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A program in Hewlett-Packard BASIC for plotting geochemical data on  
ternary diagrams, using HP-Series 80 computers

by

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A Program in Hewlett-Packard BASIC for plotting geochemical data on ternary diagrams, using HP-Series 80 computers

INTRODUCTION

Ternary diagrams are used extensively in petrologic and geochemical studies to show phase relationships and covariance of three simple or complex variables. The program described here permits display of ternary diagrams on a cathode-ray tube, drafting diagrams with a plotter or printing diagrams with a dot-matrix printer. The program provides for a variety of plotting symbols, allows portions of the ternary diagram to be expanded, and permits input of data from the keyboard or from files stored by the electronic worksheet program "VISICALC". Options also permit adding standard reference lines or points in four ternary systems: the polybaric minimum at 0.5, 1, 2, 3, 5, and 10 kb in the system quartz-albite-orthoclase (Q-AB-OR), the 2 and 8 kb eutectic curves in the system anorthite-albite-orthoclase (AN-AB-OR), lines separating peraluminous, metaluminous, and peralkaline fields in the molar system Al-(NA+K)-CA, and lines representing  $Th/U = 4.73$ ,  $K/U = .95 \times 10^4$ , and  $Th/K = 5.0 \times 10^{-4}$  in the system U-Th-( $K \times 10^{-4}$ ). Finally, the program can be used to digitize points on the ternary diagram both in terms of ordinate and abscissa, and in terms of relative proportions of three end members.

EQUIPMENT REQUIRED

The program is written for use with Hewlett-Packard series 80 computers and may require modifications if it is to be used with other computers that operate in BASIC. Disc storage requires 68 records of 256-byte length. The program requires approximately 40,000 bytes of memory to run, and is dimensioned to plot a maximum of 254 data points. Plotting may be done either on a cathode-ray tube (CRT), a hard-copy plotter compatible with the HP-series 80 computers, such as the HP-2673A, or a graphic printer, such as the HP-82905A. This last option is possible if either a plotter ROM has been installed or if the binary program "GDUMP" (which is available on the Hewlett-Packard demonstration disc) is loaded into memory.

PROGRAM OPERATION

Most queries that appear during program operation are self explanatory and will be described only briefly. All queries are answered by typing a response and pressing "END LINE". Multiple answers to a single query should be separated by commas. All alpha answers should be in upper case.

The first query (which appears each time printed output is requested) is "PLEASE SPECIFY PRINTER ADDRESS". The input of an impossible printer address will cause the query to reappear. The input of a possible address will be accepted even if the requested device is not turned on.

The second query "VISICALC DATA FILE (V) OR KEYBOARD DATA ENTRY (K)?" request the source of data to be plotted. Pressing "K" and "END LINE" allows keyboard entry of data with the following queries: "SAMPLE NAME? ENTER 'END' WHEN THROUGH" is answered with either the sample name (maximum of 18 characters) or "END" followed by pressing "END LINE". The program then asks for values in the sequence "UPPER APEX", "LOWER LEFT APEX", and "LOWER RIGHT APEX". Once

254 samples have been entered into memory (from "VISICALC", keyboard or a combination of the two), the program automatically continues to subsequent program segments.

If "VISICALC" data are to be plotted, the second query should be answered by "V" and "END LINE". The program then displays "ENTER FILE NAME, OR PRESS [END LINE] FOR CATALOG" (of disc content). A sample "VISICALC" file is presented in Table 1. Once a file name has been entered, the program asks for information needed to read the file. The program assumes that either the first column or first row contains sample identification information. The next query is "DO YOU WANT 3 COLUMNS OR 3 ROWS (C) OR (R)", which is answered by either "C" or "R" and "END LINE". Column reading is the default mode, and therefore any answer other than "R" will cause columns to be read with column 1 read as sample identifiers. The next query asks for three inputs of either row numbers or letters used by "VISICALC" to designate columns. The final query prior to reading the data file is "DO YOU WANT TO USE A PLOTTING SYMBOL FROM THE DATA FILE? IF YES, ENTER ROW NUMBER OR COLUMN LETTERS; OTHERWISE ENTER \*". This option allows one more row or column of alpha-numeric characters to be read which have been stored with the data and which can then be used as plotting symbols on subsequent ternary plots. Row 2 of Table 1 contains examples of stored plotting symbols. If no plotting symbol has been stored with the data, an asterisk "\*" should be entered.

Table 1.- Sample Visicalc data file used as input for plotting figures 2 through 5 and for printed output on figure 1

SAMPLE	155079	155136	155535	155553	155555	155565	155569	155571
SYMBOL	X	#	*	O	\$	&	e	Q
	.484	41.522	40.668	29.31	34.156	32.039	33.792	33.309
AB	43.143	21.294	34.018	43.806	41.503	38.404	31.803	29.086
OR	17.595	27.691	18.365	23.808	21.215	24.084	28.479	30.705
AN	15.681		.591	.468	.721	2.514	2.591	1.997
Al	.170947	.090230	.135738	.137209	.131226	.138778	.122498	.117201
Na+K	.11435	.104214	.097607	.125393	.115937	.115759	.110655	.110051
Ca	.09308	.003388	.005171	.002140	.003031	.009451	.00945	.009629
U	1.19	3.73	2.43	2.02	2.84	1.36	6.36	2.92
Th	3.2	19.2	4.5	18.3	21.7	2	13.9	9.75
R	2.52	3.85	2.82	3.40	3.14	3.34	3.95	4.45

After the input of a row number, column letter or an asterisk, the program proceeds to reading the desired file. If the file is not found, the program will display "FILE DOES NOT EXIST! DO YOU NEED TO CHANGE MASS STORAGE (YES OR NO)". An answer of "Y" will allow a change of mass storage, and the program will again attempt to read the file. An answer of "N" will generate a query for a new file name, and the program will read the designated file. Responding with any other alpha-numeric key will return the program to the query for the type of data to be entered.

Once the desired file name has been located, the display indicates that it is being loaded. If the first data entry read does not correspond to "VISICALC" format, the program displays "IS THIS A 'VISICALC' FILE?" and re-asks for a file name. Entering a new file name restarts data reading as set up previously. If other rows or columns are desired, the machine must be reset and the program restarted.

If errors are generated during the data-loading process, such as an attempt to read non-numeric data, the display will indicate the error number and line number, and the program will pause to provide the user with an opportunity to recover the error. Null data will be converted to values of zero.

After the data have been loaded either from storage or keyboard entry, the program will ask for labels for the three apexes. Each label can be up to seven characters in length. The program next asks if data are to be printed. An answer of "Y" will generate a printout of row numbers, sample numbers, the data, and plotting symbols if these were read with the data. Two examples of printouts are shown on figure 1. Any other answer will generate a display of "ARE DATA OK AND READY TO PLOT? (YES OR NO)". Any answer other than "Y" will send the program to a subroutine to edit the data which will ask for row number, parameter name, and new value for that variable. After the data are edited for a sample, the display asks if the data are ready to plot. An answer of "Y" moves the program to a loop which adjusts the data for each sample to a sum of 1.0. Any samples for which all values are zero are indicated on the currently selected printer. Normalization of the data is followed by a query that provides an option to print the normalized results. Examples of this printout are presented on figure 1.

