

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MICROMAG: A Magnetometer Data Processor for
Portable Magnetometer and Apple Microcomputer

by

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Open-File Report 85-40

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1985

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I. ABSTRACT

This report describes MICROMAG, a magnetometer data processing program for the EG&G Geometrics G-856 portable magnetometer and an Apple II+ microcomputer. Additionally, it serves as a user manual for the program.

MICROMAG transfers readings stored electronically in the magnetometer to Apple disk files, restructures data into files of individual traverses, edits data, corrects for diurnal drift, filters for noise with a weighted moving average and plots the profile on a dot matrix printer. It also does forward calculation of magnetic anomalies for hypothetical horizontal prismatic bodies.

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II. STATEMENT OF PROBLEM

An increasing number of field instruments automatically take readings and store data electronically. Such automation increases the field worker's productivity but also encourages the gathering of large amounts of data. Unless subsequent data analysis is similarly expedited, a bottleneck arises after field data have been collected.

The electronic field magnetometer can temporarily store a large number of readings. It uses random access integrated circuit memory (RAM) which is vulnerable to battery failure, short circuit, lightning, or accidental erasure due to operator error. It is desirable to download each day's readings to a more permanent medium as soon as possible. A microcomputer with floppy disk drives is an ideal device for such duty because it can be stationed at the field camp and is rugged and relatively inexpensive.

Once the data are downloaded to the microcomputer, it is usually unnecessary to retransmit the data to a mainframe computer for analysis. The microcomputer can usually conduct the necessary analysis as well as prepare documents for publication. MICROMAG facilitates rapid data reduction and profile construction while in the field, allowing the user to quickly assess the need for further work in the surveyed area. Data analysis on microcomputer can proceed during periods of bad weather when field work is impractical, thus making use of time that was previously unproductive.

MICROMAG is a completely menu-driven program. It is unnecessary for the user to know any operating system commands or file structures. As with most custom software, MICROMAG prompts the user with only those questions appropriate to the analysis of magnetometer data. Typical off-the-shelf, general purpose data base systems often require many more keystrokes to accomplish the same task, or may be incapable of producing the desired results.

III. PROGRAM DESCRIPTION

MICROMAG, was written for an Apple II+ microcomputer to process data from a EG&G Geometrics G-856 portable proton precession magnetometer.

It has the following capabilities:

1. Downloads data from an EG&G Geometrics G-856 portable magnetometer to an Apple disk file via RS-232 port.
2. Divides raw data into individual traverse data sets.
3. Edits traverse data sets.
 - a. Reverse order of points (last becomes first)
 - b. Delete points from a traverse
 - c. Merge traverses (append one traverse to another)
4. Provides printout listing of raw data or traverse data.
5. Provides high resolution screen plots of reading profile.
6. Corrects for diurnal drift based on the difference in base station readings.
7. Provides noise filtering (smoothing) of reading profile using 'n' point weighted moving average.
8. Provides high resolution printer plot of traverse profile.
 - a. Scale adjusts to fit any map.
 - b. Vertical axis (field strength) scale 0-12 inches.
 - c. Survey station interval in feet or meters.
 - d. Fixed station interval or variable length interval based on changes entered by the user during the survey.
9. Allows construction of "Talwani-type" models of magnetic anomalies. Calculation of the field strength from hypothetical horizontal prismatic bodies.
 - a. Up to 5 source bodies, up to 20 corners in each body.
 - b. Up to 30 topographic coordinates.
 - c. Capable of modeling effects of topography.
 - d. Displays and prints:
 1. cross section of body along traverse axis.
 2. x-y plot of calculated field strength vs traverse axis.
 3. x-y plot of observed field strength vs traverse axis. Observed readings can be entered from keyboard or read from a traverse file on disk
 - e. Draped survey or constant altitude survey.
 - f. Can subtract the calculated profile from the observed profile and model the residual field.
 - g. Can add regional gradient to calculated fields.
- 10) Initialization of blank disks for data storage. Deletion of

data files.

1) Downloading data

The EG&G magnetometer data originates as readings stored in the magnetometer memory circuits. At each field station, the user presses the appropriate magnetometer control panel button to take the reading. It is automatically stored in memory along with the station number, date, time etc. At base camp, the data is downloaded from the magnetometer to the microcomputer using a cable connection between the devices. Maximum number of magnetometer readings allowed in each microcomputer disk file is 1000. The data transmitted from the EG&G Geometrics magnetometer is of the following format:

```
_ABB_CCC_DDEEFF_GGGG_HHHHHH ..... record 1
_ABB_CCC_DDEEFF_GGGG_HHHHHH ..... record 2
.
.
.
_ABB_CCC_DDEEFF_GGGG_HHHHHH ..... record n (n <= 1000)
```

where:

_ = blank
A = traverse number
BB = station interval
CCC = day of year
DDEEFF = hour, minute, second
GGGG = sequence number
HHHHHH = magnetic reading in gammas

The station interval reflects the distance to the next reading station. This convention removes ambiguity about the meaning of the first interval in the traverse. The last interval is not used. Despite EG&G's documentation to the contrary, the magnetometer treats the first field, 'ABB' as one field and right justifies a one- or two-digit entry. That is, if no station interval is entered, the magnetometer places the traverse number in column four. In raw data sets, MICROMAG employs the same format. However, when forming traverse data sets, MICROMAG 'decodes' the field in the following manner:

single digit entry = traverse number
additional second or third digits = station interval
regardless of their position in the field.

The operator can change the station interval during a traverse permitting more intensive sampling of interesting areas. The interval changes must be entered via the magnetometer control panel during the traverse, not afterwards during analysis.

2) Dividing raw data sets into traverse data sets.

MICROMAG converts the raw data into individual traverses based on their sequence number. The first field is logically parsed as stated above. The hour, minute and second are converted to seconds. The user has the option of using the first base station as a traverse station, in which case MICROMAG repeats the first base station in record 3. The maximum file size is 500 points.

While making a traverse in the field, it may be more convenient to interrupt one traverse to take readings on another. Or, a number of traverses may share the same base station. Consequently, MICROMAG prompts the user to specify a starting and ending sequence number as well as which points are to be included in, or excluded from, that range. It does not make use of the traverse number from the raw data to formulate traverse data sets.

The resulting disk file format is displayed below.

```

-----
AAA
B                               header records
CCCCCCCCCCCCCCCCCCCC
DDD
EEEEEE
FFFFF                           starting base station
GG -----
DDD
EEEEEE
FFFFF                           ending base station
GG -----
DDD
EEEEEE
FFFFF
GG                               survey stations
.
.
.
. -----
DDD
EEEEEE
FFFFF                           last station in traverse
GG -----

```

where:

AAA	= number of survey and base stations in the file
B	= 'B' point weighted moving average smoothing
CCCCCCCCCCCCCCCCCCCC	= diurnal correction on or off
DDD	= sequence number
EEEEEE	= magnetometer reading in nano Teslas
FFFFF	= time in seconds
GG	= station interval (distance to next reading on map in feet or meters)

The 'B' and 'C' fields are explained in sections 6 and 7.

3) Editing of traverse data sets

Traverses in the field are frequently taken in the opposite direction from which they are intended to be plotted. MICROMAG can reverse the order of survey stations, leaving the base stations the same. The station intervals are adjusted as in the example below so they continue to reflect the distance to the next station.

	<u>original data</u>				<u>reversed</u>				<u>reversed again</u>			
seq. no.	1	2	3	4	4	3	2	1	1	2	3	4
interval	10	20	30	40	30	20	10	40	10	20	30	40

When deleting stations, the user has the option of deleting just the magnetic reading or deleting the entire station. When deleting readings, the value is set to 0 so it is not plotted in sections 5-8. The station interval remains in the file to preserve the length of the original traverse. This option can be used instead of, or before using the noise filter if an obviously erroneous reading occurs in the profile. When deleting the entire station, all fields, A-F are deleted and the traverse is shortened by the number of stations deleted. This option is used if a section of the traverse was retraced in the field.

When merging traverse data sets, the appended data set loses its base stations. MICROMAG first checks if both data sets have been corrected for diurnal drift. If so, it adjusts each reading in the traverse with the higher readings, down to the lower one by subtracting the difference between their first base stations. If one or both data sets have not been corrected for diurnal drift the user is so informed and asked if he wishes to continue with the data merge. Diurnal correction after merging could yield incorrect results.

4) Printout listing of data

MICROMAG can print out both raw and traverse data sets. It automatically determines which type it is reading and selects the correct format (see Tables 1 and 2, p. 21).

5) Screen plots

On the field strength (vertical) axis, the minimum and maximum are taken from the file, or they can be entered at the keyboard. If taken from the file, the minimum is rounded down to the nearest 100 nT (nano Tesla) and the maximum is rounded up to the nearest 100 nT. Only the last five digits are displayed to save space.

On the distance (horizontal) axis, the user has the option of plotting the station interval from the data or selecting a fixed length. If taken from the data, the plot can reflect any change in interval during the traverse. The true minimum, true maximum, mean and deviation are displayed as well as the smoothing factor and diurnal correction. The base station with the lower of the two readings is plotted to the left of the

traverse.

The Apple screen is 192 vertical by 280 horizontal pixels and the plot is automatically scaled to fill the screen.

6) Diurnal correction

MICROMAG can apply a linear correction for drift during the traverse using the starting and ending base stations and the clock reading at each station. This option is part of the plotting program, allowing before-and-after comparisons to be made quickly.

7) Weighted moving average

The weighted moving average noise filter is part of the plot options. Successively wider or narrower filters can be applied and viewed quickly since both the input file and the filtered file reside in memory simultaneously. The filter uses the following algorithm:

for a given 'n' point weighted moving average where

$n = 1, 3, 5, 7, \text{etc}$

$$\text{let } k = \frac{n - 1}{2}$$

for $i = 1$ to n

$$\text{weight}_i = 2^{(k-1) - |i-k|}$$

and

$$\text{average} = \frac{\sum (\text{reading}_i * \text{weight}_i)}{\sum \text{weight}_i}$$

For instance, in a 5 point moving average, a set of 5 consecutive field strength values are multiplied by weights of 1,2,4,2,1; added together and divided by the sum of the weights (10). Then the position mask is moved to the next point in the traverse and the algorithm is applied again. Points at the ends of the traverse cannot be smoothed because they are not surrounded by a full set. In a 5 point average, the first 2 points and last 2 points of the traverse cannot be smoothed and are plotted unchanged.

8) Printer plots

The resolution of printer plots depends on the printer (see section V, Hardware). The accuracy of the overall length, even

on long plots, was found to be extremely good. Map overlays are quite feasible. The user can enter any scale and plot field intervals in feet, tens of feet, meters or tens of meters. Variable station interval option is supported just as it is on screen plots. The base station with the lower of the two readings is plotted before the traverse points. The sequence number is plotted next to each point.

The field strength axis can be up to 12 inches long and is divided into ten intervals. The minimum and maximum values are taken from the file or entered by the user. If taken from the file, the minimum is rounded down to the nearest 100 nT and the maximum is rounded up to the nearest 100 nT.

9) Modeling

The following description of the modeling program and its history is adapted from Campbell (1983). The algorithm is based on earlier work by Heintzler et al (1962) and Talwani and Heintzler (1964), on two dimensional bodies with an infinite strike length. Later algorithms of Shuey and Pasquale (1973), Talwani (1974) and Cady (1979) allowed the ends of the prismatic bodies to be truncated vertically -- hence the term '2 1/2 dimensional'. The version presented here is based on the work of Rasmussen and Pederson (1979). Using their methods, Campbell (1983) developed several gravity and magnetic programs for the Hewlett Packard 85 computer.

This author has modified a later version of Campbell's NEWMAG 1/4 (Campbell 1983, p. 26), and translated it to Apple Basic. The main addition is the use of an existing traverse file as the source of observed fields. Menus and prompts have been added or expanded to make the program more user-friendly.

The program calculates the magnetic field due to induced magnetism only. Effects due to permanent magnetization, demagnetization or interactions between magnetic bodies are not calculated (see Sampaio, 1982).

In the lower third of the screen the program displays a cross-section along the x-axis (traverse direction) of the modeled body or bodies. The y-axis is perpendicular to the screen and parallel to the strike of the body. The z-axis is vertical and lies in the plane of the screen. Together they represent a right handed coordinate system with x increasing to the right, y increasing towards the user and z increasing up. When calculating fields, however, the program reverses the z-axis.

The user is prompted for x-axis length unless an observed field file is read from disk. If read from disk, the x-axis length is the sum of all the field intervals in the traverse file. The program scales the x-axis to fit the screen and displays as much of the the z-axis as possible. Some or all of the bodies may not be visible on the screen. The program compensates for rectangular pixels so the scale in the x and z direction is equal on most monitors. A dashed line above the topography represents the survey flight or traverse. It can be 'draped' on or above the topography, or it can maintain a constant altitude. A ground magnetometer survey is draped at zero distance so the dashed survey line is not plotted.

In the top two thirds of the screen, the program plots the calculated field strength as X's and the observed field strength as a solid line. The vertical axis represents nano Teslas (nT) and is divided into ten intervals. The horizontal axis is the same as the traverse axis as in the cross section below it. The x-axis intercepts the y-axis at 0 nT. If the origin is off the screen, the x-axis is not drawn.

After the screen plot, the program can subtract the calculated field from the observed field and model the residual field.

The user can choose to model the effect of the topography alone. Only the topography above the lowest topographic point is included in the calculations.

MICROMAG main menu

observed field parameters

- strength
- inclination
- strike
- point coordinates

topographic parameters

- point coordinates
- draped or constant elevation survey

body parameters

- susceptibility
- corner coordinates

screen plot of body section

calculate field

screen plot of field and body

printout

main menu

- exit program
- new session (new model)
- change body parameters
- model the residual field

Figure 1. Simplified flow chart for modeling program.

10) Initializing disks, deleting files

Standard 5.25" disks must be formatted before data can be stored on them. Formatting erases whatever information is on the disk so MICROMAG checks for the presence of Apple DOS files before proceeding. It will NOT warn the user of files in other operating systems that may exist on the disk. For instance, a disk formatted in Apple CP/M or Pascal will appear blank to MICROMAG. Be careful!

This option also shows the disk catalog and prompts the user for files to delete. Each disk holds about 4000 raw data readings or 7000 traverse data set readings.

IV. ACCESSORY SOFTWARE

The Apple DOS 3.3 operating system is used, however, it is relocated to the 16K RAM card by using the DOS Mover (BONGERS, 1981). This increases program and array space from 36K to 46K bytes. If you try to boot with regular DOS and run MICROMAG, the program will not execute.

To download data, MICROMAG calls Data Capture 4.0 (Southeastern Software, 1980). Other communications software may be substituted but only Data Capture 4.0 can be invoked from within MICROMAG.

Text on the graphics screen is 'XDRAWN' from a shape table (Myers, 1982, p. 61-67). The clipping subroutine in the modeling program is from the same book, p. 73-77.

V. HARDWARE REQUIREMENTS

MICROMAG was written for the following hardware configuration:

- 1) Apple II+ with 48K motherboard memory and a 16K RAM card installed in slot #0
- 2) Two 5 1/4 inch floppy disk drives controlled from slot #6
- 3) Orange Micro Grappler printer interface card installed in slot #1.
- 4) Printers:
 - a. IDS 560 dot matrix printer.
 - b. C. Itoh 1550A dot matrix printer.
- 4) Apple Communications Card installed in slot #2

The 16K byte RAM card is used to store the disk operating system (see section IV). The printer interface is used to make high resolution screen dumps in the modeling program.

The printer plots of traverse files have the following resolution:

<u>printer</u>	<u>dots per inch (mm)</u>	
	<u>traverse axis</u>	<u>field strength axis</u>
a. IDS 560	48 (1.89)	120 (4.72)
b. C. Itoh	144 (5.67)	160 (6.30)

Downloading data from the magnetometer requires an Apple Communications card installed in Apple slot #2. Pin

configuration for the RS-232 connector follows:

Comm Card --- Magnetometer

2	-----	3
3	-----	2
7	-----	7

Also, other 300 baud serial communications cards may be substituted but either the pin connections or the Data Capture 4.0 parameters may have to be changed.

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Appendix A: Users Manual

The notational conventions used in this section are as follows:

Qn: screen prompt number 'n'
R: operator response

Place MICROMAG program disk in drive 1. Turn on the Apple. Menu Q1 (below) should appear on the screen. Place the disk intended for data storage in drive 2. If it is a formatted disk, proceed with item 1 below. If it is an unformatted disk, or a question exists about the disk's format, select item 7 below.

