UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

DOCUMENTATION AND PROGRAM LISTINGS FOR THE TEKTRONIX 4051 PLOT PACKAGE--

Using Honolulu Series Lavas petrochemical data

By

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TABLE OF CONTENTS

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

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INTRODUCTION

This plot package is designed to read files of geochemical data stored in magnetic tape cartridges, perform various computations, and provide both graphical and numerical output of the data using a Tektronix Model 4051 interactive graphics computer. These plot routines were designed for a specific data set (Honolulu Series Lavas), but they can be easily adapted to different suites, provided that a particular data format is maintained.

The purpose of this report is to describe: 1) the use of the plot programs using data for the Honolulu Series Lavas (HSL), 2) the preparation of additional files of data from different rock suites, and 3) the modification of the existing programs for generating the same plots for other data sets.

Data Storage

Petrochemical data are entered directly onto the Tektronix data tape according to a particular format which permits easy editing of the data. The "Data Loader" program was designed to be interactive so that the user, with little programming background, can modify the algorithms to suit data sets of various sizes.

Plot Routines

The plot package consists of two parts. The first is a "Bootstrap" program which initializes all variables according to the user's specifications, reads the data file, and lists all available plot routines. The user then selects the preferred plot format. At this point the appropriate plot subprogram is appended to the "Bootstrap" program; this constitutes the second part of the plot package. Portions of the bootstrap program which are no longer needed are automatically deleted in order to minimize the amount of memory space required during program execution.

After the specific plot routines or calculations have been executed, the user may either keep the subprogram in the memory buffer to generate additional plots (using the same subprogram), or may request a different plot routine. In this event, system control reverts back to the bootstrap program, which then loads a new plot subprogram into the memory buffer. It is not necessary to reload the data tape when changing plot formats.

Output

Fine quality X-Y and ternary plots of petrochemical data are generated on a Tektronix peripheral unit. In addition, hard copy of numerical data, such as averages and standard deviations of major oxide and trace element ratios, may be obtained using a high-speed line printer, which is usually interfaced with the Tektronix system*.

Further Instruction

Several excellent references are available concerning the use of the Tektronix system as both an interactive BASIC computer and high quality, versatile digital plotter. It is suggested that the user familiarize himself/herself with the essentials of the Basic programming language and the elements of graphics computing using the Plot 50 Graphics System Tutorial Program of the System Software Tape. This tape is found in the back of the Tektronix 4051 Graphics System Operators Manual. All error messages are coded numerically and are fully described in the back of the Operators Manual. Some additional useful Tektronix resources are:

(1) Plot 50 - Introduction to Programming in BASIC.

(2) Plot 50 - Introduction to Graphic Programming in BASIC.

(3) Instruction Manual for Use of Peripheral Plotting Device.

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* Note that not all Tektronix 4051 graphics systems are equipped with a high-speed printer. Some use thermafax copiers instead, which provide a photocopy of the information (or graphics) displayed on the screen.

SETTING UP THE PROGRAMS

The high cost of the Tektronix data tape cartridges precludes their being copied and mass-distributed. Therefore, prospective users must set up their own program tapes, using the program listings supplied with the documentation. Detailed instructions for preparing the tapes are given below.

Initializing the program tape

An entire blank cartridge will be required to store all of the programs in this package. The user must allocate sufficient blocks of space on the tape for each of the plot subprograms.

To set up space for the first program (data loading routine), the user first types "find 0", and then, after the tape drive has stopped, "mark 1,19200". The "Busy" light will be illuminated while the space is being allocated.

Space for the second program is allocated by typing "find 2", followed by "mark 1,5632". Again, the busy light will be on momentarily while the tape is being marked. No computing can be done during this period.

The procedure for space allocation for the remaining programs is essentially the same. The following outline gives the amount of space (in bits) which must be set aside for the rest of the programs in the plot package:

Program 3 - 23552
Program 4 - 24320
Program 5 - 24064
Program 6 - 25600
Program 7 - 26624
Program 8 - 25344
Program 9 - 25600
Program 10 - 18176
Program 11 - 6656
Program 12 - 13312

After the tape has been properly marked, it is ready to be programmed. Each program has been listed in the last section of this documentation. The programs should be copied into the tape as they appear in the listing. They should be entered in the tape in the order of their appearance in the documentation.

To store the first program in the plot package, after the tape has been properly marked, the user types in the complete coding, then "find 1", followed by "save". The "Busy" and I/O" lamps will be illuminated while the program is being copied from the memory buffer onto the tape. As soon as the lights are extinguished, the transfer is completed and the user may then add the next program in the series. To add the second program, the user first types in the entire listing for that program, then "find 2", followed by "save".

This same procedure is followed for the remaining programs. Complete listings for all of the programs in the plot package are contained in the following pages:

Program #	Pages (for listings)
1	35 - 39
2	40 - 41
3	42 - 47
4	48 - 53
5	54 - 59
6	60 - 65
7	66 - 71
8	72 - 77
9	78 - 83
10	84 - 87
11	88 - 89
12	90 - 92

LOADING DATA

Once the program tape has been assembled, the user must load petrochemical data onto a separate tape. Sufficient space must be allocated on the data tape to store a matrix of 41 elements by 45 or fewer samples. In general, about 50,000 bits are required to store a matrix of this size. In order to prepare the data tape to store a matrix of this size, the user first types "find 0" , followed by "mark 1,30000". Less data space needs to be allocated when fewer samples are to be included.

The first program in the plot package has been designed to load the data type in an interactive manner. The user accesses it by simply pressing the "Autoload" button after the program tape has been inserted. Within a few seconds the following message will appear on the screen:

Do you want to load data (A) or generate plots (B)?

Type 'A' or 'B'.

By typing "A", followed by a carriage return, the user enters the data entry mode. Typing "B" instead would replace the data loading program with the plot package bootstrap program. This cannot be used, however, until some data have been entered onto the data tape.

After the user has decided to load data, the following message will appear on the screen:

How many samples do you have?

This number determines the size of the matrix which will be used in the plot package. The number of samples should not be greater than 45. The next message the user receives will be:

Do you want instructions (yes or no)?

If the user responds affirmatively the following message will be printed on the screen:

DATA WILL BE LOADED ONE ELEMENT AT A TIME, starting with SiO2.
You will insert elemental data for each sample. For example,

if you have 30 samples, you will first provide 30 values for SiO2, then for Al2O3, etc. The name of the element will appear at the top of the screen. The sample number will appear at the left side of the screen, followed by a question mark. Print the amount of the element present in that particular sample (wt. percent for major elements, ppm for trace elements) and then hit "return". If a value is not available for a particular sample, type '-1'. However, if a particular element was not analyzed in the data set, type '-2'. The program will not ask for additional entries for that element--it will instead request data for the following element.

Had the user not chosen to receive program instructions, the above message would have been skipped. However, all users will receive the following instructions:

This program will wait until you insert the data tape. . .
Hit "return" to continue with the program:
INSERT DATA TAPE.

The properly marked data tape is then inserted into the slot, followed by a carriage return. As soon as this is done, the following message will appear:

File number where data are to be stored?

If the data are to be stored in the first marked section of the data tape, the user types "1" followed by a carriage return. The following message will then appear:

If a value for a particular element is not available in a given sample, type '-1' when data for that sample are requested. If values for a particular element are lacking in the entire data set, type '-2' when a value for the first sample is requested. If you want to change the previous data entry, type '3'.

After this message is received actual data loading can begin. The user will enter data starting with SiO2 and ending with Mg# (100+(Mg/(Mg + Fe))), one

sample at a time. The request for a data entry for SiO2 will appear on the screen in the following format:

SiO2 SAMPLE # 1 ???

The user simply types in the appropriate value next to the question mark, followed by a carriage return. Data for the next sample is then requested:

SiO2 SAMPLE # 2 ???

After SiO2 data for all samples have been supplied, values for the next element will be requested:

Al2O3 SAMPLE # 1 ???

If no value is available for Al2O3 in sample #1, the user types -1. If Al2O3 was not analyzed in the data set, the user types -2. No additional Al2O3 values will be requested. For example:

Al2O3 SAMPLE # 1 ??? (-2)
Fe2O3 SAMPLE # 1 ???

Since the user typed -2, no further Al2O3 values were requested. The program requested data for the next element instead (in this case, Fe2O3).

In order to facilitate text editing, the user may change a previous entry by typing -3 when a value for a particular sample is requested. For example, if the user inadvertently specified an FeO value of 435.67 for sample #2, he or she may correct this by typing -3 when data for sample #3 are requested. For example:

FeO SAMPLE # 1 ??? (11.34)
FeO SAMPLE # 2 ??? (435.67)
FeO SAMPLE # 3 ??? (-3)
FeO SAMPLE # 2 ??? (9.45)

Note that the user has substituted a correct value for sample #2. The program will then resume as before, and request data for sample #s 3, 4, 5, etc.

After data for all 41 elements have been supplied, the user will have the option of having his/her data listed on the line printer:

Would you like a listing of your data? (type yes or no).

If the user responds affirmatively, he or she will get the following message:

Turn on line printer -- hit "return" to continue.

As soon as this is done, a table of values for each sample will be generated on the line printer. It may take considerable time for this to be completed, depending on the number of samples the user specified.

After the table is printed the user will then be given the opportunity to make corrections in the data before they become stored on the tape. This same option is available to the user who did not request a listing of his/her data. The following message will appear on the screen:

Do you need to make any corrections in the data? (type yes or no).

If the user types "no", he or she will get the following message:

Data loading and editing completed. Values will be loaded onto the tape.

The "Busy" and "I/O" lamps will be illuminated while the data tape is being loaded. This process should take several minutes. After this is done, the user will be given the option of using the plot package for graphing values in the newly-prepared tape:

DONE !!!
Insert program tape if you want to use the plot package.
Hit "return" to continue once you have done this.
Type "end" if you want to leave the program.

If the user types "end" the program will terminate. If instead he or she replaces the data tape with the program tape in the console and hits the carriage return key, the bootstrap program will be loaded into the memory

buffer, and the user will be asked to select one of the plot programs in the package.

If the user had elected to make corrections in the data, the following table would be printed on the screen:

1	*SiO2*	*2*	*Al2O3*	*3*	*Fe2O3*	*4*	*FeO*
5	*MgO*	*6*	*CaO*	*7*	*Na2O*	*8*	*K2O*
9	*TiO2*	*10*	*P2O5*	*11*	*MnO*	*12*	*Sc*
13	*V*	*14*	*Cr*	*15*	*Co*	*16*	*Ni*
17	*Cu*	*18*	*Zn*	*19*	*Ga*	*20*	*Rb*
21	*Sr*	*22*	*Y*	*23*	*Zr*	*24*	*Nb*
25	*Ba*	*26*	*La*	*27*	*Ce*	*28*	*Nd*
29	*Sm*	*30*	*Eu*	*31*	*Tb*	*32*	*Yb*
33	*Lu*	*34*	*Hf*	*35*	*Ta*	*36*	*Pb*
37	*Th*	*38*	*Li*	*39*	*U*	*40*	*87Sr/86Sr*
41	*Mg#*						

After the table has been printed, the user would receive the following message:

> *Use element and sample number to correct data:*
> *How many samples do you want to correct?*

As soon as the user has specified the number of samples to be corrected, he or she will then specify the element number (using the above table for reference) and the sample number. The current value for that particular sample will be displayed, followed by a request for a new value:

> *Element number?*
> *Sample number?*
> *Current value=*
> *Input new value:*

If the user elects to change three samples, the above message will be repeated three times. After all specified samples have been corrected, the user will receive the following message:

> *Data loading and editing completed. Values will be loaded onto the tape.*

As previously described, the program will pause for a few minutes while the data tape is being loaded. Again, the user will have the option of either terminating the program at this point, or continuing with one of the plot programs in the package. The procedure for selecting one of these options has been described on page 8.

GENERATING PLOTS USING HSL DATA

Accessing plot programs

In order to generate plots using the HSL data file, a magnetic cartridge (Program Tape 1) is loaded into the Tektronix terminal. Press the button on the upper right hand side of the console marked "Autoload". After a few seconds the following message will appear on the screen:

Do you want to load data (A) or generate plots (B)?
Type "A" or "B".

To begin the plotting package, the user types "B". This will access the "Bootstrap" program. Once this program is loaded, the following message will appear on the screen (accompanied by a buzzer):

INSERT DATA TAPE -- data tape file number?

The program will pause until the user has inserted the data tape into the terminal and selected the data file number to be read. It will take several minutes for the tape to be processed.

Following this, the program will display the available plot formats on the screen:

Your data can be plotted in any of the following formats:

1) X vs Y
*2) C1 * X vs C2 * Y*
3) X/Y vs Z
*4) C1 * (X/Y) vs C2 * Z*

*5) C1 * (X/Y) vs C2 * (W/Z)*

*6) C1 * X + C2 * Y vs C3 * Z*

*7) C1 * X + (C2 * Y/C3 * Z) vs C4 * W*

8) REE Plot (semi-log)

9) Average and standard deviation calculation (no plot)

*10) C1 * X vs C2 * Y vs C3 * Z (ternary plot)*

The program will then ask:

Which plot would you like?

The user then selects one of the above nine choices. After the "Return" key has been depressed, the program lists the various elements which can be plotted:

THE FOLLOWING CHEMICAL ELEMENTS CAN BE PLOTTED:

1) SiO2	*2) Al2O3*	*3) Fe2O3*	*4) FeO*
5) MgO	*6) CaO*	*7) Na2O*	*8) K2O*
9) TiO2	*10) P2O5*	*11) MnO*	
12) Sc	*13) V*	*14) Cr*	*15) Co*
16) Ni	*17) Cu*	*18) Zn*	*19) Ga*
20) Rb	*21) Sr*	*22) Y*	*23) Zr*
24) Nb	*25) Ba*	*26) La*	*27) Ce*
28) Nd	*29) Sm*	*30) Eu*	*31) Tb*
32) Yb	*33) Lu*	*34) Hf*	*35) Ta*
36) Pb	*37) Th*	*38) Li*	*39) U*
40) 87Sr/86Sr	*41) Mg#(100 * (Mg/(Mg+Fe))).*		

Use corresponding numbers to input programs to be plotted or calculated.

INSERT PROGRAM TAPE -- (type "1" to continue)?

The computer will pause until the program tape has been inserted. The numeral "1" must be entered to signal that this has been done so that the program can resume.

As soon as this is done the bootstrap program will load the appropriate plot routine into the memory buffer. Portions of the bootstrap program will

be deleted to conserve space. Since one of several possible programs will be accessed, each one will be individually discussed in the following section.

X-Y plots

As soon as this program has been appended the screen will display the following message:

Which element for X-axis?

The user inputs the desired element for the X-axis with the numerical code displayed in the upper portion of the screen. For example, SiO2 is number 1, Th is 37, and TiO2 is number 9. The same procedure is repeated for the Y-axis:

Which element for Y-axis?

After the elements to be plotted are chosen, the user is given the option of eliminating one or two of the three rock groups used in the program (melilitite, nephelinite, alkali olivine basalt + basinite, hereafter referred to as AOB+bas)). The following message will appear on the screen:

Do you want to eliminate samples from any rock group? (type yes or no).

If the user chooses to eliminate samples, the following message will appear on the screen:

Group 1 = melilitite, Group 2 = nephelinite,
Group 3 = AOB+Bas)
How many groups do you want to eliminate?

The user will input either 1 or 2. Following this the user will be asked:

Which groups do you want to eliminate (use #)?
#

The user will type the number of the group to be eliminated from all plots

and calculations next to the number symbol (#). For example, to exclude the melilitite group from calculations, type "1" next to the number symbol. If the user chooses to eliminate two groups, the number symbol will appear again after the first rock group has been selected for elimination; i.e.,

Which groups do you want to eliminate (use #)?
#
#

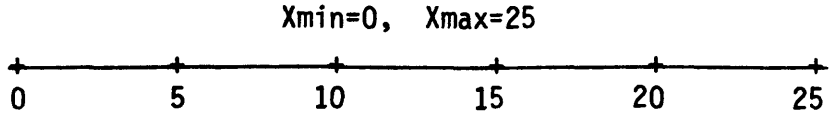
At this point the program determines the maximum and minimum values of the elements or ratios selected for both the X and Y axes. This information is displayed on the screen to assist the user in selecting the optimum range of values for the X and Y axes (the range is termed the window in the program):

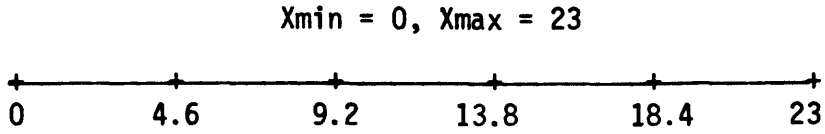
Minimum X-value: *Maximum X-value:*
Minimum Y-value: *Maximum Y-value:*

Following this display the user is asked to select his/her desired range of values:

WINDOW SETTINGS
Lowest X-value desired?
Highest X-value desired?
Lowest Y-value desired?
Highest Y-value desired?

It is suggested that the lowest X and Y values be set at zero, and that the difference between the maximum and minimum values be a multiple of five. For example, if Xmin is 0, the Xmax should be 25 or 22.5, not 23 or 21. Alternatively, if Xmin is 70, Xmax could be 90, 95, or 92.5 rather than 91 or 93. This is not imperative for the operation of the program, but tends to provide a less cumbersome axis scale; i.e.,





Be sure that the paper has been loaded into the plotter and that the pen has been positioned on the paper at the upper right-hand corner. After the user has selected the appropriate window settings, the X - Y plotter will draw a rectangle.

After the box has been drawn the user will be asked to identify the axes and title the plot:

X - axis heading:
Y - axis heading:
(Type "stop" here if you want to re-start the program)
Title of graph:

If the user types "Stop" instead of the name of the data set (in this case, Honolulu Series Lavas), the program will be aborted. The user will then be asked if he or she wants to rerun the existing plot routine or change to a different one. This "escape" option has been included into the program to enable the user to re-start the program if he or she made an error in axis labeling or window settings. It is important that this excape provision be used rather than the "Break" key. Use of the latter feature requires that the data and program tapes be read again (a time-consuming operation).

If the user types "Stop" when asked for the title of the graph, the screen would display the following message:

Want another plot?

If the user types "No", program execution is immediately terminated. If the user answers "Yes", an additional question is displayed on the screen:

Want a different plotting routine?

If the user types "No", the screen will then display the list of major

oxides and trace elements, and the user will be asked to specify elements for X and Y axes. In other words, the program is simply re-run. If the user types "Yes", the existing program is deleted, and the screen displays the choice of available plot routines in the package. The user is asked to select a new plot subprogram.

Unless the user types "Stop" when the title of the graph is requested, the computer will begin executing the main part of the program. The title of the graph that the user selects will be printed on all diagrams. The X-Y plotter will label all axes, draw and label all tic marks, and plot the data points. Three plot symbols will be used in the graph: squares for AOB+Bas samples, crosses for nephelinites, and triangles for melilitites. The user should make no entries at the keyboard until the plotting is completed.

As soon as the X-Y plotter pauses, the following message will appear on the screen:

> *Would you like a least-squares best-fit line drawn through the data points (type "yes" or "no")?*

If the user types "No", system control passes to the last portion of the program, in which a key of plot symbols is printed by the X-Y plotter. This operation is described more fully in the next section.

If the user types "Yes" instead, he or she gets an additional message on the screen:

> *Do you want any samples eliminated from calculations? (Type yes or no).*

This step gives the user an opportunity to exclude spurious samples from the regression line and correlation coefficient. If the user enters "No", the program begins the calculations in the following sequence:

(a) X-total
(b) Y-total
(c) X-mean

(d) Y-mean
(e) variance
(f) slope
(g) Y-intercept
(h) predicted Y-value for minimum X-value
(i) predicted Y-value for maximum X-value
(j) standard error of estimate
(k) correlation coefficient

A regression line is drawn through the data points, and the symbol key and statistical data are printed at the lower right-hand corner of the diagram.

If the user types "Yes", that is, if he or she wants to eliminate samples from the regression line and calculations, a message on the screen instructs the user to:

Turn on line printer -- Type "1" to continue.

The user switches on the high-speed line printer which is interfaced with the Tektronix system. The printer then generates a listing of each X- and Y- value for all samples. The print-out would look something like this:

1	X= 26	Y= 13.5
2	X= 24	Y= 37
3	X= 50	Y= 105

This listing enables the user to identify those spurious values which should be eliminated from the regression line and correlation coefficient.

After printing is completed, the following question will appear on the screen:

How many samples do you want to eliminate?

The user responds by simply typing a number (followed by the return key). Afterward, the following message will appear on the screen:

Sample # ?

The user will type the number which appeared in the listing. The "sample #" message will appear for each sample to be eliminated. For example, if the user chose to eliminate four samples, the input message "Sample #" would appear four times.

As soon as the last value has been entered, the "Busy" marker light on the right-hand side of the Tektronix console comes on, indicating that the calculations are being performed. Following this, a regression line is drawn through the selected data points.

In the final part of the program, the plotter generates a key of graphics symbols used in the diagram. Below this key the slope, Y-intercept, standard error of estimate, and correlation coefficient are printed.

Afterward, the user is asked if another plot is desired. If he or she types "No, the program is immediately terminated. However, if the user responds affirmatively, he or she is given another choice:

Want a different plotting routine?

If no, the existing plot program in the buffer is re-run from the beginning. The list of major- and trace-elements is displayed, and the user is asked to select his or her choices for the X and Y axes. However, if the user does want a different plotting routine, the existing sub-program is deleted and the list of available plot subprograms is displayed. At this point the user can select a different routine.

Before this is done the user should remove the completed diagram from the X-Y plotter, reload it with new paper, and position the pen at the upper right-hand corner.

GENERATING MORE SPECIALIZED PLOTS USING HSL DATA

Most other plots in this package are similar in format to the one just

discussed. Therefore, it is not necessary to repeat the whole description for each plot. Instead, the essentials will be discussed, along with the basic procedural differences. The sub-programs will be described here in the order that they appear on the program tape.

(1) C1*X vs C2*Y Sub-Program 4

This is the same as the basic X-Y plot, except that the user selects a constant multiplier for each axis. This feature is useful for converting major oxides in weight percent to elements in parts per million. For example, if the user wishes to plot Zr vs Ti, he or she must convert TiO2 (wt. percent) to Ti (ppm). This is done by multiplying TiO2 by 5995. However, since Zr is already in ppm, it should be multiplied by 1.

When the program starts, the list of major oxides and trace elements which can be plotted will appear on the screen, along with the following message:

Which element for X-axis?
X-constant?
Which element for Y-axis?
Y-constant?

The remainder of the program is executed in the same manner as the basic X-Y routine.

(2) X/Y vs Z Sub-Program 5

This program is similar to the basic X-Y format, except that the Y axis represents a ratio rather than a single major oxide or trace element value.

When the user appends this program, the following message appears on the screen:

Which element for X-axis?
Which sub-element for Y-axis (numerator)?
Additional sub-element for Y-axis (denominator)?

The input structure for the Y axis is:

Y = numerator/denominator

The element selected for the X axis may be the same as the numerator or denominator of the Y axis. The execution of the remainder of the program is the same.

