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I.O.S.

Digitisation and Computer Plotting of Mark I Pop-Up Bottom Seismic Recorder (PUBS) Data

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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W. DAVEY

1. INTRODUCTION

Seismic refraction work is carried out in order to obtain information about the oceanic crust and the upper mantle. A Pop-up bottom seismic recorder (PUBS) is laid on the sea bed and records the seismic arrivals from an explosion at the sea surface as described by Langford and Whitmarsh (1976). The explosions, or shots, may be regularly or irregularly fired, the regular firing of shots corresponding to an air-gun being used and the irregular shots to when explosives are used.

2. DIGITISATION

The objective of the digitisation process is the transfer of the analogue PUBS data from $\frac{1}{4}$" magnetic tape to $\frac{1}{2}$" computer compatable magnetic tape, using the Camac PDP11/05 system to digitise the Ground Wave (GW) arrivals for a particular shot (with about 5-10 seconds of preceding background noise) and to continue digitising until at least the first Water Wave (WW) arrival.

2.1 Brief Description of Replay system

A flow diagram showing the basic units in the digitisation process is shown in figure (1).

The PUBS tape is replayed on a Uher Tape Recorder, and has four outputs. The first of these is the Direct Record (DR) output which goes to a loudspeaker or headphones. The other three outputs are:-

1) The clock signal
2) The FM HI gain channel
3) The FM LO gain channel

The HI gain channel has ten times the gain of the LO gain channel. These latter three outputs are pre-amplified before passing into the main replay unit. The clock signal is an FSK (Frequency Shift Key) signal consisting of bursts of two frequencies, 1 kHz and 500 Hz. The FSK clock signal undergoes two main processes, one of these is the frequency demodulation of the clock signal to give a 10 Hz internal clock signal, and the other is that the pre-amplified FSK signal goes into a frequency converter having three main functions:-

1) Converts FSK signal to 125 synchronisation (sync.) pulse per second, controlling the sampling rate.
2) Detects 10 second mark from clock
3) Formats the sync. pulses starting from a 10 second mark.

When the first 10 second pulse is detected by the frequency converter, a steady stream of 125 Hz negative going sync. pulses is fed into the ADC (Analogue to Digital Converter) Module. The digitisation of the data commences on the first sync. pulse the

ADC receives, i.e. on the first 10 second mark, and gives 1 sample per sync. pulse. The length of the data sample (stream of sync. pulses) is controlled by a gated clock in the frequency converter. Normally the sample length is 60 seconds although this may be changed to 120 seconds, if desired, by means of a slider switch on the frequency converter panel.

The FM signal channels are further amplified in the replay unit before being demodulated. The signal then appears as an analogue signal which, by means of the patch panel on the front of the unit may be filtered. A Low Pass 50 Hz anti-aliasing filter is used which removes unwanted high frequencies and also gives an input signal to the Camac of a frequency suited to the sampling rate. The filtered signal is then given a d.c. offset voltage to suit the Camac ADC and is connected into the ADC itself. See figure 4 for specification of input to the ADC module.

The digitised data is then written as a file on the $\frac{1}{2}$" Magnetic Tape, the Camac Tape being 9 track, PDP binary with no labels, no serial numbers and a density of 800 bits per inch. The tape is also unblocked with a fixed length data records of 800 bits per inch.

Before each data file there is a file header which is entered from the terminal, the format of which is shown in figure 2. The file structure of the Camac Tape is shown in figure 3.

The analogue signal and the clock signal are also recorded on the oscillomink recorder, to give a permanent record of the precise segment of data which has been digitised together with the demodulated clock signal.

2.2. Setting up Procedures

2.2.1 PDP 11/05 and CAMAC

1. Before switching on the Camac system ensure that all the Camac modules are plugged in:-

i.e.
   i) ADC 9070 module in Station 9.
   ii) TELETYPEWRITER V24 7061 module in station 6
   iii) MAGNETIC TAPE CS0042 module in station 13
   iv) DMA EC369 module in station 20

2. Switch on both power switches at wall socket.

3.
   i) Ensure all data switches (numbered 0-15) on the PDP 11/05 are down
   ii) Ensure key on PDP 11/05 is in POWER ON position (not PANEL LOCK or OFF)
   iii) Check terminal is correctly set
      i.e.
      a) DUPLEX set to FULL
      b) PARITY set to NONE
      c) BAUD RATE set to 2400
      d) REMOTE and CAPS LOCK keys pressed down
      e) All other keys in up position

4. Press down the LOAD ADRS switch on PDP 11.

5. List the ENABLE/HALT switch on PDP 11.

6. Press down the START switch.

   If the CATY3 system is resident the following message will appear on the Visual Display Unit (VDU)

CATY2 IOS RELEASE 1.3 29/10/76

7. To clear core of unwanted subroutines type !NS or type ! NE to clear just the main program.

8. The subroutines and main program can now be loaded, only in the order given below, via the Paper Tape reader as follows - (enter command with appropriate tape loaded in P/T reader and press RETURN)

COMMAND ENTRIES ON VDU	PROGRAM	
! SR	CONFIG TAPE	
! SR	MAGT	
! SR	BUFBTM	
! SR	ASCEB	On subroutines tape
! SR	KEYIN	
! SR	DISPLAY	
! SR	TFILEN	
! TR	B.W. DIGITIZATION PROGRAM	

The CONFIG Tape should consist of the following basic strings:-

MAGT	=	1,1,13
ADC	=	1,1,9
CONSOL	=	1,1,6
DMA	=	1,1,20
SWREG	=	1,1,10

These can be examined after loading the CONFIG tape by listing the program on the VDU using the command

! PA

The ½" Magnetic Tape is loaded onto the SE data 8000 tape unit with the permit ring in, thus enabling the tape to be written to. The tape heads on the M/T unit should be cleaned with special head cleaning fluid at the start of each day. This prevents the build up of oxide on the heads, which has been known to cause parity errors both on writing to and reading back from the tape. Also the heads on the Uher tape-recorder should be cleaned at the start of a new PUBS tape, again preventing the build up of oxide on the heads. It is also advisable to de-Gauss the heads of the Uher, as they have been found to become slightly magnetized and hence to interfere with the signal coming from the PUBS tape. This should be done about once a month. Also the ¼ inch PUBS tape should be wound fast forward and fast rewind before digitizing as "print through" of signals from one layer of tape to the next can occur with tapes that have been stored for a while.

When a new reel of ½" M/T is being started the tape must have a tape header as described earlier; if the tape already contains some files of PUBS data the position of the last file on the M/T must be found. This procedure is explained later under the section entitled digitizing.

2.2.2. REPLAY SYSTEM

To set up the replay system the following checks should be made:-

i) Rockland filter set to Low Pass 50 Hz, RC and 0dB gain.

ii) Battery pre-amp switched on

iii) The Microreg Power Supply to replay unit set to 15V

iv) The Dual Farrell Supply set to 6V and 12V

v) TR speed 15/16 ips

vi) Slider switches on frequency converter in correct position. See back page of PUBS digitization log book.

vii) Do HI and CLOCK channels need inter changing (see box lid)

Finally the paper speed of the oscillomink is set to 10 mm/sec.

2.3 DIGITIZING EXPLOSION TRACES

Having checked that the 9-track magnetic tape is loaded and enabled (in this stage the two lights on the M/T unit should be on), and that the configuration tape is correct, the program can be run using the command

! RUZ

The system will then come up with

START AT FILE N

FER?

Then enter the file number you wish to start on, remembering that there are two files per shot (file header + data file) as well as two files at the beginning of the tape (tape header + blank file)

e.g. 10 shots already digitized on M/T = 22 files

therefore, enter 23 as file entry required.

This positions the M/T correctly.

When ready the system displays a header and requests a single letter command, viz:

ENTER COMMAND S, R OR E (SET-UP, RUN or END)

S - SET UP e.g. to set up the ADC

R - RUN e.g. start data input

E - END e.g. terminate tape by writing three end of file (EOF) markers.

Before digitization takes place the ADC must be set up to either 2.5 mV / step or 1.25 mV / step. By entering "S" the following header is displayed

ENTER MAXIMUM SIGNAL AMPLITUDE (Millivolts)

?

Enter 5000, this sets the step size to 2.5 mV / step and allows a maximum amplitude of 5V. (The entered value can be between 0 and 5121 mV. Above 2500 mV the step size is 2.5 mV and below 2500 mV the step size is 1.25 mV).

The program may be adjusted however to give step size of 1.25 mV, 2.5 mV, 5 mV, 10 mV or 20 mV. The maximum number which can be recorded is 4096.
i.e. a 5.12 V signal with a step size of 1.25 mV.

The format of the data file header is shown in figure 2. The station number has six character spacing and includes the station number plus a preceding letter identifying the ship used for the data acquisition,

S = Shackleton

D = Discovery

When digitizing on HI channel, there must be a B in column 19 and a Z in column 21. When digitizing on LO channel there must be a B in column 25 and an L in column 27

B stands for PUBS data

L stands for LO channel

Z stands for HI channel

Also the PUBS gain must be entered on the data file header. This is preset on board ship and the value can be found in the log book. This gain is given as a value in mV and is the input voltage to a dummy hydrophone giving a maximum undistorted signal of 3.5 V peak to peak after adjusting the PUBS gain.

A number identifying the PUBS used is entered into column 52. The code is as follows:-

PUBS	A	B	C	D	E
CODE	1	2	3	4	5

The rest of the data file header is self explanatory (see fig. 3).

