THE CLASSIFICATION OF EARLY IRONWORKING SLAGS

VOL II

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CONTENTS

TABLES

FIGURES

PLATES

TABLES 9.2.1 - 9.2.3 FARTHINGSTONE DATA

TABLE 9.2.1 FARTHINGSTONE X-RAY DIFFRACTION PATTERNS AND INTERPRETATION (d-SPACINGS)

FARTHINGSTONE	QUARTZ	FAYALITE
3.57		$3.55^{(80)}$
$3.38^{(100)}$	$3.34^{(100)}$	
2.83		$2.83^{(90)}$
2.57		$2.57^{(70)}$
2.51		$2.50^{(100)}$
1.78		$1.77^{(90)}$

TABLE 9.2.2 FARTHINGSTONE BULK AND INCLUSION ANALYSES

	Bulk 1	Bulk 2	Bulk 3	Bulk 4	Bulk 5	Inclusions 1	2	3
Na_2O	N.D	0.5	N.D	N.D	0.7	0.5	0.2	0.1
MgO	N.D	0.4	0.1	N.D	0.3	0.4	N.D	N.D
Al_2O_3	9.1	8.9	8.9	8.9	8.1	9.8	7.8	7.2
SiO_2	43.5	43.7	45.0	43.9	43.1	1.4	1.6	1.9
P_2O_5	1.3	1.8	1.7	1.8	1.8	N.D	N.D	0.2
S	0.1	0.1	0.2	N.D	0.1	N.D	N.D	0.1
K_2O	1.6	1.7	1.8	1.7	1.7	N.D	0.2	0.1
CaO	0.5	0.5	0.6	0.6	0.6	N.D	0.1	N.D
TiO_2	0.6	0.5	0.5	0.6	0.7	4.8	4.1	2.8
V_2O_5	0.1	N.D	N.D	0.2	N.D	1.9	0.9	0.1
Cr_2O_6	0.1	0.1	0.1	0.1	N.D	3.5	0.1	N.D
MnO	0.1	N.D	N.D	0.1	N.D	N.D	N.D	N.D
FeO	41.2	42.1	42.6	42.9	42.5	72.3	81.9	79.7
CoO	N.D	0.1	0.1	0.1	0.2	0.2	0.1	0.4
NiO	0.1	N.D	0.2	0.1	N.D	0.3	0.2	0.3
Total	98.3	100.4	101.8	101.0	99.8	95.1	97.2	92.9

TABLE 9.2.3 FARTHINGSTONE BULK AND INCLUSION NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	Bulk 1	Bulk 2	Bulk 3	Bulk 4	Bulk 5	Inclusions 1	Inclusions 2	Inclusions 3
APATITE	0.9	0.9	1.0	1.0	1.1			
VIVIANITE	2.4	3.6	3.1	3.4	3.4			0.6
ULVITE	1.7	1.4	1.4	1.7	2.0	15.0	12.0	8.5
PYRRHOTITE	0.3	0.2	0.5		0.3			0.2
KALSILITE							0.7	0.4
K-SILICATE								
NEPHELINE						2.6	1.0	0.5
NA-SILICATE								
ANORTHITE							0.5	
HERCYNITE	12.8	10.6	11.7	12.0	8.7	17.1	12.6	12.8
MULLITE								
CA-SILICATE								
FORSTERITE						0.8		
TEPHROITE								
FAYALITE						0.5	2.6	5.8
GEHLENITE								
WUSTITE						63.9	70.7	71.2
ORTHOCLASE	9.6	10.0	10.5	10.0	10.1			
ALBITE		4.2			6.0			
WOLLASTONITE								
ENSTATITE		1.0	0.2		0.8			
RHODONITE	0.2			0.2				
FERROSILITE	62.5	63.2	62.4	63.6	65.3			
QUARTZ	9.6	4.8	9.1	8.2	2.5			

TABLES 9.3.1 - 9.3.7 LEVISHAM DATA

TABLE 9.3.1 LEVISHAM PUBLISHED ANALYSES

	1	2	3	4	5	6	7
Na_2O	n.d	n.d	n.d	n.d	n.d	n.d	n.d
MgO	0.22	0.94	0.71	0.36	0.58	n.d	n.d
Al_2O_3	5.83	5.03	3.11	9.33	4.30	1.7	2.6
SiO_2	83.26	41.04	39.52	12.94	28.98	1.46	23.0
P_2O_5	0.3	0.53	0.44	1.00	0.68	n.d	n.d
S	n.d	n.d	n.d	n.d	n.d	n.d	n.d
K_2O	n.d	n.d	n.d	n.d	n.d	n.d	n.d
CaO	0.1	2.70	2.00	0.10	1.90	1.4	1.5
TiO_2	0.4	0.28	0.33	0.28	0.23	0.1	0.4
V_2O_5	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Cr_2O_6	n.d	n.d	n.d	n.d	n.d	n.d	n.d
MnO	0.1	5.64	5.17	0.66	3.51	7.6	0.5
FeO	3.95	38.1	47.4	70.05	49.2	n.d	n.d
CoO	n.d	n.d	n.d	n.d	n.d	n.d	n.d
NiO	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Total	94.6	94.26	98.68	94.77	89.38	12.26	28.0

n.d not determined

TABLE 9.3.2 SAMPLE LEVISHAM VOLUMETRIC PHASE PERCENTAGES

AREA	TEXTURE	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	2R	65	5	30	32.5	4.3
2	1F	60	30	10	25.0	26.0
3	2R	65	10	25	30.0	8.7
4	2R	50	10	40	45.0	8.7
5	1R	65	20	15	25.0	17.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	23				
3	5	18			
4	13	26	15		
5	15	9	10	22	

