12-1987

Soil Solution: Documentation, Source Code, and Program Key Version 1.4

University of Tennessee Agricultural Experiment Station

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rtment of Plant and Soil Science

Research Report 87-19
December, 1987

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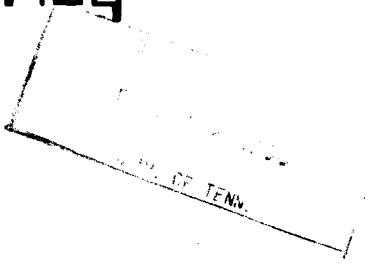

Jeff Wolt

Soil Solution

Documentation, Source Code, and Program Key

Version 1.4

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University of Tennessee
Knoxville, TN

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| Soil Solution [SOILSOLN.BAS] |
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| An ion speciation program |
| for chemical equilibrium |
| modeling of soil solutions |
| for the IBM PC/XT/AT and |
| compatibles. |
+----------------------------+
| Jeff Wolt |
| Dep Plant and Soil Sci |
| University of Tennessee |
| Knoxville |
+----------------------------+

Version 1.4
1 Jan 1988

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NOTE TO USER

The version of Soil Solution which is provided has been extensively reviewed. It may, however, contain undetected bugs or inaccuracies in computation. This version of Soil Solution is provided solely for your use. Comments concerning problems with or suggested modifications of this program are welcomed.

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1.0 Introduction

The program SOIL SOLUTION iteratively estimates pair values concentrations, and activities of ions in soil solutions. The following input data are requested: problem ID, EC (dS/m), and total ion concentrations (mmol/L). The present version of SOIL SOLUTION supports the following inputs: Ca, Mg, K, Na, NH4, Mn, Zn, Al, Si, Cl, P, NO3, SO4, F, DOC, and CO2 (atm). NH4 represents total ammoniacal N and is used to calculate NH4 and NH3. HPO4 and H2PO4 are calculated from P and pH. CO3 and HCO3 are calculated from CO2 and pH. SOIL SOLUTION iteratively solves for ion activities and free ion concentrations using an averaging routine to reduce iterative cycles. The program is terminated when successive iterations converge or after 99 cycles. If Al or Zn are included in the input data, hydrolytic species are computed in subroutines. Fluoride is included in the Al subroutine. If DOC is included in the input data, metal-organic complexes are estimated.

SOIL SOLUTION outputs ionic speciation, percent free ion, and free ion activities. Additionally, ion activity products (IAP) and disequilibria indicies are computed for selected mineral species. Percent organic complexes are computed when DOC is included in the input data.

2.0 History

This program is the result of the author's efforts to teach chemical equilibria modeling in a graduate level course in Soil Solution Chemistry. The program GEOCHEM proved somewhat cumbersome for the student to assimilate and to put rapidly into use. A somewhat less comprehensive, PC-accessible program seemed more appropriate for instruction and student problem-solving. SOIL SOLUTION is a BASIC program modeled after a family of FORTRAN programs (CALPHOS, ALCONS, ALCAP, and ALCAL) developed and used by Fred Adams and coworkers at Auburn University in the 1970's [1]. SOIL SOLUTION differs from these programs in several aspects: ion pairs are included in the computation of ionic strength; total ammoniacal N and total Si when input are used with pH to calculate NH4 and H4SiO4, respectively; F when input is used in the Al subroutine; DOC is used to estimate metal-organic complexes; output includes percent free ions and disequilibria indicies for selected mineral species. SOIL SOLUTION will soon be updated into a more comprehensive menu-driven program with user-modifiable thermodynamic file.

3.0 How Input Data Are Treated

Input data are transformed to molar concentrations. For any chemical component not entered, the concentration is set to zero. SOIL SOLUTION uses a charge balance approach, and so assumes the input data are comprehensive. Input data are used to compute ion difference; if the ion difference exceeds 20%, this is flagged in the first output data screen to warn the user that computations may not realistically represent true soil solution composition. EC is used as a problem identifier and is not used in the speciation model.

When NH4 is input, the value entered is assumed to represent total ammoniacal N. The concentration of ammonium ion is calculated from this value and pH. When Si is input, H4SiO4 is calculated from this value and

pH. When P is input, the concentration is initially distributed equally between HPO4 and H2PO4. In subsequent iterations, the equilibrium distribution of phosphate ions is calculated dependent on total P and pH. When CO2(g) is input, the distribution of CO3 and HCO3 is calculated using pH and the partial pressure of CO2. When DOC is input, divalent metal-mixed fulvate [10] and Al-fulvate [9] models are used to estimate metal-organic complexes.

In each iterative cycle, ionic strength is calculated and ion activities are then estimated using the extended Debye-Huckel equation (if appropriate beta values are not available, the Davies equation is used instead). Ion pair concentrations are next calculated and free ion concentrations are determined as the difference between total input concentration and ion pairs. In alternate iterations, the current and previous estimates of free ion concentrations are averaged before proceeding to the next iteration. In this manner, convergence criteria are more rapidly attained. SOIL SOLUTION will terminate when successive computations of activity agree to within +/-1% for each ion input, or after 99 iterations.

For trace constituents (Al, F, Zn), free ion concentrations are calculated in subroutines following convergence of the main program.

4.0 Thermodynamic Data File (TDF)

Ref.

4.1 Ammoniacal N

[NHT] = Total Ammoniacal N
[NH3] = [NHT]/(1 + (H) x 10exp9.238)

4.2 Silica

[Si] = [H4SiO4] + [H3SiO4] + [H2SiO4]
[H4SiO4] = [SI]/(1 + 10exp(pH-9.49) + 10exp(2pH-22.05))

4.3 Phosphate

[P] = [HPO4] + [H2PO4]
(HPO4) = fH2PO4 x fHPO4 x [P]/(fH2PO4 + fHPO4 x 10exp(7.21-pH))
(H2PO4) = (HPO4) x 10exp(7.21-pH) [1]

4.4 Carbonate

pCO2 = Partial Pressure CO2(g), atm
(HCO3) = (4.45 x 10exp-7 x .0338 x pCO2)/(H) [1]
(CO3) = (4.67 x 10exp-11 x 4.45 x 10exp-7 x .0338 x pCO2)/(H)exp2

4.5 Ion Pairs

(NH4SO4)	= (NH4)(SO4)/0.0793	[1]
(KSO4)	= (K)(SO4)/0.11	[1]
($NaSO_4$)	= (Na)(SO_4)/0.24	[7]
($CaSO_4$)	= (Ca)(SO_4)/0.00525	[1]
(MgSO4)	= (Mg)(SO4)/0.0059	[1]
(MnSO4)	= (Mn)(SO4)/0.00525	[1]
(CaHPO4)	= (Ca)(HPO4)/0.00198	[1]
(MgHPO4)	= (Mg)(HPO4)/0.00316	[1]
(CaH2PO4)	= (Ca)(H2PO4)/0.083	[1]
(MgH2PO4)	= (Mg)(H2PO4)/0.1	[1]

(CaHCO3)	= (Ca)(HCO3)/0.055	[1]
(MgHCO3)	= (Mg)(HCO3)/0.069	[1]
(AlSO4)	= (Al)(SO4)/0.000631	[1]
(AlH2PO4)	= (Al)(H2PO4)/0.001	[3]
(AlF)	= (Al)(F)(10exp6.98)	[7]
(AlF2)	= (Al)(F)exp2(10exp12.6)	[7]
(AlF3)	= (Al)(F)exp3(10exp16.65)	[7]
(ZnSO4)	= (Zn)(SO4)/0.00468	[7]
(ZnHPO4)	= (Zn)(H2PO4)(10exp-3.9)/(H)	[7]
(ZnH2PO4)	= (Zn)(H2PO4)/0.0251	[7]

4.6 Hydrolytic Species

(AlOH)	= (Al)/(10exp5.01)(H)	[1]
(Al(OH)2)	= (Al)/(10exp8.7)(H)exp2	[8]
(Al(OH)3)	= (Al)/(10exp15.2)(H)exp3	[8]
(Al(OH)4)	= (Al)/(10exp23.33)(H)exp4	[7]
(ZnOH)	= (Zn)/(10exp7.69)(H)	[7]
(Zn(OH)2)	= (Zn)/(10exp16.8)(H)exp2	[7]

4.7 Beta Values (x 10exp8)

NH4	K	Na	Ca	Mg	Mn	Al	Zn
2.5	3	4.5	6	8	6	9	6

Cl	NO3	SO4	HPO4	H2PO4	HCO3	CO3	F
3	3	4	4	4.5	4.5	4.5	3.5

AlOH
7

4.8 Reference Minerals

	pK	
Cryptocrystalline gibbsite	32.8	[6]
Kaolinite	76.4	[4]
Hydroxyinterlayered vermiculite*	159.5	[5]
Variscite	30.5	[7]
Hydroxyapatite	55.9	[7]
Basaluminite	117.6	[2]
Alunite	85.4	[2]

*pFe calculated from goethite solubility:
pFe = 0.02 + 3pH

4.9 Fulvate Models

For DOC (mmol/L): [10]

Fu#1 = (.10957)(DOC)(.09)/1000
Fu#2 = (.10957)(DOC)(.91)/1000
Fu#3 = (.10957)(DOC)/1000

For M++: [10]

ML = (10exp(logK))(M++)(Fu)

Where M++ =

	log K*	
	Fu#1	Fu#2
Ca	3.12	1.23
Mg	2.71	0.69
Mn	3.93	2.23
Zn	3.54	1.74

* conditional for pH 5.0 and I=.1M

For Al:

ML#1 = (.346)(Al)(Fu#3)/H [9]

$$ML\#2 = (.240)(Al)(Fu\#3)/H$$

5.0 Output Screens

SOIL SOLUTION outputs problem identifiers and a table of ion specie concentrations, free ion percentages, and free ion activities. Percent metal-organic complexes are output if DOC is input. If requested, a table of selected ion activity products and disequilibria indicies will also be output.

The Disequilibria Index = log(IAP/Ksp). For DI > 0, the solution is oversaturated with respect to the mineral of interest. For DI < 0, the solution is undersaturated with respect to the mineral of interest.

