APPENDIX A: PHYSICAL PROPERTIES

Test series	Note	Series 1	Series 1	Series 1	Series 2	Series 2	Series 2
Layer		TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Reference		MIN31	MIN32	MIN33	MIN12	MIN13	MIN14
Pressure drop [mmH2O]		1100	1100	1100	1500	1500	1500
Tumbler test							
Tumbler index %+6.30mm	1	46.12	61.39	68.80	42.80	60.60	72.10
Tumbler index %-6.30+0.50mm	2	49.89	34.00	26.50	53.30	35.10	23.30
Abrasive index %-0.50mm	3	3.99	4.61	4.70	3.90	4.30	4.60
Sieve analyses (%)							
+40		1.40	6.23	14.90	0.00	2.55	5.01
-40+25		4.66	18.97	24.20	3.27	13.00	10.49
-25+16		18.72	27.30	24.53	12.56	29.73	19.15
-16+12.5		13.33	11.98	9.15	12.41	12.90	16.78
-12.5+10		11.60	7.75	6.60	12.52	9.47	11.49
-10+5		32.88	16.49	12.11	39.64	20.92	23.23
-5		17.42	11.27	8.52	19.59	11.43	13.85
Mean particle size							
Mean particle size [mm]		11.97	18.37	22.41	10.20	15.96	15.18
Mean particle size [mm] of +5mm fraction		13.75	20.25	24.17	11.82	17.57	17.05

Notes:

1. Std. Deviation: 0.32%
2. Std. Deviation: 0.31%
3. Std. Deviation: 0.13%

APPENDIX B: CHEMICAL ANALYSIS (%)

Test series	Note	Series 1	Series 1	Series 1	Series 2	Series 2	Series 2
Layer		TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Reference		MIN31	MIN32	MIN33	MIN12	MIN13	MIN14
Pressure drop [mmH2O]		1100	1100	1100	1500	1500	1500
Fe(tot)	1	53.30	53.20	52.80	52.10	52.30	52.50
Fe(met)	1	0.25	0.12	0.07	0.01	0.03	0.03
FeO	1	6.55	6.82	6.99	6.02	6.49	6.59
Fe2O3	1	68.60	68.30	67.60	67.80	67.50	67.60
CaO	1	11.90	12.10	12.40	12.50	12.50	12.60
MgO	1	2.66	2.75	2.78	2.71	2.72	2.74
SiO2	1	6.03	6.12	6.33	5.81	5.88	5.88
Al2O3	1	1.93	2.03	2.10	2.04	2.06	2.02
K2O	1	0.04	0.03	0.04	0.10	0.08	0.08
Na2O	1	0.04	0.04	0.04	0.02	0.02	0.02
MnO	1	1.34	1.24	1.31	1.34	1.29	1.28
TiO2	1	0.13	0.13	0.15	0.12	0.13	0.12
P	1	0.05	0.06	0.06	0.07	0.08	0.07
S	1	0.030	0.020	0.020	0.025	0.025	0.022
C	1	0.31	0.25	0.16	0.23	0.20	0.26
CaO/SiO2		1.97	1.98	1.96	2.15	2.13	2.14

Notes:

1. Std. Deviation: 0.5%

APPENDIX C: PHASE ANALYSIS (vol%)