Once set up the system requires another single letter command. By entering "R" the following header is displayed:-

ENTER HEADER INFORMATION, TERMINATING WITH NULL LINE

Before entering the data file header, the PUBS tape must be positioned for the shot. To find the shot position on the PUBS tape, use the log book to get the approximate turn number of the required shot and listen on the headphones whilst the tape

is being wound fast forward. When the shot has been heard the tape must be rewound to before the first Ground Wave (GW) arrival. The shot heard is the Water Wave (WW) arrival and the GW arrivals can normally be heard by replaying at normal speed and listening on the headphones (remember to turn the volume down!). The GW's, if heard, can be identified by a higher pitched "twittering" sound. The tape is rewound to between 10-20 seconds before the first GW arrival. If the GW arrival cannot be heard or distinguished from background noise, a good guide for ensuring that the first GW arrival is in the digitized window, is that the number of seconds between WW arrival and first GW arrival is approximately equal to half of the range in kilometres of the shot from the PUBS (add 20 seconds for good measure).

The choice of whether to digitize on HI or LO channel depends on the strength of the GW arrival. If the lower frequency GW arrivals are overloaded on HI channel (see the Oscillomink record), then LO channel must be used. Otherwise use HI channel.

The file header may now be entered as described earlier. After entering the header the system displays,

READY TO START

The system is now ready for digitizing and will commence on the first sync. pulse fed to the ADC. To do this follow the steps below:-

1) Start Uher Tape Recorder at 15/16 ips

2) Start Oscillomink

3) Push and release RESET quickly followed by START on the frequency converter panel.

The data will then start to be digitized on the next 10 second pulse and will continue for KBØ seconds (usually KBØ= 60, but may be 120 depending on the position of a slider switch). On completion of a run an EOF (end-of-file) mark is put onto the ½" Magnetic Tape by pressing the "L" button on the CAMAC crate switch panel and the number of samples is displayed,

i.e. 125 Hz sync. pulses per minute would produce 7500 decimal samples.

In practice we only get 7496 decimal samples due to the loss of 4 samples somewhere in the digitisation process, probably in the RESET and START procedure. 7496 decimal samples = 16510 octal samples. The number of samples is usually displayed in octal. (Decimal numbers are obtained by typing !DC). Octal numbers are always preceded by a string of 0's, whereas dec. numbers are not.

The system again requires a single letter command.

To continue digitizing, enter "S" and repeat the procedure.

To terminate enter "E" and this will rewind to BOT (Beginning of Tape).

2.4. Digitizing Airgun Data

The digitization of Airgun Data is very similar to that for explosion data apart from starting and stopping procedure.

The Tape Header is as for explosion data and again followed by a blank file. The file header is written to the Camac Tape as before except for one change. The shot weight now equals - 1, enabling the airgun data to be distinguished from explosion data.

The main difference between the digitization of airgun and explosion data is that for the airgun there is only one data file containing all the shots (as opposed to one data file per shot in the case of explosion data). This is because of the regular firing of the airgun (normally every 2 minutes) and the whole PUBS tape is digitized.

In the processing of the airgun Camac Tape to produce a Master Tape (see later), the data is divided into one file per shot and the shot number incremented in the program. There is a switch on the frequency converter panel marked AIRGUN or NORMAL. When switched to AIRGUN a continuous stream of sync. pulses is fed to the ADC without stopping after KBØ seconds.

The procedure for the digitization of airgun data is as follows.

i) Set PUBS tape position as for explosion data.

ii) Start Oscillomink

iii) Push RESET followed by START on frequency converter panel.

iv) After first 10 second mark (seen from Oscillomink record) switch from NORMAL to AIRGUN.

v) After the first couple of airgun analogue records, stop oscillomink (NBSEC (see later) may be estimated from these and is constant for the whole tape).

To enable the Master copying program to recognize the end of the data, it is necessary to finish with an incomplete number of 2 minutes worth of data.

e.g. (N x 2 mins) + 10 or 20 seconds

where N = number of shots.

To end digitization do as below,

i) Switch from AIRGUN to NORMAL

ii) Push RESET

iii) Push button L to put end of file mark on the Camac Tape.

The sampling stops the instant RESET is pushed.

2.5 Closing down

When closing down at the end of a day, enter "E" when the system next requires a single letter command. This will rewind the Magnetic Tape to its BOT position. Then,

1) Press down the ENABLE/HALT switch on the PDP 11/05

2) Switch off the battery pre-amplifier

3) Power off at both wall sockets.

3. PREPARATION OF THE HONEYWELL 66/20 TAPE

Once the Camac tape has been completed, it is sent to Bidston by the Tape Librarian, where it is copied onto a PUBS Master Tape in a form suited to the Honeywell system and ready for plotting in conjunction with the plotting program.

3.1. PUBS Data Programs.

The PUBS data programs and subroutines are stored in files under the catalog RBW, e.g. RBW/MASTUNFM. The current programs are stored on fixed disk, while the older programs are stored on removeable disk.

i) Main Programs and Subroutines.

File Name	Run	Description
MASTUNFM	Run at Terminal System = CARD *	Creates unformatted MASTER Tape from CAMAC Tape of explosions
PDPBCN	Subroutine used in MASTUNFM, MASTGUN, etc.	Converts PDP numbers from CAMAC Tape to decimal numbers.
MASTGUN	Run at Terminal, System = CARD	Creates unformatted MASTER Tape from CAMAC Tape of airgun shots.
GETREC	Subroutine used in MASTGUN	Gets array of decimal numbers from CAMAC Tape.
ASSEMBU	Run from cards	Main plotting program which reads unformatted MASTER Tapes.

* In this report the system CARDIN is called CARD.

ii) Useful Extra Programs.

DUMP	Run at Terminal System = CARD	Lists selected records and files from any magnetic tape
MERGE	Run at Terminal, System = CARD.	Merges two MASTER Tapes to form a new MASTER Tape.

File Name	Run	Description
PROG	Run at Terminal, System = CARD	Lists a CAMAC data file in decimal numbers.
READUNFM	Run at Terminal, System = CARD	Reads and lists unformatted MASTER Tape.

iii) Old Programs.

These programs are stored on the removeable disk, IOSO9 under catalog RBW. They are the old versions of MASTUNFM, READUNFM and ASSEMBU that created, read and plotted a formatted MASTER Tape. They are run in the same way as the current programs.

File Name	Run	Description
MASTCOPY	Run at Terminal, System = CARD	Creates formatted MASTER Tape from Explosion CAMAC Tape.
ASSEMB	Run from cards	Version of plotting program which reads formatted MASTER Tape.
MASTREAD	Run at terminal System = CARD	Reads and lists formatted MASTER Tape.

3.2. Use of Terminal

All of the preceding programs are run from the terminal except for the plotting programs ASSEMB and ASSEMBU. A brief description of the use of the terminal is given below.

Lower case = text generated by the system

Upper case = characters typed in by user

N.B. After each line of characters typed in by user press RETURN Key.

i) Log-On

Press Keys "CNTL" and "A" together.

program name - TSS

User id - RBW RBW; G230

system? CARD OLD program file name

ii) If you cannot Log-On press keys "CNTL" and "C" and then try pressing "CNTL" and "A" again.

iii) To list a file after the command, OLD file name system or * LIST

This will list the whole file. To list just certain line numbers of a program, enter the first and last line numbers desired and the program will be listed inclusive of and between the numbers.

e.g. to list lines 10-90 of a program system or

* LIST 10-90

iv) To stop listing a file and return to system level, press the key "BREAK"

v) To alter a line in a file you can either,

a) Type in the complete corrected line again or

b) Press up "REMOTE" key

Correct line

Press down "REMOTE" key

Press "TRANSMIT" key

If these changes are to be permanent, the file must then be resaved.

vi) To resave a file

* RESA program file name.

data saved program file name.

vii) To delete a character, press key with @

viii) To run a program

* RUN

card format, disposition? N,R(WA) (this directs the output to Wormley)

snumb - - - - T (note this number it is the only way of tracing your job)

IX) To find the status of a job (how far it has got)

* JSTS job number

X) To Log-Off

system or * BYE

3.3. PRODUCTION OF MASTER TAPE

3.3.1 Explosion Master Tape

By using the program MASTUNFM, selected files from the Camac tape are copied onto another Magnetic tape in Honeywell System Standard Format producing a Master tape.

The program, MASTUNFM, produces an unformatted Master tape, writing to the tape in a more economical way than the old program, MASTCOPY, which produced a formatted Master Tape.

The Tape Header and File Headers are copied to the Master Tape with no alterations. The PDP numbers in the data files are converted to ASCII numbers and are normalised so as to have a mean value of zero before writing to the Master Tape. The file structure of the Master Tape is shown in figure 3. The Master Tape is 9 track, ASCII, no labels and has a density of 800 bits per inch. It also has variable length, blocked records.

The program MASTUNFM is run from the terminal using the system CARD and the following lines may need to be changed before run time -

Line number	Description
50 - 70	Utility activity to postition the CAMAC Tape. Check CAMAC Tape number in line 50.
400 and 410	IF and IL. First and last CAMAC file numbers for each of the sets, up to a maximum of 10 sets.
420	ISKIP = number of files initially skipped on CAMAC Tape. ISKIP = 0 if Tape Header is to be read.
430	ITAPE = 1 to copy Tape Header File. Otherwise = 0
440	NSETS = number of sets of CAMAC files
3120	CAMAC Tape number
3150 and 3190	MASTER Tape number.

The Camac tape may be edited, skipping bad files, by selecting which files are to be copied to the Master Tape in lines 400 and 410 of the programme. Bad files may occur on the Camac tape for a number of reasons.

i) Ground Waves and Water Wave not in digitised window.
ii) Incorrect format on Data File Header
iii) Wrong number of samples on digitising
iv) Parity error on tape.

It has been found that about 20ft of Master Tape is needed for each shot.

