (see later) is then carried out at the end of the day's digitising.

2.5 Digitising airgun data

Each series of airgun shots is digitised automatically, one after the other. The exact 10 sec mark on which to start digitising is worked out beforehand from a knowledge of the initial ground wave to water wave time and from the maximum value of this parameter in the data to be digitised. If this time, and consequently the distance from airgun to PUBS, increases with shot numberthen digitising starts on the 10 sec mark immediately preceding the water wave arrival. On the other hand, if the time, and also range, decreases with increasing shot number then digitising must start with the water wave arrival appearing at the end of the initial digitising period. The switch on the interrupt unit should be set to "SS". If digitising is to start on say the second 10 sec mark after the even minute, then the "START" button is pressed immediately after the 10 sec period dot goes off during the first 10 sec period i.e. when 1 is flashing. The switch on the interrupt unit is set to "N" immediately after this.

An oscillomink record (paper speed 50 mm/sec) is made of the initial and final digitised periods. Regular checks must be made to ensure that the correct section is being digitised (i.e. that the clock has not "jumped") and that the correct number of samples is being obtained for each digitising period. If a "jump" has occurred then the analogue tape is rewound to the PUBS time of the last successful check, "CNTL" and "X" pressed together to "escape" from the program, !RUZ typed to use the F command for locating the corresponding file on the CAMAC tape, and a new header entered. To end the digitising series, this switch is set to single shot "(SS)" during the digitisation of the last shot, or any subsequent digitising sequence. To assist with the digitising of airgun data a table is made up from Precision Echo-Sounder records and the PUBS log book giving the PUBS time and time of day of the first and last shot of each airgun shot series.

2.6 Closing down

1. Press REWIND on the magnetic tape unit and remove the CAMAC tape.

2. Rewind the data tape and return to tape store

3. Remove floppy discs from DRIVE 1 and Ø and then switch off unit

4. Press down ENABLE/HALT switch on PDP 11

5. Power off at both wall sockets

3. Producing a Master Tape

The CAMAC tape is sent by post to Bidston, and a FORTRAN program is run on the Honeywell 66/20 computer to translate and copy the data from the CAMAC tape onto a Master Tape in system standard format which is compatible with the Honeywell machine.

3.1 CAMAC Tape - Description

The magnetic tapes created on the CAMAC system have the following general format.

9-track, density of 800 bits per inch, no labels or serial numbers.

Header files - ASCII, unblocked, fixed length record of 200 Honeywell words (Fig. 4)

Data files - PDP binary, unblocked, fixed length records of 400 Honeywell words.

Explosion data - file header file followed by only one data file
Airgun data - file header file followed by a series of data files.

Each block of a data file contains 800 PDP numbers. For hydrophone data, each PDP number is a sample from the hydrophone, so there are 800 samples in each block. For geophone data, there is a scan counter before each scan of samples from the three geophones. The scan counter takes one PDP number. There are 200 scans in each block giving 600 data samples, 200 from each geophone.

The data on one CAMAC tape is transferred onto one or several master tapes using one of four programs run on a HP 2640A terminal (Appendix I). Generally a separate Master tape is used for each PUBS on a station with airgun data, and one for each station with explosion data.

The four programs in use are:-

MASTEXP1 - for explosion data on the hydrophone channel
MASTEXP3 - for explosion data on the 3 geophone channels
MASTAIR1 - for airgun data on the hydrophone channel
MASTAIR3 - for airgun data on the 3 geophone channels

Note: MASTEXP1 and MASTAIR1 can also be used for MARK I PUBS data. Ref. C. Leary "MARK II PUBS DATA PROGRAMS", CCL/PUBS/2, 8th May 1979.

3.2 Programs MASTEXP1 and MASTEXP3

The tape header is not verified, and is copied directly to the file. For each pair of file header and data files:-
The file header is checked to see whether it is for PUBS Mark II hydrophone or geophone data i.e. verified for "A" in column 19 and "H" in col. 21 for hydrophone data or verified for A in cols. 19,25 and 31 and Z,Y,X in cols. 21,27,33 respectively for

geophone data. The letter "B" in column 19 would indicate PUBS Mark I data. The shot number and the number of seconds of data recorded are read and stored. The file header is copied with no alteration, to the Master tape.

The PDP numbers in the data files are translated to Honeywell numbers using subroutine PDPBCN. The data is normalised using an average calculated from the first 800 samples, and written to the Master tape.

3.3 Programs MASTAIR1 and MASTAIR3

The tape header is not verified, and is copied directly to the Master tape.

For each group of file header and data files:-

Same checks as above for A with H or X,Y,Z (same columns).

The file header is copied to the Master tape before each data file, and the shot number field in the header is incremented by one each time. (Fig. 6).

The PDP numbers in the data files are translated to Honeywell numbers using subroutine PDPBCN. The data is normalised using an average calculated from the first 800 samples, and written to the Master tape.

3.4 Running the master tape programs

The programs are run on the Honeywell computer from a terminal using the JRN command. The file containing the Fortran program with its job control cards must be examined at the terminal before it is run.

The magnetic tape numbers for the "CAMAC" and Master tapes will probably need to be altered. The sets of adjacent files on the CAMAC tape that are to be used to create the Master tape must be specified. The rate of sampling must be checked.

Table showing line numbers to be checked.

	MASTEXP1	MASTEXP3	MASTAIR1	MASTAIR3
No. of CAMAC tape	50	50	40	40
IF = first CAMAC file nos. in each set (always file header nos.)	400	400	550	480
IL = last CAMAC file nos. in each set (always data file nos.)	410	410	560	490
ISKIP = number of files initially skipped on CAMAC usually = 0	420	420	570	500
ITAPE = 1 to copy header = 0 not to copy header	430	430	580	510
NSETS = no. of pairs of IF's and IL's	440	440	590	520
RS = rate of sampling no. of samples/sec.	450	450	600	530
No. of CAMAC tape	3160	3370	3460	3570
No. of MASTER tape	3190	3400	3490	3600

A line printer output accompanies each program run (Figs. 7 and 8). The reason for an unsuccessful run will be written on the line printer output e.g. a wrong tape number or parity error. A parity error indicates a probable malfunction of the CAMAC system and the data concerned may have to be redigitised.

The expected number of samples on a data file is calculated from rate of sampling and the number of seconds of data recorded i.e.: expected number of samples = RS x N.

When either MASTAIR1 or MASTAIR3 find a data file on the CAMAC tape where the number of samples is not within ± 10% of the expected number, the file is overwritten with zeros and the program continues. This is indicated by a new page being started on the line printer output.

When either MASTEXP1 or MASTEXP3 find the number of samples is not within ± 1%, that file, together with its corresponding header are overwritten with the next header and data file.

3.5 Master tape - description

9-track, density of 800 bits per inch, no labels.

Variable length, blocked records

Header files - ASCII

Data files - Binary

Apart from having no label and several files on a tape, the Master tape is in Honeywell System Standard Format.

3.6 Format

Each record contains 30 Binary numbers.

For hydrophone data, the records are padded with zeros for the absent channels. There are 10 samples in each record.

WORD:	1	2	3	4	5	6	30
DATA:	hydro	0	0	hydro	0	0	.... etc.

for geophone data, each number is a sample from the geophones. There are 30 samples in each record, 10 scans of 1 sample from each geophone.

WORD:	1	2	3	4	5	6	30
DATA:	geoX	geoY	geoZ	geoX	geoY	geoZ	etc.

4. Computer plotting of PUBS data

4.1 Explosion data

Once a Master Tape has been produced, the Fortran plotting program ASMAIN2B (Appendix II) reads the tape and produces the time-distance plots. The job is run by loading the JCL (Job Control Language) and data cards at the Honeywell 707 at Wormley. The following JCL cards are needed:-

Column 1	Column 8	Column 16
$	IDENT	RBW, WHITMARSH
$	USERID	RBW$RBW
$	MSG1	1, LIMITS OF 0.15HR AND 46K AND -3K
$	FILSYS	
	FC	OPS/WORMLEY/CC936/RBWØ1, BLOCKS/50,9999/
$	LOWLOAD	
$	OPTION	RELMEM, FORTRAN, NOMAP
$	LIBRARY	BB, AA
$	USE	GTLIT
$	FORTRAN	ASCII, NLSTIN
$	SELECT	RBW/ASMAIN2B
$	EXECUTE	
$	LIMITS	15, 46K, -3K
$	PRMFL	BB, R, R, RBW/LIB/ASSEML/B1
$	PRMFL	AA, R, R, LIBRARY/SPI
$	TAPE9	12,X1D,,91234,,RBW,,DEN8
$	FFILE	12,MLTFIL, NLABEL
$	PRMFL	15,W,S,OPS/WORMLEY/CC936/RBWØ1
$	SYSOUT	Ø6, ORG
$	DATA	Ø5
	Data cards	
$	END JOB	

______This is an estimate of the maximum computer time needed to run the job. Each shot takes approximately 0.006 HR.

______This is the file name of the Calcomp plotter tape and must be unique i.e. only one job using that file name may be in the system at any one time.

- - - -This is the number referring to the Master Tape from which the plot is to be produced.

