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

University of Tennessee Agricultural Experiment Station

Jeff Wolt

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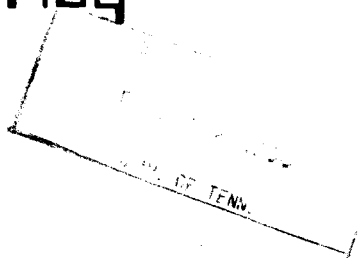
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STACKS

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



*Jeff Wolt*

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**Documentation, Source Code,**  
**and Program Key**  
**Version 1.4**

**Jeff Wolt**  
**University of Tennessee**  
**Knoxville, TN**

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### Documentation

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Soil Solution [SOILSOLN.BAS]

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

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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, NH<sub>4</sub>, Mn, Zn, Al, Si, Cl, P, NO<sub>3</sub>, SO<sub>4</sub>, F, DOC, and CO<sub>2</sub> (atm). NH<sub>4</sub> represents total ammoniacal N and is used to calculate NH<sub>4</sub> and NH<sub>3</sub>. HPO<sub>4</sub> and H<sub>2</sub>PO<sub>4</sub> are calculated from P and pH. CO<sub>3</sub> and HCO<sub>3</sub> are calculated from CO<sub>2</sub> 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 indices are computed for selected mineral species. Percent organic complexes are computed when DOC is included in the input data.

## 2.0 History

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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 NH<sub>4</sub> and H<sub>4</sub>SiO<sub>4</sub>, 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 indices 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 NH<sub>4</sub> 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, H<sub>4</sub>SiO<sub>4</sub> is calculated from this value and

pH. When P is input, the concentration is initially distributed equally between  $\text{HPO}_4$  and  $\text{H}_2\text{PO}_4$ . In subsequent iterations, the equilibrium distribution of phosphate ions is calculated dependent on total P and pH. When  $\text{CO}_2(\text{g})$  is input, the distribution of  $\text{CO}_3$  and  $\text{HCO}_3$  is calculated using pH and the partial pressure of  $\text{CO}_2$ . 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  $\pm 1\%$  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  $\text{CO}_2(\text{g})$ , 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]  
 (NaSO4) = (Na)(SO4)/0.24 [7]  
 (CaSO4) = (Ca)(SO4)/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]

$(\text{CaHCO}_3) = (\text{Ca})(\text{HCO}_3)/0.055$  [1]  
 $(\text{MgHCO}_3) = (\text{Mg})(\text{HCO}_3)/0.069$  [1]  
 $(\text{AlSO}_4) = (\text{Al})(\text{SO}_4)/0.000631$  [1]  
 $(\text{AlH}_2\text{PO}_4) = (\text{Al})(\text{H}_2\text{PO}_4)/0.001$  [3]  
 $(\text{AlF}) = (\text{Al})(\text{F})(10^{\text{exp}6.98})$  [7]  
 $(\text{AlF}_2) = (\text{Al})(\text{F})^2(10^{\text{exp}12.6})$  [7]  
 $(\text{AlF}_3) = (\text{Al})(\text{F})^3(10^{\text{exp}16.65})$  [7]  
 $(\text{ZnSO}_4) = (\text{Zn})(\text{SO}_4)/0.00468$  [7]  
 $(\text{ZnHPO}_4) = (\text{Zn})(\text{H}_2\text{PO}_4)(10^{\text{exp}-3.9})/(\text{H})$  [7]  
 $(\text{ZnH}_2\text{PO}_4) = (\text{Zn})(\text{H}_2\text{PO}_4)/0.0251$  [7]

#### 4.6 Hydrolytic Species

$(\text{AlOH}) = (\text{Al})/(10^{\text{exp}5.01})(\text{H})$  [1]  
 $(\text{Al}(\text{OH})_2) = (\text{Al})/(10^{\text{exp}8.7})(\text{H})^2$  [8]  
 $(\text{Al}(\text{OH})_3) = (\text{Al})/(10^{\text{exp}15.2})(\text{H})^3$  [8]  
 $(\text{Al}(\text{OH})_4) = (\text{Al})/(10^{\text{exp}23.33})(\text{H})^4$  [7]  
 $(\text{ZnOH}) = (\text{Zn})/(10^{\text{exp}7.69})(\text{H})$  [7]  
 $(\text{Zn}(\text{OH})_2) = (\text{Zn})/(10^{\text{exp}16.8})(\text{H})^2$  [7]

#### 4.7 Beta Values (x 10<sup>exp</sup>8)

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:

$$\text{pFe} = 0.02 + 3\text{pH}$$

#### 4.9 Fulvate Models

For DOC (mmol/L): [10]

$$\text{Fu\#1} = (.10957)(\text{DOC})(.09)/1000$$

$$\text{Fu\#2} = (.10957)(\text{DOC})(.91)/1000$$

$$\text{Fu\#3} = (.10957)(\text{DOC})/1000$$

For M++:

$$\text{ML} = (10^{\text{exp}(\log K)})(\text{M}^{++})(\text{Fu})$$

Where M++ =

	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:

$$\text{ML\#1} = (.346)(\text{Al})(\text{Fu\#3})/\text{H}$$

[9]



$$ML\#2 = (.240)(A1)(Fu\#3)/H$$

## 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 indices will also be output.

The Disequilibria Index =  $\log(IAP/K_{sp})$ . 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