Q1: MAGNETOMETER DATA PROCESSOR

- 1) TRANSFER DATA FROM MAGNETOMETER
TO APPLE VIA RS-232 PORT
- 2) TRANSFORM RAW DATA TO TRAVERSE
DATA SETS
- 3) EDIT TRAVERSE DATA SETS
- 4) PRINT OUT DATA
- 5) PROFILE PLOT, DIURNAL CORRECTION,
SMOOTHING
- 6) MODEL BODIES
- 7) FORMAT DISKS, DELETE FILES
- 8) END SESSION

PLEASE MAKE A SELECTION:

1) Transfer Data From Magnetometer to Apple Via RS-232 Port

Q2: The Data Capture header appears on the screen.

R: Press the ESC key.

Q3: The Data Capture menu appears.

R: TA Selects drive 2 for data files.

The Apple is now ready to receive data from the magnetometer. Follow the instructions in the EG&G manual, p. 30 (EG&G Geometrics, 197?) for transferring data. Press 'OUTPUT' and 'ENTER' on the magnetometer. The readings should appear on the Apple monitor, one line at a time. When the entire file is in Apple memory:

R: ESC W

Q4: FILE NAME?_____

R: Enter a file name such as 'BIRCH.RAW'.

Q5: ENTER FIRST LINE

R: 1 Enter the number of the first line of useable data. It may be necessary to eliminate some lines or parts of lines at the beginning of the file. This extraneous information is due to the vagaries of transmission and is best eliminated in Data Capture or in a word processor program.

Q6: ENTER LAST LINE

R: Enter the number of the last line of data. This is listed in the header information at the top of the screen.

R: RETURN ESC Q (to quit)

Q7: ARE YOU SURE YOU WANT TO QUIT?

R: Y Program control returns to Q1.

2) Transform Raw Data to Traverse Data Sets

Option #2 of the main menu evokes the following prompts:

Q10: (catalog list of files on data disk, drive 2 appears)

ENTER RAW DATA SET NAME:

R: Enter a raw data set name from the catalog list that automatically appears before Q10. If MICROMAG cannot read any of the records in the raw file they will be listed on the screen. These records have an incorrect format (probably due to transmission errors) and must be corrected in a text editor outside MICROMAG.

Q11: 'n' RECORDS IN RAW DATA SET 'filename'

SEQUENCE NUMBERS FROM 'x' TO 'y'

Q12: ENTER STARTING BASE STATION SEQUENCE

NUMBER:

R: Enter the sequence number of the first base station of the traverse data set you are creating.

Q13: ENTER ENDING BASE STATION SEQUENCE

NUMBER:

R: Enter the sequence number of the last base station of the traverse data set you are creating.

Q14: IS THE BASE STATION 'x' ALSO THE FIRST

SURVEY STATION IN THE TRAVERSE? (Y/N):

R: Answer 'Y' or 'N'.

Q15: I) INCLUDE A RANGE OF SURVEY

STATION NUMBERS

E) EXCLUDE A RANGE OF NUMBERS

RETURN) INCLUDE ALL POINTS BETWEEN

BASE STATIONS 'x' AND 'y'

PLEASE MAKE A SELECTION:

R: I Go to Q15a.
E Go to Q15b.
RETURN Go to Q15c.

Q15a: ENTER RANGE(S) OF SEQUENCE NUMBERS TO BE
INCLUDED

USE FORMAT SUCH AS 3-7/9/18-23

This option creates a traverse file which includes all stations between those stations specified in Q15a. Program goes to Q17.

Q15b: ENTER RANGE(S) OF SEQUENCE NUMBERS TO BE
EXCLUDED

USE FORMAT SUCH AS 3-7/9/18-23

This option creates a traverse file which includes all stations between the base stations specified in Q12 and Q13 except those stations specified in Q15b. Program goes to Q17.

Q15c: Program goes to Q17.

This option creates a traverse file which includes all the survey stations between the base stations specified in Q12 and Q13.

Q17: ENTER OUTPUT DATA SET NAME:

R: Enter a name such as 'BIRCH.T1'

Q18: E) END DATA SET CONSTRUCTION

RETURN) CREATE MORE TRAVERSE DATA SETS

PLEASE MAKE A SELECTION:

R: E Go to Q1.
RETURN Go to Q11.

3) Edit Traverse Data Sets

Option #3 in the main menu allows the following editing features:

Q30: 1) INVERT A FILE (LAST/FIRST)

2) REMOVE POINTS FROM A FILE

3) MERGE FILES

4) END EDIT SESSION

PLEASE MAKE A SELECTION:

R: 1 Go to Q31.
2 Go to Q33.
3 Go to Q37.
4 Go to Q1.

Q31: A catalog of disk files appears.

ENTER TRAVERSE DATA SET NAME OR

'RETURN' TO CANCEL READ:

R: Enter a name from the catalog that appears in
Q31, or press "RETURN" to go to Q30.

Q32: ENTER OUTPUT DATA SET NAME:

R: Enter a name for the inverted file. Program control
returns to Q30.

Q33: A catalog of files in drive 2 appears.

ENTER TRAVERSE DATA SET NAME OR

'RETURN' TO CANCEL READ:

R: Enter a name from the catalog that appears before
Q33.

Q34: 1) DELETE POINT(S) BUT KEEP SPACE ON

PLOTS

2) DELETE POINT(S) AND CLOSE UP SPACE

ON PLOTS

R: 1 Option 1 leaves space on the profile plots where the
deleted readings once were.
2 Option 2 deletes reading(s) and interval(s) so the gap

is eliminated on a profile plot.

Q35: ITEM # SEQ. NO.

1	64
2	65
.	.
etc.	

ENTER ITEM NUMBERS TO BE DELETED OR

'RETURN' TO SEE LIST AGAIN

ENTER FORMAT SUCH AS 3-7/9/18-23

R: Enter the sequence numbers of points to be deleted. The "ITEM" numbers are current row numbers and change when points are deleted.

Q36: ENTER OUTPUT DATA SET NAME:

R: Enter a name for the output disk file.

Q37: (a catalog of disk files appears)

ENTER TRAVERSE DATA SET NAME OR

'RETURN' TO CANCEL READ:

R: Enter a file name from the catalog list that appears before Q37.

Q38: ENTER DATA SET NAME TO APPEND TO 'filename'

OR 'RETURN' TO CANCEL MERGE:

R: Enter a file name. If the two files differ in the amount of smoothing or the diurnal correction, MICROMAG will warn you and ask if you wish to proceed.

Q39: ENTER OUTPUT FILE NAME FOR MERGED

DATA OR 'RETURN' TO CANCEL MERGE:

R: Enter an output file name. Program control returns to Q30.

4) Print Out Data

Q50: ENTER DATA SET NAME TO BE PRINTED OR

'RETURN' TO END PRINT:

R: Enter a data set name from the catalog list that appears before Q50. MICROMAG automatically detects the type of file (raw or traverse) and prints the correct format as shown below.

Table 1.--Raw data printout

DATA SET NAME = BIRCH.RAW

	<u>TIME</u>	<u>SEQ#</u>	<u>nT</u>
150	062 141826	0	538207
150	062 143011	1	537788
	.		
	.		
	.		
150	062 160433	122	538378
250	062 161627	123	538906
250	062 161758	124	538926
	.		
	.		
	.		

Table 2.-- Traverse data set printout

DATA SET NAME = BIRCH.T1.7D

7 POINT WEIGHTED MOVING AVERAGE

DIURNAL CORRECTION ON

STATION INTERVAL	TIME IN SECONDS	STATION NUMBER	MAGNETOMETER READING nT
50	51506	0 BS	538207
50	52873	122 BS	538378
50	52211	1	537769.066
50	52345	2	537788.717
50	52377	3	537835.608
	.		
	.		
	.		
50	56023	121	538760.686

5) Profile Plot, Smoothing, Diurnal Correction

Q60: A catalog of disk files in drive 2 appears.

ENTER TRAVERSE DATA SET NAME OR

'RETURN' TO CANCEL READ:

R: BIRCH.T1 Enter a traverse data set name from the
 catalog.

Q61: VERTICAL AXIS (nT) SCALE

DEFAULTS = 537700 to 538900 These are the minimum and
 maximum nT readings in file
 'BIRCH.T1'

1) ENTER NEW LIMITS

RETURN) SELF SCALING (ACCEPT DEFAULTS)

PLEASE MAKE A SELECTION:

R: 1 Go to Q61a.
 RETURN Go to Q62.

Q61a: ENTER LOWER LIMIT

 DEFAULT = 537700 Minimum in 'BIRCH.T1'

R: Enter a new value or 'RETURN' to accept default.

Q61b: ENTER UPPER LIMIT

 DEFAULT = 538900 Maximum in 'BIRCH.T1'

R: Enter a new value or 'RETURN' to accept default.
 Program returns to Q61.

Q62: SURVEY STATION INTERVAL(S)

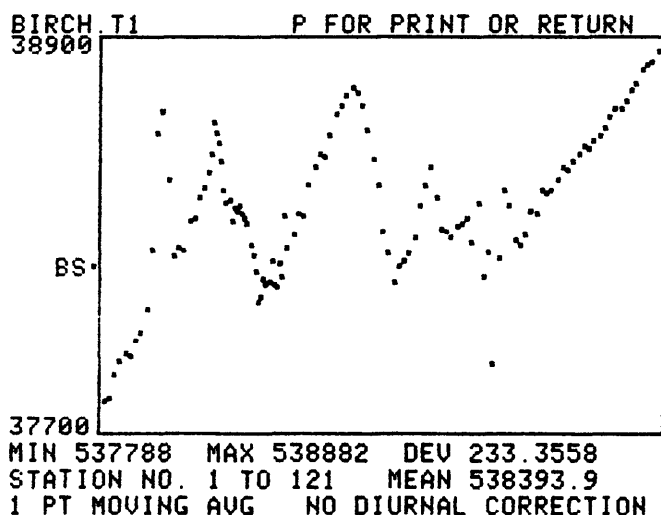
50 25 50 Every change in spacing in the data set is
 listed. In this example from 'BIRCH.T1' the
 interval starts out at 50, changes to 25,
 then changes back to 50.

1) USE ABOVE INTERVAL(S)

RETURN) PLOT POINTS EQUIDISTANT

R: 1 The points of the profile are spaced according to the
 intervals in the data.
 RETURN The points of the profile are spaced evenly,
 regardless of the intervals.

Q63:



R: RETURN

Q64: PLEASE NOTE!! SMOOTHING ERASES DIURNAL
CORRECTIONS UNLESS THEY WERE SAVED TO
DISK. SMOOTH FIRST, THEN DIURNAL CORRECT

CURRENT INPUT FILE = BIRCH.T1

3,5,ETC) 'N' POINT WEIGHTED MOVING AVG.

D) DIURNAL CORRECTION

R) REMOVE DIURNAL CORRECTION OR

SMOOTHING NOT SAVED TO DISK

V) VIEW LAST PLOT AGAIN

S) SAVE CHANGES TO DISK

C) CHANGE INPUT DATA SETS

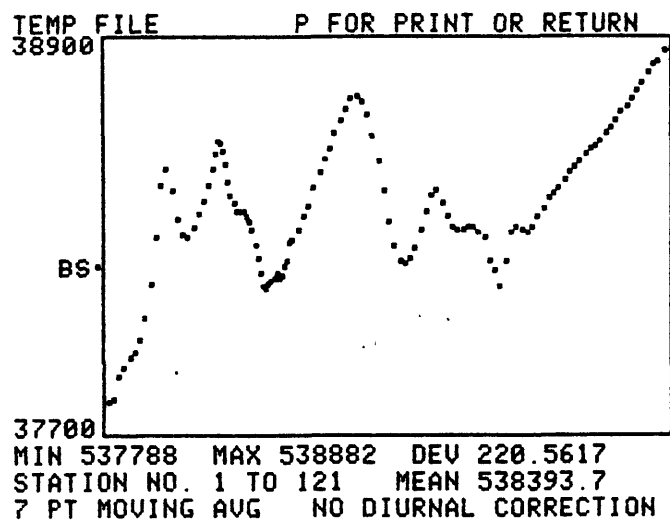
RETURN) RETURN TO MAIN MENU

PLEASE MAKE A SELECTION:

R: 7 7 point weighted moving average. Go to Q65.
D Go to Q66.
R Go to Q63.
V Go to last plot.
S Go to Q72.
C Go to Q60.

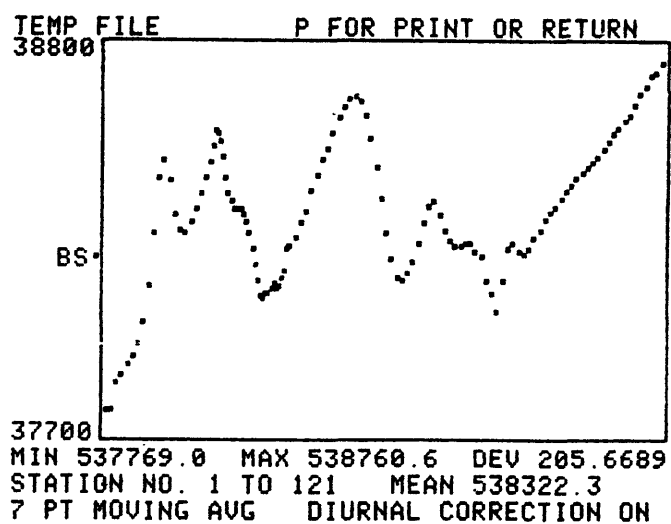
Q61 and Q62 repeat here.

Q65:



R: 'RETURN' Go to Q64.

Q67: Q61 and Q62 repeat here.



R: P Go to Q67.

Q67: ENTER SCALE SUCH AS 1:500

1:

R: 5000

Q68: ENTER Y AXIS (GAMMA) LENGTH IN INCHES OR

'RETURN' TO ACCEPT DEFAULT OF 6.67 IN.

0 <= LENGTH < 12:

R: 'RETURN'

Q69: DISTANCE BETWEEN SURVEY STATIONS IS IN

M) METERS

RETURN) FEET

PLEASE MAKE A SELECTION:

R: 'RETURN'

Q70: 50 25 50 These intervals are from 'BIRCH.T1'

ABOVE INTERVALS REPRESENT:

N) FEET

X) TENS OF FEET

OR IGNORE ABOVE INTERVALS AND ENTER:

xxx) NUMBER OF FEET BETWEEN POINTS

RETURN) DEFAULT OF 100 FEET

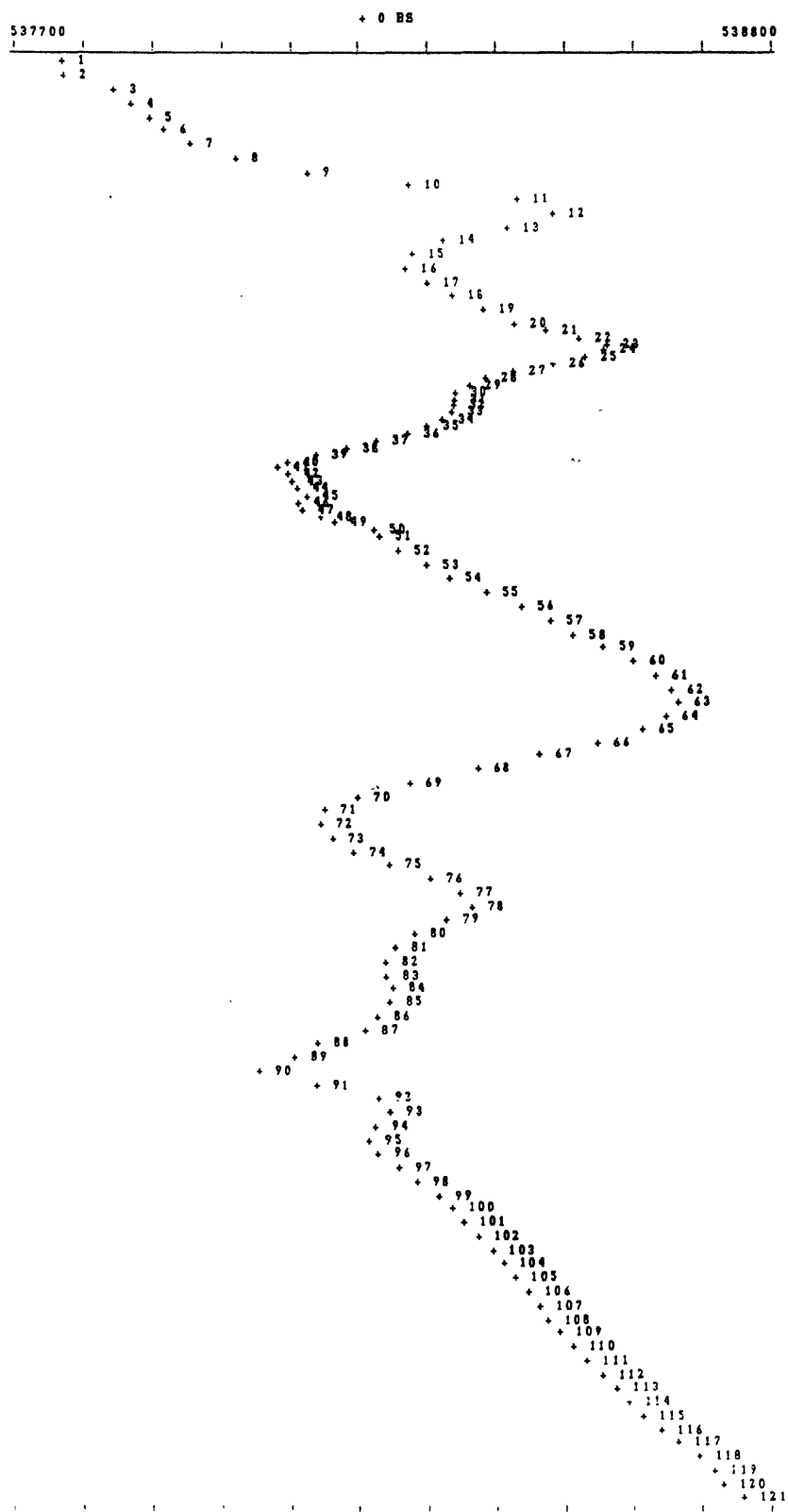
PLEASE MAKE A SELECTION:

If the answer to Q69 had been 'M' then Q70 would have 'METERS' substituted for 'FEET' throughout.