Mean r-factor = 16 Standard Deviation = 7

TABLE 9.3.3 LEVISHAM BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.2	N.D	0.5	N.D	N.D
MgO	0.3	N.D	0.5	0.6	N.D
Al_2O_3	0.4	1.5	1.6	1.0	0.5
SiO_2	11.5	21.3	23.9	24.1	18.2
P_2O_5	0.3	0.6	0.6	0.6	0.1
S	0.2	0.2	0.2	0.2	N.D
K_2O	0.4	0.9	1.0	0.4	0.2
CaO	1.8	3.7	4.0	2.8	1.7
TiO_2	0.3	0.5	0.5	0.1	0.2
V_2O_5	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.2	N.D	0.2	N.D	N.D
MnO	6.9	7.8	8.1	9.8	8.8
FeO	77.2	63.9	59.5	63.0	70.5
CoO	0.4	0.3	0.2	N.D	0.3
NiO	0.2	N.D	0.2	N.D	N.D
Total	100.3	100.7	101.0	102.6	100.5

TABLE 9.3.4 LEVISHAM PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	SIL3	GLASS1	GLASS2	FEOX1	FEOX2	FEOX3	FEOX4
Na_2O	N.D	0.3	0.4	1.2	0.8	0.1	0.1	0.3	0.2
MgO	0.4	0.7	0.2	N.D	N.D	N.D	0.3	0.1	0.2
Al_2O_3	0.1	0.1	0.1	21.4	21.4	0.2	0.2	0.3	0.2
SiO_2	30.2	29.1	29.8	40.0	38.0	0.9	0.7	0.7	0.7
P_2O_5	0.1	N.D	0.7	0.8	1.4	N.D	N.D	N.D	N.D
S	N.D	N.D	0.1	0.1	N.D	N.D	N.D	N.D	N.D
K_2O	N.D	N.D	0.1	30.4	28.1	0.1	N.D	0.1	0.1
CaO	1.9	2.4	14.3	1.1	1.1	N.D	0.1	N.D	0.1
TiO_2	N.D	N.D	0.1	0.5	0.6	N.D	N.D	0.3	N.D
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	0.2	N.D	N.D
Cr_2O_6	N.D	0.1	N.D	N.D	0.1	N.D	N.D	0.1	N.D
MnO	13.2	12.3	9.2	0.3	0.5	4.8	4.8	3.1	5.1
FeO	56.1	56.2	47.6	3.0	5.1	92.7	92.7	94.8	92.5
CoO	0.2	0.3	0.2	N.D	N.D	0.3	0.3	0.4	N.D
NiO	0.1	0.1	0.1	N.D	0.1	0.4	0.1	N.D	0.3
Total	102.3	101.6	102.9	98.8	97.2	99.5	99.5	100.2	99.4

TABLE 9.3.5 LEVISHAM NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	0.7	1.4	1.4	1.3	0.2
ULVITE	0.8	1.4	1.4	0.3	0.5
PYHROTITE	0.5	0.5	0.5	0.5	
KALSILITE	1.3	3.0	3.4	1.3	0.7
K-SILICATE					
NEPHELINE					
NA-SILICATE	0.4		0.4		
ANORTHITE					
HERCYNITE					
MULLITE					
CA-SILICATE	2.2	3.5	5.0	2.1	1.9
FORSTERITE	0.5		0.9	1.0	
TEPHROITE	9.9	11.1	11.7	13.6	12.5
FAYALITE	23.6	51.7	56.0	59.2	45.3
GEHLENITE		1.4		1.5	0.8
WUSTITE	60.1	25.9	19.4	19.1	38.1
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 9.3.6 LEVISHAM NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	SIL3	GLASS1	GLASS2
APATITE	0.2		1.6	1.9	2.0
VIVIANITE					1.5
ULVITE			0.3	1.4	1.7
PYHROTITE			0.3	0.3	
KALSILITE			0.3	59.4	61.5
K-SILICATE				17.6	14.1
NEPHELINE					
NA-SILICATE		0.5	0.8	2.4	1.6
ANORTHITE	0.3				
HERCYNITE					
MULLITE					
CA-SILICATE	2.6	3.7	20.0	0.1	
FORSTERITE	0.7	1.2	0.3	0.4	
TEPHROITE	18.3	17.4	12.8	2.7	0.7
FAYALITE	77.4	73.1	59.8		4.6
GEHLENITE	0.5				
WUSTITE		4.2	3.9		
ORTHOCLASE				13.8	12.3
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 9.3.7 LEVISHAM NORMATIVE TERNARY GROUPINGS