A preliminary (or stage 1) plot of all shot data is produced first to check that the water-wave arrivals are correctly aligned, and that there are no timing errors. If a water-wave arrival is mis-aligned by an integral number of 10 seconds, then the NBSEC value for that particular trace is wrong and must be corrected before the next plot. However if a random timing error has occurred, the shot concerned has to be re-digitised.

A typical set of data cards is shown in Figure 9. (For a full explanation of parameters see W. Davey IOS Internal Document No. 38, (Figs. 9-16) July 1978). The parameter NVO is the number of the channel to be plotted.

NVO = 1 when plotting data from the hydrophone

NVO = 1,2,3 when plotting data from the Z,Y,X geophones respectively.

The parameter ECH2I us used to set the trace amplitudes.

Once a satisfactory stage 1 plot has been obtained (Figure 10), a stage 2 plot is produced which is a reduced travel time plot displaying the ground waves.

The parameter SED is a correction which adjusts the trace position along the time axis to compensate for the sea-depth, sediment-thickness (if known), shot depth and the clock drift. The sea-depth correction is a negative quantity and is equal to 0.65 x sea-depth (km) for arrivals with apparent velocities in the range 6 to 8 km/s. The shot depth and clock drift corrections are obtained from the BSOUT listing (the output file of the program BSEIA). The three corrections are added together to give the SED correction, one for each shot, which is entered on CARD 8.

4.2 Trace amplitude

The trace amplitude on the time distance plots is controlled by a number of parameters which are taken account of in the subroutines VOGA31, LECFEN and GPSTR effectively using the formulae below.

For hydrophone data:

$$\text{amplitude of trace} = \frac{ITAB}{ECH2} \cdot \frac{GA1}{1250} \cdot (GA2 + GA3/100) \cdot MLT(1)$$

where ITAB is the digitised number on the Master Tape

ECH2 is defined below

GA1 is the CAMAC step size (V)

GA2 is PUBS hydrophone "gain" (mV) - columns 77 and 78

GA3 is PUBS hydrophone "gain" (1/100mV) - columns 79 and 80

MLT(1) is a multiplier, equal to "once" for hydrophone

) read from the data file header on the Master tape

For geophone data:

$$\text{amplitude} = \frac{ITAB \cdot (GA2/1250)}{ECH2 \cdot (100 \times GA2 + GA3)} \cdot \frac{1}{MLT(NVOIE)}$$

ITAB, ECH2, GA1 as above

NVOIE = 1, 2, 3

(100 x GA2) + GA3 = (gain of signal amplifier) x (gain of modulator amplifier)

E.g. (100 x 10) + (1 x 0) = 50 x 20

4.3 Shot weight and distance scaling

The parameters IWT and DISTI are used for scaling the trace amplitudes on a stage 2 plot to compensate for thevarious shot sizes and, if required, the varying distance of the shots from the PUBS.

For shot size, scaling factor = $\left(\frac{IQ}{IWT}\right)^{EXPOW}$

where

IQ = shot size, as read from file header

IWT = shot size to be used for scaling

EXPOW = 0.67 (from a data statement in subroutine GPSTR

For distance, scaling factor = $\left(\frac{DIST}{DISTI}\right)^{EXPO}$

where,

DIST = shot distance as read from file header (or DISTC)

DISTI = distance to be used for scaling

EXPO = -1 usually (entered on card 6). This causes the trace amplitude scaling factor to increase linearly with distance.

These scaling factors are combined to give,

$$ECH2 = ECH2I \cdot \left(\frac{DIST}{DISTI}\right)^{EXPO} \cdot \left(\frac{IQ}{IWT}\right)^{EXPOW}$$

where,

ECH2 (millimicrons/sec/cm) is the value which appears on the plot.

4.4 Filtering

Traces may be digitally filtered (high-pass and low-pass) by entering the required values on card 4.

Rejection filters can also be used by entering the required value for the parameter NFPR on card 9 (W. Davey IOS Internal Document No. 38 July 1978).

4.5 Output from ASMAIN2B

A typical page from the line-printer output of ASMAIN2B is shown in Fig. 11. This is part of a listing of a final stage 2 plot, where the SED corrections have been added and the traces filtered and scaled for shot size (IWT) and distance (DISTI). The corresponding plot obtained is shown in Figure 12.

4.6 Airgun Data (R.B. Whitmarsh, The semi-automatic processing and plotting of airgun record sections, 4th June 1979).

The same procedure is followed as for explosion data, but with the following changes:-

1. In the JCL replace $ SELECT ASMAIN2B by,

   $ SELECT AMAIN2GB

2. For an estimation of computer time - 100 shots take approximately 0.11 HR. (when digitising period is 30 seconds)

3. The NBSEC value for the whole series of shots is the start of digitising with respect to the whole second on which the gun was fired.

4. A preliminary plot is made using data cards as shown in Figure 13. Cards 1-6 have the same format as for explosion data. There is now only one card 8 for each plot, and it has four parametersL- NFC, NBSEC, DISTC and ICARTE.

where,

NFC is the number of the first file required

NBSEC - as above

DISTC is the range (kms) of the shot corresponding to file NFC

ICARTE is always -9 for airgun data.

Card 9 contains the DELX and IFILE2 values (see range calculations). DELX is the trace separation (kms) and IFILE2 is the number of the last file for which the corresponding DELX value is valid. Therefore, for any one plot, there will usually be several card 9's.

4.7 Range calculations

Each airgun shot is played out on the Oscillomink records and the water-wave arrival time read by eye. The program BSEIA uses these values and a suitable relocity/depth model of the sea area concerned to calculate the airgun to PUBS range of each shot. The utility Grafix program LIBRARY/AUTOGRAF (see DP/US/GRAFIX/5) plots calculated range against shot number directly from BSOUT (the output file for program BSEIA). This plot is then approximated by several straight lines and thus a series of shot to shot separations (DELX values) is obtained.

4.8 Sea-depth and sediment thickness models

After a preliminary plot (Figure 14) has been produced and examined for clock "jumps" each trace is SED corrected to compensate for the travel time spent in the sea and in the sediments. This is achieved by producing a sea-depth and sediment thickness model along the seismic refraction profile under consideration.

Firstly the bathymetric profile is drawn with time as the horizontal axis. The sediment thicknesses are obtained from the seismic reflection profile (obtained by a 40 cubic inch airgun firing every 12 seconds, in between the 1000 cubic inch airgun shots). This profile gives the sediment thickness in terms of two-way travel time, and is converted to true thickness by assuming a sediment interval velocity of 1.7 km sec^{-1}. These thicknesses are added to the bathymetric profile and the sea-bed and base-of-sediment interfaces are approximated by a number of straight line segments (Figure 15). The points on each interface (time of day, depth (m)) are entered into files and plotted using the AUTOGRAF program. This profile is then checked against the original hand drawn profile. One of two programs, FTCORR1 and FTCORR2, is then used to calculate the sea depth and sediment corrections. The output file contains in the format required by Program ASMAIN2B (i.e. NFC, NBSEC, SED (total sediment correction), and DISTC (range)). The explosion plotting program ASMAIN2B is used because now each airgun trace has a different SED value (Figure 16).

APPENDIX I

Use of Terminal (also see IOS Computer User's Guide, section 4, September 1978).

HP 2640A

Note: DUPLEX is set to "HALF"

PARITY is set to "EVEN"

BAUD RATE is set to 1200

Upper case = characters to be typed by user

To Log-on

Press "Return"

If no reply press "CNTL" and "A" together

If no reply press "CNTL" and "C" together then "CNTL and "A" together

program name - TSS (time sharing system)

user id - CED$CED;G230

To access a file * OLD filename e.g. OLD MASTEXP1

To alter a file * OLD filename

* LIST (This lists the whole file unless "BREAK" is pressed to stop).

or e.g. * LIST 10-100 (This lists lines 10 to 100 of the file)

Put "REMOTE" key up

Type in amendment (to one line at a time)

Put "REMOTE" key down

Press "TRANSMIT"

Repeat last four lines if necessary

*RESA filename (RESA resaves)

To create a new file * SAVE filename

To release a file *RELE filename

Appendix I (contd)

To run a program file:

* OLD filename

* JRN *:N,ROUT(WA) or */RUNQ

(for a batch program with the output to lineprinter at Wormley (WA)

* FRN for a Fortran time sharing program

To list a file on the lineprinter at Wormley

*OLD filename

* JPRINT *: IDENT (userid, project no.), ASIS, ROUT(WA)

or */PRINT

The job number in both cases will appear as snumb ------T

Useful commands

*CATA,S lists names of files and catalogues directly under master catalogue in alaphabetical order.

*JSTS snumb gives progress of specified batch job

*CMDS snumb gives continued progress of specified batch job in full

*JABT snumb aborts the specified batch job

*JOUT snumb lists batch job output on terminal

Use of (HP 2648A) Graphics Terminal (ref. User's Manual)

This type of terminal can be used in the same way as the HP2640A terminal but the position of the "BREAK" and "ENTER" keys are different. It has the facility of screen plotting.