R: N

The profile plot of BIRCH.T1 with smoothing and diurnal correction follows. Stations 20 through 50 are spaced at 25 foot intervals, the rest at 50 feet. The resolution of the IDS 560 printer is 1/48 inch (.53 mm) on the distance axis and 1/120 inch (.21 mm) on the field strength axis. For the C. Itoh - 1/144 inch (.18 mm) and 1/160 inch (.16 mm) respectively. The MICROMAG plotting algorithm is such that the plotting error is not cumulative. Plots of any length have overall lengths accurate to 1/48 inch.

Figure 2. Printer plot of 'BIRCH.T1' after 7 point moving average and diurnal correction.



INPUT DATA SET NAME = BIRCH.T1
 PLOTTED DATA SET NAME = TEMP FILE
 SCALE = 1:5000
 SEQUENCE NUMBERS FROM 1 TO 121
 7 POINT MOVING AVERAGE SMOOTHING
 DIURNAL CORRECTION ON
 FIELD STATION INTERVAL(S)
 50 25 50 FEET

Go to Q64.

Q72: ENTER DATA SET NAME OR

'RETURN' TO CANCEL WRITE:

R: Enter a name such as BIRCH.T1.7D. If the file is not
saved, the smoothing and diurnal correction will be
lost. Go to Q64.

6) Model Bodies

Q80: MAGNETIC FIELD MODELING PROGRAM

TWO AND A HALF DIMENSIONAL

ENTER TOTAL FIELD STRENGTH (nT)

R: Enter the total field strength in the survey area. The area's international geomagnetic reference field is adequate. If the resulting calculated fields are too large, reduce the field strength by a factor of 10.

Q81: ENTER FIELD INCLINATION (DEGREES):

R: Enter the local magnetic field inclination from maps or other references.

Q82: ENTER THE STRIKE ANGLE
(THE ANGLE BETWEEN MAGNETIC NORTH
AND THE STRIKE OF THE MODELED BODY.
COUNT DEGREES POSITIVE COUNTER-
CLOCKWISE):

R: The strike direction is always normal to the traverse direction regardless of the body's dimensions.

Q83: PLOT:

O) OBSERVED FIELDS + FIELDS
CALCULATED FROM MODEL

RETURN) FIELDS CALCULATED FROM MODEL
ONLY

PLEASE MAKE A SELECTION:

R: Option 'O' displays observed field strengths as well as fields calculated from the model. Go to Q84.

Press "RETURN" to display calculated fields only. Go to Q88.

Q84: OBSERVED TRAVERSE DATA

K) ENTER VALUES FROM KEYBOARD

RETURN) USE PRE-EXISTING TRAVERSE DATA
FILE FROM DISK

PLEASE MAKE A SELECTION:

R: Option "K" allows observed points entered from keyboard. Go

to Q85.

Press "RETURN" to read points from a disk file. Go to Q87.

Q85: ENTER TRAVERSE AXIS DIMENSIONS

XMIN, XMAX, DX:

R: Enter the length and interval of the traverse axis. Most often, XMIN is set to 0.

Q86: OBSERVED FIELD (nT) AT X = 0

R: Enter the field strength at each survey station. Program execution goes to Q89.

Q87: DATA DISK MUST BE IN DRIVE 2

PRESS RETURN TO CONTINUE

Catalog of disk drive 2 follows.

ENTER TRAVERSE DATA SET NAME OR RETURN
TO CANCEL READ:

R: Enter the data set containing the magnetometer readings.
Press "RETURN" to go back to the main menu (Q1 section 2) if you have not prepared any traverse data sets. If a valid set of data is found, MICROMAG proceeds to question Q89.

Q88: ENTER TRAVERSE AXIS DIMENSIONS

XMIN, XMAX, DX:

R: Enter the traverse axis length and increment.
XMIN is usually set to 0.

Q89: ENTER TOPOGRAPHIC POINTS? (Y/N)

R: N Go to Q94.
Y Proceed below.

Q90: HOW MANY TOPOGRAPHIC POINTS?

R: Enter the number of coordinate pairs used to create the topography along the traverse axis.

Q91: TOPO-X(1), TOPO-Z(1)

R: Enter the coordinate pairs in the same dimensions as the traverse axis (Q88).

Q92: DRAPED SURVEY? (Y/N)

R: Y Survey follows contours. Go to Q93.
N Constant altitude survey. Go to Q94.

Q93: DRAPED DISTANCE ABOVE GROUND:

R: Enter the distance in the same units as the
traverse axis (Q88). Go to Q95.

Q94: ENTER ELEVATION OF SURVEY

R: Enter the elevation above ground in the same units
as the traverse axis.

Q95: HOW MANY BODIES?

R: Enter the number of bodies to be modeled. If number is
greater than 0, proceed to Q98.

Q96: TOPOGRAPHIC SUSCEPTIBILITY?

R: Enter the magnetic susceptibility of the material
above the lowest topographic point.

Q97: TOPOGRAPHIC END COORDS, Y1,Y2?

R: Enter the y coordinates (normal to traverse direction) of
the endpoints of the material in the calculated field.
Use the same units as the traverse length (Q88).
Proceed to Q102.

Q98: FOR BODY NO. 1
SUSCEPTIBILITY?

R: Enter the magnetic susceptibility of the body in question.
A values of .001 is a good starting point if the rock type
is unknown.

Q99: NUMBER OF CORNERS?

R: Enter the number of apices in the cross sectional view of
the modeled body.

Q100: BODY-X(1), BODY-Z(1)

R: Enter the coordinates of the apices in the same units as
traverse axis (Q88).

Q101: END COORDS Y1(1), Y2(1)

R: Enter the y coordinates (normal to the traverse direction)
for the endpoints of the modeled body. For instance, -1000,
1000 means the body extends 1000 units on either side of the
traverse axis.

A plot of the body sections appears on the screen. Check position and size of bodies. Press the "RETURN" key to continue.

Q102: CALCULATE THIS CASE? (Y/N)

R: Y Calculate field strength. Proceed below.
N Discard this case. Go to Q107.

Q103: ADD REGIONAL GRADIENT TO CALCULATED FIELDS? (Y/N)

R: Y Add a linear increase to the calculated fields. Go to Q104.
N Plot the calculated data without a correction. Go to Q105.

Q104: ENTER STARTING AND ENDING VALUES IN
NANO TESLAS (nT) AT F(0), F(N)

R: Enter the regional correction at the first and last points in the traverse.

MICROMAG calculates fields for bodies in the previous screen plot.

Q105: ENTER END COORDINATES FOR GRAPH AXIS
ENTER MIN < Z1, MAX > Z2 nT

R: Enter the field strength axis min and max for the screen plot. MICROMAG divides the range into 10 intervals. Z1 and Z2 are the min and max present in the calculated and observed fields.

MICROMAG plots the fields and the bodies. Press the "RETURN" key to continue.

Q106: 'X' = CALCULATED FIELD
'----' = OBSERVED FIELD

A) SEE PLOT AGAIN

RETURN) CONTINUE WITH PROGRAM

PLEASE MAKE A SELECTION:

R: A Return to plot above.

R: RETURN Proceed below.

Q107: PRINT OUTPUT? (Y/N)

R: Type "Y" for a high resolution printout of the screen plot and a listing of the field strengths.

Figure 3. Printout of modeled body and calculated field strength.

FIELD=55000 INCL=50 STRIKE=60

BODY #1	SUSC=1E-03	
Y1=-1000	Y2=1000	
	BODX	BODZ
1	300	0
2	400	100
3	500	0
4	500	-75
5	300	-75

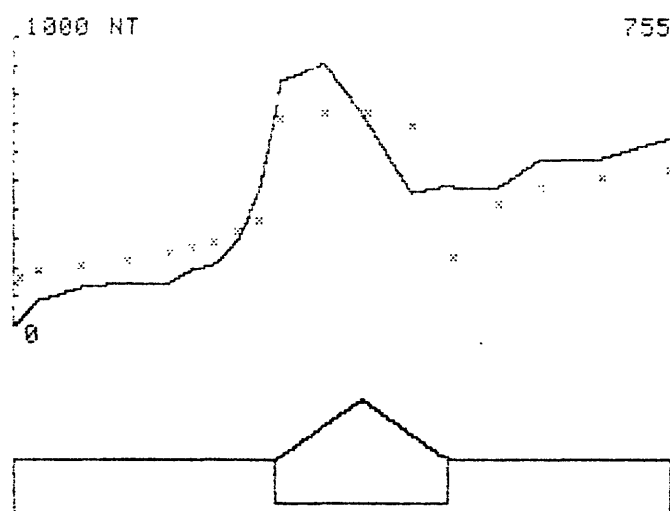
SUM FIELD FOR ALL BODIES

-X-	-Z-	FIELD
0	0	139.693014
10	0	161.74013
30	0	183.576103
50	0	204.580447
130	0	225.152467
180	0	245.505545
205	0	267.263551
230	0	290.602327
255	0	318.803879
280	0	362.58709
305	5	709.856524
355	55	735.974628
405	95	732.498094
455	45	690.343248
505	0	228.04357
555	0	416.440512
605	0	471.112324
675	0	507.966731
755	0	536.16246

REGIONAL GRADIENT IS $F(0)=0$ nT AND $F(755)=400$ nT

'X' = CALCULATED FIELD

'---' = OBSERVED FIELD



Q108: E) EXIT MODELING PROGRAM
 N) NEW MODELING SESSION
 C) MAKE CHANGES TO BODIES
 RETURN) MODEL THE RESIDUAL FIELD

PLEASE MAKE A SELECTION:

R: E Go to Q1.
 N Start over with new bodies. Go to Q80.
 C Change body apices etc. Go to Q109.
 RETURN Subtract the calculated field from the observed
field and display the residual field. Go to Q116.

Q109:CHANGE SUSCEPTIBILITY? (Y/N)

R: Y Change the susceptibility for any of the bodies.
 Go to Q110.
 N Go to Q111.

Q110:SUSC FOR BODY # 1

R: Enter the new value for each body. Go to Q111.

Q111:CHANGE BODY # 1 ? (Y/N)

R: Y Change apex coordinates for body. Go to Q112.
 N Go to Q113.

Q112:CHANGE CORNER # 3
 NEW X(3), NEW Z(3)

R: Enter the new coordinates for each corner.

Q113:CHANGE END COORDS Y1,Y2? (Y/N)

R: Y Change the length of the body. Go to Q114.
 N Use old endpoints. Go to Q115.

Q114:Y1,Y2 FOR BODY # 1

R: Enter the new endpoints for the body.

Q115:ADD BODIES? (Y/N)

R: Y Go to Q98.
 N Go to Q102.

Q116:A plot appears showing topo but no bodies. Press "RETURN"
 to continue.

CALCULATE THIS CASE? (Y/N)

R: Y Continue with residual field. Goto Q117.
 N End residual field calculations. Go to 108.

Q117:A plot appears showing the residual field. Press "RETURN"

to continue. Go to Q95.

7) Format disks, delete files

Q130: THIS PROGRAM INITIALIZES DATA DISKS

1) RETURN TO MAIN MENU

2) ERASE FILES

RETURN) INITIALIZE DISK FOR DATA STORAGE

PLEASE MAKE A SELECTION:

R: 1 Go to Q1.
2 Go to Q131.
RETURN Most new disks are unformatted. This option
prepares them for use in MICROMAG. Go to Q132.

Q131: A catalog of disk files on drive 2 appears.

ENTER FILE NAME TO ERASE OR PRESS RETURN

TO QUIT

R: file name Go to Q131.
RETURN Go to Q130.

Q132: PLACE NEW DISK IN DRIVE 2

PRESS RETURN TO CONTINUE

A catalog of disk files on drive 2 appears. If the
disk is unformatted, no catalog appears. Instead,
program execution goes to Q134.

THE ABOVE FILES EXIST ON THE DATA DISK

1) INITIALIZE AND ERASE ALL FILES

2) SEE CATALOG AGAIN

3) CHANGE DATA DISKS

RETURN) ERASE SPECIFIC FILES AND
KEEP THE OTHER FILES

PLEASE MAKE A SELECTION:

R: 1 Go to Q133.
2 Go to Q132.
3 Go to Q132.
RETURN Go to Q131.

Q133:ARE YOU SURE YOU WANT TO ERASE ALL
THE FILES ON THE DISK IN DRIVE 2 ?
THEY WILL BE GONE FOREVER!!!

ANSWER Y/N

R: Y MICROMAG formats the disk and returns to Q130.
N Go to Q132.

Q134:MAKE SURE DOOR IN DRIVE 2 IS CLOSED

PRESS RETURN TO CONTINUE

R: RETURN MICROMAG formats the disk and returns to Q130.