BULK	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	36.2	3.7	60.1	61.95	3.2
2	66.3	7.7	25.9	29.75	6.7
3	73.6	7.0	19.4	22.9	6.1
4	75.9	5.0	19.1	21.6	4.3
5	59.7	2.2	38.1	39.2	1.9

NORMATIVE TERNARY 'r-factor' VALUES

	1	2	3	4	5
1					
2	32.4				
3	39.2	6.8			
4	40.4	8.45	2.2		
5	22.8	10.6	16.8	17.8	

Mean r-factor = 19.7 Standard Deviation = 13.6

VOLUMETRIC - NORMATIVE TERNARY 'r-factor' VALUES

		VOLUMETRIC 1	2	3	4	5
TERNARY	1	29.5	43.4	32.4	17.8	39.55
	2	3.7	19.9	2.0	15.4	11.6
	3	9.8	20.0	7.6	22.2	11.4
	4	10.9	22.0	9.5	23.8	13.4
	5	7.1	28.0	11.4	8.9	21.0

Mean r-factor = 17.7 Standard Deviation = 10.7

TABLES 9.4.1 - 9.4.14 AMERSHAM MANTLES GREEN ANALYTICAL DATA

TABLE 9.4.1 SAMPLE AM714 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	30	10	25.0	26.0
2	60	30	10	25.0	26.0
3	50	30	20	35.0	26.0
4	65	25	10	22.5	21.65
5	55	30	15	30.0	26.0

SAMPLE AM714 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	0				
3	10	10			
4	5	5	13		
5	5	5	5	9	

Mean r-factor = 7 Standard Deviation = 4

TABLE 9.4.2 SAMPLE AM714 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	SIL	GLAS	FEOX1	FEOX2
Na_2O	0.3	N.D	0.5	0.2	0.1	0.7	0.2	N.D
MgO	1.1	1.5	0.5	0.3	1.8	0.1	N.D	N.D
Al_2O_3	1.4	2.8	6.5	7.2	0.2	12.8	14.5	18.8
SiO_2	31.9	30.5	31.0	32.6	30.2	31.7	3.5	7.8
P_2O_5	1.1	0.4	1.3	1.1	0.4	2.2	N.D	0.5
S	0.1	N.D	0.1	N.D	N.D	0.3	N.D	0.1
K_2O	1.4	0.7	1.7	1.9	N.D	3.9	0.2	0.7
CaO	4.2	2.6	5.1	5.4	1.0	8.2	0.7	1.9
TiO_2	0.2	0.1	0.3	0.3	N.D	0.6	2.4	2.4
V_2O_5	N.D	N.D	N.D	0.1	N.D	N.D	0.2	0.2
Cr_2O_6	N.D	0.2	0.1	N.D	N.D	N.D	N.D	0.1
MnO	9.3	10.8	8.6	8.3	12.8	3.4	2.6	3.0
FeO	47.1	51.4	45.3	44.3	56.1	35.4	72.1	60.8
CoO	0.5	0.3	0.2	0.2	0.4	0.1	0.4	0.4
NiO	0.1	0.1	0.2	0.1	0.3	0.2	0.3	0.4
Total	102.1	101.4	101.4	102.0	103.3	99.6	97.1	97.1

TABLE 9.4.3 SAMPLE AM714 NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	SIL	GLASS	FEOX1	FEOX2
APATITE	2.5	0.9	3.0	2.5	0.9	5.1		1.2
VIVIANITE								
ULVITE	0.6	0.3	0.8	0.8		1.7	7.0	7.0
PYRRHOTITE	0.3		0.3			0.8		0.3
KALSILITE	3.5	2.3	5.6	4.5		12.7	0.7	2.5
K-SILICATE								
NEPHELINE	1.3		2.3	0.9	0.5	3.2	0.9	
NA-SILICATE								
ANORTHITE	9.1	5.4	10.4	12.9		20.4	3.6	6.4
HERCYNITE							22.5	28.1
MULLITE								
CA-SILICATE	1.3	1.4	1.9	2.0	0.6	1.9		
FORSTERITE	1.9	2.5	0.9	0.5	3.1	0.2		
TEPHROITE	13.0	15.0	12.1	11.6	17.8	4.9	3.9	4.5
FAYALITE	64.6	70.9	62.6	61.0	76.1	48.1	0.9	10.5
GEHLENITE		1.2			0.1			
WUSTITE					1.0		60.5	39.6
ORTHOCLASE	2.0		0.1	3.2		0.9		
ALBITE								
WOLLASTONITE								
ENSTATITE								
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 9.4.4 SAMPLE AM714 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	79.5	20.5	0.0	10.25	17.75
2	88.4	11.6	0.0	5.8	10.05
3	75.6	24.4	0.0	12.2	21.1
4	73.1	26.9	0.0	13.45	23.3

