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A program in Hewlett-Packard BASIC for calculation of CIPW normative minerals using HP-Series 80 computers and VISICALC electronic worksheet

by

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INTRODUCTION

The calculation of normative minerals was originally proposed by Cross and others (1902) as a basis for classification of igneous rocks. Although the taxonomy-based nomenclature is no longer used, the standardized set of normative minerals is still employed to characterize rocks or igneous suites and to compare rocks that have crystallized under different physical conditions.

The program "NORM" described here follows closely the subroutine with the same name in the FORTRAN program "GNAP" (Graphic Normative Analysis Program, Stuckless and VanTrump, 1979). Options suggested by Washington (1917) for minor modification to the normative calculations have been retained. Use of these options is initiated by the user through answers to queries from the program.

The program "NORM" uses data stored by the "VISICALC" electronic worksheet program as input. The program writes results to a "/SS" file which can be loaded into "VISICALC" for printing or modification to publishable quality tables. Normative results are usually reported in weight percent, but calculations are performed in molecular proportions. The program allows for creation of a data file which contains the molecular proportions of both oxides and minerals.

EQUIPMENT, TIMING, AND STORAGE REQUIREMENTS

NORM is written for HP-Series 80 computers and may require modifications if it is to be run on other computers that use "BASIC" as a programming language. Storage of the program requires 90 records of 256-byte length. Calculated results are written to a file of 256-byte length records. The number of records is equal to 5 times the number of samples plus 13.

Execution of the program as listed in Appendix I requires approximately 77 K bytes of memory. Redimensioning the matrix to accept only 45 instead of 62 samples (line 10, Appendix I) lowers the memory requirement to approximately 63 K bytes.

Most of the execution time is consumed by the data read and data write segments. It takes about 2-1/2 minutes to read in the data for 62 samples, and about 13 minutes to write the results to a "/SS" file. The calculations for 62 samples which generated 19 error statements, 27 quartz-free analyses, and approximately 20 queries, required about 7-1/2 minutes.

NORMATIVE CALCULATIONS

The steps used to compute normative minerals are exactly the same as those used by Stuckless and VanTrump (1979), and the description of those steps is reproduced here for the convenience of the users of NORM. Oxides used by the program and minerals calculated are presented in Table 1 together with chemical formulae and abbreviations used for each mineral.

1. The arithmetic sum of the analyzed elements is adjusted for F and Cl because these are actually combined with some of the cations that are reported in the analysis as oxides. (Usually this adjustment changes the total by only a few tenths of a percent.) No attempt is made to adjust the sum for S because such an adjustment requires assumptions about the analytical methods used for S and FeO; for most analyses the correction would be negligible. For rocks with a high content of S, the effect of this correction should be checked. The sum, corrected for F and Cl is used to normalize the analysis to 100 percent, and the adjusted oxides (and elements) are converted to molar amounts by dividing each by its molecular weight. In the following discussion, oxides should be understood as oxides and elements, and amounts as molar amounts. (Washington (1917) ignored amounts less than 0.02, but they are used by NORM).

2. The amounts of MnO and NiO are added to FeO, and BaO and SrO are added to CaO. The automatic additon of BaO to CaO can be overridden as described below. The addition of BaO to CaO (or K_2O or Na_2O) has the effect of yielding a low total for the normative minerals relative to the oxide total because the conversion of the calcium-bearing minerals from mole percent (in which they are calculated) to weight percent does not take into account the much heavier barium component of the mineral.

3. In the nine steps of rule 3, amounts of minor oxides are combined with amounts of major oxides to form trace minerals. If an excess of minor constituents exist, NORM uses as much of the minor constituent as possible, and then reports the weight percent excess in an error message. In this case, the normative total is lower than the oxide total. Minor oxides are apportioned as follows:

3a. CaO equal to 3.33 times P_2O_5 is used for apatite.

3b. Na_2O equal to 0.5 times Cl is used for halite.

3c. Equal amounts of Na_2O and SO_3 are combined for thenardite.

3d. FeO equal to 0.5 times S is used for pyrite.

3e. Equal amounts of FeO and Cr_2O_3 are used for chromite.

3f. Equal amounts of FeO and TiO_2 are used for ilmenite. CaO equal to any excess TiO_2 is provisionally allotted to titanite (sphene). (If there is not enough CaO to use up the Al_2O_3 in the anorthite calculations (4d) titanite is not calculated.) Excess TiO_2 is calculated as rutile.

3g. F equal to 2/3 the amount of apatite (3a) is considered to be contained in apatite. Any excess is used with half as much CaO for fluorite.

3h. If the rock contains modal cancrinite, equal amounts of Na_2O and CO_2 are combined for sodium carbonate, otherwise this part of step 3h is skipped. Excess CO_2 is first combined with an equal amount of CaO for calcite. Any excess CO_2 is

subsequently combined with equal amounts of MgO for magnesite, and then with FeO for siderite.

4. Alumina and potash are apportioned as follows:

   4a. Equal amounts of K_2O and Al_2O_3 are used for orthoclase.

   4b. Excess K_2O is equal to the amount of potassium metasilicate.

   4c. Excess Al_2O_3 is combined with an equal amount of Na_2O and is equal to the amount of albite.

   4d. Excess Al_2O_3 is combined with an equal amount of CaO (including the CaO that had been provisionally assigned to titanite if necessary) to make anorthite.

   4e. Any excess Al_2O_3 is equal to the amount of corundum.

5. Sodium oxide and ferric iron are apportioned as follows:

   5a. Fe_2O_3 equal to the excess of Na_2O is used for acmite.

   5b. Any excess Na_2O is equal to the amount of sodium metasilicate.

   5c. Excess Fe_2O_3 and an equal amount of FeO are used for magnetite.

   5d. Any excess Fe_2O_3 is equal to the amount of hematite.

6. The relative proportion of any remaining FeO and MgO are determined.

7. Lime, ferrous iron and magnesia are apportioned as follows:

   7a. CaO equal to the sum of FeO and MgO is used for diopside.

   7b. Excess CaO is equal to the amount of excess wollastonite (that is wollastonite in excess of that contained in the diopside molecule).

   7c. Excess MgO + FeO is equal to the amount of hypersthene. The proportions of enstatite and ferrosilite are the same as the MgO-FeO proportions determined in (6).

8. Silica is adjusted for the minerals calculated in steps 3 through 7. If there is a deficiency in silica, the silica-rich minerals are recalculated as silica-poor minerals.

   8a. The SiO_2 remaining after (3i) is decreased by the amount of titanite, 4 times the amount of acmite, the amount of sodium metasilicate, the amount of potassium metasilicate, 6 times the amount of orthoclase, 6 times the amount of albite, the amount of excess wollastonite, twice the amount of anorthite, twice the amount of diopside and the amount of hypersthene.

8b. Excess SiO_2 is equal to the amount of quartz.

8c. If there is a silica deficiency after (8a), hypersthene is converted to olivine (forsterite and fayalite proportions are as determined in rule (6)) and SiO_2 is increased by 1/2 the amount of hypersthene. If this results in a SiO_2 excess, hypersthene is increased (from zero) and olivine is decreased until SiO_2 is equal to zero.

8d. If there is still a silica deficiency, titanite is converted to perovskite and silica is increased by the amount of titanite.

8e. If there is still a silica deficiency, albite is converted to nepheline and SiO_2 is increased by 3 times the amount of albite. If this results in a silica excess, albite is increased (from zero) and nepheline is decreased until SiO_2 is equal to zero.

8f. If there is still a silica deficiency, orthoclase is converted to leucite and SiO_2 is increased by 1/3 the amount of orthoclase. If this results in a silica excess, orthoclase is increased (from zero) and leucite is decreased until SiO_2 equals zero.

8g. If there is still a silica deficiency, the clinopyroxenes are converted to calcium orthosilicate and olivine. Wollastonite is converted first, then diopside. SiO_2 is increased by twice the amount of clinopyroxene and the clinopyroxene is changed to orthosilicate. If an excess in silica results, clinopyroxene is increased from zero and orthosilicate is decreased until silica equals zero.

9. Molecular amounts of minerals are converted to weight percent by multiplying molar amounts by molecular weights.

10. The total normative minerals are then calculated and divided into two categories. Salic minerals include quartz, corundum, zircon, orthoclase, albite, anorthite, leucite, nepheline, kaliophilite, halite, thenardite, and sodium carbonate. All other minerals listed in Table 1 are femic. If silica is still deficient after step (8h), NORM follows the convention of Washington (1917) and reports silica deficiencies after step (8h) as excesses of MgO and FeO (in weight percent) with normative olivine decreased. This has the effect of yielding a low normative total.

The output of approximate norms and excess oxides provides sets of usable information. The approximate norm allows data from the sample to be evaluated in the same manner as samples for which an accurate norm could be calculated. The excess oxides can then be evaluated in terms of analytical error or the existence of modal minerals that are not considered in the normative calculations. For example, an analysis with a low analytical total (e.g. 98.98%) and a large excess of P_2O_5 beyond that used in the norm (e.g. 0.50%) could result from abundant rare earth phosphates in the rock.

Alternatively, an analytical total near 100 percent and an excess of P_2O_5 beyond that used in the norm of 0.01 percent indicates that the norm is accurate within the limits of analytical uncertainty. As a third example, the analysis of a dunite may have an analytical total near 100 percent, but contain a large excess of MgO beyond that used in the normative calculation. This could indicate the existence of periclase or brucite in the rock.