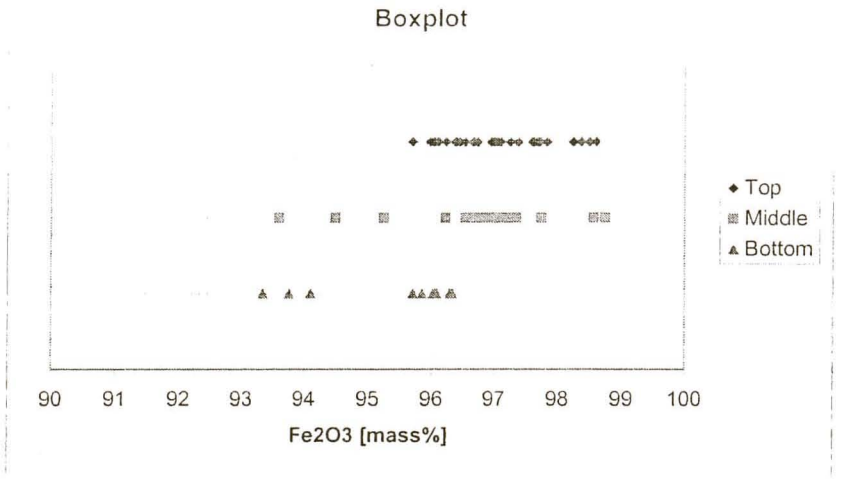
Test series	Note	Series 1	Series 1	Series 1	Series 2	Series 2	Series 2
Layer		TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Reference		MIN31	MIN32	MIN33	MIN12	MIN13	MIN14
Pressure drop [mmH2O]		1100	1100	1100	1500	1500	1500
Magnetite	1	27.60	29.00	32.80	29.80	22.00	22.20
Massive Hematite	1	18.60	8.60	8.60	19.40	26.00	23.60
Crystalline Hematite	1	6.60	9.00	6.60	7.20	6.90	6.70
Secondary Hematite	1	0.20	0.60	0.20	0.10	0.10	0.20
Total Hematite		25.40	18.20	15.40	26.70	33.00	30.50
Columnar SFCA	1	5.80	10.80	8.40	3.00	4.00	7.30
Acicular SFCA	1	24.60	28.80	26.40	25.80	26.50	30.20
Dendritic SFCA	1	5.40	4.00	5.00	4.80	4.40	2.30
Total SFCA		35.80	43.60	39.80	33.60	34.90	39.80
Ca-Silicate	2	3.00	5.00	6.80	3.40	3.10	3.30
Glass	2	4.60	3.40	3.00	3.70	2.20	1.90
Periclase	2	2.40	0.60	2.00	1.80	3.80	1.20
Wustite	2	1.00	0.00	0.00	0.10	0.20	0.20
Manganosite	2	0.20	0.20	0.20	0.40	0.50	0.10

Notes:
1. Std. Deviation: 1.0%
2. Std. Deviation: 0.5%

Magnification: 40x
More than 1000 points counted over sample area in steps of 2um.

APPENDIX D: HEMATITE - HYPOTHESIS TESTS

HEMATITE SERIES 2 (1500mmH2O)



Anova: Single Factor

SUMMARY

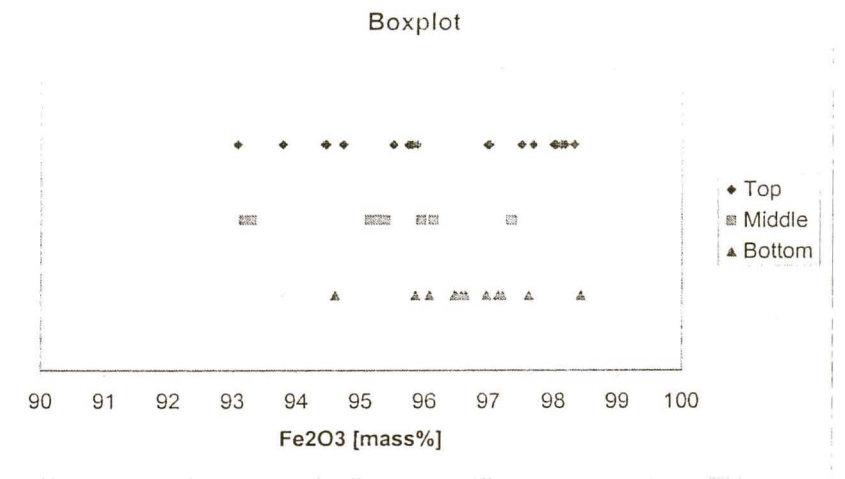
Groups	*Count*	*Sum*	*Average*	*Variance*
Top	28	2716.886	97.03163	0.669867
Middle	25	2392.743	95.70974	14.6318
Bottom	10	953.5019	95.35019	1.31748