6.0 Hardcopy Output

Hardcopy output of the input data as well as the three output data screens is obtained using the PRINT SCREEN option of your PC. The program prompts the user to PRINT SCREEN at the appropriate points in the program. For some PCs, Ctrl-PRINT SCREEN must be entered instead of PRINT SCREEN alone. Check your PC Guide to Operations for the specific requirements of your system. This program does not provide for hardcopy output other than by way of a PRINT SCREEN key.

7.0 Program Key

SOIL SOLUTION is provided as an uncompiled BASIC source program to allow for ease of modification by individual users. Modifications of the source program which may aid individual users could entail inclusion of additional ion pair constants or alteration of Screen 4 (Ion Activity Products) to evaluate a different suite of minerals. Although customization of SOIL SOLUTION is encouraged, the author cannot be responsible for unregistered or modified copies of the program. A program Key follows.

CONCENTRATIONS, BETA VALUES, AND VALENCE

I=	C#(I) or CNEW#(I)	B#(I)	V#(I)
1	NH_4/1000	2.5	1
3	K/1000	3	1
4	Mg/1000	8	2
5	SO_4/1000	4	2
6	Cl/1000	3	2
7	NO_3	3	1
8	HPO_4	4	1

9	H_2PO_4	4.5	1
10	P/1000	0	0
11	Mn/1000	6	2
12	HCO_3	4.5	1
13	CO_3	4.5	2
14	CO_2	0	0
15	Al/1000	9	3
16	Zn/1000	6	2
17	Na/1000	4.5	1
18	H_4SiO_4/1000	0	0
19	Al^{3+}		
20	$Al(OH)^{2+}$		
21	$Al(OH)_2^{1+}$		
22	$Al(OH)_3^{o}$		

ION PAIR ASSIGNMENT

Pair#(26) =		$AlCl^{+2}$
Pair#(27) =		$AlH_2PO_4^{+2}$
Pair#(28) =	A# (15) * A# (5)/.000631	$AlSO_4^{+}$
Pair#(29) =	A# (16) * A# (9)/.0251	$ZnH_2PO_4^{+}$
Pair#(30) =	A# (16) * A# (5)/.00468	$ZnSO_4^{o}$
Pair#(31) =	A# (16) * A# (9) * 10 exp (-3.9)/H#	$ZnHPO_4^{o}$
Pair#(32) =	A# (17) * A# (5)/.24	$NaSO_4^{-}$

Al SUBROUTINE

C#(19)	Al^{3+}
C#(20)	$AlOH^{2+}$
C#(21)	$Al(OH)_2^{+}$
C#(22)	$Al(OH)_3^{o}$

C#(23) $AlH_2PO_4^-$

C#(24) $AlSO_4^+$

C#(25) F

C#(26) AlF^{+2}

C#(27) AlF_2^+

C#(28) AlF_3^o

C#(29) $Al(OH)_4^-$

ZINC SUBROUTINE

C#(30) Zn^{+2}

C#(31) $ZnOH^+$

C#(32) $Zn(OH)_2^o$

CC#(2) $ZnSO_4^o$

CC#(3) $ZnHPO_4^o$

ION PAIR ASSIGNMENT (A#(I)=Activity)

Pair#(1) = A# (1) * A# (5)/0.0793 $NH_4SO_4^-$

Pair#(2) = A# (2) * A# (5)/0.11 KSO_4^-

Pair#(3) = A# (3) * A# (5)/0.00525 $CaSO_4^o$

Pair#(4) = A# (4) * A# (5)/0.0059 $MgSO_4^o$

Pair#(5) = A# (11)* A# (5)/0.00525 $MnSO_4^o$

Pair#(6) = $NH_4HPO_4^-$

Pair#(7) = $KHPO_4^-$

Pair#(8) = A# (3) * A# (8)/0.00198 $CaHPO_4^o$

Pair#(9) = A# (4) * A# (8)/0.00316 $MgHPO_4^o$

Pair#(10) = $MnHPO_4^o$

Pair#(11) = $NH_4H_2PO_4^o$

Pair#(12) = $KH_2PO_4^o$

Pair#(13) = A# (3) * A# (9)/0.083 $CaH_2PO_4^+$

Pair#(14) = A# (4) * A# (9)/0.1 $MgH_2PO_4^+$

Pair#(15) = $MnH_2PO_4^+$

Pair#(16) = $NH_4HCO_3^o$

Pair#(17) = $KHCO_3^o$

Pair#(18) = A# (3) * (12)/0.055 $CaHCO_3^o$

Pair#(19) = A# (4) * (12)/0.069 $MgHCO_3^o$

Pair#(20) = $MnHCO_3^o$

Pair#(21) = $NH_4CO_3^-$

Pair#(22) = KCO_3^-

Pair#(23) = $CaCO_3^o$

Pair#(24) = $MgCO_3^o$

Pair#(25) = $MnCO_3^o$

OTHER

PAIRV#(I) = Ion pair valence

PK#(I) = Reference pKsp

KLOG1#(I) and KLOG2(I) Conditional pK for metal-fulvate complexes

F#(I) = Activity coefficient

ANEW#(I) = Newly iterated activity

LOGF#(I) = Log of the activity coefficient

PCONC#(I) and PACT#(I)= -Log of concentration

PCT#(I) = Percent free ion concentration

IAP#(I) = Ion activity product

DEQ#(I) = Disequilibrium index

CONV#(I) = Convergence criteria

FU#(I) = Fulvic acid concentration

ML1#(I) and ML2#(I) = Metal-fulvate complexes

PCTML#(I) = Percent organic complexes

H# = Hydrogen ion activity

8.0 References

[1] Adams, F. 1971. Soil Sci. Soc. Am. Proc. 35:420-426
[2] Adams, F. and Rawajfih, Z. 1977. Soil Sci. Soc. Am. J. 41:686-692
[3] Bohn, H. L. and M. Peech. 1969. Soil Sci. Soc. Am. Proc. 33:873-880.
[4] Helgeson, H. C. 1969. Am. J. Sci. 267:729-804.
[5] Karanthansis, A. D. et al. 1983. Soil Sci. Soc. Am. J. 47:1247-1251.
[6] Kittrick, J. A. 1966. Soil Sci. Soc. Am. Proc. 30:595-598.
[7] Lindsay, W. L. 1979. Chemical Equilibria in Soils. John Wiley and Sons,
[8] Parks, G. A. 1972. Am. Mineral. 57:1163-1189.
[9] Plankey, B. J. and H. H. Patterson. 1987. Environ. Sci. Technol. 21:595-601.
[10] Sposito, G. et al. 1981. Soil Sci. Soc. Am. J. 45:465-468.

9.0 Copies and Registration

Copies of SOIL SOLUTION and documentation may be obtained from:

Jeff Wolt
Dep. Plant and Soil Science
University of Tennessee
PO Box 1071
Knoxville, TN 37901-1071

Users are encouraged to register their copy of SOIL SOLUTION with the author so that they may be informed of modifications and updates to the program. Since the source program may be freely modified by the user, the author is responsible only for registered copies of the unaltered source program.

This program is free of charge but a blank diskette would be appreciated.

10.0 Examples

10.1 Input/Output Screens

The following pages show the input/output screens for soil solution displaced from a Grenada silt loam B horizon.

10.2 Comparison of Soil Solution/Geochem

The following table compares free ion concentrations calculated for a Redding soil saturation extract using Soil Solution and Geochem.

		Output Data [-log Free Ion Concentration]	
	Input Data	Soil Solution	Geochem
H	pH 5.60	5.60	5.60
	mmol/L		
Ca	0.70	3.22	3.22
Mg	1.50	2.89	2.87
K	0.40	3.40	3.40
Na	2.80	2.55	2.56
CO3	1.00 (.03 atm)	8.29	8.33
SO4	2.25	2.66	2.72
Cl	2.10	2.63	2.68

```
SOIL SOLUTION

                                                    INPUT FORMAT
      Problem Identification: Grenada                 <=20 char

                          pH: 5.01                      xx.xx
                          EC: .161                      dS/m


      Ca: .107      mmol/L        Si: .1          mmol/L
      Mg: .26                     Cl: .582
       K: .057                     P: .002
      Na: .611                   NO3: .794
     NH4: 0                      SO4: .004
      Mn: 0                       F: 0
      Zn: 0                     DOC: .212
      Al: .013                  CO2: .03          atm
```

Screen 1: Data Entry.

```
SOIL SOLUTION -- Output Data

      Problem:  Grenada                    Solved in  NCOUNT=  5
      pH:  5.01 EC:  .161 dS/m             I:     1.847852E-03
      Ion Difference:  0  %

                          -log CONCENTRATION, mol/L
        Free      Cl        NO3       SO4       H2PO4      HPO4      HCO3      CO3
Free                    3.23      3.10      5.42       5.70      7.84      4.33      9.59
Ca      3.97                                7.27       8.69      9.27      7.14
Mg      3.58                                6.93       8.38      9.08      6.85
K       4.24                                8.80
Na      3.21                                8.11
NH4
Mn
Al      6.14                                8.60       9.02

  AlOH  6.24    Al(OH)2   4.98      Al(OH)3   6.49     Al(OH)4   9.59
                                    DOC       3.67     H4SiO4    4.00
```

Screen 2: Concentration of free ions and complexes.