The only major difference in the normative calculations by NORM and the rules proposed by Washington, is in the treatment of CO_2. Washington proposed that CO_2 be treated three different ways, depending on petrographic results: (1) if cancrinite was present, CO_2 was first used for sodium carbonate and added to the salic component with any excess CO_2 used for calcite, (2) if primary calcite was present, CO_2 was calculated as calcite and added to the femic component, and (3) if secondary calcite was present, CO_2 was calculated as calcite, but calcite was not used in either the femic or salic totals. NORM provides for a user-initiated calculation of sodium carbonate which is added to the salic component. After sodium carbonate is calculated, or if this calculation is not requested, CO_2 is assigned to calcite, with excess CO_2 used for magnesite, and if necessary, siderite. These three carbonates are added to the femic total regardless of whether they are primary or secondary.

PROGRAM OPERATIONS

The format for data input for NORM is fixed as follows: The data must have been stored to mass storage from the program VISICALC or other program that creates a "/SS" type file. The first row must contain sample identification. The second row may contain a plotting symbol, a blank, or other sample information. The third through twenty-third rows must contain numeric data or blanks that correspond to oxide or element concentrations in the order SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, K_2O, H_2O (which can be total water, - water, + water, or LOI (loss on ignition)), TiO_2, P_2O_5, MnO, ZrO_2, CO_2, SO_3, Cl, F, S, Cr_2O_3, NiO, and BaO. If information other than blanks (which are read as zeros) or numeric characters are encountered during the reading of rows three through twenty three, the program will pause and an error will be displayed.

The program runs interactively through a series of queries, which are largely self-explanatory and are generally answered by "Y" or "N" followed by pressing "END LINE". The first query asks for the file name for the data to be loaded and provides an option to view the catalog of the disc in the current mass storage device by pressing "END LINE" without entering any file name. After a file name has been entered, the restrictions for data format (given above) are displayed on the CRT (Cathode-Ray Tube). The program then asks if the data file is ready to load. Any answer other than "Y" will cause the program to restart. An answer of "Y" will lead to the query "WHAT IS PRINTER ADDRESS FOR ERROR MESSAGES AND RUN CONDITIONS". The designation of an external, hard-copy printer provides a permanent record of error messages such as an excess of an element left over after calculation of the norm, or of user-imposed conditions such as calculations made water free.

If the requested file is not found, the program displays "FILE DOES NOT EXIST! DO YOU NEED TO CHANGE MASS STORAGE? (YES OR NO)". An answer of "N" prompts a query for a new file name. An answer of "Y" prompts a query for a new mass storage address. Any other input restarts the program. The entry of

either a new file name or new mass storage address causes a new attempt to read the desired file.

After the data are loaded, the program presents a series of queries. The first query "DO ANY OF THE SAMPLES CONTAIN CANCRINITE" (YES OR NO)" sets a flag for calculation of sodium-carbonate. An answer of "Y" will cause a query during the norm calculation for all samples that contain both Na_2O and CO_2: "DOES SAMPLE [name] CONTAIN CANCRINITE? (YES OR NO)". An answer of "Y" will cause sodium carbonate to be calculated before other carbonates for the specified samples.

The next query is "DO YOU WANT CALCULATIONS WATER FREE? (YES OR NO)". An answer of "Y" does not change the reported analytical total (which is always adjusted for F and Cl if they are reported); however, the total for the normative minerals will equal 100 percent rather than the analytical total adjusted to 100 percent. Thus, if the analytical total adjusted to 100 percent contains 2 percent H_2O, an answer of "N" will yield a normative mineralogy total of 98 percent and an answer of "Y" will yield a normative mineralogy total of 100 percent. This query treats the entire data set in the same way and generates a printed message if calculations are made water free.

The next query is "DO YOU WANT MOLAR DATA STORED IN A FILE? (YES OR NO)". An answer of "Y" will prompt a query for a file name and cause molar data for both oxides and minerals to be stored in that file.

The next query is "FILE NAME FOR NORMATIVE DATA". This file will contain weight percent data of oxides and minerals. The file name must be different from any file names on the disc in use, including the file for the molar data (if one was requested).

The responses to the next two queries determine the format the output data. Any answer other than "Y" to the query "DO YOU WANT VALUES WITH NO DATA REPRESENTED BY LEADERS (---)? (YES OR NO)" will cause zeros to be used in the output file. The query "ROUND TO HOW MANY DECIMAL PLACES?" requires a numeric answer. Rounding is done as the file is stored, and therefore has no affect on accuracy of calculations.

The program then proceeds to adjusting values to a total of 100%, and conversion of these values from weight percent to molar proportions. Minor elements are then added to major elements as described under rule 2 in the preceding section. If a sample is found to contain BaO, the user is given the option of adding it to Na_2O (if SO_3 is also given in the analysis), K_2O, or CaO. A message as to where BaO was added is printed.

The program then proceeds with calculating normative minerals. If an excess of elements or oxides are encountered, error messages are sent to the printer; for example: "THERE IS EXCESS P205 OF (X) WT% IN SAMPLE (name)". Similar messages can be generated for Cl, S, Cr_2O_3, F, CO_2, and ZrO. If there is insufficient SiO_2 to complete the normative calculations, it is expressed as excess FeO and MgO in an error message. After data storage, the total number of error messages generated is printed.

In addition to normative minerals, NORM calculates and stores a few standard variables: the differentiation index of Thornton and Tuttle (1960),

which is identified as "D INDEX"; the partitioning of clinopyroxene (DI) into DIEN (Mg component), DIFS (Fe component), DIWO (Ca component); WOL (Ca component in excess of that used to form diopside; HY (Mg and Fe component in excess of that used to form diopside): HYEN and HYFS (the Mg and Fe components of HY, respectively); OL (the total of FO and FA); PERAL (the molar ratio of Al to (Na+K+Ca)), and PERALK (the molar ratio of Al to (Na+K)). Total normative mineralogy and salic and femic components are also presented.

Data are written to mass storage with several instructions for the VISICALC program. The row identifiers (oxides and calculated minerals) are left justified by a local formatting command, whereas all other information is right justified by a global command. Column width is set at 8 spaces, and page length is set at 20 lines. Any recalculation is set to occur automatically and by columns. An example of output from NORM (slightly modified by the addition of horizontal lines) is presented in Appendix II.

Table 1.--List of variable names used in NORM

Oxides and Elements

1.	SiO_2	12.	MnO
2.	Al_2O_3	13.	ZrO_2
3.	Fe_2O_3	14.	CO_2
4.	FeO	15.	SO_3
5.	MgO	16.	Cl
6.	CaO	17.	F
7.	Na_2O	18.	S
8.	K_2O	19.	Cr_2O_3
9.	H_2O	20.	NiO
10.	TiO_2	21.	BaO
11.	P_2O_5		

Minerals

1. Q = quartz (SiO_2)
2. C = corundum (Al_2O_3)
3. Z = zircon ($ZrSiO_4$)
4. OR = orthoclase ($KAlSi_3O_8$)
5. AB = albite ($NaAlSi_3O_8$)
6. AN = anorthite ($CaAl_2Si_2O_8$)
7. LC = leucite ($K_2Al_2Si_4O_{12}$)
8. NE = nepheline ($Na_2Al_2Si_2O_8$)
9. KP = kaliophilite ($K_2Al_2Si_2O_8$)
10. HL = halite (NaCl)
11. TH = thenardite (Na_2SO_4)
12. NC = sodium carbonate (Na_2CO_3)
13. AC = acmite ($Na_2Fe_2Si_4O_{12}$)
14. NS = sodium metasilicate (Na_2SiO_3)
15. KS = potassium metasilicate (K_2SiO_3)
16. WO = wollastonite ($CaSiO_3$)
17. EN = enstatite ($MgSiO_3$)
18. FS = ferrosilite ($FeSiO_3$)
19. FO = forsterite (Mg_2SiO_4)
20. FA = fayalite (Fe_2SiO_4)
21. CS = calcium orthosilicate (Ca_2SiO_4)
22. MT = magnetite (Fe_3O_4)
23. CM = chromite ($FeCr_2O_4$)
24. HM = hematite ($Fe_2)_3$)
25. IL = ilmenite ($FeTiO_3$)
26. TN = titanite-sphene ($CaTiSiO_5$)
27. PF = perovskite ($CaTiO_3$)
28. RU = rutile (TiO_2)
29. AP = apatite ($Ca_5F(PO_4)_3$)
30. FR = fluorite (CaF_2)
31. PR = pyrite (FeS_2)
32. CC = calcite ($CaCO_3$)
33. MG = magnesite ($MgCO_3$)
34. SD = siderite ($FeCO_3$)
35. DI = diopside (EN+FS+WO-WOL)
36. HY = hypersthene (EN+FS)
37. OL = olivine (FO+FA)