PROGRAM "M" (MAIN PROGRAM)

LIST

```

100 DIM T(1000),S(1000),G(1000),N(1000)
110 DIM S1(500),G1(500),N1(500),T1(500)
120 DIM V$(100),VA(100),VN(500),V(100)
150 D$ = CHR$(4):G$ = CHR$(7):L$ = CHR$(12)
160 ESC$ = CHR$(27):I$ = CHR$(9):N$ = CHR$(14)
180 B$ = "000"
1000 REM

```

MAIN MENU

```

1010 HOME : PRINT "MAGNETOMETER DATA PROCESSOR"
1020 VTAB 4: HTAB 6: PRINT "1) TRANSFER DATA FROM MAGNETOMETER"
1030 HTAB 10: PRINT "TO APPLE VIA RS-232 PORT"
1040 PRINT : HTAB 6: PRINT "2) TRANSFORM RAW DATA TO TRAVERSE"
1042 HTAB 10: PRINT "DATA SETS"
1050 PRINT : HTAB 6: PRINT "3) EDIT TRAVERSE DATA SETS"
1060 PRINT : HTAB 6: PRINT "4) PRINT OUT DATA"
1070 PRINT : HTAB 6: PRINT "5) PROFILE PLOT, SMOOTHING,"
1074 HTAB 10: PRINT "DIURNAL CORRECTION"
1076 PRINT : HTAB 6: PRINT "6) MODEL BODIES"
1080 PRINT : HTAB 6: PRINT "7) FORMAT DISKS OR ERASE FILES"
1090 PRINT : HTAB 6: PRINT "8) END SESSION"
1100 GOSUB 12050
1110 ON A GOTO 1700,2010,7010,1600,1300,1250,1710,1720
1200 PRINT G$;G$: GOTO 1010
1250 PRINT D$"RUN MM,D1"
1300 PRINT D$"RUN X,D1"
1600 PRINT D$"RUN P,D1"
1700 PRINT D$"EXEC DCAP 4.0 LOADER,D1"
1710 PRINT D$"RUN MAGFOR,D1"
1720 END
2000 REM

```

READ RAW DATA

```

2010 E = 1: ONERR GOTO 13010
2020 HOME : PRINT D$"CATALOG,D2"
2040 PRINT : INPUT "ENTER RAW DATA SET NAME: ";FL$
2042 IF FL$ = "" THEN GOTO 1010
2060 PRINT D$;"VERIFY";FL$
2100 PRINT D$;"OPEN ";FL$
2110 L = - 1
2130 ONERR GOTO 2300
2132 PRINT D$"READ";FL$
2140 L = L + 1
2150 INPUT " ";A$
2160 J = 0
2170 FOR I = 1 TO 4:X$ = MID$(A$,I,1)
2180 IF X$ = " " THEN J = I:I = 4
2190 NEXT
2192 IF J = 0 THEN HOME : VTAB 8: PRINT G$;G$;"CANNOT READ LINE ";L +
1;" IN DATA": GOSUB 12300: GOTO 1010
2194 IF J = 4 THEN GOTO 2220
2196 A$ = LEFT$(B$,4 - J) + A$
2200 :
2220 H = VAL ( MID$(A$,9,2))

```

```

2230 M = VAL ( MID$ (A$,11,2))
2240 S = VAL ( MID$ (A$,13,2))
2242 N(L) = 0:LINE = VAL ( LEFT$ (A$,3))
2246 IF LINE > = 10 THEN N(L) = VAL ( MID$ (A$,3,1))
2248 IF LINE > = 100 THEN N(L) = VAL ( MID$ (A$,2,2))
2250 T(L) = (H * 60 + M) * 60 + S
2260 S(L) = VAL ( MID$ (A$,17,3))
2270 G(L) = VAL ( MID$ (A$,21,6))
2280 GOTO 2140
2300 PRINT D$"CLOSE";FL$
2301 E = 2: ONERR GOTO 13010
2302 GOTO 2410
2304 HOME : VTAB 5
2310 PRINT : HTAB 6: INVERSE : PRINT "E";: NORMAL : PRINT "> END DATA S
ET CONSTRUCTION"
2320 PRINT : INVERSE : PRINT "RETURN";: NORMAL
2330 PRINT "> CREATE MORE TRAVERSE DATA SETS"
2340 PRINT : HTAB 10: PRINT "FROM DATA SET '";FL$;"'"
2350 GOSUB 12010
2360 IF A$ = "E" THEN GOTO 1010
2370 IF A$ < > "" THEN PRINT G$;G$: GOTO 2310
2400 :
2410 HOME : VTAB 3
2411 PRINT L;" RECORDS IN RAW DATA SET '";FL$;"'"
2412 PRINT : PRINT "SEQUENCE NUMBERS FROM ";S(0);" TO ";S(L - 1)
2420 VTAB 9: PRINT "ENTER STARTING BASE STATION SEQUENCE"
2430 PRINT : INPUT "NUMBER: ";B1
2432 IF B1 < 0 OR B1 > (L - 1) THEN PRINT G$;G$: GOTO 2410
2440 PRINT : PRINT : PRINT "ENTER ENDING BASE STATION SEQUENCE"
2450 PRINT : INPUT "NUMBER: ";B2
2452 IF B2 < 0 OR B2 > (L - 1) THEN PRINT G$;G$: GOTO 2410
2460 HOME : VTAB 8
2470 PRINT "IS BASE STATION '";B1;"' ALSO THE FIRST"
2480 VTAB 11: PRINT "SURVEY STATION IN THE TRAVERSE?";: GOSUB 12200
2482 PL$ = A$
2483 IF NOT (A$ = "Y" OR A$ = "N") THEN PRINT G$;G$: GOTO 2460
2484 HOME : VTAB 5: HTAB 6
2490 INVERSE : PRINT "I";: NORMAL
2500 PRINT "> INCLUDE A RANGE OF SURVEY": PRINT : HTAB 10: PRINT "STATI
ON NUMBERS"
2510 PRINT : HTAB 6: INVERSE : PRINT "E";: NORMAL
2520 PRINT "> EXCLUDE A RANGE OF NUMBERS"
2540 PRINT : INVERSE : PRINT "RETURN";: NORMAL
2550 PRINT "> INCLUDE ALL POINTS BETWEEN"
2560 PRINT : HTAB 10: PRINT "BASE STATIONS ";B1;" AND ";B2
2570 GOSUB 12010
2680 IF A$ = "" THEN GOSUB 5410: GOTO 2752
2682 IF NOT (A$ = "I" OR A$ = "E") THEN PRINT G$;G$: GOTO 2484
2690 PRINT : PRINT "ENTER RANGE(S) OF SEQUENCE NUMBERS TO BE";
2700 PRINT : IF A$ = "E" THEN PRINT " EXCLUDED"
2710 IF A$ = "I" THEN PRINT " INCLUDED"
2720 GOSUB 3010
2730 IF V$ = "" THEN GOTO 2301
2740 IF A$ = "E" THEN GOSUB 5510
2750 IF A$ = "I" THEN GOSUB 5010
2752 SI = 1:DC$ = "NO DIURNAL CORRECTION"
2760 E = 2:R = 1: GOTO 2800
2790 REM

```

WRITE TRAVERSE DATA FILE

```

2800 PRINT D$ "CATALOG,D2"
2804 PRINT : INPUT "ENTER OUTPUT DATA SET NAME: ";FO$
2808 ONERR GOTO 2820
2809 PRINT D$ "VERIFY";FO$
2810 PRINT : PRINT G$;G$;"FILE ALREADY EXISTS"
2811 PRINT : PRINT "DO YOU WISH TO OVERWRITE?";
2812 GOSUB 12200
2813 IF A$ = "N" THEN GOTO 2800
2814 IF A$ < > "Y" THEN GOTO 2810
2818 PRINT D$ "DELETE";FO$
2820 ONERR GOTO 13010
2822 PRINT D$ "OPEN";FO$
2840 PRINT D$ "WRITE";FO$
2842 PRINT K: PRINT S1: PRINT DC$
2848 FOR I = 1 TO K
2850 PRINT S1(I): PRINT G1(I): PRINT T1(I): PRINT N1(I)
2860 NEXT
2870 PRINT D$ "CLOSE";FO$
2900 ON R GOTO 2304,7010,7010,710
3000 REM

```

ENTER SEQUENCE NOS.

```

3010 PRINT : INPUT "USE FORMAT SUCH AS 3-7/9/18-23 ";V$
3020 IF V$ = "" THEN GOTO 3220
3030 LS = LEN (V$): FOR I = 1 TO LS:V$(I) = MID$ (V$,I,1):V(I) = VAL
(V$(I)):VA(I) = ASC (V$(I)):NEXT
3040 I = 1:J = 0
3050 IF VA(I) < 48 OR VA(I) > 57 THEN GOSUB 3310: GOTO 3010
3060 J = J + 1:VN(J) = V(I)
3070 I = I + 1: IF I > LS THEN GOTO 3210
3080 IF VA(I) > 47 AND VA(I) < 58 THEN VN(J) = VAL (V$(I - 1) + V$(I))
:I = I + 1: IF I > LS THEN GOTO 3210
3082 IF VA(I) > 47 AND VA(I) < 58 THEN VN(J) = VAL (V$(I - 2) + V$(I -
1) + V$(I)):I = I + 1: IF I > LS THEN GOTO 3210
3090 IF V$(I) = "-" THEN GOTO 3120
3100 IF V$(I) = "/" THEN GOTO 3180
3110 GOSUB 3310: GOTO 3010
3120 I = I + 1: IF I > LS THEN GOSUB 3320: GOTO 3010
3130 IF VA(I) < 48 OR VA(I) > 57 THEN GOSUB 3310: GOTO 3010
3140 J = J + 1:VN(J) = V(I)
3150 I = I + 1: IF I > LS THEN GOSUB 3290: GOTO 3210
3160 IF VA(I) > 47 AND VA(I) < 58 THEN VN(J) = VAL (V$(I - 1) + V$(I))
:I = I + 1
3162 IF VA(I) > 47 AND VA(I) < 58 THEN VN(J) = VAL (V$(I - 2) + V$(I -
1) + V$(I)):I = I + 1
3170 GOSUB 3290
3180 I = I + 1: IF I > LS THEN GOTO 3210
3190 IF VA(I) > 47 AND VA(I) < 58 THEN GOTO 3050
3200 GOSUB 3310: GOTO 3010
3210 IF VN(J) > L THEN GOSUB 3310: GOTO 3010
3220 RETURN
3280 :
3290 M = J:N = J - 1 + VN(J) - VN(J - 1):Q = VN(J - 1): FOR J = M TO N:Q
= Q + 1:VN(J) = Q: NEXT :J = J - 1: RETURN
3300 :
3310 :
3320 REM :ERROR IN ENTERING VARIABLE(S)
3330 VTAB 21: CALL - 958: VTAB 22

```

```

3340 FLASH : PRINT G$"INVALID VARIABLE(S)": NORMAL
3350 FOR I = 1 TO 1000: NEXT : PRINT G$;: FOR I = 1 TO 2000: NEXT
3360 VTAB 21: CALL - 958: VTAB 22
3390 RETURN
5000 REM

```

STORE INCLUDED NUMBERS

```

5010 GOSUB 5910
5020 FOR K = 1 TO J:I = K + ST
5040 S1(I) = S(VN(K))
5050 G1(I) = G(VN(K))
5052 T1(I) = T(VN(K))
5054 N1(I) = N(VN(K))
5060 NEXT
5070 K = K + ST - 1
5100 RETURN
5400 REM

```

STORE ALL

```

5410 J = B2 - B1 - 1
5420 FOR I = 1 TO J
5430 VN(I) = S(B1 + I)
5440 NEXT
5450 GOSUB 5010
5460 RETURN
5500 REM

```

STORE EXCLUDED NUMBERS

```

5510 GOSUB 5910
5520 K = 2:J = 1
5530 FOR I = B1 + 1 TO B2 - 1
5550 IF VN(J) = S(I) THEN J = J + 1: GOTO 5710
5552 K = K + 1
5560 S1(K) = S(I)
5570 G1(K) = G(I)
5580 T1(K) = T(I)
5590 N1(K) = N(I)
5710 NEXT
5800 RETURN
5900 :
5910 S1(1) = S(B1):S1(2) = S(B2)
5920 G1(1) = G(B1):G1(2) = G(B2)
5930 T1(1) = T(B1):T1(2) = T(B2)
5940 N1(1) = N(B1):N1(2) = N(B2)
5950 ST = 2
5952 IF PL$ = "N" THEN GOTO 5990
5954 ST = 3
5960 S1(3) = S1(1):G1(3) = G1(1)
5970 T1(3) = T1(1):N1(3) = N1(1)
5990 RETURN
7000 REM

```

EDIT MENU

```

7010 E = 3: HOME : VTAB 5: PRINT "EDIT TRAVERSE DATA FILES"
7020 VTAB 8: PRINT "1) INVERT A FILE (LAST/FIRST)"
7030 PRINT : PRINT "2) REMOVE POINTS FROM A FILE"

```

```

7040 PRINT : PRINT "3) MERGE FILES"
7050 PRINT : PRINT "4) END EDIT SESSION"
7060 GOSUB 12050
7070 ON A GOTO 8010,9010,10010,1010
7080 PRINT G$;G$: GOTO 7010
8000 REM

```

INVERT A FILE

```

8010 R = 2: GOTO 8410
8020 K = L
8030 IF L < 4 THEN 8110
8040 T = N1(L)
8042 FOR I = L TO 4 STEP - 1:N1(I) = N1(I - 1): NEXT
8050 N1(3) = T
8060 L = INT (L / 2) + 1
8070 FOR I = 3 TO L:J = K - (I - 3)
8080 T = S1(I):S1(I) = S1(J):S1(J) = T
8090 T = G1(I):G1(I) = G1(J):G1(J) = T
8092 T = T1(I):T1(I) = T1(J):T1(J) = T
8094 T = N1(I):N1(I) = N1(J):N1(J) = T
8100 NEXT
8110 GOTO 2800
8400 REM

```

READ TRAVERSE DATA FILE

```

8410 HOME : PRINT D$"CATALOG,D2"
8420 PRINT : PRINT "ENTER TRAVERSE DATA SET NAME OR"
8430 PRINT : INVERSE : PRINT "RETURN";: NORMAL
8440 INPUT " TO CANCEL READ: ";FI$
8460 IF FI$ = "" THEN ON R GOTO ,7010,7010,7010
8470 PRINT D$"VERIFY";FI$
8480 PRINT D$"OPEN";FI$
8490 PRINT D$"READ";FI$
8500 INPUT L
8510 INPUT SI
8520 INPUT DC$
8530 FOR I = 1 TO L
8540 INPUT S1(I)
8550 INPUT G1(I)
8570 INPUT T1(I)
8580 INPUT N1(I)
8590 NEXT
8600 PRINT D$"CLOSE";FI$
8610 ON R GOTO 1010,8020,9040,10040
9000 REM

```

REMOVE POINTS FROM A FILE

```

9010 R = 3: GOTO 8410
9040 HOME : VTAB 5: PRINT "1) DELETE POINT(S) BUT KEEP SPACE ON"
9160 PRINT : HTAB 6: PRINT "PLOTS"
9170 VTAB 10: PRINT "2) DELETE POINT(S) AND CLOSE UP SPACE"
9180 PRINT : HTAB 10: PRINT "ON PLOTS"
9190 VTAB 13: GOSUB 12050
9200 HOME :I = 2:K = 0
9210 PRINT "ITEM #"; TAB( 10);"SEQ. NO": PRINT
9220 I = I + 1:K = K + 1
9230 IF I > L THEN GOTO 9270

```

```

9240 PRINT I - 2; TAB( 10);S1(I)
9250 IF K = 16 THEN GOSUB 12300:K = 0
9260 GOTO 9220
9270 PRINT : PRINT "ENTER ITEM NUMBERS TO BE DELETED OR"
9280 PRINT : INVERSE : PRINT "RETURN";: NORMAL
9290 PRINT " TO SEE LIST AGAIN"
9300 GOSUB 3010
9310 IF V$ = "" THEN GOTO 9200
9320 IF A = 1 THEN GOSUB 9520
9330 IF A = 2 THEN GOSUB 9560
9350 GOTO 2800
9510 :
9520 J = 1: FOR I = 3 TO L
9530 IF I - 2 = VN(J) THEN J = J + 1:G1(I) = 0
9540 NEXT
9542 K = L
9550 RETURN
9552 :
9560 J = 1:K = 2
9570 FOR I = 3 TO L
9580 IF I - 2 = VN(J) THEN J = J + 1: GOTO 9600
9582 K = K + 1
9590 S1(K) = S1(I):G1(K) = G1(I)
9592 T1(K) = T1(I):N1(K) = N1(I)
9600 NEXT
9620 RETURN
10000 REM

```

MERGE DATA

```

10010 R = 4: GOTO 8410
10040 E = 4: ONERR GOTO 13010
10160 HOME : PRINT D$"CATALOG"
10170 PRINT : PRINT "ENTER DATA SET NAME TO APPEND TO '";FI$;"'"
10172 PRINT : PRINT "OR ";: INVERSE : PRINT "RETURN";: NORMAL
10180 INPUT " TO CANCEL MERGE: ";FA$
10190 IF FA$ = "" THEN GOTO 7010
10210 PRINT D$"VERIFY";FA$
10220 PRINT D$"OPEN";FA$
10222 PRINT D$"READ";FA$
10230 INPUT M
10232 INPUT S2
10234 INPUT DT$
10236 FOR I = 1 TO M
10238 INPUT S(I)
10240 INPUT G(I)
10242 INPUT T(I)
10244 INPUT N(I)
10246 NEXT
10248 PRINT D$"CLOSE";FA$
10250 IF S1 = S2 AND DC$ = DT$ THEN GOTO 10260
10251 GOSUB 10810
10252 IF A$ = "N" THEN GOTO 10040
10254 IF A$ < > "Y" THEN PRINT G$;G$: GOTO 10250
10260 IF DC$ = DT$ AND DC$ = "DIURNAL CORRECTION ON" THEN GOSUB 10710:
GOTO 10330
10270 GOSUB 10610
10320 REM

```

WRITE MERGED DATA

```
10330 PRINT D$"CATALOG"
10332 PRINT : PRINT "ENTER OUTPUT FILE NAME FOR MERGED"
10334 PRINT : PRINT "DATA OR ";; INVERSE : PRINT "RETURN";: NORMAL
10335 INPUT " TO CANCEL WRITE: ";FO$
10336 IF FO$ = "" THEN GOTO 7010
10340 ONERR GOTO 10410
10350 PRINT D$"VERIFY";FO$;" ,D2"
10360 PRINT : PRINT G$;G$;"FILE ALREADY EXISTS. DO YOU WISH TO"
10362 PRINT : PRINT "OVERWRITE?";
10370 GOSUB 12200
10380 IF A$ = "N" THEN GOTO 10330
10390 IF A$ < > "Y" THEN GOTO 10360
10400 PRINT D$"DELETE";FO$
10410 ONERR GOTO 13010
10420 PRINT D$"OPEN";FO$
10440 PRINT D$"WRITE";FO$
10441 PRINT L + M - 2: PRINT SI: PRINT DC$
10442 FOR I = 1 TO L
10450 PRINT S1(I): PRINT G1(I)
10452 PRINT T1(I): PRINT N1(I)
10460 NEXT
10470 FOR I = 3 TO M
10490 PRINT S(I): PRINT G(I)
10492 PRINT T1(I): PRINT N1(I)
10500 NEXT
10510 PRINT D$"CLOSE";FO$
10520 GOTO 7010
10600 REM
```