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	32.49411	2	16.24706	2.557873	0.085893	3.150411
Within Groups	381.107	60	6.351784			
Total	413.6011	62				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3 content of the different samples

HEMATITE SERIES 1 (1100mmH2O)



Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Top	21	2033.004	96.80971	4.376214
Middle	10	954.2147	95.42147	2.001166
Bottom	12	1159.979	96.66489	0.904577

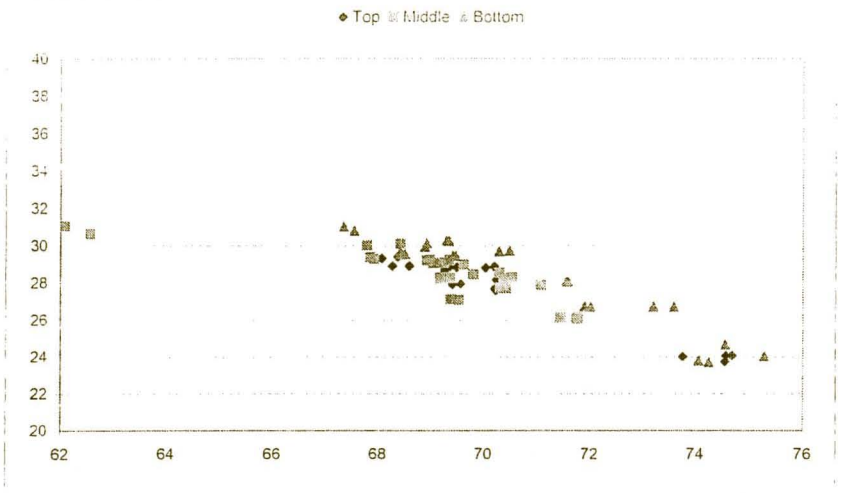
ANOVA

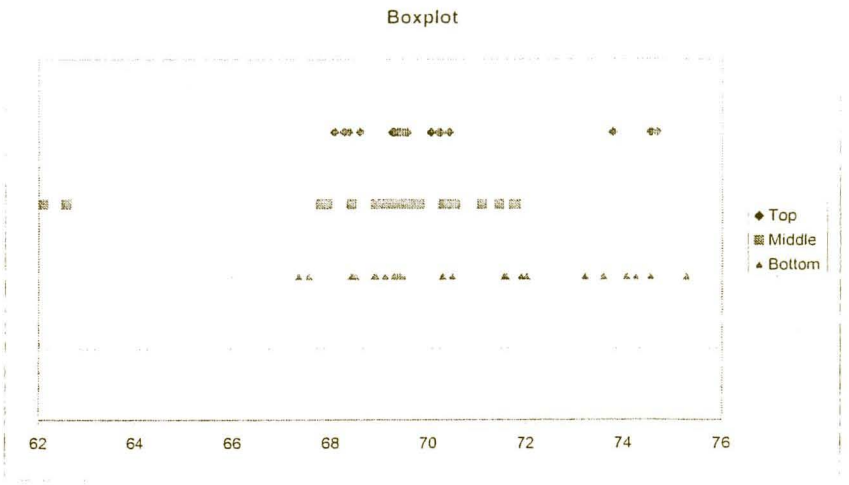
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	13.84959	2	6.924797	2.398507	0.103805	3.231733
Within Groups	115.4851	40	2.887128			
Total	129.3347	42				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3 content of the different samples

APPENDIX E: MAGNETITE - HYPOTHESIS TESTS

MAGNETITE SERIES 1 (1100mmH2O)





Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Top	20	1408.525	70.42624	4.650113
Middle	30	2077.683	69.25609	4.769674
Bottom	26	1835.124	70.58169	5.533724