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APPENDIX I

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10 REM CIPW NORMATIVE PROGRAM BY J. S. STUCKLESS AUG 29,1983
20 DIM C$[51],S(74,62),N$(62),T(24,62),M$(62),RM(21),WM(34)
30 I$=" ("&CHR$ (217)&"ES OR "&CHR$ (296)&"O)" @ CLEAR @ JMAX,E=0 @ E$="N"
40 GOSUB 230 @ INPUT A$
50 IF NOT LEN (A$) THEN GOSUB 250 @ CLEAR @ GOTO 40
60 CLEAR ! ***** DISPLAY PROGRAM RESTRICTIONS FOR DATA INPUT **********
70 DISP "PROGRAM ASSUMES THAT SAMPLE NAME IS IN ROW 1, SYMBOL IS IN ROW 2, "
80 DISP "OXIDE NAMES ARE IN COLUMN 1 IN THE ORDER : SiO2, Al2O3, Fe2O3, FeO,"
90 DISP "MgO, CaO, Na2O, K2O, LOI, TiO2, P2O5, MnO, ZrO2, CO2, SO3, Cl, F, "
100 DISP "S, Cr2O3, NiO, and BaO." @ DISP @ DISP
110 DISP "BLANKS WILL BE READ AS ZEROS" @ DISP
120 DISP "DATA MUST HAVE BEEN STORED FROM 'VISICALC' OR OTHER '/SS' TYPE FILE."
130 DISP @ DISP "IS "&A$&" DATA FILE OK TO LOAD ? "&I$ @ INPUT B$
140 IF B$#"Y" THEN 40
150 DISP "WHAT IS PRINTER ADDRESS FOR ERROR MESSAGES AND RUN CONDITIONS"
160 INPUT A@ PRINTER IS A @ CLEAR @ GOTO 280
170 OFF ERROR @ IF ERRN -89 THEN DISP "INVALID DATA ENCOUNTERED IN ROW";I
180 GOTO 2550
190 OFF ERROR @ BEEP @ DISP A$;" FILE DOES NOT EXIST! DO YOU NEED TO CHANGE MASS
 STORAGE?:"&I$ @ INPUT A$
200 IF A$="N" THEN CLEAR @ GOSUB 230 @ GOTO 280
210 IF A$#"Y" THEN CLEAR @ GOTO 40
220 DISP "MASS STORAGE IS '_____'" @ INPUT S$@ MASS STORAGE IS S$ @ GOTO 280
230 CLEAR @ DISP @ DISP "ENSURE THAT FILE IS ON THE CURRENT STORAGE MEDIUM BEFOR
E ENTERING FILE NAME" @ DISP
240 DISP "ENTER FILE NAME, OR PRESS [END LINE] FOR CATALOG." @ RETURN
250 CRT IS 2 @ DISP @ CAT @ DISP USING "3/" @ CRT IS 1
260 DISP @ DISP "PRESS [CONT] KEY WHEN READY " @ PAUSE
270 RETURN
280 ON ERROR GOTO 190 @ ASSIGN# 1 TO  A$ ! SUBROUTINE TO LOAD 'VISICALC' FILE *
300 CLEAR @ DISP "FILE NAME: "&A$&" IS BEING LOADED" @ ON ERROR GOTO 170
310 READ# 1 ; C$
320 IF POS (C$,">") THEN 340 ELSE ASSIGN# 1 TO  * @ CLEAR @ GOTO 450
330 IF POS (C$[1],"/") THEN GOTO 310
340 IF C$[2,2]="A" AND NUM (C$[3])<58 THEN 310
350 C$=C$[2] @ J=NUM (C$)-65 @ GOSUB 430 @ C$=C$[2]
360 IF NUM (C$)<59 THEN 390 ELSE X=NUM (C$)-64
370 IF J=0 THEN J=25+X ELSE J=51+X
380 GOSUB 430 @ C$=C$[2]
390 I=VAL (C$) @ Z=POS (C$,":")+1 @ C$=C$[Z] @ IF I<3 THEN 410 ELSE I=I-2
400 S(I,J)=VAL (C$) @ GOTO 310
410 IF I=1 THEN N$(J)=C$[2] ELSE M$(J)=C$
420 GOTO 310
430 IF J>JMAX THEN JMAX=J
440 RETURN
450 CLEAR @ DISP "DATA FILE "&A$&" IS LOADED" @ DISP @ DISP
460 DISP "DO ANY SAMPLES CONTAIN CARBONDIOXIDE ?"&I$ @ INPUT D$@ CLEAR
470 DISP "DO YOU WANT CALCULATIONS AFTER FREE ?"&I$ @ INPUT B$
480 DISP "DO YOU WANT MOLAR DATA STORED IN A FILE ?" @ INPUT G$
490 IF G$="Y" THEN DISP "FILE NAME FOR MOLAR DATA ?" @ INPUT L$
500 DISP @ DISP "FILE NAME FOR NORMATIVE DATA ?" @ INPUT K$@ DISP
510 DISP "DO YOU WANT VALUES WITH NO DATA REPRESENTED BY LEADERS (----) "&I$
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520 INPUT E$@ DISP @ DISP "ROUND TO HOW MANY DECIMAL PLACES?" @ INPUT E9
530 DISP "ADJUSTING OXIDES TO 100%" @ IF B$#"Y" THEN 550
540 PRINT "NORMATIVE RESULTS CALCULATED WATER FREE" @ PRINT
550 FOR J=1 TO JMAX @ S=0 ! FIND SUM OF EACH COLUMN ****************************
560 FOR I=1 TO 21 @ ON ERROR GOTO 580
570 S=S+S(I,J) @ NEXT I @ GOTO 590
580 OFF ERROR @ IF ERRN =7 THEN S(I,J)=0 @ GOTO 570 ELSE GOTO 170
590 S=S-.42*S(17,J)-.23*S(16,J) ! ADJUST SUM FOR F AND CI ***********************
600 S(22,J)=S @ IF B$#"Y" THEN S(23,J)=S(22,J) ELSE S(23,J)=S(22,J)-S(9,J)
610 NEXT J
620 FOR J=1 TO JMAX @ FOR I=1 TO 21 @ T(I,J)=S(I,J)/(S(23,J)/100) @ NEXT I
630 NEXT J @ IF E$="Y" THEN 690
640 FOR I=1 TO 21 @ READ RM(I)@ NEXT I ! MOLECULAR CONVERSION FOR OXIDES *******
650 DATA .01664314,.009807652,.006262047,.01391858,.02480688,.01783186,.0161345,
.01061533,.05550825,.01251583,.007045002,.01409694,.008115645,.02272213
660 DATA .01249029,.02820636,.05263601,.03118762,.006579372,.0133852,.006521481
670 GOSUB 680 @ GOTO 860
680 CLEAR @ DISP "CONVERTING OXIDES TO MOLAR VALUES"
690 FOR J=1 TO JMAX @ S=0
700 FOR I=1 TO 21 @ T(I,J)=T(I,J)*RM(I) @ S=S+T(I,J) @ NEXT I
710 T(22,J)=S @ IF E$="Y" THEN 850
720 T(4,J)=T(4,J)+T(12,J)+T(20,J) ! ADD MnO AND NiO TO FeO **********************
730 IF T(15,J)*T(21,J)=0 THEN 770 ! ADD BaO TO Na2O OR K2O OR CaO **************
740 CLEAR @ DISP "DOES SAMPLE "&N$(J)&" CONTAIN BARITE  ?"&I$ @ INPUT B$
750 IF B$#"Y" THEN 780 ELSE T(7,J)=T(7,J)+T(21,J)
760 PRINT "BaO ADDED TO Na2O FOR SAMPLE "&N$(J) @ PRINT @ GOTO 840
770 IF T(21,J)=0 THEN 840 ELSE CLEAR
780 DISP @ DISP "DEFAULT ADDS Ba TO Ca."
790 DISP "DO YOU WANT Ba ADDED TO K FOR SAMPLE "&N$(J)&I$;
800 INPUT B$@ IF B$#"Y" THEN 830
810 PRINT "BaO ADDED TO K2O FOR SAMPLE "&N$(J) @ PRINT
820 T(8,J)=T(8,J)+T(21,J) @ GOTO 840
830 T(6,J)=T(6,J)+T(21,J)
840 S(73,J)=T(2,J)/(T(7,J)+T(8,J)+T(6,J)) @ S(74,J)=T(2,J)/(T(7,J)+T(8,J))
850 NEXT J @ RETURN
860 DISP "CALCULATING NORM"
870 FOR J=1 TO JMAX
880 IF T(11,J)=0 THEN S(54,J)=0 @ GOTO 950 ! CALCULATE APATITE ***************
890 IF 3.33333*T(11,J)<T(6,J) THEN 940 ELSE S(54,J)=T(6,J)/3.33333
900 T(11,J)=(T(11,J)-S(54,J))/RM(11) @ T(6,J)=0 @ X=T(11,J)
910 IF X>.004 THEN GOSUB 2520 ELSE GOTO 950
920 PRINT "THERE IS EXCESS P2O5 OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
930 E=E+1 @ GOTO 950
940 T(6,J)=T(6,J)-3.33333*T(11,J) @ S(54,J)=T(11,J)
950 IF T(16,J)=0 THEN S(35,J)=0 @ GOTO 1020 ! CALCULATE HALITE ***************
960 IF .5*T(16,J)<T(7,J) THEN 1010 ELSE S(35,J)=T(7,J)
970 T(16,J)=(T(16,J)-2*S(35,J))/RM(16) @ T(7,J)=0 @ X=T(16,J)
980 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1020
990 PRINT "THERE IS EXCESS CL OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1000 E=E+1 @ GOTO 1020
1010 S(35,J)=.5*T(16,J) @ T(7,J)=T(7,J)-.5*T(16,J)
1020 IF T(15,J)=0 THEN S(36,J)=0 @ GOTO 1060 ! CALCULATE THENARDITE ***********
```