SOIL SOLUTION -- Output Data

Problem: Grenada

FREE ION, Percent

Ca	100	Mg	100	K	100	Na	100	NH4		Mn		Al	5	Zn
Cl	100	NO3	100	SO4	94	H2PO4	0	HPO4	1	HCO3	100	CO3	0	F

-log ACTIVITY

Ca	4.05	Mg	3.66	K	4.26	Na	3.23	NH4		Mn		Al	6.31	Zn
Cl	3.25	NO3	3.12	SO4	5.50	H2PO4	5.72	HPO4	7.92	HCO3	4.35	CO3	9.67	F

ORGANIC COMPLEXES, Percent

Ca	0	Mg	0							Mn		Al	8	Zn

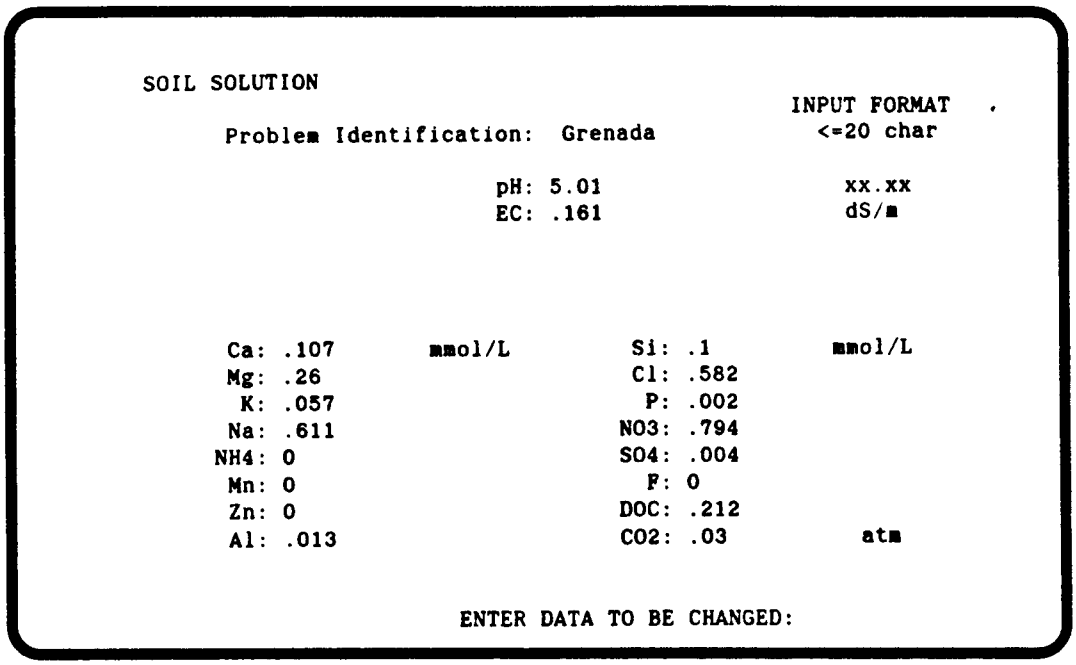
Screen 3: Free ion percents, ion activities, and percent organic complexes.

SOIL SOLUTION -- Ion Activity Products

Problem: Grenada

[IAP]	p[IAP]	Reference Mineral	pK	Disequil. Index
(Al)2(OH)6(H4SiO4)2	74.6	Kaolinite	76.4	1.85
(Al)(OH)3	33.3	Crypto. Gibbsite	32.8	-0.48
(Al)4(OH)10(SO4)	120.6	Basaluminite	117.6	-3.03
(K)(AL)3(OH)6(SO4)2	88.1	Alunite	85.4	-2.73
(Al)(H2PO4)(OH)2	30.0	Variscite	30.5	0.49
(Ca)5(OH)(PO4)3	75.0	Hydroxyapatite	55.9	-19.13
(Al)3.77(H4SiO4)3.24(K)0.24(Ca)0.08(Fe)0.24(Mg)0.20(OH)12.83				
	157.8	HIV	159.5	1.74

Screen 4: Ion activity products.



Screen 5: Data modification.