(3) C1*(X/Y) vs C2*Z Sub-Program 6

Very similar to the basic X/Y vs Z sub-program, except that the user supplies constants for reasons discussed earlier. The input format is illustrated below:

X axis = element* constant
Y axis = numerator*constant/denominator*constant

When this particular plot routine is selected, the following message appears on the screen:

Which element for X-axis?
X-constant?
Which sub-element for Y-axis (numerator)?
Numerator-constant?
Additional sub-element for Y axis (denominator)?
Denominator-constant?

Execution of the remainder of the program is the same.

(4) C1*(X-Y) vs C2*(W/Z) Sub-Program 7

Ratios (adjusted by user-supplied constants) are calculated and plotted for both X and Y axes. The following input format is used:

X axis= numerator*constant / denominator* constant, i.e., $\frac{Xn^* \text{ constant}}{Xd^* \text{ constant}}$

Y axis= numerator*constant / denominator* constant, i.e., $\frac{Yn^* \text{ constant}}{Yd^* \text{ constant}}$

Once this program is accessed, the following message will appear on the screen:

Which sub-element for X-axis (numerator)?
Numerator-constant?
Additional sub-element for X-axis (denominator)?
Denominator-constant?

Which sub-element for Y-axis (numerator)?

Numerator-constant?
Additional sub-element for Y-axis (denominator)?
Denominator-constant?

Following this procedure, execution of the program is the same as before.

(5) (C1*X + C2*Y) vs C3*Z Sub-Program 8

This program enables two elements to be modified by user-supplied constants and combined; their sum is plotted as a Y-value against an X-value which is also modified by a constant. An example of this plot format would be:

X axis= (FeO*1 + Fe203*.9)

Y axis= (TiO2 * 5995)

Titania (TiO2, in wt. percent) would be converted to titanium (Ti, in ppm) and stored as X-values, while Y-values would be total iron as FeO, in wt. percent. Note how Fe203 was multiplied by a constant (0.9) to convert it to FeO.

When this program is accessed, the following message will appear on the screen:

Which element for X-axis?
X-constant?
Which sub-element for Y-axis?
Y sub-element-constant?
Additional sub-element for Y-axis (to be added)?
Additional Y sub-element-constant?

Following this message, program execution is the same as in the basic X-Y routine.

(6) (C1*X + C2*Y) / C3*Z vs C4*W Sub-Program 9

The input format for this program may be illustrated as follows:

X axis=element * constant, i.e., 9 (TiO2) * 25(constant)

Y axis=numerator ($element_1$ * constant + $element_2$ * constant)/ denominator (element * constant), i.e., $\frac{9(TiO2)*25+/(SiO2)*25}{2(Al2O3) * 25}$

When this program is accessed, the following message appear on the screen:

Which element for X-axis?
X-constant?
First numerator sub-element for Y-axis?
First numerator-constant?
Second numerator sub-element for Y-axis?
Second numerator-constant?
Additional sub-element for Y-axis (denominator)?
Denominator-constant?

Program execution is similar once X and Y values have been identified and calculated.

(7) REE Plot (semi-log) Sub-Program 10

This plot is very different from previous programs, since the Y axis is logarithmic, and the X axis consists of fixed data points (the REEs lanthanum through lutetium). An algorithm to normalize the REEs to chondrites has been included in the program (normalizing factors are those of Frey, F.A., Poetz, J., and Hawkins, L. A., 1968, Rare earth abundances in some basic rocks: J. Geophys. Res., v. 73, p. 6085-6098).

As soon as this program is placed in the memory buffer, the X-Y plotter begins to assemble the diagram. Therefore, it is imperative that the plotter be completely set up (paper inserted, pen positioned at the upper right-hand corner) before the program is loaded.

After the graph has been drawn, the following message will appear on the screen:

*Sample number (1 through 41)**

If the sample selected was not analyzed for rare-earth elements, the following message will appear on the screen:

No REE data available for this sample. Pick another one.
Sample number (1 through 41).

The user then selects another sample. If the sample chosen contains a complete set of REEs, the user will get the following message:

Which plot symbol: 1 = triangle, 2 = square, 3 = cross, 4 = diamond, 5 = invert. triangle.

The user will then select the appropriate plot symbol for the REE pattern. Data from the following eight of 15 REEs comprise the pattern: La, Ce, Nd, Sm, Eu, Tb, Yb, Lu.

After the line is drawn, the user is given the choice of either generating a new graph, or plotting REE patterns for additional samples on the same graph. Also, if the user does not want to plot any more samples, he or she should still request that another graph be printed, in order for the descriptions of plot symbols to be printed on the completed diagram. In order to make this selection, the user will be given the following message on the screen:

Do you want another sample plotted?

If not, then the screen will clear, and the user will be asked to supply a new sample number. This begins a new plot cycle. If the user does want a new graph printed, he or she will be asked to provide sample identification names for each plot symbol. For example, the following message will appear on the screen if a new graph is requested:

Triangles represent which sample #?
Squares represent which sample #?
Crosses represent which sample #?
Diamonds represent which sample #?
Invert. triangles represent which sample #?
Title of graph?

If the program operator did not use a given plot symbol, he or she would

---

* Remember that there are 41 samples in the Honolulu Series set. This number was established in the bootstrap program. If a different data set is used with this program, such that it has fewer or greater than 41 samples, then this number can be easily changed at the beginning of the plot series.

simply not supply a sample name when requested. Just hitting the "Return" key satisfies the input request.

After this procedure the plotter will print the title of the graph and the expression "Rock/Chondrites" vertically along the Y axis. A symbol identification key will be printed in the lower right-hand corner of the diagram.

Subsequently, the following message will appear on the screen:

Change paper in X-Y plotter--hit "return" to continue.

After the user responds, the program will return to the starting point and generate another semi-log REE plot.

(8) Average and standard deviation Sub-Program 11

This abbreviated program does not generate a plot--it simply calculates the average and standard deviation of an elemental ratio for the entire data set. For example, the user can determine the mean and standard deviation of MgO/TiO2 for the Honolulu Series Lavas. Hard copies of these calculations will be generated on the high-speed line printer which is usually interfaced with the Tektronix system.

When this program is accessed, the following message will appear on the screen:

Turn on line printer--hit "Return" to continue program.
Numerator?
Numerator-constant?
Denominator?
Denominator-constant?
Equation?

After this information has been typed in, the computer will pause momentarily while the ratio and statistics are being calculated. Figure 1 is an example of how these data are displayed in the print-out. Note that four

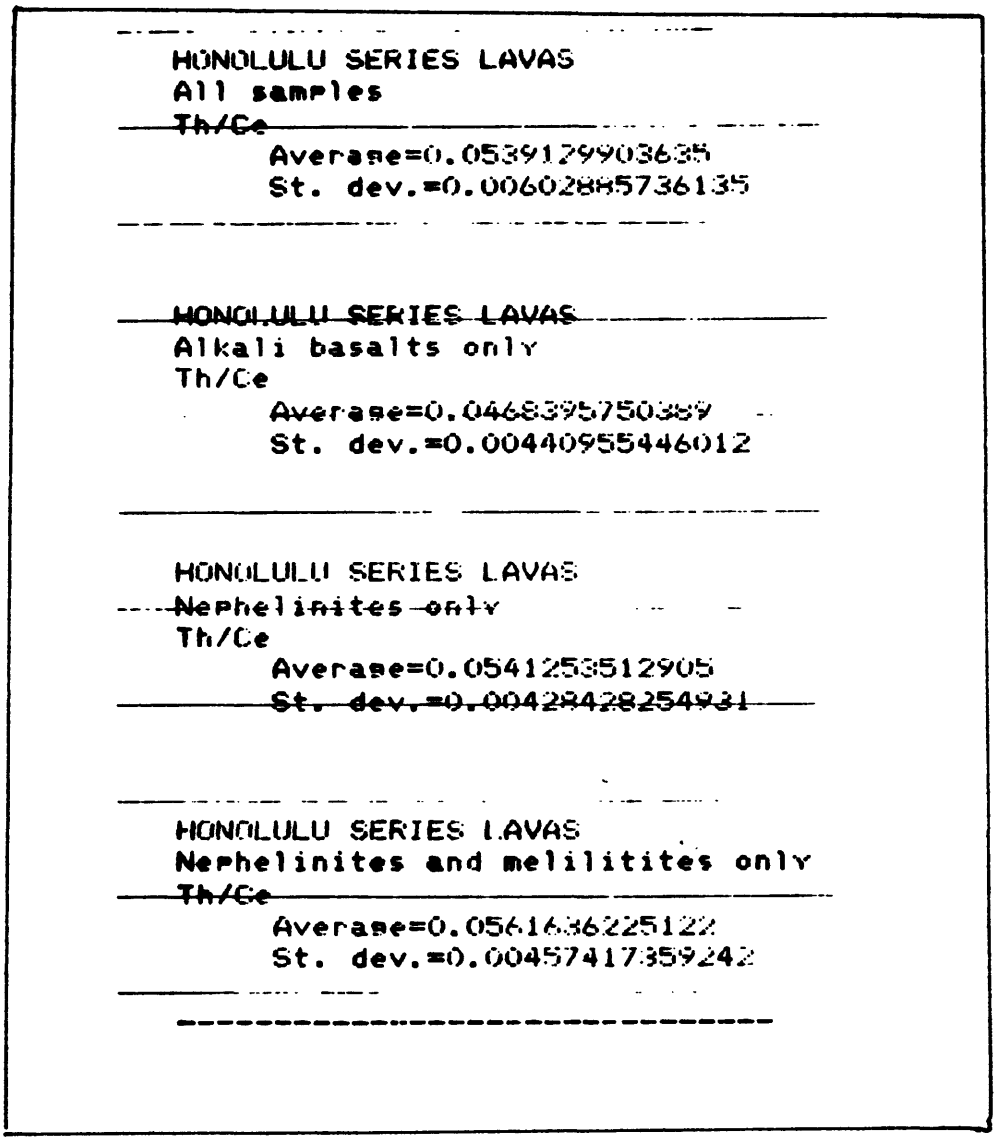


Figure 1: Averages and standard deviations for Th/Ce (Honolulu Series Lavas) are printed out according to this format. Note that separate calculations are made for all samples, alkali basalt samples only, nephelinite samples only, and nephelinites and melilitites only.

separate calculations have been made for the ratio Th/Ce of the Honolulu Series Lavas: 1) all samples, 2) alkali basalts only, 3) nephelinites only, and 4) nephelinites and melilitites only. After the fourth calculation a dashed line is printed to indicate that values for a new ratio will follow.

(9) C1*X vs C2*Y vs C3*Z (Ternary plot) Sub-Program 12

This program generates ternary plots of any three major- or trace-elements, modified by user-supplied constants. The input format is basically similar to the previously described two-component plots.

When the program is accessed the following message will appear on the screen:

YOU WILL CHOOSE THREE ELEMENTS TO BE PLOTTED:
Which element for left-corner?
Element name?
Constant?
Which element for right-corner?
Element name?
Constant?
Which element for top-corner?
Element name?
Constant?
Do you want to eliminate samples from any rock group?
Type "yes" or "no".

In this program it is not necessary to specify minimum and maximum values for the X and Y axes, since the data are normalized to 100 percent. The user will still be requested to either terminate the program or specify the title of the graph with the following message:

Type "stop" here if you wish to re-start the program.
Title of graph:

Program execution is similar to the typical X-Y format, except that a ternary diagram is drawn. Three basic plot symbols are used: triangles, squares, and crosses. As soon as the diagram is completed, the following message

will appear on the screen:

Want another plot?
Want a different plotting routine?

EXAMPLES OF PLOTS

Several of the plots described in the text have been included here:

Figure 2 - X vs Y plot

Figure 3 - Z vs X/Y plot

Figure 4 - C1*Z vs C2*(X/Y)

Figure 5 - REE plot (semi-log)

MAKING MODIFICATIONS IN THE PLOT PROGRAMS

The plot package has been specifically designed for chemical data from the Honolulu Series Lavas. However, the user may substitute a different data set by simply making minor changes in the bootstrap program. This will assure that the new data tape (containing the user's own data set) is read properly. An important proviso is that the data set must not contain more than 45 samples, since memory space in the Tektronix is limited. A larger data set will have to be broken into subsets of 45 or less samples.

Please refer to the listing for the bootstrap program, pages 40 through 41 . If the user's data set contains 30 samples (rather than 41 as in the Honolulu Series Laves), he or she simply needs to change statement #160. It presently reads:

```
160 Let R= 41.
```

The user can change this variable by typing:

```
160  Let R= 30.
```

The program will have to be saved in order to make the change permanent.

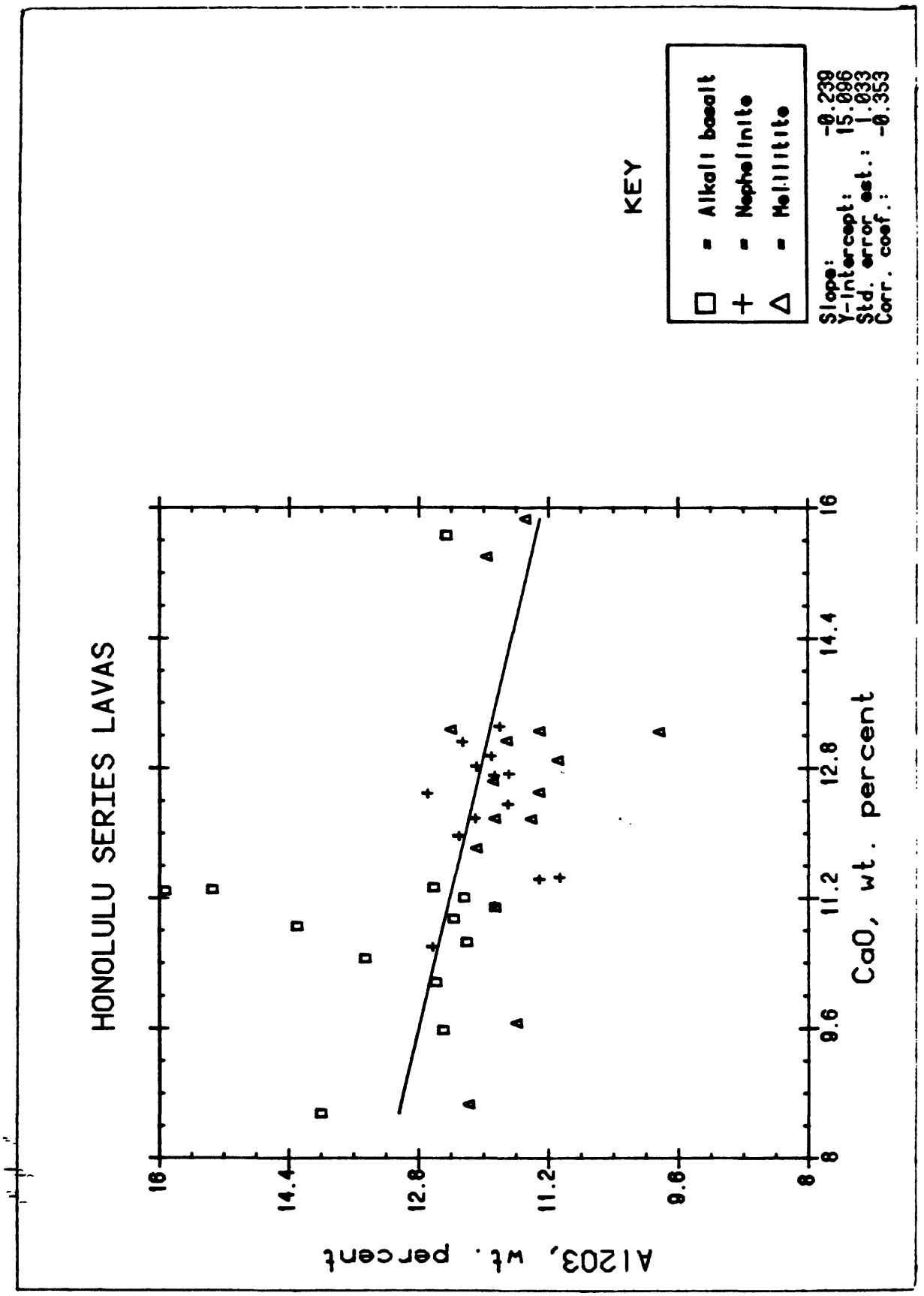


Figure 2: X vs. Y plot (using Honolulu Series Lavas data)

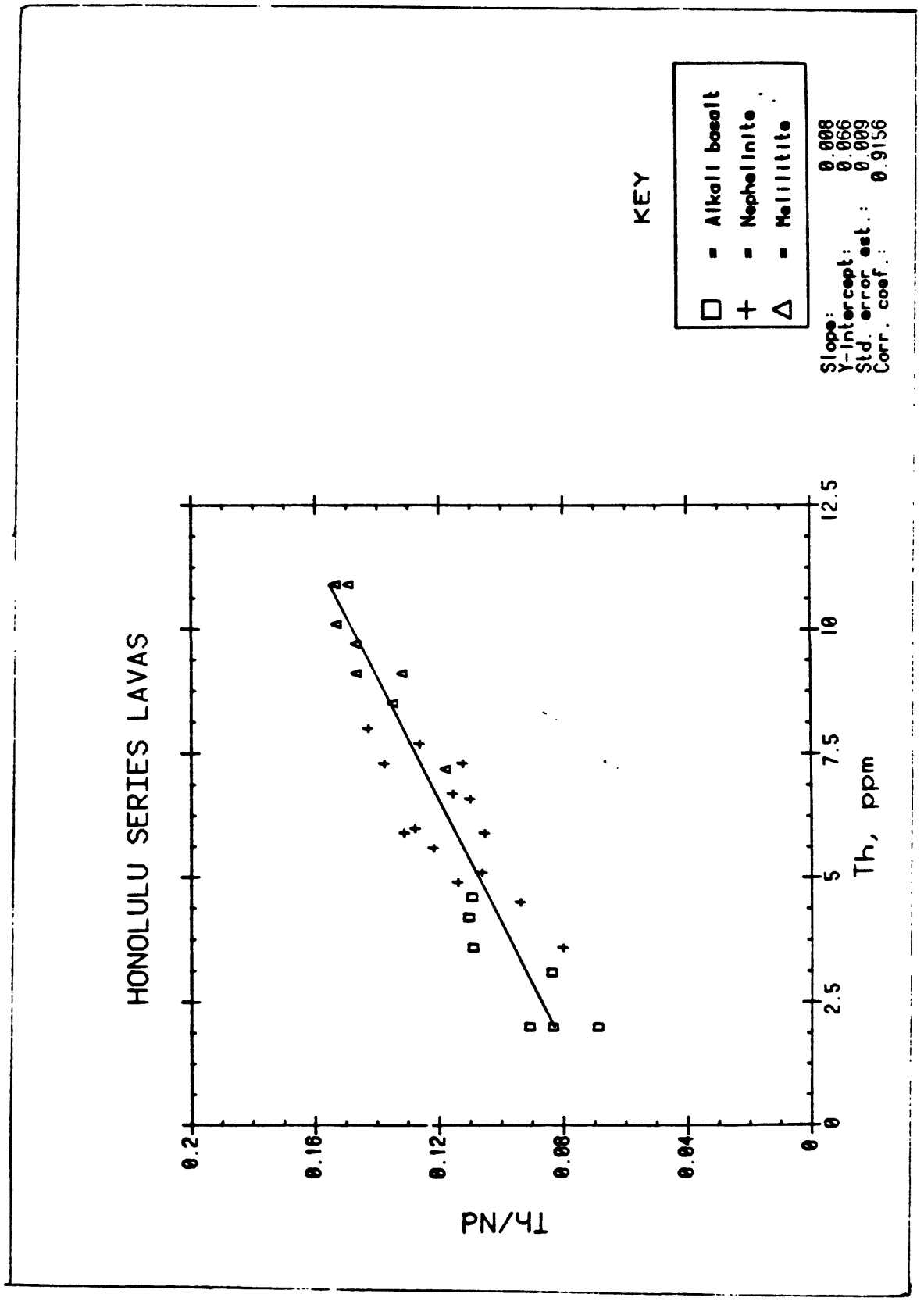


Figure 3: Z vs. X/Y plot (using Honolulu Series data)

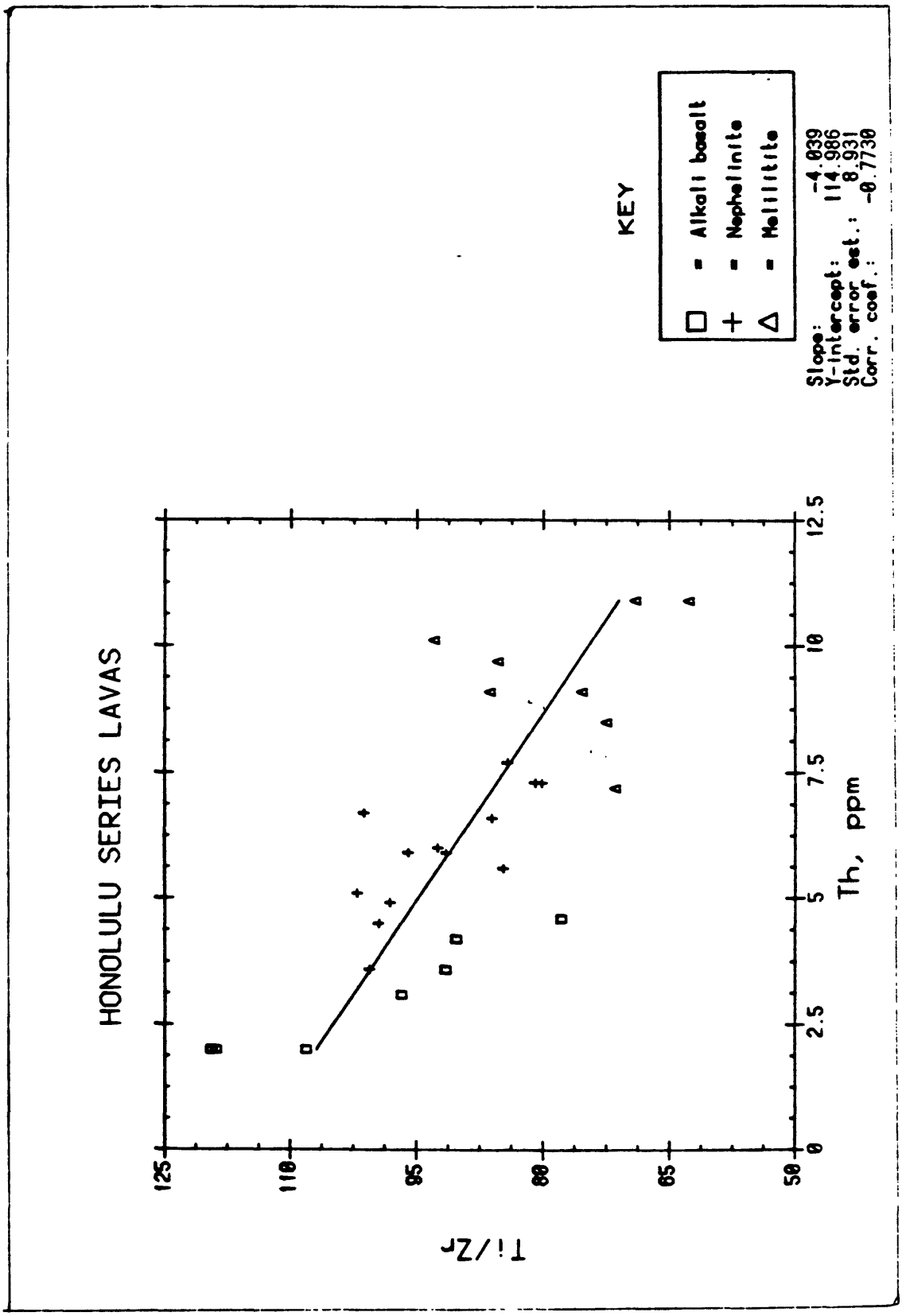


Figure 4: Cl*Z vs. C2* (X/Y) plot (using Honolulu Series data)