1 OR BOTH NOT CORRECTED SO BASE STATIONS WILL BE LOST

```
10610 HOME : VTAB 8: PRINT G$;G$;"WARNING !!!"
10620 PRINT : PRINT "ONE OR BOTH FILES HAVE NOT BEEN COR-"
10630 PRINT : PRINT "RECTED FOR DIURNAL DRIFT. THE MERGED"
10640 PRINT : PRINT "FILE MAY NOT BE CORRECTIBLE LATER"
10650 PRINT : PRINT "BECAUSE BASE STATIONS FOR '";FA$;"'"
10660 PRINT : PRINT "WILL BE NOT BE PRESENT"
10670 VTAB 22: GOSUB 12300
10680 RETURN
10700 REM
```

BOTH CORRECTED SO ADJUST HIGHER ONE DOWN

```
10710 G = G1(1) - G(1)
10730 IF G > 0 THEN FOR I = 3 TO L:G1(I) = G1(I) - G: NEXT :G1(1) = G(
1):S1(1) = S(1)
10740 IF G < = 0 THEN FOR I = 3 TO M:G(I) = G(I) + G: NEXT
10750 RETURN
10800 REM
```

DATA SETS DIFFER?

```
10810 HOME : PRINT G$;G$;"DATA SET"
10820 PRINT : PRINT FI$; TAB( 16);SI;" PT MOVING AVG"
10830 PRINT : PRINT TAB( 16);DC$
10840 PRINT : PRINT : PRINT FA$; TAB( 16);S2;" PT MOVING AVG"
10842 PRINT : PRINT TAB( 16);DT$
10850 VTAB 17: PRINT "DO YOU WISH TO CONTINUE IN SPITE"
```

```

10860 PRINT : PRINT "THE ABOVE DIFFERENCES?";: GOSUB 12200
10870 RETURN
12000 REM

```

GENERAL PURPOSE SUBROUTINES

```

12010 PRINT : PRINT : INPUT "PLEASE MAKE A SELECTION: ";A$
12020 RETURN
12050 PRINT : PRINT : INPUT "PLEASE MAKE A SELECTION: ";A
12060 RETURN
12200 PRINT " (";: INVERSE : PRINT "Y";: NORMAL
12210 PRINT "/" ;: INVERSE : PRINT "N";: NORMAL
12220 INPUT "): ";A$
12230 RETURN
12300 PRINT : PRINT "PRESS ";: INVERSE : PRINT "RETURN";: NORMAL
12310 INPUT " TO CONTINUE ";A$: PRINT
12320 RETURN
13000 REM

```

ERROR HANDLING

```

13010 TEXT : HOME : VTAB 5
13020 PK = PEEK (222): PRINT G$;"ERROR CODE = ";PK: PRINT : INVERSE
13030 IF PK = 8 THEN PRINT "CANNOT USE DISK IN DRIVE 2": PRINT : PRINT
      "DOOR MAY BE OPENED OR DISK UNINITIALIZED": GOTO 13080
13040 IF PK = 9 THEN PRINT "DISK IN DRIVE ";DR$;" IS FULL. INSERT ANOT
      HER OR": GOTO 13080
13050 IF PK = 6 OR PK = 11 THEN PRINT "BAD FILE NAME": GOTO 13080
13060 IF PK = 4 THEN PRINT "DISK IS WRITE PROTECTED. REMOVE TAB": GOTO
      13080
13070 PRINT "UNFAMILIAR ERROR. CONSULT AUTHOR"
13080 NORMAL : PRINT : PRINT "PRESS ";: INVERSE : PRINT "RETURN";: NORMAL
      : INPUT " TO CONTINUE";A$
13090 ON E GOTO 1010,2304,7010,10150

```

PROGRAM "MM" (MODELING PROGRAM)

LIST

```

100 REM 2HDMAG JUNE, 1984
101 GOSUB 12010
102 LOMEM: 27000
110 ER = 1: ONERR GOTO 17220
120 DIM X(30,10),Z(30,10),X(700),Z(100),F(100),V1(30),V2(30),H(700)
130 DIM H0(10,100)
140 PI = 3.14192:D$ = CHR$(4):I$ = CHR$(9):G$ = CHR$(7)
142 HOME: VTAB 5: PRINT "MAGNETIC FIELD MODELING PROGRAM"
144 VTAB 8: PRINT "FOR 2 1/2 DIMENSIONAL BODIES"
150 LH = 10E36:HH = - 10E36
160 FOR I = 1 TO 10:L(I) = 0: NEXT
170 DS$ = "N"
200 VTAB 13: INPUT "ENTER TOTAL FIELD STRENGTH (nT) ";T0
220 PRINT: INPUT "ENTER FIELD INCLINATION (DEGREES): ";I0
240 PRINT: PRINT: PRINT "ENTER STRIKE ANGLE"
242 PRINT: HTAB 5: PRINT "(THE ANGLE BETWEEN MAGNETIC NORTH"
244 PRINT: HTAB 5: PRINT "AND THE STRIKE OF THE MODELED BODY."
246 PRINT: HTAB 5: PRINT "COUNT DEGREES POSITIVE COUNTER-"
248 PRINT: HTAB 5: INPUT "CLOCKWISE): ";S0
250 GOSUB 13010: REM OBS FIELDS?
254 IF A$ = "" THEN GOSUB 14610: GOTO 400: REM X AXIS FROM KBRD
260 GOSUB 13810: REM KEYBOARD OR FILE?
267 IF A$ = "" THEN GOSUB 14010: GOTO 300: REM FILE INPUT
270 GOSUB 14610: REM X AXIS FROM KBRD
280 GOSUB 14810: REM OBS FLDS FROM KBRD
300 GOSUB 13310: REM FIND MIN MAX FOR OBS FLD, ADJ OBS FLD TO 0
400 PRINT: INPUT "ENTER TOPOGRAPHIC POINTS? (Y/N)";Y0$
420 IF Y0$ < > "Y" THEN 710
430 REM

```

TOPO INPUT

```

432 PRINT
436 PRINT "TRAVERSE DISTANCE = ";X(1);" TO ";X(M0): PRINT
440 INPUT "HOW MANY TOPOGRAPHIC POINTS? ";V
460 PRINT: FOR I = 1 TO V
470 PRINT "TOPO-X(";I;"), TOPO-Z(";I;
480 INPUT ") ";V1(I),V2(I)
490 NEXT I
492 IF V = 1 THEN V1(1) = X9
500 PRINT: INPUT "DRAPED SURVEY? (Y/N) ";DS$
520 IF DS$ < > "Y" THEN 730
530 PRINT: INPUT "DRAPED DISTANCE ABOVE GROUND: ";V3
550 FOR M = 1 TO M0
560 W = X(M)
570 REM

```

INTERPOLATION

```

580 IF W > V1(1) THEN 610
590 F0 = V2(1)
600 GOTO 680
610 IF W < V1(V) THEN 640
620 F0 = V2(V)
630 GOTO 680
640 FOR J = 2 TO V

```

```

650 IF W < V1(J) THEN 670
660 NEXT J
670 F0 = V2(J - 1) + (V2(J) - V2(J - 1)) * (W - V1(J - 1)) / (V1(J) - V1
(J - 1))
680 Z(M) = F0 + V3
690 NEXT M
700 GOTO 800
710 REM

```

CONST ALT SURVEYS

```

720 V = 1:V1(1) = X9:V2(1) = 0
722 PRINT : PRINT "TOPOGRAPHIC ELEVATION IS 0"
730 PRINT : INPUT "ENTER ELEVATION OF SURVEY ";E
750 FOR M = 1 TO M0:Z(M) = E: NEXT
780 V3 = 0
800 REM

```

BODY PARAMS

```

810 PRINT : INPUT "HOW MANY BODIES? ";N
830 IF N > 0 THEN 1100
840 PRINT : INPUT "TOPOGRAPHIC SUSCEPTIBILITY? ";K(1)
860 INPUT "TOPOGRAPHIC END COORDS, Y1,Y2? ";Y1(1),Y2(1)
880 L0 = 99999
890 FOR I = 1 TO V
900 X0(I,1) = V1(I)
910 Z0(I,1) = V2(I)
920 IF V2(I) < L0 THEN L0 = V2(I)
930 NEXT
940 I = 0
950 IF V2(V) = L0 THEN 1010
960 X0(V + 1) = 2 * X9 - X8
970 Z0(V + 1,1) = V2(V)
980 X0(V + 2,1) = 2 * X9 - X8
990 Z0(V + 2,1) = L0
1000 I = 2
1010 IF V2(1) = L0 THEN 1070
1020 X0(V + I + 1,1) = 2 * X8 - X9
1030 Z0(V + I + 1,1) = L0
1040 X0(V + I + 2,1) = 2 * X8 - X9
1050 Z0(V + I + 2,1) = V2(1)
1060 I = I + 2
1070 N = 1
1080 N1(1) = V + I
1090 GOTO 1230
1100 FOR I = 1 TO N
1110 PRINT : PRINT "FOR BODY NO. ";I
1120 PRINT : INPUT "SUSCEPTIBILITY? ";K(I)
1140 PRINT : INPUT "NUMBER OF CORNERS? ";N1(I)
1150 PRINT "TRAVERSE DISTANCE = ";X(1);" TO ";X(M0): PRINT
1160 PRINT : FOR J = 1 TO N1(I)
1170 PRINT "BODY-X(";J;"), BODY-Z(";J;
1180 INPUT ") ";X0(J,I),Z0(J,I)
1190 NEXT
1200 PRINT : PRINT "END COORDS Y1(";I;"), Y2(";I;
1210 INPUT ") ";Y1(I),Y2(I)
1220 NEXT
1230 GOSUB 2980: REM DRAW PICTURE
1240 GOSUB 1250

```

```

1242 GOTO 1370
1250 PRINT : PRINT "FIELD=";T0;" INCL=";I0;" STRIKE=";S0
1260 FOR I = 1 TO N
1270 PRINT
1280 PRINT "BODY #";I;" SUSC=";K(I)
1290 PRINT "Y1=";Y1(I);" Y2=";Y2(I)
1300 PRINT "J BODX BODZ"
1310 FOR J = 1 TO N1(I)
1320 PRINT J;
1330 X = X0(J,I): GOSUB 5040
1332 PRINT TAB( 13);X$;
1334 X = Z0(J,I): GOSUB 5040
1336 PRINT TAB( 26);X$
1340 NEXT J
1350 NEXT I
1352 RETURN
1360 REM

```

CALCULATE FIELD

```

1370 F(1) = 0:D3 = 0
1380 PRINT : PRINT : PRINT "ADD REGIONAL GRADIENT TO CALCULATED": PRINT
      : INPUT "FIELDS? (Y/N) ";GD$
1390 IF GD$ < > "Y" THEN 1450
1400 PRINT : PRINT : PRINT "ENTER STARTING AND ENDING VALUES IN": PRINT
      : PRINT "NANO TESLAS (nT) AT F(";X8;"), F(";X9;
1410 INPUT ") ";F(1),F0
1412 R8 = F(1):R9 = F0
1420 D3 = F0 - F(1)
1450 FOR M = 1 TO M0
1460 F(M) = F(1) + (M - 1) * D3 / (M0 - 1)
1470 NEXT M
1480 FOR I = 1 TO N
1490 IF L(I) = 1 THEN 2170
1500 N0 = N1(I)
1510 J1 = T0 * SIN (I0 * PI / 180)
1520 J2 = T0 * COS (I0 * PI / 180) * SIN (S0 * PI / 180)
1530 J3 = T0 * COS (I0 * PI / 180) * COS (S0 * PI / 180)
1550 PRINT : PRINT "***FOR BODY # ";I
1560 PRINT " X Z ZFIELD"
1570 PRINT "XFIELD YFIELD FIELD"
1580 FOR M = 1 TO M0
1590 X1 = X0(N0,I) - X(M)
1600 Z1 = - Z0(N0,I) + Z(M)
1610 R1 = SQR (X1 ^ 2 + Z1 ^ 2)
1620 P1 = SQR (R1 ^ 2 + Y1(I) ^ 2)
1630 Q1 = SQR (R1 ^ 2 + Y2(I) ^ 2)
1640 E1 = R1 * R1 / ((Q1 + Y2(I)) * (P1 - Y1(I)))
1650 IF E1 = 0 THEN 1670
1660 E1 = LOG (E1)
1670 F1 = 0:F2 = 0:F3 = 0
1680 FOR J = 1 TO N0
1690 X2 = X0(J,I) - X(M)
1700 Z2 = - Z0(J,I) + Z(M)
1710 R2 = SQR (X2 ^ 2 + Z2 ^ 2)
1720 P2 = SQR (R2 ^ 2 + Y1(I) ^ 2)
1730 Q2 = SQR (R2 ^ 2 + Y2(I) ^ 2)
1740 E2 = R2 * R2 / ((Q2 + Y2(I)) * (P2 - Y1(I)))
1750 IF E2 = 0 THEN 1770
1760 E2 = LOG (E2)

```

```

1770 L = E2 - E1
1780 TX = X2 - X1:TY = Z2 - Z1
1782 GOSUB 6010
1784 P = THETA
1790 C = COS (P):S = SIN (P)
1800 U1 = C * X1 + S * Z1
1810 U2 = C * X2 + S * Z2
1820 W1 = C * Z1 - S * X1
1830 TX = W1 * Q2:TY = U2 * Y2(I): GOSUB 6010
1832 T2 = THETA
1834 TX = W1 * Q1:TY = U1 * Y2(I): GOSUB 6010
1836 T2 = T2 - THETA
1860 TY = U2 * Y1(I):TX = W1 * P2: GOSUB 6010
1861 T3 = THETA
1862 TY = U1 * Y1(I):TX = W1 * P1: GOSUB 6010
1864 T3 = T3 - THETA
1890 T2 = T2 - T3
1900 I4 = 0
1910 IF Y1(I) = 0 THEN 1930
1920 I4 = LOG ((Q2 - U2) * (Q1 + U1) / ((Q2 + U2) * (Q1 - U1))) / 2
1930 IF Y2(I) = 0 THEN 1950
1940 I4 = I4 - LOG ((P2 - U2) * (P1 + U1) / ((P2 + U2) * (P1 - U1))) /
2
1950 G1 = C * J2 + S * J1
1960 G2 = C * J1 - S * J2
1970 G3 = G1 * L + G2 * T2 + J3 * I4
1980 B1 = C * G3
1990 B2 = - (S * G3)
2000 B3 = (C * J1 - S * J2) * I4 - J3 * T2
2010 X1 = X2
2020 Z1 = Z2
2030 R1 = R2
2040 P1 = P2
2050 Q1 = Q2
2060 E1 = E2
2070 F1 = F1 + B1
2080 F2 = F2 + B2
2090 F3 = F3 + B3
2100 NEXT J
2110 F0 = (J1 * F1 + J2 * F2 + J3 * F3) / SQR (J1 ^ 2 + J2 ^ 2 + J3 ^ 2)
2120 H0(I,M) = F0
2130 X = X(M): GOSUB 5040: PRINT X#;
2132 X = Z(M): GOSUB 5040: PRINT TAB( 13);X#;
2134 X = F1 * K(I): GOSUB 5040: PRINT TAB( 26);X#;
2140 X = F2 * K(I): GOSUB 5040: PRINT X#;
2142 X = F3 * K(I): GOSUB 5040: PRINT TAB( 13);X#;
2144 X = F0 * K(I): GOSUB 5040: PRINT TAB( 26);X#;
2150 PRINT
2160 NEXT M
2170 NEXT I
2180 FOR I = 1 TO N
2190 FOR M = 1 TO M0
2200 F(M) = F(M) + K(I) * H0(I,M)
2210 NEXT M
2220 L(I) = 1: REM BOD CALC'D
2230 NEXT I
2330 GOSUB 3380: REM PLOT FIELDS
2340 GOSUB 15010: REM PRINTOUT?
2410 GOSUB 16010: REM TRY CHANGES OR QUIT?