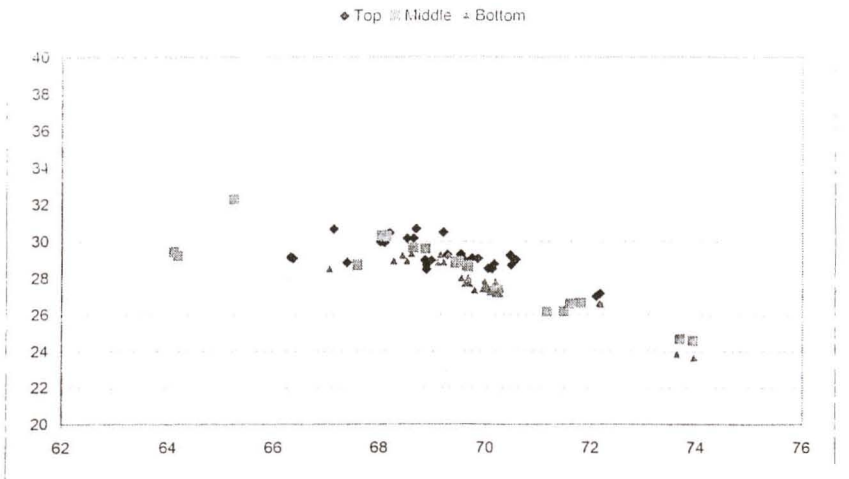
ANOVA

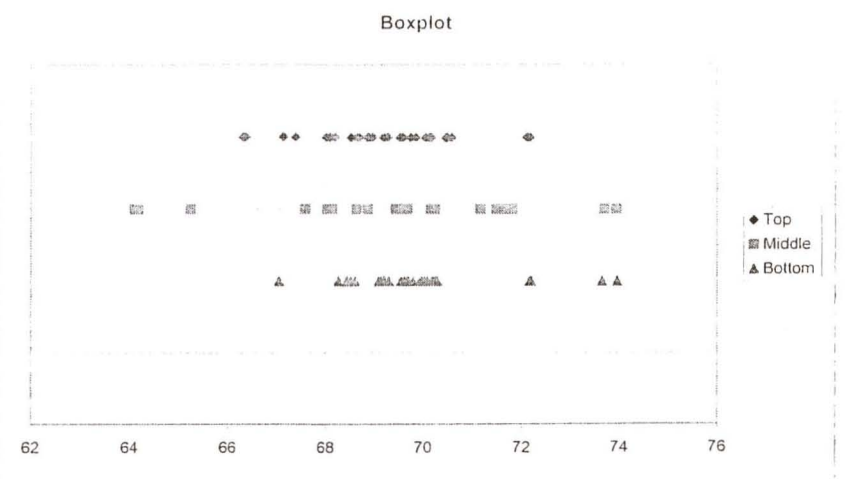
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	29.0099	2	14.50495	2.900865	0.061338	3.122103
Within Groups	365.0158	73	5.000216			
Total	394.0257	75				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3+Al2O3 content of the different samples

APPENDIX E: MAGNETITE - HYPOTHESIS TESTS (continues)

MAGNETITE SERIES 2 (1500mmH2O)





Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Top	29	2005.774	69.16463	1.963918
Middle	21	1454.647	69.26889	7.092478
Bottom	30	2098.603	69.95344	2.08457