To look at a plot from a file,

*CRUN LIBRARY/SPITOH,R

filename - OPS/WORMLEY/CC936/RBW01 (for example)

Appendix I (contd)

When an equals sign appears, either enter a scaling factor or press "RETURN" e.g. a scaling factor of 0.5 would halve the size of the plot. When the plot is complete it will disappear from the screen. To retain it press "SHIFT" and "A DSP" together then "SHIFT" and "G DSP" together. The plot can be enlarged or reduced by using "G CURSOR", "ZOOM IN" and "ZOOM OUT". Type DONE when finished.

APPENDIX II

Program File CED/ASSMAIN2

This is the source for the B.C.D. versions of the plotting program RBW/ASMAIN2B (for explosions). A flow diagram of the subroutines used is shown in Fig. 17.

Different versions of the plotting program stored separately under the Master catalog use a lot of filespace. This has been reduced by placing most of the subroutines in object format in a library, i.e. RBW/LIB/ASSEMLIB1 (Fig. 18)

The source of each subroutine is stored in a file such as

RBW/IOSØ9/Fsubroutine name

eg RBW/IOSØ9/FGPSTR

To change one of the subroutines in the library the program RBW/ADDLIB (Fig. 19) is used with $\not{S}$ SELECT new subroutine name

CED/ASSMAIN2 consists of:-

Main program

Subroutine VOGA31 Calculates amplitudes and gain for MARK I, II.

Subroutine GPSET Reads MARK II header information <u>only</u>

In general if a subroutine appears in both CED/ASSMAIN2 and in library then the former version is used during execution of the program.

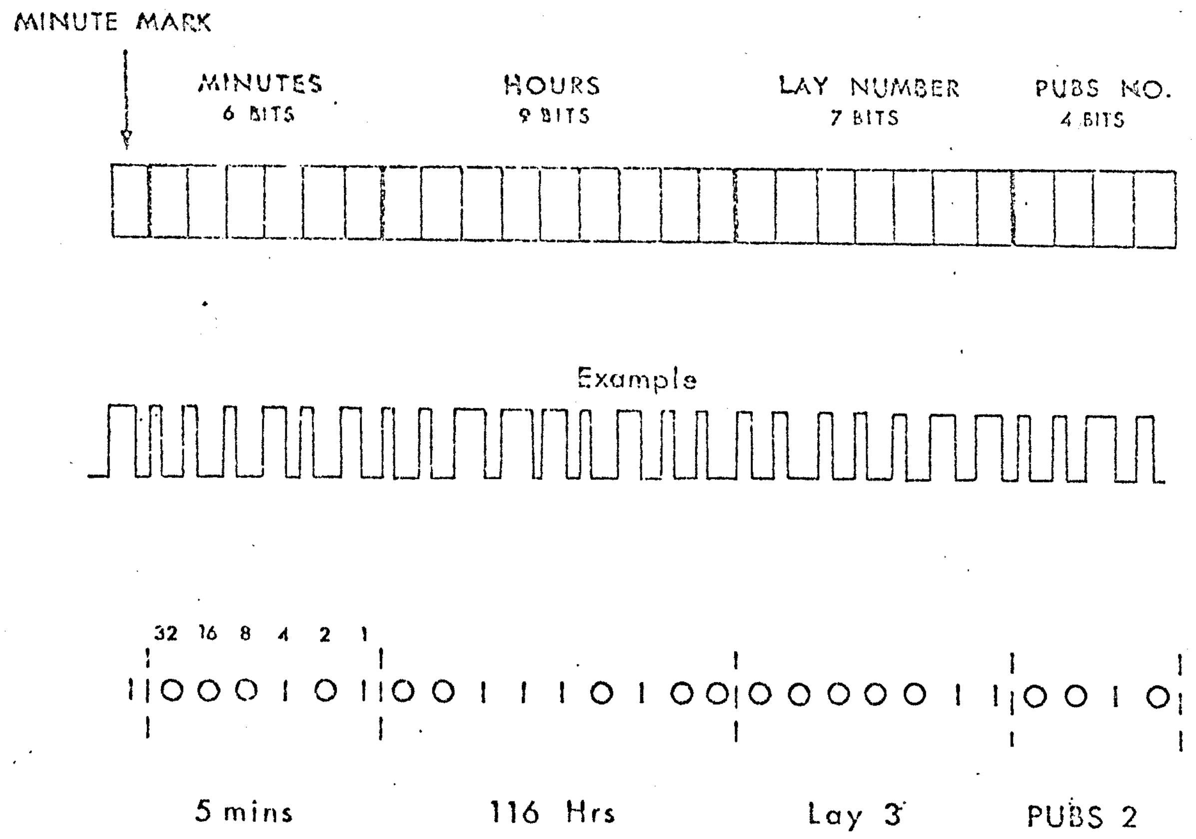
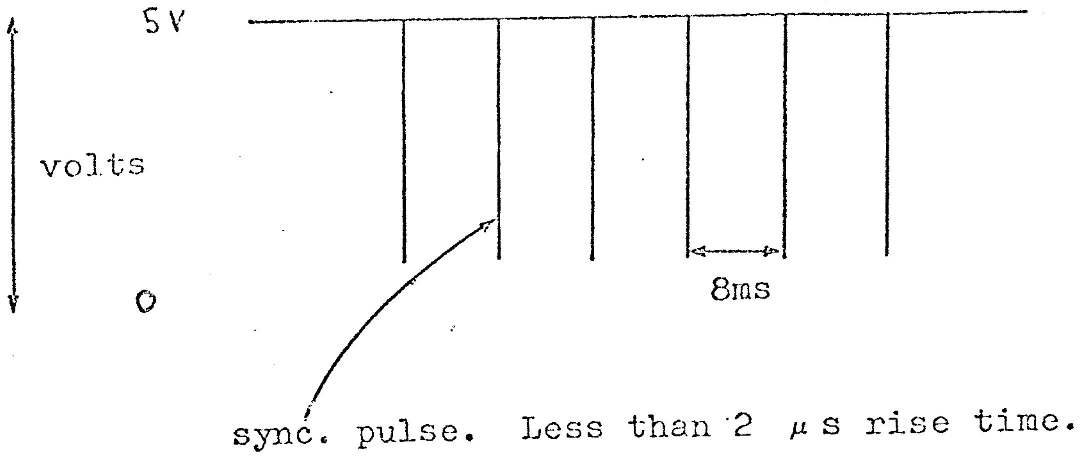
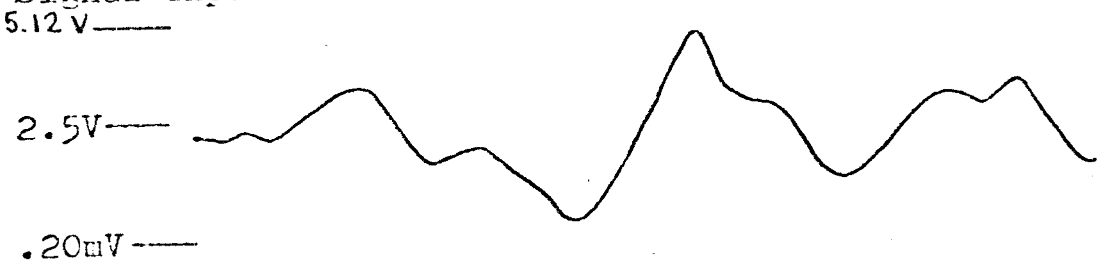


Figure 1. PUBS MKII BINARY CODES INFORMATION ON THE CLOCK TRACE

1/. Clock input (interrupt pulses)



2/. Signal input



The signal must have a positive voltage and lie in the range 20 mV - 5.12V.