When the program has been run, a record of the files copied appears as output at the line printer. Part of this output is shown in figure 6. To see that the job has run succesfully the following should be checked.

a) Normal Termination for all 4 activities (this is not shown in figure 6, but appears on the output immediately after the listing of the JCL)
b) Expected number of samples = Actual number of samples. The actual number of samples must be within plus or minus 5 of the expected number or this file will have been overwritten on the Master Tape.
c) Check that the Master File numbers run in order and are not repeated. (If they are repeated this is probably because of the wrong number of samples in the previous data file).

d) Check that the correct Camac files have been copied onto the Master Tape. Also check that the format of the file header is correct, remembering that the file header is copied from the Camac Tape without alteration.

If the program MASTUNFM has not run, there will be an Abort message with an error code in the line printer output. This message will appear in the Activities listing at the beginning of the output under whichever Activity has failed. Consult the User Guide to find the meaning of the error message and, if still in difficulty ask someone in User Support.

Also make sure that the tape which is to become the Master Tape has been given RBW-WRITE permission. Ask for this permission when obtaining the clean tape at Bidston, via the Tape Librarian at Wormley.

If the job has failed due to a parity error on the Camac Tape, this file will have to be skipped and the appropriate shot redigitised at a later date.

3.3.2. Airgun Master Tape

By using the program MASTGUN, an unformatted airgun Master Tape may be produced.

The large data file is split into files, each smaller file containing a single shot. The shot number is increment on the file header before each small data file.

As each shot takes 2 minutes of digitisation, much of the digitised data is of no use, so a parameter DSEC has been introduced which specifies the number of seconds of data

to be digitised.

The program is again run from the terminal using the system CARD. The following lines may need to be changed.

Line Number	Description
40 - 60	Utility activity to position CAMAC Tape. Check CAMAC Tape number.
440 and 450	IF and IL. First and last CAMAC file numbers for each of the sets of data. (normally one set of data)
460	ISKIP = number of files initially skipped on CAMAC tape.
470	ITAPE = 1 to copy tape header, otherwise = 0
480	NSETS = number of sets of CAMAC file
490	DSEC = number of seconds of data to be written to MASTER Tape.
500	RS = Rate of sampling = 125
3500	CAMAC Tape number
3530 and 3570	MASTER Tape number.

3.4. Use of DUMP, PROG, MERGE.

If the program MASTUNFM has failed it is often useful to check the contents of the Camac Tape (e.g. to find which file has a parity error).

This can be done by using the program DUMP which is a utility program to list selected records and files from a magnetic tape (either Camac Tape or Master Tape). The records are listed on the line printer in both octal and ASCII characters. This program is also run from the terminal using the system CARD

and the following lines may need to be changed before run time.

Line Number	Description
60	Tape Number
80	01, PHYREC, ASA9 for Camac Tape 01, PHYREC for Master Tape
100	ADUMP = list in octal and ASCII
	RPT = repeat
	P = instruction
	R = record
	F = file

It is line 100 which specifies the records and files to be dumped.
e.g. ADUMP/1R/, SKIP/2F/, RPT/2P. 10T/, ADUMP/1R/, SKIP/1F/
means Dump1 record, skip 2 files, repeat next two instructions 10 times, Dump1 record, skip 1 file
and will list the first record of the tape header and the first records of the first 10 files.

The program PROG may be used to list records from a single file on the Camac Tape in decimal numbers. This is done using the Subroutine PDPBCN which converts PDP numbers into decimal.
This program is run from the terminal using system CARD.
The following lines may need to be changed before run time.

Line Number	Description
30 - 60	Utility activity to position Camac Tape at required file.
290	NREC = number of physical records (blocks) to be listed (1 Record in file header, 76 in datafile)
470	Camac Tape Number.

Sometimes it is necessary to merge two Master Tapes together. For example, some shots on a particular station may have been redigitized and thus the shots for this station appear on two different Master Tapes. The program MERGE is a utility program which will copy files from two Master Tapes onto a single new Master Tape.

This program is run from the terminal using system CARD.

The following lines may need to be changed before run time.

Line Number	Description
70	First Master Tape number
80	Second Master Tape number
90	New Master Tape number
120 - 160	Files to be copied from each Tape.

See figure 7 for explanation of MERGE

4. COMPUTER PLOTTING OF PUBS DATA

There are two main objectives in the computer plotting of the digitised PUBS data. The first of these is to check that the correct data window has been digitised and the second is the

display of Ground Waves for geophysical interpretation.

4.1 Brief Description of the Plotting Program, ASSEMBU

The plotting program ASSEMBU is a Fortran program to read unformatted Master Tapes and to produce plots. It is a version of the French (Institut de Physique du Globe, Paris) program, ASSEMBL which has been converted to run on a Honeywell computer. (There is a similar version called ASSEMB which is stored on removeable disk and deals with the old formatted Master Tapes).

The input parameters to the program may be adjusted to give constant gain or fixed maximum amplitude of trace, to scale amplitudes for shot weight and distance, to filter out unwanted frequencies, to give reduced travel time plots and also to apply clock drift and sediment corrections. Details of this are given later in the text.

The program ASSEMBU calls many subroutines in adjusting for these parameters and figure 8 is a flow diagram showing the main program and the subroutines called. Below is a table explaining the function of each subroutine.

SUBROUTINE	FUNCTION
ASGPS	Reads Data Cards, gives Line Printer output. Calls plotting Subroutines.
GPAS	Determines Window to be plotted.
GPSET	Reads file header and determines window to be filtered and plotted.
LECFEN	Selects data channel and reads window.
VOGA 3	Calculates amplitude and gain.

GPSTR	Scales for distance and shot weight.
AXDIS	Writes title and draws distance axis
AXTITR	Initialisation of plot, annotates and draws time axis.
ELCOMP	Elimination of the D.C. component of a trace using only every Nth value (where Nc NPAS)
FILB3	Sets up filtering and sampling Interval (Low Pass and High Pass at 18 dB/octave).
FILREC	Recursive filter with cut-off frequency. Notch filtering 36 dB/octav
FILREJ	Rejection filter set up.
FRECUR	Recursive filter set up.
GPSFIL	Entry S/R for the group of filters.
INCOMP	Calculates mean sample value prior to the elimination of the DC component of a trace.
MAXR	Calculates maximum and minimum values.
UNEVOI	All the filtering required for the processing of the trace is carried out.
FILFSP	Honeywell utility program to skip to beginning of data file.

4.2. Executing the plotting program ASSEMBU

The program is stored as an object deck in the BCD file RBW/ASSEMBU and is already compiled. To run the job a deck of cards with the JCL (Job Control Language) and data is loaded at the Honeywell 707 at Wormley.

The following JCL cards are needed:-

Column 1	Column 8	Column 16
£	IDENT	RBW, WHITMARSH, G 23Ø
£	USERID	RBW £ RBW
£	MSGI	1,LIMITS OF 0.15HR AND 43K AND -3K
£	FILSYS	
	FC	OPS/WORMLEY/CL936/RBWØ1, BLOCKS/5Ø, 9999/
£	LOWLOAD	
£	OPTION	FORTRAN, NOMAP, RELMEM
£	LIBRARY	AA
£	USE	.GTLIT
£	SELECT	RBW/ASSEMBU
£	EXECUTE	
£	LIMITS	15, 43K, - 3K
£	PRMFL	AA,R,R,LIBRARY/SPI
£	TAPE9	12, XID,,9Ø112,,RBW,,DEN8
£	FFILE	12, MLTFIL, NLABEL
£	PRMFL	15, W, S, OPS/WORMLEY/CC936/RBWØ1
£	SYSOUT	Ø6, ORG
£	DATA	Ø5
	Data Cards	
£	ENDJOB	

Check List of Possible Changes Required.

Check . . . /RBWØ1 does not already exist.

File name on Calcomp plotter tape (File code 15) on the same tape before running job (see both lines). Juse more file names if running several jobs a day.

Master Tape (File code 12) - Master Tape number is correct.

The plotting of the data is normally carried out in two stages, Stage 1 being an unfiltered, normalised plot of all the shots of the Station to check that the water-wave traces are correctly aligned. The stage 2 plot is a reduced travel time plot of the data displaying the Ground Waves suitably for interpretation. Figures 9-16 show the parameters to be defined on each data card with an explanation of each parameter.

i) Stage 1 plot.

For the stage 1 plot the data cards should have the following values:-

a) SH = 1.0

ECDIS = 1.0 ECTEM = 1.0

ITMIN = 0 ITMAX = KBØ (length of digitised sample) seconds.

IDMIN, IDMAX are minimum and maximum ranges (kms). Choose

NSCRUT = 125

b) VR = V_1 = V_2 = 999° T_1 = 0.0 T_2 = KBØ (usually 60 secs)

c) NBAND = Tape number as appears on Tape header e.g. 001

d) FILI(1) = FILI (2) = NFPH = NFPB = INDFI(1,2, . . . 5)=0

NPAS = 2

e) NVO = 1 i.e. HI channel

ECH2I = 1.0 DISTI = 1.0 EXPO = 0.0 (constant maximum amplitude trace)

NFEN = IDIR = IR = IALFA = NIND = 0

For each file,

IVOIE = 2 i.e. LO channel, only if corresponding HI channel is overloaded, otherwise IVOIE = 0

NBSEC = estimated from analogue records (see Note below)

DISTC = corrected range (km). Only enter if range needs to be corrected or was not entered in the file header during digitisation.

All other parameters are zero. Card number 8 (see fig 9) is the data file card and there must be one for every file on the Master Tape. The last data card must always be blank.

The value NBSEC is estimated using an approximate Water Wave travel time (TWW) and the analogue record made at the time of digitisation. If TWW has not been calculated at the time of initial plotting of the data it can be estimated as the difference between shot instant and WW arrival time (plus an integral number of 10 seconds). Using the analogue record count back TWW seconds from the WW arrival and then go back to the immediately preceding 10 second mark. NBSEC is simply the beginning of the actual digitised data series (in seconds) measured relative to this 10 second mark. It will always be an integral multiple of 10 seconds and is often, but not always, negative.