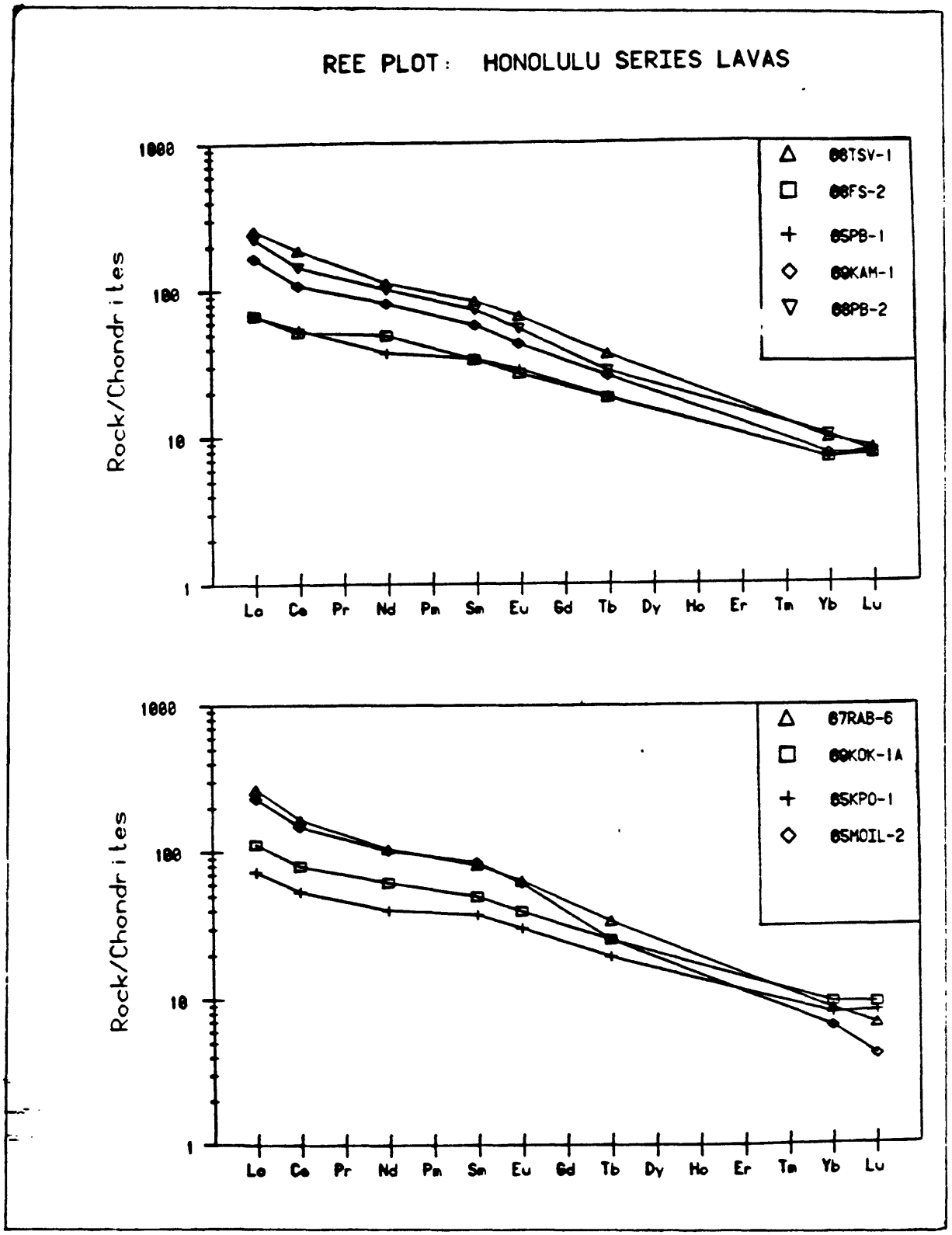


Figure 5: Chondrite-normalized Rare-Earth Element plot (using Honolulu Series data)

This procedure is fully described in another section.

Although the number of samples in the data set may be established by the user, the number of elements in this program is fixed at 41. If the user has data for less than 41 elements, he or she will have to insert a dummy variable (-1) in order to maintain the correct spacing in the matrix. The procedure for doing this will be fully explained later in this section.

Another change that can be made is the classification of the lavas. The Honolulu Series Lava suite is divided into three groups:

(1) Melilitite
(2) Nephelinite
(3) Alkali Olivine Basalt + Basinite (AOB + Bas)

Statement numbers 330 through 340 in the bootstrap program are data statements which contain codes for the given rock types (1 = melilitite in line 330, etc.). There are a total of 41 entries in the data statements, corresponding to each sample. The user must change these two data statements when substituting a different data set.

Making the change

In order to make the necessary changes in the bootstrap program, the user must first access it from the appropriate program tape by inserting the tape cartridge and typing:

"find 2".

It will take several seconds for the tape drive to stop. Once it does the user then types:

"old".

Both the "Busy" and "I/O" marker lamps on the console will be illuminated for a few seconds while the program is being loaded from the tape into the memory buffer. Once the lights go off the program has been loaded and is ready for modification.

After the user has made the suggested changes, he or she can retain these modifications by typing:

"find 2".

Once the tape drive has stopped, the user then types:

"save" (followed, of course, by a carriage return).

After a few moments the "Busy" and "I/O" lamps will go out, indicating that the updated program has been saved. Obviously, the original program will have been superceded by the updated version.

Changes in rock nomenclature

The user may wish to substitute other rock classification names for the ones supplied in this program package (melilitite, nephelinite, AOB+Bas). In order to do this, each plot sub-program will have to be slightly modified, using the method outlined above. For example, if the user wishes to substitute "basalt, andesite, dacite" for "AOB+Bas nephelinite, melilitite", respectively, in the basic X-Y program, he or she will first have to access the program by typing:

"find 3"

followed by:

"old".

Refer to pages 42 through 47 for documentation of the program. These pages include the appropriate listings of statements which need to be changed. For example, statement #1100 reads:

"Group 1 = melilitite, Group 2 = nephelinite, Group 3 = "AOB+Bas".

It should be modified to read:

"Group 1 = dacite, Group 2 = andesite, Group 3 = basalt".

Similarily, statement #3870 reads:

3870 Print @1: "AOB+Bas".

The user should modify this to read:

3870 Print @1: "Basalt".

The same procedure applied to statement #s 3930 (nephelinites), and 4000 (melilitites).

After the changes have been made the user saves the modified program by typing:

"find 3",

followed by

"save".

These changes can be easily made in the other programs as well. Table 1 lists the numbers and location of the appropriate statements which must be changed in each program in order to modify the rock identification names. It should not be necessary to make any additional changes in the programs.

Table 1: Numbers and locations of statements for changing rock identification names in subprograms.

PLOT PROGRAM	PAGES	STATEMENT NUMBERS
Bootstrap Program	40	310
X vs. Y	42, 46	1100, 3870, 3930, 4000
C1*X vs. C2*Y	48, 52, 53	1095, 4380, 4440, 4510
X/Y vs. Z	54, 58, 59	1155, 4360, 4420, 4490
C1*(X/Y) vs. C2*Z	60, 65	1155, 4360, 4420, 4490
C1*(X/Y) vs. C2*(W/Z)	66, 71	1185, 4490, 4550, 4620
C1*X +C2*Y vs. C3*Z	72, 76, 77	1144, 4360, 4420, 4490
C1*X +(C2*Y/ C3*Z) vs. C4*W	78, 83	1135, 4360, 4420, 4490
REE Plot	no changes are necessary	
Average and standard deviation calculations	89	1680, 1700, 1720
C1*X vs. C2*Y vs. C3*Z (Ternary diagram)	90, 92	1155, 4360, 4420, 4490

1. Data Loading Program

```
90 PAGE
100 REM    BEGINNING OF MULTICS PLOT PACKAGE FOR CHEMICAL DATA
110 REM    DESIGNED BY BRIAN GLOBERMAN, USGS  1980
120 DIM B$(10),A$(10)
130 PRINT "DO YOU WANT TO LOAD DATA (A) OR GENERATE PLOTS (B)?"
140 PRINT "TYPE `A' OR `B':";
150 INPUT B$
160 IF B$="A" THEN 200
170 REM    BRANCH TO MASTER PROGRAM
180 FIND 2
190 OLD
200 REM    DATA LOADING PROGRAM
210 PAGE
220 PRINT "How many samples do you have?";
230 INPUT R
240 DELETE A
250 DIM A(41,R)
260 PRINT "Do you want instructions (yes or no)?";
270 INPUT B$
280 IF B$="no" THEN 460
290 PRINT
300 PRINT "DATA LOADING INSTRUCTIONS_____"
310 PRINT "     DATA WILL BE LOADED ONE ELEMENT AT A TIME, starting"
320 PRINT "  with SiO2.   You will insert elemental data for each"
330 PRINT "  sample.  For example, if you have 30 samples, you will"
340 PRINT "  first provide 30 values for SiO2, then for Al2O3, etc."
350 PRINT "  The name of the element will appear at the top of the"
360 PRINT "  screen.  The sample number will appear at the left side"
370 PRINT "  of the screen, followed by a question mark.  Print the"
380 PRINT "  amount of the element present in that particular sample "
390 PRINT "  (wt. percent for major-elements, ppm for trace-elements)"
400 PRINT "  and then hit `return'.  If a value is not available for"
410 PRINT "  a particular sample, type `-1'.  However, if a particular"
420 PRINT "  element was not analyzed in the data set, type `-2'."
430 PRINT "  The program will not ask for additional entries for that"
440 PRINT "  element-- it will instead request data for the following"
450 PRINT "  element."
460 REM    BEGIN DATA-ENTRY PART OF PROGRAM
470 PRINT "This program will wait until you insert the data tape..."
480 PRINT "Hit `return' to continue with the program:";
490 PRINT "INSERT DATA TAPE_____"
500 INPUT B$
510 PRINT
520 PRINT "File number where data are to be stored?";
530 INPUT X1
540 FOR Z1=1 TO 41
550 GO TO 1800
560 IF Z1=1 THEN 970
570 IF Z1=2 THEN 990
580 IF Z1=3 THEN 1010
590 IF Z1=4 THEN 1030
600 IF Z1=5 THEN 1050
610 IF Z1=6 THEN 1070
620 IF Z1=7 THEN 1090
630 IF Z1=8 THEN 1110
640 IF Z1=9 THEN 1130
650 IF Z1=10 THEN 1150
660 IF Z1=11 THEN 1170
670 IF Z1=12 THEN 1190
680 IF Z1=13 THEN 1210
690 IF Z1=14 THEN 1230
700 IF Z1=15 THEN 1250
710 IF Z1=16 THEN 1270
```

```
720 IF Z1=17 THEN 1290
730 IF Z1=18 THEN 1310
740 IF Z1=19 THEN 1330
750 IF Z1=20 THEN 1350
760 IF Z1=21 THEN 1370
770 IF Z1=22 THEN 1390
780 IF Z1=23 THEN 1410
790 IF Z1=24 THEN 1430
800 IF Z1=25 THEN 1450
810 IF Z1=26 THEN 1470
820 IF Z1=27 THEN 1490
830 IF Z1=28 THEN 1510
840 IF Z1=29 THEN 1530
850 IF Z1=30 THEN 1550
860 IF Z1=31 THEN 1570
870 IF Z1=32 THEN 1590
880 IF Z1=33 THEN 1610
890 IF Z1=34 THEN 1630
900 IF Z1=35 THEN 1650
910 IF Z1=36 THEN 1670
920 IF Z1=37 THEN 1690
930 IF Z1=38 THEN 1710
940 IF Z1=39 THEN 1730
950 IF Z1=40 THEN 1750
960 IF Z1=41 THEN 1770
970 A$="SiO2"
980 GO TO 1790
990 A$="Al2O3"
1000 GO TO 1790
1010 A$="Fe2O3"
1020 GO TO 1790
1030 A$="FeO"
1040 GO TO 1790
1050 A$="MgO"
1060 GO TO 1790
1070 A$="CaO"
1080 GO TO 1790
1090 A$="Na2O"
1100 GO TO 1790
1110 A$="K2O"
1120 GO TO 1790
1130 A$="TiO2"
1140 GO TO 1790
1150 A$="P2O5"
1160 GO TO 1790
1170 A$="MnO"
1180 GO TO 1790
1190 A$="Sc"
1200 GO TO 1790
1210 A$="V"
1220 GO TO 1790
1230 A$="Cr"
1240 GO TO 1790
1250 A$="Co"
1260 GO TO 1790
1270 A$="Ni"
1280 GO TO 1790
1290 A$="Cu"
1300 GO TO 1790
1310 A$="Zn"
1320 GO TO 1790
1330 A$="Ga"
1340 GO TO 1790
```

```
1350 A$="Rb"
1360 GO TO 1790
1370 A$="Sr"
1380 GO TO 1790
1390 A$="Y"
1400 GO TO 1790
1410 A$="Zr"
1420 GO TO 1790
1430 A$="Nb"
1440 GO TO 1790
1450 A$="Ba"
1460 GO TO 1790
1470 A$="La"
1480 GO TO 1790
1490 A$="Ce"
1500 GO TO 1790
1510 A$="Nd"
1520 GO TO 1790
1530 A$="Sm"
1540 GO TO 1790
1550 A$="Eu"
1560 GO TO 1790
1570 A$="Tb"
1580 GO TO 1790
1590 A$="Yb"
1600 GO TO 1790
1610 A$="Lu"
1620 GO TO 1790
1630 A$="Hf"
1640 GO TO 1790
1650 A$="Ta"
1660 GO TO 1790
1670 A$="Pb"
1680 GO TO 1790
1690 A$="Th"
1700 GO TO 1790
1710 A$="Li"
1720 GO TO 1790
1730 A$="U"
1740 GO TO 1790
1750 A$="87Sr/86Sr"
1760 GO TO 1790
1770 A$="Ms#"
1780 GO TO 1790
1790 RETURN
1800 PAGE
1810 PRINT "  If a value for a particular element is not available in"
1820 PRINT "  a given sample, type `-1' when data for that sample is"
1830 PRINT "  requested.  If values for a particular element are"
1840 PRINT "  lacking in the entire data set, type `-2' when a value"
1850 PRINT "  for the first sample is requested."
1860 PRINT "  If you want to change the previous data entry, type `-3'"
1870 PRINT
1880 GOSUB 560
1890 FOR N=1 TO R
1900 IF N=15 THEN 1950
1910 IF N=30 THEN 1950
1920 IF N=45 THEN 1950
1930 IF N=60 THEN 1950
1940 GO TO 1960
1950 PAGE
1960 PRINT A$;"     SAMPLE #";N;"  ???   ";
1970 INPUT P
```

```
1980 IF P=-2 THEN 2000
1990 GO TO 2040
2000 FOR M=1 TO R
2010 A(Z1,M)=-1
2020 NEXT M
2030 GO TO 2120
2040 IF P=-3 THEN 2070
2050 A(Z1,N)=P
2060 GO TO 2110
2070 IF N>1 THEN 2090
2080 GO TO 1960
2090 N=N-1
2100 GO TO 1960
2110 NEXT N
2120 NEXT Z1
2130 PAGE
2140 PRINT "  Would you like a listing of your data? (type yes or no)?"
2150 INPUT B$
2160 IF B$="yes" THEN 2180
2170 GO TO 2270
2180 PRINT "Turn on line printer-- hit `return' to continue";
2190 INPUT B$
2200 FOR Z1=1 TO 41
2210 GOSUB 560
2220 PRINT @41:A$
2230 FOR N=1 TO R
2240 PRINT @41:A(Z1,N)
2250 NEXT N
2260 NEXT Z1
2270 PRINT
2280 PRINT "  Do you need to make any corrections in the data---"
2290 PRINT "  type yes or no?";
2300 INPUT B$
2310 IF B$="yes" THEN 2330
2320 GO TO 2620
2330 PAGE
2340 Z1=1
2350 GOSUB 560
2360 FOR Z2=1 TO 10
2370 FOR Z3=1 TO 4
2380 GOSUB 560
2390 PRINT Z1;"  ";A$;"  ";
2400 Z1=Z1+1
2410 NEXT Z3
2420 PRINT
2430 NEXT Z2
2440 GOSUB 560
2450 PRINT Z1;"   ";A$;"   "
2460 PRINT
2470 PRINT "  Use element and sample number to correct data:"
2480 PRINT "  How many samples do you want to correct?";
2490 INPUT Z5
2500 FOR N=1 TO Z5
2510 PRINT "   Element number?";
2520 INPUT Z6
2530 PRINT "   Sample number?";
2540 INPUT Z7
2550 PRINT
2560 PRINT "  Old value= ";A(Z6,Z7)
2570 PRINT "   Input new value: ";
2580 INPUT Z8
2590 A(Z6,Z7)=Z8
2600 PRINT
```

```
2610 NEXT N
2620 PRINT "   Data loading and editing completed.  Values will be"
2630 PRINT "   loaded onto the tape"
2640 FIND X1
2650 PRINT @33:A
2660 PRINT "DONE!!!_____"
2670 REM    Branch to bootstrap program
2680 PAGE
2690 PRINT "Insert program tape if you want to use the plot package--"
2700 PRINT "Hit `return' to continue once you have done this"
2710 INPUT B$
2720 FIND 2
2730 OLD
2740 END
```

2. X-Y Plot Package Bootstrap Program

```
5 INIT
10 PAGE
100 REM     X-Y PLOT PROGRAM DESIGNED BY BRIAN GLOBERMAN.
110 REM     USGS MENLO PARK, MARCH 1980
130 DIM A$(10),B$(50),C$(50),D$(70),J$(10),U(4)
140 DIM E$(10),F$(10),G$(10),H$(10),I$(10)
160 LET R=41
161 DELETE A,B
162 DIM A(43,R),B(R)
180 H$="no"
190 F$="INITIALIZE"
200 PRINT "     *** X - Y  PLOTTING  PROGRAM  ***_____"
210 PRINT
220 PRINT "INSERT DATA TAPE_____-----"
221 PRINT "  Data tape file number?";
223 INPUT T
230 FIND T
240 PRINT
270 ON EOF (0) THEN 310
280 INPUT @33:A
310 REM     1= melilitite, 2= nephelinite, 3= AOB + Bas
320 READ B
330 DATA 1,2,2,1,1,1,2,1,1,1,2,2,2,2,3,3,3,1,2,2,3,3,3,3,1,2,2,2,1
340 DATA 3,3,2,2,1,1,3,3,3,3,1,1
350 DELETE 5,340
370 PRINT "Your data can be plotted in any of the following formats"
380 PRINT "1) X vs. Y"
390 PRINT "2) C1*X vs. C2*Y"
400 PRINT "3) X/Y vs. Z"
410 PRINT "4) C1*(X/Y) vs. C2*Z"
420 PRINT "5) C1*(X/Y) vs. C2*(W/Z)"
430 PRINT "6) C1*X + C2*Y vs. C3*Z"
440 PRINT "7) C1*X + C2*Y/C3*Z  VS. C4*W"
450 PRINT "8) REE PLOT (semi-log)"
460 PRINT "9) AVERAGE AND STANDARD DEVIATION CALCULATION (no plot)"
465 PRINT "10) C1*X VS. C2*Y VS. C3*Z (TERNARY PLOT)"
480 PRINT
500 PRINT "Which plot would you like?";
510 INPUT P
520 P=P+2
530 PRINT
560 PAGE
561 U=0
562 IF P=10 THEN 790
570 PRINT "THE FOLLOWING CHEMICAL ELEMENTS CAN BE PLOTTED:"
580 PRINT
590 PRINT USING 710:"1) SiO2","2) Al2O3","3) Fe2O3","4) FeO"
600 PRINT USING 710:"5) MgO","6) CaO","7) Na2O","8) K2O"
610 PRINT USING 710:"9) TiO2","10) P2O5","11) MnO","       "
620 PRINT
630 PRINT USING 710:"12) Sc","13) V","14) Cr","15) Co"
640 PRINT USING 710:"16) Ni","17) Cu","18) Zn","19) Ga"
650 PRINT USING 710:"20) Rb","21) Sr","22) Y","23) Zr"
660 PRINT USING 710:"24) Nb","25) Ba","26) La","27) Ce"
670 PRINT USING 710:"28) Nd","29) Sm","30) Eu","31) Tb"
680 PRINT USING 710:"32) Yb","33) Lu","34) Hf","35) Ta"
681 IF T=2 THEN 690
682 PRINT USING 710:"36) Pb","37) Th","38) Li","39) U"
683 GO TO 700
690 PRINT USING 710:"36) Pb","37) Th","38) Li","39) H2O(t)"
700 PRINT USING 720:"40) 87Sr/86Sr","41) Mg#"
710 IMAGE 5T,10A,20T,10A,40T,10A,60T,10A
720 IMAGE 5t, 15a,20t,15a
```

```
730 PRINT
740 PRINT "Use corresponding numbers to input elements to be plotted"
741 PRINT "    or calculated."
750 PRINT "_____"
770 IF H$="yes" THEN 790
780 IF F$="yes" THEN 840
790 DELETE 850,60000
800 PRINT "INSERT PROGRAM TAPE____ (type `1' to continue)";
810 INPUT Q
820 FIND P
830 APPEND 840
840 REM     TARGET STATEMENT FOR APPENDED PROGRAM
```