```

```

2423 IF A$ = "C" THEN 2550
2430 IF A$ = "N" THEN HOME : GOTO 150
2450 REM

```

MODEL RESIDUAL

```

2460 FOR M = 1 TO M0: H(M) = H(M) - F(M): NEXT M
2462 N = 0: J = - 1
2470 H1 = H(1): L0 = H(1)
2472 FOR M = 2 TO M0: IF H(M) > H1 THEN H1 = H(M)
2474 IF H(M) < L0 THEN L0 = H(M)
2476 NEXT M
2480 Z8 = ( INT (L0 / 100) - 1) * 100
2490 Z9 = ( INT (H1 / 100) + 1) * 100
2500 GOSUB 2980
2510 GOSUB 3470
2530 TEXT : GOTO 810
2540 REM

```

CHANGE BODIES

```

2550 HOME : VTAB 5: INPUT "CHANGE SUSCEPTIBILITY? (Y/N)"; Y0$
2570 IF Y0$ < > "Y" THEN 2620
2580 FOR I = 1 TO N
2590 PRINT : PRINT "SUSC FOR BODY# "; I;
2600 INPUT " "; K(I)
2610 NEXT I
2620 FOR I = 1 TO N
2630 PRINT : PRINT "CHANGE BODY # "; I;
2640 INPUT " ? (Y/N)"; Y0$
2650 IF Y0$ < > "Y" THEN 2900
2660 L(I) = 0
2670 PRINT : PRINT "TYPE 0 TO END THIS BODY"
2680 PRINT : INPUT "CHANGE CORNER # "; J
2700 IF J = 0 THEN 2850
2710 IF J < 0 THEN 2760
2720 IF J > N1(I) THEN N1(I) = J
2730 PRINT "NEW X("; J; ")", NEW Z("; J;
2740 INPUT " "; X0(J, I), Z0(J, I)
2750 GOTO 2680
2760 J = - J: REM DELETE CORNER
2770 IF J = N1(I) THEN 2830
2780 IF J > N1(I) THEN 2850
2790 FOR M = J TO N1(I) - 1
2800 X0(M, I) = X0(M + 1, I)
2810 Z0(M, I) = Z0(M + 1, I)
2820 NEXT M
2830 N1(I) = N1(I) - 1
2840 GOTO 2680
2850 INPUT "CHANGE END COORDS Y1, Y2? (Y/N)"; Y0$
2870 IF Y0$ < > "Y" THEN 2900
2880 PRINT "Y1, Y1 FOR BODY # "; I;
2890 INPUT " "; Y1(I), Y2(I)
2900 NEXT I
2910 INPUT "ADD BODIES? (Y/N)"; Y0$
2930 IF Y0$ < > "Y" THEN 1230
2940 N = N + 1
2950 L(N) = 0
2960 FOR I = N TO N
2970 GOTO 1110

```

```

2980 REM

DRAW PICTURE

2990 HGR2 : HCOLOR= 3: ROT= 0: SCALE= 1
3000 H1 = - 99999
3010 FOR M = 1 TO M0
3020 IF Z(M) > H1 THEN H1 = Z(M)
3030 NEXT M
3040 X7 = X9 - X8
3050 Y8 = H1 - X7 / 4: IF Y8 > 0 THEN Y8 = - Y8
3060 Y9 = H1 + X7 / 2
3070 XU = 279 / X7:ZU = 191 / ( ABS (Y9) + ABS (Y8))
3075 ZU = ZU * (192 / 280): REM COMPENSATE FOR RECT. PIXELS
3080 ZI = 191 + Y8 * ZU: REM Z INTERCEPT BY X AXIS
3090 XC(1) = X9 * XU:Y(1) = ZI - V2(V) * ZU
3092 XC(2) = X9 * XU:Y(2) = ZI - Y8 * ZU: GOSUB 7010
3100 HPLOT 279,191 TO 0,191
3104 XC(1) = X8 * XU:Y(1) = ZI - Y8 * ZU
3105 XC(2) = X8 * XU:Y(2) = ZI - V2(1) * ZU: GOSUB 7010
3110 XC(1) = X8 * XU:Y(1) = ZI - V2(1) * ZU:XC(2) = V1(1) * XU:Y(2) = ZI
- V2(1) * ZU: GOSUB 7010
3126 IF V = 1 THEN 3180
3130 FOR I = 2 TO V
3140 XC(1) = V1(I - 1) * XU:Y(1) = ZI - V2(I - 1) * ZU:XC(2) = V1(I) * X
U:Y(2) = ZI - V2(I) * ZU: GOSUB 7010
3150 NEXT I
3160 XC(1) = V1(V) * XU:Y(1) = ZI - V2(V) * ZU
3170 XC(2) = X9 * XU:Y(2) = ZI - V2(V) * ZU: GOSUB 7010
3180 IF DS$ = "Y" AND V3 = 0 THEN 3240
3182 FOR M = 2 TO M0 STEP 2: REM PLOT SURVEY DASHES
3190 HPLOT X(M - 1) * XU,ZI - Z(M - 1) * ZU TO X(M) * XU,ZI - Z(M) * ZU

3220 NEXT M
3240 IF N < 1 THEN 3320
3250 FOR I = 1 TO N
3260 N0 = N1(I)
3280 FOR J = 2 TO N0
3290 XC(1) = X0(J - 1,I) * XU:Y(1) = ZI - Z0(J - 1,I) * ZU:XC(2) = X0(J,
I) * XU:Y(2) = ZI - Z0(J,I) * ZU: GOSUB 7010
3300 NEXT J
3304 XC(1) = X0(N0,I) * XU:Y(1) = ZI - Z0(N0,I) * ZU:XC(2) = X0(1,I) * X
U:Y(2) = ZI - Z0(1,I) * ZU: GOSUB 7010
3310 NEXT I
3320 GOSUB 12710
3330 TEXT : HOME
3340 INPUT "CALCULATE THIS CASE? (Y/N)";Y0$
3360 IF Y0$ = "N" THEN POP : GOTO 2410
3370 RETURN
3380 REM

PLOT FIELDS

3410 PRINT
3422 GOSUB 13510: REM FIND MIN MAX FOR CALC FLDS
3440 GOSUB 13610: REM FIND MIN MAX FOR CALC AND OBS
3450 PRINT : PRINT "ENTER END COORDINATES FOR GRAPH AXIS"
3452 PRINT : PRINT "ENTER MIN < ";L0;" , MAX > ";H1;
3460 INPUT " nT ";Z8,Z9
3470 Z7 = Z9 - Z8

```

```

3480 ZU = 110 / 27
3490 ZI = 8 + 29 * ZU
3500 ZD = 27 * ZU
3508 POKE - 16299,0: POKE - 16304,0: REM HGR2
3510 HPLLOT 0,8 TO 0,ZD + 8
3520 FOR I = 0 TO 10: HPLLOT 1,ZD * (I / 10) + 8 TO 2,ZD * (I / 10) + 8:
NEXT I
3530 IF ZI > 7 AND ZI < 118 THEN HPLLOT 1,ZI TO 279,ZI
3540 ST$ = STR$ (Z8):HU = 5:VU = 124: GOSUB 12330
3542 ST$ = STR$ (Z9) + " NT":HU = 5:VU = 7: GOSUB 12330
3544 ST$ = STR$ (X9):HU = 279 - 7 * LEN (ST$): GOSUB 12330
3550 IF J < 0 THEN 3640
3570 FOR M = 1 TO M0
3572 X = X(M) * XU:Z = ZI - F(M) * ZU
3574 IF M = 1 THEN X = X + 1
3576 IF M = M0 THEN X = X - 1
3580 GOSUB 10010
3590 IF ZI > 7 AND ZI < 118 THEN HPLLOT X,ZI - 1 TO X,ZI + 1
3630 NEXT M
3640 IF LH = 10E36 THEN GOTO 3690
3660 FOR M = 2 TO M0: REM PLOT OBS FLD
3662 XC(1) = X(M) * XU:Y(1) = ZI - H(M) * ZU
3664 XC(2) = X(M - 1) * XU:Y(2) = ZI - H(M - 1) * ZU
3670 GOSUB 7010
3680 NEXT M
3690 GET Y0$
3691 TEXT : HOME : VTAB 5
3692 PRINT "'X' = CALCULATED FIELD"
3694 PRINT : PRINT "'____' = OBSERVED FIELD"
3695 VTAB 11: HTAB 6: INVERSE : PRINT "A";: NORMAL
3696 PRINT "> SEE PLOT AGAIN"
3697 PRINT : INVERSE : PRINT "RETURN";: NORMAL
3698 PRINT "> CONTINUE WITH PROGRAM"
3699 GOSUB 12810
3702 IF A$ = "A" THEN POKE - 16299,0: POKE - 16304,0: GOTO 3690
3704 IF A$ < > "" THEN PRINT G$;G$: GOTO 3691
3710 RETURN
5000 REM

```

FORMATTING TO LEN 10 OR LESS

```

5010 X = VAL (X$)
5040 X$ = STR$ (X)
5050 LG = LEN (X$)
5052 UL = 999999999.6
5054 LN = .01
5060 IF ABS (X) > UL OR ABS (X) < LN THEN 5120
5062 X$ = LEFT$ (X$,10): RETURN
5120 FOR IZ = 1 TO LG
5130 IF MID$ (X$,IZ,1) < > "E" THEN NEXT
5140 IF IZ > 6 THEN X$ = LEFT$ (X$,5) + RIGHT$ (X$,LG - IZ + 1)
5150 RETURN
6000 REM

```

ARCTAN UP TO +- PI

```

6010 IF TX < > 0 THEN GOTO 6019
6012 IF TY < 0 THEN THETA = - PI / 2: RETURN
6014 THETA = PI / 2: RETURN
6019 THETA = ATN (TY / TX)

```

```

6020 IF TX > 0 THEN 6050
6030 THETA = PI + ATN (TY / TX)
6040 IF TY < 0 THEN THETA = ATN (TY / TX) - PI
6050 RETURN
7000 REM

```

CLIPPING SUBR. ELIM PTS OFF SCREEN

```

7010 XR = 279:XL = 0:YT = 0:YB = 191
7030 FOR K = 1 TO 2
7040 GOSUB 7100
7050 NEXT K
7060 GOSUB 7200
7070 RETURN
7090 REM

```

CLASSIFY ENDPNTS

```

7100 LL(K) = 0:R(K) = 0:T(K) = 0:B(K) = 0
7110 IF XC(K) < XL THEN LL(K) = 1
7120 IF XC(K) > XR THEN R(K) = 1
7130 IF Y(K) < YT THEN T(K) = 1
7140 IF Y(K) > YB THEN B(K) = 1
7150 RETURN
7180 REM

```

CLIPPING SUBR

```

7190 GOSUB 7100
7200 IF LL(1) * LL(2) + R(1) * R(2) + T(1) * T(2) + B(1) * B(2) < > 0 THEN
  RETURN
7210 K = 1: IF LL(K) + R(K) + T(K) + B(K) = 0 THEN K = 2: IF LL(K) + R(K)
  + T(K) + B(K) = 0 THEN HPLOT XC(1),Y(1) TO XC(2),Y(2): RETURN
7220 IF LL(K) = 1 THEN Y(K) = Y(1) + (Y(2) - Y(1)) * (XL - XC(1)) / (XC
  (2) - XC(1)):XC(K) = XL: GOTO 7190
7230 IF R(K) = 1 THEN Y(K) = Y(1) + (Y(2) - Y(1)) * (XR - XC(1)) / (XC
  (2) - XC(1)):XC(K) = XR: GOTO 7190
7240 IF T(K) = 1 THEN XC(K) = XC(1) + (XC(2) - XC(1)) * (YT - Y(1)) / (
  Y(2) - Y(1)):Y(K) = YT: GOTO 7190
7250 IF B(K) = 1 THEN XC(K) = XC(1) + (XC(2) - XC(1)) * (YB - Y(1)) / (
  Y(2) - Y(1)):Y(K) = YB: GOTO 7190
10000 REM

```

PLOT X

```

10010 IF Z < 1 OR Z > 128 THEN GOTO 10060
10012 HPLOT X,Z
10020 HPLOT X + 1,Z + 1
10030 HPLOT X - 1,Z - 1
10040 HPLOT X + 1,Z - 1
10050 HPLOT X - 1,Z + 1
10060 RETURN
10100 REM

```

PLOT +

```

10110 HPLOT X - 1,Z
10120 HPLOT X + 1,Z
10130 HPLOT X,Z - 1
10140 HPLOT X,Z + 1
10150 RETURN
12000 REM

```

LOAD SHAPE TABLE FOR HI RES TEXT

```

12010 ONERR GOTO 17050
12020 PRINT CHR$(4);"BLOAD SHAPE ALPHABET.DOT,A24577,D1"
12030 POKE 216,0
12040 POKE 232,1: POKE 233,96
12050 RETURN
12300 REM

```

PLOTS CHARACTERS ON HI RES SCREEN

```

12330 FOR I = 1 TO LEN (ST$)
12340 CH = ASC ( MID$ (ST$,I,1)) - 32
12350 IF CH = 0 THEN GOTO 12370
12360 XDRAW CH AT HU,VU
12370 HU = HU + 7
12390 NEXT I
12400 RETURN
12700 REM

```

LESSER PROMPTS AND MESSAGES

```

12710 ST$ = "PRESS RETURN TO CONTINUE"
12720 HU = 0:VU = 20: GOSUB 12330
12730 INPUT " ";A$
12740 HU = 0:VU = 20: GOSUB 12330
12750 RETURN
12800 :
12810 PRINT : PRINT : PRINT
12820 INPUT "PLEASE MAKE A SELECTION: ";A$
12830 RETURN
12910 PRINT : PRINT : PRINT "PRESS ";; INVERSE : PRINT "RETURN";: NORMAL
12912 PRINT " TO CONTINUE ";
12920 INPUT " ";A$
12930 RETURN
13000 REM

```

OBSERVED FIELDS?

```

13010 HOME : VTAB 5: PRINT "PLOT:"
13012 PRINT : PRINT : HTAB 6: INVERSE : PRINT "O";: NORMAL
13014 PRINT "> OBSERVED FIELDS + FIELDS"
13016 PRINT : HTAB 10: PRINT "CALCULATED FROM MODEL"
13020 PRINT : PRINT : INVERSE : PRINT "RETURN";: NORMAL
13030 PRINT "> FIELDS CALCULATED FROM MODEL"
13032 PRINT : HTAB 10: PRINT "ONLY"
13040 GOSUB 12810
13050 IF A$ < > "O" AND A$ < > "" THEN PRINT G$: GOTO 13010
13060 RETURN
13300 REM

```

FIND MIN MAX FOR OBS FIELD

```

13310 FOR I = 1 TO M0
13330 IF H(I) < LH THEN LH = H(I)
13340 IF H(I) > HH THEN HH = H(I)
13350 NEXT I
13355 REM

```

ADJ OBS FLD TO ZERO

```

13360 IF LH < = 0 THEN 13430
13362 FOR I = 1 TO M0
13370 H(I) = H(I) - LH
13380 NEXT
13390 HH = HH - LH
13400 PRINT : PRINT : PRINT LH;" nT HAS BEEN SUBTRACTED FROM"
13410 PRINT : PRINT "ALL OBSERVED FIELD READINGS TO"
13412 PRINT : PRINT "FACILITATE PLOTTING"
13430 RETURN
13500 REM

```

FIND MIN MAX FOR CALC FLDS

```

13510 H1 = - 99999
13520 L0 = 99999
13540 FOR M = 1 TO M0
13550 IF F(M) < L0 THEN L0 = F(M)
13560 IF F(M) > H1 THEN H1 = F(M)
13570 NEXT M
13580 RETURN
13600 REM

```

FIND MIN MAX FOR ALL FIELDS

```

13610 IF LH = 10E36 THEN GOTO 13680
13620 IF LH < L0 THEN L0 = LH
13630 IF HH > H1 THEN H1 = HH
13680 RETURN
13800 REM

```

OBS FIELDS FROM KBRD OR DISK FILE?

```

13810 HOME : VTAB 5: PRINT "OBSERVED TRAVERSE DATA"
13820 VTAB 8: HTAB 6: INVERSE : PRINT "K";: NORMAL
13830 PRINT "> ENTER VALUES FROM KEYBOARD"
13840 PRINT : INVERSE : PRINT "RETURN";: NORMAL
13850 PRINT "> USE PRE-EXISTING TRAVERSE DATA"
13860 PRINT : HTAB 10: PRINT "FILE FROM DISK"
13870 GOSUB 12810
13880 IF A$ < > "K" AND A$ < > "" THEN PRINT G$: GOTO 13810
13900 RETURN
14000 REM