The next segment of the program creates a plotting base on either the CRT or on an external plotter as specified by the user. If the CRT is chosen, the base will be stored on the disc in the currently active mass storage unit under the name of "OUTLINE". This will require approximately 50 records of 256 bytes each, and if insufficient space exists on the disc in current use, an error will result, and the program will pause. True equilateral triangles are produced for external plotters and the HP-84 CRT. Parameters in program lines 1050 through 1200 can be adjusted if correction of the isocetes triangles produced on the HP-87 CRT or output to a graphics printer is desired.

The plotting base can be a standard ternary diagram in which each side of the triangle represent 0 percent of the component labeled at the opposite apex or a blow-up of any portion of the standard diagram as long as more than 1 percent of the area of a standard diagram is chosen. This is calculated from the minimum percentages of the three components which are asked for if an expanded diagram is requested by the user. This information is entered in answer to the queries: "DO YOU WANT A BLOW-UP OF A SECTION OF THE TRIANGLE (YES OR NO)". (Any answer other than "Y" will result in a plotting base of a standard ternary diagram). If this query is answered by "Y", the program will ask for the "MINIMUM PERCENTAGES FOR UPPER, LOWER LEFT, AND LOWER RIGHT APEXES". The plot base will be marked along each side in 10 equal increments and a reference triangle will be drawn in the upper right-hand corner of the paper (or CRT) with the location of the expanded diagram outlined as shown on figures 2 through 5.

Q	AB	OR	ROW	SAMPLE	SYMBOL
.484	43.143	17.595	1	155079	
41.622	21.294	27.691	2	155136	
40.668	34.018	18.365	3	155535	
29.810	43.808	23.808	4	155553	
34.156	41.503	21.215	5	155555	
32.039	38.404	24.084	6	155565	
33.792	31.803	28.479	7	155569	
33.309	29.086	30.706	8	155571	

Q	AB	OR	ROW	SAMPLE	SYMBOL
.008	.705	.287	1	155079	
.459	.235	.306	2	155136	
.437	.366	.197	3	155535	
.306	.450	.244	4	155553	
.353	.428	.219	5	155555	
.339	.406	.255	6	155565	
.359	.338	.303	7	155569	
.358	.312	.330	8	155571	

AN	AB	OR	ROW	SAMPLE	SYMBOL
15.681	43.143	17.595	1	155079	X
0.000	21.294	27.691	2	155136	#
.591	34.018	18.365	3	155535	*
.468	43.808	23.808	4	155553	O
.721	41.503	21.215	5	155555	\$
2.514	38.404	24.084	6	155565	&
2.591	31.803	28.479	7	155569	@
1.997	29.086	30.706	8	155571	Q

AN	AB	OR	ROW	SAMPLE	SYMBOL
.205	.565	.230	1	155079	X
0.000	.435	.565	2	155136	#
.011	.642	.347	3	155535	*
.007	.643	.350	4	155553	O
.011	.654	.334	5	155555	\$
.039	.591	.371	6	155565	&
.041	.506	.453	7	155569	@
.032	.471	.497	8	155571	Q

Fig. 1. Print out of raw data and data adjusted to a sum of 1.0 for two different reads of the data in a "VISICALC" file (Table 1). No stored plot symbol was requested for the first set of data, whereas row 2 (Table 1) was read as a plot symbol for the second set of data.

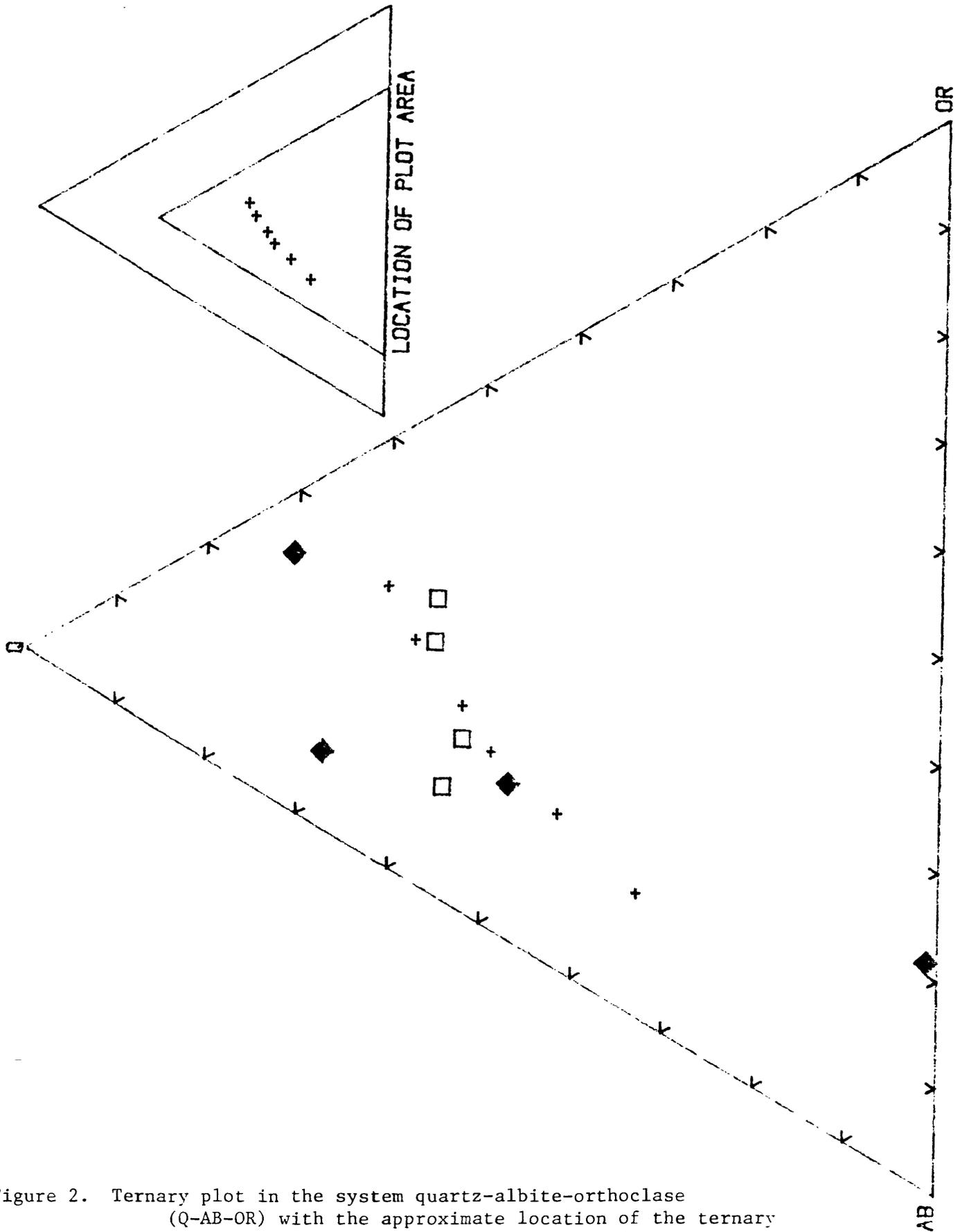


Figure 2. Ternary plot in the system quartz-albite-orthoclase (Q-AB-OR) with the approximate location of the ternary minimum at 0.5, 1, 2, 3, 5, and 10 kb indicated by plus symbols. Data points were plotted in two sets and are represented as polygons. The expanded diagram is bounded by minimum percentages of Q = 0, AB = 20, and OR = 15. Ternary minima from Tuttle and Bowen (1958) and Luth and others (1964).