SOIL SOLUTION [SOILSOLN.BAS] -- VERSION 1.4 -- JEFF WOLT -- 1 JAN 1988

```
10      KEY OFF:CLEAR:CLS:SCREEN 0,0:COLOR 2,0
20      LOCATE 3,24:PRINT "SOIL SOLUTION (SOILSOLN.BAS)"
30      LOCATE 5,24:PRINT "A PROGRAM FOR COMPUTATION OF"
40      LOCATE 7,17:PRINT "ION ACTIVITIES OF SOIL SOLUTION COMPONENTS"
50      LOCATE 11,33:PRINT "BY JEFF WOLT"
60      LOCATE 13,21:PRINT "UNIVERSITY OF TENNESSEE, KNOXVILLE"
70      LOCATE 15,32:PRINT "SEPTEMBER 1987"
80      COLOR 6,0:LOCATE 23,45:PRINT "HIT ANY KEY TO CONTINUE"
90      A$ = INKEY$:IF A$ = "" THEN 90
100     CLS:LOCATE 3,9:COLOR 6,0:PRINT "SOIL SOLUTION":COLOR 2,0
110     LOCATE 5,15:PRINT "The program SOIL SOLUTION iteratively estimates pair"

120     LOCATE 6,15:PRINT "values, concentrations, and activities of ions in soi
l"
130     LOCATE 7,15:PRINT "solutions.  The following input data are requested:"
140     LOCATE 8,15:PRINT "problem ID, solution pH, EC (dS/m), and total ion"
150     LOCATE 9,15:PRINT "concentrations (mmol/L).  The present version of SOIL
 "
160     LOCATE 10,15:PRINT "SOLUTION supports the following inputs: Ca, Mg, K, N
a,"
170     LOCATE 11,15:PRINT "NH4, Mn, Zn, Al, Si, Cl, P, NO3, SO4, F, DOC, and CO
2"
180     LOCATE 12,15:PRINT "(atm).  HPO4 and H2PO4 are calculated from P and pH.
"
190     LOCATE 13,15:PRINT "Carbonates are calculated from CO2 and pH."
200     LOCATE 15,15:PRINT "SOIL SOLUTION iteratively solves for ion activities"

210     LOCATE 16,15:PRINT "and free ion concentrations using an averaging routi
ne"
220     LOCATE 17,15:PRINT "to reduce iterative cycles.  The program is terminat
ed"
230     LOCATE 18,15:PRINT "when successive iterations converge or after 99 cycl
es."
240     LOCATE 19,15:PRINT "If Al or Zn are included in the input data, hydrolyt
ic"
250     LOCATE 20,15:PRINT "species are computed.  Fluoride is included in the A
l"
260     LOCATE 21,15:PRINT "subroutine."
270     COLOR 6,0:LOCATE 23,45:PRINT "HIT ANY KEY TO CONTINUE"
280     B$ = INKEY$:IF B$ = "" THEN 280
290     CLS:COLOR 6,0:LOCATE 3,9:PRINT "SOIL SOLUTION":COLOR 2,0
300     LOCATE 5,15:PRINT "SOIL SOLUTON outputs ionic speciation and percent"
310     LOCATE 6,15:PRINT "free ion.  When DOC is input, percent metal complexa-
 "
320     LOCATE 7,15:PRINT "tion fulvic acid is estimated.  Additionally, ion"
330     LOCATE 8,15:PRINT "activity products (IAP) are computed for selected"
340     LOCATE 9,15:PRINT "mineral species."
350     COLOR 6,0:LOCATE 23,40:LINE INPUT "DO YOU WISH TO RUN A PROBLEM? Y/N ";C
$
```

```
360     IF C$ = "Y" OR C$ = "y" THEN 370 ELSE 4950
370     CLS:CLEAR:LOCATE 3,9:PRINT "SOIL SOLUTION"
380     LOCATE 4,57:PRINT "INPUT FORMAT"
390     LOCATE 5,59:PRINT "<=20 char":LOCATE 5,15:LINE INPUT "Problem Identificat
ion: ";D$:COLOR 2,0:LOCATE 5,39:PRINT D$
400     COLOR 6,0:LOCATE 7,61:PRINT "xx.xx":LOCATE 7,35:INPUT "pH: ",PH:LOCATE 7,
38:COLOR 2,0:PRINT PH
410     COLOR 6,0:LOCATE 8,61:PRINT "dS/m":LOCATE 8,35:INPUT "EC: ",EC:LOCATE 8,3
8:COLOR 2,0:PRINT EC
420     COLOR 6,0:LOCATE 13,30:PRINT "mmol/L":LOCATE 13,15:INPUT "Ca: ",CA:LOCATE
 13,18:COLOR 2,0:PRINT CA
430     COLOR 6,0:LOCATE 14,15:INPUT "Mg: ",MG:LOCATE 14,18:COLOR 2,0:PRINT MG
440     COLOR 6,0:LOCATE 15,16:INPUT "K: ",K:LOCATE 15,18:COLOR 2,0:PRINT K
450     COLOR 6,0:LOCATE 16,15:INPUT "Na: ",NA:LOCATE 16,18:COLOR 2,0:PRINT NA
460     COLOR 6,0:LOCATE 17,14:INPUT "NH4: ",NHT:LOCATE 17,18:COLOR 2,0:PRINT NHT

470     COLOR 6,0:LOCATE 18,15:INPUT "Mn: ",MN:LOCATE 18,18:COLOR 2,0:PRINT MN
480     COLOR 6,0:LOCATE 19,15:INPUT "Zn: ",ZN:LOCATE 19,18:COLOR 2,0:PRINT ZN
490     COLOR 6,0:LOCATE 20,15:INPUT "Al: ",AL:LOCATE 20,18:COLOR 2,0:PRINT AL
500     COLOR 6,0:LOCATE 13,60:PRINT "mmol/L":LOCATE 13,45:INPUT "Si: ",SIT:LOCAT
E 13,48:COLOR 2,0:PRINT SIT
510     COLOR 6,0:LOCATE 14,45:INPUT "Cl: ",CL:LOCATE 14,48:COLOR 2,0:PRINT CL
520     COLOR 6,0:LOCATE 15,46:INPUT "P: ",P:LOCATE 15,48:COLOR 2,0:PRINT P
530     COLOR 6,0:LOCATE 16,44:INPUT "NO3: ",NO3:LOCATE 16,48:COLOR 2,0:PRINT NO3

540     COLOR 6,0:LOCATE 17,44:INPUT "SO4: ",SO4:LOCATE 17,48:COLOR 2,0:PRINT SO4

550     COLOR 6,0:LOCATE 18,46:INPUT "F: ",F:LOCATE 18,48:COLOR 2,0:PRINT F
560     COLOR 6,0:LOCATE 19,44:INPUT "DOC: ",DOC:LOCATE 19,48:COLOR 2,0:PRINT DOC

570     COLOR 6,0:LOCATE 20,62:PRINT "atm":LOCATE 20,44:INPUT "CO2: ",CO2:LOCATE
20,48:COLOR 2,0:PRINT CO2
580     COLOR 6,0:LOCATE 24,20:LINE INPUT "DO YOU WISH A HARDCOPY OF THIS SCREEN?
 Y/N ";C$
590     IF C$="Y" OR C$="y" THEN 600 ELSE 640
600     LOCATE 23,10:PRINT "PRINTER ON. HIT ANY KEY, THEN PRINT SCREEN. HIT ANY K
EY TO RESUME."
610     E$= INKEY$:IF E$="" THEN 610
620     LOCATE 23,10:PRINT SPC(70)
630     F$= INKEY$:IF F$ = "" THEN 630
640     DIM B#(18):DIM V#(18):DIM PAIRV#(32):DIM PK#(12):DIM KLOG1#(4):DIM KLOG2#
(4)
650     FOR I=1 TO 18:READ B#(I):NEXT I
660     DATA 2.5,3,6,8,4,3,3,4,4.5,0,6,4.5,4.5,0,9,6,4.5,0
670     FOR J=1 TO 18:READ V#(J):NEXT J
680     DATA 1,1,2,2,2,1,1,2,1,0,2,1,2,0,3,2,1,0
690     FOR KL=1 TO 32:READ PAIRV#(KL):NEXT KL
700     DATA 1,1,0,0,0,1,1,0,0,0,0,0,1,1,1,0,0,1,1,1,1,1,0,0,0,2,2,1,1,0,0,0
710     FOR KK=1 TO 12:READ PK#(KK):NEXT KK
720     DATA 76.4,32.8,117.6,85.4,30.5,55.9,159.5,0,0,0,0,0
730     FOR Y=1 TO 4:READ KLOG1#(Y):DATA 3.12,2.71,3.93,3.54:NEXT Y
740     FOR Z=1 TO 4:READ KLOG2#(Z):DATA 1.23,0.69,2.23,1.74:NEXT Z
750     CLS
```

```
760     DIM A#(32):DIM C#(32):DIM F#(32):DIM CNEW#(32)
770     DIM ANEW#(18):DIM PAIR#(32):DIM LOGF#(32):DIM CHOL#(18)
780     DIM PCONC#(32):DIM PPAIR#(32):DIM PCT#(32):DIM PACT#(32):DIM IAP#(12):DIM
 DEQ#(12):DIM CONV#(17)
790     DIM CC#(3):DIM AA#(3):DIM LLOGF#(3):DIM FF#(3):DIM PPCONC#(3)
800     DIM FU#(3):DIM ML1#(5):DIM ML2#(5):DIM METAL#(5):DIM PCTML#(5)
810     NH3=NHT/(1+(10^9.238-PH)):NH4=NHT-NH3
820     SI=SIT/(1+(10^(PH-9.49))+(10^((PH*2)-22.05)))
830     C#(1)=NH4/1000:C#(2)=K/1000:C#(3)=CA/1000:C#(4)=MG/1000:C#(5)=SO4/1000
840     C#(6)=CL/1000:C#(7)=NO3/1000:C#(10)=P/1000:C#(11)=MN/1000:C#(15)=AL/1000:
C#(16)=ZN/1000:C#(17)=NA/1000:C#(18)=SI/1000:C#(14)=CO2
850     C#(25)=F/1000
860     IF DOC=0 THEN GOTO 900
870     FU#(1)=(.10957*DOC)*(9.000001E-02)/1000
880     FU#(2)=(.10957*DOC)*(.91)/1000
890     FU#(3)=(.10957*DOC)/1000
900     NX=0:NCOUNT=1:NEG=0
910     LOCATE 5,39:COLOR 2,0:PRINT "Solving... NCOUNT= ":COLOR 6,0:LOCATE 5,58:P
RINT NCOUNT
920     FOR LL=1 TO 18:CHOL#(LL)=C#(LL):NEXT LL
930     C#(8)=.5*C#(10):C#(9)=.5*C#(10):H#=10^(-PH)
940     ANEW#(12)=(4.45*.0000001*.0338*C#(14))/H#:C#(12)=ANEW#(12)
950     ANEW#(13)=(4.67*(10^(-11))*4.45*(10^(-7))*.338*C#(14))/(H#^2)