SAMPLE AM714 Normative Phase 'r-factor' Values

	1	2	3	4
1				
2	8.9			
3	3.9	12.8		
4	6.4	15.3	2.5	

Mean r-factor = 8.3 Standard Deviation = 5.0

SAMPLE AM714 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4
VOLUMETRIC	1	16.9	25.0	13.7	11.9
	2	16.9	25.0	13.7	11.9
	3	26.1	33.3	23.3	21.7
	4	12.9	20.3	10.3	9.2
	5	21.4	29.0	18.5	16.8

Mean r-factor = 18.4 Standard Deviation = 7.2

TABLE 9.4.5 SAMPLE AM878 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60	10	30	35.0	8.7
2	50	10	40	45.0	8.7
3	45	5	50	52.5	4.3
4	60	10	30	35.0	8.7
5	60	15	25	32.5	13.0

SAMPLE AM878 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	10				
3	18	9			
4	0	10	18		
5	5	13	22	5	

Mean r-factor = 11 Standard Deviation = 7

TABLE 9.4.6 SAMPLE AM878 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.5	0.4	0.1	0.3	0.3
MgO	0.5	0.7	0.6	0.1	0.6
Al_2O_3	2.8	3.4	2.9	3.3	3.2
SiO_2	17.4	17.7	17.5	16.7	18.2
P_2O_5	1.0	0.7	0.9	0.8	0.8
S	0.1	N.D	N.D	0.2	N.D
K_2O	0.8	0.4	1.1	1.0	0.9
CaO	1.5	1.4	1.9	2.1	1.9
TiO_2	0.1	0.1	N.D	0.1	0.2
V_2O_5	N.D	N.D	0.2	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	0.1	N.D
MnO	7.4	7.9	7.9	7.5	7.8
FeO	67.0	69.7	65.7	68.0	67.2
CoO	0.3	0.3	0.2	0.3	0.4
NiO	0.2	0.3	0.1	0.4	0.1
Total	99.6	103.1	99.1	100.9	101.6

TABLE 9.4.7 SAMPLE AM878 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	FEOX1	FEOX2
Na_2O	N.D	0.2	0.1	N.D	N.D	0.1
MgO	1.4	1.1	N.D	N.D	N.D	N.D
Al_2O_3	0.3	0.6	16.3	15.1	0.7	0.4
SiO_2	28.3	28.4	31.4	29.1	0.6	0.6
P_2O_5	0.4	0.4	5.3	5.4	0.1	N.D
S	0.1	N.D	0.5	0.3	0.1	N.D
K_2O	N.D	0.1	8.5	7.5	0.1	0.1
CaO	0.6	0.8	11.9	10.4	0.1	0.1
TiO_2	N.D	N.D	0.1	N.D	0.1	0.1
V_2O_5	N.D	N.D	0.1	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D
MnO	10.9	11.3	4.0	4.6	3.9	4.0
FeO	55.4	56.2	23.4	27.1	91.5	93.0
CoO	0.1	N.D	0.2	N.D	0.4	N.D
NiO	0.3	0.1	0.1	0.1	0.1	0.2
Total	97.8	99.0	101.9	99.8	97.2	98.8

TABLE 9.4.8 SAMPLE AM878 BULK NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	2.3	1.6	2.1	1.9	1.8
VIVIANITE					
ULVITE	0.3	0.3		0.3	0.6
PYRRHOTITE	0.3			0.6	
KALSILITE	2.7	1.3	3.7	3.4	3.0
K-SILICATE					
NEPHELINE	2.3	1.8	0.5	1.4	1.4
NA-SILICATE					
ANORTHITE	0.9	2.3	3.6	4.2	4.2
HERCYNITE	1.3	2.4	0.4		0.3
MULLITE					
CA-SILICATE					
FORSTERITE	0.9	1.2	1.1	0.2	1.0
TEPHROITE	10.6	11.0	11.4	10.7	11.0
FAYALITE	39.4	38.1	36.4	32.8	36.6
GEHLENITE				0.5	
WUSTITE	38.9	40.0	40.8	44.3	40.2
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 9.4.9 SAMPLE AM878 PHASE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2
APATITE	1.0	0.9	12.1	12.6
VIVIANITE				
ULVITE			0.3	
PYRRHOTITE	0.3		1.4	0.7
KALSILITE		0.3	27.3	25.3
K-SILICATE				
NEPHELINE		0.9	0.5	
NA-SILICATE				
ANORTHITE	0.3		18.7	16.4
HERCYNITE	0.3			1.7
MULLITE				
CA-SILICATE		0.2	1.7	
FORSTERITE	2.5	1.9		
TEPHROITE	16.0	16.2	5.6	6.6
FAYALITE	78.4	75.8	30.9	36.0
GEHLENITE		0.4		
WUSTITE	1.3	3.3		0.5
ORTHOCLASE			1.5	
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 9.4.10 SAMPLE AM878 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	50.9	10.1	38.9	44.0	8.75
2	50.4	9.8	39.9	44.8	8.5
3	48.9	10.5	40.7	46.0	9.1
4	43.7	12.0	44.3	50.3	10.4
5	48.6	11.5	40.0	45.75	10.0