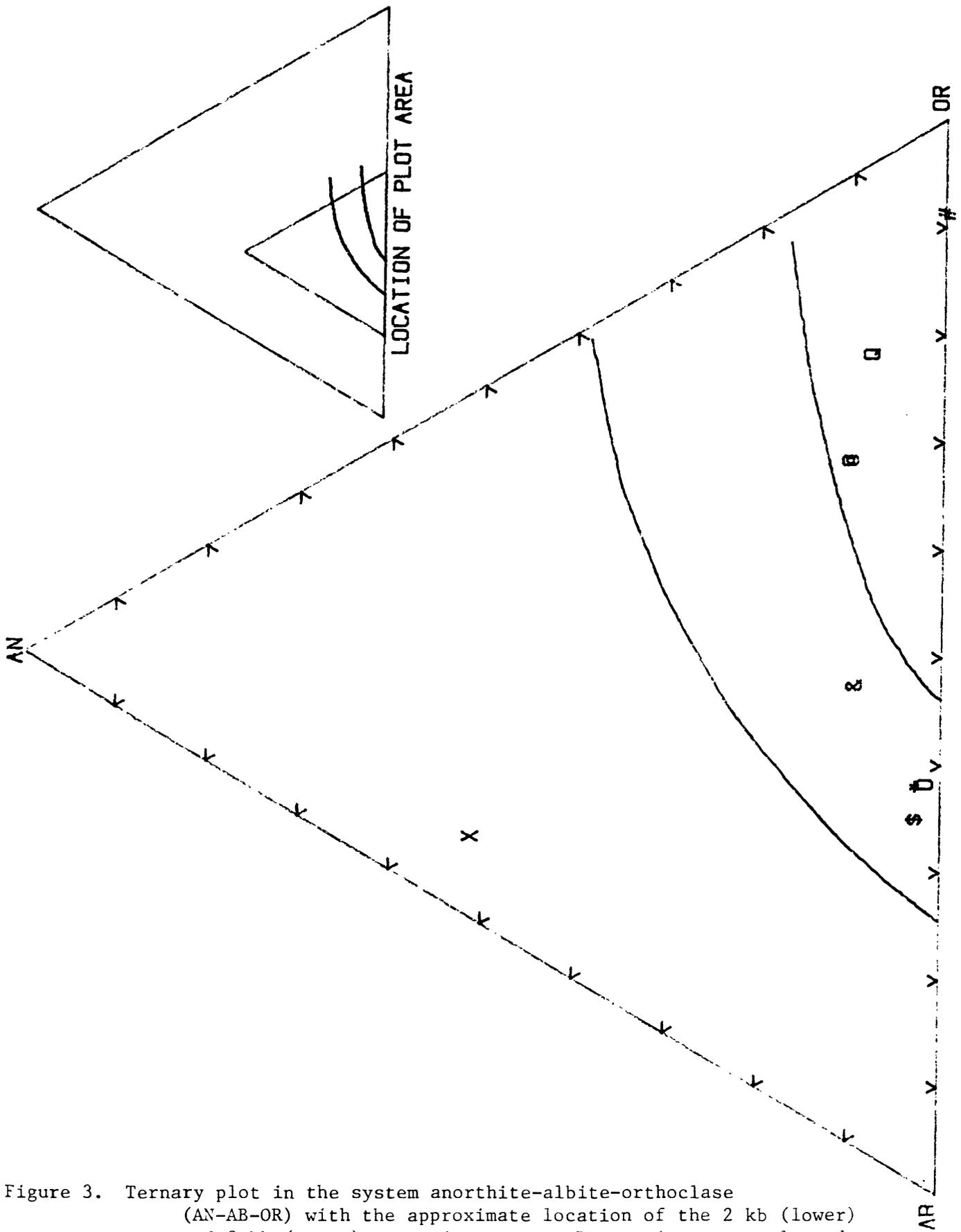


Figure 3. Ternary plot in the system anorthite-albite-orthoclase (AN-AB-OR) with the approximate location of the 2 kb (lower) and 8 kb (upper) eutectic curves. Data points were plotted as a single set of symbols stored with the data. The expanded diagram is bounded by minimum percentages of AN = 0, AB = 40, and OR = 20. Eutectic data from Whitney (1975).