```
1030 IF T(7,J)>T(15,J) THEN S(36,J)=T(15,J) ELSE S(36,J)=T(7,J)
1040 T(7,J)=T(7,J)-S(36,J) @ T(15,J)=T(15,J)-S(36,J)
1050 T(18,J)=T(18,J)+T(15,J) !                                   ADD EXCESS SO3 TO S
1060 IF T(18,J)=0 THEN S(56,J)=0 @ GOTO 1130 ! CALCULATE PYRITE ***************
1070 IF T(18,J)*.5<T(4,J) THEN 1120 ELSE S(56,J)=T(4,J)
1080 T(18,J)=(T(18,J)-2*T(4,J))/RM(18) @ T(4,J)=0 @ X=T(18,J)
1090 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1130
1100 PRINT "THERE IS EXCESS S OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1110 E=E+1 @ GOTO 1130
1120 S(56,J)=.5*T(18,J) @ T(4,J)=T(4,J)-.5*T(18,J)
1130 IF T(19,J)=0 THEN S(48,J)=0 @ GOTO 1200 ! CALCULATE CHROMITE **************
1140 IF T(19,J)<T(4,J) THEN 1190 ELSE S(48,J)=T(4,J)
1150 T(19,J)=(T(19,J)-T(4,J))/RM(19) @ T(4,J)=0 @ X=T(19,J)
1160 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1200
1170 PRINT "THERE IS EXCESS Cr2O3 OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1180 E=E+1 @ GOTO 1200
1190 S(48,J)=T(19,J) @ T(4,J)=T(4,J)-T(19,J)
1200 IF T(4,J)>T(10,J) THEN S(50,J)=T(10,J) ELSE S(50,J)=T(4,J) ! ILMENITE ****
1210 T(4,J)=T(4,J)-S(50,J) @ T(10,J)=T(10,J)-S(50,J)
1220 IF T(17,J)=0 THEN S(55,J)=0 @ GOTO 1300 ! ADJUST F FOR AP & MAKE FR ******
1230 T(17,J)=T(17,J)-2/3*S(54,J) @ IF T(17,J)<0 THEN T(17,J)=0
1240 IF T(17,J)*.5<T(6,J) THEN GOTO 1290 ELSE S(55,J)=T(6,J)
1250 T(17,J)=(T(17,J)-2*T(6,J))/RM(17) @ T(6,J)=0 @ X=T(17,J)
1260 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1300
1270 PRINT "THERE IS EXCESS F OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1280 E=E+1 @ GOTO 1300
1290 S(55,J)=.5*T(17,J) @ T(6,J)=T(6,J)-.5*T(17,J)
1300 IF T(14,J)=0 THEN S(37,J),S(57,J),S(58,J),S(59,J)=0 @ GOTO 1510
1310 IF B$#"Y" THEN S(37,J)=0 @ GOTO 1390 ! CALCULATE CARBONATES **************
1320 CLEAR @ DISP "DOES SAMPLE "&N$(J)&" CONTAIN CANCRINITE ?"&I$ @ INPUT B$
1330 DISP @ DISP "CONTINUING WITH NORM CALCULATION"
1340 IF B$#"Y" THEN S(37,J)=0 @ GOTO 1390
1350 PRINT "NA2O3 ATTEMPTED FOR SAMPLE "&N$(J) @ PRINT
1360 IF T(14,J)<T(7,J) THEN 1380 ELSE S(37,J)=T(7,J) ! SODIUM CARBONATE LOOP
1370 T(14,J)=T(14,J)-T(7,J) @ T(7,J)=0 @ GOTO 1390
1380 S(37,J)=T(14,J) @ T(14,J),S(57,J),S(58,J),S(59,J)=0 @ T(7,J)=T(7,J)-S(37,J)
 @ GOTO 1510
1390 IF T(14,J)<T(6,J) THEN 1410 ELSE S(57,J)=T(6,J) ! CALCITE LOOP
1400 T(14,J)=T(14,J)-S(57,J) @ T(6,J)=0 @ GOTO 1420
1410 S(57,J)=T(14,J) @ T(14,J),S(58,J),S(59,J)=0 @ T(6,J)=T(6,J)-S(57,J) @ GOTO
1510
1420 IF T(14,J)<T(5,J) THEN 1440 ELSE S(58,J)=T(5,J) ! MAGNESITE LOOP
1430 T(14,J)=T(14,J)-S(58,J) @ T(5,J)=0 @ GOTO 1450
1440 S(58,J)=T(14,J) @ T(14,J),S(59,J)=0 @ T(5,J)=T(5,J)-S(58,J) @ GOTO 1510
1450 IF T(14,J)<T(4,J) THEN 1500 ELSE S(59,J)=T(4,J) ! SIDERITE LOOP
1460 T(14,J)=(T(14,J)-S(59,J))/RM(14) @ T(4,J)=0 @ X=T(14,J)
1470 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1510
1480 PRINT "THERE IS EXCESS CO2 OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1490 E=E+1 @ GOTO 1510
1500 S(59,J)=T(14,J) @ T(4,J)=T(4,J)-T(14,J)
1510 IF T(13,J)=0 THEN S(28,J)=0 @ GOTO 1580 ! CALCULATE ZIRCON **************
1520 IF T(13,J)<T(1,J) THEN 1570 ELSE S(28,J)=T(1,J)
1530 T(13,J)=(T(13,J)-T(1,J))/RM(13) @ T(1,J)=0 @ X=T(13,J)
```