On examining the stage 1 plot it may be found that one or more of the traces do not line up. If the error corresponds to an integral number of 10 seconds, the NBSEC value has probably been estimated wrongly. Check this value again from the analogue record and change the appropriate data card. If the error is not due to NBSEC check that the shot instant value was entered correctly in the file header at the time of digitisation. This can be found in the line printer output (see figure 19).

The annotation on the stage 1 plot should be as follows:-

At the top of the plot values of VR, V1, V2, T1, T2, NPAS and the title.

The vertical axis is the distance axis and to the left of the axis should appear the shot number and PUBS number for each trace.

The horizontal axis is the time axis.

At the right hand edge of the plot should appear

a) Z or L depending on channel digitised for each trace.

b) The gain of the trace in MU/S/CM for each trace.

c) The Master Tape file number for each trace.

d) The values of DISTC and NBSEC (if any) for each trace.

ii) Stage 2 plot.

The stage 2 plot is a reduced travel time plot of a selected window in the digitised data series containing the Ground Waves for interpretation. This is done using the subroutine GPSET (see note later).

The first of the stage 2 plots is usually an unfiltered, constant maximum amplitude, reduced travel time plot without any scaling for shot weight or distance.

The parameters for this plot are as follows:-

a) SH = 2.0

ECDIS = 1.0 ECTEM = 2.5

ITMIN = -2 ITMAX = 12

NSCRUT, IDMIN, IDMAX are same as for stage 1 plot.

b) VR = V_1 = V_2 = 6.0 T_1 = -2.0 T_2 = 10.0

c) FILI(1) = FILI(2) = NFPH = NFPB = INDFI(1,2 . . . 5)=0

NPAS = 2

d) NVO = 1 ECH2I = 1.0 DISTI = 1.0 EXPO = 0.0

Other parameters are zero.

For each file, the cards are the same as for the stage 1 plot.

In further stage 2 plots steps are required to give the best filtering, to apply sediment and clock drift corrections and possibly to apply scaling factors for shot weight and distance.

4.3 The parameter SED

The parameter SED is a correction which adjusts the trace position along the time axis to compensate for any clock drift during the PUBS experiment and also for time delays caused by sediments (if known).

Clock drift is only detected at the end of a PUBS experiment and is expressed as secs/hr for each PUBS from the time the clocks were reset. Hence to apply clock drift corrections it is necessary to know, either

i) when the clocks were reset

ii) the time of each shot

iii) the drift rate.

or i) The time correction for each PUBS/shot combination.

Due to the way the program is written the simplest course of action is to add the clock correction to the sediment correction (if any) using this variable, SED.

If a PUBS clock is slow (i.e. PUBS time less than ships clock at the end of the experiment), then the time correction

must be added to all the PUBS times and consequently all the digitised data.

For a slow PUBS clock add the time correction to SED.

For a fast PUBS clock subtract the time correction from SED.

The correction is normally negative and in such cases has the effect of counter acting the time delay introduced by the sediments.

Thus the parameter SED is a single correction, for both Clock drift and sediment thickness corrections and is entered individually for each trace on card number 8 (see fig. 9).

4.4. Shot weight and Distance Scaling.

Due to various shot sizes being used on a single PUBS station and the varying distance of the shot from the PUBS it is often desirable to attempt to scale the trace amplitudes to compensate for the variations caused by these parameters. The scaling calculations are carried out in the subroutine GPSTR. By studying the original unscaled Stage 2 plot a suitable shot weight and distance are chosen, to which all other traces are scaled.

The shot weight scaling factor is parameter IWT and is entered on card number 6 and applies to all the traces. Similarly the distance scaling factor DISTI is entered on card number 6 and likewise applies to all traces.

The shot size scaling equation used in GPSTR is

$$\text{Gain} = \left(\frac{IQ}{IWT} \right)^{EXPOW}$$

IQ = original shot size and is read from file header.

EXPOW = power preset in program

The distance scaling equation is:-

$$\text{Gain} = \left(\frac{\text{DIST}}{\text{DISTI}} \right)^{\text{EXPO}}$$

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

EXPO = -1 usually and is entered on card number 6.

A constant gain setting ECH2I must also be included and is chosen once again by studying the gain values from the original plot.

The various scaling factors are then combined into one equation.

$$\text{i.e.} \quad \text{ECH2} = \text{ECH2I} \times \left(\frac{\text{DIST}}{\text{DISTI}} \right)^{\text{EXPO}} \times \left(\frac{\text{IQ}}{\text{IWT}} \right)^{\text{EXPOW}}$$

ECH2 is the value (in"MU/CM/SEC") which appears on the plot.

4.5. Filtering of Traces.

Filtering may either be applied to all traces on the plot by entering the desired filter values in card number 4, or to individual traces by entering the filter values on the appropriate file card.

Rejection Filters, Notch filters, High Pass and Low Pass filters may be used.

4.6 Subroutine GPSET

This subroutine determines the first and last digitised

sample value to be plotted for each file of sampled data according to various input parameters. This description is provided to obtain a clearer understanding of the variables used in the subroutine (see Figure 17 for a graphical explanation of the variables).

VARIABLES

KBØ	Length of digitised data series (secs)
V1, T1	Limits of data window to be processed and plotted
V2, T2	($km.s^{-1}$, secs)
NBSEI	Always zero (secs)
NETSE	number of seconds of data to be plotted for each trace (secs)

Times relative to the 10 second mark which immediately precedes the shot instant (all in secs).

HØ	shot instant
KDATØ) NBSEC)	beginning of the digitised data (integers)
TT1, TT2	time limits (beginning and end) of the data window to be processed for the current trace.

Times relative to the start of the digitised data (secs)

DEB	time of first sample in the window to be processed
FIN	time of last sample in the window to be processed
TTR	time of zero reduced travel time

4.7 Checks on ASSEMBU Line printer output.

Figure 18 shows a typical example of the line printer output. Things to check on the output are:-

i) NFC = correct Master Tape file number.

ii) File header is correct (copied directly from Master Tape)

iii) Distance, DIST, lies between IDMIN and IDMAX

iv) IVIDE = 0 (if = 1, then this is a default statement)

v) Filter values

vi) Values of IWT and IQ.

If the program has not run, check for any error messages in the Activity listing. Check the error messages using the User's Guide as for MASTUNFM.

Also check that the correct value for NBAND (tape number) was entered on card 3.

If there are errors on individual traces, then the message IVIDE = 1 will appear in the listing for that file on the tape. This could be for any of the following reasons.

i) Value of DIST does not lie between IDMIN and IDMAX. Check values of the parameter and change accordingly.

ii) Wrong channel entered on data card.

iii) Wrong Master Tape being read. Check Master Tape Number entered in JCL.

4.8 Computer Plotting of Airgun Data.

The Program ASSEMBU, described above deals with an unformatted explosion Master Tape. There is a similar version of ASSEMBU, called ASSEMGB, which deals with the unformatted airgun Master Tape.

This program is run in the same way as ASSEMBU, by loading a card job on the Honeywell 707 at Wormley. Once again check Camac and Master Tape numbers in the JCL and change the SELECT card to:-

Col 1.	Col 8.	Col 16.
£	SELECT	RBW/ASSEMGB

The output is of the same format as for ASSEMBU and plots are produced in the same way.

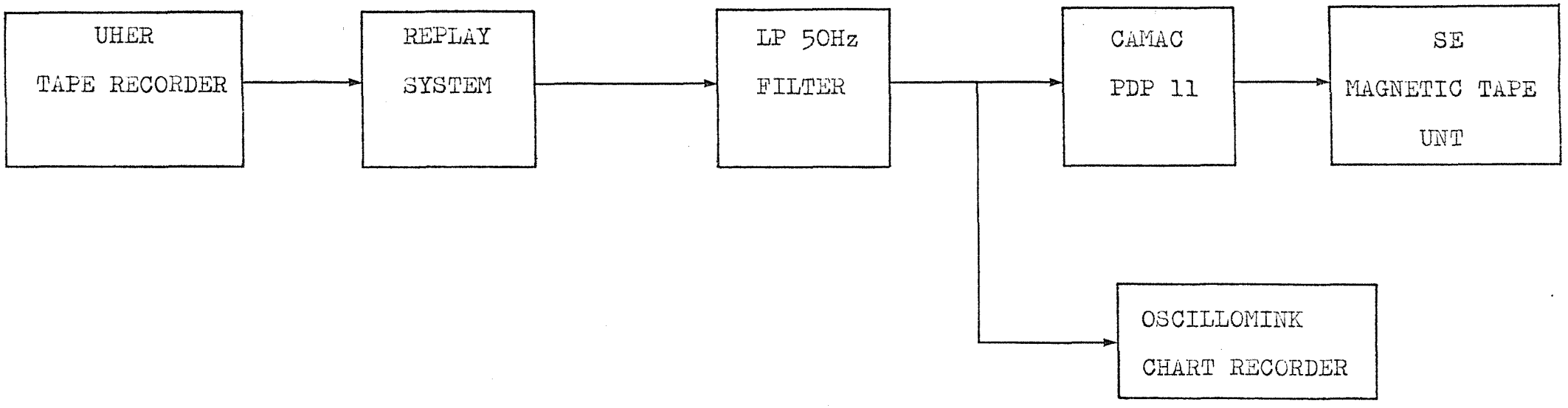


Figure 1. Flow diagram showing set up of digitisation and replay equipment.