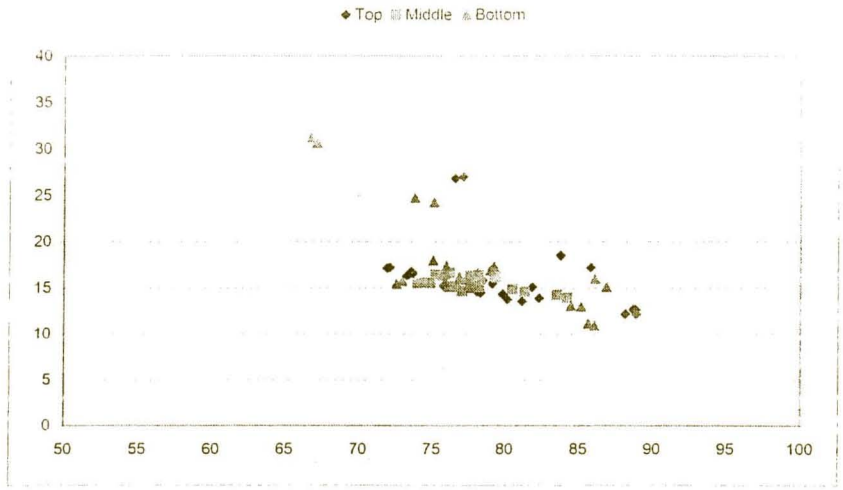
ANOVA

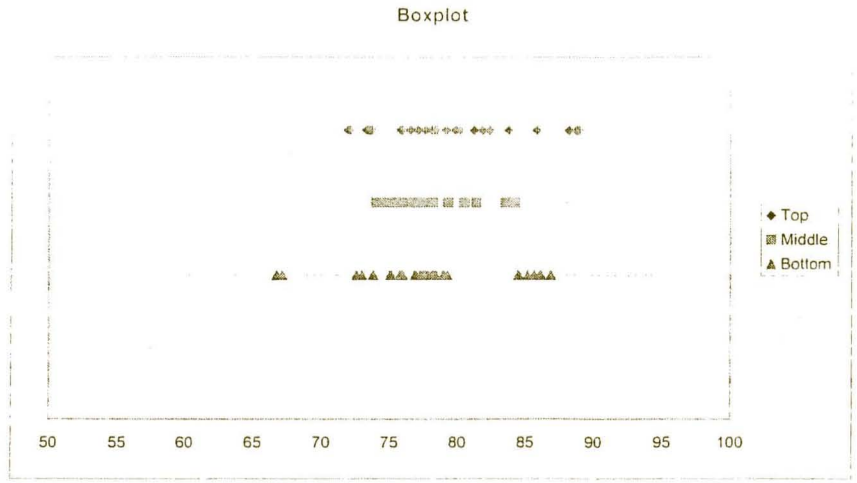
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10.53972	2	5.269862	1.577117	0.213169	3.11536
Within Groups	257.2918	77	3.341452			
Total	267.8315	79				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3+Al2O3 content of the different samples

APPENDIX F: SFCA - HYPOTHESIS TESTS

SFCA SERIES 1 (1100mmH2O)





Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Top	27	2142.469	79.3507	27.61653
Middle	22	1706.81	77.58228	7.811781
Bottom	32	2429.356	75.91737	74.80208