```
1540 IF X>.004 THEN GOSUB 2520 ELSE GOTO 1580
1550 PRINT "THERE IS EXCESS TiO OF";X;" WT % IN SAMPLE "&N$(J) @ PRINT
1560 E=E+1 @ GOTO 1580
1570 S(28,J)=T(13,J) @ T(1,J)=T(1,J)-T(13,J)
1580 IF T(8,J)>T(2,J) THEN 1600 ELSE S(29,J)=T(8,J) ! CALCULATE OR & KS ********
1590 T(2,J)=T(2,J)-T(8,J) @ T(8,J)=0 @ S(40,J)=0 @ GOTO 1620
1600 S(29,J)=T(2,J) @ T(8,J)=T(8,J)-T(2,J) @ T(2,J)=0
1610 S(40,J)=T(8,J) @ T(8,J)=0
1620 IF T(7,J)>T(2,J) THEN 1640 ELSE S(30,J)=T(7,J) ! CALCULATE ALBITE *********
1630 T(2,J)=T(2,J)-T(7,J) @ T(7,J)=0 @ GOTO 1650
1640 S(30,J)=T(2,J) @ T(7,J)=T(7,J)-T(2,J) @ T(2,J)=0
1650 IF T(2,J)>T(6,J) THEN 1670 ELSE S(31,J)=T(2,J) ! CALCULATE AN & C**********
1660 T(6,J)=T(6,J)-T(2,J) @ T(2,J)=0 @ S(27,J)=0 @ GOTO 1690
1670 S(31,J)=T(6,J) @ T(2,J)=T(2,J)-T(6,J) @ T(6,J)=0
1680 S(27,J)=T(2,J) @ T(2,J)=0
1690 IF T(6,J)<T(10,J) THEN 1710 ELSE S(51,J)=T(10,J) ! CALCULATE TN & RU ******
1700 T(6,J)=T(6,J)-T(10,J) @ T(10,J)=0 @ S(53,J)=0 @ GOTO 1730
1710 S(51,J)=T(6,J) @ T(10,J)=T(10,J)-T(6,J) @ T(6,J)=0
1720 S(53,J)=T(10,J)
1730 IF T(7,J)=0 THEN S(38,J),S(39,J)=0 @ GOTO 1780 ! AC, NS, MT, & HM *********
1740 IF T(7,J)<T(3,J) THEN 1770
1750 S(38,J)=T(3,J) @ T(7,J)=T(7,J)-T(3,J) @ T(3,J)=0
1760 S(39,J)=T(7,J) @ T(7,J)=0 @ GOTO 1780
1770 S(38,J)=T(7,J) @ T(3,J)=T(3,J)-T(7,J) @ T(7,J),S(39,J)=0
1780 IF T(4,J)>T(3,J) THEN 1800 ELSE S(47,J)=T(4,J)
1790 T(3,J)=T(3,J)-T(4,J) @ T(4,J)=0 @ S(48,J)=T(3,J) @ GOTO 1810
1800 S(47,J)=T(3,J) @ T(4,J)=T(4,J)-T(3,J) @ S(49,J)=0
1810 S(42,J)=T(5,J) @ S(41,J)=T(6,J) @ S(43,J)=T(4,J) ! EN, FS, DI, & WO *******
1820 S(61,J)=S(42,J)+S(43,J) @ IF S(61,J)=0 THEN 1840
1830 T(20,J)=S(42,J)/S(61,J) @ T(21,J)=S(43,J)/S(61,J)
1840 IF S(61,J)>T(6,J) THEN 1860 ELSE S(60,J)=S(61,J)
1850 T(6,J)=T(6,J)-S(61,J) @ S(67,J)=T(6,J) @ S(61,J)=0 @ GOTO 1870
1860 S(60,J)=T(6,J) @ S(67,J)=0 @ S(61,J)=S(61,J)-S(60,J)
1870 S(32,J),S(33,J),S(34,J),S(46,J),S(62,J),S(52,J)=0 ! BALANCE SILICA ********
1880 T(9,J)=S(51,J)+4*S(38,J)+S(39,J)+S(40,J)+6*(S(29,J)+S(30,J))+S(41,J)+2*S(31
,J)+S(42,J)+S(43,J)
1890 IF T(9,J)>T(1,J) THEN 1910 ELSE S(26,J)=T(1,J)-T(9,J)
1900 S(41,J)=S(41,J)-S(67,J) @ GOTO 1920
1910 GOSUB 2150
1920 S(41,J)=S(67,J)+S(60,J) @ S(68,J)=S(67,J) @ S(64,J),S(67,J)=S(60,J)
1930 S(65,J)=S(60,J)*T(20,J) @ S(66,J)=S(60,J)*T(21,J)
1940 S(42,J)=(S(61,J)+S(60,J))*T(20,J) @ S(43,J)=(S(61,J)+S(60,J))*T(21,J)
1950 S(69,J)=S(61,J) @ S(70,J)=S(61,J)*T(20,J) @ S(71,J)=S(61,J)*T(21,J)
1960 S(44,J)=S(62,J)*T(20,J) @ S(45,J)=S(62,J)*T(21,J) @ S(72,J)=S(62,J)
1970 T(9,J),T(20,J),T(21,J),T(1,J)=0
1980 NEXT J
1990 IF G$="Y" THEN 2020 ELSE CLEAR @ DISP "RELOADING MOLAR VALUES FOR OXIDES."
2000 F$="Y" @ GOSUB 620 @ GOSUB 2620
2010 E$="N" @ RESTORE 2030
2020 FOR I=1 TO 34 @ READ MM(I)@ NEXT I ! MOLECULAR CONVERSIONS FOR MINERALS *
2030 DATA 60.0848,101.9612,183.3036,556.6734,524.449,278.2102,436.5038,284.1098,
316.3342,116.8856,142.0412,105.989,462.0104,122.0638,154.2982,116.1642,100.3562
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2040 DATA 131.9312,140.7076,203.7776,172.2436,231.5383,223.8363,159.6922,151.744
9,196.063,135.9782,79.8988,336.2048,78.0768,119.975,100.0894,84.32135,115.8564
2050 CLEAR @ DISP "CONVERTING MINERALS TO WEIGHT PERCENT."
2060 FOR J=1 TO JMAX @ S=0 @ FOR I=26 TO 59 @ IF S(I,J)=0 THEN 2080
2070 S(I,J)=S(I,J)*WM(I-25) @ S=S+S(I,J) @ IF I<38 THEN S(61,J)=S
2080 NEXT I @ S(60,J)=S @ S(62,J)=S(60,J)-S(61,J)
2090 S(63,J)=S(26,J)+S(29,J)+S(30,J)+S(33,J)+S(34,J)+S(32,J)
2100 S(68,J)=S(68,J)*WM(15) @ S(67,J)=S(41,J)-S(68,J)
2110 S(66,J)=S(66,J)*WM(18) @ S(65,J)=S(65,J)*WM(17) @ S(70,J)=S(70,J)*WM(17)
2120 S(64,J)=S(65,J)+S(66,J)+S(67,J) @ S(71,J)=S(71,J)*WM(18)
2130 S(69,J)=S(70,J)+S(71,J) @ S(72,J)=S(44,J)+S(45,J) @ S(25,J)=0
2140 NEXT J @ GOTO 2580
2150 X=T(1,J)-T(9,J)+S(61,J) @ S(26,J)=0 ! CONVERT HY TO OL & SiO2 ************
2160 Y=2*X-S(61,J) @ IF Y<0 THEN 2190
2170 S(62,J)=S(61,J)-X @ S(61,J)=Y
2180 RETURN
2190 S(62,J)=.5*S(61,J) @ S(61,J)=0
2200 X=X-S(62,J)+S(51,J) @ IF X<0 THEN 2220 ! CONVERT TN TO PF & SiO2 *********
2210 S(52,J)=S(51,J)-X @ S(51,J)=X @ RETURN
2220 X=X+6*S(30,J) @ S(52,J)=S(51,J) @ S(51,J)=0 ! CONVERT AB TO NE & SiO2 ****
2230 Y=X-2*S(30,J) @ IF Y<0 OR X>6*S(30,J) THEN 2250
2240 S(33,J)=1.5*S(30,J)-.25*X @ S(30,J)=.25*Y @ RETURN
2250 S(33,J)=S(30,J) @ S(30,J)=0 @ X=X-2*S(33,J)+6*S(29,J)
2260 Y=X-4*S(29,J) ! CONVERT OR TO LO & SiO2 ************************************
2270 IF Y<0 OR X>6*S(29,J) THEN 2290
2280 S(32,J)=3*S(29,J)-.5*X @ S(29,J)=.5*Y @ RETURN
2290 S(32,J)=S(29,J) @ S(29,J)=0
2300 X=X-4*S(32,J)+S(67,J) ! CONVERT WO TO CS & SiO2 ***************************
2310 Y=S(67,J)-X @ Z=2*X-S(67,J)
2320 IF Y<0 OR Z<0 THEN 2340
2330 S(40,J)=Y @ S(67,J)=Z @ RETURN
2340 X=X+2*S(60,J) @ Y1=2*(X-S(60,J))-S(67,J) ! CONVERT DI TO CS, OL, & SiO2 *
2350 Y2=4*S(60,J)+S(67,J)-2*X @ Y3=Y2+2*S(67,J)
2360 IF Y1<0 OR Y2<0 OR Y3<0 THEN 2390
2370 S(46,J)=.25*Y3 @ S(62,J)=S(62,J)+.25*Y2
2380 S(60,J)=.5*Y1 @ S(67,J),S(41,J)=0 @ RETURN
2390 S(62,J)=S(62,J)+.5*S(60,J) @ S(46,J)=.5*(S(67,J)+S(60,J))
2400 X=X-S(60,J)-.5*S(67,J)+4*S(32,J) ! CONVERT LC TO KP AND SiO2 ************
2410 S(60,J),S(67,J)=0 @ Y1=X-2*S(32,J) @ Y2=X-2*Y1
2420 IF Y1>= 0 THEN 2500 ELSE S(62,J)=S(62,J)+Y1
2430 X=ABS (X) @ T(5,J)=2*T(20,J)*ABS (Y1)/RM(5) @ X,T(1,J)=0
2440 T(4,J)=2*T(21,J)*ABS (Y1)/RM(4) @ S(34,J)=S(32,J) @ S(32,J)=0
2450 X=T(4,J) @ GOSUB 2520 @ T(4,J)=X
2460 X=T(5,J) @ GOSUB 2520 @ T(5,J)=X
2470 PRINT "THERE IS A DEFICIENCY OF SiO2 IN SAMPLE "&N$(J)
2480 PRINT "EQUIVALENT TO EXCESS FeO AND MgO OF";T(4,J);"AND";T(5,J);"WT %"
2490 PRINT @ I=I+1 @ RETURN
2500 S(34,J)=.5*Y2 @ S(32,J)=.5*Y1 @ RETURN
2510 RUN ROUND TO Y DECIMAL PLACES ***************************************
2520 X=X*10^Y @ IF CEIL (X)=CEIL (X+.5) THEN X=INT (X) ELSE X=CEIL (X)
2530 X=X/10^Y @ RETURN
2540 OLD ERROR @ IF ERRN <63 THEN 2570
2550 DISP "ERROR ENCOUNTERED; NUMBER ";ERRN ;" ON LINE NUMBER ";ERRL
```