SAMPLE AM878 Normative Phase 'r-factor' Values

	1	2	3	4	5
1					
2	0.9				
3	2.0	1.3			
4	6.5	5.8	4.5		
5	2.2	1.75	0.9	4.6	

Mean r-factor = 3.0 Standard Deviation = 2.1

SAMPLE AM878 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE				
		1	2	3	4	5
VOLUMETRIC	1	9.0	9.8	11.0	15.4	10.8
	2	1.05	0.3	1.0	5.6	1.5
	3	9.6	8.75	8.1	6.5	8.8
	4	8.95	9.8	11.0	15.4	10.8
	5	12.2	13.1	14.0	18.0	13.6

Mean r-factor = 9.4 Standard Deviation = 4.7

TABLE 9.4.11 SAMPLE AM783 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	30	10	25.0	26.0
2	60	30	10	25.0	26.0
3	65	25	10	22.5	21.65
4	55	30	15	30.0	26.0
5	65	30	5	20.0	26.0

SAMPLE AM783 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	0				
3	5	5			
4	5	5	9		
5	5	5	5	10	

Mean r-factor = 5 Standard Deviation = 3

TABLE 9.4.12 SAMPLE AM783 BULK AND PAHSE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
Na_2O	0.2	0.1	0.2	N.D	0.5	0.6	0.3	0.5
MgO	0.5	0.5	0.2	N.D	0.7	0.6	N.D	0.2
Al_2O_3	5.0	4.4	5.2	4.3	4.8	0.1	12.8	15.1
SiO_2	33.7	33.8	32.6	32.8	33.0	30.0	46.0	42.4
P_2O_5	1.1	1.0	1.3	1.0	1.0	N.D	3.5	2.7
S	N.D	N.D	0.1	0.1	0.1	0.1	0.5	0.2
K_2O	1.2	1.1	1.2	1.0	1.1	N.D	3.4	3.5
CaO	2.5	2.2	2.6	2.3	2.3	0.4	9.0	8.5
TiO_2	0.2	0.2	0.3	0.2	0.3	N.D	0.4	0.7
V_2O_5	N.D	0.2	N.D	N.D	N.D	N.D	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
MnO	4.8	5.0	4.6	4.9	5.1	5.8	2.3	2.1
FeO	52.4	54.1	50.8	52.9	52.4	63.3	22.6	22.5
CoO	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3
NiO	0.2	0.5	0.3	0.1	0.2	0.4	N.D	N.D
Total	101.9	103.2	99.6	99.8	101.7	101.5	101.0	98.8

TABLE 9.4.13 SAMPLE AM783 NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
APATITE	2.5	2.3	3.0	2.3	2.3		8.1	6.4
VIVIANITE								
ULVITE	0.6	0.6	0.9	0.6	0.8		1.1	2.0
PYRRHOTITE			0.3	0.3	0.3	0.3	1.4	0.6
KALSILITE								
K-SILICATE								
NEPHELINE								
NA-SILICATE						1.0		
ANORTHITE	5.1	4.3	4.4	4.9	4.8		21.6	24.9
HERCYNITE	2.5	2.4	3.4	2.5	1.7		1.1	2.6
MULLITE								
CA-SILICATE					0.5	0.6		
FORSTERITE					1.2	1.0		
TEPHROITE	1.4				7.2	8.2		
FAYALITE	71.2	72.6	68.2	68.8	71.3	88.5		10.6
GEHLENITE								
WUSTITE						0.3		
ORTHOCLASE	7.0	6.3	7.1	5.9	6.4		20.0	21.0
ALBITE	1.6	0.8	1.7		4.2		2.5	4.3
WOLLASTONITE								
ENSTATITE	1.2	1.2	0.5					0.5
RHODONITE	6.9	9.0	8.6	9.1			4.2	3.9
FERROSILITE		0.4	1.9	5.6			37.1	23.2
QUARTZ							2.9	

TABLE 9.4.14 SAMPLE AM783 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	89.3	10.7	0.0	5.35	9.3
2	90.6	9.4	0.0	4.7	8.1
3	87.9	12.1	0.0	6.05	10.5
4	89.4	10.6	0.0	5.3	9.2
5	89.9	10.1	0.0	5.05	8.75

SAMPLE AM783 Normative Phase 'r-factor' Values

	1	2	3	4	5
1					
2	1.4				
3	1.4	2.7			
4	0.1	1.2	1.5		
5	0.6	0.7	2.0	0.5	

Mean r-factor = 1.2 Standard Deviation = 0.8

SAMPLE AM783 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	NORMATIVE 2	NORMATIVE 3	NORMATIVE 4	NORMATIVE 5
1	25.8	27.0	24.5	25.9	26.4
2	25.8	27.0	24.5	25.9	26.4
3	21.15	22.35	19.9	21.2	21.7
4	29.8	31.0	28.5	29.9	30.3
5	22.2	23.5	20.9	22.3	22.8