960     C#(13)=ANEW#(13)
970     CAT=C#(1)+C#(2)+C#(17)+2*(C#(3)+C#(4)+C#(11)+C#(16))+3*C#(15)+H
980     AN=C#(6)+C#(7)+C#(9)+C#(12)+2*(C#(5)+C#(8)+C#(13))+10^(PH-14)
990     IONDIFF%=(ABS(CAT-AN)/(CAT+AN))*100:ANCOR=CAT/AN
1000     C#(6)=ANCOR*C#(6):C#(7)=ANCOR*C#(7):C#(9)=ANCOR*C#(9)
1010     C#(12)=ANCOR*C#(12):C#(5)=ANCOR*C#(5):C#(8)=ANCOR*C#(8)
1020     C#(13)=ANCOR*C#(13)
1030     MU#=0:FOR I=1 TO 17:MU#=MU#+(.5)*(C#(I)*(V#(I)^2)):NEXT I
1040     FOR N=1 TO 9:LOGF#(N)=(.509*V#(N)^2)*SQR(MU#)/(1+(.328*B#(N)*SQR(MU#)))
1050     F#(N)=10^(-LOGF#(N)):NEXT N
1060     FOR M=11 TO 13
1070     LOGF#(M)=(.509*V#(M)^2)*SQR(MU#)/(1+(.328*B#(M)*SQR(MU#))):F#(M)=10^(-LO
GF#(M)):NEXT M
1080     FOR PU=15 TO 17
1090     LOGF#(PU)=(.509*V#(PU)^2)*SQR(MU#)/(1+(.328*B#(PU)*SQR(MU#))):F#(PU)=10^
(-LOGF#(PU)):NEXT PU
1100     LOGF#(25)=.509*SQR(MU#)/(1+(1.148*SQR(MU#))):F#(25)=10^(-LOGF#(25))
1110     DAVIES=.509*(SQR(MU#)/(1+SQR(MU#))-.3*MU#)
1120     FOR N=1 TO 7:ANEW#(N)=F#(N)*CNEW#(N):NEXT N
1130     ANEW#(8)=F#(8)*F#(9)*CNEW#(10)/(F#(9)+F#(8)*(10^(7.21-PH)))
1140     ANEW#(9)=ANEW#(8)*(10^(7.21-PH)):ANEW#(11)=F#(11)*CNEW#(11)
1150     ANEW#(12)=F#(12)*CNEW#(12):ANEW#(13)=(10^(-10.33))*ANEW#(12)/H#
1160     FOR PS=15 TO 17:ANEW#(PS)=F#(PS)*CNEW#(PS):NEXT PS
1170     IF NCOUNT=1 THEN 1270 ELSE 1180
1180     CNEW#(8)=ANEW#(8)/F#(8):CNEW#(9)=ANEW#(9)/F#(9)
1190     CNEW#(12)=ANEW#(12)/F#(12):CNEW#(13)=ANEW#(13)/F#(13)
1200     FOR ZZ=1 TO 16
```

```
1210    IF ANEW#(ZZ)>0 THEN CONV#(ZZ)=ABS(ANEW#(ZZ)-A#(ZZ))/ANEW#(ZZ)
1220    NEXT ZZ
1230    FOR YZ=1 TO 16
1240    IF CONV#(YZ)>=.01 THEN 1270
1250    NEXT YZ
1260    GOTO 1850
1270    FOR M=1 TO 9:A#(M)=ANEW#(M):NEXT M
1280    FOR N=11 TO 13:A#(N)=ANEW#(N):NEXT N
1290    FOR PT=15 TO 17:A#(PT)=ANEW#(PT):NEXT PT
1300    PAIR#(1)=A#(1)*A#(5)/.0793:PAIR#(2)=A#(2)*A#(5)/.11
1310    PAIR#(3)=A#(3)*A#(5)/.00525:PAIR#(4)=A#(4)*A#(5)/.0059
1320    PAIR#(5)=A#(11)*A#(5)/.00525
1330    PAIR#(8)=A#(3)*A#(8)/.00198:PAIR#(9)=A#(4)*A#(8)/.00316
1340    PAIR#(13)=A#(3)*A#(9)/.083:PAIR#(14)=A#(4)*A#(9)/.1
1350    PAIR#(18)=A#(3)*A#(12)/.055:PAIR#(19)=A#(4)*A#(12)/.069
1360    PAIR#(28)=A#(15)*A#(5)/.000631:PAIR#(29)=A#(16)*A#(9)/.0251
1370    PAIR#(30)=A#(16)*A#(5)/.00468:PAIR#(31)=A#(16)*A#(9)*(10^(-3.9))/H#
1380    PAIR#(32)=A#(17)*A#(5)/.24
1390    IF NCOUNT=2 THEN PAIR#(3)=.5*PAIR#(3)
1400    IF NCOUNT=2 THEN PAIR#(4)=.5*PAIR#(4)
1410    CNEW#(1)=C#(1)-PAIR#(1)
1420    CNEW#(2)=C#(2)-PAIR#(2)
1430    CNEW#(3)=C#(3)-PAIR#(3)-PAIR#(8)-PAIR#(13)-PAIR#(18)-ML1#(1)-ML2#(1)
1440    CNEW#(4)=C#(4)-PAIR#(4)-PAIR#(9)-PAIR#(14)-PAIR#(19)-ML1#(2)-ML2#(2)
1450    CNEW#(5)=C#(5)-PAIR#(1)-PAIR#(2)-PAIR#(3)-PAIR#(4)-PAIR#(5)-PAIR#(28)-PA
IR#(30)-PAIR#(32)
1460    CNEW#(6)=C#(6)
1470    CNEW#(7)=C#(7)
1480    CNEW#(10)=C#(10)-PAIR#(8)-PAIR#(9)-PAIR#(13)-PAIR#(14)-PAIR#(29)
1490    CNEW#(11)=C#(11)-PAIR#(5)-ML1#(3)-ML2#(3)
1500    CNEW#(12)=C#(12)-PAIR#(18)-PAIR#(19)
1510    CNEW#(13)=A#(13)/F#(13)
1520    CNEW#(14)=C#(14)
1530    CNEW#(15)=C#(15)-PAIR#(28)-ML1#(5)-ML2#(5)
1540    CNEW#(16)=C#(16)-PAIR#(29)-PAIR#(30)-PAIR#(31)-ML1#(4)-ML2#(4)
1550    CNEW#(17)=C#(17)-PAIR#(32)
1560    CNEW#(18)=C#(18)
1570    ANEW#(8)=F#(8)*F#(9)*CNEW#(10)/(F#(9)*F#(8)*(10^(7.21-PH)))
1580    ANEW#(9)=ANEW#(8)*(10^(7.21-PH))
1590    CNEW#(8)=ANEW#(8)/F#(8):CNEW#(9)=ANEW#(9)/F#(9)
1600    IF DOC>0 THEN GOSUB 4960
1610    FOR I=1 TO 17:IF CNEW#(I)<0 THEN 1620 ELSE NEXT I:GOTO 1640
1620    LOCATE 8,15:PRINT "CNEW     became negative at NCOUNT= "
1630    LOCATE 8,20:COLOR 6,0:PRINT I:LOCATE 8,50:PRINT NCOUNT:COLOR 2,0:GOTO 18
50
1640    IF NX=0 THEN 1720
1650    NX=0
1660    FOR J=1 TO 7:CNEW#(J)=(CNEW#(J)+CHOL#(J))/2:NEXT J
1670    FOR KM=10 TO 17:CNEW#(KM)=(CNEW#(KM)+CHOL#(KM))/2:NEXT KM
1680    ANEW#(8)=F#(8)*F#(9)*CNEW#(10)/(F#(9)+F#(8)*(10^(7.21-PH)))
1690    ANEW#(9)=ANEW#(8)*(10^(7.21-PH))
1700    CNEW#(8)=ANEW#(8)/F#(8):CNEW#(9)=ANEW#(9)/F#(9)
```

```
1710    GOTO 1730
1720    NX=1
1730    FOR M=1 TO 7:CHOL#(M)=CNEW#(M):NEXT M
1740    FOR N=10 TO 17:CHOL#(N)=CNEW#(N):NEXT N
1750    MUNEW#=0
1760    FOR PR=1 TO 17:MUNEW#=MUNEW#+(.5)*(CNEW#(PR)*(V#(PR)^2)):NEXT PR
1770    FOR Q=1 TO 32:MUNEW#=MUNEW#+(.5)*(PAIR#(Q)*(PAIRV#(Q)^2)):NEXT Q
1780    MU#=MUNEW#:IF MU#>0 THEN 1810
1790    LOCATE 9,15:PRINT "Ionic Strength became negative at NCOUNT= "
1800    LOCATE 9,57:COLOR 6,0:PRINT NCOUNT:COLOR 2,0:GOTO 2380
1810    NCOUNT=NCOUNT+1
1820    LOCATE 5,39:COLOR 2,0:PRINT "Solving... NCOUNT= ":COLOR 6,0:LOCATE 5,58:
PRINT NCOUNT
1830    IF NCOUNT<99 THEN 1040
1840    LOCATE 4,15:PRINT "Convergence criteria not met in 99 iterations"
1850    LOCATE 5,39:COLOR 2,0:PRINT "Solved in  NCOUNT= ":COLOR 6,0:LOCATE 5,58:
PRINT NCOUNT
1860    IF C#(15) <= 0 THEN 2240
1870    A#(25)=C#(25)*F#(25)
1880    LOGF#(19)=4.581*SQR(MU#)/(1+(2.952*SQR(MU#)))
1890    F#(19)=10^(-LOGF#(19))
1900    LOGF#(20)=2.036*SQR(MU#)/(1+(2.296*SQR(MU#)))
1910    F#(20)=10^(-LOGF#(20))
1920    LOGF#(21)=DAVIES
1930    F#(21)=10^(-LOGF#(21))
1940    LOGF#(26)=DAVIES*4:F#(26)=10^(-LOGF#(26))
1950    LOGF#(27)=DAVIES:F#(27)=10^(-LOGF#(27))
1960    LOGF#(29)=DAVIES:F#(29)=10^(-LOGF#(29))
1970    LOGF#(23)=DAVIES:F#(23)=10^(-LOGF#(23)):LOGF#(24)=DAVIES:F#(24)=10^(-LOG
F#(24))
1980    DEN=(1/F#(19))+(1/((10^5.01)*H#*F#(20)))+(1/((10^8.7)*H#^2*F#(21)))+(1/(
(10^15.2)*H#^3))+(A#(5)*(10^3.2)/F#(24))+(A#(9)*(10^3)/F#(23))+(1/((10^23.33)*H#
^4*F#(29)))+((10^6.98)*A#(25)/F#(26))+((10^12.6)*(A#(25)^2)/F#(27))+((10^16.65)*
(A#(25)^3))
1990    IF DOC=0 GOTO 2010
2000    DEN=DEN+(.346*FU#(3)/H#)+(.24*FU#(3)/H#)
2010    A#(19)=C#(15)/DEN
2020    C#(19)=A#(19)/F#(19)
2030    IF DOC=0 GOTO 2060
2040    ML1#(5)=.346*C#(19)*FU#(3)/H#
2050    ML2#(5)=.24*C#(19)*FU#(3)/H#
2060    A#(20)=A#(19)/((10^5.01)*H#):C#(20)=A#(20)/F#(20)
2070    A#(21)=A#(19)/((10^8.7)*H#^2):C#(21)=A#(21)/F#(21)
2080    A#(22)=A#(19)/((10^15.2)*H#^3):C#(22)=A#(22)
2090    A#(23)=A#(19)*A#(9)*10^3:C#(23)=A#(23)/F#(23)
2100    A#(24)=A#(19)*A#(5)/.000631:C#(24)=A#(24)/F#(24)
2110    IF C#(25)=0 GOTO 2220
2120    A#(26)=A#(19)*A#(25)*10^6.98:C#(26)=A#(26)/F#(26)
2130    A#(27)=A#(19)*(A#(25)^2)*10^12.6:C#(27)=A#(27)/F#(27)
2140    A#(28)=A#(19)*(A#(25)^3)*10^16.65:C#(28)=A#(28)
2150    NORM=(C#(25)+C#(26)+2*C#(27)+3*C#(28))/(F/1000)
```

```
2160     CFNEW#=C#(25)/NORM
2170     IF ABS(CFNEW#-C#(25))/C#(25)<=.1 GOTO 2210
2180     IF CFNEW#<(10^-6)*F GOTO 2210
2190     C#(25)=CFNEW#
2200     GOTO 1870
2210     CF#=C#(26)/NORM+C#(27)/NORM+C#(28)/NORM:PF#=-.434*LOG(CF#)