```
2560 DISP "PROGRAM IS PAUSED." @ PAUSE
2570 DISP "DUPLICATE FILE NAME ENCOUNTERED. CHOOSE A NEW FILE NAME OR DIFFERENT
DISC." @ INPUT A$@ GOTO 2680
2580 FOR J=1 TO JMAX ! SUBROUTINE TO STORE DATA TO /SS FILE **********
2590 FOR I=24 TO 3 STEP -1 @ S(I,J)=S(I-2,J) @ NEXT I
2600 X=S(24,J) @ GOSUB 2510 @ S(24,J)=X
2610 NEXT J @ A$=K$ @ GOTO 2670
2620 FOR J=1 TO JMAX @ S=0
2630 FOR I=24 TO 3 STEP -1 @ T(I,J)=T(I-2,J) @ NEXT I @ S(63,J),S(25,J)=0
2640 FOR I=26 TO 59 @ S=S+S(I,J)+S @ IF I<38 THEN S(61,J)=S
2650 NEXT J @ S(60,J)=S @ S(62,J)=S(60,J)-S(61,J) @ S(64,J)=2*S(64,J)
2660 NEXT J @ A$=L$
2670 RESTORE 2920
2680 DISP "STORING DATA FILE "&A$ @ ON ERROR GOTO 2540 @ CREATE A$,5*JMAX+13
2690 ASSIGN# 1 TO  A$
2700 FOR J=1 TO JMAX
2710 READ C$@ C$=">"&C$ @ D$=C$
2720 FOR I=3 TO 74 @ IF E$#"Y" OR I>24 THEN 2760
2730 IF T(I,J)=0 AND F$="Y" THEN 2790
2740 X=T(I,J) @ GOSUB 2520
2750 GOTO 2780
2760 IF S(I,J)=0 AND F$="Y" THEN 2790
2770 X=S(I,J) @ GOSUB 2520
2780 C$=D$&VAL$ (I)&":"&VAL$ (X) @ GOTO 2800
2790 C$=D$&VAL$ (I)&":'--- "
2800 GOSUB 2880
2810 NEXT I
2820 C$=D$&"1:'"&N$(J) @ GOSUB 2890 @ C$=D$&"2:"&M$(J) @ GOSUB 2890
2830 NEXT J @ GOSUB 2940
2840 C$="/N1"&CHR$ (13)&"/GDC"&CHR$ (13)&"/GRA"&CHR$ (13) @ GOSUB 2890
2850 C$="/GC0" @ GOSUB 2880 @ C$="/GFR" @ GOSUB 2880 @ C$="/GP" @ GOSUB 2880
2860 C$="/X"&CHR$ (42+128)&"/X>A1:>A1:" @ GOSUB 2890
2870 ASSIGN# 1 TO  * @ GOTO 2900
2880 C$=C$&CHR$ (13)
2890 PRINT# 1 ; C$ @ RETURN
2900 IF E$#"Y" THEN 3010
2910 DISP "RESULTS ARE STORED IN "&A$ @ WAIT 5000 @ RETURN
2920 DATA B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z,AA,AB,AC,AD,AE,AF,AG
,AH,AI,AJ,AK,AL,AM,AN,AO,AP,AQ,AR,AS,AT,AU,AV,AW,AX,AY,AZ
2930 DATA BA,BB,BC,BD,BE,BF,BG,BH,BI,BJ,BK
2940 B$=":/FL" @ RESTORE 2960
2950 FOR I=1 TO 74 @ READ D$@ C$=">A"&VAL$ (I)&B$&D$ @ GOSUB 2880 @ NEXT I
2960 DATA 'SAMPLE,' SYMBOL
2970 DATA 'Si02,'Al203,'Fe203,'FeO,'MgO,'CaO,'Na20,'K20,'LOI,'Ti02,'P205,'MnO,'Z
r20,'CO2,'SO3,'Cl,'F,'S,'Cr203,'Ni0,'BaO,'TOTAL,' NORM,'Q,'C,'Z,'OR,'AB,'AN,'LC
2980 DATA 'NE,'KP,'HL,'TH,'NC,'AC,'NS,'KS,'WO,'EN,'FS,'FO,'FA,'CS,'RT,'CM,'UM,'I
L,'TN,'PF,'RU,'AP,'FR,'PR,'CC,'MC,'SO,'TOTAL,' SALIC,' FEMIC,'D INDEX
2990 DATA DI,' DIEN,' DIFS,' DIWO,'NOR,'HY,' HYEN,' HYFS.'OL,'PERAL,'PERALK
3000 RETURN
3010 DISP "END PROGRAM; RESULTS ARE STORED IN "&A$
3020 PRINT "THIS RUN GENERATED";I ;"ERRORS OF INCOMPLETE NORMS." @ PRINT
3030 END
```

APPENDIX II
Sample Calculations

The following provides an example of output from NORM. The chemical compositions used are the same as those used for GNAP PROBLEM 1 by Stuckless and VanTrump (1979) except that the third sample was entered with no water and water has been renamed LOI (loss on ignition). The first page of output (fig. 1) contains statements of errors and user-imposed conditions generated during program operations. The next two pages (Table 2) provide a printout of the weight percent data file. The last two pages (Table 3) provide a printout of the molar data file. The samples provide a good test for the operation of NORM in that they use nearly all possible branches in the program.

The first two samples are identical except for the increased Cl in the second, which causes an error statement. The first and third samples are identical except for the lack of water in the sample MN06H. The norm for this sample is therefore equivalent to that which would be calculated for MN06A by the water-free command. Samples 1210A and 1210B are identical, except that 1201B contains enough CO_2 to cause an excess and print an error statement. Similar relationships exist between the remaining pairs of A and B suffixed samples.

Samples 1165B and 1165C differ in that the calculation of sodium carbonate was requested for the latter as indicated on the printout of error messages and execution conditions. This calculation reduces the CO_2 sufficiently such that no excess is left after the normative calculation.

Samples AI.I, AI.IS, and AI.IK show the effect of adding BaO to CaO (the default condition), Na_2O, and K_2O, respectively. The printout of error messages and execution conditions indicates any use of BaO other than the default condition.

The total execution time for the 24 analyses in this example, including creation to two data files, was 16 minutes and 15 seconds.

Table 1.--Output data from NORM expressed in weight percent

SAMPLE	278 A	278 B	339 A	339 B	LC2-9	A2.1I	A311I	A1.I	A1.IS	A1.IK	25	46
SYMBOL	*	*	*	*	%	%	%	%	%	%	%	%
SiO2	52.1	52.1	72.9	72.9	37.51	51.17	34.98	53.7	53.7	53.7	55.9	48.6
Al2O3	16.6	16.6	13.5	13.5	2.41	6.25	10.6	11.16	11.16	11.16	20.5	17.7
Fe2O3	6.3	6.3	1.9	1.9	1.63	3.22	1.42	3.1	3.1	3.1	2.65	7.16
FeO	.8	.2	.08	.08	8.95	9.64	21.33	1.21	1.21	1.21	1.58	1.8
MgO	4.5	4.5	.36	.36	48.59	19.9	19.3	6.44	6.44	6.44	.87	3.11
CaO	6.6	6.6	1.2	1.2	.07	17.76	.43	3.46	3.46	3.46	2.98	6.84
Na2O	3.7	3.7	3.6	3.6	.05	2.03	.17	1.67	1.67	1.67	9.04	6.42
K2O	2.4	2.4	4.6	4.6	.05	2.51	5.42	11.16	11.16	11.16	4.26	3.64
LOI	3	3	.85	.85	.13	2.49	1.26	3.41	3.41	3.41	.39	1.41
TiO2	1.7	1.7	.37	.37	.33	2.96	5.18	1.92	1.92	1.92	.76	2.42
P2O5	.81	.81	.1	.1	.17	1.69	---	1.75	1.75	1.75	.17	.56
MnO	.1	.1	.04	.04	.17	---	---	.04	.04	.04	.2	.22
ZrO	---	---	---	---	---	---	---	---	---	---	.13	.1
CO2	.02	.02	.01	.01	---	---	---	---	---	---	.01	.03
SO3	---	---	---	---	---	---	---	.06	.06	.06	---	---
Cl	---	---	---	---	---	---	---	.03	.03	.03	---	---
F	.03	.03	.02	.02	---	---	---	.44	.44	.44	.11	.11
S	---	---	---	.2	---	---	---	---	---	---	---	---
Cr2O3	---	.7	---	---	---	---	---	.04	.04	.04	---	---
NiO	---	---	---	---	---	---	---	---	---	---	---	---
BaO	---	---	---	---	---	---	---	.81	.81	.81	.1	.08
TOTAL	100.647	100.747	99.522	99.722	100.26	99.62	100.31	100.208	100.208	100.208	99.604	100.354
NORM												
Q	4.094	4.09	31.745	31.681	---	---	---	---	---	---	---	---
C	---	---	.713	.711	2.268	---	3.86	---	---	---	---	---
Z	---	---	---	---	---	---	---	---	---	---	.194	.148
OR	14.091	14.077	27.313	27.259	---	---	---	60.803	60.803	60.803	25.274	21.434
AB	31.107	31.076	30.609	30.547	---	---	---	---	---	---	37.86	26.994
AN	21.459	21.438	5.18	5.17	---	.531	2.127	---	---	---	2.787	8.697
LC	---	---	---	---	---	---	20.739	---	---	---	---	---
NE	---	---	---	---	.229	9.341	.777	---	---	---	21.094	17.952
KP	---	---	---	---	.167	8.461	3.114	---	---	---	---	---
HL	---	---	---	---	---	---	---	.049	.049	.049	---	---
TH	---	---	---	---	---	---	---	.106	.106	.106	---	---
NC	---	---	---	---	---	---	---	---	---	---	---	---
AC	---	---	---	---	---	---	---	8.95	8.95	8.95	---	---
NS	---	---	---	---	---	---	---	.775	1.418	.775	---	---
KS	---	---	---	---	---	---	---	1.388	1.388	2.201	---	---
WO	1.368	---	---	---	---	---	---	1.336	.724	.724	4.326	8.517
EN	11.135	11.124	.901	.899	---	---	---	9.157	9.157	9.157	2.175	7.36
FS	---	---	---	---	---	---	---	---	---	---	---	---
FO	---	---	---	---	79.859	31.601	33.579	4.799	4.799	4.799	---	.261
FA	---	---	---	---	10.687	7.135	22.667	---	---	---	---	---
CS	---	---	---	---	---	23.783	---	---	---	---	---	---
MT	---	---	---	---	2.646	4.686	2.053	---	---	---	3.556	---
CM	---	.932	---	---	---	---	---	.059	.059	.059	---	---
RM	8.247	8.238	1.909	1.905	---	---	---	---	---	---	.208	7.135
IL	1.891	---	.256	---	.625	5.643	9.898	2.596	2.596	2.596	1.449	4.257