Figure 2. INPUT SIGNALS TO CAMAC ADC MODULE

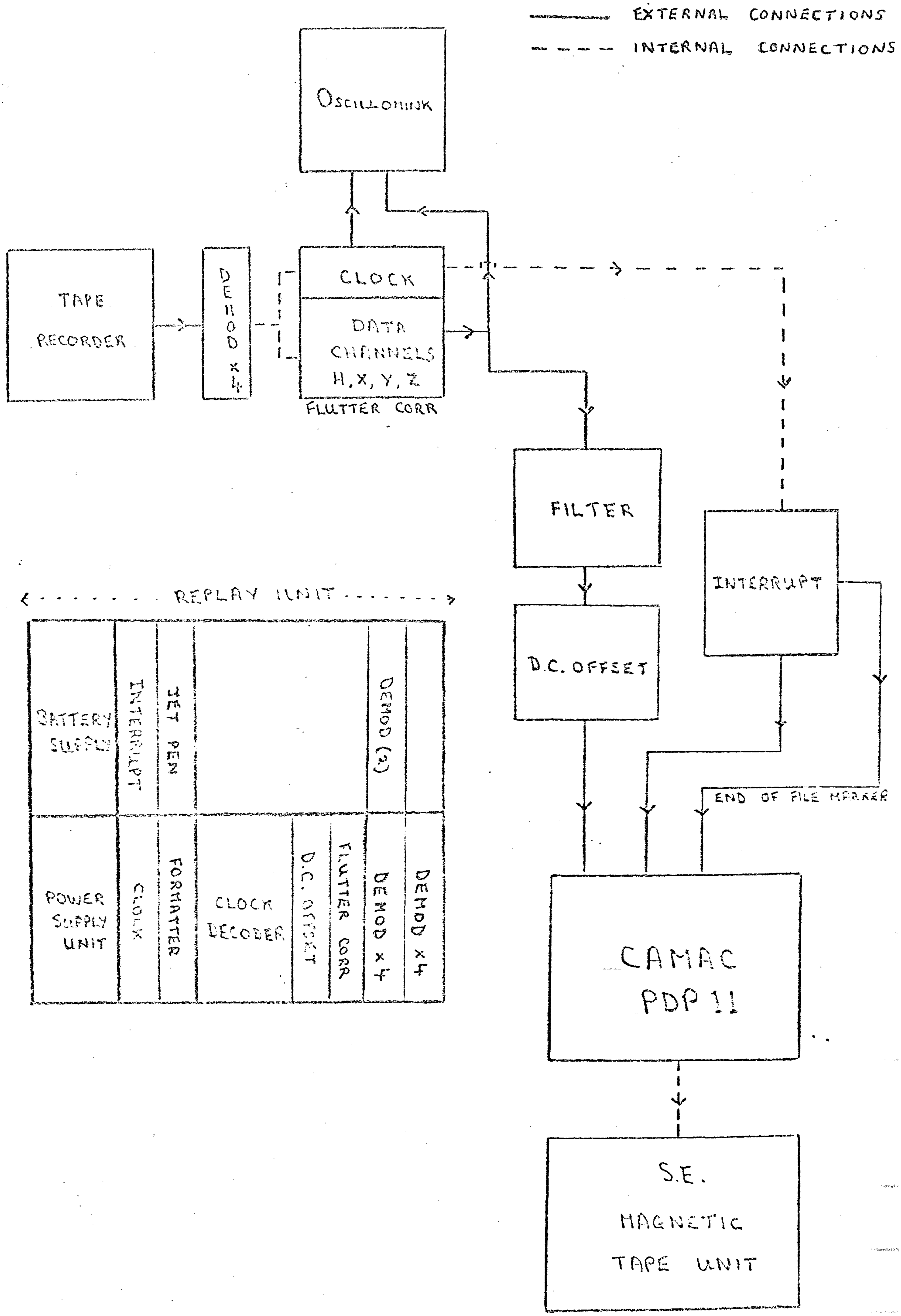


Figure 3. FLOW DIAGRAM OF REPLAY AND DIGITISING EQUIPMENT

X20-7327-6 U/M050
Printed in U.K.
No. of sheets per pad may vary.

FORTRAN Coding Form

FORTRAN STATEMENT

FORMAT

A2 | I4 | <———— A74 ————>

EXAMPLE

CD 21Ø 23/8/79 9824 AIR1 LPSØ FILTER MAX SIG 5V STEP 2.5MV 100 SAMP/SEC M937

TAPE NUMBER | DATE | STATION NUMBER | DIGITISING PROGRAM | ANTI-ALIASING FILTER | MAXIMUM SIGNAL | CAMAC STEP SIZE | SAMPLING RATE | WORMLEY TAPE NUMBER

Figure 4. TAPE HEADER FORMAT AND DESCRIPTION

FORTRAN Coding Form

INUM	KM	KM1	GA(1)	D(1)	DUM(1)	MLT(1)	D(2)	DUM(2)	MLT(2)	D(3)	DUM(3)	MLT(3)	IT	ISH	KBØ	IPUB	IQ	IHR	IMIN	ISEC	IMSEC	IYR	GA(2)	GA(3)
A6	I4	I4	I4	A2	A2	I2	I2	A2	I2	A2	A2	I2	I4	I4	I4	I4	I4	I4	I4	I4	I4	I4	I2	I2
Station number	KMS range	1/100 KMS	CAMAC GAIN(V)	D(1,2,3) = PUBS identification character DUM(1,2,3) = PUBS channel identification character MLT(1,2,3) = gain multiplier for channel 1,2, & 3.									trace inversion	shot number	secs in file	PUBS USED	SHOT WEIGHT (LBS)	HRS	MINS	SECS (Shot instant)	MSECS (Shot instant)	YEAR	PUBS gain (sec)	

EXAMPLES

Hydrophone data (explosion) with gain 0.6mV

```
D9824  43  212500A H  1                 19  60  4  100  0  0  6  78  1978 06
```

Geophones (airgun) with gain 1000

```
D9824       2500H Z  1A Y  1A X  1       1  30  3  -1   0  0  0      19781000
```