3. X vs. Y Subprogram #3

```
1003 REM     X VS. Y SUBPROGRAM #3( of program tape)
1010 PRINT "Which element for X-axis?";
1020 INPUT X
1030 PRINT "Which element for Y-axis?";
1040 INPUT Y
1050 PRINT "Do you want to eliminate samples from any rock group?"
1060 PRINT "Type `yes' or `no'";
1070 INPUT J$
1080 IF J$="no" THEN 1180
1100 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1110 PRINT "How many groups do you want to eliminate?";
1120 INPUT U(4)
1130 PRINT "Which group(s) do you want to eliminate (use #):"
1140 FOR N=1 TO U(4)
1150 PRINT "#";
1160 INPUT U(N)
1170 NEXT N
1180 PAGE
1181 GOSUB 1190
1182 GO TO 1370
1190 M2=9999999
1200 M4=0
1210 M6=9999999
1220 M8=0
1230 FOR N=1 TO R
1240 IF B(N)=U(1) THEN 1260
1241 IF B(N)=U(2) THEN 1260
1242 IF B(N)=U(3) THEN 1260
1250 GO TO 1300
1260 IF A(X,N)<0 THEN 1360
1270 IF A(Y,N)<0 THEN 1360
1280 A(X,N)=A(X,N)*-100000
1290 A(Y,N)=A(Y,N)*-100000
1300 IF A(X,N)<0 THEN 1360
1310 IF A(Y,N)<0 THEN 1360
1320 M2=M2 MIN A(X,N)
1330 M4=M4 MAX A(X,N)
1340 M6=M6 MIN A(Y,N)
1350 M8=M8 MAX A(Y,N)
1360 NEXT N
1361 RETURN
1370 PRINT
1380 PRINT "Minimum X-value:";M2;"      ";"Maximum X-value:";M4
1390 PRINT "Minimum Y-value:";M6;"      ";"Maximum Y-value:";M8
1400 PRINT
1410 PRINT
1420 PRINT "      WINDOW SETTINGS_____"
1430 PRINT "Lowest X-value desired?";
1440 INPUT W1
1450 PRINT "Highest X-value desired?";
1460 INPUT W2
1470 PRINT "Lowest Y-value desired?";
1480 INPUT W3
1490 PRINT "Highest Y-value desired?";
1500 INPUT W4
1510 MOVE @1:30,10
1520 RDRAW @1:70,0
1530 RDRAW @1:0,70
1540 RDRAW @1:-70,0
1550 RDRAW @1:0,-70
1560 V1=(W2-W1)/10
1570 V2=(W4-W3)/10
1580 PAGE
```

```
1590 PRINT "X axis heading:"
1600 INPUT B$
1610 PRINT "Y axis heading:"
1620 INPUT C$
1630 PRINT "(type `stop' here if you want to re-start the program)"
1640 PRINT "Title of graph:"
1650 INPUT D$
1660 IF D$="stop" THEN 3630
1670 L1=LEN(B$)
1680 L2=LEN(C$)
1690 L3=LEN(D$)
1700 L4=35-L1
1710 L5=35-L2
1720 L6=35-L3
1730 PRINT @1,17:2,3.5
1740 MOVE @1:30,3
1750 RMOVE @1:L4,0
1760 PRINT @1:B$
1770 MOVE @1:30,85
1780 RMOVE @1:L6,0
1790 PRINT @1:D$
1800 MOVE @1:20,10
1810 RMOVE @1:0,L5
1820 SET DEGREES
1830 PRINT @1,25:90
1840 PRINT @1:C$
1850 PRINT @1,25:0
1860 W5=(W2-W1)/5
1870 PRINT @1,17:1.2,2.5
1880 MOVE @1:29,7
1890 FOR N=W1 TO W2 STEP W5
1900 C$=STR(N)
1910 Z2=LEN(C$)-1
1920 Z3=Z2/2
1930 RMOVE @1:-Z3,0
1940 PRINT @1:N
1950 RMOVE @1:Z3,0
1960 RMOVE @1:14,0
1970 NEXT N
1980 W6=(W4-W3)/5
1990 Z1=28
2000 MOVE @1:Z1,9.5
2010 FOR N=W3 TO W4 STEP W6
2020 C$=STR(N)
2030 Z2=LEN(C$)
2040 RMOVE @1:-Z2,0
2050 PRINT @1:N
2060 RMOVE @1:Z2,14
2070 NEXT N
2080 MOVE @1:30,10
2090 RDRAW @1:0,-1
2100 RMOVE @1:0,1
2110 FOR N1=1 TO 5
2120 FOR N2=1 TO 3
2130 RMOVE @1:3.5,0
2140 RDRAW @1:0,0.5
2150 RMOVE @1:0,-0.5
2160 NEXT N2
2170 RMOVE @1:3.5,0
2180 RMOVE @1:0,-1
2190 RDRAW @1:0,2
2200 RMOVE @1:0,-1
2210 NEXT N1
```

```
2220 RDRAW @1:1,0
2230 RMOVE @1:-1,0
2240 FOR N1=1 TO 5
2250 FOR N2=1 TO 3
2260 RMOVE @1:0,3.5
2270 RDRAW @1:-0.5,0
2280 RMOVE @1:0.5,0
2290 NEXT N2
2300 RMOVE @1:0,3.5
2310 RMOVE @1:1,0
2320 RDRAW @1:-2,0
2330 RMOVE @1:1,0
2340 NEXT N1
2350 RDRAW @1:0,1
2360 RMOVE @1:0,-1
2370 FOR N1=1 TO 5
2380 FOR N2=1 TO 3
2390 RMOVE @1:-3.5,0
2400 RDRAW @1:0,-0.5
2410 RMOVE @1:0,0.5
2420 NEXT N2
2430 RMOVE @1:-3.5,0
2440 RMOVE @1:0,1
2450 RDRAW @1:0,-2
2460 RMOVE @1:0,1
2470 NEXT N1
2480 RDRAW @1:-1,0
2490 RMOVE @1:1,0
2500 FOR N1=1 TO 5
2510 FOR N2=1 TO 3
2520 RMOVE @1:0,-3.5
2530 RDRAW @1:0.5,0
2540 RMOVE @1:-0.5,0
2550 NEXT N2
2560 RMOVE @1:0,-3.5
2570 RMOVE @1:-1,0
2580 RDRAW @1:2,0
2590 RMOVE @1:-1,0
2600 NEXT N1
2610 VIEWPORT 30,100,10,80
2620 WINDOW W1,W2,W3,W4
2630 PRINT @1,17:1.5,1.5
2640 FOR N=1 TO R
2650 IF A(X,N)<0 THEN 2690
2660 IF A(Y,N)<0 THEN 2690
2670 MOVE @1:A(X,N),A(Y,N)
2680 GOSUB B(N) OF 2710,2780,2870
2690 NEXT N
2700 GO TO 2950
2710 WINDOW 0,130,0,100
2720 RMOVE @1:-0.75,-0.75
2730 RDRAW @1:1.5,0
2740 RDRAW @1:-0.75,1.5
2750 RDRAW @1:-0.75,-1.5
2760 WINDOW W1,W2,W3,W4
2770 RETURN
2780 WINDOW 0,130,0,100
2790 RMOVE @1:-0.75,0
2800 RDRAW @1:1.5,0
2810 RMOVE @1:-0.75,0
2820 RMOVE @1:0,0.75
2830 RDRAW @1:0,-1.5
2840 RMOVE @1:0,0.75
```

```
2850 WINDOW W1,W2,W3,W4
2860 RETURN
2870 WINDOW 0,130,0,100
2880 RMOVE @1:-0.75,-0.75
2890 RDRAW @1:1.5,0
2900 RDRAW @1:0,1.5
2910 RDRAW @1:-1.5,0
2920 RDRAW @1:0,-1.5
2930 WINDOW W1,W2,W3,W4
2940 RETURN
2950 PRINT "Would you like a least-squares best-fit line drawn  through"
2960 PRINT "the data points (type `yes' or `no')?";
2970 INPUT G$
2980 IF G$="no" THEN 3630
2990 PRINT "Do you want any samples eliminated from calculations-"
3000 PRINT "-type `yes' or `no'?";
3010 INPUT I$
3020 IF I$="no" THEN 3150
3030 PRINT "Turn on line printer-- Type `1' to continue";
3040 INPUT Q
3050 FOR N=1 TO R
3052 IF A(X,N)<0 THEN 3070
3053 IF A(Y,N)<0 THEN 3070
3060 PRINT @41:N;"----X=  ";A(X,N);"      Y=   ";A(Y,N)
3070 NEXT N
3080 PRINT "How many samples do you want to eliminate?";
3090 INPUT I1
3100 FOR N=1 TO I1
3110 PRINT "Sample #?";
3120 INPUT I3
3130 A(Y,I3)=A(Y,I3)*-100000
3140 NEXT N
3150 A1=0
3160 A2=0
3170 R1=0
3180 FOR N=1 TO R
3190 IF A(X,N)<0 THEN 3240
3200 IF A(Y,N)<0 THEN 3240
3210 A1=A1+A(X,N)
3220 A2=A2+A(Y,N)
3230 R1=R1+1
3240 NEXT N
3250 A1=A1/R1
3260 A2=A2/R1
3270 B1=0
3280 B2=0
3290 FOR N=1 TO R
3300 IF A(X,N)<0 THEN 3340
3310 IF A(Y,N)<0 THEN 3340
3320 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3330 B2=B2+(A(X,N)-A1)^2
3340 NEXT N
3341 GOSUB 1190
3350 B3=B1/B2
3360 A3=A2-B3*A1
3370 B4=A3+B3*M2
3380 B5=A3+B3*M4
3390 S1=0
3400 FOR N=1 TO R
3410 IF A(X,N)<0 THEN 3450
3420 IF A(Y,N)<0 THEN 3450
3430 B6=A3+B3*A(X,N)
3440 S1=S1+(A(Y,N)-B6)^2
```

```
3450 NEXT N
3460 S2=SQR(S1/(R1-2))
3470 MOVE @1:M2,B4
3480 DRAW @1:M4,B5
3490 REM     DETERMINE CORRELATION COEFFICIENT (using normalized data)
3500 C3=0
3510 C4=0
3520 C5=0
3530 FOR N=1 TO R
3540 IF A(X,N)<0 THEN 3610
3550 IF A(Y,N)<0 THEN 3610
3560 C1=A(X,N)/W2-A1/W2
3570 C2=A(Y,N)/W4-A2/W4
3580 C3=C3+C1*C2
3590 C4=C4+C1^2
3600 C5=C5+C2^2
3610 NEXT N
3620 C6=C3/SQR(C4*C5)
3630 FOR N=1 TO R
3640 IF A(X,N)>-2 THEN 3650
3645 A(X,N)=A(X,N)/-100000
3650 NEXT N
3660 FOR N=1 TO R
3665 IF A(Y,N)>-2 THEN 3680
3670 A(Y,N)=A(Y,N)/-100000
3680 NEXT N
3690 IF D$="stop" THEN 4120
3700 WINDOW 0,150,0,100
3710 VIEWPORT 0,150,0,100
3720 MOVE @1:120,10
3730 RDRAW @1:30,0
3740 RDRAW @1:0,15
3750 RDRAW @1:-30,0
3760 RDRAW @1:0,-15
3770 RMOVE @1:12,18
3780 PRINT @1,17:2.05,2.5
3790 PRINT @1:"KEY"
3800 MOVE @1:121,20
3810 RDRAW @1:2,0
3820 RDRAW @1:0,2
3830 RDRAW @1:-2,0
3840 RDRAW @1:0,-2
3850 PRINT @1,17:1.2,2.5
3860 RMOVE @1:6,0
3870 PRINT @1:"AOB + Bas"
3880 MOVE @1:122,16
3890 RDRAW @1:0,2
3900 RMOVE @1:-1,-1
3910 RDRAW @1:2,0
3920 RMOVE @1:4,-1
3930 PRINT @1:"Nephelinite"
3940 MOVE @1:122,12
3950 RMOVE @1:-1,0
3960 RDRAW @1:2,0
3970 RDRAW @1:-1,2
3980 RDRAW @1:-1,-2
3990 RMOVE @1:6,0
4000 PRINT @1:"Melilitite"
4010 IF G$="no" THEN 4120
4020 MOVE @1:115,7
4030 PRINT @1: USING 4100:"Slope:",B3
4040 MOVE @1:115,5
4050 PRINT @1: USING 4100:"Y-intercept:",A3
```

```
4060 MOVE @1:115,3
4070 PRINT @1: USING 4100:"Std. error est.:",S2
4080 MOVE @1:115,1
4090 PRINT @1: USING 4110:"Corr. coef.:",C6
4100 IMAGE 16a,4d.4d
4110 IMAGE 16a,3d.3d
4120 PAGE
4130 PRINT "Want another plot?";
4140 INPUT F$
4150 IF F$="no" THEN 4200
4160 PRINT "Want a different plotting routine?";
4170 INPUT H$
4180 IF H$="yes" THEN 370
4190 GO TO 560
4200 END
```

4. C1*X vs. C2*Y Subprogram #4

```
1003 REM     C1*X vs. C2*Y SUBPROGRAM #4 (of program tape)
1020 PRINT "Which element for X-axis?";
1030 INPUT X
1040 PRINT "X-constant?";
1050 INPUT D1
1060 PRINT "Which element for Y-axis?";
1070 INPUT Y
1080 PRINT "Y-constant";
1090 INPUT D2
1091 PRINT "Do you want to eliminate samples from any rock group?"
1092 PRINT "Type `yes' or `no':";
1093 INPUT J$
1094 IF J$="no" THEN 1105
1095 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1096 PRINT "How many groups do you want to eliminate?";
1097 INPUT U(4)
1098 PRINT "Which groups do you want to eliminate (use #)?"
1099 FOR N=1 TO U(4)
1100 PRINT "#";
1101 INPUT U(N)
1102 NEXT N
1105 PAGE
1140 FOR N=1 TO R
1150 A(X,N)=A(X,N)*D1
1160 A(Y,N)=A(Y,N)*D2
1170 NEXT N
1180 PAGE
1190 GOSUB 1290
1191 GO TO 1410
1290 M2=9999999
1300 M4=0
1310 M6=9999999
1320 M8=0
1330 FOR N=1 TO R
1331 IF B(N)=U(1) THEN 1335
1332 IF B(N)=U(2) THEN 1335
1333 IF B(N)=U(3) THEN 1335
1334 GO TO 1340
1335 IF A(X,N)<0 THEN 1400
1336 IF A(Y,N)<0 THEN 1400
1337 A(X,N)=A(X,N)*-100000
1338 A(Y,N)=A(Y,N)*-100000
1340 IF A(X,N)<0 THEN 1400
1350 IF A(Y,N)<0 THEN 1400
1360 M2=M2 MIN A(X,N)
1370 M4=M4 MAX A(X,N)
1380 M6=M6 MIN A(Y,N)
1390 M8=M8 MAX A(Y,N)
1400 NEXT N
1401 RETURN
1410 PRINT "Minimum X-value:";M2;"      ";"Maximum X-value:";M4
1420 PRINT "Minimum Y-value:";M6;"      ";"Maximum Y-value:";M8
1450 PRINT
1460 PRINT
1470 PRINT "     WINDOW SETTINGS_____"
1480 PRINT "Lowest X-value desired?";
1490 INPUT W1
1500 PRINT "Highest X-value desired?";
1510 INPUT W2
1520 PRINT "Lowest Y-value desired?";
1530 INPUT W3
1540 PRINT "Highest Y-value desired?";
1550 INPUT W4
```

```
1580 MOVE @1:30,10
1590 RDRAW @1:70,0
1600 RDRAW @1:0,70
1610 RDRAW @1:-70,0
1620 RDRAW @1:0,-70
1630 V1=(W2-W1)/10
1640 V2=(W4-W3)/10
1660 PAGE
1670 PRINT "X axis heading:"
1680 INPUT B$
1690 PRINT "Y axis heading:"
1700 INPUT C$
1710 PRINT "(type `stop' here if you want to re-start the program)"
1720 PRINT "Title of graph:"
1730 INPUT D$
1740 IF D$="stop" THEN 4140
1750 L1=LEN(B$)
1760 L2=LEN(C$)
1770 L3=LEN(D$)
1780 L4=35-L1
1790 L5=35-L2
1800 L6=35-L3
1810 PRINT @1,17:2,3.5
1830 MOVE @1:30,3
1840 RMOVE @1:L4,0
1850 PRINT @1:B$
1870 MOVE @1:30,85
1880 RMOVE @1:L6,0
1890 PRINT @1:D$
1910 MOVE @1:20,10
1920 RMOVE @1:0,L5
1930 SET DEGREES
1940 PRINT @1,25:90
1950 PRINT @1:C$
1960 PRINT @1,25:0
1980 W5=(W2-W1)/5
1990 PRINT @1,17:1.2,2.5
2000 MOVE @1:29,7
2010 FOR N=W1 TO W2 STEP W5
2020 C$=STR(N)
2030 Z2=LEN(C$)-1
2040 Z3=Z2/2
2050 RMOVE @1:-Z3,0
2060 PRINT @1:N
2070 RMOVE @1:Z3,0
2080 RMOVE @1:14,0
2090 NEXT N
2100 REM     NUMBER Y- AXIS
2110 W6=(W4-W3)/5
2120 Z1=28
2130 MOVE @1:Z1,9.5
2140 FOR N=W3 TO W4 STEP W6
2150 C$=STR(N)
2160 Z2=LEN(C$)
2170 RMOVE @1:-Z2,0
2180 PRINT @1:N
2190 RMOVE @1:Z2,14
2200 NEXT N
2240 MOVE @1:30,10
2250 RDRAW @1:0,-1
2260 RMOVE @1:0,1
2270 FOR N1=1 TO 5
2280 FOR N2=1 TO 3
```

```
2290 RMOVE @1:3.5,0
2300 RDRAW @1:0,0.5
2310 RMOVE @1:0,-0.5
2320 NEXT N2
2330 RMOVE @1:3.5,0
2340 RMOVE @1:0,-1
2350 RDRAW @1:0,2
2360 RMOVE @1:0,-1
2370 NEXT N1
2390 RDRAW @1:1,0
2400 RMOVE @1:-1,0
2410 FOR N1=1 TO 5
2420 FOR N2=1 TO 3
2430 RMOVE @1:0,3.5
2440 RDRAW @1:-0.5,0
2450 RMOVE @1:0.5,0
2460 NEXT N2
2470 RMOVE @1:0,3.5
2480 RMOVE @1:1,0
2490 RDRAW @1:-2,0
2500 RMOVE @1:1,0
2510 NEXT N1
2530 RDRAW @1:0,1
2540 RMOVE @1:0,-1
2550 FOR N1=1 TO 5
2560 FOR N2=1 TO 3
2570 RMOVE @1:-3.5,0
2580 RDRAW @1:0,-0.5
2590 RMOVE @1:0,0.5
2600 NEXT N2
2610 RMOVE @1:-3.5,0
2620 RMOVE @1:0,1
2630 RDRAW @1:0,-2
2640 RMOVE @1:0,1
2650 NEXT N1
2670 RDRAW @1:-1,0
2680 RMOVE @1:1,0
2690 FOR N1=1 TO 5
2700 FOR N2=1 TO 3
2710 RMOVE @1:0,-3.5
2720 RDRAW @1:0.5,0
2730 RMOVE @1:-0.5,0
2740 NEXT N2
2750 RMOVE @1:0,-3.5
2760 RMOVE @1:-1,0
2770 RDRAW @1:2,0
2780 RMOVE @1:-1,0
2790 NEXT N1
2820 VIEWPORT 30,100,10,80
2830 WINDOW W1,W2,W3,W4
2840 PRINT @1,17:1.5,1.5
2900 FOR N=1 TO R
2910 IF A(X,N)<0 THEN 2950
2920 IF A(Y,N)<0 THEN 2950
2930 MOVE @1:A(X,N),A(Y,N)
2940 GOSUB B(N) OF 2980,3060,3160
2950 NEXT N
2960 GO TO 3260
2980 WINDOW 0,130,0,100
2990 RMOVE @1:-0.75,-0.75
3000 RDRAW @1:1.5,0
3010 RDRAW @1:-0.75,1.5
3020 RDRAW @1:-0.75,-1.5
```

```
3030 WINDOW W1,W2,W3,W4
3040 RETURN
3060 WINDOW 0,130,0,100
3070 RMOVE @1:-0.75,0
3080 RDRAW @1:1.5,0
3090 RMOVE @1:-0.75,0
3100 RMOVE @1:0,0.75
3110 RDRAW @1:0,-1.5
3120 RMOVE @1:0,0.75
3130 WINDOW W1,W2,W3,W4
3140 RETURN
3160 WINDOW 0,130,0,100
3170 RMOVE @1:-0.75,-0.75
3180 RDRAW @1:1.5,0
3190 RDRAW @1:0,1.5
3200 RDRAW @1:-1.5,0
3210 RDRAW @1:0,-1.5
3220 WINDOW W1,W2,W3,W4
3230 RETURN
3260 PRINT "Would you like a least-squares best-fit line drawn  through"
3270 PRINT "the data points (type `yes' or `no')?";
3280 INPUT G$
3290 IF G$="no" THEN 4140
3300 REM      ELIMINATE ABBERANT SAMPLES FROM CALCULATIONS
3310 PRINT "Do you want any samples eliminated from calculations-"
3320 PRINT "-type `yes' or `no'?";
3330 INPUT I$
3340 IF I$="no" THEN 3490
3341 PRINT "Turn on line printer-- Type `1' to continue";
3342 INPUT Q
3343 FOR N=1 TO R
3344 IF A(X,N)<0 THEN 3349
3345 IF A(Y,N)<0 THEN 3349
3346 PRINT @41:N;"-----X=      ";A(X,N);"       Y=      ";A(Y,N)
3349 NEXT N
3350 PRINT "How many samples do you want to eliminate?";
3360 INPUT I1
3370 FOR N=1 TO I1
3410 PRINT "Sample #?";
3420 INPUT I3
3450 A(Y,I3)=A(Y,I3)*-100000
3460 NEXT N
3490 A1=0
3500 A2=0
3510 R1=0
3520 FOR N=1 TO R
3530 IF A(X,N)<0 THEN 3580
3540 IF A(Y,N)<0 THEN 3580
3550 A1=A1+A(X,N)
3560 A2=A2+A(Y,N)
3570 R1=R1+1
3580 NEXT N
3590 A1=A1/R1
3600 A2=A2/R1
3630 B1=0
3640 B2=0
3650 FOR N=1 TO R
3660 IF A(X,N)<0 THEN 3700
3670 IF A(Y,N)<0 THEN 3700
3680 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3690 B2=B2+(A(X,N)-A1)^2
3700 NEXT N
3701 GOSUB 1290
```

```
3720 B3=B1/B2
3750 A3=A2-B3*A1
3760 B4=A3+B3*M2
3770 B5=A3+B3*M4
3800 S1=0
3810 FOR N=1 TO R
3820 IF A(X,N)<0 THEN 3860
3830 IF A(Y,N)<0 THEN 3860
3840 B6=A3+B3*A(X,N)
3850 S1=S1+(A(Y,N)-B6)^2
3860 NEXT N
3870 S2=SQR(S1/(R1-2))
3910 MOVE @1:M2,B4
3920 DRAW @1:M4,B5
3980 C3=0
3990 C4=0
4000 C5=0
4010 FOR N=1 TO R
4020 IF A(X,N)<0 THEN 4090
4030 IF A(Y,N)<0 THEN 4090
4040 C1=A(X,N)/W2-A1/W2
4050 C2=A(Y,N)/W4-A2/W4
4060 C3=C3+C1*C2
4070 C4=C4+C1^2
4080 C5=C5+C2^2
4090 NEXT N
4100 C6=C3/SQR(C4*C5)
4140 FOR N=1 TO R
4141 IF A(X,N)>-2 THEN 4160
4142 A(X,N)=A(X,N)/-100000
4160 NEXT N
4165 FOR N=1 TO R
4170 IF A(Y,N)>-2 THEN 4180
4175 A(Y,N)=A(Y,N)/-100000
4180 NEXT N
4181 IF D$="stop" THEN 4630
4210 WINDOW 0,150,0,100
4220 VIEWPORT 0,150,0,100
4230 MOVE @1:120,10
4240 RDRAW @1:30,0
4250 RDRAW @1:0,15
4260 RDRAW @1:-30,0
4270 RDRAW @1:0,-15
4280 RMOVE @1:12,18
4290 PRINT @1,17:2.05,2.5
4300 PRINT @1:"KEY"
4310 MOVE @1:121,20
4320 RDRAW @1:2,0
4330 RDRAW @1:0,2
4340 RDRAW @1:-2,0
4350 RDRAW @1:0,-2
4360 PRINT @1,17:1.2,2.5
4370 RMOVE @1:7,0
4380 PRINT @1:"AOB + Bas"
4390 MOVE @1:122,16
4400 RDRAW @1:0,2
4410 RMOVE @1:-1,-1
4420 RDRAW @1:2,0
4430 RMOVE @1:5,-1
4440 PRINT @1:"Nephelinite"
4450 MOVE @1:122,12
4460 RMOVE @1:-1,0
4470 RDRAW @1:2,0
```

```
4480 RDRAW @1:-1,2
4490 RDRAW @1:-1,-2
4500 RMOVE @1:7,0
4510 PRINT @1:"Melilitite"
4520 IF G$="no" THEN 4630
4530 MOVE @1:115,7
4540 PRINT @1: USING 4610:"Slope:",B3
4550 MOVE @1:115,5
4560 PRINT @1: USING 4610:"Y-intercept:",A3
4570 MOVE @1:115,3
4580 PRINT @1: USING 4610:"Std. error est.:",S2
4590 MOVE @1:115,1
4600 PRINT @1: USING 4620:"Corr. coef.:",C6
4610 IMAGE 16a,4d.4d
4620 IMAGE 16a,3d.3d
4630 PAGE
4640 PRINT "Want another plot?";
4650 INPUT F$
4660 IF F$="no" THEN 4820
4710 FOR N=1 TO R
4720 A(X,N)=A(X,N)/D1
4730 A(Y,N)=A(Y,N)/D2
4740 NEXT N
4780 PRINT "Want a different plotting routine?";
4790 INPUT H$
4800 IF H$="yes" THEN 370
4810 GO TO 560
4820 END
```