2220     A#(29)=A#(19)/((10^23.33)*H#^4):C#(29)=A#(29)/F#(29)
2230     CCHEK=C#(19)+C#(20)+C#(21)+C#(22)+C#(23)+C#(24)+C#(26)+C#(27)+C#(28)+C#(
29)+ML1#(5)+ML2#(5):NORMAL=CCHEK/C#(15)
2232     FOR NR=19 TO 24:C#(NR)=C#(NR)/NORMAL:NEXT NR
2234     FOR NM=26 TO 29:C#(NM)=C#(NM)/NORMAL:NEXT NM
2236     ML1#(5)=ML1#(5)/NORMAL:ML2#(5)=ML2#(5)/NORMAL
2240     IF C#(16)<=0 THEN 2380
2250     LOGF#(30)=2.036*SQRT(MU#)/(1+1.974*SQRT(MU#)):F#(30)=10^(-LOGF#(30))
2260     LOGF#(31)=DAVIES:F#(31)=10^(-LOGF#(31))
2270     LLOGF#(1)=DAVIES:FF#(1)=10^(-LLOGF#(1))
2280     DENOM=(1/F#(30))+(A#(5)*10^2.33)+(10^(-7.69)/(F#(31)*H#))+(10^(-16.8)/H#
^2)+(10^(-3.9)*A#(9)/H#)+(10^1.6*A#(9))
2290     A#(30)=C#(16)/DENOM:C#(30)=A#(30)/F#(30)
2300     A#(31)=A#(30)*10^(-7.69)/H#:C#(31)=A#(31)/F#(31)
2310     A#(32)=A#(30)*10^(-16.8)/H#^2:C#(32)=A#(32)
2320     AA#(1)=A#(30)*A#(9)/.0251:CC#(1)=AA#(1)/FF#(1)
2330     AA#(2)=A#(30)*A#(5)/.00468:CC#(2)=AA#(2)
2340     AA#(3)=A#(30)*A#(9)*10^(-3.9)/H#:CC#(3)=AA#(3)
2350     CHEKZN=C#(30)+C#(31)+C#(32)+CC#(1)+CC#(2)+CC#(3)
2360     FOR I=1 TO 3:IF CC#(I)>0 THEN PPCONC#(I)=-.434*LOG(CC#(I))
2370     NEXT I
2380     FOR X=1 TO 18:IF CNEW#(X)>0 THEN PCONC#(X)=-.434*LOG(CNEW#(X))
2390     NEXT X
2400     FOR PQ=1 TO 32:IF PAIR#(PQ) > 0 THEN PPAIR#(PQ)=-.434*LOG(PAIR#(PQ))
2410     NEXT PQ
2420     FOR V=19 TO 32:IF C#(V)>0 THEN PCONC#(V)=-.434*LOG(C#(V))
2430     NEXT V
2440     CLS:COLOR 6,0:LOCATE 3,9:PRINT "SOIL SOLUTION"
2450     COLOR 2,0:LOCATE 3,23:PRINT "-- Output Data"
2460     LOCATE 5,15:PRINT "Problem: ":COLOR 6,0:LOCATE 5,24:PRINT D$
2470     LOCATE 5,50:COLOR 2,0:PRINT "Solved in  NCOUNT= ":COLOR 6,0:LOCATE 5,69:
PRINT NCOUNT
2480     COLOR 2,0:LOCATE 6,15:PRINT "pH: ":LOCATE 6,25:PRINT "EC: "
2490     LOCATE 6,35:PRINT "dS/m            I: ":COLOR 6,0:LOCATE 6,19
2500     PRINT PH:LOCATE 6,29:PRINT EC:LOCATE 6,55:I!=MU#:PRINT I!:COLOR 2,0
2510     LOCATE 7,15:PRINT "Ion Difference: ":LOCATE 7,36:PRINT "%":COLOR 6,0
2520     LOCATE 7,31:PRINT IONDIFF%
2530     IF IONDIFF%>20 THEN 2540 ELSE 2550
2540     COLOR 2,0:LOCATE 7,40:PRINT "Be Careful, exceeds 20%"
2550     COLOR 6,0:LOCATE 10,31:PRINT "-log CONCENTRATION, mol/L"
2560      COLOR 2,0:LOCATE 11,10:PRINT "Free      Cl        NO3       SO4      H2PO4
    HPO4      HCO3      CO3"
2570     LOCATE 13,2:PRINT "Free":LOCATE 14,2:PRINT "Ca":LOCATE 15,2:PRINT "Mg"
2580     LOCATE 16,2:PRINT "K":LOCATE 17,2:PRINT "Na":LOCATE 18,2:PRINT "NH4"
2590     LOCATE 19,2:PRINT "Mn":IF CNEW#(15) > 0 THEN LOCATE 20,2:PRINT "Al"
2600     IF CNEW#(16) > 0 THEN LOCATE 21,2:PRINT "Zn"
```

```
2610    COLOR 6,0
2620    IF PCONC#(3) > 0 THEN LOCATE 14,10:PRINT USING "##.##";PCONC#(3)
2630    IF PCONC#(4) > 0 THEN LOCATE 15,10:PRINT USING "##.##";PCONC#(4)
2640    IF PCONC#(2) > 0 THEN LOCATE 16,10:PRINT USING "##.##";PCONC#(2)
2650    IF PCONC#(17) > 0 THEN LOCATE 17,10:PRINT USING "##.##";PCONC#(17)
2660    IF PCONC#(1) > 0 THEN LOCATE 8,10:PRINT USING "##.##";PCONC#(1)
2670    IF PCONC#(11) > 0 THEN LOCATE 19,10:PRINT USING "##.##";PCONC#(11)
2680    IF CNEW#(15) > 0 THEN LOCATE 20,10:PRINT USING "##.##";PCONC#(19)
2690    IF CNEW#(16) > 0 THEN LOCATE 21,10:PRINT USING "##.##";PCONC#(30)
2700    IF PCONC#(6) > 0 THEN LOCATE 13,17:PRINT USING "##.##";PCONC#(6)
2710    IF PCONC#(7) > 0 THEN LOCATE 13,26:PRINT USING "##.##";PCONC#(7)
2720    IF PCONC#(5) > 0 THEN LOCATE 13,35:PRINT USING "##.##";PCONC#(5)
2730    IF PCONC#(9) > 0 THEN LOCATE 13,45:PRINT USING "##.##";PCONC#(9)
2740    IF PCONC#(8) > 0 THEN LOCATE 13,54:PRINT USING "##.##";PCONC#(8)
2750    IF PCONC#(12) > 0 THEN LOCATE 13,63:PRINT USING "##.##";PCONC#(12)
2760    IF PCONC#(13) > 0 THEN LOCATE 13,71:PRINT USING "##.##";PCONC#(13)
2770    IF PPAIR#(3) > 0 THEN LOCATE 14,35:PRINT USING "##.##";PPAIR#(3)
2780    IF PPAIR#(13) > 0 THEN LOCATE 14,45:PRINT USING "##.##";PPAIR#(13)
2790    IF PPAIR#(8) > 0 THEN LOCATE 14,54:PRINT USING "##.##";PPAIR#(8)
2800    IF PPAIR#(18) > 0 THEN LOCATE 14,63:PRINT USING "##.##";PPAIR#(18)
2810    IF PPAIR#(4) > 0 THEN LOCATE 15,35:PRINT USING "##.##";PPAIR#(4)
2820    IF PPAIR#(14) > 0 THEN LOCATE 15,45:PRINT USING "##.##";PPAIR#(14)
2830    IF PPAIR#(9) > 0 THEN LOCATE 15,54:PRINT USING "##.##";PPAIR#(9)
2840    IF PPAIR#(19) > 0 THEN LOCATE 15,63:PRINT USING "##.##";PPAIR#(19)
2850    IF PPAIR#(32) > 0 THEN LOCATE 17,35:PRINT USING "##.##";PPAIR#(32)
2860    IF PPAIR#(2) > 0 THEN LOCATE 16,35:PRINT USING "##.##";PPAIR#(2)
2870    IF PPAIR#(1) > 0 THEN LOCATE 18,35:PRINT USING "##.##";PPAIR#(1)
2880    IF PPAIR#(5) > 0 THEN LOCATE 19,35:PRINT USING "##.##";PPAIR#(5)
2890    IF CNEW#(15) > 0 THEN LOCATE 20,35:PRINT USING "##.##";PCONC#(24)
2900    IF CNEW#(15) > 0 THEN LOCATE 20,45:PRINT USING "##.##";PCONC#(23)
2910    IF CNEW#(15) > 0 THEN LOCATE 22,5:COLOR 2,0:PRINT "AlOH ":LOCATE 22,10:C
OLOR 6,0:PRINT USING "##.##";PCONC#(20)
2920    IF CNEW#(15) > 0 THEN LOCATE 22,18:COLOR 2,0:PRINT "Al(OH)2 ":LOCATE 22,
26:COLOR 6,0:PRINT USING "##.##";PCONC#(21)
2930    IF CNEW#(15) > 0 THEN LOCATE 22,37:COLOR 2,0:PRINT "Al(OH)3 ":LOCATE 22,
45:COLOR 6,0:PRINT USING "##.##";PCONC#(22)
2940    IF CNEW#(15) > 0 THEN LOCATE 22,55:COLOR 2,0:PRINT "Al(OH)4 ":LOCATE 22,
63:COLOR 6,0:PRINT USING "##.##";PCONC#(29)
2950    IF PF# > 0 THEN LOCATE 22,71:COLOR 2,0:PRINT "Al-F ":LOCATE 22,75:COLOR
6,0:PRINT USING "##.##";PF#
2960    IF CNEW#(16)>0 THEN LOCATE 21,35:PRINT USING "##.##";PPCONC#(2)
2970    IF CNEW#(16)>0 THEN LOCATE 21,45:PRINT USING "##.##";PPCONC#(1)
2980    IF CNEW#(16)>0 THEN LOCATE 21,54:PRINT USING "##.##";PPCONC#(3)
2990    IF CNEW#(16)>0 THEN LOCATE 23,5:COLOR 2,0:PRINT "ZnOH":LOCATE 23,10:COLO
R 6,0:PRINT USING "##.##";PCONC#(31)
3000    IF CNEW#(16)>0 THEN LOCATE 23,18:COLOR 2,0:PRINT "Zn(OH)2":LOCATE 23,26:
COLOR 6,0:PRINT USING "##.##";PCONC#(32)
```

```
3010    IF DOC>0 THEN LOCATE 23,37:PDOC#=-.434*LOG(DOC/1000):COLOR 2,0:PRINT "DO
C":LOCATE 23,45:COLOR 6,0:PRINT USING "##.##";PDOC#
3020    IF C#(18)>0 THEN LOCATE 23,55:COLOR 2,0:PRINT "H4Si04":LOCATE 23,63:COLO
R 6,0:PRINT USING "##.##";PCONC#(18)
3030    IF C#(25)>0 THEN LOCATE 23,71:COLOR 2,0:PRINT "F":LOCATE 23,75:COLOR 6,0
:PRINT USING "##.##";PCONC#(25)
3040    COLOR 6,0:LOCATE 24,20:LINE INPUT "DO YOU WISH A HARDCOPY OF THIS SCREEN
? Y/N ";C$
3050    IF C$="Y" OR C$="y" THEN 3060 ELSE 3100
3060    LOCATE 23,10:PRINT "PRINTER ON. HIT ANY KEY, THEN PRINT SCREEN. HIT ANY
KEY TO RESUME."
3070    E$= INKEY$:IF E$="" THEN 3070
3080    LOCATE 23,10:PRINT SPC(70)
3090    F$= INKEY$:IF F$ = "" THEN 3090
3100    CLS:COLOR 6,0:LOCATE 3,9:PRINT "SOIL SOLUTION"