Figure 5. FILE HEADER FORMAT AND DESCRIPTION

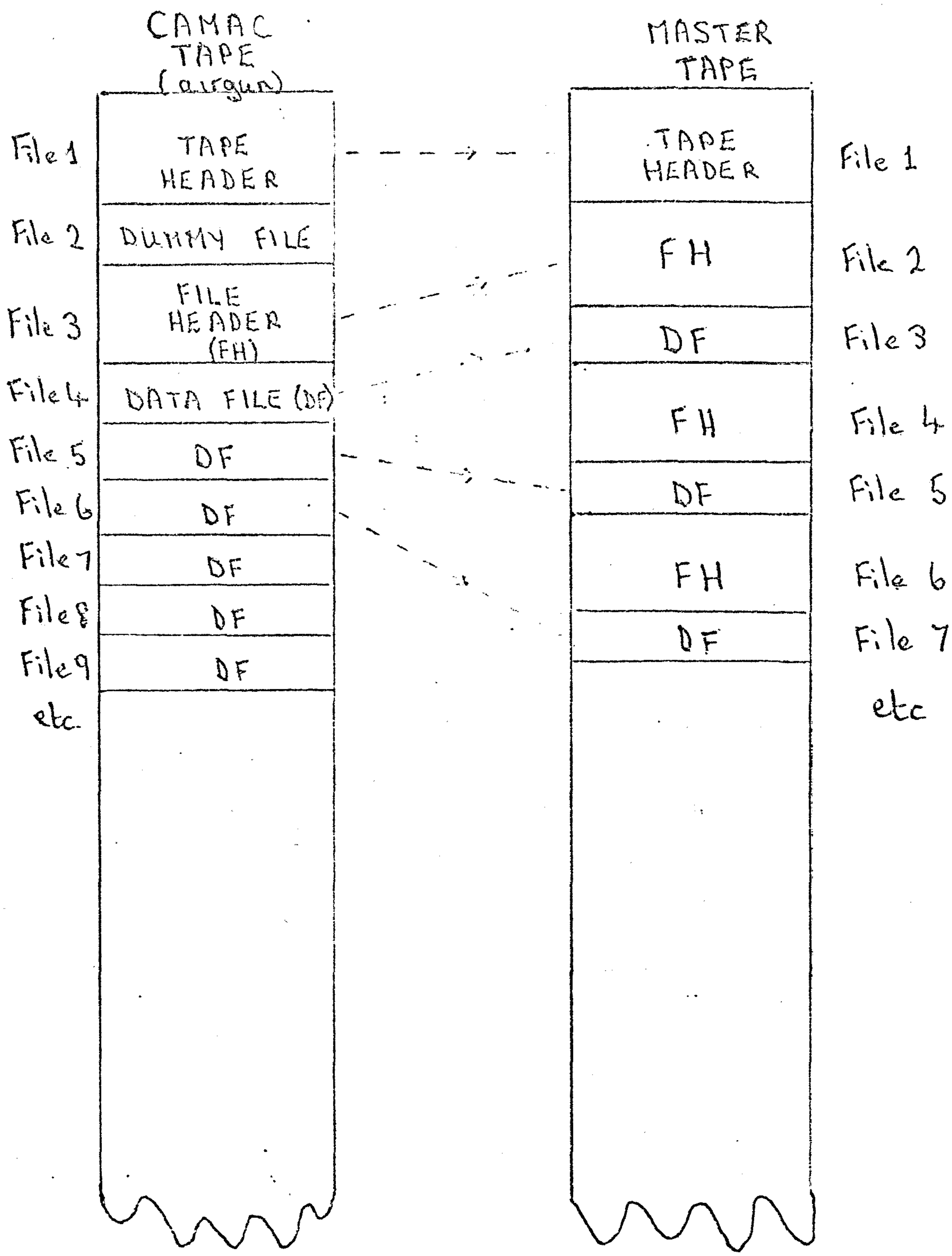


Figure 6. ARRANGEMENT OF FILES ON AIRGUN CAMAC AND MASTER TAPES

```
 *****  TAPE HEADER WRITTEN ONTO MASTER TAPE              MASTER FILE NUMBER      1   *****
 CD 063 12/6/79 EXP1 EP50 MAX SIG 5V STEP 2.5MV 100 SAMP/SEC M942
CAMAC FILE NUMBER TO BE USED NEXT    43 LAST CAMAC FILE NUMBER USED      1

PUBS MARK II EXPLOSION HYDROPHONE DATA

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE              MASTER FILE NUMBER      2                  SHOT NUMBER      1  *****
  D9803   24   102500A H   1                        1  60   2  25    0    0    2 38  1978 03



 *****  DATA FILE WRITTEN ONTO MASTER TAPE                MASTER FILE NUMBER      3                  SHOT NUMBER      1  *****
    EXPECTED NUMBER OF SAMPLES = 6000 ACTUAL NUMBER OF SAMPLES = 6001
    AVERAGE VALUE CALCULATED FROM 6001 SAMPLES =      1007.
    AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =       1008.

******************************************************************************************************
CAMAC FILE NUMBER TO BE USED NEXT    45 LAST CAMAC FILE NUMBER USED    44

PUBS MARK II EXPLOSION HYDROPHONE DATA

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE              MASTER FILE NUMBER      4                  SHOT NUMBER      2  *****
  D9803   25   812500A H   1                        2  60   2  25    0    0    3 34  1978 03



 *****  DATA FILE WRITTEN ONTO MASTER TAPE                MASTER FILE NUMBER      5                  SHOT NUMBER      2  *****
    EXPECTED NUMBER OF SAMPLES = 6000 ACTUAL NUMBER OF SAMPLES = 6001
    AVERAGE VALUE CALCULATED FROM 6001 SAMPLES =      1007.
    AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =       1008.

******************************************************************************************************
CAMAC FILE NUMBER TO BE USED NEXT    47 LAST CAMAC FILE NUMBER USED    46

PUBS MARK II EXPLOSION HYDROPHONE DATA

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE              MASTER FILE NUMBER      6                  SHOT NUMBER      3  *****
  D9803   27   432500A H   1                        3  60   2  25    0    0    4 12  1978 03



 *****  DATA FILE WRITTEN ONTO MASTER TAPE                MASTER FILE NUMBER      7                  SHOT NUMBER      3  *****
    EXPECTED NUMBER OF SAMPLES = 6000 ACTUAL NUMBER OF SAMPLES = 5991
    AVERAGE VALUE CALCULATED FROM 5991 SAMPLES =      1006.
    AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =       1006.

******************************************************************************************************
```

Figure 7. PART OF LINE PRINTER OUTPUT FROM MASTEXP1

```
 *****  TAPE HEADER WRITTEN ONTO MASTER TAPE          MASTER FILE NUMBER     1  *****
 CD 062 9802 11/6/79 AIR1B LP50 MAX SIG 5V STEP 2.5MV 100 SAMP/SEC M941
CAMAC FILE NUMBER TO BE USED NEXT   3 LAST CAMAC FILE NUMBER USED   1

PUBS MARK II AIR GUN HYDROPHONE DATA

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE          MASTER FILE NUMBER     2               SHOT NUMBER    16   *****
D9802          2500A H   1                     16   30     4  -1    0    0    0   01978 03

 *****  DATA FILE WRITTEN ONTO MASTER TAPE            MASTER FILE NUMBER     3               SHOT NUMBER    16   *****
  EXPECTED NUMBER OF SAMPLES = 3000 ACTUAL NUMBER OF SAMPLES = 3000
  AVERAGE VALUE CALCULATED FROM 3000 SAMPLES =        877.
  AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =          878.

*************************************************************************************************************

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE          MASTER FILE NUMBER     4               SHOT NUMBER    17   *****
D9802          2500A H   1                     17   30     4  -1    0    0    0   01978 03

 *****  DATA FILE WRITTEN ONTO MASTER TAPE            MASTER FILE NUMBER     5               SHOT NUMBER    17   *****
  EXPECTED NUMBER OF SAMPLES = 3000 ACTUAL NUMBER OF SAMPLES = 3001
  AVERAGE VALUE CALCULATED FROM 3001 SAMPLES =        877.
  AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =          878.

*************************************************************************************************************

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE          MASTER FILE NUMBER     6               SHOT NUMBER    18   *****
D9802          2500A H   1                     18   30     4  -1    0    0    0   01978 03

 *****  DATA FILE WRITTEN ONTO MASTER TAPE            MASTER FILE NUMBER     7               SHOT NUMBER    18   *****
  EXPECTED NUMBER OF SAMPLES = 3000 ACTUAL NUMBER OF SAMPLES = 3001
  AVERAGE VALUE CALCULATED FROM 3001 SAMPLES =        877.
  AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =          878.

*************************************************************************************************************

 *****  FILE HEADER WRITTEN ONTO MASTER TAPE          MASTER FILE NUMBER     8               SHOT NUMBER    19   *****
D9802          2500A H   1                     19   30     4  -1    0    0    0   01978 03

 *****  DATA FILE WRITTEN ONTO MASTER TAPE            MASTER FILE NUMBER     9               SHOT NUMBER    19   *****
  EXPECTED NUMBER OF SAMPLES = 3000 ACTUAL NUMBER OF SAMPLES = 3001
  AVERAGE VALUE CALCULATED FROM 3001 SAMPLES =        878.
  AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =          879.

*************************************************************************************************************
```

Figure 8. PART OF LINE PRINTER OUTPUT FROM MASTAIR1

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE
PROGRAMMER	DATE		PUNCH	

CARD

(1)

SH	ECDIS	ECTEM	ITHIN	ITMAX	IDMIN	IDMAX	NSCRUT
1.	1.	1.	0	60	26	86	100

(2)

VR	V1	T1	V2	T2
9999.	9999.	0.	9999.	60.

(3)

NBAND
063

(4)

		NPAS
		2

(5)

ITITR	ITITRE →
1	DISCOVERY STA. 9809 PUBS 4

(6)

NVO
1

(7) Not needed, omit

(8)