5. X/Y vs. Z Subprogram #5

```
1003 REM    X/Y VS. Z SUBPROGRAM #5 (of program tape)
1020 PRINT "Which element for X-axis?";
1030 INPUT X
1060 PRINT "Which subelement for Y-axis (numerator)?";
1070 INPUT Y
1100 PRINT "Additional subelement for Y-axis (denominator)?";
1110 INPUT D3
1151 PRINT "Do you want to eliminate samples from any rock group?"
1152 PRINT "Type `yes' or `no'";
1153 INPUT J$
1154 IF J$="no" THEN 1165
1155 PRINT "Group1=melilitite, Group2=nephelinite, Group3= "AOB + Bas"
1156 PRINT "How many groups do you want to eliminate?";
1157 INPUT U(4)
1158 PRINT "Which group(s) do you want to eliminate (use #):";
1159 FOR N=1 TO U(4)
1160 PRINT "# ";
1161 INPUT U(N)
1162 NEXT N
1165 PAGE
1170 FOR N=1 TO R
1180 A(42,N)=-1
1190 IF A(Y,N)<0 THEN 1250
1200 IF A(D3,N)<0 THEN 1250
1240 A(42,N)=A(Y,N)/A(D3,N)
1250 NEXT N
1260 H=Y
1270 Y=42
1280 PAGE
1300 GOSUB 1390
1310 GO TO 1510
1390 M2=9999999
1400 M4=0
1410 M6=9999999
1420 M8=0
1430 FOR N=1 TO R
1431 IF B(N)=U(1) THEN 1435
1432 IF B(N)=U(2) THEN 1435
1433 IF B(N)=U(3) THEN 1435
1434 GO TO 1440
1435 IF A(X,N)<0 THEN 1500
1436 IF A(Y,N)<0 THEN 1500
1437 A(X,N)=A(X,N)*-100000
1438 A(Y,N)=A(Y,N)*-100000
1440 IF A(X,N)<0 THEN 1500
1450 IF A(Y,N)<0 THEN 1500
1460 M2=M2 MIN A(X,N)
1470 M4=M4 MAX A(X,N)
1480 M6=M6 MIN A(Y,N)
1490 M8=M8 MAX A(Y,N)
1500 NEXT N
1501 RETURN
1510 PRINT "Minimum X-value:";M2;"     ";"Maximum X-value:";M4
1520 PRINT "Minimum Y-value:";M6;"     ";"Maximum Y-value:";M8
1540 PRINT
1550 PRINT
1560 PRINT "     WINDOW SETTINGS_____"
1570 PRINT "Lowest X-value desired?";
1580 INPUT W1
1590 PRINT "Highest X-value desired?";
1600 INPUT W2
1610 PRINT "Lowest Y-value desired?";
1620 INPUT W3
```

```
1630 PRINT "Highest Y-value desired?";
1640 INPUT W4
1660 MOVE @1:30,10
1670 RDRAW @1:70,0
1680 RDRAW @1:0,70
1690 RDRAW @1:-70,0
1700 RDRAW @1:0,-70
1710 V1=(W2-W1)/10
1720 V2=(W4-W3)/10
1740 PAGE
1750 PRINT "X axis heading:"
1760 INPUT B$
1770 PRINT "Y axis heading:"
1780 INPUT C$
1790 PRINT "(type `stop' here if you want to re-start the program)"
1800 PRINT "Title of graph:"
1810 INPUT D$
1820 IF D$="stop" THEN 4130
1830 L1=LEN(B$)
1840 L2=LEN(C$)
1850 L3=LEN(D$)
1860 L4=35-L1
1870 L5=35-L2
1880 L6=35-L3
1890 PRINT @1,17:2,3.5
1910 MOVE @1:30,3
1920 RMOVE @1:L4,0
1930 PRINT @1:B$
1950 MOVE @1:30,85
1960 RMOVE @1:L6,0
1970 PRINT @1:D$
1990 MOVE @1:20,10
2000 RMOVE @1:0,L5
2010 SET DEGREES
2020 PRINT @1,25:90
2030 PRINT @1:C$
2040 PRINT @1,25:0
2060 W5=(W2-W1)/5
2070 PRINT @1,17:1.2,2.5
2080 MOVE @1:29,7
2090 FOR N=W1 TO W2 STEP W5
2100 C$=STR(N)
2110 Z2=LEN(C$)-1
2120 Z3=Z2/2
2130 RMOVE @1:-Z3,0
2140 PRINT @1:N
2150 RMOVE @1:Z3,0
2160 RMOVE @1:14,0
2170 NEXT N
2190 W6=(W4-W3)/5
2200 Z1=28
2210 MOVE @1:Z1,9.5
2220 FOR N=W3 TO W4 STEP W6
2230 C$=STR(N)
2240 Z2=LEN(C$)
2250 RMOVE @1:-Z2,0
2260 PRINT @1:N
2270 RMOVE @1:Z2,14
2280 NEXT N
2310 MOVE @1:30,10
2320 RDRAW @1:0,-1
2330 RMOVE @1:0,1
2340 FOR N1=1 TO 5
```

```
2350 FOR N2=1 TO 3
2360 RMOVE @1:3.5,0
2370 RDRAW @1:0,0.5
2380 RMOVE @1:0,-0.5
2390 NEXT N2
2400 RMOVE @1:3.5,0
2410 RMOVE @1:0,-1
2420 RDRAW @1:0,2
2430 RMOVE @1:0,-1
2440 NEXT N1
2460 RDRAW @1:1,0
2470 RMOVE @1:-1,0
2480 FOR N1=1 TO 5
2490 FOR N2=1 TO 3
2500 RMOVE @1:0,3.5
2510 RDRAW @1:-0.5,0
2520 RMOVE @1:0.5,0
2530 NEXT N2
2540 RMOVE @1:0,3.5
2550 RMOVE @1:1,0
2560 RDRAW @1:-2,0
2570 RMOVE @1:1,0
2580 NEXT N1
2600 RDRAW @1:0,1
2610 RMOVE @1:0,-1
2620 FOR N1=1 TO 5
2630 FOR N2=1 TO 3
2640 RMOVE @1:-3.5,0
2650 RDRAW @1:0,-0.5
2660 RMOVE @1:0,0.5
2670 NEXT N2
2680 RMOVE @1:-3.5,0
2690 RMOVE @1:0,1
2700 RDRAW @1:0,-2
2710 RMOVE @1:0,1
2720 NEXT N1
2740 RDRAW @1:-1,0
2750 RMOVE @1:1,0
2760 FOR N1=1 TO 5
2770 FOR N2=1 TO 3
2780 RMOVE @1:0,-3.5
2790 RDRAW @1:0.5,0
2800 RMOVE @1:-0.5,0
2810 NEXT N2
2820 RMOVE @1:0,-3.5
2830 RMOVE @1:-1,0
2840 RDRAW @1:2,0
2850 RMOVE @1:-1,0
2860 NEXT N1
2880 VIEWPORT 30,100,10,80
2890 WINDOW W1,W2,W3,W4
2900 PRINT @1,17:1.5,1.5
2950 FOR N=1 TO R
2960 IF A(X,N)<0 THEN 3000
2970 IF A(Y,N)<0 THEN 3000
2980 MOVE @1:A(X,N),A(Y,N)
2990 GOSUB B(N) OF 3030,3110,3210
3000 NEXT N
3010 GO TO 3300
3030 WINDOW 0,130,0,100
3040 RMOVE @1:-0.75,-0.75
3050 RDRAW @1:1.5,0
3060 RDRAW @1:-0.75,1.5
```

```
3070 RDRAW @1:-0.75,-1.5
3080 WINDOW W1,W2,W3,W4
3090 RETURN
3110 WINDOW 0,130,0,100
3120 RMOVE @1:-0.75,0
3130 RDRAW @1:1.5,0
3140 RMOVE @1:-0.75,0
3150 RMOVE @1:0,0.75
3160 RDRAW @1:0,-1.5
3170 RMOVE @1:0,0.75
3180 WINDOW W1,W2,W3,W4
3190 RETURN
3210 WINDOW 0,130,0,100
3220 RMOVE @1:-0.75,-0.75
3230 RDRAW @1:1.5,0
3240 RDRAW @1:0,1.5
3250 RDRAW @1:-1.5,0
3260 RDRAW @1:0,-1.5
3270 WINDOW W1,W2,W3,W4
3280 RETURN
3300 PRINT "Would you like a least-squares best-fit line drawn  through"
3310 PRINT "the data points (type `yes' or `no')?";
3320 INPUT G$
3330 IF G$="no" THEN 4130
3350 PRINT "Do you want any samples eliminated from calculations-"
3360 PRINT "-type `yes' or `no'?";
3370 INPUT I$
3380 IF I$="no" THEN 3520
3381 PRINT "Turn on line printer-- Type `1' to continue";
3382 INPUT 0
3383 FOR N=1 TO R
3384 IF A(X,N)<0 THEN 3389
3385 IF A(Y,N)<0 THEN 3389
3386 PRINT @41:N;"-----X=    ";A(X,N);"     Y=    ";A(Y,N)
3389 NEXT N
3390 PRINT "How many samples do you want to eliminate?";
3400 INPUT I1
3410 FOR N=1 TO I1
3440 PRINT "Sample #?";
3450 INPUT I3
3480 A(Y,I3)=A(Y,I3)*-100000
3490 NEXT N
3520 A1=0
3530 A2=0
3540 R1=0
3541 A8=0
3542 A3=0
3543 A4=0
3550 FOR N=1 TO R
3560 IF A(X,N)<0 THEN 3610
3570 IF A(Y,N)<0 THEN 3610
3580 A1=A1+A(X,N)
3590 A2=A2+A(Y,N)
3591 A8=A8+A(Y,N)^2
3600 R1=R1+1
3610 NEXT N
3620 A1=A1/R1
3630 A2=A2/R1
3660 B1=0
3670 B2=0
3680 FOR N=1 TO R
3690 IF A(X,N)<0 THEN 3730
3700 IF A(Y,N)<0 THEN 3730
```

```
3701 A3=A3+(A(Y,N)-A8)
3702 A4=A4+(A(Y,N)-A8)^2
3710 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3720 B2=B2+(A(X,N)-A1)^2
3730 NEXT N
3731 GOSUB 1390
3750 B3=B1/B2
3780 A3=A2-B3*A1
3790 B4=A3+B3*M2
3800 B5=A3+B3*M4
3830 S1=0
3840 FOR N=1 TO R
3850 IF A(X,N)<0 THEN 3890
3860 IF A(Y,N)<0 THEN 3890
3870 B6=A3+B3*A(X,N)
3880 S1=S1+(A(Y,N)-B6)^2
3890 NEXT N
3900 S2=SQR(S1/(R1-2))
3920 MOVE @1:M2,B4
3930 DRAW @1:M4,B5
3980 C3=0
3990 C4=0
4000 C5=0
4010 FOR N=1 TO R
4020 IF A(X,N)<0 THEN 4090
4030 IF A(Y,N)<0 THEN 4090
4040 C1=A(X,N)/W2-A1/W2
4050 C2=A(Y,N)/W4-A2/W4
4060 C3=C3+C1*C2
4070 C4=C4+C1^2
4080 C5=C5+C2^2
4090 NEXT N
4100 C6=C3/SQR(C4*C5)
4130 FOR N=1 TO R
4131 IF A(X,N)>-2 THEN 4150
4132 A(X,N)=A(X,N)/-100000
4150 NEXT N
4155 FOR N=1 TO R
4160 IF A(Y,N)>-2 THEN 4170
4161 A(Y,N)=A(Y,N)/-100000
4170 NEXT N
4180 IF D$="stop" THEN 4610
4190 WINDOW 0,150,0,100
4200 VIEWPORT 0,150,0,100
4210 MOVE @1:120,10
4220 RDRAW @1:30,0
4230 RDRAW @1:0,15
4240 RDRAW @1:-30,0
4250 RDRAW @1:0,-15
4260 RMOVE @1:12,18
4270 PRINT @1,17:2.05,2.5
4280 PRINT @1:"KEY"
4290 MOVE @1:121,20
4300 RDRAW @1:2,0
4310 RDRAW @1:0,2
4320 RDRAW @1:-2,0
4330 RDRAW @1:0,-2
4340 PRINT @1,17:1.2,2.5
4350 RMOVE @1:7,0
4360 PRINT @1:"AOB + Bas"
4370 MOVE @1:122,16
4380 RDRAW @1:0,2
4390 RMOVE @1:-1,-1
```

```
4400 RDRAW @1:2,0
4410 RMOVE @1:5,-1
4420 PRINT @1:"Nephelinite"
4430 MOVE @1:122,12
4440 RMOVE @1:-1,0
4450 RDRAW @1:2,0
4460 RDRAW @1:-1,2
4470 RDRAW @1:-1,-2
4480 RMOVE @1:7,0
4490 PRINT @1:"Melilitite"
4500 IF G$="no" THEN 4610
4510 MOVE @1:115,7
4520 PRINT @1: USING 4590:"Slope:",B3
4530 MOVE @1:115,5
4540 PRINT @1: USING 4590:"Y-intercept:",A3
4550 MOVE @1:115,3
4560 PRINT @1: USING 4590:"Std. error est.:",S2
4570 MOVE @1:115,1
4580 PRINT @1: USING 4600:"Corr. coef.:",C6
4590 IMAGE 16a,4d.4d
4600 IMAGE 16a,3d.3d
4610 PAGE
4620 PRINT "Want another plot?";
4630 INPUT F$
4640 IF F$="no" THEN 4780
4660 Y=H
4740 PRINT "Want a different plotting routine?";
4750 INPUT H$
4760 IF H$="yes" THEN 370
4770 GO TO 560
4780 END
```

6. C1* (X/Y) vs. C2*Z Subprogram #6

```
1003 REM    C1*(X/Y) VS. C2*Z SUBPROGRAM #6 (of program tape)
1020 PRINT "Which element for X-axis?";
1030 INPUT X
1040 PRINT "X-constant?";
1050 INPUT D1
1060 PRINT "Which subelement for Y-axis (numerator)?";
1070 INPUT Y
1080 PRINT "Numerator-constant?";
1090 INPUT D2
1100 PRINT "Additional subelement for Y-axis (denominator)?";
1110 INPUT D3
1120 PRINT "Denominator-constant?";
1130 INPUT D4
1151 PRINT "Do you want to eliminate samples from any rock group?"
1152 PRINT "Type `yes' or `no'";
1153 INPUT J$
1154 IF J$="no" THEN 1165
1155 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1156 PRINT "How many groups do you want to eliminate?";
1157 INPUT U(4)
1158 PRINT "Which group(s) do you want to eliminate (use #):";
1159 FOR N=1 TO U(4)
1160 PRINT "# ";
1161 INPUT U(N)
1162 NEXT N
1165 PAGE
1170 FOR N=1 TO R
1180 A(42,N)=-1
1190 IF A(Y,N)<0 THEN 1250
1200 IF A(D3,N)<0 THEN 1250
1210 A(X,N)=A(X,N)*D1
1220 A(Y,N)=A(Y,N)*D2
1230 A(D3,N)=A(D3,N)*D4
1240 A(42,N)=A(Y,N)/A(D3,N)
1250 NEXT N
1260 H=Y
1270 Y=42
1280 PAGE
1300 GOSUB 1390
1310 GO TO 1510
1390 M2=9999999
1400 M4=0
1410 M6=9999999
1420 M8=0
1430 FOR N=1 TO R
1431 IF B(N)=U(1) THEN 1435
1432 IF B(N)=U(2) THEN 1435
1433 IF B(N)=U(3) THEN 1435
1434 GO TO 1440
1435 IF A(X,N)<0 THEN 1500
1436 IF A(Y,N)<0 THEN 1500
1437 A(X,N)=A(X,N)*-100000
1438 A(Y,N)=A(Y,N)*-100000
1440 IF A(X,N)<0 THEN 1500
1450 IF A(Y,N)<0 THEN 1500
1460 M2=M2 MIN A(X,N)
1470 M4=M4 MAX A(X,N)
1480 M6=M6 MIN A(Y,N)
1490 M8=M8 MAX A(Y,N)
1500 NEXT N
1501 RETURN
1510 PRINT "Minimum X-value:";M2;"      ";"Maximum X-value:";M4
1520 PRINT "Minimum Y-value:";M6;"      ";"Maximum Y-value:";M8
```

```
1540 PRINT
1550 PRINT
1560 PRINT "     WINDOW SETTINGS_____"
1570 PRINT "Lowest X-value desired?";
1580 INPUT W1
1590 PRINT "Highest X-value desired?";
1600 INPUT W2
1610 PRINT "Lowest Y-value desired?";
1620 INPUT W3
1630 PRINT "Highest Y-value desired?";
1640 INPUT W4
1660 MOVE @1:30,10
1670 RDRAW @1:70,0
1680 RDRAW @1:0,70
1690 RDRAW @1:-70,0
1700 RDRAW @1:0,-70
1710 V1=(W2-W1)/10
1720 V2=(W4-W3)/10
1740 PAGE
1750 PRINT "X axis heading:"
1760 INPUT B$
1770 PRINT "Y axis heading:"
1780 INPUT C$
1790 PRINT "(type 'stop' here if you want to re-start the program)"
1800 PRINT "Title of graph:"
1810 INPUT D$
1820 IF D$="stop" THEN 4130
1830 L1=LEN(B$)
1840 L2=LEN(C$)
1850 L3=LEN(D$)
1860 L4=35-L1
1870 L5=35-L2
1880 L6=35-L3
1890 PRINT @1,17:2,3.5
1910 MOVE @1:30,3
1920 RMOVE @1:L4,0
1930 PRINT @1:B$
1950 MOVE @1:30,85
1960 RMOVE @1:L6,0
1970 PRINT @1:D$
1990 MOVE @1:20,10
2000 RMOVE @1:0,L5
2010 SET DEGREES
2020 PRINT @1,25:90
2030 PRINT @1:C$
2040 PRINT @1,25:0
2060 W5=(W2-W1)/5
2070 PRINT @1,17:1.2,2.5
2080 MOVE @1:29,7
2090 FOR N=W1 TO W2 STEP W5
2100 C$=STR(N)
2110 Z2=LEN(C$)-1
2120 Z3=Z2/2
2130 RMOVE @1:-Z3,0
2140 PRINT @1:N
2150 RMOVE @1:Z3,0
2160 RMOVE @1:14,0
2170 NEXT N
2190 W6=(W4-W3)/5
2200 Z1=28
2210 MOVE @1:Z1,9.5
2220 FOR N=W3 TO W4 STEP W6
2230 C$=STR(N)
```

```
2240 Z2=LEN(C$)
2250 RMOVE @1:-Z2,0
2260 PRINT @1:N
2270 RMOVE @1:Z2,14
2280 NEXT N
2310 MOVE @1:30,10
2320 RDRAW @1:0,-1
2330 RMOVE @1:0,1
2340 FOR N1=1 TO 5
2350 FOR N2=1 TO 3
2360 RMOVE @1:3.5,0
2370 RDRAW @1:0,0.5
2380 RMOVE @1:0,-0.5
2390 NEXT N2
2400 RMOVE @1:3.5,0
2410 RMOVE @1:0,-1
2420 RDRAW @1:0,2
2430 RMOVE @1:0,-1
2440 NEXT N1
2460 RDRAW @1:1,0
2470 RMOVE @1:-1,0
2480 FOR N1=1 TO 5
2490 FOR N2=1 TO 3
2500 RMOVE @1:0,3.5
2510 RDRAW @1:-0.5,0
2520 RMOVE @1:0.5,0
2530 NEXT N2
2540 RMOVE @1:0,3.5
2550 RMOVE @1:1,0
2560 RDRAW @1:-2,0
2570 RMOVE @1:1,0
2580 NEXT N1
2600 RDRAW @1:0,1
2610 RMOVE @1:0,-1
2620 FOR N1=1 TO 5
2630 FOR N2=1 TO 3
2640 RMOVE @1:-3.5,0
2650 RDRAW @1:0,-0.5
2660 RMOVE @1:0,0.5
2670 NEXT N2
2680 RMOVE @1:-3.5,0
2690 RMOVE @1:0,1
2700 RDRAW @1:0,-2
2710 RMOVE @1:0,1
2720 NEXT N1
2740 RDRAW @1:-1,0
2750 RMOVE @1:1,0
2760 FOR N1=1 TO 5
2770 FOR N2=1 TO 3
2780 RMOVE @1:0,-3.5
2790 RDRAW @1:0.5,0
2800 RMOVE @1:-0.5,0
2810 NEXT N2
2820 RMOVE @1:0,-3.5
2830 RMOVE @1:-1,0
2840 RDRAW @1:2,0
2850 RMOVE @1:-1,0
2860 NEXT N1
2880 VIEWPORT 30,100,10,80
2890 WINDOW W1,W2,W3,W4
2900 PRINT @1,17:1.5,1.5
2950 FOR N=1 TO R
2960 IF A(X,N)<0 THEN 3000
```

```
2970 IF A(Y,N)<0 THEN 3000
2980 MOVE @1:A(X,N),A(Y,N)
2990 GOSUB B(N) OF 3030,3110,3210
3000 NEXT N
3010 GO TO 3300
3030 WINDOW 0,130,0,100
3040 RMOVE @1:-0.75,-0.75
3050 RDRAW @1:1.5,0
3060 RDRAW @1:-0.75,1.5
3070 RDRAW @1:-0.75,-1.5
3080 WINDOW W1,W2,W3,W4
3090 RETURN
3110 WINDOW 0,130,0,100
3120 RMOVE @1:-0.75,0
3130 RDRAW @1:1.5,0
3140 RMOVE @1:-0.75,0
3150 RMOVE @1:0,0.75
3160 RDRAW @1:0,-1.5
3170 RMOVE @1:0,0.75
3180 WINDOW W1,W2,W3,W4
3190 RETURN
3210 WINDOW 0,130,0,100
3220 RMOVE @1:-0.75,-0.75
3230 RDRAW @1:1.5,0
3240 RDRAW @1:0,1.5
3250 RDRAW @1:-1.5,0
3260 RDRAW @1:0,-1.5
3270 WINDOW W1,W2,W3,W4
3280 RETURN
3300 PRINT "Would you like a least-squares best-fit line drawn  through"
3310 PRINT "the data points (type `yes' or `no')?";
3320 INPUT G$
3330 IF G$="no" THEN 4130
3350 PRINT "Do you want any samples eliminated from calculations-"
3360 PRINT "-type `yes' or `no'?";
3370 INPUT I$
3380 IF I$="no" THEN 3520
3381 PRINT "Turn on line printer-- Type `1' to continue";
3382 INPUT D
3383 FOR N=1 TO R
3384 IF A(X,N)<0 THEN 3389
3385 IF A(Y,N)<0 THEN 3389
3386 PRINT @41:N;"-----X=    ";A(X,N);"     Y=    ";A(Y,N)
3389 NEXT N
3390 PRINT "How many samples do you want to eliminate?";
3400 INPUT I1
3410 FOR N=1 TO I1
3440 PRINT "Sample #?";
3450 INPUT I3
3480 A(Y,I3)=A(Y,I3)*-100000
3490 NEXT N
3520 A1=0
3530 A2=0
3540 R1=0
3541 A8=0
3542 A3=0
3543 A4=0
3550 FOR N=1 TO R
3560 IF A(X,N)<0 THEN 3610
3570 IF A(Y,N)<0 THEN 3610
3580 A1=A1+A(Y,N)
3590 A2=A2+A(Y,N)
3591 A8=A8+A(Y,N)^2
```

```
3600 R1=R1+1
3610 NEXT N
3620 A1=A1/R1
3630 A2=A2/R1
3660 B1=0
3670 B2=0
3680 FOR N=1 TO R
3690 IF A(X,N)<0 THEN 3730
3700 IF A(Y,N)<0 THEN 3730
3701 A3=A3+(A(Y,N)-A8)
3702 A4=A4+(A(Y,N)-A8)^2
3710 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3720 B2=B2+(A(X,N)-A1)^2
3730 NEXT N
3731 GOSUB 1390
3750 B3=B1/B2
3780 A3=A2-B3*A1
3790 B4=A3+B3*M2
3800 B5=A3+B3*M4
3830 S1=0
3840 FOR N=1 TO R
3850 IF A(X,N)<0 THEN 3890
3860 IF A(Y,N)<0 THEN 3890
3870 B6=A3+B3*A(X,N)
3880 S1=S1+(A(Y,N)-B6)^2
3890 NEXT N
3900 S2=SQR(S1/(R1-2))
3920 MOVE @1:M2,B4
3930 DRAW @1:M4,B5
3980 C3=0
3990 C4=0
4000 C5=0
4010 FOR N=1 TO R
4020 IF A(X,N)<0 THEN 4090
4030 IF A(Y,N)<0 THEN 4090
4040 C1=A(X,N)/W2-A1/W2
4050 C2=A(Y,N)/W4-A2/W4
4060 C3=C3+C1*C2
4070 C4=C4+C1^2
4080 C5=C5+C2^2
4090 NEXT N
4100 C6=C3/SQR(C4*C5)
4130 FOR N=1 TO R
4131 IF A(X,N)>-2 THEN 4150
4132 A(Y,N)=A(Y,N)/-100000
4150 NEXT N
4155 FOR N=1 TO R
4160 IF A(Y,N)>-2 THEN 4170
4161 A(Y,N)=A(Y,N)/-100000
4170 NEXT N
4180 IF D$="stop" THEN 4610
4190 WINDOW 0,150,0,100
4200 VIEWPORT 0,150,0,100
4210 MOVE @1:120,10
4220 RDRAW @1:30,0
4230 RDRAW @1:0,15
4240 RDRAW @1:-30,0
4250 RDRAW @1:0,-15
4260 RMOVE @1:12,18
4270 PRINT @1,17:2.05,2.5
4280 PRINT @1:"KEY"
4290 MOVE @1:121,20
4300 RDRAW @1:2,0
```

```
4310 RDRAW @1:0,2
4320 RDRAW @1:-2,0
4330 RDRAW @1:0,-2
4340 PRINT @1,17:1.2,2.5
4350 RMOVE @1:7,0
4360 PRINT @1:"AOB + Bas"
4370 MOVE @1:122,16
4380 RDRAW @1:0,2
4390 RMOVE @1:-1,-1
4400 RDRAW @1:2,0
4410 RMOVE @1:5,-1
4420 PRINT @1:"Nephelinite"
4430 MOVE @1:122,12
4440 RMOVE @1:-1,0
4450 RDRAW @1:2,0
4460 RDRAW @1:-1,2
4470 RDRAW @1:-1,-2
4480 RMOVE @1:7,0
4490 PRINT @1:"Melilitite"
4500 IF G$="no" THEN 4610
4510 MOVE @1:115,7
4520 PRINT @1: USING 4590:"Slope:",B3
4530 MOVE @1:115,5
4540 PRINT @1: USING 4590:"Y-intercept:",A3
4550 MOVE @1:115,3
4560 PRINT @1: USING 4590:"Std. error est.:",S2
4570 MOVE @1:115,1
4580 PRINT @1: USING 4600:"Corr. coef.:",C6
4590 IMAGE 16a,4d.4d
4600 IMAGE 16a,3d.3d
4610 PAGE
4620 PRINT "Want another plot?";
4630 INPUT F$
4640 IF F$="no" THEN 4780
4660 Y=H
4670 FOR N=1 TO R
4680 A(X,N)=A(X,N)/D1
4690 A(Y,N)=A(Y,N)/D2
4700 A(D3,N)=A(D3,N)/D4
4710 NEXT N
4740 PRINT "Want a different plotting routine?";
4750 INPUT H$
4760 IF H$="yes" THEN 370
4770 GO TO 560
4780 END
```