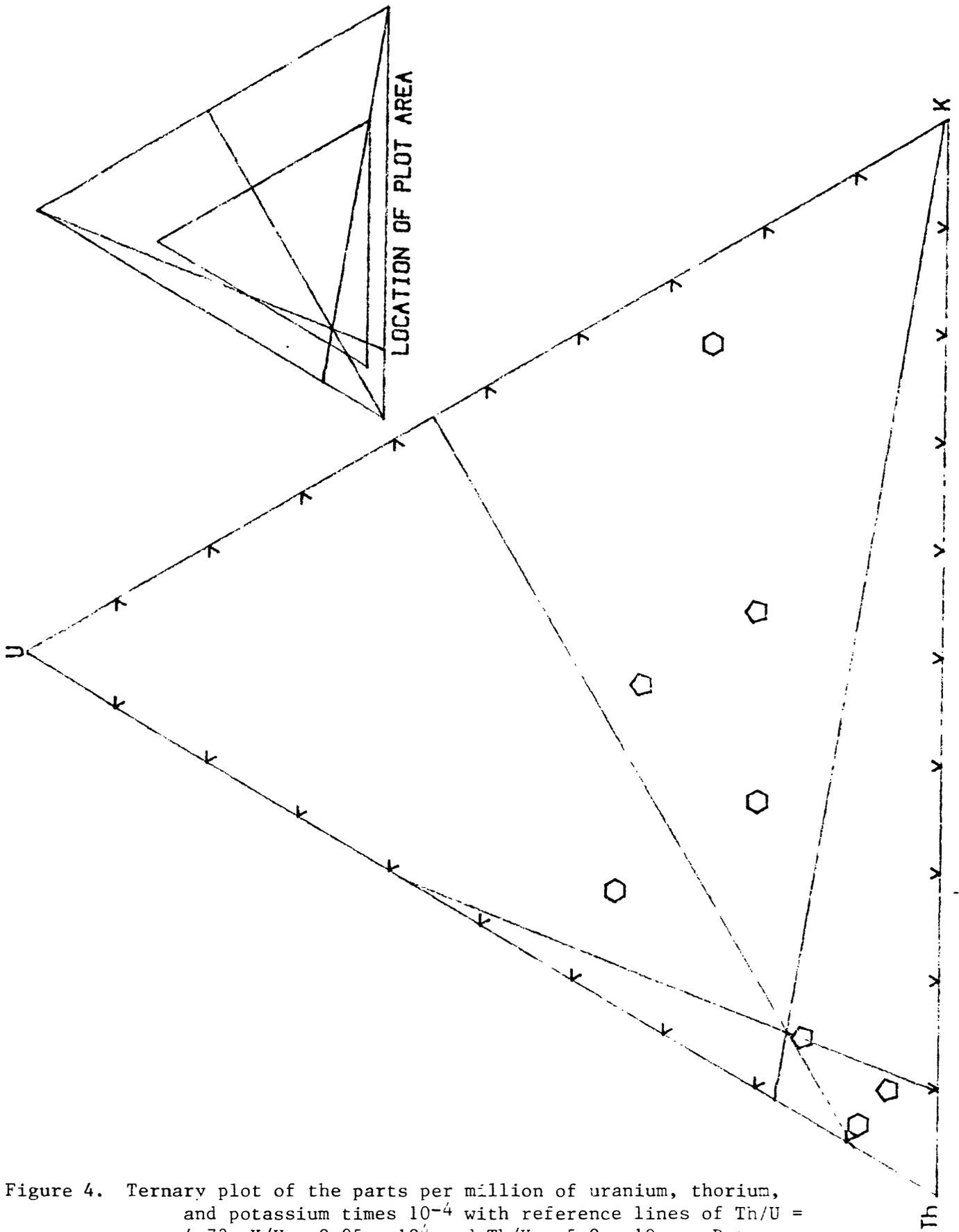


Figure 4. Ternary plot of the parts per million of uranium, thorium, and potassium times  $10^{-4}$  with reference lines of  $\text{Th}/\text{U} = 4.73$ ,  $\text{K}/\text{U} = 0.95 \times 10^{-4}$  and  $\text{Th}/\text{K} = 5.0 \times 10^{-4}$ . Data were plotted in two sets using the polygon command. The expanded diagram is bounded by the minimum percentages of  $\text{U} = 5$ ,  $\text{Th} = 25$ , and  $\text{K} = 10$ . Average radioelement ratios for granitic rocks from Stuckless and VanTrump (1982).

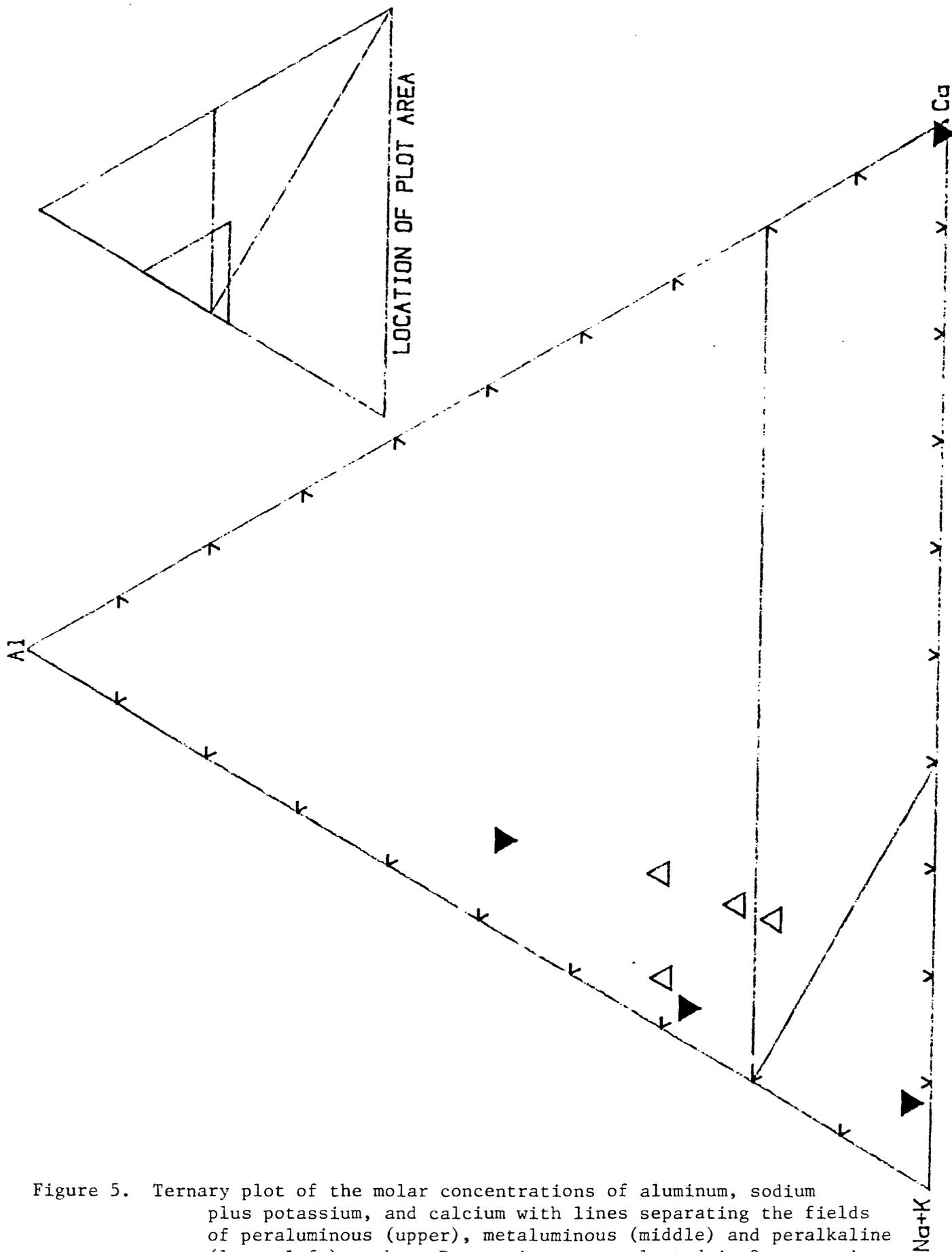


Figure 5. Ternary plot of the molar concentrations of aluminum, sodium plus potassium, and calcium with lines separating the fields of peraluminous (upper), metaluminous (middle) and peralkaline (lower left) rocks. Data points were plotted in 2 sets using the polygon command. The expanded diagram is bounded by minimum percentage of Al = 45, Na+K = 30, and Ca = 0. Alumina saturation fields as described by Shand (1951).

After the plot base has been created, the program will ask for sets to be plotted. This query requires two inputs: the first and last set. If only one sample is desired, it must be entered twice. For example, "1,1" plots only the first sample of a data set. If the CRT is being used for plotting, the user is given the option of reloading the blank plotting base after choosing samples to be plotted.

The next segment of the program provides several options for plot symbols. A slash (/) will cause any symbols stored with the data to be used; a "P" will cause polygons to be plotted; and any other alpha-numeric entry will be used as a plotting symbol. If polygons are chosen as plot symbols, the program will display "# OF SIDES, OPEN OR SOLID (O OR S), SIZE (mm), AND ROTATION (0 TO 360)" Examples of symbols and input necessary to generate these symbols are shown on figure 6. If data are encountered that plot outside the limits of an expanded diagram, samples will be identified on the currently specified printer.