NFC	NBSEC
2	-20
4	-10
6	-20

Figure 9. A TYPICAL SET OF INPUT DATA CARDS FOR A STAGE 1 EXPLOSION PLOT USING ASMAIN2B

C. IP36. 0. 03/12/79

VR= 999.00KM/S V1= 999.00KM/S V2= 999.00KM/S SH = 1.00 EXPO = 0. ECH2I = 0. DISTI = 100
NPAS= 2. T1= 0.00 S T2= 60.00 S

DISCOVERY STA. 9816 P4

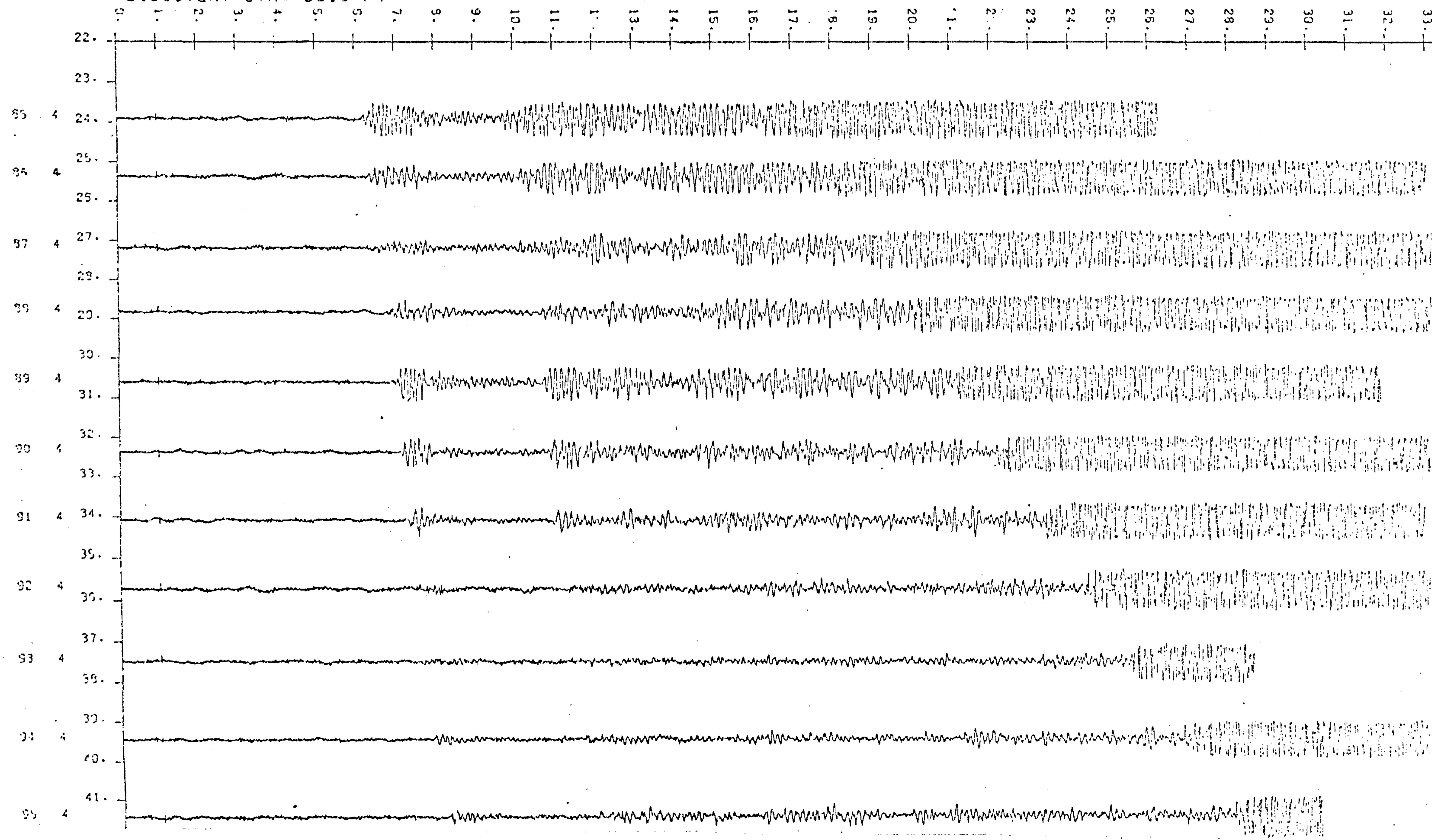


Figure 10. A TYPICAL STAGE 1 EXPLOSION PLOT USING ASMAIN2B

```
SUUB = 10500, ACTIVITY E = 03, , REPORT CODE = 06, RECORD COUNT = 000251

SH=  2.00 ECDIS=  1.00 ECTEM=  2.50 ITMIN=    -3 ITMAX=    6 IDMIN=    20 IDMAX=    50 NSCRUT=   100
VR=  6.00 VI=  6.00 T1= -3.00 V2=  6.00 T2=  6.00

BANDE IP     37       BANDE CALCUP       0       DESSIN       0
NUMERO BD=CD  37              24/1/79 9823 EXP1 LP50 MAX SIG 5V STEP 2.5MV 100 SAMP/SEC M913
FILT(1)=      6.00 , FILT(2)=      12.00 , NPAS=  2 , NFPH=  1 , NFPB=  1 DECON=  0 POLAR=  0 PREDI=  0 VITESSE=  0 DEPLA=  0
ITITR=  1            DISCOVERY STA. 9823 P4
NVC=  1 FCH2I=      2.0000DISTI=   100.000 EXPO=       0.     NFEN=500 NO5=  0 IOTR=  0 IR=  0 IALFA=  0 NIND=  0 INT=    25
INT=    25 IG=    0
--------------------------------------------------------------------------------------------------------------------------------
NFC=    48 , FIL(1)=  0.   , FIL(2)=  0.   , IVOIE=    0 , NBSEC=  -30 , NBTSE=    0 , NBSEI=    0
SED=    -1.570 , SHI=       2.000 , DISTC=    0.      , INVER=  1 , NPH=  1 , NPB=  1   ICARTE= 0
NFC12=  INFC= 48
 D9823  24  442500A H  1     0      0   0   1   60    4   25
HO=    0 H    0 MN    1 S 150/1000 YEAR=1978    060

DIST=      24.44 T1R=     35.223 TT1=     2.223 TT2=    11.223 NBVR=  3522 NBDEB=  3380 NBFIN=  4278 NPOIN=    21
DATE EN TEMPS REDUIT DU PREMIER POINT TX=       -3.000
VALEURS CORRIGEES DE NBDEB=      1 NBFIN=  901
FILTRE PASSE BAS - ORDRE 3 - BUTTERWORTH  FC= 0.12000E 02
FILTRE PASSE HAUT- ORDRE 3 - BUTTERWORTH FC= 0.60000E 01
MIN=      -3.446    MAX=        3.586
MAX=  3.6 MIN= -3.4
INT=    25 IG=     25
FCH1=       0.5000 CM/MU/S        FCH2=      2.0000 MU/S/CM
--------------------------------------------------------------------------------------------------------------------------------

--------------------------------------------------------------------------------------------------------------------------------
NFC=    50 , FIL(1)=  0.    , FIL(2)=  0.    , IVOIE=     0 , NBSEC=   -20 , NBTSE=     0 , NBSEI=     0
SED=    -1.570 , SHI=       2.000 , DISTC=    0.      , INVER=  1 , NPH=  1 , NPB=  1   ICARTE= 0
NFC12= 49NFC= 50
 D9823  25  922500A  H  1     0     0   0   2   60    4   25
HO=    0 H    0 MN    9 S 620/1000  YEAR=1978      060

DIST=      25.92 T1R=     34.140 TT1=     11.140 TT2=    20.140 NBVR=  3414 NBDEB=  3272 NBFIN=  4170 NPOIN=    29
DATE EN TEMPS REDUIT DU PREMIER POINT TX=     -3.000
VALEURS CORRIGEES DE NBDEB=      1  NBFIN=   901
FILTRE PASSE BAS - ORDRE 3 - BUTTERWORTH  FC= 0.12000E 02
FILTRE PASSE HAUT- ORDRE 3 - BUTTERWORTH FC= 0.60000E 01
MIN=      -2.629    MAX=       3.331
MAX=  3.3 MIN= -2.6
INT=    25 IG=     25
FCH1=       0.5000 CM/MU/S        FCH2=      2.0000 MU/S/CM
--------------------------------------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------------------------------------------
```

Figure 11.   PART OF LINE PRINTER OUTPUT FROM ASMAIN2B

IP 6.   0.   04/02/79

R= 6.00 KM/S   V1= 6.00 KM/S   2= 6.00 KM/S   SH = 1.00 EXPO = 0.   ECH2I = 2.000 DISTI = 100.000
NPAS= 2.   T1= -3.00 S   T2= 6.00 S AMPLITUDE NORMALISED W.R.T. 25 LBS. FOR SHOT SIZE 0 LBS
1. FILTRAGE PASSE-BAS * 12.00 HZ
1. FILTRAGE PASSE-HAUT * 6.00 HZ

DISCOVERY STA. 9816 P4

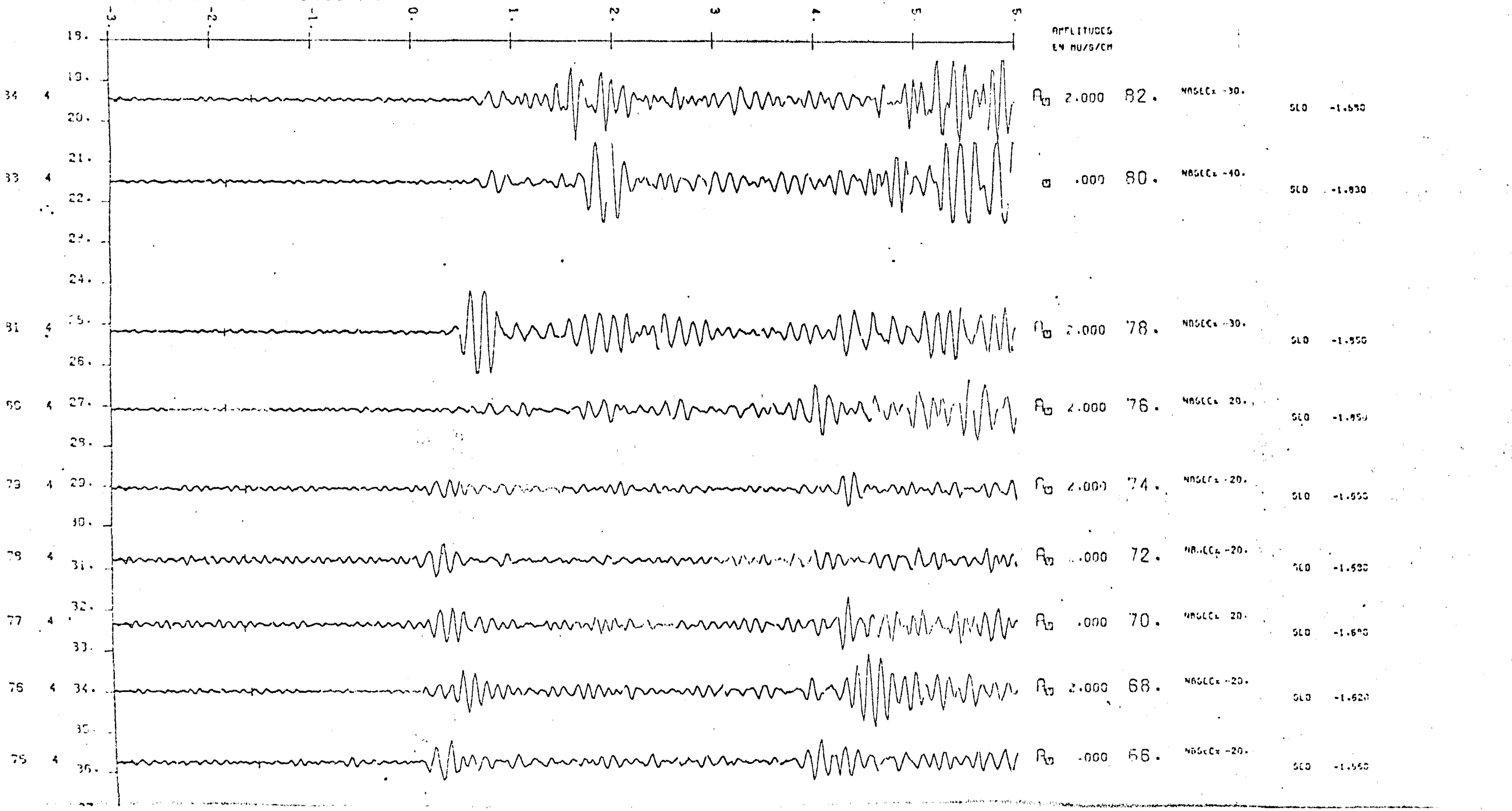


Figure 12. A TYPICAL STAGE 2 EXPLOSION PLOT USING ASMAIN2B

FORTRAN Coding Form

PROGRAMMER	DATE
PUNCHING INSTRUCTIONS	GRAPHIC / PUNCH
PAGE OF	CARD ELECTRO NUMBER*

FORTRAN STATEMENT

CARD

(1) 2. 2. 2.5 0 10 0 15 100

(2) 6. 6. 0. 6. 10.