3110    COLOR 2,0:LOCATE 3,23:PRINT "-- Output Data"
3120    LOCATE 5,15:PRINT "Problem: ":COLOR 6,0:LOCATE 5,24:PRINT D$
3130    LOCATE 7,32:PRINT "FREE ION, Percent"
3140     COLOR 2,0:LOCATE 8,7:PRINT "Ca       Mg       K        Na        NH4
    Mn       Al       Zn "
3150     COLOR 2,0:LOCATE 10,7:PRINT "Cl       NO3      SO4      H2PO4     HPO4
     HCO3     CO3      F"
3160    IF C#(1)>0 THEN PCT#(1)=CNEW#(1)*100/C#(1)
3170    IF C#(10)>0 THEN PCT#(8)=CNEW#(8)*100/C#(10)
3180    IF C#(10)>0 THEN PCT#(9)=CNEW#(9)*100/C#(10)
3190    IF C#(11)>0 THEN PCT#(11)=CNEW#(11)*100/C#(11)
3200    IF C#(14)>0 THEN PCT#(12)=CNEW#(12)*100/(CNEW#(12)+CNEW#(13))
3210    IF C#(14)>0 THEN PCT#(13)=100-PCT#(12)
3220    IF C#(15)>0 THEN PCT#(19)=C#(19)*100/C#(15)
3230    IF C#(16)>0 THEN PCT#(30)=C#(30)*100/C#(16)
3240    IF C#(17)>0 THEN PCT#(17)=CNEW#(17)*100/C#(17)
3250    IF C#(25)>0 THEN PCT#(25)=(C#(25)/F)*10^5
3260    FOR PP=2 TO 7:IF C#(PP)>0 THEN PCT#(PP)=CNEW#(PP)*100/C#(PP)
3270    NEXT PP
3280    COLOR 6,0
3290    LOCATE 8,10:IF C#(3)>0 THEN PRINT USING "###";PCT#(3)
3300    LOCATE 8,20:IF C#(4)>0 THEN PRINT USING "###";PCT#(4)
3310    LOCATE 8,28:IF C#(2)>0 THEN PRINT USING "###";PCT#(2)
3320    LOCATE 8,40:IF C#(17)>0 THEN PRINT USING "###";PCT#(17)
3330    LOCATE 8,49:IF C#(1)>0 THEN PRINT USING "###";PCT#(1)
3340    LOCATE 8,59:IF C#(11)>0 THEN PRINT USING "###";PCT#(11)
3350    LOCATE 8,67:IF C#(15)>0 THEN PRINT USING "###";PCT#(19)
3360    LOCATE 8,75:IF C#(16)>0 THEN PRINT USING "###";PCT#(30)
3370    LOCATE 10,10:IF C#(6)>0 THEN PRINT USING "###";PCT#(6)
3380    LOCATE 10,20:IF C#(7)>0 THEN PRINT USING "###";PCT#(7)
3390    LOCATE 10,28:IF C#(5)>0 THEN PRINT USING "###";PCT#(5)
3400    LOCATE 10,40:IF C#(10)>0 THEN PRINT USING "###";C#(9)
```

```
3410    LOCATE 10,49:IF C#(10)>0 THEN PRINT USING "###";PCT#(8)
3420    LOCATE 10,59:IF C#(14)>0 THEN PRINT USING "###";PCT#(12)
3430    LOCATE 10,67:IF C#(14)>0 THEN PRINT USING "###";PCT#(13)
3440    LOCATE 10,75:IF C#(25)>0 THEN PRINT USING "###";PCT#(25)
3450    LOCATE 12,33:PRINT "-log ACTIVITY"
3460     COLOR 2,0:LOCATE 13,2:PRINT "Ca        Mg        K         Na         N
H4        Mn        Al        Zn "
3470     COLOR 2,0:LOCATE 15,2:PRINT "Cl        NO3       SO4       H2PO4      H
PO4       HCO3      CO3       F"
3480    FOR X=1 TO 17:IF ANEW#(X)>0 THEN PACT#(X)=-.434*LOG(ANEW#(X))
3490    NEXT X
3500    IF C#(15)>0 THEN PACT#(19)=-.434*LOG(A#(19))
3510    IF C#(16)>0 THEN PACT#(30)=-.434*LOG(A#(30))
3520    IF C#(25)>0 THEN PACT#(25)=-.434*LOG(A#(25))
3530    IF C#(18)>0 THEN PACT#(18)=-.434*LOG(C#(18))
3540    IF C#(8)>0 THEN PACT#(32)=-.434*LOG(10^(-12.36)*A#(8)/H#)
3550    COLOR 6,0
3560    LOCATE 13,5:IF C#(3)>0 THEN PRINT USING "##.##";PACT#(3)
3570    LOCATE 13,15:IF C#(4)>0 THEN PRINT USING "##.##";PACT#(4)
3580    LOCATE 13,25:IF C#(2)>0 THEN PRINT USING "##.##";PACT#(2)
3590    LOCATE 13,37:IF C#(17)>0 THEN PRINT USING "##.##";PACT#(17)
3600    LOCATE 13,48:IF C#(1)>0 THEN PRINT USING "##.##";PACT#(1)
3610    LOCATE 13,58:IF C#(11)>0 THEN PRINT USING "##.##";PACT#(11)
3620    LOCATE 13,68:IF C#(15)>0 THEN PRINT USING "##.##";PACT#(19)
3630    LOCATE 13,76:IF C#(16)>0 THEN PRINT USING "##.##";PACT#(30)
3640    LOCATE 15,5:IF C#(6)>0 THEN PRINT USING "##.##";PACT#(6)
3650    LOCATE 15,15:IF C#(7)>0 THEN PRINT USING "##.##";PACT#(7)
3660    LOCATE 15,25:IF C#(5)>0 THEN PRINT USING "##.##";PACT#(5)
3670    LOCATE 15,37:IF C#(10)>0 THEN PRINT USING "##.##";PACT#(9)
3680    LOCATE 15,48:IF C#(10)>0 THEN PRINT USING "##.##";PACT#(8)
3690    LOCATE 15,58:IF C#(14)>0 THEN PRINT USING "##.##";PACT#(12)
3700    LOCATE 15,68:IF C#(14)>0 THEN PRINT USING "##.##";PACT#(13)
3710    LOCATE 15,76:IF C#(25)>0 THEN PRINT USING "##.##";PACT#(25)
3720    IF DOC=0 THEN GOTO 3880
3730    COLOR 6,0:LOCATE 17,29:PRINT "ORGANIC COMPLEXES, Percent"
3740     COLOR 2,0:LOCATE 18,7:PRINT "Ca       Mg
    Mn        Al        Zn "
3750    FOR II=1 TO 5:PCTML#(II)=((ML1#(II)+ML2#(II))*100):NEXT II
3760    FOR JJ=1 TO 5:IF PCTML#(JJ)<0 THEN PCTML#(JJ)=0:NEXT JJ
3770    IF C#(3)<=0 GOTO 3800
3780    FOR JJ=1 TO 5:IF PCTML#(JJ)<0 THEN PCTML#(JJ)=0:NEXT JJ
3790    PCTML#(1)=PCTML#(1)/C#(3):LOCATE 18,10:COLOR 6,0:PRINT USING "###";PCTML
#(1)
3800    IF C#(4)<=0 GOTO 3820
3810    PCTML#(2)=PCTML#(2)/C#(4):LOCATE 18,20:PRINT USING "###";PCTML#(2)
3820    IF C#(11)<=0 GOTO 3840
3830    PCTML#(3)=PCTML#(3)/C#(11):LOCATE 18,59:PRINT USING "###";PCTML#(3)
3840    IF C#(15)<=0 GOTO 3860
3850    PCTML#(5)=PCTML#(5)/C#(15):LOCATE 18,67:PRINT USING "###";PCTML#(5)
```

```
3860    IF C#(16)<=0 GOTO 3880
3870    PCTML#(4)=PCTML#(4)/C#(16):LOCATE 18,75:PRINT USING "###";PCTML#(4)
3880    COLOR 6,0:LOCATE 24,20:LINE INPUT "DO YOU WISH A HARDCOPY OF THIS SCREEN
? Y/N ";C$
3890    IF C$="Y" OR C$="y" THEN 3900 ELSE 3940
3900    LOCATE 23,10:PRINT "PRINTER ON. HIT ANY KEY, THEN PRINT SCREEN. HIT ANY
KEY TO RESUME."
3910    E$= INKEY$:IF E$="" THEN 3910
3920    LOCATE 23,10:PRINT SPC(70)
3930    F$= INKEY$:IF F$ = "" THEN 3930
3940    LOCATE 23,10:PRINT SPC(70):LOCATE 23,23:LINE INPUT "DO YOU WISH TO CALCU
LATE IAP? Y/N  ";E$
3950    IF E$="Y" OR E$="y" THEN 3960 ELSE 4390
3960    CLS:COLOR 6,0:LOCATE 3,9:PRINT "SOIL SOLUTION"
3970    COLOR 2,0:LOCATE 3,23:PRINT "-- Ion Activity Products"
3980    LOCATE 5,15:PRINT "Problem: ":COLOR 6,0:LOCATE 5,24:PRINT D$
3990    LOCATE 7,13:PRINT "[IAP]       p[IAP]   Reference Mineral    pK    Diseq
uil. Index"
4000    COLOR 2,0
4010    LOCATE 9,5:PRINT "(Al)2(OH)6(H4SiO4)2":LOCATE 9,35:PRINT "Kaolinite
     76.4"
4020    LOCATE 10,5:PRINT "(Al)(OH)3":LOCATE 10,35:PRINT "Crypto. Gibbsite   32.
8"
4030    LOCATE 11,5:PRINT "(Al)4(OH)10(SO4)":LOCATE 11,35:PRINT "Basaluminite
   117.6"
4040    LOCATE 12,5:PRINT "(K)(AL)3(OH)6(SO4)2":LOCATE 12,35:PRINT "Alunite
       85.4"
4050    LOCATE 13,5:PRINT "(Al)(H2PO4)(OH)2":LOCATE 13,35:PRINT "Variscite
    30.5"
4060    LOCATE 14,5:PRINT "(Ca)5(OH)(PO4)3":LOCATE 14,35:PRINT "Hydroxyapatite
   55.9"
4070    LOCATE 15,5:PRINT "(Al)3.77(H4SiO4)3.24(K)0.24(Ca)0.08(Fe)0.24(Mg)0.20(O
H)12.83"
4080    LOCATE 16,35:PRINT "HIV                159.5"
4090    COLOR 6,0
4100    IF PACT#(19)<=0 THEN 4310
4110    IF PCONC#(18)<=0 THEN 4170
4120   IAP#(1)=2*PACT#(19)+6*(14-PH)+2*PCONC#(18):DEQ#(1)=PK#(1)-IAP#(1)
4130    LOCATE 9,26:PRINT USING "###.#";IAP#(1):LOCATE 9,66:PRINT USING "###.##"
;DEQ#(1)
4140    PFE=(3*PH)-.02
4150    IAP#(7)=(3.77*PACT#(19))+(3.24*PCONC#(18))+(.24*PACT#(2))+(.08*PACT#(3))