After requested data points have been plotted, seven options are displayed. To redraw the plotting base or change the plotter, enter "Y". To print a diagram shown on the CRT, enter "P". To digitize points on an external plotter, enter "V". To add data from the keyboard, enter "K". To add standard reference lines or points for the systems Q-AB-OR, or AN-AB-OR, or U-Th-K, or molar Al-(Na+K)-Ca, enter "S". To edit data, enter "E". To continue without changes, enter "C" or any other alpha-numeric character because this is the default condition. The program returns to display the seven options after any have been executed.

If the option to add standard reference lines or points is chosen, the four possible systems are displayed with a corresponding numeric response for choosing the desired system. If an expanded plotting base has been used, the reference points will be plotted on both the expanded base and the inset reference triangle. Reference points that plot outside the expanded base will be plotted on the inset only.

If the option for a dot-matrix print of the CRT display is chosen, the program will display: "INPUT PRINTER TYPE: 0=82905B, -1=82905A, 1=MOST OTHERS". Operation of the dot matrix print option requires either a plotter ROM or prior storage of the binary program "GDUMP" which is available on the Hewlett-Packard demonstration disc. If an improper printer type is entered, the attempt to copy the CRT display will produce nonsense. After the CRT graphics have been copied, the CRT display returns to the seven options discussed above. Some printers may need to be reset after making a graphics print. To do this, edit line 2700 to read: "2700 RESET [interface selected code] @ GOTO 1300".

A complete listing of the program is presented in Appendix I.

▲ 3, S, 4, 0	△ 3, 0, 4, 0
◀ 3, S, 4, 30	◁ 3, 0, 4, 30
▼ 3, S, 4, 60	▽ 3, 0, 4, 60
▶ 3, S, 4, 90	▷ 3, 0, 4, 90
◆ 4, S, 4, 0	◇ 4, 0, 4, 0
■ 4, S, 4, 45	▣ 4, 0, 4, 45
♠ 5, S, 4, 0	♠ 5, 0, 4, 0
♣ 5, S, 4, 36	♣ 5, 0, 4, 36
♠ 6, S, 4, 0	♠ 6, 0, 4, 0
♣ 6, S, 4, 30	♣ 6, 0, 4, 30
● 12, S, 4, 0	○ 12, 0, 4, 0

Figure 6. Plotting symbols generated by the polygon command and the input used to draw each.

#### REFERENCES CITED

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APPENDIX I

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10 REM TERNARY PLOTTING PROGRAM BY J. S. STUCKLESS MAY 22, 1983
20 DIM B$(1511),S(254,3),S$(254),N$(254) [18],L$(4),T(10,2),U(10,2),V(10,2)
30 DIM X(37),Y(37),D(3)
40 RMIN=1 @ R9,RMAX,99,X=0 @ I$=" ("&CHR$(217)&"ES OR "&CHR$(206)&"O)"
50 CLEAR @ GOSUB 370
60 DISP "VISICALC DATA FILE (V) OR KEYBOARD DATA ENTRY (K) ?" @ INPUT A$
70 IF A$="K" THEN 1720
80 CLEAR @ IF A$#="V" THEN GO
90 GOSUB 320 @ INPUT A$ ! DISPLAY PROGRAM RESTRICTIONS FOR DATA INPUT *****
100 CLEAR @ IF NOT LEN (A$) THEN GOSUB 340 @ GOTO 90
110 DISP "PROGRAM READS COLUMN 1 OR ROW 1 OF DATA SET AS SAMPLE NUMBERS" @ DISP
120 DISP "DO YOU WANT 3 COLUMNS OR 3 ROWS ("&CHR$(195)&") OR ("&CHR$(210)&")"
130 INPUT K$ @ IF K$="R" THEN 150
140 DISP "WHAT 3 COLUMN HEADINGS DO YOU WANT (A THRU BK)." @ DISP @ GOTO 160
150 DISP "WHAT 3 ROW NUMBERS DO YOU WANT (1 THRU 254)." @ DISP
160 DISP "ENTRIES START WITH UPPER APEX, THEN LOWER LEFT, THEN LOWER RIGHT"
170 DISP "REGARDLESS OF ACTUAL ORDER (e.g. B, AK, S OR 6, 28, 15)."

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490 IF B$(2,2)="A" AND NUM (B$(3,3))<58 THEN I=VAL (B$(3)) @ GOTO 560
500 FOR J=1 TO N @ IF K$="R" THEN GOTO 630
510 IF B$(2,2)=L$(J) AND NUM (B$(3,3))<58 THEN B$=B$(3) @ GOTO 530
520 IF B$(2,3)=L$(J) THEN B$=B$(4) @ GOTO 530 ELSE GOTO 540
530 I=VAL (B$) @ GOTO 550
540 NEXT J @ GOTO 440
550 IF I>RMAX THEN RMAX=I
560 Z=POS (B$,";")+1 @ IF NUM (B$(Z))#34 THEN 620 ELSE Z=Z+1
570 IF J=4 THEN S$(I)=B$(Z) @ GOTO 440
580 IF J=0 THEN 600
590 IF I>RMIN THEN RMIN=I
600 IF POS (B$,CHR$ (13)) THEN Z1=POS (B$,CHR$ (13))-1
610 N$(I)=B$(Z,Z1) @ GOTO 440
620 S(I,J)=VAL (B$(Z)) @ GOTO 440
630 IF NUM (B$(3,3))<58 THEN M=VAL (B$(3)) ELSE M=VAL (B$(4))
640 IF M#L(J) THEN 540
650 IF NUM (B$(3,3))<58 THEN I=NUM (B$(2,2))-64 @ GOTO 550
660 IF NUM (B$(2,2))=65 THEN I=NUM (B$(3,3))-38 ELSE I=NUM (B$(3,3))-12
670 GOTO 550
680 OFF ERROR @ IF ERRN =7 THEN S(I+R,J)=0 @ GOTO 720 ELSE GOTO 240
690 OFF ERROR @ IF ERRN =7 THEN S$(I+R)=" " @ GOTO 730 ELSE GOTO 240
700 R=RMIN @ RMAX=RMAX-R @ RMIN=1
710 FOR I=1 TO RMAX @ ON ERROR GOTO 680 @ FOR J=1 TO 3
720 S(I,J)=S(I+R,J) @ NEXT J @ ON ERROR GOTO 690
730 S$(I)=S$(I+R) @ N$(I)=N$(I+R) @ NEXT I
740 DISP "LABELS FOR APEXES (7 CHARACTER MAXIMUM)" @ DISP
750 DISP "UPPER, LOWER LEFT, AND LOWER RIGHT" @ DISP
760 INPUT L$(1),L$(2),L$(3)
770 GOSUB 790 @ GOSUB 970
780 IF Q9=1 THEN RETURN ELSE DISP "DO YOU WANT RELATIVE PROPORTIONS PRINTED"&I$
@ GOSUB 800 @ GOTO 1030
790 DISP "DO YOU WANT DATA PRINTED ?"&I$
800 INPUT A$ @ IF A$="Y" THEN GOSUB 370 ELSE 860
810 PRINT USING 950 : L$(1),L$(2),L$(3) ! PRINT DATA *****
820 X9=1 @ FOR I=1 TO RMAX
830 FOR J=1 TO 3 @ X(X9)=S(I,J) @ X9=X9+1 @ NEXT J
840 PRINT USING 960 ; X(1),X(2),X(3),I,N$(I),S$(I)
850 X9=1 @ NEXT I @ PRINT @ PRINT @ IF R9=1 THEN RETURN
860 DISP @ DISP "ARE DATA OK AND READY TO PLOT ?"&I$ @ INPUT A$ @ IF A$="Y" THEN
RETURN
870 CLEAR ! SUBROUTINE TO EDIT DATA *****
880 DISP "EDIT VALUES IN ROW NUMBER ___?" @ INPUT I
890 IF I<RMIN OR I>RMAX OR I#INT (I) THEN DISP "INVALID ROW #" @ GOTO 880
900 DISP "EDIT PARAMETER NAMED ___?" @ INPUT A$
910 FOR J=1 TO 3 @ IF UPC$(A$)=UPC$(L$(J)) THEN 930
920 NLXT J @ IF J=4 THEN DISP "PARAMETER NOT FOUND IN CURRENT DATA SET. TRY AGAI
N." @ GOTO 900
930 DISP "ROW";I;"SAMPLE ";N$(I);"PARAMETER ";L$(J);"=";" @ INPUT S(I,J)
940 IF Q9=2 THEN RETURN ELSE GOTO 860
950 IMAGE X,3(XAAAAAAA)," ROW ", " SAMPLE SYMBOL"
960 IMAGE 3(DDDD.DDD),X,DDD,XXXXXX,9A,XXXX.A
970 IF Q9=1 THEN 990 ! NORMALIZE DATA TO 100% *****
980 CLEAR @ DISP "TAKING RATIOS, A FEW MOMENTS PLEASE" @ DISP @ R9=1
990 FOR I=RMIN TO RMAX @ Z=S(I,1)+S(I,2)+S(I,3)