Mean r-factor = 25.1 Standard Deviation = 3.2

TABLES 9.5.1 - 9.5.5 BAYSDALE DATA

TABLE 9.5.1 SAMPLE BAYSDALE VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60	30	10	25.0	26.0
2	50	40	10	30.0	34.6
3	50	40	10	30.0	34.6
4	55	40	5	25.0	34.6
5	45	50	5	30.0	43.3

Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	10				
3	10	0			
4	9	5	5		
5	18	9	9	10	

Mean r-factor = 8.5 Standard Deviation = 5

TABLE 9.5.2 BAYSDALE BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.5	N.D	N.D	0.3	0.7
MgO	5.4	3.9	4.2	3.4	3.4
Al_2O_3	9.8	10.0	9.2	10.7	9.0
SiO_2	26.2	27.4	27.6	25.9	29.7
P_2O_5	2.6	2.7	2.6	2.9	1.9
S	0.1	0.1	0.2	0.3	0.3
K_2O	1.9	2.2	2.1	2.2	2.7
CaO	9.4	11.0	10.7	10.1	10.9
TiO_2	0.6	0.6	0.6	0.6	0.8
V_2O_5	0.3	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	0.1	0.1	N.D	N.D
MnO	1.4	1.4	1.3	1.2	1.1
FeO	41.0	41.3	41.5	40.9	40.6
CoO	0.1	0.2	0.3	0.3	N.D
NiO	N.D	N.D	N.D	N.D	N.D
Total	99.3	100.9	100.4	98.8	101.1

TABLE 9.5.3 BAYSDALE PHASE ANALYSES (Weight Percent)

	SIL	GLASS1	GLASS2	FEOX1	FEOX2
Na_2O	0.6	0.6	0.1	N.D	N.D
MgO	16.5	0.2	0.1	N.D	0.2
Al_2O_3	0.4	10.2	12.7	0.6	0.5
SiO_2	34.2	32.6	31.2	1.1	1.4
P_2O_5	0.7	4.2	2.6	N.D	0.1
S	N.D	0.4	0.4	N.D	N.D
K_2O	0.2	5.6	3.7	N.D	N.D
CaO	1.4	19.2	19.1	0.5	0.6
TiO_2	N.D	0.6	0.8	0.9	0.6
V_2O_5	N.D	N.D	N.D	0.2	N.D
Cr_2O_6	N.D	N.D	N.D	0.1	0.1
MnO	1.8	0.8	0.7	0.2	0.4
FeO	44.2	24.3	27.9	92.7	94.3
CoO	0.5	0.2	0.1	0.5	0.6
NiO	N.D	N.D	0.1	0.1	0.3
Total	100.5	98.9	99.5	96.9	99.1

TABLE 9.5.4 BAYSDALE BULK AND PHASE NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
APATITE	6.1	6.2	4.9	6.8	3.9	1.6	9.9	5.9
VIVIANITE								
ULVITE	1.7	1.7	1.4	1.7	2.0		1.7	2.2
PYHROTITE	0.3	0.3	0.4	0.8	0.7		1.1	1.1
KALSILITE	6.4	7.3	5.8	7.5	8.0		13.3	12.2
K-SILICATE								
NEPHELINE	2.3			1.4	2.8		2.8	0.5
NA-SILICATE						0.9		
ANORTHITE	8.3	4.6	15.5	11.7	11.9		8.7	22.8
HERCYNITE								
MULLITE								
CA-SILICATE			4.4		7.7		18.6	16.5
FORSTERITE	9.5	6.8	6.0	6.0	5.2	25.3	0.4	0.2
TEPHROITE	2.0	2.0	1.5	1.7	1.4	2.6	1.2	1.0
FAYALITE	42.3	52.6	46.4	42.7	48.2	62.5	32.1	35.5
GEHLENITE	10.7	15.8	13.7	9.9	8.2			2.1
WUSTITE	10.3	2.7		9.7				
ORTHOCLASE						1.2	10.2	
ALBITE								
WOLLASTONITE						1.0		
ENSTATITE						4.9		
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 9.5.5 SAMPLE BAYSDALE NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	53.8	35.9	10.3	28.25	31.1
2	61.4	35.9	2.7	20.65	31.1
3	53.9	46.1	0.0	23.05	39.9
4	50.4	39.9	9.7	29.65	34.55
5	54.8	45.2	0.0	22.6	39.1

Ternary 'r-factor' Values

	1	2	3	4	5
1					
2	7.6				
3	10.2	9.1			
4	3.7	9.6	8.5		
5	9.8	8.2	0.9	8.4	

Mean r-factor = 7.6 Standard Deviation = 3.0

VOLUMETRIC/NORMATIVE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	6.05	6.7	14.0	9.7	13.3
	2	3.9	10.0	8.7	0.3	8.7
	3	3.9	10.0	8.7	0.3	8.7
	4	4.8	5.6	5.7	4.6	5.1
	5	12.3	15.4	7.7	8.8	8.5