(3) 064

(4) 2

(5) 1 DISCOVERY STA. 9809 PUBS 4 SERIES 1

(6) 1

(7) Not needed, omit

(8) NFC NBSEC DISTC ICHRTE
2 -4 0.39 -9

(9) DELX IFILE2
0.137 8
0.291 36
0.245 94
0.267 152
etc

Figure 13. A TYPICAL SET OF INPUT DATA CARDS FOR A STAGE 1 AIRGUN PLOT USING AMAIN2GB

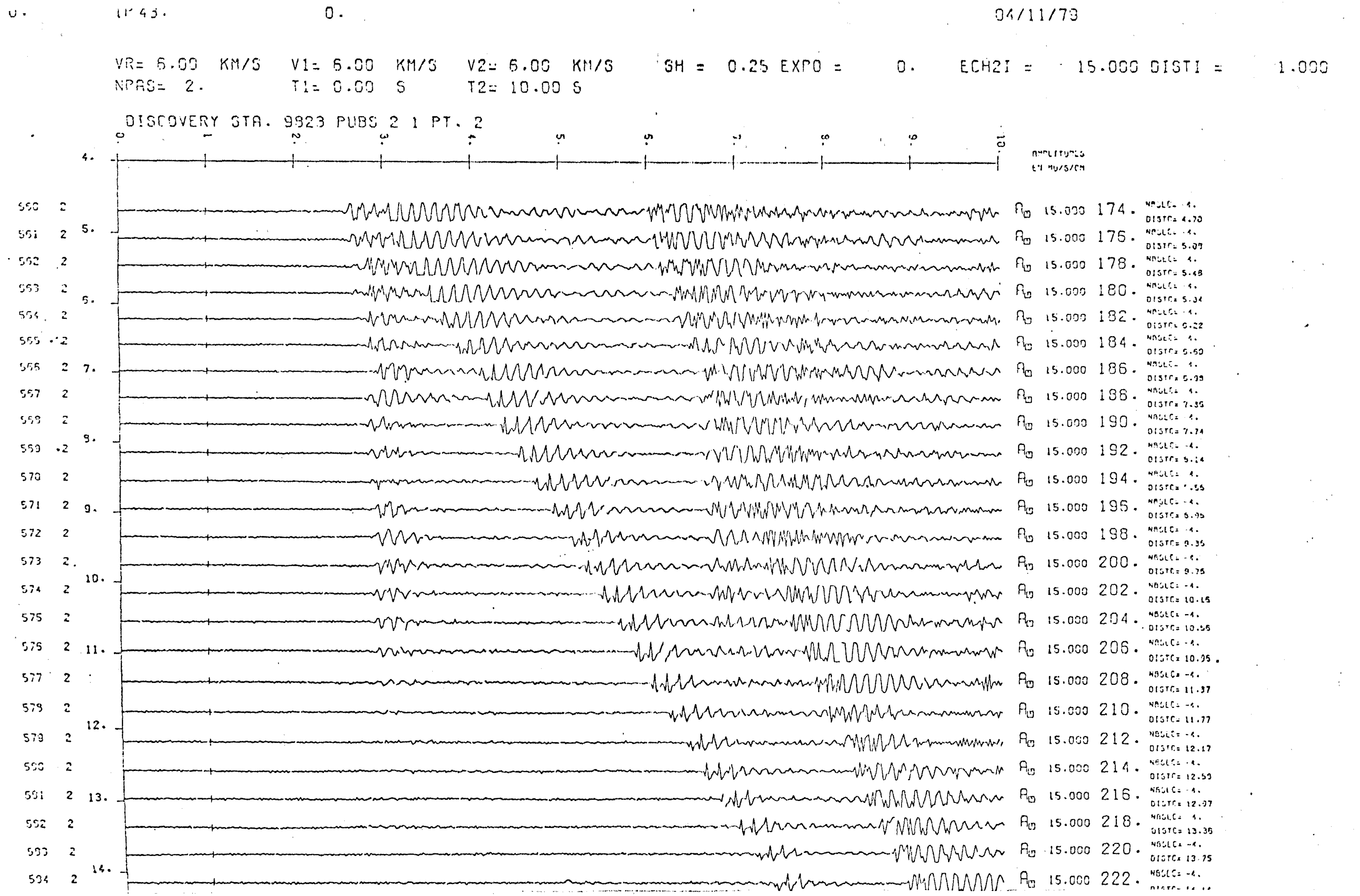


Figure 14. A TYPICAL STAGE 1 AIRGUN PLOT USING AMAIN2GB

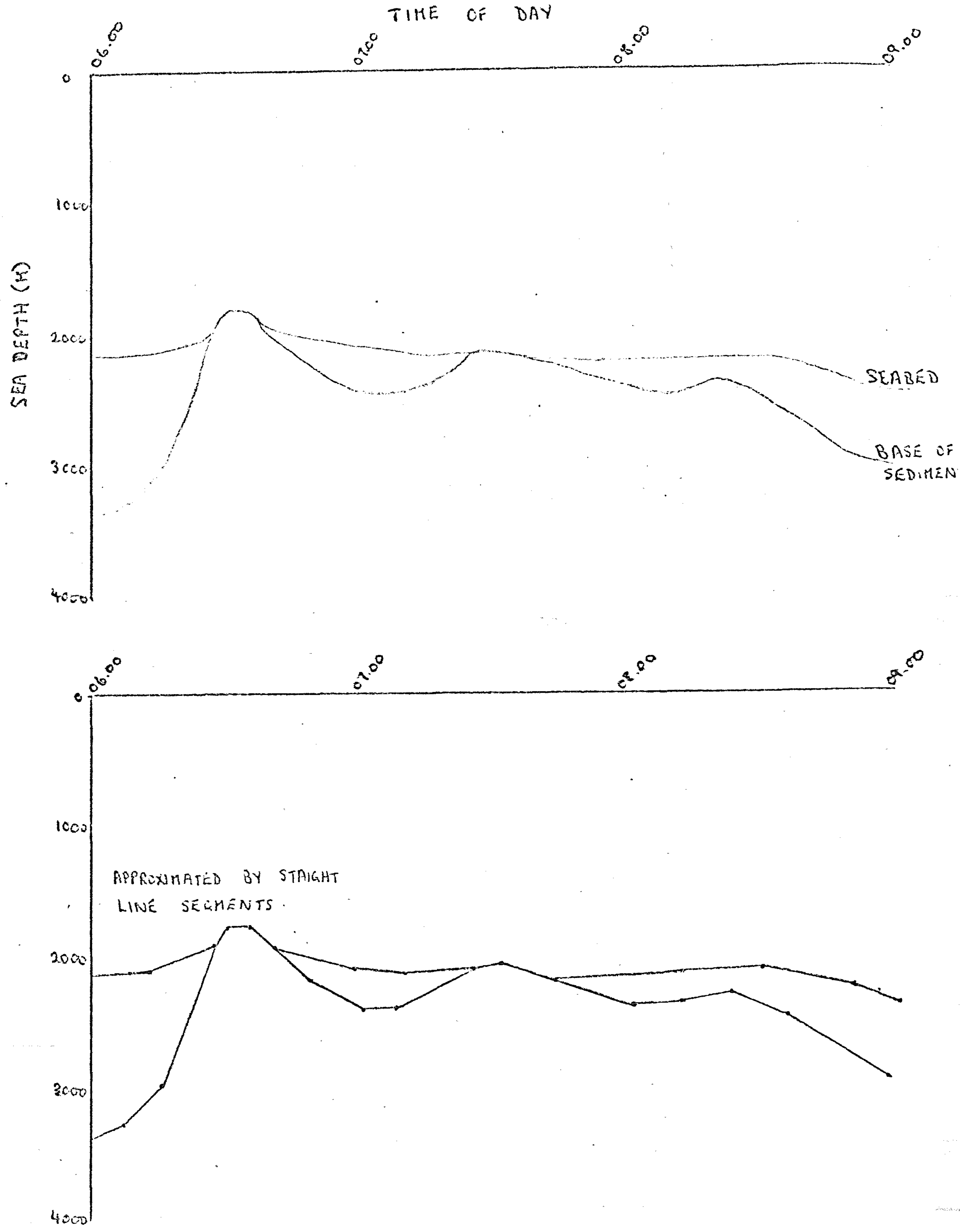


Figure 15. EXAMPLE OF A SEDIMENT THICKNESS MODEL

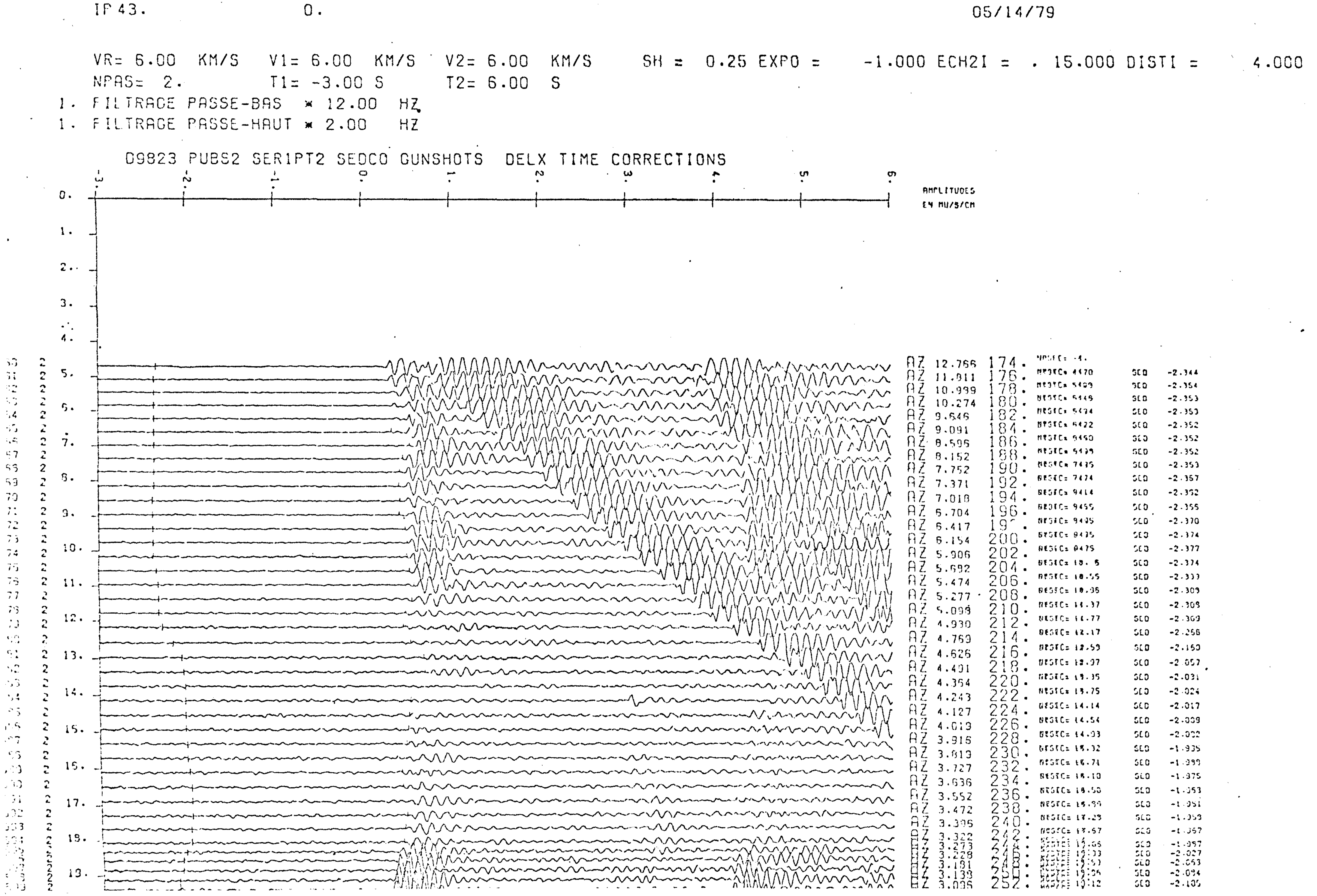


Figure 16. A TYPICAL STAGE 2 AIRGUN PLOT USING AMAIN2GB

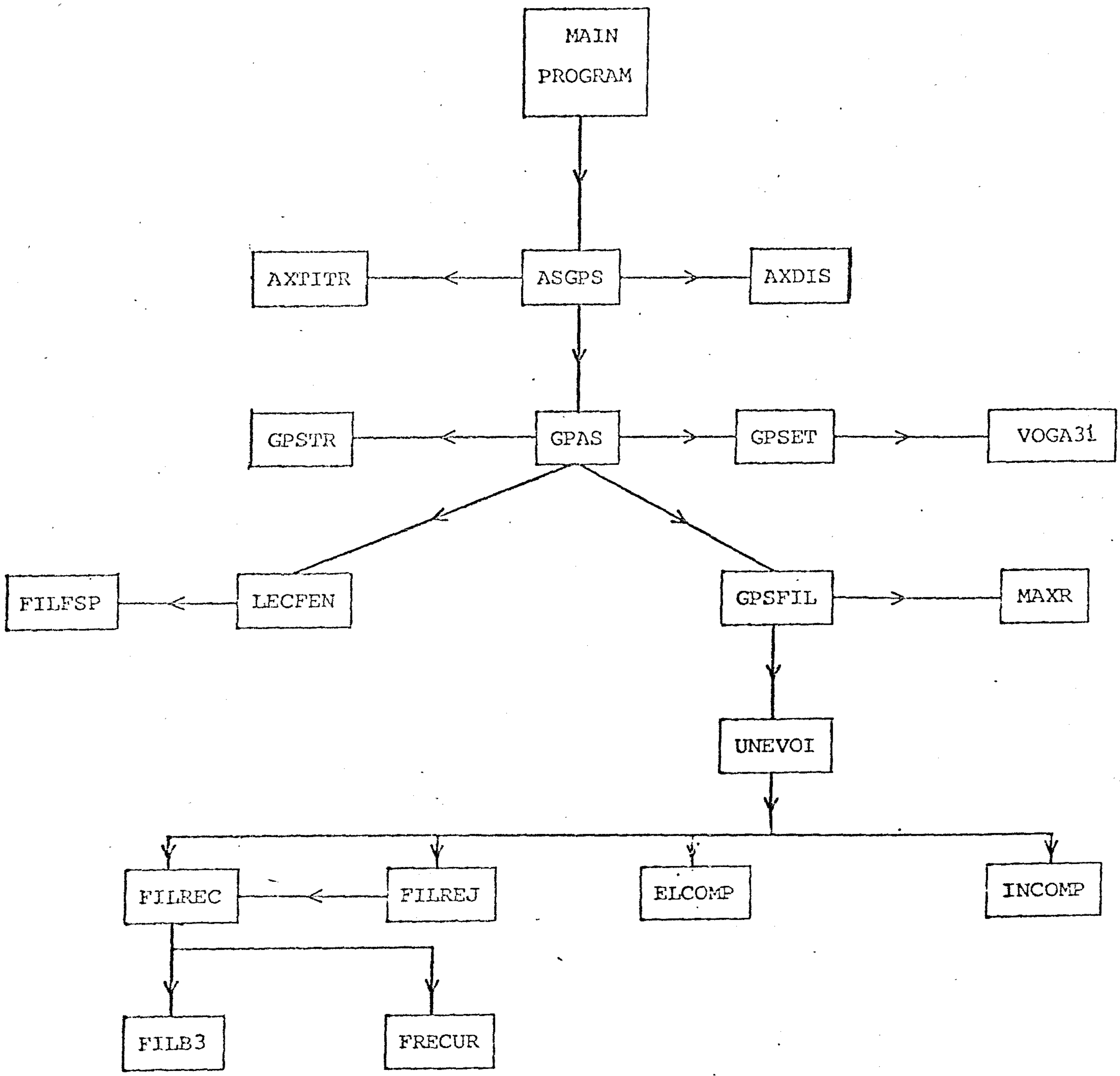


Figure 17. FLOW DIAGRAM OF NON-SYSTEM-SUPPLIED SUBROUTINES USED IN PROGRAM RBW/ASMAIN2B

Figure 18. Table showing source and function of subroutines contained in RBW/LIB/ASSEMLIB1

Subroutines under RBW/LIB/ASSEMLIB1	SOURCE	FUNCTION
ASGPS	RBW/IOSØ9/FASGPS	Reads data cards, gives line printer output. Calls plotting subroutines.
AXTITR	/FAXTITR	Initialisation of plot, annotates and draws time axis.
ELCOMP	/FELCOMP	Elimination of the D.C. component of a trace using only every Nth value (where N = NPA8)