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1000 IF Z=0 THEN PRINT "SET ";I;" HAS NO VALID DATA" @ GOTO 1020
1010 S(I,1)=S(I,1)/Z @ S(I,2)=S(I,2)/Z @ S(I,3)=S(I,3)/Z
1020 NEXT I @ RETURN ! CREATE PLOTTING BASE *****
1030 CLEAR @ DISP "ENTER 1 FOR CRT PLOT OR PLOTTER NUMBER";@ INPUT Q8
1040 PLOTTER IS Q8 @ DEG @ GCLEAR @ M1,M2,M3=0 @ ON ERROR GOTO 240
1050 IF Q8=1 THEN LIMIT 0,125.6,0,75.2 @ GOTO 1070
1060 LIMIT 0,257,0,191
1070 IF Q8=1 THEN SHOW 0,200,-5,195 ELSE LOCATE 12,120,4,95
1080 IF Q8#1 THEN MSCALE 5,1
1090 DISP "DO YOU WANT A BLOW-UP OF A SECTION OF THE TRIANGLE ?"&I$ @ INPUT Q$
1100 IF Q$="Y" THEN GOSUB 1890
1110 PLOT 100,173.2 @ LORG 5 @ RPLLOT 0,2,-2 @ LABEL L$(1) @ PLOT 100,173.2,1
1120 PLOT 0,0,-1 @ LORG 7 @ RPLLOT -2,0,-2 @ LABEL L$(2) @ PLOT 0,0,1
1130 PLOT 200,0,-1 @ LORG 1 @ RPLLOT 2,0,-2 @ LABEL L$(3) @ PLOT 200,0,1
1140 PLOT 100,173.2,-1 @ PEN UP
1150 FOR I=1 TO 9 @ K1=I*20 @ Y=K1*TAN (60)/2 @ X=Y/TAN (60) @ PLOT X,Y,-2
1160 RPLLOT 2,0,-1 @ PLOT X,Y,1 @ RPLLOT 1,-1.73,2 @ NEXT I
1170 FOR I=1 TO 9 @ K1=I*20 @ Y=K1*TAN (60)/2 @ X=Y/TAN (120)+200 @ PLOT X,Y,-2
1180 RPLLOT -2,0,-1 @ PLOT X,Y,1 @ RPLLOT -1,-1.73,2 @ NEXT I
1190 FOR I=1 TO 9 @ X=20*I @ Y=0 @ PLOT X,Y,-2
1200 RPLLOT -1,1.73,-1 @ PLOT X,Y,1 @ RPLLOT 1,1.73,2 @ NEXT I
1210 IF Q$="Y" THEN GOSUB 1920
1220 IF Q8=1 THEN GSTORE "OUTLINE"
1230 ALPHA @ CLEAR @ DEG ! PLOT DATA *****
1240 DISP "SETS TO BE PLOTTED (FOR 1 SET ENTER SET NUMBER TWICE e.g. 1,1)" @ INP
UT IMIN,IMAX @ X$="N"
1250 IF Q8=1 THEN DISP "DO YOU WANT A CLEAN PLOTTING BASE "&I$ @ INPUT X$
1260 IF Q8=1 AND X$="Y" THEN GRAPH @ GLOAD "OUTLINE"
1270 GOSUB 1480 @ IF Q8#1 THEN 1300
1280 CLEAR @ ALPHA @ DISP "PRESS 'A/G' KEY TO VIEW PLOT; OR [CONT] TO CONTINUE"
1290 PAUSE
1300 CLEAR @ DISP " DO YOU WANT TO CHANGE PLOTTER OR REDRAW BASE ? (Y)" @ DISP
1305 DISP "DO YOU WANT A DOT-MATRIX PRINT OF THE DIAGRAM ? (P)" @ DISP
1310 DISP " DO YOU WANT RELATIVE PROPORTIONS FOR A POINT ON THE CURRENT PLOT ? (
V)"
1320 DISP " (this can only be done on external plotter)" @ DISP
1330 DISP " DO YOU WANT TO ADD DATA FROM THE KEYBOARD ? (K)" @ DISP
1340 DISP " DO YOU WANT TO EDIT EXISTING DATA ? (E)" @ DISP
1350 DISP " DO YOU WANT TO ADD STANDARD REFERENCE LINES ? (S)"
1360 DISP @ DISP " DO YOU WANT TO CONTINUE WITHOUT CHANGES ? (C)" @ INPUT A$
1370 IF A$="Y" THEN 1030
1380 IF A$="K" THEN GOSUB 1740 @ GOTO 1300
1390 IF A$="V" THEN GOSUB 1820 @ GOTO 1300
1400 IF A$="S" THEN 2030
1405 IF A$="P" THEN 2670
1410 IF A$#="E" THEN 1230
1420 Q9=2 @ GOSUB 870
1430 IF S(I,J)<0 THEN S(I,J)=-LGT (ABS (S(I,J)/L(J))) @ GOTO 1450
1440 IF S(I,J)#0 THEN S(I,J)=LGT (S(I,J)/L(J))
1450 CLEAR @ DISP "DO YOU WANT TO EDIT MORE DATA ? "&I$ @ INPUT A$
1460 IF A$="Y" THEN 1420
1470 GOTO 1230 ? SUBROUTINES FOR PLOTTING DATA SYMBOLS *****
1480 CLEAR @ DISP " SYMBOL CAN BE ANY ALPHA-NUMERIC KEY." @ DISP @ DISP
1490 DISP "OR A 'P' FOR POLYGON OR '/' FOR STORED SYMBOLS" @ INPUT A$
1500 IF A$="P" THEN GOSUB 1630 ELSE GOSUB 1610