7. C1* (X/Y) vs. C2* (W/Z) Subprogram #7

```
1003 REM    C1*(X/Y) VS. C2*(W/Z) SUBPROGRAM #7 (of program tape)
1020 PRINT "Which subelement for X-axis (numerator)?";
1030 INPUT X
1040 PRINT "Numerator-constant?";
1050 INPUT D1
1060 PRINT "Additional subelement for X-axis (denominator)?";
1070 INPUT D6
1080 PRINT "Denominator-constant?";
1090 INPUT D7
1100 PRINT "Which subelement for Y-axis (numerator)?";
1110 INPUT Y
1120 PRINT "Numerator-constant?";
1130 INPUT D2
1140 PRINT "Additional subelement for Y-axis (denominator)?";
1150 INPUT D3
1160 PRINT "Denominator-constant?";
1170 INPUT D4
1181 PRINT "Do you want to eliminate samples from any rock group?"
1182 PRINT "Type `yes' or `no':";
1183 INPUT J$
1184 IF J$="no" THEN 1200
1185 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1186 PRINT "How many groups do you want to eliminate?";
1187 INPUT U(4)
1188 PRINT "Which groups do you want to eliminate (use #):"
1189 FOR N=1 TO U(4)
1190 PRINT "# ";
1191 INPUT U(N)
1192 NEXT N
1200 PAGE
1210 FOR N=1 TO R
1220 A(42,N)=-1
1230 A(43,N)=-1
1240 IF A(Y,N)<0 THEN 1340
1250 IF A(D3,N)<0 THEN 1340
1260 IF A(X,N)<0 THEN 1340
1270 IF A(D6,N)<0 THEN 1340
1280 A(X,N)=A(X,N)*D1
1290 A(Y,N)=A(Y,N)*D2
1300 A(D3,N)=A(D3,N)*D4
1310 A(D6,N)=A(D6,N)*D7
1320 A(42,N)=A(X,N)/A(D6,N)
1330 A(43,N)=A(Y,N)/A(D3,N)
1340 NEXT N
1350 H1=X
1360 H2=Y
1370 X=42
1380 Y=43
1390 PAGE
1391 GOSUB 1500
1392 GO TO 1620
1500 M2=9999999
1510 M4=0
1520 M6=9999999
1530 M8=0
1540 FOR N=1 TO R
1541 IF B(N)=U(1) THEN 1545
1542 IF B(N)=U(2) THEN 1545
1543 IF B(N)=U(3) THEN 1545
1544 GO TO 1550
1545 IF A(X,N)<0 THEN 1610
1546 IF A(Y,N)<0 THEN 1610
1547 A(X,N)=A(X,N)*-100000
```

```
1548 A(Y,N)=A(Y,N)*-100000
1550 IF A(X,N)<0 THEN 1610
1560 IF A(Y,N)<0 THEN 1610
1570 M2=M2 MIN A(X,N)
1580 M4=M4 MAX A(X,N)
1590 M6=M6 MIN A(Y,N)
1600 M8=M8 MAX A(Y,N)
1610 NEXT N
1611 RETURN
1620 PRINT "Minimum X-value:";M2;"      ";"Maximum X-value:";M4
1630 PRINT "Minimum Y-value:";M6;"      ";"Maximum Y-value:";M8
1640 REM     ADJUST WINDOW SETTINGS
1650 PRINT
1660 PRINT
1670 PRINT "     WINDOW SETTINGS_____"
1680 PRINT "Lowest X-value desired?";
1690 INPUT W1
1700 PRINT "Highest X-value desired?";
1710 INPUT W2
1720 PRINT "Lowest Y-value desired?";
1730 INPUT W3
1740 PRINT "Highest Y-value desired?";
1750 INPUT W4
1760 REM     MAKE BOX AND TIC MARKS, NUMBER AXES
1770 MOVE @1:30,10
1780 RDRAW @1:70,0
1790 RDRAW @1:0,70
1800 RDRAW @1:-70,0
1810 RDRAW @1:0,-70
1820 V1=(W2-W1)/10
1830 V2=(W4-W3)/10
1840 REM     AXIS LABELING AND HEADING
1850 PAGE
1860 PRINT "X axis heading:"
1870 INPUT B$
1880 PRINT "Y axis heading:"
1890 INPUT C$
1900 PRINT "(type `stop' here if you want to re-start the program)"
1910 PRINT "Title of graph:"
1920 INPUT D$
1930 IF D$="stop" THEN 4270
1940 L1=LEN(B$)
1950 L2=LEN(C$)
1960 L3=LEN(D$)
1970 L4=35-L1
1980 L5=35-L2
1990 L6=35-L3
2000 PRINT @1,17:2,3.5
2020 MOVE @1:30,3
2030 RMOVE @1:L4,0
2040 PRINT @1:B$
2050 REM     PRINT GRAPH HEADING
2060 MOVE @1:30,85
2070 RMOVE @1:L6,0
2080 PRINT @1:D$
2100 MOVE @1:20,10
2110 RMOVE @1:0,L5
2120 SET DEGREES
2130 PRINT @1,25:90
2140 PRINT @1:C$
2150 PRINT @1,25:0
2170 W5=(W2-W1)/5
2180 PRINT @1,17:1.2,2.5
```

```
2190 MOVE @1:29,7
2200 FOR N=W1 TO W2 STEP W5
2210 C$=STR(N)
2220 Z2=LEN(C$)-1
2230 Z3=Z2/2
2240 RMOVE @1:-Z3,0
2250 PRINT @1:N
2260 RMOVE @1:Z3,0
2270 RMOVE @1:14,0
2280 NEXT N
2300 W6=(W4-W3)/5
2310 Z1=28
2320 MOVE @1:Z1,9.5
2330 FOR N=W3 TO W4 STEP W6
2340 C$=STR(N)
2350 Z2=LEN(C$)
2360 RMOVE @1:-Z2,0
2370 PRINT @1:N
2380 RMOVE @1:Z2,14
2390 NEXT N
2420 MOVE @1:30,10
2430 RDRAW @1:0,-1
2440 RMOVE @1:0,1
2450 FOR N1=1 TO 5
2460 FOR N2=1 TO 3
2470 RMOVE @1:3.5,0
2480 RDRAW @1:0,0.5
2490 RMOVE @1:0,-0.5
2500 NEXT N2
2510 RMOVE @1:3.5,0
2520 RMOVE @1:0,-1
2530 RDRAW @1:0,2
2540 RMOVE @1:0,-1
2550 NEXT N1
2570 RDRAW @1:1,0
2580 RMOVE @1:-1,0
2590 FOR N1=1 TO 5
2600 FOR N2=1 TO 3
2610 RMOVE @1:0,3.5
2620 RDRAW @1:-0.5,0
2630 RMOVE @1:0.5,0
2640 NEXT N2
2650 RMOVE @1:0,3.5
2660 RMOVE @1:1,0
2670 RDRAW @1:-2,0
2680 RMOVE @1:1,0
2690 NEXT N1
2710 RDRAW @1:0,1
2720 RMOVE @1:0,-1
2730 FOR N1=1 TO 5
2740 FOR N2=1 TO 3
2750 RMOVE @1:-3.5,0
2760 RDRAW @1:0,-0.5
2770 RMOVE @1:0,0.5
2780 NEXT N2
2790 RMOVE @1:-3.5,0
2800 RMOVE @1:0,1
2810 RDRAW @1:0,-2
2820 RMOVE @1:0,1
2830 NEXT N1
2840 REM     MARK LEFT AXIS
2850 RDRAW @1:-1,0
2860 RMOVE @1:1,0
```

```
2870 FOR N1=1 TO 5
2880 FOR N2=1 TO 3
2890 RMOVE @1:0,-3.5
2900 RDRAW @1:0.5,0
2910 RMOVE @1:-0.5,0
2920 NEXT N2
2930 RMOVE @1:0,-3.5
2940 RMOVE @1:-1,0
2950 RDRAW @1:2,0
2960 RMOVE @1:-1,0
2970 NEXT N1
2990 VIEWPORT 30,100,10,80
3000 WINDOW W1,W2,W3,W4
3010 PRINT @1,17:1.5,1.5
3060 FOR N=1 TO R
3070 IF A(X,N)<0 THEN 3110
3080 IF A(Y,N)<0 THEN 3110
3090 MOVE @1:A(X,N),A(Y,N)
3100 GOSUB B(N) OF 3140,3220,3320
3110 NEXT N
3120 GO TO 3410
3140 WINDOW 0,130,0,100
3150 RMOVE @1:-0.75,-0.75
3160 RDRAW @1:1.5,0
3170 RDRAW @1:-0.75,1.5
3180 RDRAW @1:-0.75,-1.5
3190 WINDOW W1,W2,W3,W4
3200 RETURN
3220 WINDOW 0,130,0,100
3230 RMOVE @1:-0.75,0
3240 RDRAW @1:1.5,0
3250 RMOVE @1:-0.75,0
3260 RMOVE @1:0,0.75
3270 RDRAW @1:0,-1.5
3280 RMOVE @1:0,0.75
3290 WINDOW W1,W2,W3,W4
3300 RETURN
3320 WINDOW 0,130,0,100
3330 RMOVE @1:-0.75,-0.75
3340 RDRAW @1:1.5,0
3350 RDRAW @1:0,1.5
3360 RDRAW @1:-1.5,0
3370 RDRAW @1:0,-1.5
3380 WINDOW W1,W2,W3,W4
3390 RETURN
3410 PRINT "Would you like a least-squares best-fit line drawn  through"
3420 PRINT "the data points (type `yes' or `no')?";
3430 INPUT G$
3440 IF G$="no" THEN 4260
3460 PRINT "Do you want any samples eliminated from calculations-"
3470 PRINT "-type `yes' or `no'?";
3480 INPUT I$
3490 IF I$="no" THEN 4260
3500 PRINT "Turn on line printer-- Type `1' to continue";
3510 INPUT D
3520 FOR N=1 TO R
3521 IF A(X,N)<0 THEN 3540
3522 IF A(Y,N)<0 THEN 3540
3530 PRINT @41:N;"--------X=     ";A(X,N);"        Y=     ";A(Y,N)
3540 NEXT N
3550 PRINT "How many samples do you want to eliminate?";
3560 INPUT I1
3570 FOR N=1 TO I1
```

```
3580 PRINT "Sample #?";
3590 INPUT I3
3620 A(Y,I3)=A(Y,I3)*-100000
3630 NEXT N
3660 A1=0
3670 A2=0
3680 R1=0
3690 FOR N=1 TO R
3700 IF A(X,N)<0 THEN 3750
3710 IF A(Y,N)<0 THEN 3750
3720 A1=A1+A(X,N)
3730 A2=A2+A(Y,N)
3740 R1=R1+1
3750 NEXT N
3760 A1=A1/R1
3770 A2=A2/R1
3800 B1=0
3810 B2=0
3820 FOR N=1 TO R
3830 IF A(X,N)<0 THEN 3870
3840 IF A(Y,N)<0 THEN 3870
3850 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3860 B2=B2+(A(X,N)-A1)^2
3870 NEXT N
3871 GOSUB 1500
3890 B3=B1/B2
3920 A3=A2-B3*A1
3930 B4=A3+B3*M2
3940 B5=A3+B3*M4
3970 S1=0
3980 FOR N=1 TO R
3990 IF A(X,N)<0 THEN 4030
4000 IF A(Y,N)<0 THEN 4030
4010 B6=A3+B3*A(X,N)
4020 S1=S1+(A(Y,N)-B6)^2
4030 NEXT N
4040 S2=SQR(S1/(R1-2))
4060 MOVE @1:M2,B4
4070 DRAW @1:M4,B5
4120 C3=0
4130 C4=0
4140 C5=0
4150 FOR N=1 TO R
4160 IF A(X,N)<0 THEN 4230
4170 IF A(Y,N)<0 THEN 4230
4180 C1=A(X,N)/W2-A1/W2
4190 C2=A(Y,N)/W4-A2/W4
4200 C3=C3+C1*C2
4210 C4=C4+C1^2
4220 C5=C5+C2^2
4230 NEXT N
4240 C6=C3/SQR(C4*C5)
4270 FOR N=1 TO I1
4271 IF A(X,N)>-2 THEN 4285
4280 A(X,N)=A(X,N)/-100000
4285 NEXT N
4286 IF A(Y,N)>-2 THEN 4300
4290 A(Y,N)=A(Y,N)/-100000
4300 NEXT N
4301 IF D$="stop" THEN 4740
4310 REM     PRINT PLOT SYMBOLS AND BEST-FIT LINE STATISTICS
4320 WINDOW 0,150,0,100
4330 VIEWPORT 0,150,0,100
```

```
4340 MOVE @1:120,10
4350 RDRAW @1:30,0
4360 RDRAW @1:0,15
4370 RDRAW @1:-30,0
4380 RDRAW @1:0,-15
4390 RMOVE @1:12,18
4400 PRINT @1,17:2.05,2.5
4410 PRINT @1:"KEY"
4420 MOVE @1:121,20
4430 RDRAW @1:2,0
4440 RDRAW @1:0,2
4450 RDRAW @1:-2,0
4460 RDRAW @1:0,-2
4470 PRINT @1,17:1.2,2.5
4480 RMOVE @1:7,0
4490 PRINT @1:"AOB + bas"
4500 MOVE @1:122,16
4510 RDRAW @1:0,2
4520 RMOVE @1:-1,-1
4530 RDRAW @1:2,0
4540 RMOVE @1:5,-1
4550 PRINT @1:"Nephelinite"
4560 MOVE @1:122,12
4570 RMOVE @1:-1,0
4580 RDRAW @1:2,0
4590 RDRAW @1:-1,2
4600 RDRAW @1:-1,-2
4610 RMOVE @1:7,0
4620 PRINT @1:"Melilitite"
4630 IF G$="no" THEN 4740
4640 MOVE @1:115,7
4650 PRINT @1: USING 4720:"Slope:",B3
4660 MOVE @1:115,5
4670 PRINT @1: USING 4720:"Y-intercept:",A3
4680 MOVE @1:115,3
4690 PRINT @1: USING 4720:"Std. error est.:",S2
4700 MOVE @1:115,1
4710 PRINT @1: USING 4730:"Corr. coef.:",C6
4720 IMAGE 16a,4d.9d
4730 IMAGE 16a,3d.5d
4740 PAGE
4750 PRINT "Want another plot?";
4760 INPUT F$
4770 IF F$="no" THEN 4930
4790 X=H1
4800 Y=H2
4810 FOR N=1 TO R
4820 A(X,N)=A(X,N)/D1
4830 A(Y,N)=A(Y,N)/D2
4840 A(D3,N)=A(D3,N)/D4
4850 A(D6,N)=A(D6,N)/D7
4860 NEXT N
4890 PRINT "Want a different plotting routine?";
4900 INPUT H$
4910 IF H$="yes" THEN 370
4920 GO TO 560
4930 END
```