IBM FIGURE 2

FORTRAN Coding Form

X28-7327-4 U/M 050
Printed in U.K.
No. of sheets per pad may vary

PROGRAM: FORMATS OF MAG. TAPE HEADERS + DATA | PUNCHING INSTRUCTIONS | GRAPHIC | PAGE OF

PROGRAMMER | DATE | PUNCH | CARD ELECTRIC NUMBER

FORTRAN STATEMENT

File(1)

ABAND IBAND

TAPE HEADER

IVAR 12

A2 I4 A74

XY 123 Date of digitisation, anti-alias filter, sampling rate, etc.

eg WD 001 25/12/77 W.DAVEY LP50 FILTER MAX.SIG 5V STEP 2.5MV 125 SAMP/SEC IW123

File(2)

ABAND+IBAND gives tape number, IBAND right justified

Blank

File(3)

DATA FILE HEADER

shot instant

INUM	KM	KM1	ICG	CG	DUM(1)	IRGD3	DUM(2)	IRG1	D5	DUM(3)	ID	IT	ISH	KBO	IPUB	IQ	IHR	IMN	ISEC	INSEC	IYR	
A6	I4	I4	I4	A2	A2	I2	A2	A2	I2	A2	A2	I2	I4	I4	I4	I4	I4	I4	I4	I4	I4	4X
STA.NO.	KMS	1/100KM	CAMAC GAIN/CHAN V	PUB	(Z)	GAIN (MV)	CHAN (LO)	HIS	(L)	GAIN (1/100 MV)	HIS	(T)	TRACE INVERSION	SHOT NO.	SECONDS IN FILE	PUBS USED	SHOT WEIGHT (LBS)	HRS	MINS	SECS	NSECS	YEAR	
eg D8895	10	21	2500	B	Z	0				30				25	60	4	25	0	0	2	8801976	

File(4)

DATA

Digitised at 125 samples/second for 60 seconds (or 120 seconds) i.e. for 60 seconds 125x60 = 7500 samples

A new file is used after each file header and for each set of sampled data.

Figure 3. FILE STRUCTURES OF MAGNETIC TAPES

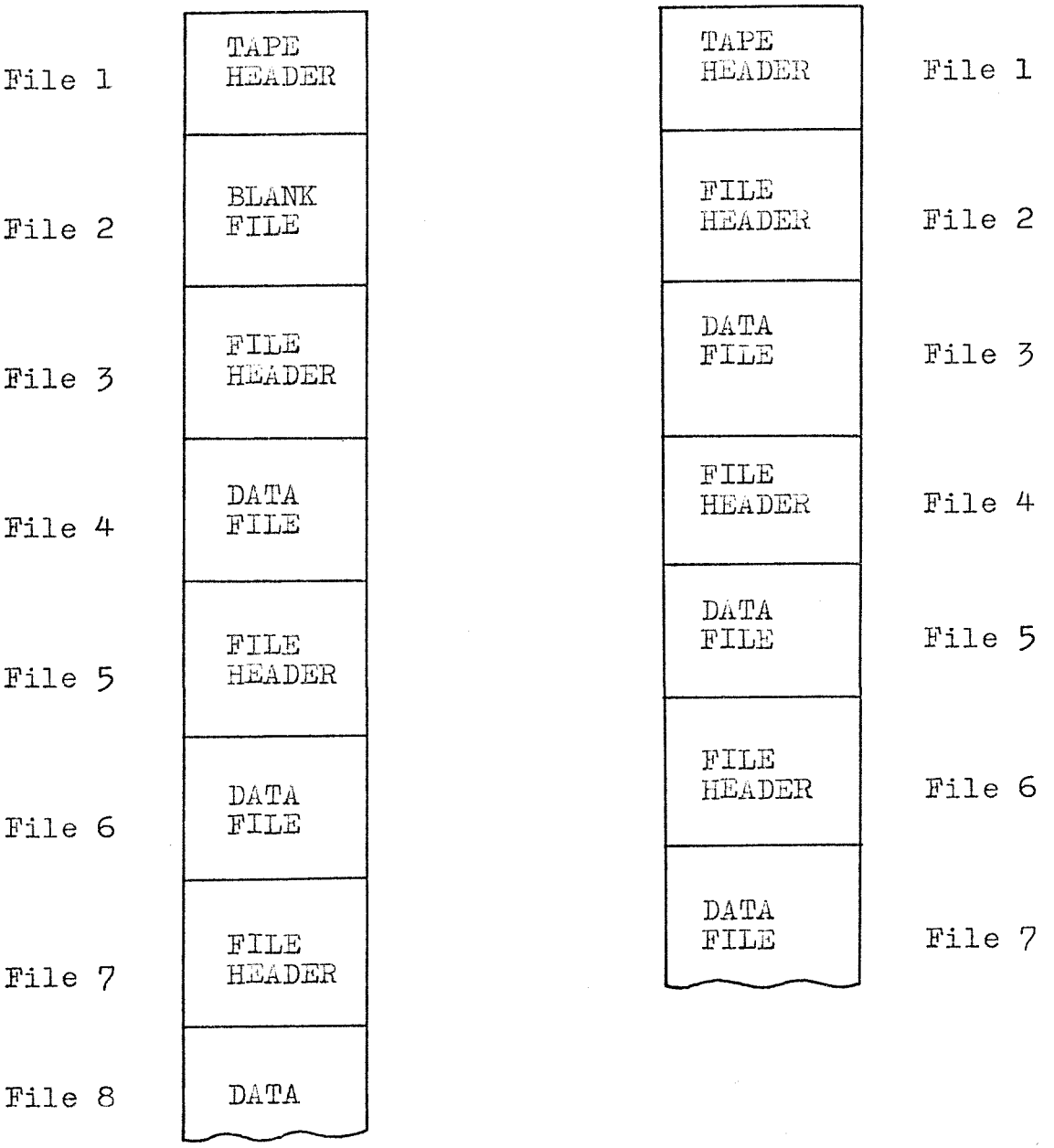
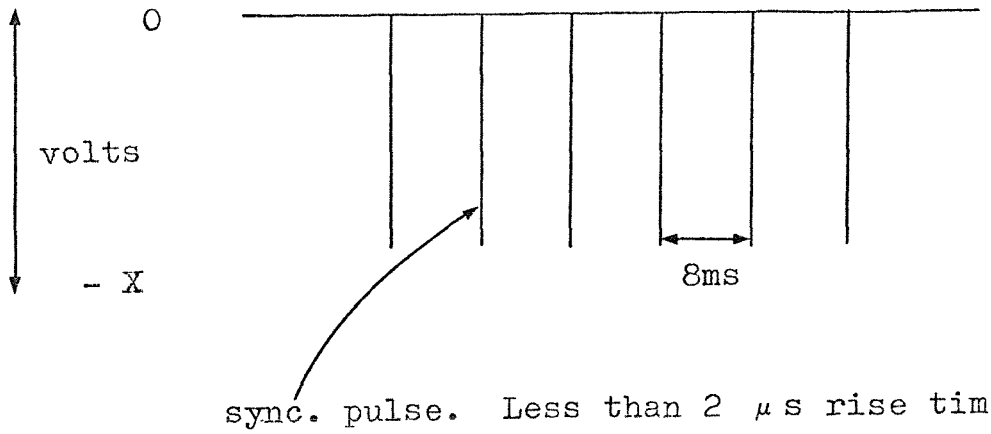


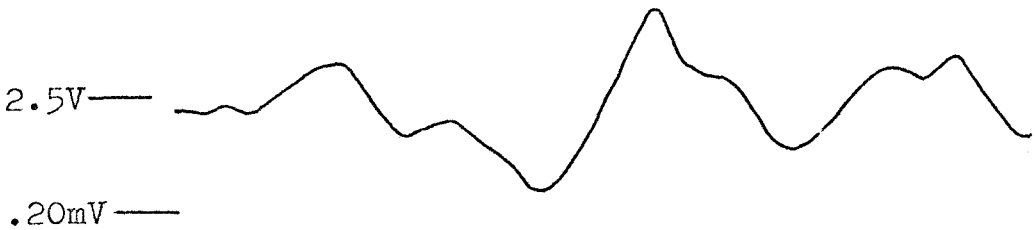
Figure 4 INPUT SIGNALS TO CAMAC ADC MODULE

1/. Clock input (sync. pulses)



sync. pulse. Less than 2 μs rise time.