Mean r-factor = 7.7 Standard Deviation = 3.8

TABLES 9.6.1 - 9.6.11 FARNDALE DATA

TABLE 9.6.1 SAMPLE OAK CRAG, FARNDALE VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	70	25	5	17.5	21.65
2	75	20	5	15.0	17.3
3	70	25	5	17.5	21.65
4	60	30	10	25.0	26.0
5	65	25	10	22.5	21.65

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5				
3	0	5			
4	9	13	9		
5	5	9	5	5	

Mean r-factor = 6.5 Standard Deviation = 4

TABLE 9.6.2 OAK CRAG, FARNDALE BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	N.D	0.4	0.3	0.5	0.3
MgO	0.1	0.7	0.6	0.2	0.5
Al_2O_3	4.8	4.8	5.3	4.1	5.0
SiO_2	27.8	30.6	30.6	27.6	27.6
P_2O_5	0.3	0.2	0.5	0.4	0.6
S	0.1	0.1	0.2	0.1	0.1
K_2O	1.9	2.2	2.2	1.8	2.1
CaO	2.4	2.5	2.4	2.3	2.5
TiO_2	0.5	0.5	0.6	0.5	0.4
V_2O_5	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	0.1
MnO	4.2	4.8	4.7	4.3	4.4
FeO	55.0	54.2	52.3	55.9	55.4
CoO	N.D	0.2	0.3	0.3	0.3
NiO	0.1	0.2	0.2	0.1	0.2
Total	97.2	101.4	100.2	98.1	99.5

TABLE 9.6.3 OAK CRAG, FARNDALE PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLASS1	GLASS2	FEOX1	FEOX2
Na_2O	N.D	0.3	0.7	0.9	0.1	0.1
MgO	0.9	0.7	N.D	N.D	N.D	N.D
Al_2O_3	0.2	0.1	14.0	12.1	0.5	2.1
SiO_2	29.4	28.3	36.9	39.0	1.2	5.1
P_2O_5	0.1	0.2	1.2	1.3	N.D	N.D
S	0.1	0.1	0.5	0.7	N.D	N.D
K_2O	0.1	0.1	8.1	9.3	N.D	0.9
CaO	0.7	1.0	7.6	10.7	0.1	0.8
TiO_2	0.1	0.1	1.4	1.6	0.6	0.8
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	N.D	0.1	N.D	0.1	N.D
MnO	6.1	5.7	1.9	1.0	1.2	1.3
FeO	62.5	62.9	25.1	22.1	91.3	88.1
CoO	0.1	0.1	0.1	N.D	0.6	0.5
NiO	0.1	0.2	N.D	0.1	0.5	0.4
Total	100.5	99.8	97.6	98.8	96.2	100.1

TABLE 9.6.4 OAK CRAG, FARNDALE BULK NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	0.7	0.4	1.2	0.9	1.4
VIVIANITE					
ULVITE	1.4	1.3	1.7	1.4	1.1
PYHROTITE	0.3	0.3	0.5	0.3	0.3
KALSILITE	6.6	7.2	6.8	6.2	7.1
K-SILICATE					
NEPHELINE		1.8	1.4	2.3	1.4
NA-SILICATE					
ANORTHITE	5.2	4.7	6.6		3.7
HERCYNITE					
MULLITE					
CA-SILICATE		1.9	0.6	0.5	
FORSTERITE	0.2	1.2	1.0	0.4	0.9
TEPHROITE	6.2	6.6	6.7	6.3	6.3
FAYALITE	72.7	73.1	72.3	74.3	68.5
GEHLENITE	2.4	1.4		3.7	2.4
WUSTITE	4.3			3.7	6.7
ORTHOCLASE			1.1		
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 9.6.5 OAK CRAG, FARNDALE PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLASS1	GLASS2
APATITE	0.2	0.5	2.9	3.1
VIVIANITE				
ULVITE	0.3	0.3	4.0	4.6
PYHROTITE	0.3	0.3	1.4	1.9
KALSILITE	0.3	0.3	16.3	15.3
K-SILICATE				
NEPHELINE			3.3	4.2
NA-SILICATE		0.6		
ANORTHITE			11.5	1.5
HERCYNITE				
MULLITE				
CA-SILICATE	0.7	1.1	5.9	13.5
FORSTERITE	1.6	1.2		
TEPHROITE	8.7	8.2	2.8	1.4
FAYALITE	87.1	83.8	31.3	25.5
GEHLENITE	0.2			
WUSTITE	0.6	3.8		
ORTHOCLASE			20.5	28.9
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 9.6.6 SAMPLE OAK CRAG, FARNDALE NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	79.1	16.6	4.3	12.6	14.4
2	80.9	19.1	0.0	9.55	16.5
3	80.0	20.0	0.0	10.0	17.3
4	84.7	11.6	3.7	9.5	10.05
5	75.7	17.6	6.7	15.5	15.2