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1510 FOR I=IMIN TO IMAX
1520 IF S(I,1)<M1 OR S(I,2)<M2 OR S(I,3)<M3 THEN 1590
1530 Y=SIN(60)*S(I,1)*200 @ X=(S(I,3)+.5*S(I,1))*200
1540 MOVE X,Y @ LORG 5
1550 IF A$="P" THEN GOSUB 1660 @ GOTO 1580
1560 IF A$="X" OR A$="O" THEN CSIZE M4,1
1570 IF A$="/" THEN LABEL S$(I) ELSE LABEL A$
1580 NEXT I @ RETURN
1590 PRINT "DATA POINT IS OUTSIDE THE PLOT BOUNDARIES FOR SET";I
1600 IF Q8=1 THEN WAIT 5000 @ GOTO 1580 ELSE GOTO 1580
1610 DISP "LETTER SIZE ? APEX LABELS ARE 3." @ INPUT M4
1620 CSIZE M4 @ RETURN ! PLOT POLYGON *****
1630 DISP "# OF SIDES, OPEN OR SOLID (O OR S), SIZE (mm), AND ROTATION (0 TO 360)"
1640 INPUT E1,E$,E3,A1 @ IF E1<3 THEN 1630
1650 A2=360/E1 @ E3=E3/3.63 @ E5=E3 @ A5=A1 @ RETURN
1660 GRAPH @ DEG @ A1=A5 @ IF E$="S" THEN E2=.1 ELSE E2=E3
1670 SEIGU @ X9=E3*SIN(A1) @ Y9=E3*COS(A1) @ RPLT X9,Y9,2
1680 FOR E5=E3 TO E2 STEP -.2
1690 FOR E=1 TO E1 @ A1=A1+A2 @ X(E)=E5*SIN(A1) @ Y(E)=E5*COS(A1)
1700 RPLT X(E),Y(E),-1 @ NEXT E @ NEXT E5 @ ALPHA @ SETUU @ PEN UP
1710 RETURN ! KEYBOARD DATA INPUT *****
1720 L$(1)="UPPER APEX" @ L$(2)="LOWER LEFT APEX" @ L$(3)="LOWER RIGHT APEX"
1730 RMAX=0 @ RMIN=1 @ GOTO 1750
1740 RMIN=RMAX+1 @ Q9=1
1750 I=RMAX+1
1760 DISP "SAMPLE NAME ? ENTER 'END' WHEN THROUGH" @ INPUT A$
1770 IF A$="END" OR I=255 THEN 1800 ELSE RMAX=I
1780 N$(I)=A$ @ FOR J=1 TO 3 @ DISP L$(J);"-" @ INPUT S(I,J) @ NEXT J
1790 I=I+1 @ GOTO 1760
1800 IF Q9=1 THEN GOSUB 770 ELSE GOTO 740
1810 CLEAR @ RETURN
1820 CLEAR @ GOSUB 370 ! SUBROUTINE TO FIND RELATIVE PROPORTIONS *****
1830 PRINT " X Y A B C"
1840 DISP "MOVE PEN TO DESIRED POINT OVER PLOT"
1850 DISP "PRESS ENTER ON PLOTTER TO CONTINUE" @ DIGITIZ X,Y
1860 A=Y/(SIN(60)*200) @ C=X/200-.5*A @ B=1-(A+C)
1861 W=X @ GOSUB 1888 @ X=W @ W=Y @ GOSUB 1888 @ Y=W @ W=A @ GOSUB 1888
1862 A=W @ W=B @ GOSUB 1888 @ B=W @ W=C @ GOSUB 1888 @ C=W @ PRINT X;Y;A;B;C
1870 DISP "DO YOU WANT TO FIND PROPORTIONS AT MORE LOCATIONS?"&I$ @ INPUT A$
1880 IF A$="Y" THEN 1830 ELSE RETURN
1888 W=W*1000 @ IF CEIL(W)=CEIL(W+.5) THEN W=INT(W) ELSE W=CEIL(W)
1889 W=W/1000 @ RETURN ! SUBROUTINE TO CREATE BLOWN UP PLOT *****
1890 DISP "MINIMUM PERCENTAGES FOR UPPER, LOWER LEFT AND LOWER RIGHT APEXES"
1900 INPUT M1,M2,M3 @ IF M1+M2+M3>90 THEN DISP "LESS THAN 1% OF PLOTTING AREA REMAINS, TRY AGAIN" @ GOTO 1890
1910 RETURN
1920 B1=M1*TAN(60) @ B2=-((2*(100-M2))*TAN(120)) @ B3=-((2*M3)*TAN(60))
1930 Y1=B1 @ Y2=B1 @ X1=(B1-B3)/TAN(60) @ X2=(B1-B2)/TAN(120)
1940 X3=(B2-B3)/(TAN(60)-TAN(120)) @ Y3=TAN(60)*X3+B3 @ GOSUB 2160
1950 PLOT 100,173 @ PLOT 0,0 @ PLOT 200,0 @ PLOT 100,173
1960 PLOT X1,Y1,-2 @ PLOT X2,Y2,-1 @ PLOT X3,Y3 @ PLOT X1,Y1,2
1970 PLOT 100,-4,-2 @ LORG 6
1980 IF Q8#1 THEN LABEL "LOCATION OF PLOT AREA" ELSE LABEL "PLOT AREA"
1990 M1=M1/100 @ M2=M2/100 @ M3=M3/100
2000 IF Q8#1 THEN LOCATE 14.6,119.3,4.5,95 @ GOTO 2020