2/. Signal input



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

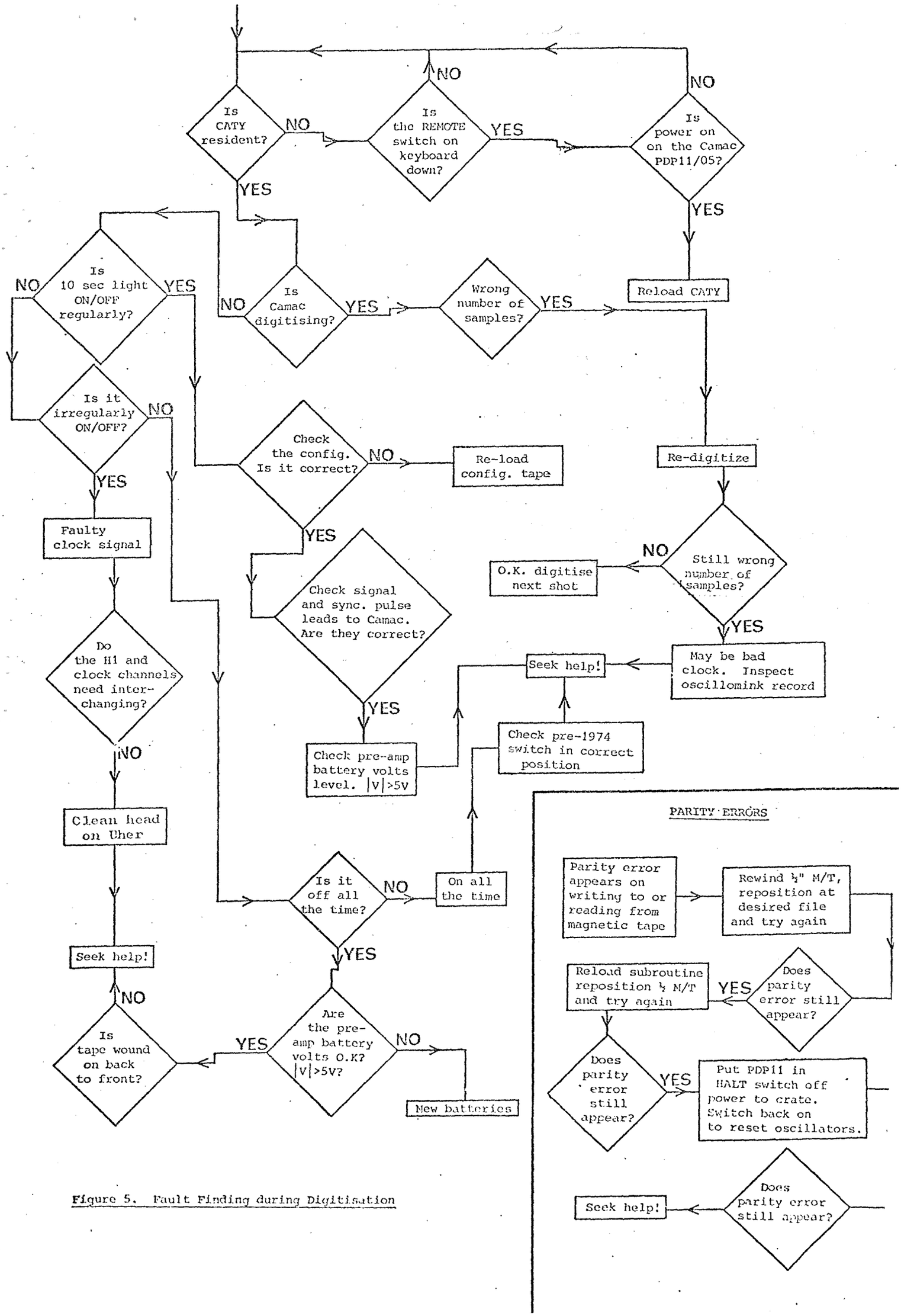


Figure 5. Fault Finding during Digitisation

```
 EXPECTED NUMBER OF SAMPLES = 7500 ACTUAL NUMBER OF SAMPLES = 7496
 AVERAGE VALUE CALCULATED FROM 7496 SAMPLES =      1040.
 AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =      1037.

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

 CAMAC FILE NUMBER TO BE USED NEXT507 LAST CAMAC FILE NUMBER USED506

  *****  FILE HEADER WRITTEN ONTO MASTER TAPE        MASTER FILE NUMBER 72              SHOT NUMBER 11  *****

 S1744 136  3125008 Z  0    30              11  60   5 300   0   0   0 8501976

  *****  DATA FILE WRITTEN ONTO MASTER TAPE        MASTER FILE NUMBER 73              SHOT NUMBER 11  *****

 EXPECTED NUMBER OF SAMPLES = 7500 ACTUAL NUMBER OF SAMPLES = 7496
 AVERAGE VALUE CALCULATED FROM 7496 SAMPLES =      989.
 AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =      988.

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

 CAMAC FILE NUMBER TO BE USED NEXT517 LAST CAMAC FILE NUMBER USED508

  *****  FILE HEADER WRITTEN ONTO MASTER TAPE        MASTER FILE NUMBER 74              SHOT NUMBER 12  *****

 S1744 146  2925008 Z  0    30              12  60   5 300   0   0   4 0101976

  *****  DATA FILE WRITTEN ONTO MASTER TAPE        MASTER FILE NUMBER 75              SHOT NUMBER 12  *****

 EXPECTED NUMBER OF SAMPLES = 7500 ACTUAL NUMBER OF SAMPLES = 7496
 AVERAGE VALUE CALCULATED FROM 7496 SAMPLES =      991.
 AVERAGE VALUE CALCULATED FROM  800 SAMPLES AND USED TO OBTAIN OUTPUT DATA =      991.

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

FIGURE 6. Line Printer output from Program MASTUNFM