8. (C1*X + C2*Y) vs. C3*Z Subprogram #8

```
1002 REM-----------------------------------------------------------------
1003 REM    (C1*X  +  C2*Y)  VS. C3*Z SUBPROGRAM #8 (of program tape)
1020 PRINT "Which element for X-axis?";
1030 INPUT X
1040 PRINT "X-constant?";
1050 INPUT D1
1060 PRINT "Which subelement for Y-axis?";
1070 INPUT Y
1080 PRINT "Y subelement constant?";
1090 INPUT D2
1100 PRINT "Additional subelement for Y-axis (to be added)?";
1110 INPUT D3
1120 PRINT "Additional Y subelement constant?";
1130 INPUT D4
1140 PRINT "Do you want to eliminate samples from any rock group?"
1141 PRINT "Type `yes' or `no'";
1142 INPUT J$
1143 IF J$="no" THEN 1160
1144 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1145 PRINT "How many groups do you want to eliminate?";
1146 INPUT U(4)
1147 PRINT "Which group(s) do you want to eliminate (use #):"
1148 FOR N=1 TO U(4)
1149 PRINT "#";
1150 INPUT U(N)
1151 NEXT N
1160 PAGE
1170 FOR N=1 TO R
1180 A(42,N)=-1
1190 IF A(Y,N)<0 THEN 1250
1200 IF A(D3,N)<0 THEN 1250
1210 A(X,N)=A(X,N)*D1
1220 A(Y,N)=A(Y,N)*D2
1230 A(D3,N)=A(D3,N)*D4
1240 A(42,N)=A(Y,N)+A(D3,N)
1250 NEXT N
1260 H=Y
1270 Y=42
1280 PAGE
1281 GOSUB 1390
1282 GO TO 1510
1390 M2=9999999
1400 M4=0
1410 M6=9999999
1420 M8=0
1430 FOR N=1 TO R
1431 IF B(N)=U(1) THEN 1440
1432 IF B(N)=U(2) THEN 1440
1433 IF B(N)=U(3) THEN 1440
1434 GO TO 1453
1440 IF A(X,N)<0 THEN 1500
1450 IF A(Y,N)<0 THEN 1500
1451 A(X,N)=A(X,N)*-100000
1452 A(Y,N)=A(Y,N)*-100000
1453 IF A(X,N)<0 THEN 1500
1454 IF A(Y,N)<0 THEN 1500
1460 M2=M2 MIN A(X,N)
1470 M4=M4 MAX A(X,N)
1480 M6=M6 MIN A(Y,N)
1490 M8=M8 MAX A(Y,N)
1500 NEXT N
1501 RETURN
1510 PRINT "Minimum X-value:";M2;"     ";"Maximum X-value:";M4
```

```
1520 PRINT "Minimum Y-value:";M6;"     ";"Maximum Y-value:";M8
1540 PRINT
1550 PRINT
1560 PRINT "     WINDOW SETTINGS_____"
1570 PRINT "Lowest X-value desired?";
1580 INPUT W1
1590 PRINT "Highest X-value desired?";
1600 INPUT W2
1610 PRINT "Lowest Y-value desired?";
1620 INPUT W3
1630 PRINT "Highest Y-value desired?";
1640 INPUT W4
1660 MOVE @1:30,10
1670 RDRAW @1:70,0
1680 RDRAW @1:0,70
1690 RDRAW @1:-70,0
1700 RDRAW @1:0,-70
1710 V1=(W2-W1)/10
1720 V2=(W4-W3)/10
1740 PAGE
1750 PRINT "X axis heading:"
1760 INPUT B$
1770 PRINT "Y axis heading:"
1780 INPUT C$
1790 PRINT "(type `stop' here if you want to re-start the program)"
1800 PRINT "Title of graph:"
1810 INPUT D$
1820 IF D$="stop" THEN 4130
1830 L1=LEN(B$)
1840 L2=LEN(C$)
1850 L3=LEN(D$)
1860 L4=35-L1
1870 L5=35-L2
1880 L6=35-L3
1890 PRINT @1,17:2,3.5
1910 MOVE @1:30,3
1920 RMOVE @1:L4,0
1930 PRINT @1:B$
1940 REM     PRINT GRAPH HEADING
1950 MOVE @1:30,85
1960 RMOVE @1:L6,0
1970 PRINT @1:D$
1990 MOVE @1:20,10
2000 RMOVE @1:0,L5
2010 SET DEGREES
2020 PRINT @1,25:90
2030 PRINT @1:C$
2040 PRINT @1,25:0
2060 W5=(W2-W1)/5
2070 PRINT @1,17:1.2,2.5
2080 MOVE @1:29,7
2090 FOR N=W1 TO W2 STEP W5
2100 C$=STR(N)
2110 Z2=LEN(C$)-1
2120 Z3=Z2/2
2130 RMOVE @1:-Z3,0
2140 PRINT @1:N
2150 RMOVE @1:Z3,0
2160 RMOVE @1:14,0
2170 NEXT N
2190 W6=(W4-W3)/5
2200 Z1=28
2210 MOVE @1:Z1,9.5
```

```
2220 FOR N=W3 TO W4 STEP W6
2230 C$=STR(N)
2240 Z2=LEN(C$)
2250 RMOVE @1:-Z2,0
2260 PRINT @1:N
2270 RMOVE @1:Z2,14
2280 NEXT N
2310 MOVE @1:30,10
2320 RDRAW @1:0,-1
2330 RMOVE @1:0,1
2340 FOR N1=1 TO 5
2350 FOR N2=1 TO 3
2360 RMOVE @1:3.5,0
2370 RDRAW @1:0,0.5
2380 RMOVE @1:0,-0.5
2390 NEXT N2
2400 RMOVE @1:3.5,0
2410 RMOVE @1:0,-1
2420 RDRAW @1:0,2
2430 RMOVE @1:0,-1
2440 NEXT N1
2460 RDRAW @1:1,0
2470 RMOVE @1:-1,0
2480 FOR N1=1 TO 5
2490 FOR N2=1 TO 3
2500 RMOVE @1:0,3.5
2510 RDRAW @1:-0.5,0
2520 RMOVE @1:0.5,0
2530 NEXT N2
2540 RMOVE @1:0,3.5
2550 RMOVE @1:1,0
2560 RDRAW @1:-2,0
2570 RMOVE @1:1,0
2580 NEXT N1
2600 RDRAW @1:0,1
2610 RMOVE @1:0,-1
2620 FOR N1=1 TO 5
2630 FOR N2=1 TO 3
2640 RMOVE @1:-3.5,0
2650 RDRAW @1:0,-0.5
2660 RMOVE @1:0,0.5
2670 NEXT N2
2680 RMOVE @1:-3.5,0
2690 RMOVE @1:0,1
2700 RDRAW @1:0,-2
2710 RMOVE @1:0,1
2720 NEXT N1
2740 RDRAW @1:-1,0
2750 RMOVE @1:1,0
2760 FOR N1=1 TO 5
2770 FOR N2=1 TO 3
2780 RMOVE @1:0,-3.5
2790 RDRAW @1:0.5,0
2800 RMOVE @1:-0.5,0
2810 NEXT N2
2820 RMOVE @1:0,-3.5
2830 RMOVE @1:-1,0
2840 RDRAW @1:2,0
2850 RMOVE @1:-1,0
2860 NEXT N1
2880 VIEWPORT 30,100,10,80
2890 WINDOW W1,W2,W3,W4
2900 PRINT @1,17:1.5,1.5
```

```
2950 FOR N=1 TO R
2960 IF A(X,N)<0 THEN 3000
2970 IF A(Y,N)<0 THEN 3000
2980 MOVE @1:A(X,N),A(Y,N)
2990 GOSUB B(N) OF 3030,3110,3210
3000 NEXT N
3010 GO TO 3300
3030 WINDOW 0,130,0,100
3040 RMOVE @1:-0.75,-0.75
3050 RDRAW @1:1.5,0
3060 RDRAW @1:-0.75,1.5
3070 RDRAW @1:-0.75,-1.5
3080 WINDOW W1,W2,W3,W4
3090 RETURN
3110 WINDOW 0,130,0,100
3120 RMOVE @1:-0.75,0
3130 RDRAW @1:1.5,0
3140 RMOVE @1:-0.75,0
3150 RMOVE @1:0,0.75
3160 RDRAW @1:0,-1.5
3170 RMOVE @1:0,0.75
3180 WINDOW W1,W2,W3,W4
3190 RETURN
3210 WINDOW 0,130,0,100
3220 RMOVE @1:-0.75,-0.75
3230 RDRAW @1:1.5,0
3240 RDRAW @1:0,1.5
3250 RDRAW @1:-1.5,0
3260 RDRAW @1:0,-1.5
3270 WINDOW W1,W2,W3,W4
3280 RETURN
3300 PRINT "Would you like a least-squares best-fit line drawn  through"
3310 PRINT "the data points (type `yes' or `no')?";
3320 INPUT G$
3330 IF G$="no" THEN 4180
3350 PRINT "Do you want any samples eliminated from calculations-"
3360 PRINT "-type `yes' or `no'?";
3370 INPUT I$
3380 IF I$="no" THEN 3520
3381 PRINT "Turn on line printer-- Type `1' to continue";
3382 INPUT Q
3383 FOR N=1 TO R
3384 PRINT @41:N;"-------X=    ";A(X,N);"       Y=    ";A(Y,N)
3385 NEXT N
3390 PRINT "How many samples do you want to eliminate?";
3400 INPUT I1
3410 FOR N=1 TO I1
3440 PRINT "Sample #?";
3450 INPUT I3
3480 A(Y,I3)=A(Y,I3)*-100000
3490 NEXT N
3520 A1=0
3530 A2=0
3540 R1=0
3550 FOR N=1 TO R
3560 IF A(X,N)<0 THEN 3610
3570 IF A(Y,N)<0 THEN 3610
3580 A1=A1+A(X,N)
3590 A2=A2+A(Y,N)
3600 R1=R1+1
3610 NEXT N
3620 A1=A1/R1
3630 A2=A2/R1
```

```
3660 B1=0
3670 B2=0
3680 FOR N=1 TO R
3690 IF A(X,N)<0 THEN 3730
3700 IF A(Y,N)<0 THEN 3730
3710 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3720 B2=B2+(A(X,N)-A1)^2
3730 NEXT N
3731 GOSUB 1390
3750 B3=B1/B2
3780 A3=A2-B3*A1
3790 B4=A3+B3*M2
3800 B5=A3+B3*M4
3830 S1=0
3840 FOR N=1 TO R
3850 IF A(X,N)<0 THEN 3890
3860 IF A(Y,N)<0 THEN 3890
3870 B6=A3+B3*A(X,N)
3880 S1=S1+(A(Y,N)-B6)^2
3890 NEXT N
3900 S2=SQR(S1/(R1-2))
3920 MOVE @1:M2,B4
3930 DRAW @1:M4,B5
3980 C3=0
3990 C4=0
4000 C5=0
4010 FOR N=1 TO R
4020 IF A(X,N)<0 THEN 4090
4030 IF A(Y,N)<0 THEN 4090
4040 C1=A(X,N)/W2-A1/W2
4050 C2=A(Y,N)/W4-A2/W4
4060 C3=C3+C1*C2
4070 C4=C4+C1^2
4080 C5=C5+C2^2
4090 NEXT N
4100 C6=C3/SQR(C4*C5)
4130 FOR N=1 TO R
4150 IF A(X,N)>-2 THEN 4153
4152 A(X,N)=A(X,N)/-100000
4153 NEXT N
4155 IF A(Y,N)>-2 THEN 4170
4160 A(Y,N)=A(Y,N)/-100000
4170 NEXT N
4171 IF D$="stop" THEN 4610
4180 REM    Print symbol key
4190 WINDOW 0,150,0,100
4200 VIEWPORT 0,150,0,100
4210 MOVE @1:120,10
4220 RDRAW @1:30,0
4230 RDRAW @1:0,15
4240 RDRAW @1:-30,0
4250 RDRAW @1:0,-15
4260 RMOVE @1:12,18
4270 PRINT @1,17:2.05,2.5
4280 PRINT @1:"KEY"
4290 MOVE @1:121,20
4300 RDRAW @1:2,0
4310 RDRAW @1:0,2
4320 RDRAW @1:-2,0
4330 RDRAW @1:0,-2
4340 PRINT @1,17:1.2,2.5
4350 RMOVE @1:7,0
4360 PRINT @1:"AOB + Bas"
```

```
4370 MOVE @1:122,16
4380 RDRAW @1:0,2
4390 RMOVE @1:-1,-1
4400 RDRAW @1:2,0
4410 RMOVE @1:5,-1
4420 PRINT @1:"Nephelinite"
4430 MOVE @1:122,12
4440 RMOVE @1:-1,0
4450 RDRAW @1:2,0
4460 RDRAW @1:-1,2
4470 RDRAW @1:-1,-2
4480 RMOVE @1:7,0
4490 PRINT @1:"Melilitite"
4500 IF G$="no" THEN 4610
4510 MOVE @1:115,7
4520 PRINT @1: USING 4590:"Slope:",B3
4530 MOVE @1:115,5
4540 PRINT @1: USING 4590:"Y-intercept:",A3
4550 MOVE @1:115,3
4560 PRINT @1: USING 4590:"Std. error est.:",S2
4570 MOVE @1:115,1
4580 PRINT @1: USING 4600:"Corr. coef.:",C6
4590 IMAGE 16a,4d.9d
4600 IMAGE 16a,3d.5d
4610 PAGE
4620 PRINT "Want another plot?";
4630 INPUT F$
4640 IF F$="no" THEN 4780
4660 Y=H
4670 FOR N=1 TO R
4680 A(X,N)=A(X,N)/D1
4690 A(Y,N)=A(Y,N)/D2
4700 A(D3,N)=A(D3,N)/D4
4710 NEXT N
4740 PRINT "Want a different plotting routine?";
4750 INPUT H$
4760 IF H$="yes" THEN 370
4770 GO TO 560
4780 END
```

9. (C1*X + C2*Y) / C3*Z vs. C4*W Subprogram #9

```
1002 REM-----------------------------------------------------------------
1003 REM    (C1*X + C2*Y)/C3*Z  VS.  C4*W  SUBPROGRAM #9 (of pro. tape)
1020 PRINT "Which element for X-axis?";
1030 INPUT X
1040 PRINT "X-constant?";
1050 INPUT D1
1060 PRINT "First numerator subelement for Y-axis?";
1070 INPUT Y
1080 PRINT "First numerator-constant?";
1090 INPUT D2
1091 PRINT "Second numerator subelement for Y-axis?";
1092 INPUT D5
1093 PRINT "Second numerator-constant?";
1094 INPUT D6
1100 PRINT "Additional subelement for Y-axis (denominator)?";
1110 INPUT D3
1120 PRINT "Denominator-constant?";
1130 INPUT D4
1131 PRINT "Do you want to eliminate samples from any rock group?"
1132 PRINT "Type `yes' or `no'";
1133 INPUT J$
1134 IF J$="no" THEN 1160
1135 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1136 PRINT "How many groups do you want to eliminate?";
1137 INPUT U(4)
1138 PRINT "Which group(s) do you want to eliminate (use #):"
1139 FOR N=1 TO U(4)
1140 PRINT "#";
1141 INPUT U(N)
1142 NEXT N
1160 PAGE
1170 FOR N=1 TO R
1180 A(42,N)=-1
1190 IF A(Y,N)<0 THEN 1250
1200 IF A(D3,N)<0 THEN 1250
1210 A(X,N)=A(X,N)*D1
1220 A(Y,N)=A(Y,N)*D2
1230 A(D3,N)=A(D3,N)*D4
1231 A(D5,N)=A(D5,N)*D6
1240 A(42,N)=(A(Y,N)+A(D5,N))/A(D3,N)
1250 NEXT N
1260 H=Y
1270 Y=42
1280 PAGE
1281 GOSUB 1390
1282 GO TO 1510
1390 M2=9999999
1400 M4=0
1410 M6=9999999
1420 M8=0
1430 FOR N=1 TO R
1431 IF B(N)=U(1) THEN 1440
1432 IF B(N)=U(2) THEN 1440
1433 IF B(N)=U(3) THEN 1440
1434 GO TO 1453
1440 IF A(X,N)<0 THEN 1500
1450 IF A(Y,N)<0 THEN 1500
1451 A(X,N)=A(X,N)*-100000
1452 A(Y,N)=A(Y,N)*-100000
1453 IF A(X,N)<0 THEN 1500
1454 IF A(Y,N)<0 THEN 1500
1460 M2=M2 MIN A(X,N)
1470 M4=M4 MAX A(X,N)
```

```
1480 M6=M6 MIN A(Y,N)
1490 M8=M8 MAX A(Y,N)
1500 NEXT N
1501 RETURN
1510 PRINT "Minimum X-value:";M2;"      ";"Maximum X-value:";M4
1520 PRINT "Minimum Y-value:";M6;"      ";"Maximum Y-value:";M8
1540 PRINT
1550 PRINT
1560 PRINT "     WINDOW SETTINGS_____"
1570 PRINT "Lowest X-value desired?";
1580 INPUT W1
1590 PRINT "Highest X-value desired?";
1600 INPUT W2
1610 PRINT "Lowest Y-value desired?";
1620 INPUT W3
1630 PRINT "Highest Y-value desired?";
1640 INPUT W4
1660 MOVE @1:30,10
1670 RDRAW @1:70,0
1680 RDRAW @1:0,70
1690 RDRAW @1:-70,0
1700 RDRAW @1:0,-70
1710 V1=(W2-W1)/10
1720 V2=(W4-W3)/10
1740 PAGE
1750 PRINT "X axis heading:"
1760 INPUT B$
1770 PRINT "Y axis heading:"
1780 INPUT C$
1790 PRINT "(type `stop' here if you want to re-start the program)"
1800 PRINT "Title of graph:"
1810 INPUT D$
1820 IF D$="stop" THEN 4130
1830 L1=LEN(B$)
1840 L2=LEN(C$)
1850 L3=LEN(D$)
1860 L4=35-L1
1870 L5=35-L2
1880 L6=35-L3
1890 PRINT @1,17:2,3.5
1910 MOVE @1:30,3
1920 RMOVE @1:L4,0
1930 PRINT @1:B$
1950 MOVE @1:30,85
1960 RMOVE @1:L6,0
1970 PRINT @1:D$
1990 MOVE @1:20,10
2000 RMOVE @1:0,L5
2010 SET DEGREES
2020 PRINT @1,25:90
2030 PRINT @1:C$
2040 PRINT @1,25:0
2060 W5=(W2-W1)/5
2070 PRINT @1,17:1.2,2.5
2080 MOVE @1:29,7
2090 FOR N=W1 TO W2 STEP W5
2100 C$=STR(N)
2110 Z2=LEN(C$)-1
2120 Z3=Z2/2
2130 RMOVE @1:-Z3,0
2140 PRINT @1:N
2150 RMOVE @1:Z3,0
2160 RMOVE @1:14,0
```

```
2170 NEXT N
2190 W6=(W4-W3)/5
2200 Z1=28
2210 MOVE @1:Z1,9.5
2220 FOR N=W3 TO W4 STEP W6
2230 C$=STR(N)
2240 Z2=LEN(C$)
2250 RMOVE @1:-Z2,0
2260 PRINT @1:N
2270 RMOVE @1:Z2,14
2280 NEXT N
2310 MOVE @1:30,10
2320 RDRAW @1:0,-1
2330 RMOVE @1:0,1
2340 FOR N1=1 TO 5
2350 FOR N2=1 TO 3
2360 RMOVE @1:3.5,0
2370 RDRAW @1:0,0.5
2380 RMOVE @1:0,-0.5
2390 NEXT N2
2400 RMOVE @1:3.5,0
2410 RMOVE @1:0,-1
2420 RDRAW @1:0,2
2430 RMOVE @1:0,-1
2440 NEXT N1
2460 RDRAW @1:1,0
2470 RMOVE @1:-1,0
2480 FOR N1=1 TO 5
2490 FOR N2=1 TO 3
2500 RMOVE @1:0,3.5
2510 RDRAW @1:-0.5,0
2520 RMOVE @1:0.5,0
2530 NEXT N2
2540 RMOVE @1:0,3.5
2550 RMOVE @1:1,0
2560 RDRAW @1:-2,0
2570 RMOVE @1:1,0
2580 NEXT N1
2600 RDRAW @1:0,1
2610 RMOVE @1:0,-1
2620 FOR N1=1 TO 5
2630 FOR N2=1 TO 3
2640 RMOVE @1:-3.5,0
2650 RDRAW @1:0,-0.5
2660 RMOVE @1:0,0.5
2670 NEXT N2
2680 RMOVE @1:-3.5,0
2690 RMOVE @1:0,1
2700 RDRAW @1:0,-2
2710 RMOVE @1:0,1
2720 NEXT N1
2740 RDRAW @1:-1,0
2750 RMOVE @1:1,0
2760 FOR N1=1 TO 5
2770 FOR N2=1 TO 3
2780 RMOVE @1:0,-3.5
2790 RDRAW @1:0.5,0
2800 RMOVE @1:-0.5,0
2810 NEXT N2
2820 RMOVE @1:0,-3.5
2830 RMOVE @1:-1,0
2840 RDRAW @1:2,0
2850 RMOVE @1:-1,0
```

```
2860 NEXT N1
2880 VIEWPORT 30,100,10,80
2890 WINDOW W1,W2,W3,W4
2900 PRINT @1,17:1.5,1.5
2950 FOR N=1 TO R
2960 IF A(X,N)<0 THEN 3000
2970 IF A(Y,N)<0 THEN 3000
2980 MOVE @1:A(X,N),A(Y,N)
2990 GOSUB B(N) OF 3030,3110,3210
3000 NEXT N
3010 GO TO 3300
3030 WINDOW 0,130,0,100
3040 RMOVE @1:-0.75,-0.75
3050 RDRAW @1:1.5,0
3060 RDRAW @1:-0.75,1.5
3070 RDRAW @1:-0.75,-1.5
3080 WINDOW W1,W2,W3,W4
3090 RETURN
3110 WINDOW 0,130,0,100
3120 RMOVE @1:-0.75,0
3130 RDRAW @1:1.5,0
3140 RMOVE @1:-0.75,0
3150 RMOVE @1:0,0.75
3160 RDRAW @1:0,-1.5
3170 RMOVE @1:0,0.75
3180 WINDOW W1,W2,W3,W4
3190 RETURN
3210 WINDOW 0,130,0,100
3220 RMOVE @1:-0.75,-0.75
3230 RDRAW @1:1.5,0
3240 RDRAW @1:0,1.5
3250 RDRAW @1:-1.5,0
3260 RDRAW @1:0,-1.5
3270 WINDOW W1,W2,W3,W4
3280 RETURN
3300 PRINT "Would you like a least-squares best-fit line drawn  through"
3310 PRINT "the data points (type `yes' or `no')?";
3320 INPUT G$
3330 IF G$="no" THEN 4190
3350 PRINT "Do you want any samples eliminated from calculations-"
3360 PRINT "-type `yes' or `no'?";
3370 INPUT I$
3380 IF I$="no" THEN 3520
3381 PRINT "Turn on line printer-- Type `1' to continue";
3382 INPUT Q
3383 FOR N=1 TO R
3384 PRINT @41:N;"-------X=     ";A(X,N);"        Y=     ";A(Y,N)
3385 NEXT N
3390 PRINT "How many samples do you want to eliminate?";
3400 INPUT I1
3410 FOR N=1 TO I1
3440 PRINT "Sample #?";
3450 INPUT I3
3480 A(Y,I3)=A(Y,I3)*-100000
3490 NEXT N
3520 A1=0
3530 A2=0
3540 R1=0
3550 FOR N=1 TO R
3560 IF A(X,N)<0 THEN 3610
3570 IF A(Y,N)<0 THEN 3610
3580 A1=A1+A(X,N)
3590 A2=A2+A(Y,N)
```

```
3600 R1=R1+1
3610 NEXT N
3620 A1=A1/R1
3630 A2=A2/R1
3660 B1=0
3670 B2=0
3680 FOR N=1 TO R
3690 IF A(X,N)<0 THEN 3730
3700 IF A(Y,N)<0 THEN 3730
3710 B1=B1+(A(X,N)-A1)*(A(Y,N)-A2)
3720 B2=B2+(A(X,N)-A1)^2
3730 NEXT N
3731 GOSUB 1390
3750 B3=B1/B2
3780 A3=A2-B3*A1
3790 B4=A3+B3*M2
3800 B5=A3+B3*M4
3830 S1=0
3840 FOR N=1 TO R
3850 IF A(X,N)<0 THEN 3890
3860 IF A(Y,N)<0 THEN 3890
3870 B6=A3+B3*A(X,N)
3880 S1=S1+(A(Y,N)-B6)^2
3890 NEXT N
3900 S2=SQR(S1/(R1-2))
3920 MOVE @1:M2,B4
3930 DRAW @1:M4,B5
3980 C3=0
3990 C4=0
4000 C5=0
4010 FOR N=1 TO R
4020 IF A(X,N)<0 THEN 4090
4030 IF A(Y,N)<0 THEN 4090
4040 C1=A(X,N)/W2-A1/W2
4050 C2=A(Y,N)/W4-A2/W4
4060 C3=C3+C1*C2
4070 C4=C4+C1^2
4080 C5=C5+C2^2
4090 NEXT N
4100 C6=C3/SQR(C4*C5)
4130 FOR N=1 TO R
4131 IF A(X,N)>-2 THEN 4135
4132 A(X,N)=A(X,N)/-100000
4135 NEXT N
4136 IF A(Y,N)>-2 THEN 4138
4137 A(Y,N)=A(Y,N)/-100000
4138 NEXT N
4170 NEXT N
4171 IF D$="stop" THEN 4610
4180 REM     PRINT PLOT SYMBOLS AND BEST-FIT LINE STATISTICS
4190 WINDOW 0,150,0,100
4200 VIEWPORT 0,150,0,100
4210 MOVE @1:120,10
4220 RDRAW @1:30,0
4230 RDRAW @1:0,15
4240 RDRAW @1:-30,0
4250 RDRAW @1:0,-15
4260 RMOVE @1:12,18
4270 PRINT @1,17:2.05,2.5
4280 PRINT @1:"KEY"
4290 MOVE @1:121,20
4300 RDRAW @1:2,0
4310 RDRAW @1:0,2
```

```
4320 RDRAW @1:-2,0
4330 RDRAW @1:0,-2
4340 PRINT @1,17:1.2,2.5
4350 RMOVE @1:7,0
4360 PRINT @1:"AOB + Bas"
4370 MOVE @1:122,16
4380 RDRAW @1:0,2
4390 RMOVE @1:-1,-1
4400 RDRAW @1:2,0
4410 RMOVE @1:5,-1
4420 PRINT @1:"Nephelinite"
4430 MOVE @1:122,12
4440 RMOVE @1:-1,0
4450 RDRAW @1:2,0
4460 RDRAW @1:-1,2
4470 RDRAW @1:-1,-2
4480 RMOVE @1:7,0
4490 PRINT @1:"Melilitite"
4500 IF G$="no" THEN 4610
4510 MOVE @1:115,7
4520 PRINT @1: USING 4590:"Slope:",B3
4530 MOVE @1:115,5
4540 PRINT @1: USING 4590:"Y-intercept:",A3
4550 MOVE @1:115,3
4560 PRINT @1: USING 4590:"Std. error est.:",S2
4570 MOVE @1:115,1
4580 PRINT @1: USING 4600:"Corr. coef.:",C6
4590 IMAGE 16a,4d.9d
4600 IMAGE 16a,3d.5d
4610 PAGE
4620 PRINT "Want another plot?";
4630 INPUT F$
4640 IF F$="no" THEN 4780
4660 Y=H
4670 FOR N=1 TO R
4680 A(X,N)=A(X,N)/D1
4690 A(Y,N)=A(Y,N)/D2
4700 A(D3,N)=A(D3,N)/D4
4701 A(D5,N)=A(D5,N)/D6
4710 NEXT N
4740 PRINT "Want a different plotting routine?";
4750 INPUT H$
4760 IF H$="Yes" THEN 370
4770 GO TO 560
4780 END
```