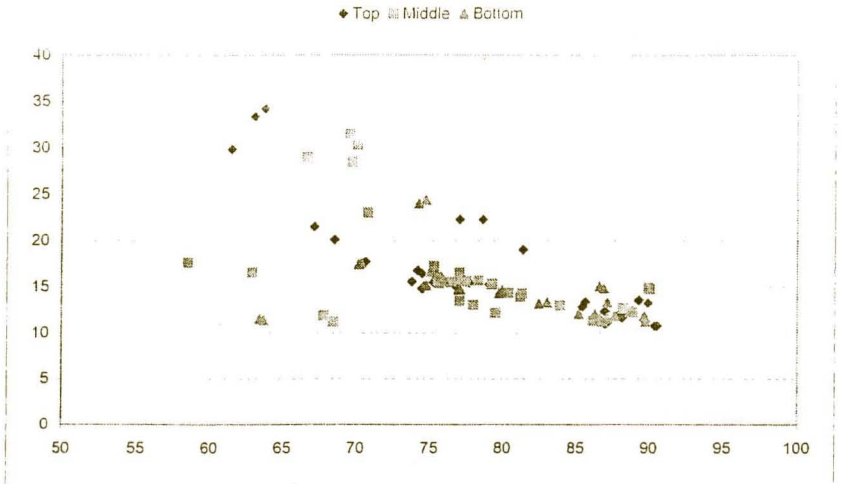
ANOVA

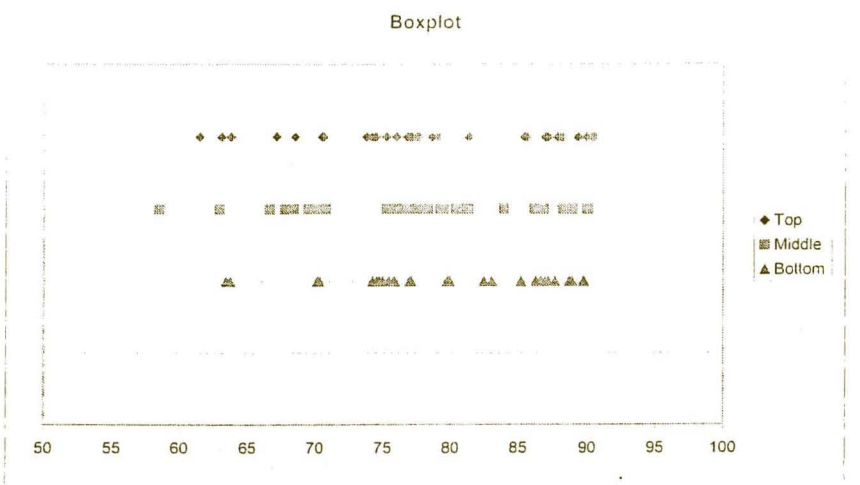
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	172.7611	2	86.38056	2.104907	0.128726	3.113797
Within Groups	3200.942	78	41.03771			
Total	3373.703	80				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3+Al2O3 content of the different samples

APPENDIX F: SFCA - HYPOTHESIS TESTS (continues)

SFCA SERIES 2 (1500mmH2O)





Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Top	33	2594.438	78.61933	72.88107
Middle	34	2628.629	77.31261	60.43059
Bottom	31	2486.372	80.20554	58.66641

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	135.8235	2	67.91176	1.060006	0.350515	3.092218
Within Groups	6086.396	95	64.06733			
Total	6222.219	97				

Hypothesis Test
Ho: a1=a2=a3
Reject Ho if F > F crit
F < F crit : a1=a2=a3
Therefore, there is not a difference in the mean Fe2O3+Al2O3 content of the different samples

APPENDIX G: EXAMPLES OF CALCULATIONS

TABLE A: Chemical analyses: Mass percentage

	Fe2O3	FeO	SiO2	TiO2	CaO	SO3	MnO	K2O	MgO	Al2O3	Na2O	P2O5	Total
Hematite	-	86.60	0.00	0.27	0.34	0.00	0.06	0.00	0.00	1.05	0.00	0.00	88.34
Magnetite	-	84.21	0.02	0.01	2.14	0.00	1.08	0.00	3.21	1.43	0.00	0.00	92.11
SFCA	-	65.46	7.85	0.09	15.02	0.00	0.24	0.00	0.54	3.53	0.00	0.01	92.74

TABLE B: Calculated chemical analyses: Mass percentage

	Fe2O3	FeO	SiO2	TiO2	CaO	SO3	MnO	K2O	MgO	Al2O3	Na2O	P2O5	Total
Hematite	96.00	0.00	0.00	0.27	0.34	0.00	0.06	0.00	0.00	1.05	0.00	0.00	97.74
Magnetite	69.51	21.39	0.02	0.01	2.14	0.00	1.08	0.00	3.21	1.43	0.00	0.00	98.80
SFCA	71.43	0.96	7.85	0.09	15.02	0.00	0.24	0.00	0.54	3.53	0.00	0.01	99.67

CALCULATIONS

Calculation of Fe2O3 in Hematite:

Step 1: mole Fe = mole FeO = %FeO / (56 + 16) = 86.60 / (56 +16) = 1.20
Step 2: 4 mole Fe reacts with 3 mole O2 resulting in 2 mole Fe2O3
Step 3: therefore, mole Fe2O3 = 0.5x mole Fe
Step 4: mole Fe2O3 = 0.5 x 1.20 = 0.6
Step 5: % Fe2O3 = mole Fe2O3 x 160 = 0.6 x 160 = 96
Step 6: Recalculate to give results of Hematite in Table B