```
0101$:IDENT:RBW,WHITMARSH,G230
0201$*$REM
0301$*$REM RBW/MERGE
0401$*$REM
0501$:UTILITY
0601$:OUTIL:ASIS
0701$:TAPE9:IN,X1D,,IW195,,RBW,,DEN8
0801$:TAPE9:IM,X2D,,IW187,,RBW,,DEN8
0901$:TAPE9:OT,X3D,,IW123,,RBW-ARITE,,DEN8
1001$:FFILE:IN,PHYREC
1101$:FFILE:IM,PHYREC
1201$:FUTIL:IN,OI,RWD/IN,OT/,COPY/53F/
1301$:FUTIL:IM,,RWD/IM/
1401$:FUTIL:IM,OI,COPY/6F/
1501$:FUTIL:OT,,RWD/OT/,ADUMP/1R/,SKIP/1F/,
1601$:ETC:RPT/2P,30T/,ADUMP/1R/,SKIP/2F/
1701$:ENDJOB
```

- FIRST MASTER TAPE
- SECOND MASTER TAPE
- NEW MASTER TAPE

- Rewinds first and new master tape and copies 53 files onto new
- Copies six files from second master tape onto new

} lists file headers on new master tape.

FIGURE 7. Explanation of Program MERGE

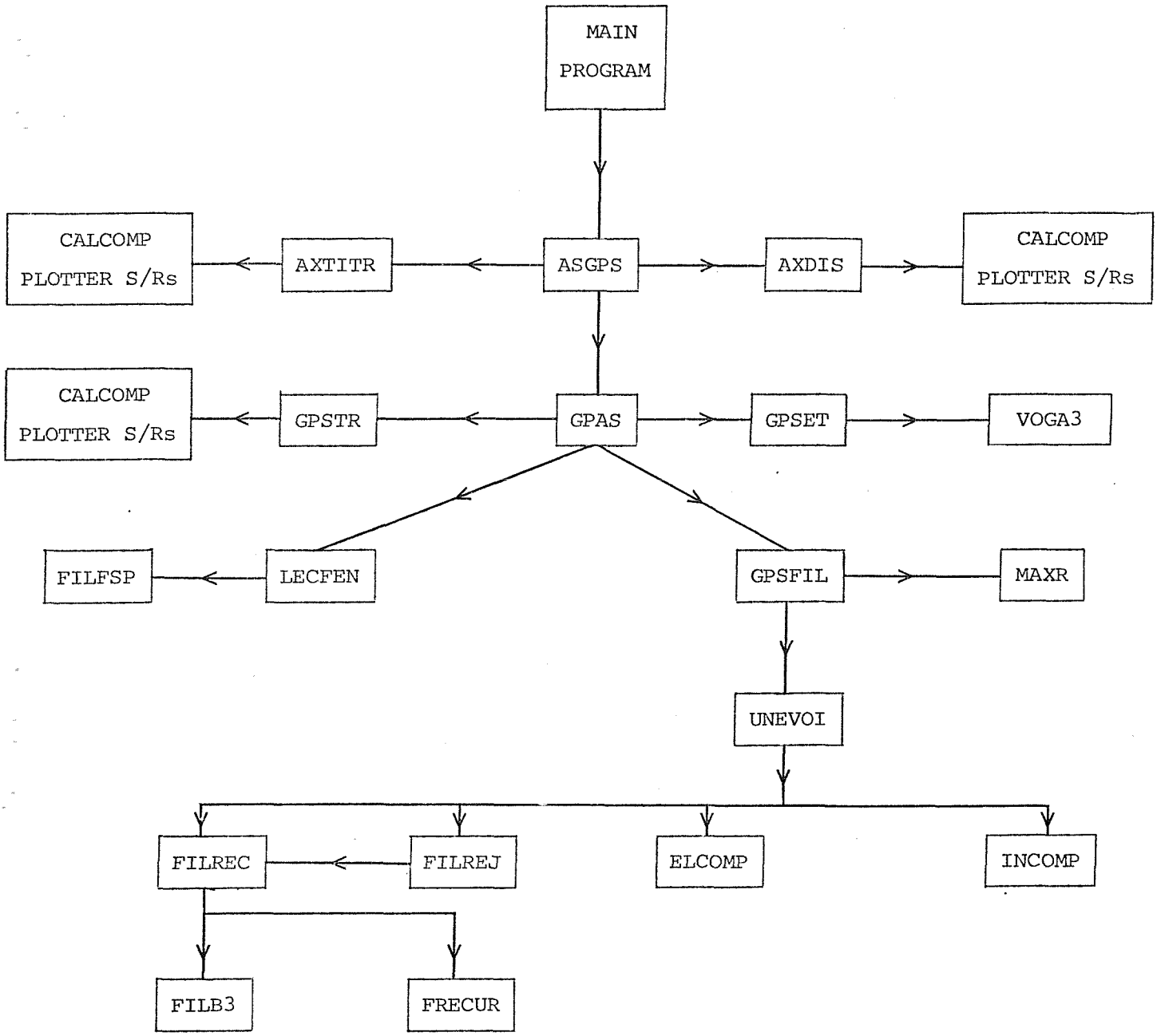


Figure 8. Subroutines used in plotting program ASSEMBU

X26-7327-6 U/M050
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No. of sheets per pad may vary.

FORTRAN Coding Form

Figure 9. Parameters on each data card

PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE OF | CARD ELECTRO NUMBER

DATE

Card	FORTRAN STATEMENT	IDENTIFICATION SEQUENCE
(1)	F6.2 SH; F6.2 ECDIS; F6.2 ECTEM; I6 ITMIN; I6 ITMAX; I6 IDMIN; I6 IDMAX; I6 NSCRUT	
(2)	F6.2 VR; F6.2 V1; F6.2 T1; F6.2 V2; F6.2 T2	
(3)	I6 NBAND(1); I6 NBAND(2); I4 NBAND(3); 15A4 NBAND(4-18)	
(4)	F6.2 FILI(1); F6.2 FILI(2); I6 NPAS; I6 NFPH; I6 NFPB; I6 INDFI(1); I6 INDFI(2); I6 INDFI(3); I6 INDFI(4); I6 INDFI(5)	
(5)	I6 ITITR; 18A4 ITITRE (1-18)	
(6)	I6 NVO; F6.3 ECH2I; F6.2 DISTI; F6.2 EXPO; I6 NFEN; I6 ND5; I6 IDIR; I6 IR; I6 IALFA; I6 NIND; I6 IWT	
(7)	F6.2 V(1); F6.2 V(2); F6.2 V(3); F6.2 etc.	
(8)	I6 NFC; F6.2 FIL(1); F6.2 FIL(2); I6 IVOIE; I6 NBSEC; I6 NBTSE; I6 NBSEI; F6.3 SED; F6.3 SHI; F6.2 DISTC; I6 INVER; I6 NPH; I6 NPB; I2 ICARTE	
(9)	I6 IVOI2; I6 NFPR; F6.2 FILR(1); F6.2 FILR(2); I6 NFIV1; I6 IPOL1	BLANK CARD AT END

Figure 10. Parameters on first data card used in plotting program.

1. INPUT CARDS READ BY S/R ASGPS

SH, ECDIS, ECTEM, ITMIN, ITMAX, IDMIN, IDMAX, NSCRUT (3F6.2, 5I6

SH = Height of trace (cm.) if SH = Ø. SH = 1Ø * ECDIS

ECDIS = distance scale (cm/km.)

ECTEM = time scale (cm/sec)

ITMIN = minimum reduced travel time (sec)

ITMAX = maximum reduced travel time (sec) (IDMAX- ITMIN + $\frac{60}{ECTEM}$. If not is forced to ITMIN +$\frac{60}{ECTE}$

IDMIN = minimum distance (km) ·(can be < 0, $= 0$, > 0)

IDMAX = maximum distance (km) (If IDMAX = 0, is forced to = IDMIN + $\frac{65}{ECDIS}$)

NSCRUT = frequency of sampling when the tape was created. NSCRUT ought in principle to be read from the header of each file (column 61 onwards)

For the moment the default option is 200.

FIGURE 11. Cards 2 and 3 used in plotting Program with parameter description.

2. VR, VI, TI, V2, T2 (5F6.2)

VR = Reduction velocity

V1, T1 = parameters of the beginning of the window

V2, T2 = parameters of the end of the window

NBAND (1), NBAND (2), NBAND (3), NBAND (4, ... 8) (2I6, I4, 15A4)

NBAND (1) = number of tape to be read (tape header number). This is compulsory and is used to test that the correct tape is mounted.

NBAND (2) = number of the plotter tape (optional)

NBAND (3) = number of the plot on plotter tape

NBAND (4, ... 8) = comments (optional)

Figure 12. Parameters on cards 4 and 5 used in plotting program

4. FILI(1), FILI(2), NPAS, NFPH, NFPB, INDFI (1 . . . 5) (2F6.2, 8I6)

FILI (1) = high pass cut off frequency (if FILI (1) = 0, no high pass filtering)

FILI (2) = low-pass cut off frequency (if FILI (2) = 0, no low pass filtering)

NPAS = a smoothing function, only every NPAS sample treated (default option NPAS = 1)

NFPH = no of high-pass filters used.

if NFPH = 0, is forced to = 1

NFPH 0 18 dB/octave cut off used

NFPH 0 36 dB/octave cut off used (non-dephased filter)

NFPB = no. of low pass filters used.

if NFPB = 0, is forced to = 1

NFPB 0, 18 dB/octave cut off used

NFPB 0, 36 dB/octave cut off used

INDFI (I) = parameters for polarisation and prediction filters. Not used for PUBS data.

5. ITITR, ITITRE (1, ... 18) (I6, 18A4)

ITITRE (1, ... 18) title of the plot if ITITR = 1

if ITITR = Ø ITITRE is put = title of first file read (as from its header).

Figure 13. Parameters used in cards 6 and 7 of plotting program.

6. NVO, ECH2I, DISTI, EXPO, NFEN, ND5, IDIR, IR, IALFA, NIND, IWT (I6, F6.3, 2F6.2, 8I6)

NVO = number of the component to be plotted (1 = HI 2=LO)

ECH2I = 0. record section with constant amplitude traces equal to SH or SHI (card 1 or header)

if ≠ 0. record section has imposed scale (see text).

NFEN = length of integration window (units are samples) for polarisation, prediction or velocity filters.

IR = advance of the polarisation or weighting coefficient (units are no of samples) on the trace, for polarisation and velocity filters IR/NPAS 10.IR and NFEN are corrected by NPAS

ND5, IDIR, IALPHA for polarisation filter only.

NIND (for velocity and prediction filtering) is number of velocities used for velocity filtering.

IWT trace is scaled to take account of varying shot size.

7. For prediction filter only. Not used for PUBS data.

Figure 14. Some of the parameters used in card 8 of the plotting program.

8. For each file, read 1 or 2 cards depending on whether ICARTE 0 or 0 respectively.

NFC, FIL (1), FIL (2), IVOIE, NBSEC, NBTSE, NBSEI, SED, SHI, DISTC, (I6, 2F6.2, 4I6, 2F6.3,
INVER, NPH, NPB, ICARTE F6.2, 3I6, I2)

NFC = no. of the file header file to be treated on the 9-track tape.

if NFC = 0 or -1, the program aborts

if NFC = -1 all the succeeding files are treated with negative distances or vice-versa, up to another reading of NFC = -1, when a new file number is read.

FIL(1) = high pass cut off frequency for that file.

FIL(2) = low pass cut off frequency for that file.

if FIL(I) = 0. same filtering as specified, in card 4.

if FIL(I) = X.X filtering at X.X H_z for this file.

if FIL(I) = -1. no filtering at all for this file.

IVOIE if IVOIE = I must plot channel I on the 9-track tape.

if IVOIE = 0 plot channel NVO. Card 6.

NBSEC = number of seconds delay/advance of the digitisation.

NBTSE = total number of seconds to plot, if NBTSE 0 (takes account of possible correction NBSEI)

if = 0 plots the whole digitised sample.

Figure. 15. More parameters used in card 8 of the plotting program.

8. (cont.)

NBSEI = number of seconds to be omitted from start of file before plotting.

SED = sediment correction (see text)

SHI = new scale or new amplitude for file NFC

DISTC = corrected distance for file NFC.

INVER = -1, trace is inverted.

NPH = no. of high-pass filters for file NFC

if NPH = 0 then NPH = NFPH (card 4)

NPB = no. of low-pass filters for file NFC

if NPB = 0 the NPB = NFPB (card 4)

ICARTE = parameter which enables a second card to be read for the file or else allows changes of colour on the plot.

if ICARTE ≤ 0 no second cord read and IPOLØ = Ø IVOI2 = Ø, NFPR = Ø

if ICARTE > 0 a second card is read

= -1, 0, +1 plot in black

= -2, +2 plot in red

= -3, +3 plot in green

Figure 16. Parameters used in card 9 of the plotting program.

9. (If ICARTE = $\pm$1) IVOI2, NFPR, FILR(1), FILR(2), NFIVI, IPOL1, C2I6, 2F6.2, 2I6)

IVOI2 = I channel IVOI2 imposed on 9-track tape. I = 9 for PUBS

IPOL1 = polarisation coefficients.

NFPR = number of band rejection filters between FILR(1) and FILR(2)

if NFPR = 0 no rejection filter.

if NFPR 0 18 dB/octave rejection filter.

if NFPR 0 36 dB/octave non-dephasing rejection filter

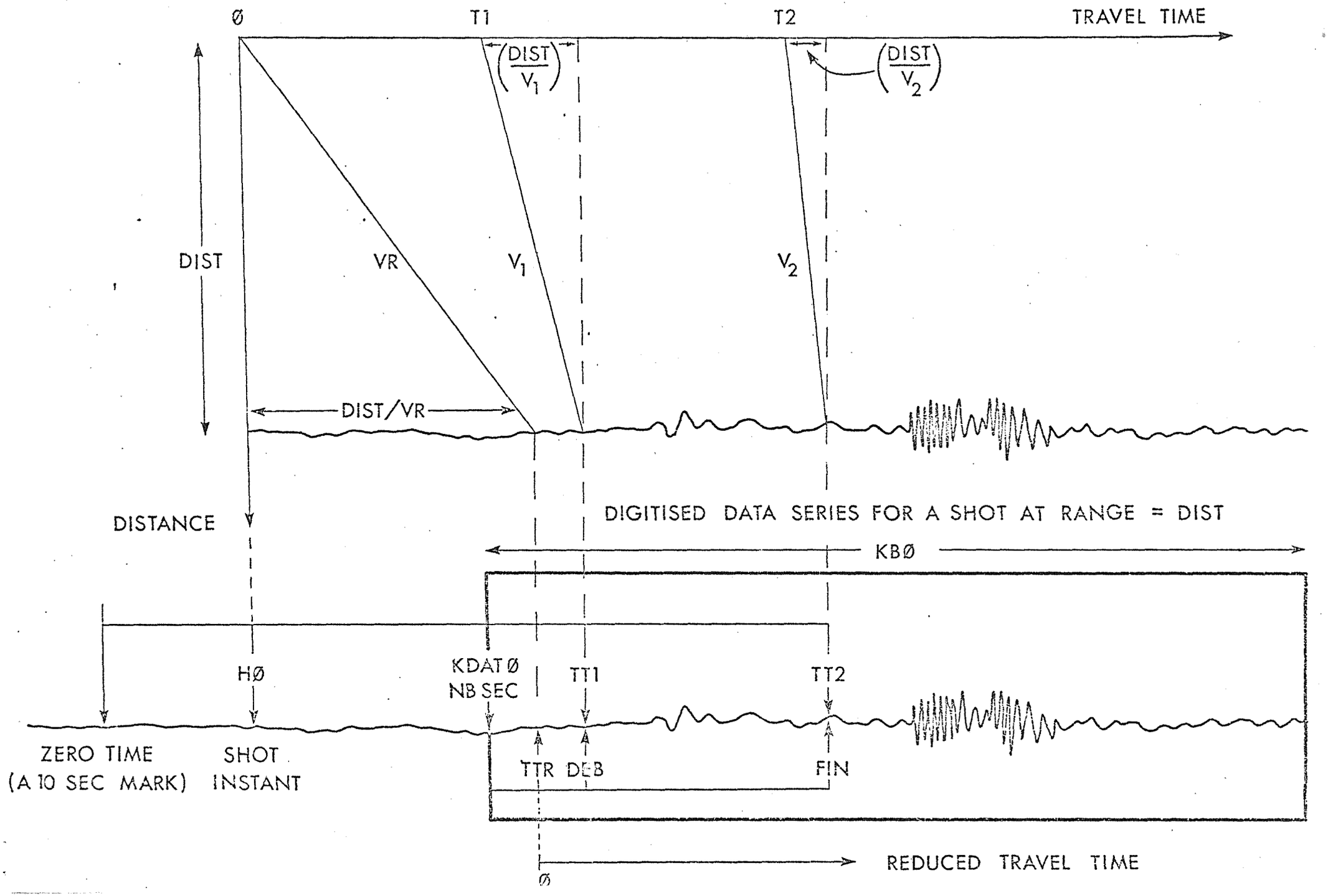
for velocity filter only.

NFIVI $\neq$ 0 no account taken of the preceding 3 traces which have been used and 3 new traces are processed.

NFIVI = 0 the last two traces are kept and 1 new one is introduced.

Figure 17

PARAMETERS USED IN S/R GPSET