```

READ TRAVERSE DATA FILE

```

14010 HOME : VTAB 8: PRINT "DATA DISK MUST BE IN DRIVE 2"
14012 GOSUB 12910
14018 PRINT D$"CATALOG,D2"
14020 PRINT : PRINT "ENTER TRAVERSE DATA SET NAME OR"
14030 PRINT : INVERSE : PRINT "RETURN";: NORMAL
14040 INPUT " TO CANCEL READ: ";FI$
14050 IF FI$ = "" THEN POP : GOTO 250
14060 ER = 2: PRINT D$"VERIFY";FI$
14070 PRINT D$"OPEN";FI$
14080 PRINT D$"READ";FI$
14090 INPUT M0
14100 FOR M = 1 TO 10
14102 INPUT A$
14104 NEXT

```

```

14110 M0 = M0 - 2:X(1) = 0
14120 FOR M = 1 TO M0
14130 INPUT A$
14140 INPUT H(M)
14150 INPUT A$
14160 INPUT I:X(M + 1) = X(M) + I
14170 NEXT
14172 X8 = 0:X9 = X(M - 1)
14180 PRINT D$"CLOSE";FI$
14190 ER = 1: RETURN
14600 REM

```

ENTER X AXIS PARAMETERS

```

14610 HOME : VTAB 5
14611 PRINT "ENTER TRAVERSE AXIS DIMENSIONS"
14612 PRINT : INPUT "XMIN, XMAX, DX: ";X8,X9,D
14620 IF D < = 0 THEN PRINT "DX MUST BE POS.": GOTO 14610
14630 M0 = 1 + INT ((X9 - X8) / D)
14640 FOR M = 1 TO M0
14650 X(M) = X8 + (M - 1) * D
14660 NEXT
14670 RETURN
14800 REM

```

ENTER OBS FIELDS FROM KEYBOARD

```

14810 PRINT
14820 FOR M = 1 TO M0
14830 PRINT "OBSERVED FIELD (nT) AT X = ";X(M);
14840 INPUT " ";H(M)
14850 NEXT
14860 RETURN
15000 REM

```

PRINTOUT?

```

15010 HOME : VTAB 5: INPUT "PRINT OUTPUT? (Y/N)";Y0$
15020 IF Y0$ < > "Y" THEN GOTO 15994
15030 PRINT D$"PR#1"
15040 GOSUB 1250
15050 PRINT : PRINT "SUM FIELD FOR ALL BODIES"
15060 PRINT "-X-          -Z-          FIELD"
15070 FOR M = 1 TO M0
15080 PRINT X(M); TAB( 13);Z(M); TAB( 25);F(M)
15090 NEXT M
15100 PRINT
15110 IF GD$ < > "Y" THEN GOTO 15930
15120 PRINT : PRINT "REGIONAL GRADIENT IS F(";X8;")=";R8;" nT AND F(";
X9;")=";R9;" nT": PRINT
15130 PRINT : PRINT "'X' = CALCULATED FIELD"
15140 IF LH < > 10E36 THEN PRINT : PRINT "'___' = OBSERVED FIELD"
15150 PRINT : PRINT I$"G2L"
15160 PRINT : PRINT : PRINT : PR# 0: CALL 1002
15170 RETURN
16000 REM

```

END OF SESSION?

```

16010 HOME : VTAB 5

```

```

16012 HTAB 6: INVERSE : PRINT "E";: NORMAL
16013 PRINT "> EXIT MODELING PROGRAM"
16016 PRINT : HTAB 6: INVERSE : PRINT "N";: NORMAL
16018 PRINT "> NEW MODELING SESSION"
16041 PRINT : HTAB 6: INVERSE : PRINT "C";: NORMAL
16042 PRINT "> MAKE CHANGES TO BODIES, ADD"
16044 PRINT : HTAB 10: PRINT "BODIES"
16050 PRINT : INVERSE : PRINT "RETURN";: NORMAL
16052 PRINT "> MODEL THE RESIDUAL FIELD"
16060 GOSUB 12810
16070 IF A$ = "E" THEN PRINT D$;"RUN M,D1"
16090 IF NOT (A$ = "" OR A$ = "N" OR A$ = "C") THEN PRINT G$;G: GOTO
      16010
16100 RETURN
17000 REM

```

ERROR MESSAGES

```

17050 TEXT : PRINT "ERROR IN LOADING MODELING PROGRAM": STOP
17220 TEXT : HOME : VTAB 5
17230 PK = PEEK (222): PRINT G$;G$;"ERROR CODE = ";PK: PRINT : INVERSE

17240 IF PK = 8 THEN PRINT "CANNOT USE DISK IN DRIVE 2": PRINT : PRINT
      "DOOR MAY BE OPENED OR DISK UNINITIALIZED": GOTO 17290
17250 IF PK = 9 THEN PRINT "DISK IN DRIVE ";DR$;" IS FULL. INSERT ANOT
      HER OR": GOTO 17290
17260 IF PK = 6 OR PK = 11 THEN PRINT "BAD FILE NAME": GOTO 17290
17270 IF PK = 4 THEN PRINT "DISK IS WRITE PROTECTED. REMOVE TAB": GOTO
      17290
17280 PRINT "UNFAMILIAR ERROR. CONSULT AUTHOR"
17290 NORMAL : GOSUB 12910
17300 ON ER GOTO 2410,250

```

PROGRAM "X" (PROFILE PLOTS)

LIST

100 REM MAGNETOMETER DATA PLOTTING FOR SCREEN AND C.I.TOH 1550 PRINTER

```

101 GOSUB 15010
102 LOMEM: 27000
110 DIM S1(700),G1(700),N1(700),T1(700),G(700)
150 D$ = CHR$(4):G$ = CHR$(7):L$ = CHR$(12)
160 ESC$ = CHR$(27):I$ = CHR$(9):N$ = CHR$(14)
190 REM ONERR GOTO 13010
200 GOTO 1010
423 * 60
500 REM

```

PLOT TEXT ON HI RES SCREEN

```

510 HU = 7 * (HT - 1):VU = 8 * VT - 1
520 IF HU > 272 THEN GOTO 620
530 FOR I = 1 TO LEN(ST$)
540 CH = ASC(MID$(ST$,I,1)) - 32
550 IF CH = 0 THEN GOTO 580
560 IF CH = 14 AND DIR$ = "V" THEN CH = 63: REM PRINT CENTERED DOT
570 XDRAW CH AT HU,VU
580 IF DIR$ = "H" THEN HU = HU + 7
590 IF DIR$ = "V" THEN VU = VU + 8
600 NEXT
610 HU = 0:VU = 0
620 RETURN
1000 REM

```

MAIN MENU

```

1010 R = 1
1020 GOSUB 9010
1030 ST = S1:DT$ = DC$
1040 GOSUB 10010
1050 R = 2
1110 HOME: PRINT "PLEASE NOTE!! SMOOTHING ERASES DIURNAL CORRECTIONS
UNLESS THEY WERE SAVED TO DISK. SMOOTH FIRST, THEN DIURNAL CORRECT
"
1120 PRINT: PRINT "CURRENT INPUT FILE = ";FI$
1150 PRINT: PRINT "3,5,ETC) 'N' POINT WEIGHTED MOVING AVG."
1190 PRINT: HTAB 7: PRINT "D) DIURNAL CORRECTION"
1210 PRINT: HTAB 7: PRINT "R) REMOVE DIURNAL CORRECTION OR"
1220 PRINT: HTAB 11: PRINT "SMOOTHING NOT SAVED TO DISK"
1222 PRINT: HTAB 7: PRINT "V) VIEW LAST PLOT AGAIN"
1230 PRINT: HTAB 7: PRINT "S) SAVE CHANGES TO DISK"
1250 PRINT: HTAB 7: PRINT "C) CHANGE INPUT DATA SETS"
1270 PRINT: PRINT " RETURN) RETURN TO MAIN MENU"
1300 GOSUB 12010:A = VAL(A$)
1310 IF A > 3 THEN GOTO 3010
1320 IF A$ = "D" THEN GOTO 2010
1330 IF A$ = "R" THEN GOTO 3510
1332 IF A$ = "V" THEN GOTO 11010
1340 IF A$ = "S" THEN GOTO 2510
1350 IF A$ = "C" THEN GOTO 1010
1360 IF A$ < > "" THEN PRINT G$;G$: GOTO 1110

```

```

1500 PRINT D$"RUN M,D1"
2000 REM

```

DIURNAL CORRECTION

```

2010 IF DC$ = "DIURNAL CORRECTION ON" THEN GOTO 2210
2012 IF T1(2) - T1(1) = 0 THEN SLOPE = 0: GOTO 2050
2020 SLOPE = (G(2) - G(1)) / (T1(2) - T1(1))
2050 FOR I = 3 TO K
2060 G(I) = G(I) - SLOPE * (T1(I) - T1(1))
2070 NEXT
2090 DT$ = "DIURNAL CORRECTION ON"
2100 FL$ = "TEMP FILE"
2110 GOTO 10010
2200 :
2210 HOME : VTAB 8
2212 PRINT G$;G$: PRINT "DATA SET '";F1$;"' ALREADY HAS"
2220 PRINT : PRINT "DIURNAL CORRECTION. DO YOU WISH TO"
2230 PRINT : PRINT "PROCEED ANYWAY?";: GOSUB 12200
2240 IF A$ = "Y" THEN GOTO 2012
2250 IF A$ = "N" THEN GOTO 1110
2260 PRINT G$;G$: GOTO 2210
2500 REM

```

SAVE CHANGES TO DISK

```

2510 HOME : PRINT D$"CATALOG,D2"
2520 PRINT : PRINT "ENTER OUTPUT DATA SET NAME OR"
2530 PRINT : INVERSE : PRINT "RETURN";: NORMAL
2540 INPUT " TO CANCEL WRITE: ";FO$
2560 IF FO$ = "" THEN PRINT D$"RUN M,D1"
2562 ONERR GOTO 2582
2564 PRINT D$"VERIFY";FO$
2566 PRINT : PRINT G$;G$;"FILE ALREADY EXISTS."
2568 PRINT : PRINT "DO YOU WISH TO OVERWRITE?";: GOSUB 12200
2570 IF A$ = "N" THEN GOTO 2510
2572 IF A$ < > "Y" THEN PRINT G$;G$: GOTO 2566
2580 PRINT D$"DELETE";FO$
2582 POKE 216,0
2588 PRINT D$"OPEN";FO$
2590 PRINT D$"WRITE";FO$
2600 PRINT K
2610 PRINT ST
2620 PRINT DT$
2630 FOR I = 1 TO K
2640 PRINT S1(I)
2650 PRINT G(I)
2670 PRINT T1(I)
2680 PRINT N1(I)
2690 NEXT
2700 PRINT D$"CLOSE";FO$
2710 GOTO 1050
3000 REM

```

SMOOTHING

```

3010 ST = A:DT$ = DC$
3050 CE = INT (A / 2)
3070 IF A / 2 - CE < > .5 THEN PRINT G$;G$: GOTO 1110
3090 :

```

```

3100 FOR I = 1 TO K
3110 N = 0:SUM = 0
3120 IF I < 3 + CE OR I > K - CE THEN G(I) = G1(I): GOTO 3240
3130 FOR J = 0 TO CE - 1
3140 F = 2 ^ J:N = N + 2 * F
3150 SUM = SUM + (G1(I - CE + J) + G1(I + CE - J)) * F
3200 NEXT
3210 SUM = SUM + G1(I) * 2 ^ J
3220 N = N + 2 ^ J
3230 G(I) = SUM / N
3240 NEXT
3300 FL$ = "TEMP FILE"
3310 GOTO 10010
3500 REM

```

REMOVE SMOOTHING OR DIUR. COR.

```

3510 FOR I = 1 TO K
3520 G(I) = G1(I)
3530 NEXT
3540 ST = SI
3570 DT$ = DC$
3580 FL$ = FI$
3590 GOTO 10010
5000 REM

```

PRINTER PLOT

```

5010 HOME : VTAB 8
5020 PRINT "ENTER SCALE SUCH AS 1:500"
5030 PRINT : INPUT "1:";S
5040 IF S < = 1 THEN PRINT G$;G$: GOTO 5010
5050 PRINT : PRINT : PRINT "ENTER Y AXIS (nT) LENGTH IN INCHES OR"
5060 INVERSE : PRINT "RETURN";: NORMAL
5070 PRINT " TO ACCEPT DEFAULT OF 6.67 IN."
5080 PRINT : INPUT "0 <= LENGTH < 12: ";YM$
5090 YM = VAL (YM$)
5100 IF YM$ = "" THEN YM = 6.67
5110 IF YM < = 0 OR YM > 12 THEN PRINT G$;G$: GOTO 5050
5112 HOME : VTAB 8: PRINT "DISTANCE BETWEEN FIELD STATIONS IS IN"
5114 VTAB 11: HTAB 6: PRINT "M) METERS"
5116 PRINT : PRINT "RETURN) FEET"
5117 GOSUB 12010
5118 IF NOT (A$ = "M" OR A$ = "") THEN PRINT G$;G$: GOTO 5112
5119 UNIT$ = "FEET": IF A$ = "M" THEN UNIT$ = "METERS"
5120 GOSUB 7010
5130 VTAB 6: HTAB 1: PRINT "ABOVE INTERVALS REPRESENT:"
5140 PRINT : HTAB 6: PRINT "N) ";UNIT$
5150 PRINT : HTAB 6: PRINT "X) TENS OF ";UNIT$
5180 VTAB 13: PRINT "OR IGNORE ABOVE INTERVALS AND ENTER:"
5190 PRINT : HTAB 4: PRINT "XXX) NUMBER OF ";UNIT$;" BETWEEN POINTS"
5200 PRINT : PRINT "RETURN) DEFAULT OF 100 ";UNIT$
5210 GOSUB 12010:DI$ = A$
5220 D = VAL (DI$)
5222 IF NOT (DI$ = "N" OR DI$ = "X" OR D > 0 OR DI$ = "") THEN PRINT
G$;G$: GOTO 5120
5230 IF DI$ = "" THEN D = 100
5232 TENX = 1
5233 XF = 12 * 144 / S
5240 IF UNIT$ = "METERS" THEN XF = 39.37009 * 144 / S

```

```

5242 IF DI$ = "X" THEN TENX = 10:UNIT$ = "TENS OF " + UNIT$
5250 YD = YM * 160 / (GH - GL)
5260 PRINT D$;"PR#1"
5270 PRINT I$;"0N"
5272 PRINT I$;"H": REM SEND HI BIT
5280 PRINT ESC$;"N": REM 10 CPI
5290 PRINT ESC$;"T24": REM 6 LPI
5310 PRINT : PRINT : PRINT "INPUT DATA SET NAME = ";FI$
5312 PRINT : PRINT "PLOTTED DATA SET NAME = ";FL$
5320 PRINT : PRINT "SCALE = 1:";S
5322 PRINT : PRINT "SEQUENCE NUMBERS FROM "; STR$ (S1(3));" TO "; STR$
(S1(K))
5324 PRINT : PRINT ST;" POINT MOVING AVERAGE SMOOTHING"
5326 PRINT : PRINT DT$
5328 PRINT : IF DI$ = "N" OR DI$ = "X" THEN GOSUB 7020: PRINT UNIT$: GOTO
5332
5330 PRINT : PRINT "FIELD STATION INTERVAL = ";D;" ";UNIT$
5332 PRINT : PRINT
5334 PRINT ESC$;"P": REM PROPORTIONAL PRINT
5336 PRINT ESC$;"T01": REM 1/144 IN. LF'S
5338 PRINT ESC$;"I": REM INCR MODE (RETURNS TO COL 1 ON CR)
5342 I = B
5350 GOSUB 6010: GOSUB 6910
5360 PRINT GL;
5370 Y% = (YM - .4) * 160: GOSUB 7310
5380 PRINT ESC$;"F";Y$;GH;
5390 GOSUB 6510
5400 F = 0:J = 0
5440 I = 3
5450 GOSUB 6010:I = I + 1
5452 IF DI$ = "N" OR DI$ = "X" THEN D = N1(I - 1)
5460 IF I < = K THEN GOSUB 5610: GOTO 5450
5470 GOSUB 6510
5472 PRINT ESC$;"N": REM 10 CPI
5474 PRINT ESC$;"T24": REM 6 LPI
5476 PRINT I$;"X": REM DO NOT SEND HI BIT
5480 PRINT : PRINT
5490 PRINT D$;"PR#0"
5500 GOTO 1110
5600 REM

```

HI RES LINE FEED

```

5610 F = F + D * TENX
5620 XD = F * XF
5630 PRINT :J = J + 1
5640 IF J < XD THEN GOTO 5630
5650 RETURN
6000 REM