TN	1.701	4.005	---	---	---	---	---	1.348	1.348	1.348	---	---
PF	---	---	---	---	---	---	---	---	---	---	---	.289
PO	---	.055	.237	.371	---	---	---	---	---	---	---	---
AP	1.906	1.904	.238	.238	.126	4.018	---	4.136	4.136	4.136	.404	1.322
FR	---	---	.023	.023	---	---	---	.582	.582	.582	.196	.173
PR	---	---	---	.202	---	---	---	---	---	---	---	---
CC	.045	.045	.023	.023	---	---	---	---	---	---	.023	.068
MG	---	---	---	---	---	---	---	---	---	---	---	---
SU	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	97.045	96.906	99.146	99.025	96.607	95.2	98.724	96.085	96.116	96.285	99.547	98.547
SALIC	70.752	70.681	95.56	95.368	2.664	18.332	30.617	60.959	60.959	60.959	87.209	69.226
FEMIC	26.293	26.304	3.587	3.66	93.943	76.867	68.107	35.126	35.157	35.327	12.338	29.321
D INDEX	49.292	49.243	89.667	89.487	.396	17.802	24.631	60.803	60.803	60.803	84.228	60.38
DI	2.55	---	---	---	---	---	---	2.491	1.349	1.349	4.632	15.877
DIEN	1.182	---	---	---	---	---	---	1.155	.626	.626	2.175	7.36
DIFS	---	---	---	---	---	---	---	---	---	---	---	---
DIWO	1.368	---	---	---	---	---	---	1.336	.724	.724	2.517	8.517
WOL	---	---	---	---	---	---	---	---	---	---	1.809	---
HY	9.953	11.124	.901	.899	---	---	---	8.003	8.532	8.532	---	---
HYEN	9.953	11.124	.901	.899	---	---	---	8.003	8.532	8.532	---	---
HYFS	---	---	---	---	---	---	---	---	---	---	---	---
OL	---	---	---	---	90.546	38.737	56.247	4.799	4.799	4.799	---	.261
PERAL	.803	.803	1.032	1.032	9.111	.163	1.5[illegible]	.515	.515	.515	.821	.656
PERALK	1.911	1.911	1.236	1.236	17.672	1.032	1.7[illegible]	.753	.726	.726	1.052	1.221

Table 2.--Output data from NORM expressed in weight percent--continued

SAMPLE	[illegible]A	[illegible]B	[illegible]	1210A	1201B	[illegible]	1165B	1165C	1101A	1101B	334 A	334 B
SYMBOL	*	#	@	*	+	=	#	@	*	#	-	#
SiO2	48.3	48.3	49.3	67.8	67.8	74.9	74.9	74.9	75.9	75.9	73.8	73.8
Al2O3	14.8	14.8	14.8	17.9	17.9	14.3	14.3	14.3	13.8	13.8	13.3	13.3
Fe2O3	2.4	2.4	2.4	.45	.45	.9	.9	.9	.1	.1	1.3	1.3
FeO	9.1	9.1	9.1	.8	.8	.26	.26	.26	.68	.68	.04	.04
MgO	8.1	8.1	8.1	.61	.3	.2	.1	.1	.11	.11	.45	.45
CaO	10	10	10	.25	.1	.24	.12	.12	.18	.18	.44	.22
Na2O	1.26	1.26	1.26	9.6	9.6	7.6	7.6	7.6	3	3	2.4	2.4
K2O	.12	.12	.12	.53	.53	.3	.3	.3	7	7	5.8	5.8
LOI	3.63	3.63	---	1.78	1.78	.66	.66	.66	.47	.47	1.5	1.5
TiO2	.68	.68	.68	.23	.23	.13	.13	.13	.14	.14	.21	.21
P2O5	.13	.13	.13	.05	.05	.03	.03	.03	.02	.02	.08	.26
MnO	.21	.21	.21	.02	.02	.02	.02	.02	.05	.05	.02	.02
Zr2O	---	---	---	---	---	---	---	---	---	---	---	---
CO2	---	---	---	.03	.6	.07	.4	.4	.03	.03	.06	.06
SO3	---	---	---	---	---	.62	.62	.62	---	---	---	---
Cl	1.4	1.53	1.4	.03	.03	.03	.03	.03	.01	.01	---	---
F	---	---	---	.04	---	---	---	---	---	.15	.02	.01
S	---	---	---	---	---	---	---	---	---	---	---	---
Cr2O3	---	---	---	---	---	---	---	---	---	---	---	---
NiO	---	---	---	---	---	---	---	---	---	---	---	---
BaO	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	99.808	99.908	96.178	100.096	100.183	100.203	100.363	100.363	101.488	101.575	99.412	99.366
NORM												
Q	10.062	10.227	10.441	8.623	10.056	31.752	32.372	35.317	30.381	30.639	36.676	37.292
C	---	---	---	1.405	1.574	1.983	2.297	3.075	1.077	1.282	2.655	3.094
Z	---	---	---	---	---	---	---	---	---	---	---	---
OR	.71	.71	.737	3.129	3.126	1.769	1.766	1.766	40.759	40.724	34.477	34.493
AB	.307	---	.319	80.933	80.863	59.904	59.809	55.059	24.94	24.919	20.428	20.438
AN	39.943	40.066	41.45	.463	---	.866	---	.398	.564	---	1.194	---
LC	---	---	---	---	---	---	---	---	---	---	---	---
NE	---	---	---	---	---	---	---	---	---	---	---	---
KP	---	---	---	---	---	---	---	---	---	---	---	---
HL	2.312	2.378	2.4	.049	.049	.049	.049	.049	.016	.016	---	---
TH	---	---	---	---	---	1.098	1.096	1.096	---	---	---	---
NC	---	---	---	---	---	---	---	.96	---	---	---	---
AC	---	---	---	---	---	---	---	---	---	---		---
NS	---	---	---	---	---	---	---	---	---	---	---	---
KS	---	---	---	---	---	---	---	---	---	---	---	---
WO	3.721	3.649	3.862	---	---	---	---	---	---	---	---	---
EN	20.212	20.192	20.975	1.518	---	.497	---	.248	.27	.202	1.127	.99
FS	14.022	14.008	14.551	.754	.018	---	---	---	1.013	1.012	---	---
FO	---	---	---	---	---	---	---	---	---	---	---	---
FA	---	---	---	---	---	---	---	---	---	---	---	---
CS	---	---	---	---	---	---	---	---	---	---	---	---
MT	3.486	3.483	3.618	.652	.651	.525	---	.525	.143	.143	---	---
CM	---	---	---	---	---	---	---	---	---	---	---	---
HM	---	---	---	---	---	.536	.897	.535	---	---	1.308	1.308
IL	1.294	1.293	1.343	.436	.436	.246	.246	.246	.262	.262	.128	.128
TN	---	---	---	---	---	---	---	---	---	---	---	---
PF	---	---	---	---	---	---	---	---	---	---	---	---
RU	---	---	---	---	---	---	---	---	---	---	.144	.144
AP	.309	.308	.32	.118	.118	.071	.071	.071	.047	.047	.191	.396
FR	---	---	---	.073	---	---	---	---	---	.211	.027	---
PR	---	---	---	---	---	---	---	---	---	---	---	---
CC	---	---	---	.068	.061	.045	.143	---	.067	---	.137	---
MG	---	---	---	---	.626	---	.208	---	---	.057	---	.116
SD	---	---	---	---	.646	---	.262	---	---	---	---	---
TOTAL	96.379	96.314	100.016	98.272	98.226	99.343	99.217	99.344	99.539	99.513	98.491	98.4
SALIC	53.334	53.381	55.347	94.603	95.67	97.422	97.39	97.72	97.737	97.58	95.43	95.316
FEMIC	43.044	42.933	44.669	3.619	2.556	1.921	1.828	1.624	1.802	1.933	3.061	3.084
D INDEX	11.079	10.937	11.498	92.685	94.047	93.428	93.947	92.142	96.08	96.281	91.581	92.222
DI	7.286	7.146	7.561	---	---	---	---	---	---	---	---	---
DIEN	2.105	2.064	2.184	---	---	---	---	---	---	---	---	---
DIFS	1.46	1.432	1.515	---	---	---	---	---	---	---	---	---
DIWO	3.721	3.649	3.862	---	---	---	---	---	---	---	---	---
WOL	---	---	---	---	---	---	---	---	---	---	---	---
HY	30.869	30.704	31.827	2.272	.018	.497	---	.248	1.283	1.214	1.127	.99
HYEN	18.107	18.128	18.791	1.518	---	.497	---	.248	.27	.202	1.127	.99
HYFS	12.562	12.576	13.036	.754	.018	---	---	---	1.013	1.012	---	---
OL	---	---	---	---	---	---	---	---	---	---	---	---
PERAL	.726	.726	.726	1.064	1.062	1.079	1.096	1.096	1.075	1.075	1.206	1.252
PERALK	6.719	6.719	6.719	1.094	1.094	1.115	1.115	1.115	1.103	1.103	1.301	1.301

Table 3.--Output data from NORM expressed in molecular proportions

SAMPLE	MN06A	MN06B	MN06H	1210A	1201E	1165A	1165B	1165C	1101A	1101B	334 A	334 B
SYMBOL	*	#	S	*	#	*	#	S	*	#	*	#
SiO2	.805	.805	.835	1.127	1.176	1.241	1.242	1.242	1.245	1.244	1.236	1.236
Al2O3	.145	.145	.151	.175	.175	.14	.14	.14	.133	.133	.131	.131
Fe2O3	.015	.015	.016	.003	.003	.006	.006	.006	.001	.001	.008	.008
FeO	.127	.127	.132	.011	.011	.004	.004	.004	.009	.009	.001	.001
MgO	.201	.201	.209	.015	.007	.005	.002	.002	.003	.003	.011	.011
CaO	.179	.178	.185	.001	.002	.004	.002	.002	.003	.003	.008	.004
Na2O	.02	.02	.021	.155	.155	.122	.122	.122	.048	.048	.039	.039
K2O	.001	.001	.001	.006	.006	.003	.003	.003	.073	.073	.062	.062
LOI	.202	.202	---	.099	.099	.037	.037	.037	.026	.026	.084	.084
TiO2	.009	.009	.009	.003	.003	.002	.002	.002	.002	.002	.003	.003
P2O5	.001	.001	.001	0	0	0	0	0	0	0	.001	.002
MnO	.003	.003	.003	0	0	0	0	0	.001	.001	0	0
Zr2O	---	---	---	---	---	---	---	---	---	---	---	---
CO2	---	---	---	.001	.014	0	.009	.009	.001	.001	.001	.001
SO3	---	---	---	---	---	.008	.008	.008	---	---	---	---
Cl	.04	.043	.041	.001	.001	.001	.001	.001	0	0	---	---
F	---	---	---	.002	---	---	---	---	---	.008	.001	.001
S	---	---	---	---	---	---	---	---	---	---	---	---