FILB3	/FFILB3	Sets up filtering and sampling interval.
FILREC	/FFILREC	Recursive filter with cut-off frequency. Notch filtering 36dB/Octave
FILREJ	/FFILREJ	Rejection filter set up
FRECUR	/FFRECUR	Recursive filter set up
GPAS	/FGPAS	Determines window to be plotted
GPSFIL	/FGPSFIL	Entry subroutine for the group of filters
GPSTR	/FGPSTR	Scales for distance and shot weight
INCOMP	/FINCOMP	Calculates the mean sample value prior to the elimination of the D.C. component of a trace
LECFEN	/FLECFEN	Selects data channel and reads window
MAXR	/FMAXR	Calculates minimum and maximum values
NAR	/FNAR	Rounds real numbers up or down to the nearest integer
UNEVOI	/FUNEVOI	Does all the filtering required for the processing

```
10$:IDENT:RBW,W,G230
20$:USERID:RBW$RBW
25$. RUN THIS FILE USING OLD, JRN
30$:FORTRAN:ASCII
41$$ SELECT(RBW/IOS09/FGPSTR)
150$:SELECT:./RANEDIT
160$:PRMFL:OT,W,R,RBW/LIB/ASSEMLIB1
170$:ENDJOB
```

Replace FGPSTR by name of required subroutine(s)

Figure 19.

Program ADDLIB which amends subroutines in library LIB/ASSEMLIB1 or which adds new subroutines to this library.