10. Chondrite-normalized REE Plot (semi-log) Subprogram #10

```
1000 REM    REE PLOT (semi-log)  SUBPROGRAM #10 (of program tape)
1010 WINDOW 0,130,0,100
1020 VIEWPORT 0,130,0,100
1030 MOVE @1:20,10
1040 RDRAW @1:0,60
1050 RDRAW @1:96,0
1060 RDRAW @1:0,-60
1070 RDRAW @1:-97.5,0
1080 RMOVE @1:7.5,0
1090 FOR N=1 TO 15
1100 RMOVE @1:0,1.5
1110 RDRAW @1:0,-3
1120 RMOVE @1:0,1.5
1130 RMOVE @1:6,0
1140 NEXT N
1150 MOVE @1:20,10
1160 FOR M=1 TO 3
1170 FOR N=1 TO 10
1180 S1=LGT(N)*20
1190 MOVE @1:20,10+(S1+(M-1)*20)
1200 RMOVE @1:-0.5,0
1210 RDRAW @1:1,0
1220 RMOVE @1:-0.5,0
1230 NEXT N
1240 RMOVE @1:-1.5,0
1250 RDRAW @1:3,0
1260 RMOVE @1:-1.5,0
1270 NEXT M
1280 MOVE @1:16,9
1290 PRINT @1:"1"
1300 MOVE @1:14,29
1310 PRINT @1:"10"
1320 MOVE @1:12.22,49
1330 PRINT @1:"100"
1340 MOVE @1:10.44,69
1350 PRINT @1:"1000"
1360 MOVE @1:24.5,6
1370 PRINT @1:"La"
1380 MOVE @1:30.5,6
1390 PRINT @1:"Ce"
1400 MOVE @1:36.5,6
1410 PRINT @1:"Pr"
1420 MOVE @1:42.5,6
1430 PRINT @1:"Nd"
1440 MOVE @1:48.5,6
1450 PRINT @1:"Pm"
1460 MOVE @1:54.5,6
1470 PRINT @1:"Sm"
1480 MOVE @1:60.5,6
1490 PRINT @1:"Eu"
1500 MOVE @1:66.5,6
1510 PRINT @1:"Gd"
1520 MOVE @1:72.5,6
1530 PRINT @1:"Tb"
1540 MOVE @1:78.5,6
1550 PRINT @1:"Dy"
1560 MOVE @1:84.5,6
1570 PRINT @1:"Ho"
1580 MOVE @1:90.5,6
1590 PRINT @1:"Er"
1600 MOVE @1:96.5,6
1610 PRINT @1:"Tm"
1620 MOVE @1:102.5,6
```

```
1630 PRINT @1:"Yb"
1640 MOVE @1:108.5,6
1650 PRINT @1:"Lu"
1655 PAGE
1660 WINDOW 0,96,0,3
1670 VIEWPORT 20,116,10,70
1680 DIM D(8)
1690 MOVE @1:0,0
1700 PRINT
1710 PRINT
1720 PRINT "Sample number (1 through ";R;")";
1730 INPUT R1
1735 IF A(26,R1)<0 THEN 1810
1740 PRINT
1750 PRINT "Which plot symbol: 1=triangle, 2=square, 3=cross"
1760 PRINT "                   4=diamond, 5=inverted triangle";
1770 INPUT R2
1780 PRINT
1800 GO TO 1830
1810 PRINT "No REE data available for this sample.  Pick another one"
1820 GO TO 1660
1830 REM    D1=La, D2=Ce, D3=Nd, D4=Sm, D5=Eu, D6=Tb, D7=Yb, D8=Lu
1840 D1=LGT(A(26,R1)/0.33)
1850 D2=LGT(A(27,R1)/0.88)
1860 D3=LGT(A(28,R1)/0.6)
1870 D4=LGT(A(29,R1)/0.181)
1880 D5=LGT(A(30,R1)/0.069)
1890 D6=LGT(A(31,R1)/0.047)
1900 D7=LGT(A(32,R1)/0.2)
1910 D8=LGT(A(33,R1)/0.034)
1920 REM    plots follow
1930 MOVE @1:6,D1
1940 GOSUB R2 OF 2940,3040,3150,3250,3360
1950 MOVE @1:6,D1
1960 DRAW @1:12,D2
1970 GOSUB R2 OF 2940,3040,3150,3250,3360
1980 MOVE @1:12,D2
1990 DRAW @1:24,D3
2000 GOSUB R2 OF 2940,3040,3150,3250,3360
2010 MOVE @1:24,D3
2020 DRAW @1:36,D4
2030 GOSUB R2 OF 2940,3040,3150,3250,3360
2040 MOVE @1:36,D4
2050 DRAW @1:42,D5
2060 GOSUB R2 OF 2940,3040,3150,3250,3360
2070 MOVE @1:42,D5
2080 DRAW @1:54,D6
2090 GOSUB R2 OF 2940,3040,3150,3250,3360
2100 MOVE @1:54,D6
2110 DRAW @1:84,D7
2120 GOSUB R2 OF 2940,3040,3150,3250,3360
2130 MOVE @1:84,D7
2140 DRAW @1:90,D8
2150 GOSUB R2 OF 2940,3040,3150,3250,3360
2160 MOVE @1:90,D8
2170 PRINT
2180 PRINT "Do you want another sample plotted?";
2190 INPUT B$
2200 IF B$="yes" THEN 2220
2210 GO TO 2940
2220 PRINT
2230 PRINT "Do you want another graph printed?";
2240 INPUT A$
```

```
2245 PAGE
2250 IF A$="no" THEN 1700
2260 PRINT "Triangles represent which sample #?";
2270 INPUT J$
2280 PRINT "Squares represent which sample #?";
2290 INPUT E$
2300 PRINT "Crosses represent which sample #?";
2310 INPUT F$
2320 PRINT "Diamonds represent which sample #?";
2330 INPUT G$
2340 PRINT "Invert. triangles represent which sample #?";
2350 INPUT H$
2360 PRINT "Title of graph?"
2370 INPUT D$
2380 WINDOW 0,150,0,100
2390 VIEWPORT 0,150,0,100
2400 PRINT @1,17:2,3.5
2410 L1=LEN(D$)
2420 L2=48-L1
2430 MOVE @1:20,80
2440 RMOVE @1:L2,0
2450 PRINT @1:D$
2460 MOVE @1:10,25
2470 SET DEGREES
2471 PRINT @1,25:90
2480 PRINT @1:"Rock/Chondrites"
2481 PRINT @1,25:0
2490 PRINT @1,17:1.25,2.5
2500 ROTATE 0
2510 MOVE @1:120,10
2520 RDRAW @1:30,0
2530 RDRAW @1:0,30
2540 RDRAW @1:-30,0
2550 RDRAW @1:0,-30
2560 MOVE @1:123,37
2570 RDRAW @1:2,0
2580 RDRAW @1:-1,2
2590 RDRAW @1:-1,-2
2600 MOVE @1:130,37
2610 PRINT @1:J$
2620 MOVE @1:123,32
2630 RDRAW @1:2,0
2640 RDRAW @1:0,2
2650 RDRAW @1:-2,0
2660 RDRAW @1:0,-2
2670 MOVE @1:130,32
2680 PRINT @1:E$
2690 MOVE @1:124,26
2710 RDRAW @1:0,2
2720 RMOVE @1:-1,-1
2730 RDRAW @1:2,0
2740 MOVE @1:130,26
2750 PRINT @1:F$
2760 MOVE @1:124,21
2770 RDRAW @1:1,1
2780 RDRAW @1:-1,1
2790 RDRAW @1:-1,-1
2800 RDRAW @1:1,-1
2810 MOVE @1:130,21
2820 PRINT @1:G$
2830 MOVE @1:124,16
2840 RDRAW @1:1,2
2850 RDRAW @1:-2,0
```

```
2860 RDRAW @1:1,-2
2870 MOVE @1:130,16
2880 PRINT @1:H$
2890 PRINT
2900 PRINT "Change paper in X-Y plotter-- Hit return to continue";
2910 INPUT A$
2920 GO TO 1010
2930 GO TO 3460
2940 REM    Subroutine to plot triangles
2950 WINDOW 0,130,0,100
2960 VIEWPORT 20,116,10,70
2970 RMOVE @1:-1,-1
2980 RDRAW @1:2,0
2990 RDRAW @1:-1,2
3000 RDRAW @1:-1,-2
3010 WINDOW 0,96,0,3
3020 VIEWPORT 20,116,10,70
3030 RETURN
3040 REM    Subroutine to plot squares
3050 WINDOW 0,130,0,100
3060 VIEWPORT 20,116,10,70
3070 RMOVE @1:-1,-1
3080 RDRAW @1:2,0
3090 RDRAW @1:0,2
3100 RDRAW @1:-2,0
3110 RDRAW @1:0,-2
3120 WINDOW 0,96,0,3
3130 VIEWPORT 20,116,10,70
3140 RETURN
3150 REM   Subroutine to plot crosses
3160 WINDOW 0,130,0,100
3170 VIEWPORT 20,116,10,70
3180 RMOVE @1:0,-1
3190 RDRAW @1:0,2
3200 RMOVE @1:-1,-1
3210 RDRAW @1:2,0
3220 WINDOW 0,96,0,3
3230 VIEWPORT 20,116,10,70
3240 RETURN
3250 REM    Subroutine to plot diamonds
3260 WINDOW 0,130,0,100
3270 VIEWPORT 20,116,10,70
3280 RMOVE @1:0,-1
3290 RDRAW @1:1,1
3300 RDRAW @1:-1,1
3310 RDRAW @1:-1,-1
3320 RDRAW @1:1,-1
3330 WINDOW 0,96,0,3
3340 VIEWPORT 20,116,10,70
3350 RETURN
3360 REM    Subroutine to plot inverted triangles
3370 WINDOW 0,130,0,100
3380 VIEWPORT 20,116,10,70
3390 RMOVE @1:0,-1
3400 RDRAW @1:1,2
3410 RDRAW @1:-2,0
3420 RDRAW @1:1,-2
3430 WINDOW 0,96,0,3
3440 VIEWPORT 20,116,10,70
3450 RETURN
3460 PRINT "DONE!!_____"
3470 END
```

11. Average and standard deviation Subprogram #11

```
1000 REM    AVERAGE AND STAND. DEV. SUBPROGRAM #11 (of program tape)
1010 REM    This program returns average and st. dev. on chemical
1020 REM    whole-rock data.
1030 PRINT
1040 PRINT "Turn on line printer-- hit return to continue program";
1050 INPUT A$
1060 PRINT "Numerator";
1070 INPUT X1
1080 PRINT "Numerator-constant";
1090 INPUT X2
1100 PRINT
1110 PRINT "Denominator";
1120 INPUT X3
1130 PRINT "Denominator-constant";
1140 INPUT X4
1150 PRINT
1160 PRINT "Equation:";
1170 INPUT D$
1180 Y=42
1190 FOR M=1 TO 4
1200 FOR N=1 TO 41
1210 A(Y,N)=-1
1220 IF A(X1,N)<0 THEN 1250
1230 IF A(X3,N)<0 THEN 1250
1240 A(Y,N)=A(X1,N)*X2/(A(X3,N)*X4)
1250 NEXT N
1260 A2=0
1270 R1=0
1280 FOR N=1 TO R
1290 IF M=2 THEN 1330
1300 IF M=3 THEN 1360
1310 IF M=4 THEN 1390
1320 GO TO 1420
1330 IF B(N)=3 THEN 1420
1340 A(Y,N)=-1
1350 GO TO 1420
1360 IF B(N)=2 THEN 1420
1370 A(Y,N)=-1
1380 GO TO 1420
1390 IF B(N)=1 THEN 1420
1400 IF B(N)=2 THEN 1420
1410 A(Y,N)=-1
1420 IF A(Y,N)<0 THEN 1450
1430 A2=A2+A(Y,N)
1440 R1=R1+1
1450 NEXT N
1460 IF A2=0 THEN 1480
1470 GO TO 1500
1480 B3=0
1490 GO TO 1590
1500 A2=A2/R1
1510 B1=0
1520 B2=0
1530 FOR N=1 TO R
1540 IF A(Y,N)<0 THEN 1560
1550 B1=B1+(A(Y,N)-A2)^2
1560 NEXT N
1570 B2=B1*(1/(R1-1))
1580 B3=SQR(B2)
1590 PRINT @41:
1600 PRINT @41:
1610 PRINT @41:"HONOLULU SERIES LAVAS"
1620 IF M=1 THEN 1660
```

```
1630 IF M=2 THEN 1680
1640 IF M=3 THEN 1700
1650 IF M=4 THEN 1720
1660 PRINT @41:"All samples"
1670 GO TO 1730
1680 PRINT @41:"Alkali basalts only"
1690 GO TO 1730
1700 PRINT @41:"Nephelinites only"
1710 GO TO 1730
1720 PRINT @41:"Nephelinites and melilitites only"
1730 PRINT @41:D$
1740 PRINT @41:"     Average=";A2
1750 PRINT @41:"     St. dev.=";B3
1760 PRINT @41:
1770 NEXT M
1780 PRINT @41:"------------------------------"
1790 PRINT @41:
1800 PRINT
1810 PRINT "Do you want another calculation (type yes or no)?";
1820 INPUT F$
1830 IF F$="no" THEN 1850
1840 GO TO 560
1850 PRINT "Do you want a different plot (type yes or no)?";
1860 INPUT H$
1870 IF H$="no" THEN 1900
1880 PAGE
1890 GO TO 370
1900 PRINT "DONE!!!____"
1910 END
```

12. C1*X vs. C2*Y vs. C3*Z (Ternary plot) Subprogram #12

```
1003 REM     C1*X VS. C2*Y VS. C3*Z (TERNARY PLOT) SUBPROGRAM #12
1010 PRINT "YOU WILL CHOOSE THREE ELEMENTS TO BE PLOTTED:"
1020 PRINT "Which element for left-corner?";
1030 INPUT X
1035 PRINT "Element name?";
1036 INPUT A$
1040 PRINT "Constant?";
1044 INPUT D1
1045 PRINT
1050 PRINT "Which element for right-corner?";
1070 INPUT Y
1075 PRINT "Element name?";
1076 INPUT B$
1080 PRINT "Constant?";
1090 INPUT D2
1095 PRINT
1100 PRINT "Which element for top-corner?";
1110 INPUT D3
1115 PRINT "Element name?";
1116 INPUT C$
1120 PRINT "Constant?";
1130 INPUT D4
1140 PRINT
1151 PRINT "Do you want to eliminate samples from any rock group?"
1152 PRINT "Type `yes' or `no'";
1153 INPUT J$
1154 IF J$="no" THEN 1165
1155 PRINT "Group1=melilitite, Group2=nephelinite, Group3="AOB + Bas"
1156 PRINT "How many groups do you want to eliminate?";
1157 INPUT U(4)
1158 PRINT "Which group(s) do you want to eliminate (use #):"
1159 FOR N=1 TO U(4)
1160 PRINT "#";
1161 INPUT U(N)
1162 NEXT N
1165 PAGE
1170 FOR N=1 TO R
1180 IF A(X,N)<0 THEN 1250
1190 IF A(Y,N)<0 THEN 1250
1200 IF A(D3,N)<0 THEN 1250
1210 A(X,N)=A(X,N)*D1
1220 A(Y,N)=A(Y,N)*D2
1230 A(D3,N)=A(D3,N)*D4
1250 NEXT N
1790 PRINT "(type `stop' here if you want to re-start the program)"
1800 PRINT "Title of graph:"
1810 INPUT D$
1820 IF D$="stop" THEN 4131
1850 L3=LEN(D$)
1880 L6=35-L3
1900 WINDOW 0,100,0,100
1901 Z1=1
1902 Z2=-1
1910 VIEWPORT 5,95.0689,5,95.0689
1920 SET DEGREES
1930 MOVE @1:0,0
1940 DRAW @1:100,0
1950 DRAW @1:50,86.60254
1960 DRAW @1:0,0
1970 FOR M1=1 TO 3
1980 FOR M2=10 TO 90 STEP 10
1990 RDRAW @1:10,0
2000 RDRAW @1:0,Z1
```

```
2010 RMOVE @1:0,Z2
2020 NEXT M2
2030 IF M1>1 THEN 2090
2040 RMOVE @1:-90,0
2050 ROTATE 60
2060 Z1=-1
2070 Z2=1
2080 GO TO 2110
2090 RMOVE @1:10,0
2100 ROTATE -60
2110 NEXT M1
2120 ROTATE -60
2130 VIEWPORT 0,100,0,100
2140 PRINT @1,17:1.5,3
2150 MOVE @1:2,1
2160 PRINT @1:A$
2170 MOVE @1:94,1
2180 PRINT @1:B$
2190 MOVE @1:49,85
2200 PRINT @1:C$
2210 MOVE @1:L6,97
2211 PRINT @1,17:3,4.5
2220 PRINT @1:D$
2230 VIEWPORT 5,95.0689,5,95.0689
2240 ROTATE 0
2900 PRINT @1,17:1.5,1.5
2950 FOR N=1 TO R
2952 MOVE @1:0,0
2955 IF A(D3,N)<0 THEN 3000
2960 IF A(X,N)<0 THEN 3000
2970 IF A(Y,N)<0 THEN 3000
2971 S1=A(X,N)
2972 S2=A(Y,N)
2973 S3=A(D3,N)
2974 S4=S1+S2+S3
2975 S5=S1/S4*100
2976 S6=S2/S4*100
2977 S7=S3/S4*100
2978 RMOVE @1:S6,0
2979 ROTATE 60
2980 RMOVE @1:S7,0
2981 ROTATE 0
2990 GOSUB B(N) OF 3030,3110,3210
3000 NEXT N
3010 GO TO 3300
3030 REM     Triangle subroutine
3040 RMOVE @1:-0.75,-0.75
3050 RDRAW @1:1.5,0
3060 RDRAW @1:-0.75,1.5
3070 RDRAW @1:-0.75,-1.5
3090 RETURN
3110 REM     Cross subroutine
3120 RMOVE @1:-0.75,0
3130 RDRAW @1:1.5,0
3140 RMOVE @1:-0.75,0
3150 RMOVE @1:0,0.75
3160 RDRAW @1:0,-1.5
3170 RMOVE @1:0,0.75
3190 RETURN
3210 REM     Square subroutine
3220 RMOVE @1:-0.75,-0.75
3230 RDRAW @1:1.5,0
3240 RDRAW @1:0,1.5
```

```
3250 RDRAW @1:-1.5,0
3260 RDRAW @1:0,-1.5
3280 RETURN
3300 REM     Print symbol key and restore variables to original values
4130 FOR N=1 TO R
4131 IF A(X,N)>-2 THEN 4170
4132 IF A(Y,N)>-2 THEN 4170
4133 IF A(D3,N)>-2 THEN 4170
4160 A(X,N)=A(X,N)/-1000000
4161 A(Y,N)=A(Y,N)/-1000000
4162 A(D3,N)=A(D3,N)/-1000000
4170 NEXT N
4180 IF D$="stop" THEN 4610
4190 WINDOW 0,150,0,100
4200 VIEWPORT 0,150,0,100
4210 MOVE @1:120,10
4220 RDRAW @1:30,0
4230 RDRAW @1:0,15
4240 RDRAW @1:-30,0
4250 RDRAW @1:0,-15
4260 RMOVE @1:12,18
4270 PRINT @1,17:2.05,2.5
4280 PRINT @1:"Key"
4290 MOVE @1:121,20
4300 RDRAW @1:2,0
4310 RDRAW @1:0,2
4320 RDRAW @1:-2,0
4330 RDRAW @1:0,-2
4340 PRINT @1,17:1.2,2.5
4350 RMOVE @1:6,0
4360 PRINT @1:"AOB + Bas"
4370 MOVE @1:122,16
4380 RDRAW @1:0,2
4390 RMOVE @1:-1,-1
4400 RDRAW @1:2,0
4410 RMOVE @1:5,-1
4420 PRINT @1:"Nephelinite"
4430 MOVE @1:122,12
4440 RMOVE @1:-1,0
4450 RDRAW @1:2,0
4460 RDRAW @1:-1,2
4470 RDRAW @1:-1,-2
4480 RMOVE @1:6,0
4490 PRINT @1:"Melilitite"
4610 PAGE
4620 PRINT "Want another plot?";
4630 INPUT F$
4640 IF F$="no" THEN 4780
4670 FOR N=1 TO R
4671 IF A(X,N)<0 THEN 4710
4672 IF A(Y,N)<0 THEN 4710
4673 IF A(D3,N)<0 THEN 4710
4680 A(X,N)=A(X,N)/D1
4690 A(Y,N)=A(Y,N)/D2
4700 A(D3,N)=A(D3,N)/D4
4710 NEXT N
4740 PRINT "Want a different plotting routine?";
4750 INPUT H$
4760 IF H$="yes" THEN 370
4770 GO TO 560
4780 END
```