Cr2O3	---	---	---	---	---	---	---	---	---	---	---	---
NiO	---	---	---	---	---	---	---	---	---	---	---	---
BaO	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	1.748	1.75	1.805	1.602	1.602	1.576	1.577	1.577	1.544	1.55	1.585	1.582
NORM												
Q	.167	.17	.174	.144	.167	.528	.539	.538	.506	.51	.61	.621
C	---	---	---	.014	.015	.019	.023	.03	.011	.013	.026	.03
Z	---	---	---	---	---	---	---	---	---	---	---	---
OR	.001	.001	.001	.006	.006	.003	.003	.003	.073	.073	.062	.062
AB	.001	---	.001	.154	.154	.114	.114	.105	.048	.048	.039	.039
AN	.144	.144	.149	.002	---	.003	---	.001	.002	---	.004	---
LC	---	---	---	---	---	---	---	---	---	---	---	---
NE	---	---	---	---	---	---	---	---	---	---	---	---
KP	---	---	---	---	---	---	---	---	---	---	---	---
HL	.02	.02	.021	0	0	0	0	0	0	0	---	---
PH	---	---	---	---	---	.008	.008	.008	---	---	---	---
NC	---	---	---	---	---	---	---	.009	---	---	---	---
AC	---	---	---	---	---	---	---	---	---	---	---	---
NS	---	---	---	---	---	---	---	---	---	---	---	---
KS	---	---	---	---	---	---	---	---	---	---	---	---
WO	.032	.031	.033	---	---	---	---	---	---	---	---	---
EN	.201	.201	.209	.015	---	.005	---	.002	.003	.002	.011	.01
FS	.105	.105	.11	.006	0	---	---	---	.008	.008	---	---
FO	---	---	---	---	---	---	---	---	---	---	---	---
FA	---	---	---	---	---	---	---	---	---	---	---	---
CS	---	---	---	---	---	---	---	---	---	---	---	---
MT	.015	.015	.016	.003	.003	.002	---	.002	.001	.001	---	---
CM	---	---	---	---	---	---	---	---	---	---	---	---
HM	---	---	---	---	---	.003	.006	.003	---	---	.008	.008
IL	.009	.009	.009	.003	.003	.002	.002	.002	.002	.002	.001	.001
TN	---	---	---	---	---	---	---	---	---	---	---	---
PF	---	---	---	---	---	---	---	---	---	---	---	---
RU	---	---	---	---	---	---	---	---	---	---	.002	.002
AP	.001	.001	.001	0	0	0	0	0	0	0	.001	.001
FR	---	---	---	.001	---	---	---	---	---	.003	0	---
PR	---	---	---	---	---	---	---	---	---	---	---	---
CC	---	---	---	.001	.001	0	.001	---	.001	---	.001	---
MC	---	---	---	---	.007	---	.002	---	---	.001	---	.001
SD	---	---	---	---	.006	---	.002	---	---	---	---	---
TOTAL	.637	.639	.723	.348	.363	.609	.7	.755	.653	.659	.766	.775
SALIC	.333	.336	.345	.319	.343	.677	.687	.745	.639	.642	.742	.752
FEMIC	.367	.363	.378	.028	.02	.013	.014	.01	.014	.016	.024	.023
D INDEX	---	---	---	---	---	---	---	---	---	---	---	---
DI	.054	.053	.056	---	---	---	---	---	---	---	---	---
DIEN	.021	.021	.022	---	---	---	---	---	---	---	---	---
DIFS	.011	.011	.011	---	---	---	---	---	---	---	---	---
DIWO	.032	.031	.033	---	---	---	---	---	---	---	---	---
WOL	---	---	---	---	---	---	---	---	---	---	---	---
HY	.276	.276	.285	.021	0	.005	---	.002	.01	.01	.011	.01
HYEN	.18	.181	.187	.015	---	.005	---	.002	.003	.002	.011	.01
HYFS	.095	.095	.099	.006	0	---	---	---	.008	.008	---	---
OL	---	---	---	---	---	---	---	---	---	---	---	---
PERAL	.726	.726	.726	1.064	1.062	1.076	1.096	1.096	1.075	1.075	1.206	1.202
PERALK	6.719	6.719	6.719	1.044	1.044	1.115	1.115	1.115	1.103	1.103	1.301	1.301

Table 3.--Output data from NORM expressed in molecular proportions--continued

SAMPLE	278 A	278 B	339 A	339 B	EC2-9	A2.II	A3III	A1.I	A1.IS	A1.IK	25	46
SYMBOL	*	#	*	§	X	W	W	W	W	W	A	A
SiO2	.362	.361	1.219	1.217	.623	.521	.58	.892	.892	.892	.934	.809
Al2O3	.162	.162	.133	.133	.024	.062	.105	.109	.109	.109	.202	.173
Fe2O3	.052	.052	.012	.012	.011	.02	.009	.019	.019	.019	.017	.045
FeO	.011	.003	.001	.001	.124	.135	.296	.017	.017	.017	.022	.025
MgO	.111	.111	.009	.009	1.232	.496	.477	.159	.159	.159	.022	.077
CaO	.117	.117	.022	.021	.001	.318	.008	.062	.062	.062	.053	.122
Na2O	.059	.059	.058	.058	.001	.033	.003	.027	.027	.027	.146	.103
K2O	.025	.025	.049	.049	.001	.027	.057	.118	.118	.118	.045	.039
LOI	.165	.165	.047	.047	.007	.139	.071	.189	.189	.189	.022	.078
TiO2	.021	.021	.005	.005	.004	.037	.065	.024	.024	.024	.01	.03
P2O5	.006	.006	.001	.001	.001	.012	---	.012	.012	.012	.001	.004
MnO	.001	.001	.001	.001	.002	---	---	.001	.001	.001	.003	.003
Zr2O	---	---	---	---	---	---	---	---	---	---	.001	.001
CO2	0	0	0	0	---	---	---	---	---	---	0	.001
SO3	---	---	---	---	---	---	---	.001	.001	.001	---	---
Cl	---	---	---	---	---	---	---	.001	.001	.001	---	---
F	.002	.002	.001	.001	---	---	---	.023	.023	.023	.006	.006
S	---	---	---	.006	---	---	---	---	---	---	---	---
Cr2O3	---	.005	---	---	---	---	---	0	0	0	---	---
NiO	---	---	---	---	---	---	---	---	---	---	---	---
BaO	---	---	---	---	---	---	---	.005	.005	.005	.001	.001
TOTAL	1.594	1.589	1.558	1.561	2.002	1.796	1.671	1.659	1.659	1.659	1.485	1.515
NORM												
Q	.068	.068	.528	.527	---	---	---	---	---	---	---	---
C	---	---	.007	.007	.022	---	.038	---	---	---	---	---
Z	---	---	---	---	---	---	---	---	---	---	.001	.001
OR	.025	.025	.049	.049	---	---	---	.109	.109	.109	.045	.039
AB	.059	.059	.058	.058	---	---	---	---	---	---	.072	.04
AN	.077	.077	.019	.019	---	.002	.008	---	---	---	.01	.031
LC	---	---	---	---	---	---	.048	---	---	---	---	---
NE	---	---	---	---	.001	.033	.003	---	---	---	.074	.063
KP	---	---	---	---	.001	.027	.01	---	---	---	---	---
WL	---	---	---	---	---	---	---	0	0	0	---	---
TH	---	---	---	---	---	---	---	.001	.001	.001	---	---
NC	---	---	---	---	---	---	---	---	---	---	---	---
AC	---	---	---	---	---	---	---	.019	.019	.019	---	---
NS	---	---	---	---	---	---	---	.006	.012	.006	---	---
KS	---	---	---	---	---	---	---	.009	.009	.014	---	---
HO	.012	---	---	---	---	---	---	.012	.006	.006	.037	.073
EN	.111	.111	.009	.009	---	---	---	.091	.091	.091	.022	.073
FS	---	---	---	---	---	---	---	---	---	---	---	---
FO	---	---	---	---	.568	.225	.239	.034	.034	.034	---	.002
FA	---	---	---	---	.052	.035	.111	---	---	---	---	---
CS	---	---	---	---	---	.138	---	---	---	---	---	---
MT	---	---	---	---	.011	.02	.009	---	---	---	.015	---
CM	---	.004	---	---	---	---	---	0	0	0	---	---
HM	.052	.052	.012	.012	---	---	---	---	---	---	.001	.045
IL	.012	---	.002	---	.004	.037	.065	.017	.017	.017	.01	.023
TN	.009	.02	---	---	---	---	---	.007	.007	.007	---	---
PF	---	---	---	---	---	---	---	---	---	---	---	.002
RU	---	.001	.003	.005	---	---	---	---	---	---	---	---
AP	.006	.006	.001	.001	0	.012	---	.012	.012	.012	.001	.004
FR	---	---	0	0	---	---	---	.007	.007	.007	.003	.002
PR	---	---	---	.002	---	---	---	---	---	---	---	---
CC	0	0	0	0	---	---	---	---	---	---	0	.001
MG	---	---	---	---	---	---	---	---	---	---	---	---
SD	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	.431	.423	.688	.688	.959	.529	.529	.326	.326	.326	.292	.463
SALIC	.23	.23	.661	.66	.024	.062	.106	.11	.11	.11	.203	.174
FEMIC	.202	.194	.027	.028	.638	.467	.423	.216	.216	.216	.089	.229
D INDEX	---	---	---	---	---	---	---	---	---	---	---	---
DI	.024	---	---	---	---	---	---	.023	.012	.012	.043	.147
DIEN	.012	---	---	---	---	---	---	.012	.006	.006	.022	.073
DIFS	---	---	---	---	---	---	---	---	---	---	---	---
DIWO	.012	---	---	---	---	---	---	.012	.006	.006	.022	.073
WOL	---	---	---	---	---	---	---	---	---	---	.016	---
HY	.009	.111	.009	.009	---	---	---	.08	.085	.085	---	---
HYEN	.009	.111	.009	.009	---	---	---	.08	.085	.085	---	---
HYFS	---	---	---	---	---	---	---	---	---	---	---	---
OL	---	---	---	---	.062	.26	.35	.034	.034	.034	---	.002
PERAL	.803	.803	1.032	1.032	9.141	.163	1.359	.515	.515	.515	.821	.959
PERALK	1.911	1.911	1.238	1.238	17.977	1.032	1.757	.753	.726	.726	1.052	1.221