```
--------------------------------------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------------------------------------------
NFC=    42 , FIL(1)=  0.    , FIL(2)=  0.    , IVOIE=     0 , NBSEC=   -10 , NBTSE=     0 , NBSEI=     0
SED=     0.099 , SHI=     1.000 , DISTC=   0.    , INVER=  1 , NPH=  1 , NPB=  1   ICARTE= 0
NFC12= 41NFC= 42
 S1746   7  8525008 Z  0    30     0   0  16  60   5   1
H0=   0 H   0 MN   5 S 337/1000  YEAR=1976

DIST=      7.9 IFDLT0=  1IDMAX=    10IDMIN=     0
INDFI(2)=     0 NVOI2=     0
AMP= 10000.000 GAIN=   166.667 NUMERO DE LA VOIE=  1
ISN=P
NVOIE=     1
DIST=      7.85 TTR=    16.645 TT1=     4.645 TT2=    16.645 NBVR=  2081 NBDEB=  1831 NBFIN=  3317 NPOIN=    45
DATE EN TEMPS REDUIT DU PREMIER POINT TX=    -1.901
IVIDE=     0
DIMENSION DES TABLEAUX YTAB ET XTAB   IY=  1487  IX=     0
VALEURS CORRIGEES DE NBDEB=     1  NBFIN=  3317
VALEURS CORRIGEES DE NBDEB=     1  NBFIN=  1489
MIN=      -1.022   MAX=       0.914
MAX=  0.9 MIN= -1.0
ECH1=      0.5166 CM/MU/S      ECH2=      1.9357 MU/S/CM
--------------------------------------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------------------------------------------
NFC=    44 , FIL(1)=  0.    , FIL(2)=  0.    , IVOIE=     0 , NBSEC=   -20 , NBTSE=     0 , NBSEI=     0
SED=     0.099 , SHI=     1.000 , DISTC=   0.    , INVER=  1 , NPH=  1 , NPB=  1   ICARTE= 0
NFC12= 43NFC= 44
 S1746   8  6625008 Z  0    30     0   0  17  60   5   1
H0=   0 H   0 MN   5 S 340/1000  YEAR=1976

DIST=      8.7 IFDLT0=  1IDMAX=    10IDMIN=     0
INDFI(2)=     0 NVOI2=     0
AMP= 10000.000 GAIN=   166.667 NUMERO DE LA VOIE=  1
ISN=P
NVOIE=     1
DIST=      8.66 TTR=    26.783 TT1=     4.783 TT2=    16.783 NBVR=  3348 NBDEB=  3098 NBFIN=  4584 NPOIN=    27
DATE EN TEMPS REDUIT DU PREMIER POINT TX=    -1.901
IVIDE=     0
DIMENSION DES TABLEAUX YTAB ET XTAB   IY=  1487  IX=     0
VALEURS CORRIGEES DE NBDEB=     1  NBFIN=  4584
VALEURS CORRIGEES DE NBDEB=     1  NBFIN=  1489
MIN=      -1.035   MAX=       0.930
MAX=  0.9 MIN= -1.0
ECH1=      0.5091 CM/MU/S      ECH2=      1.9643 MU/S/CM
--------------------------------------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------------------------------------------
NFC=    0 , FIL(1)=  0.    , FIL(2)=  0.    , IVOIE=     0 , NBSEC=     0 , NBTSE=     0 , NBSEI=     0
SED=     0.    , SHI=     1.000 , DISTC=   0.    , INVER=  1 , NPH=  1 , NPB=  1   ICARTE= 0
PLOTTER FILE USED
```

FIGURE 18. Line Printer output from Program ASSEMBU

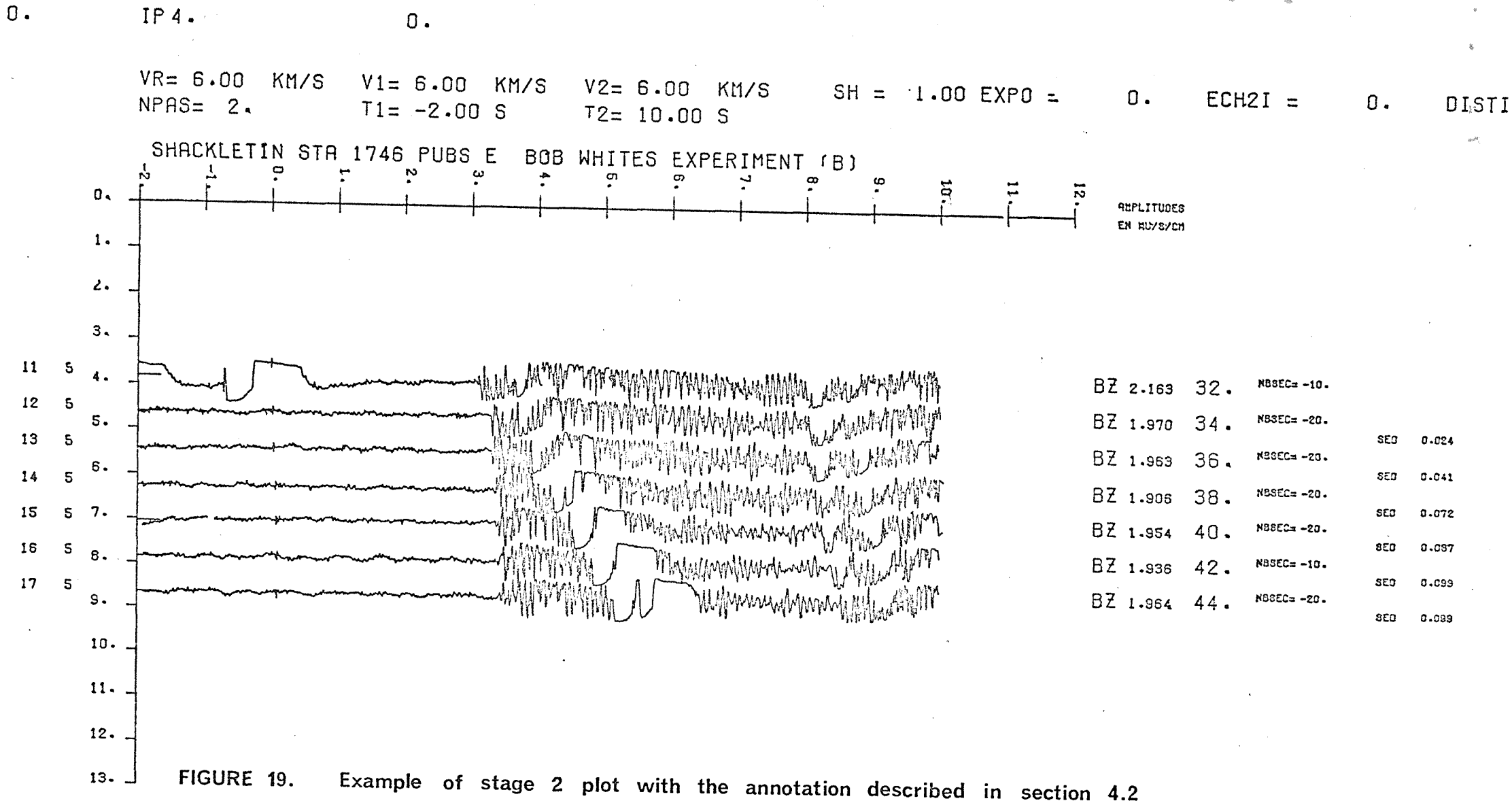


FIGURE 19. Example of stage 2 plot with the annotation described in section 4.2