

Sample...259543 pH = 9.1 Water-soluble ions: Percent CaO.....0.001 MgO......001 Na <sub>2</sub> O......084 K <sub>2</sub> O......001 SO <sub>3</sub> ......041 Fe <sub>2</sub> O <sub>3</sub> ..... Relative amounts of clay minerals: Montmorillonite...33 Mixed-layer.....43 Illite.....17 Chlorite.....3 Kaolinite.....4 Total clay.....75 Total minerals.....94	Interlayer							Octahedral					Tetrahedral						
	(K <sub>0.50</sub> Na <sub>0.52</sub> Ca <sub>0.14</sub> Mg Al H ) <sub>1.16</sub>	(Al <sub>2.57</sub> Ti <sub>0.08</sub> Fe <sup>+3</sup> <sub>0.52</sub> Fe <sup>+2</sup> <sub>0.17</sub> Mn <sub>0.01</sub> Mg <sub>0.50</sub> ) <sub>3.84</sub>	(Al <sub>0.25</sub> Si <sub>7.75</sub> ) <sub>8</sub>	O <sub>20</sub>	(OH, F <sub>0.06</sub> ) <sub>4</sub>	Calculations for structural formula for montmorillonite and mixed-layer clay													
Apatite = 2.64 x P <sub>2</sub> O <sub>5</sub> [ $>0.5$ percent] CaO = 1.45 x P <sub>2</sub> O <sub>5</sub> F = 0.11 x P <sub>2</sub> O <sub>5</sub> CO <sub>2</sub> = 0.08 x P <sub>2</sub> O <sub>5</sub>	Barite = 1.52 x BaO [ $>0.5$ percent] S = 0.23 x BaO	Pyrite = 1.87 x S FeO = 1.12 x S	Water-soluble ions [ $>0.5$ percent]	Gypsum = 2.15 x SO <sub>3</sub> CaO = 0.70 x SO <sub>3</sub> H <sub>2</sub> O+ = 0.45 x SO <sub>3</sub>	Jarosite <sup>1</sup> or Alunite <sup>2</sup>	Calcite = 2.27 x CO <sub>2</sub> CaO = 1.27 x CO <sub>2</sub>	Dolomite = 2.10 x CO <sub>2</sub> (or other CaO = 0.64 x CO <sub>2</sub> carbonates <sup>3</sup> ) MgO = 0.46 x CO <sub>2</sub>	Potassium feldspar <sup>4</sup> Plagioclase <sup>5</sup>	Clinoptilolite <sup>6</sup>	Quartz Cristobalite	Kaolinite [percent] Al <sub>2</sub> O <sub>3</sub> = 40 SiO <sub>2</sub> = 46 H <sub>2</sub> O+ = 14	Chlorite [percent] FeO = 21 SiO <sub>2</sub> = 29 MgO = 21 Al <sub>2</sub> O <sub>3</sub> = 17 H <sub>2</sub> O+ = 12	Illite [percent] Al <sub>2</sub> O <sub>3</sub> = 27 SiO <sub>2</sub> = 53 Fe <sub>2</sub> O <sub>3</sub> = 4 TiO <sub>2</sub> = 1 FeO = 1 MgO = 2 K <sub>2</sub> O = 7 H <sub>2</sub> O+ = 5	Remaining constituents: Montmorillonite and mixed-layer clay (obtained by difference)	Molecular weight: of oxide divided by cations per molecule, equals - Cation equivalents, times - Valence, equals - Charge equivalents Cations per unit cell (f x cation equivalents)				
Amounts, in percent (X-ray)			?					1	1	16	3	2	13						
SiO <sub>2</sub> 60.23								(58.97) <sup>7</sup> 1.26	(58.27) 0.70	(42.27) 16.00	(40.89) 1.38	(40.31) .58	(33.42) 6.89	33.42	60.1	0.556	4	2.224	7.75
TiO <sub>2</sub> .61													(.48) .13	.48	79.9	.006	4	.024	.08
Al <sub>2</sub> O <sub>3</sub> 15.92								(15.48) .44	(15.37) .11	(14.17) 1.20	(13.83) .34	(10.32) 3.51	10.32	51.0	.202	3	.606	2.82	
Fe <sub>2</sub> O <sub>3</sub> 3.46													(2.94) .52	2.94	79.9	.037	3	.111	.52
FeO 2.37												(1.01) .42	(.88) .13	.88	71.9	.012	2	.024	.17
MnO .04														.04	70.9	.001	2	.002	.01
MgO 2.12												(1.70) .42	(1.44) .26	1.44	40.3	.036	2	.072	.50
CaO .91				(0.87) 0.04	(0.63) 0.24	(.57) .06								.57	56.1	.010	2	.020	.14
Na <sub>2</sub> O 1.27						(1.19) .08	(1.15) .04							1.15	31.0	.037	1	.037	.52
K <sub>2</sub> O 2.79						(2.63) .16	(2.61) .02					(1.70) .91		1.70	47.1	.036	1	.036	.50
H <sub>2</sub> O - 2.95														2.95	f = $\frac{3.156}{44 \text{ charges per unit cell charge equivalents}}$ = 13.94				
H <sub>2</sub> O + 5.19				(5.16) .03	(.03)			(5.03) .13		(4.61) .42	(4.37) .24	(3.72) .65	3.72						
F .07														.07	19.0	0.004			0.06
CO <sub>2</sub> .19						.19													
P <sub>2</sub> O <sub>5</sub> .13																			
SO <sub>3</sub> .06					.06														
S .84				.84															
BaO .13																			
Total 99.28				1.78	.13	.43		2.00	1.00	16.00	3.00	2.00	13.00	59.68					

Organic matter 1.5 percent

<sup>1</sup>Jarosite = 3.03 x SO<sub>3</sub>  
Fe<sub>2</sub>O<sub>3</sub> = 1.49 x SO<sub>3</sub>  
Na<sub>2</sub>O = 0.03 x SO<sub>3</sub>  
K<sub>2</sub>O = 0.15 x SO<sub>3</sub>  
H<sub>2</sub>O+ = 0.36 x SO<sub>3</sub>

<sup>2</sup>Alunite = 2.59 x SO<sub>3</sub>  
Al<sub>2</sub>O<sub>3</sub> = 0.95 x SO<sub>3</sub>  
K<sub>2</sub>O = 0.29 x SO<sub>3</sub>  
H<sub>2</sub>O+ = 0.34 x SO<sub>3</sub>

<sup>3</sup>Weight percent CaO:MgO:FeO = 35:2:3 for mixed calcite, 3:2:15 for siderite, 2:1:2 for rhodochrosite

<sup>4</sup>Potassium feldspar,  
in percent  
SiO<sub>2</sub> = 65  
Al<sub>2</sub>O<sub>3</sub> = 18  
K<sub>2</sub>O = 17

<sup>5</sup>Plagioclase,  
in percent  
SiO<sub>2</sub> = 61  
Al<sub>2</sub>O<sub>3</sub> = 25  
CaO = 6  
Na<sub>2</sub>O = 8

<sup>6</sup>Clinoptilolite,  
in percent  
SiO<sub>2</sub> = 70  
Al<sub>2</sub>O<sub>3</sub> = 11  
Na<sub>2</sub>O = 4  
K<sub>2</sub>O = 2  
H<sub>2</sub>O+ = 13

<sup>7</sup>Figures within parentheses represent remainder of sample after the amount of a particular mineral is determined

WORKSHEET FOR CHEMICAL-MINERALOGICAL CALCULATIONS ILLUSTRATED WITH  
DATA FOR SAMPLE 259543 (SEE FIGURE 3 FOR X-RAY DATA)