+(.24*PFE)+(.2*PACT#(4))+(12.83*(14-PH)):DEQ#(7)=PK#(7)-IAP#(7)
4160    LOCATE 16,26:PRINT USING "###.#";IAP#(7):LOCATE 16,66:PRINT USING "###.#
#";DEQ#(7)
4170    IAP#(2)=PACT#(19)+3*(14-PH):DEQ#(2)=PK#(2)-IAP#(2)
4180    LOCATE 10,26:PRINT USING "###.#";IAP#(2):LOCATE 10,66:PRINT USING "###.#
#";DEQ#(2)
4190    IF PACT#(5)<=0 THEN 4220
4200    IAP#(3)=4*PACT#(19)+10*(14-PH)+PACT#(5):DEQ#(3)=PK#(3)-IAP#(3)
```

```
4210    LOCATE 11,26:PRINT USING "###.#";IAP#(3):LOCATE 11,66:PRINT USING "###.#
#";DEQ#(3)
4220    IF PACT#(2)<=0 THEN 4250
4230    IAP#(4)=PACT#(2)+3*PACT#(19)+6*(14-PH)+2*PACT#(5):DEQ#(4)=PK#(4)-IAP#(4)

4240    LOCATE 12,26:PRINT USING "###.#";IAP#(4):LOCATE 12,66:PRINT USING "###.#
#";DEQ#(4)
4250    IF PACT#(9)<=0 THEN 4300
4260    IAP#(5)=PACT#(19)+PACT#(9)+2*(14-PH):DEQ#(5)=PK#(5)-IAP#(5)
4270    IAP#(6)=5*PACT#(3)+(14-PH)+3*PACT#(32):DEQ#(6)=PK#(6)-IAP#(6)
4280    LOCATE 14,26:PRINT USING "###.#";IAP#(6):LOCATE 14,66:PRINT USING "###.#
#";DEQ#(6)
4290    LOCATE 13,26:PRINT USING "###.#";IAP#(5):LOCATE 13,66:PRINT USING "###.#
#";DEQ#(5)
4300    GOTO 4320
4310    LOCATE 22,29:PRINT "Insufficient Input Data"
4320    COLOR 6,0:LOCATE 24,20:LINE INPUT "DO YOU WISH A HARDCOPY OF THIS SCREEN
? Y/N ";C$
4330    IF C$="Y" OR C$="y" THEN 4340 ELSE 4380
4340    LOCATE 23,10:PRINT "PRINTER ON. HIT ANY KEY, THEN PRINT SCREEN. HIT ANY
KEY TO RESUME."
4350    E$= INKEY$:IF E$="" THEN 4350
4360    LOCATE 23,10:PRINT SPC(70)
4370    F$= INKEY$:IF F$ = "" THEN 4370
4380    CLS
4390    COLOR 6,0:LOCATE 24,32:LINE INPUT "DO YOU WISH TO MODIFY DATA AND RERUN?
 Y/N ";C$
4400    IF C$="Y" OR C$="y" THEN 4410 ELSE 4930
4410    CLS:COLOR 6,0:LOCATE 3,9:PRINT "SOIL SOLUTION"
4420    LOCATE 4,57:PRINT "INPUT FORMAT"
4430    LOCATE 5,59:PRINT "<=20 char":LOCATE 5,15:PRINT "Problem Identification:
 ":COLOR 2,0:LOCATE 5,39:PRINT D$
4440    COLOR 6,0:LOCATE 7,61:PRINT "xx.xx":LOCATE 7,35:PRINT "pH: ":LOCATE 7,38
:COLOR 2,0:PRINT PH
4450    COLOR 6,0:LOCATE 8,61:PRINT "dS/m":LOCATE 8,35:PRINT "EC: ":LOCATE 8,38:
COLOR 2,0:PRINT EC
4460    COLOR 6,0:LOCATE 13,30:PRINT "mmol/L":LOCATE 13,15:PRINT "Ca: ":LOCATE 1
3,18:COLOR 2,0:PRINT CA
4470    COLOR 6,0:LOCATE 14,15:PRINT "Mg: ":LOCATE 14,18:COLOR 2,0:PRINT MG
4480    COLOR 6,0:LOCATE 15,16:PRINT "K: ":LOCATE 15,18:COLOR 2,0:PRINT K
4490    COLOR 6,0:LOCATE 16,15:PRINT "Na: ":LOCATE 16,18:COLOR 2,0:PRINT NA
4500    COLOR 6,0:LOCATE 17,14:PRINT "NH4: ":LOCATE 17,18:COLOR 2,0:PRINT NHT
4510    COLOR 6,0:LOCATE 18,15:PRINT "Mn: ":LOCATE 18,18:COLOR 2,0:PRINT MN
4520    COLOR 6,0:LOCATE 19,15:PRINT "Zn: ":LOCATE 19,18:COLOR 2,0:PRINT ZN
4530    COLOR 6,0:LOCATE 20,15:PRINT "Al: ":LOCATE 20,18:COLOR 2,0:PRINT AL
4540    COLOR 6,0:LOCATE 13,60:PRINT "mmol/L":LOCATE 13,45:PRINT "Si: ":LOCATE 1
3,48:COLOR 2,0:PRINT SIT
4550    COLOR 6,0:LOCATE 14,45:PRINT "Cl: ":LOCATE 14,48:COLOR 2,0:PRINT CL
```

```
4560    COLOR 6,0:LOCATE 15,46:PRINT "P: ":LOCATE 15,48:COLOR 2,0:PRINT P
4570    COLOR 6,0:LOCATE 16,44:PRINT "NO3: ":LOCATE 16,48:COLOR 2,0:PRINT NO3
4580    COLOR 6,0:LOCATE 17,44:PRINT "SO4: ":LOCATE 17,48:COLOR 2,0:PRINT SO4
4590    COLOR 6,0:LOCATE 18,46:PRINT "F: ":LOCATE 18,48:COLOR 2,0:PRINT F
4600    COLOR 6,0:LOCATE 19,44:PRINT "DOC: ":LOCATE 19,48:COLOR 2,0:PRINT DOC
4610    COLOR 6,0:LOCATE 20,62:PRINT "atm":LOCATE 20,44:PRINT "CO2: ":LOCATE 20,
48:COLOR 2,0:PRINT CO2
4620    LOCATE 23,32:PRINT SPC(40):COLOR 6,0:LOCATE 23,32:INPUT "ENTER DATA TO B
E CHANGED: ",P$
4630    LOCATE 23,32:PRINT SPC(40)
4640  LOCATE 23,32:IF P$="pH" THEN INPUT "pH: ",PH:LOCATE 7,38:COLOR 7,0:PRINT P
H
4650    LOCATE 23,32:IF P$="Ca" THEN INPUT "Ca: ",CA:LOCATE 13,18:COLOR 7,0:PRIN
T CA
4660    LOCATE 23,32:IF P$="Mg" THEN INPUT "Mg: ",MG:LOCATE 14,18:COLOR 7,0:PRIN
T MG
4670    LOCATE 23,32:IF P$="K" THEN INPUT "K: ",K:LOCATE 15,18:COLOR 7,0:PRINT K

4680    LOCATE 23,32:IF P$="Na" THEN INPUT "Na: ",NA:LOCATE 16,18:COLOR 7,0:PRIN
T NA
4690    LOCATE 23,32:IF P$="NH4" THEN INPUT "NH4: ",NHT:LOCATE 17,18:COLOR 7,0:P
RINT NHT
4700    LOCATE 23,32:IF P$="Mn" THEN INPUT "Mn: ",MN:LOCATE 18,18:COLOR 7,0:PRIN
T MN
4710    LOCATE 23,32:IF P$="Zn" THEN INPUT "Zn: ",ZN:LOCATE 19,18:COLOR 7,0:PRIN
T ZN
4720    LOCATE 23,32:IF P$="Al" THEN INPUT "Al: ",AL:LOCATE 20,18:COLOR 7,0:PRIN
T AL
4730    LOCATE 23,32:IF P$="Si" THEN INPUT "Si: ",SIT:LOCATE 13,48:COLOR 7,0:PRI
NT SIT
4740    LOCATE 23,32:IF P$="Cl" THEN INPUT "Cl: ",CL:LOCATE 14,48:COLOR 7,0:PRIN
T CL
4750    LOCATE 23,32:IF P$="P" THEN INPUT "P: ",P:LOCATE 15,48:COLOR 7,0:PRINT P

4760    LOCATE 23,32:IF P$="NO3" THEN INPUT "NO3: ",NO3:LOCATE 16,48:COLOR 7,0:P
RINT NO3
4770    LOCATE 23,32:IF P$="SO4" THEN INPUT "SO4: ",SO4:LOCATE 17,48:COLOR 7,0:P
RINT SO4
4780    LOCATE 23,32:IF P$="F" THEN INPUT "F: ",F:LOCATE 18,48:COLOR 7,0:PRINT F

4790    LOCATE 23,32:IF P$="DOC" THEN INPUT "DOC: ",DOC:LOCATE 19,48:COLOR 7,0:P
RINT DOC
4800    LOCATE 23,32:IF P$="CO2" THEN INPUT "CO2: ",CO2:LOCATE 20,48:COLOR 7,0:P
RINT CO2
```

```
4810    LOCATE 23,32:PRINT SPC(40):COLOR 6,0:LOCATE 23,32:INPUT "CHANGE ADDITION
AL DATA? Y/N ";S$
4820    IF S$="Y" OR S$="y" THEN GOTO 4620 ELSE 4830
4830    ERASE A#,C#,F#,CNEW#,ANEW#,PAIR#,LOGF#,CHOL#,PCONC#,PPAIR#,PCT#,PACT#,IA
P#,DEQ#,FU#,ML1#,ML2#,METAL#,PCTML#,CONV#,CC#,AA#,LLOGF#,FF#,PPCONC#
4840    FREEF#=0:PDOC#=0
4850    COLOR 6,0:LOCATE 23,20:LINE INPUT "DO YOU WISH A HARDCOPY OF THIS SCREEN
? Y/N ";C$
4860    IF C$="Y" OR C$="y" THEN 4870 ELSE 4910
4870    LOCATE 23,10:PRINT "PRINTER ON. HIT ANY KEY, THEN PRINT SCREEN. HIT ANY
KEY TO RESUME."
4880   E$= INKEY$:IF E$="" THEN 4880
4890  LOCATE 23,10:PRINT SPC(70)
4900   F$= INKEY$:IF F$ = "" THEN 4900
4910   CLS
4920    GOTO 750
4930    COLOR 6,0:LOCATE 24,32:LINE INPUT "DO YOU WISH TO RUN ANOTHER PROBLEM? Y
/N ";C$
4940    IF C$="Y" OR C$="y" THEN 370 ELSE 4950
4950    SYSTEM
4960    METAL#(1)=CNEW#(3):METAL#(2)=CNEW#(4):METAL#(3)=CNEW#(11):METAL#(4)=CNEW
#(16):METAL#(5)=C#(15)
4970    FOR Y=1 TO 4
4980    ML1#(Y)=(10^(KLOG1#(Y)))*METAL#(Y)*FU#(1)
4990    NEXT Y
5000    FOR Z=1 TO 4
5010    ML2#(Z)=(10^(KLOG2#(Z)))*METAL#(Z)*FU#(2)
5020    NEXT Z
5030    RETURN
```

SoilSoln.Doc

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SOIL SOLUTION -- Copy Request and Registration

Please send a copy of Soil Solution [SoilSoln.Bas] with documentation to:

My primary application of SOIL SOLUTION will be for:

----- Teaching
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Send requests to:

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PO Box 1071
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