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2010 LOCATE 33.5,133.5,2.5,90
2020 SCALE X1,X2,Y1,Y3 @ RETURN
2030 CLEAR ! SUBROUTINES FOR STANDARD REFERENCE DIAGRAMS *****
2040 DISP "STANDARD REFERENCE LINES OF POINTS ARE AVAILABLE FOR:" @ DISP "Q - OR
- AB (1)" @ DISP "AN - AB - OR (2)"
2050 DISP "U - Th - K (3)" @ DISP "Al - Na+K - Ca (4)"
2060 DISP @ DISP "WHICH DO YOU WANT ?" @ INPUT A
2070 ON A GOSUB 2180,2260,2380,2570
2080 IF Q8=1 THEN GOTO 1280 ELSE GOTO 1300
2090 DATA .3022,.0005,.3055,.0052,.3084,.0089,.3126,.0144,.316,.0192,.3199,.0236
,.3243,.0284,.3294,.0346,.3342,.0395,.3388,.0439,.3443,.0489,.349,.0532
2100 DATA .3538,.0578,.3601,.0627,.364,.0664,.3703,.0716,.3773,.0771,.3848,.0826
,.3919,.0869,.3989,.0911,.4054,.0949,.4137,.0997,.4231,.1049,.4309,.1085,.4386
2110 DATA .1116,.4469,.1153,.454,.1182,.4631,.1221,.4735,.1244,.4848,.1272,.4941
,.1293,.5088,.132,.5178,.1342,.5309,.1362,.5449,.1382,.5625,.1397,.5805,.1418
2120 DATA .3845,0,.3864,.003,.3892,.0056,.3921,.0082,.3949,.0102,.3984,.0135,.40
33,.0162,.4064,.0187,.4106,.0213,.4162,.0243,.4219,.0272,.4297,.03,.4354,.032
2130 DATA .4431,.0348,.4512,.0374,.4572,.0394,.4643,.0414,.4706,.0431,.4803,.045
5,.4899,.0477,.4982,.0499,.5087,.0521,.5201,.0538,.5297,.0554,.5411,.057
2140 DATA .5543,.059,.5651,.061,.5768,.062,.5886,.063,.5991,.0634,.611,.0639,.62
1,.0646
2150 DATA .5158,.34,.4836,.3229,.444,.2938,.4166,.2757,.3795,.235,.3317,.1857
2160 IF Q8=1 THEN LOCATE 115,150,70,100 ELSE LOCATE 90,130,60,100
2170 SCALE 0,200,0,200 @ RETURN ! Q-OR-AB TERNARY MINIMUM *****
2180 RESTORE 2150 @ IF Q8="Y" THEN GOSUB 2160 ELSE GOTO 2250
2190 FOR I=1 TO 6 @ READ X(I),Y(I) @ X(I)=X(I)*200 @ Y(I)=Y(I)*200
2200 PLOT X(I),Y(I),-2 @ LABEL "+" @ NEXT I @ GOSUB 2000
2210 FOR I=1 TO 6 @ IF Y(I)>Y3 OR Y(I)<Y1 THEN 2240
2220 IF Y(I)-TAN (60)*X(I)>B3 OR Y(I)-TAN (120)*X(I)>B2 THEN 2240
2230 PLOT X(I),Y(I),-2 @ LABEL "+"
2240 NEXT I @ RETURN
2250 FOR I=1 TO 6 @ READ X,Y @ PLOT X*200,Y*200,-2 @ LABEL "+" @ NEXT I @ RETURN
2260 RESTORE 2090 @ N=37 ! 2 AND 8 Kb EUTECTIC CURVES *****
2270 IF Q8="Y" THEN GOSUB 2160 ELSE GOTO 2350
2280 FOR I=1 TO N @ READ X(I),Y(I) @ X(I)=X(I)*200 @ Y(I)=Y(I)*200
2290 IF I=1 THEN MOVE X(I),Y(I) ELSE PLOT X(I),Y(I),-1
2300 NEXT I @ GOSUB 2000 @ W=0
2310 FOR I=1 TO N @ IF Y(I)>Y3 OR Y(I)<Y1 THEN 2340
2320 IF Y(I)-TAN (60)*X(I)>B3 OR Y(I)-TAN (120)*X(I)>B2 THEN 2340
2330 W=W+1 @ IF W=1 THEN MOVE X(I),Y(I) ELSE PLOT X(I),Y(I),-1
2340 NEXT I @ IF I>33 THEN N=31 @ GOTO 2270 ELSE PEN UP @ RETURN
2350 FOR I=1 TO N @ READ X,Y
2360 IF I=1 THEN MOVE X*200,Y*200 ELSE PLOT X*200,Y*200,-1
2370 NEXT I @ IF I>33 THEN N=31 @ GOTO 2350 ELSE PEN UP @ RETURN
2380 IF Q8="Y" THEN GOSUB 2160 ELSE 2550 ! U-Th-K PROPORTIONS *****
2390 GOSUB 2550 @ GOSUB 2000
2400 IF Y1>30.22 THEN X(1),X(2),Y(1),Y(2)=0 @ GOTO 2440
2410 X(1)=(33.1-B3)/(TAN (60)+.1655) @ Y(1)=-(.1655*X(1))+33.1
2420 X(2)=(33.1-B2)/(TAN (120)+.1655) @ IF X(2)>X1 THEN X(2)=(Y2-33.1)/(-.1655)
2430 Y(2)=-(.1655*X(2))+33.1
2440 IF Y2>88.82 THEN X(3),X(4),Y(3),Y(4)=0 @ GOTO 2480
2450 X(3)=-((B2/TAN (120)-.5972)) @ Y(3)=-.5972*X(3)
2460 X(4)=-((B3/TAN (60)-.5972)) @ IF X(4)<X1 THEN X(4)=Y1/.5972
2470 Y(4)=-.5972*X(4)

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2480 X(5)=(B1+86.62)/2.5979 @ Y(5)=B1
2490 IF X(5)<X1 THEN X(5),X(6),Y(5),Y(6)=0 @ GOTO 2520
2500 W6=(B2+86.62)/(2.5979-TAN (120)) @ W7=(B3+86.62)/(2.5979-TAN (60))
2510 W8=2.5979*W6-86.62 @ W9=2.5979*W7-86.62
2515 IF W8<W9 THEN Y(6)=W8 @ X(6)=W6 ELSE Y(6)=W9 @ X(6)=W7
2520 FOR I=1 TO 6 STEP 2 @ IF X(I)=0 AND X(I+1)=0 THEN 2540
2530 MOVE X(I),Y(I) @ PLOT X(I+1),Y(I+1),-1
2540 NEXT I @ PEN UP @ RETURN
2550 MOVE 17.45,30.22 @ PLOT 200,0,-1 @ MOVE 0,0 @ PLOT 148.7,88.82,-1
2560 MOVE 33.33,0 @ PLOT 100,173.2,-1 @ PEN UP @ RETURN
2570 IF Q$="Y" THEN GOSUB 2160 ELSE 2660 ! Al-Na+K-Ca PROPORTIONS *****
2580 GOSUB 2660 @ GOSUB 2000 @ IF Y1>86.6 THEN RETURN
2590 Y(1),Y(2)=86.6 @ X(1)=(86.6-B2)/TAN (120)
2600 X(2)=(86.6-B3)/TAN (60) @ IF M1<M2 THEN X(3)=(115.46-B2)/(TAN (120)+.5773)
ELSE X(3)=(115.46-B1)/.5773
2610 Y(3)=-(.5773*X(3))+115.46
2620 X(4)=(115.46-B3)/(TAN (60)+.5773) @ Y(4)=-(.5773*X(4))+115.46
2630 IF Y3<86.6 THEN 2650
2640 MOVE X(1),Y(1) @ PLOT X(2),Y(2),-1
2650 MOVE X(4),Y(4) @ PLOT X(3),Y(3),-1 @ PEN UP @ RETURN
2660 MOVE 150,86.6 @ PLOT 50,86.6,-1 @ PLOT 200,0,-1 @ PEN UP @ RETURN
2670 GOSUB 370 ! SUBROUTINE TO DUMP GRAPHICS *****
2680 DISP "INPUT PRINTER TYPE: 0=82905B, -1=82905A, 1=MOST OTHERS" @ INPUT I
2690 DUMP GRAPHICS 0,0,1,I
2700 GOTO 1300
2710 END

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