```

FIND Y POSITION, PLOT +

```

6010 IF G(I) = 0 THEN GOTO 6390
6020 Y% = YD * (G(I) - GL): GOSUB 7310
6030 PRINT ESC$;"F";Y$;"+";S1(I);
6080 IF I = B THEN PRINT " BS";
6390 RETURN
6500 REM

```

PRINT TICKS, BAR

```

6510 GOSUB 6910
6512 PRINT ESC$;"F0003";:
6520 L = (GH - GL) / 100
6530 IF L = 1 THEN L = 10
6540 YG = 160 * YM
6542 FOR N = 0 TO L
6546 Y% = YG * N / L + 2: GOSUB 7310
6548 PRINT ESC$;"F";Y$;:
6550 PRINT ESC$;"V0002"; CHR$ (255);: REM BAR
6552 NEXT
6560 PRINT : PRINT ESC$;"F0003";
6570 Y% = YG: GOSUB 7310
6580 PRINT ESC$;"V";Y$; CHR$ (192)
6590 GOSUB 6910
6600 RETURN
6900 :
6910 FOR N = 1 TO 20: PRINT : NEXT
6920 RETURN
7000 REM

```

LIST STATION INTERVALS

```

7010 HOME
7020 PRINT "FIELD STATION INTERVAL(S)"
7030 PRINT :IT = N1(B): PRINT IT;" ";
7040 FOR I = 3 TO K
7050 IF N1(I) < > IT THEN IT = N1(I): PRINT IT;" ";
7070 NEXT
7090 RETURN
7300 REM

```

PAD TO 4 DIGITS

```

7310 Y$ = STR$ (Y%)
7320 IF Y% < 1000 THEN Y$ = "0" + Y$
7330 IF Y% < 100 THEN Y$ = "0" + Y$
7340 IF Y% < 10 THEN Y$ = "0" + Y$
7350 RETURN
9000 REM

```

READ NORMALIZED DATA

```

9010 HOME : PRINT D$"CATALOG,D2"
9020 PRINT : PRINT "ENTER TRAVERSE DATA SET NAME OR"
9030 PRINT : INVERSE : PRINT "RETURN";: NORMAL
9040 INPUT " TO CANCEL READ: ";FI$
9042 FL$ = FI$
9050 IF FI$ = "" THEN ON R GOTO 1500,1110
9070 PRINT D$"VERIFY";FI$
9200 PRINT D$"OPEN";FI$
9210 PRINT D$"READ";FI$
9220 INPUT K
9230 INPUT SI
9240 INPUT DC$
9260 FOR I = 1 TO K
9270 INPUT S1(I)
9280 INPUT G1(I)
9290 G(I) = G1(I)
9300 INPUT T1(I)

```

```

9310 INPUT N1(I)
9320 NEXT
9400 PRINT D$ "CLOSE"; F1$
9500 ON R GOTO 1030,1050
10000 REM

FIND MIN, MAX, MEAN, DEV

10010 GH = 0:GL = 0
10020 J = 0:SUM = 0:SQ = 0
10030 DEV$ = "0":MEAN = 0
10220 FOR I = 3 TO K
10230 IF G(I) > 0 THEN GL = G(I):GH = G(I):I = K
10240 NEXT
10250 :
10260 FOR I = 3 TO K
10270 IF G(I) < = 0 THEN GOTO 10300
10280 IF G(I) > GH THEN GH = G(I)
10290 IF G(I) < GL THEN GL = G(I)
10291 SQ = SQ + G(I) ^ 2
10292 SUM = SUM + G(I)
10293 J = J + 1
10300 NEXT
10301 X = GL: GOSUB 16010:MIN$ = X$
10302 X = GH: GOSUB 16010:MAX$ = X$
10303 IF J < 2 THEN GOTO 10310
10304 MEAN = SUM / J:X = MEAN: GOSUB 16010:MEAN$ = X$
10305 VAR = (SQ - J * MEAN ^ 2) / (J - 1)
10306 X = SQR (VAR): GOSUB 16010:DEV$ = X$
10310 B = 2
10320 IF G(1) < G(2) THEN B = 1
10330 IF G(B) < GL THEN GL = G(B)
10340 IF G(B) > GH THEN GH = G(B)
10350 IF RIGHT$ (STR$ (GH),2) = "00" THEN GOTO 10370
10360 GH = INT (GH / 100 + (1 - 10 ^ - 10)) * 100
10370 GL = INT (GL / 100) * 100
10500 REM

```

PROMPT FOR Y AXIS SCALING

```

10510 HOME : VTAB 5
10520 PRINT "VERTICAL AXIS (nT) SCALE"
10522 VTAB 8: PRINT "DEFAULTS = ";GL;" TO ";GH
10530 VTAB 13: HTAB 6: PRINT "1) ENTER NEW LIMITS"
10550 PRINT : PRINT "RETURN) SELF SCALING (ACCEPT DEFAULTS)"
10570 GOSUB 12010
10580 IF A$ = "" THEN GOTO 10810
10590 IF A$ < > "1" THEN PRINT G$;G$: GOTO 10510
10600 HOME : VTAB 8
10610 PRINT "ENTER LOWER LIMIT"
10620 PRINT : PRINT "DEFAULT

```

PROGRAM "MAGFOR" (INITIALIZES DISKS)

LIST

```
120 D$ = CHR$(4):G$ = CHR$(7)
140 REM
```

MAIN MENU

```
150 HOME : PRINT "THIS PROGRAM INITIALIZES DATA DISKS"
170 VTAB 9: HTAB 6: INVERSE : PRINT "1";: NORMAL
180 PRINT ") RETURN TO MAIN MENU"
190 PRINT : HTAB 6: INVERSE : PRINT "2";: NORMAL
200 PRINT ") ERASE FILES"
230 PRINT : INVERSE : PRINT "RETURN";: NORMAL
240 PRINT ") INITIALIZE DISK FOR DATA STORAGE"
250 VTAB 23: INPUT "PLEASE MAKE A SELECTION: ";A$
260 A1 = VAL (A$) + 1
270 ON A1 GOTO 430,290,890
280 PRINT G$;G$: GOTO 150
290 PRINT D$;"RUN M,D1"
420 REM
```

INITIALIZE DISK

```
430 HOME : VTAB 10: PRINT "PLACE NEW DISK IN DRIVE 2"
440 VTAB 13: PRINT "PRESS ";: INVERSE : PRINT "RETURN";: NORMAL : INPUT
" TO CONTINUE: ";A$
450 ONERR GOTO 470
460 PRINT D$;"LOAD ZXHKE43ZZ,D2"
470 E = PEEK (222)
480 IF E < > 8 THEN GOTO 550
490 HOME : VTAB 10
500 PRINT G$;G$;"MAKE SURE DOOR IN DRIVE 2 IS CLOSED "
510 VTAB 13: GOSUB 4770
520 ONERR GOTO 540
530 PRINT D$;"LOAD ZXHKE43ZZ,D2"
540 E = PEEK (222): IF E = 8 THEN GOTO 820
550 IF E < > 6 THEN GOTO 4860
560 PRINT D$"CATALOG,D2": GOSUB 4770
570 HOME : VTAB 8: PRINT "THE ABOVE FILES EXIST ON THE DATA DISK"
580 PRINT : HTAB 6: INVERSE : PRINT "1";: NORMAL
590 PRINT ") INITIALIZE AND ERASE ALL FILES"
600 PRINT : HTAB 6: INVERSE : PRINT "2";: NORMAL
610 PRINT ") SEE CATALOG AGAIN"
620 PRINT : HTAB 6: INVERSE : PRINT "3";: NORMAL
630 PRINT ") CHANGE DATA DISKS"
640 PRINT : INVERSE : PRINT "RETURN";: NORMAL
650 PRINT ") ERASE SPECIFIC FILES AND"
660 PRINT : HTAB 12: PRINT "KEEP THE OTHER FILES"
670 PRINT : PRINT : INPUT "PLEASE MAKE A SELECTION: ";A$
680 IF A$ < > "1" AND A$ < > "2" AND A$ < > "3" AND A$ < > "" THEN
PRINT G$;G$: GOTO 570
690 A2 = VAL (A$) + 1
700 ON A2 GOTO 890,740,560,710
710 HOME : VTAB 10: PRINT "REPLACE DISK IN DRIVE 2"
720 GOSUB 4770
730 GOTO 560
740 HOME : VTAB 8: PRINT "ARE YOU SURE YOU WANT TO ERASE ALL"
750 PRINT : PRINT "THE FILES ON THE DISK IN DRIVE 2 ?"
```

```

760 VTAB 13: PRINT "THEY WILL BE GONE FOREVER !!! "
770 GOSUB 4750
780 IF A$ = "Y" THEN GOTO 820
790 IF A$ = "N" THEN GOTO 150
800 PRINT G$;G$: GOTO 740
810 :
820 ONERR GOTO 850
830 POKE 42348,209: POKE 42349,164
840 PRINT CHR$(4)"INIT HELLO,D2"
850 POKE 42348,151: POKE 42349,163
860 E = PEEK(222): IF E < > 13 THEN GOTO 4860
870 GOTO 150
880 :
890 ONERR GOTO 920
900 HOME
910 PRINT D$"CATALOG,D2"
920 PRINT : PRINT "ENTER FILE NAME TO ERASE OR PRESS ";
930 INVERSE : PRINT "RETURN";: NORMAL
940 PRINT : INPUT " TO QUIT ";A$
950 IF A$ = "" THEN GOTO 150
960 PRINT D$"DELETE ";A$;","D2"
1000 GOTO 910
4750 PRINT : PRINT : PRINT "ANSWER ";: INVERSE : PRINT "Y";: NORMAL
4760 PRINT "/":: INVERSE : PRINT "N";: NORMAL : INPUT " ";A$: RETURN
4770 PRINT : PRINT : PRINT "PRESS ";: INVERSE : PRINT "RETURN";: NORMAL

4780 INPUT " TO CONTINUE ";A$
4790 RETURN
4850 REM

```

ERROR HANDLING

```

4860 HOME : PRINT G$;G$;"CANNOT INITIALIZE THIS DISK.": PRINT : PRINT "
      ERROR=";E
4870 GOTO 4950
4880 PRINT : PRINT AA$: PRINT "YOU HAVE ENTERED SOMETHING WRONG": PRINT
      AA$: PRINT
4890 X = - 16336: FOR IY = 1 TO 50:Z = PEEK(X) - PEEK(X) + PEEK(X
      ) - PEEK(X) + PEEK(X) - PEEK(X) + PEEK(X): NEXT IY
4900 RETURN
4910 RETURN
4920 HOME : VTAB 5: PRINT G$;G$;"CANNOT FIND NECESSARY FILES IN DRIVE 2
      "
4930 GOSUB 4770: GOTO 150
4940 HOME : PRINT G$;G$;"UNFAMILIAR ERROR"
4950 PRINT : PRINT "CONSULT APPLE PROGRAMMER OR AUTHOR"
4960 GOSUB 4770: GOTO 150

```

PROGRAM "P" (DATA PRINTOUTS)

LIST

```

100  REM MAGNETOMETER PRINTER PROGRAM FOR C.I.TOH 1550

110  DIM ST$(1000),S(1000),G(1000),T(1000),N(1000)
150  D$ = CHR$(4):G$ = CHR$(7):L$ = CHR$(12)
160  ESC$ = CHR$(27):I$ = CHR$(9):N$ = CHR$(14)
180  B$ = " "
1000 REM

READ DATA

1010 HOME : ONERR GOTO 13010
1020 PRINT D$"CATALOG,D2"
1030 PRINT : PRINT "ENTER DATA SET NAME TO BE PRINTED OR"
1040 PRINT : INVERSE : PRINT "RETURN";: NORMAL
1050 INPUT " TO END PRINT: ";FL$
1060 IF FL$ = "" THEN PRINT D$"RUN M,D1"
1070 REM ONERR GOTO 13010
1080 PRINT D$"VERIFY";FL$
1090 PRINT D$"OPEN";FL$
1100 K = 1
1110 PRINT D$"READ";FL$: INPUT ST$(1)
1120 IF LEN (ST$(1)) > 6 THEN GOTO 1318
1130 K = VAL (ST$(1))
1132 INPUT SI
1133 INPUT DC$
1134 FOR I = 1 TO K
1135 INPUT S(I)
1136 INPUT G(I)
1137 INPUT T(I)
1138 INPUT N(I)
1139 NEXT
1160 PRINT D$"CLOSE";FL$
1162 GOSUB 20010
1170 PRINT D$"PR#1"
1171 PRINT I$"135N"
1192 PRINT ESC$;"N": REM 10CPI
1200 PRINT "DATA SET NAME = ";FL$: PRINT
1202 PRINT SI;" POINT WEIGHTED MOVING AVERAGE"
1204 PRINT : PRINT DC$: PRINT : PRINT
1210 PRINT "STATION      TIME      STATION      MAGNETOMETER"
1212 PRINT "INTERVAL    IN          NUMBER      READING IN"
1214 PRINT "              SECONDS              nT"
1230 FOR I = 1 TO 45: PRINT CHR$(95);: NEXT
1240 PRINT : PRINT
1250 FOR I = 1 TO K
1252 PRINT N(I); LEFT$(B$,11 - LEN (STR$(N(I)))));
1253 PRINT T(I); LEFT$(B$,11 - LEN (STR$(T(I)))));
1254 PRINT S(I);:L = LEN (STR$(S(I)))
1255 IF I < 3 THEN PRINT " BS";:L = L + 3
1256 PRINT LEFT$(B$,11 - L);
1257 PRINT G(I)
1270 NEXT
1271 PRINT : PRINT : PRINT
1280 PRINT D$"PR#0"
1290 GOTO 1010
1300 REM

```

PRINT RAW DATA

```

1310 ONERR GOTO 1350
1312 K = K + 1
1314 INPUT ST$(K)
1318 J = 0
1320 FOR I = 1 TO 4: X$ = MID$(ST$(K), I, 1)
1322 IF X$ = " " THEN J = I: I = 4
1324 NEXT
1326 IF J = 0 THEN HOME : VTAB 8: PRINT G$: G$; "CANNOT READ LINE "; L +
1; " IN DATA": GOSUB 12300: GOTO 1340
1328 IF J = 4 THEN GOTO 1340
1330 ST$(K) = LEFT$(B$, 4 - J) + ST$(K)
1340 GOTO 1310
1350 K = K - 1
1351 POKE 216, 0
1352 GOSUB 20010
1360 PRINT D$ "PR#1"
1362 PRINT I$ "135N"
1370 PRINT ESC$; "N"
1380 PRINT "DATA SET NAME = "; FL$: PRINT
1390 PRINT "          TIME SEQ# nT"
1410 FOR I = 1 TO 26: PRINT CHR$(95);: NEXT
1420 PRINT : PRINT
1430 FOR I = 1 TO K
1440 PRINT ST$(I)
1450 NEXT
1460 PRINT D$ "PR#0"
1470 GOTO 1010
12000 REM

```

GENERAL PURPOSE SUBROUTINES

```

12010 PRINT : PRINT : INPUT "PLEASE MAKE A SELECTION: "; A$
12020 RETURN
12050 PRINT : PRINT : INPUT "PLEASE MAKE A SELECTION: "; A
12060 RETURN
13000 REM

```

ERROR HANDLING

```

13010 TEXT : HOME : VTAB 5
13020 PK = PEEK(222): PRINT G$; "ERROR CODE = "; PK: PRINT : INVERSE
13030 IF PK = 8 THEN PRINT "CANNOT USE DISK IN DRIVE 2": PRINT : PRINT
"DOOR MAY BE OPENED OR DISK UNINITIALIZED": GOTO 13080
13040 IF PK = 9 THEN PRINT "DISK IN DRIVE "; DR$; " IS FULL. INSERT ANOT
HER OR": GOTO 13080
13050 IF PK = 6 OR PK = 11 THEN PRINT "BAD FILE NAME": GOTO 13080
13060 IF PK = 4 THEN PRINT "DISK IS WRITE PROTECTED. REMOVE TAB": GOTO
13080
13070 PRINT "UNFAMILIAR ERROR. CONSULT AUTHOR"
13080 NORMAL : PRINT : PRINT "PRESS ";: INVERSE : PRINT "RETURN";: NORMAL
: INPUT " TO CONTINUE"; A$
13090 GOTO 1010
20000 REM

```

SET TOP OF FORM ON PRINTER

```

20010 HOME : VTAB 6

```

```
20020 PRINT "TURN PLATTEN KNOB ON PRINTER TO AVOID"  
20030 PRINT : PRINT "CREASE"  
20040 VTAB 15: PRINT "PRESS ";  
20050 INVERSE : PRINT "RETURN";: NORMAL  
20060 INPUT " TO CONTINUE";A$  
20080 RETURN
```