Recalculation of Fe2O3 and FeO in Magnetite assuming a M3O4 structure

Step 1: Calculate the mole cations from the chemical analyses shown in TABLE A

mole cations = % MO / molar mass of MO

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	1.17	0.00	0.03	0.08	0.04	0.02	1.33

Step 2: Recalculate the mole cations to ensure that the sum of the cations equals 3

mole cations = (3 / 1.33) x mole cations calculated in step 1

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	2.63	0.00	0.06	0.18	0.09	0.03	3.00

Step 3: Determine the mole oxygen anions associated with the cations as calculated in step 2

mole oxygen anions associated with:

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	2.63	0.00	0.09	0.18	0.09	0.03	3.02

Step 4: Fe3+ cations is present if the total mole oxygen anions calculated in step 3 is less than four.

Step 5: mole Fe3+ cations = 2 x (4 - total mole oxygen anions) = 2 x (4 - 3.02) = 1.96

Step 6: %Fe2O3 = (mole Fe3+ cations x total mole cations / 3) x 160 x 0.5
therefore, %Fe2O3 = 1.96 x 1.33 / 3 x 160 x 0.5 = 69.51

Step 7: mole Fe2+ cations = mole Fe2+ cations calculated in step 3 - mole Fe3+ cations = 2.63 - 1.96 = 0.67

Step 8: %FeO = (mole Fe2+ cations x total mole cations / 3) x 72
therefore, %FeO = 0.67 x 1.33 / 3 x 72 = 21.39

Step 9: Recalculate to give results of the chemical analyses of Magnetite in Table B

Step 10: Accordingly, Magnetite Stoichiometry (XY2O4) = (Fe,Mg,Si,Ca,Mn) (Fe,Al)2 O4

i Fe2+	i Mg2+	i Si4+	i Ca2+	i Mn2+		i Fe3+	i Al3+		i O2-
0.67	0.18	0.00	0.09	0.03	1.00	1.96	0.06	2.00	4.00

Recalculation of Fe2O3 and FeO in SFCA assuming a M25O36 structure

Step 1: Calculate the mole cations from the chemical analyses shown in TABLE A

mole cations = % MO / molar mass of MO

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	0.91	0.13	0.07	0.01	0.27	0.00	1.39

Step 2: Recalculate the mole cations to ensure that the sum of the cations equals 25

mole cations = (25 / 1.39) x mole cations calculated in step 1

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	16.30	2.35	1.24	0.24	4.81	0.06	25.00

Step 3: Determine the mole oxygen anions associated with the cations as calculated in step 2

mole oxygen anions associated with:

n Fe3+	n Fe2+	n Si4+	n Al3+	n Mg2+	n Ca2+	n Mn2+	Total
-	16.30	4.70	1.86	0.24	4.81	0.06	27.97

Step 4: mole Fe3+ cations = 2 x (36 - total mole oxygen anions) = 2 x (36 - 27.97) = 16.06

Step 5: %Fe2O3 = (mole Fe3+ cations x total mole cations / 25) x 160 x 0.5
therefore, %Fe2O3 = 16.06 x 1.39 / 25 x 160 x 0.5 = 71.43

Step 6: mole Fe2+ cations = mole Fe2+ cations calculated in step 3 - mole Fe3+ cations = 16.30 - 16.06 = 0.24

Step 7: %FeO = (mole Fe2+ cations x total mole cations / 25) x 72
therefore, %FeO = 0.24 x 1.39 / 25 x 72 = 0.96

Step 8: Recalculate to give results in Table B

Step 9: Accordingly, SFCA Stoichiometry (M25O36) = Ca5,Si2,(Fe,Al)18 O4

i Fe2+	i Mg2+	i Si4+	i Ca2+	i Mn2+		i Fe3+	i Al3+		i O2-
0.24	0.24	2.35	4.81	0.06	7.70	16.06	1.24	17.30	36.00