<u>I=</u>	<u>C#(I) or CNEW#(I)</u>	<u>B#(I)</u>	<u>V#(I)</u>
1	NH <sub>4</sub> /1000	2.5	1
3	K/1000	3	1
4	Mg/1000	8	2
5	SO <sub>4</sub> /1000	4	2
6	Cl/1000	3	2
7	NO <sub>3</sub>	3	1
8	HPO <sub>4</sub>	4	1

9	$\text{H}_2\text{PO}_4$	4.5	1
10	P/1000	0	0
11	Mn/1000	6	2
12	$\text{HCO}_3$	4.5	1
13	$\text{CO}_3$	4.5	2
14	$\text{CO}_2$	0	0
15	Al/1000	9	3
16	Zn/1000	6	2
17	Na/1000	4.5	1
18	$\text{H}_4\text{SiO}_4/1000$	0	0
19	$\text{Al}^{3+}$		
20	$\text{Al}(\text{OH})^{2+}$		
21	$\text{Al}(\text{OH})_2^{1+}$		
22	$\text{Al}(\text{OH})_3^{\circ}$		

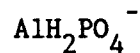
## ION PAIR ASSIGNMENT

Pair#(26) =	$\text{AlCl}^{+2}$
Pair#(27) =	$\text{AlH}_2\text{PO}_4^{+2}$
Pair#(28) = A# (15) * A# (5)/.000631	$\text{AlSO}_4^{+}$
Pair#(29) = A# (16) * A# (9)/.0251	$\text{ZnH}_2\text{PO}_4^{+}$
Pair#(30) = A# (16) * A# (5)/.00468	$\text{ZnSO}_4^{\circ}$
Pair#(31) = A# (16) * A# (9) * 10 exp (-3.9)/H#	$\text{ZnHPO}_4^{\circ}$
Pair#(32) = A# (17) * A# (5)/.24	$\text{NaSO}_4^{-}$

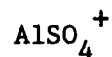
## Al SUBROUTINE

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

C#(23)



C#(24)



C#(25)

F

C#(26)



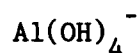
C#(27)



C#(28)



C#(29)



## ZINC SUBROUTINE

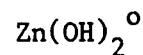
C#(30)



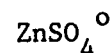
C#(31)



C#(32)



CC#(2)

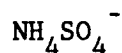


CC#(3)



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

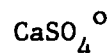
Pair#(1) = A# (1) \* A# (5)/0.0793



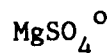
Pair#(2) = A# (2) \* A# (5)/0.11



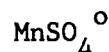
Pair#(3) = A# (3) \* A# (5)/0.00525



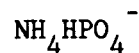
Pair#(4) = A# (4) \* A# (5)/0.0059



Pair#(5) = A# (11)\* A# (5)/0.00525



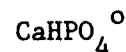
Pair#(6) =



Pair#(7) =



Pair#(8) = A# (3) \* A# (8)/0.00198



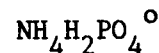
Pair#(9) = A# (4) \* A# (8)/0.00316



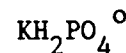
Pair#(10) =



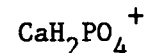
Pair#(11) =



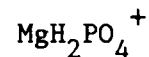
Pair#(12) =



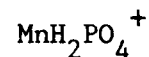
Pair#(13) = A# (3) \* A# (9)/0.083



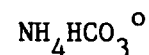
Pair#(14) = A# (4) \* A# (9)/0.1



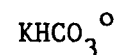
Pair#(15) =



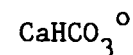
Pair#(16) =



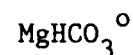
Pair#(17) =



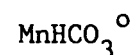
Pair#(18) = A# (3) \* (12)/0.055



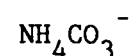
Pair#(19) = A# (4) \* (12)/0.069



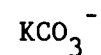
Pair#(20) =



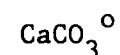
Pair#(21) =



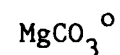
Pair#(22) =



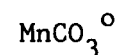
Pair#(23) =



Pair#(24) =



Pair#(25) =



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
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- [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

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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.

	Input Data	Output Data [-log Free Ion Concentration]	
		Soil Solution	Geochem
H	pH 5.60 mmol/L	5.60	5.60
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

Problem Identification: Grenada

## INPUT FORMAT

&lt;=20 char

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

	Free	Cl	NO3	SO4	H2PO4	HP04	HC03	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.



SOIL SOLUTION

Problem Identification: Grenada

INPUT FORMAT  
 <=20 char

pH: 5.01  
 EC: .161

xx.xx  
 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

ENTER DATA TO BE CHANGED:

Screen 5: Data modification.

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

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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
1"
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
$

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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 1,1,0,0,0,1,1,0,0,0,0,0,1,1,1,0,0,1,1,1,1,0,0,0,2,2,1,1,0,0,0
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

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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

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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 PCONC*(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"

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```

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:CO
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)

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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 "H4SiO4":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)

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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)

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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)

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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

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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:

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My primary application of SOIL SOLUTION will be for:

----- Teaching  
----- Research  
----- Reference/Evaluation  
----- Other

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Send requests to:

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

Please submit a blank diskette along with requests.