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	3.7				
3	3.9	0.9			
4	5.3	6.45	7.3		
5	3.0	6.1	5.9	7.9	

Mean r-factor = 5.0 Standard Deviation = 2.1

VOLUMETRIC - TERNARY R-FACTORS

		NORMATIVE 1	NORMATIVE 2	NORMATIVE 3	NORMATIVE 4	NORMATIVE 5
VOLUMETRIC	1	8.75	9.5	8.7	14.1	6.75
	2	3.8	5.5	5.0	9.1	4.2
	3	8.75	9.5	8.7	14.1	6.75
	4	17.0	18.1	17.3	22.2	14.4
	5	12.3	13.9	13.2	17.4	9.5

Mean r-factor = 11.1 Standard Deviation = 4.9

TABLE 9.6.7 SAMPLE PARK NORTH VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	75	25	0	12.5	21.65
2	70	30	0	15.0	26.0
3	80	20	0	10.0	17.3
4	80	20	0	10.0	17.3
5	80	20	0	10.0	17.3

SAMPLE PARK NORTH VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5.0				
3	5.0	10.0			
4	5.0	10.0	0.0		
5	5.0	10.0	0.0	0.0	

Mean r-factor = 5.0 Standard Deviation = 4.1

TABLE 9.6.8 PARK NORTH BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
Na_2O	0.1	0.3	0.3	0.4	0.4	0.3	0.3
MgO	0.3	0.2	0.1	0.1	0.2	1.1	N.D
Al_2O_3	6.5	6.3	6.0	7.7	7.1	0.2	13.2
SiO_2	28.3	28.2	28.9	28.1	28.0	28.1	35.7
P_2O_5	0.5	0.9	0.5	0.9	0.6	N.D	5.2
S	0.1	0.1	0.1	0.2	0.1	N.D	0.7
K_2O	1.8	1.9	1.5	2.1	2.4	N.D	9.5
CaO	1.4	1.5	1.2	1.6	1.7	0.2	10.4
TiO_2	0.3	0.5	0.3	0.4	0.3	0.1	1.1
V_2O_5	0.1	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	0.1	0.1	N.D	0.2	N.D	N.D
MnO	0.2	0.2	0.3	0.1	0.2	0.4	N.D
FeO	59.2	57.8	58.7	57.2	55.4	67.6	22.6
CoO	0.4	0.2	0.5	N.D	0.2	0.6	N.D
NiO	0.2	0.2	0.2	N.D	N.D	0.2	N.D
Total	99.5	98.4	98.7	98.8	96.8	98.8	98.7

TABLE 9.6.9 PARK NORTH BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
APATITE	1.2	2.1	1.2	2.1	1.4		12.3
VIVIANITE							
ULVITE	0.9	1.4	0.9	1.1	0.9	0.3	3.1
PYRRHOTITE	0.3	0.3	0.3	0.6	0.3		1.9
KALSILITE	5.6	4.5	2.9	5.3	8.4		17.7
K-SILICATE							
NEPHELINE	0.5	1.4	1.4	1.8	1.9		1.4
NA-SILICATE							
ANORTHITE	3.7	1.6	2.8	2.1	4.7		6.7
HERCYNITE	5.3	5.5	5.0	6.9	3.9		
MULLITE							
CA-SILICATE						0.3	3.4
FORSTERITE	0.5	0.4	0.2	0.2	0.4	2.0	
TEPHROITE	0.3	0.3	0.4	0.2	0.3	0.6	
FAYALITE	80.9	78.9	81.0	76.4	77.4	92.6	27.5
GEHLENITE							
WUSTITE					0.5	3.9	
ORTHOCLASE	0.9	3.6	3.9	3.3			25.8
ALBITE							
WOLLASTONITE							
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 9.6.10 SAMPLE PARK NORTH NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	81.7	18.3	0.0	9.15	15.85
2	79.6	20.4	0.0	10.2	17.7
3	81.6	18.4	0.0	9.2	15.9
4	76.8	23.2	0.0	11.6	20.1
5	78.1	21.4	0.5	11.2	18.5

SAMPLE PARK NORTH NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	2.1				
3	0.1	2.1			
4	4.9	2.8	4.8		
5	3.35	1.3	3.3	1.65	

Mean r-factor = 2.6 Standard Deviation = 1.5

SAMPLE PARK NORTH VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	6.7	11.7	1.7	1.7	1.7
2	4.6	9.6	0.45	0.45	0.45
3	6.6	11.65	1.6	1.6	1.6
4	1.8	6.8	3.2	3.2	3.2
5	3.4	8.4	1.7	1.7	1.7

Mean r-factor = 3.9 Standard Deviation = 3.4

TABLE 9.6.11 OAK CRAG AND PARK NORTH MEAN BULK ANALYSES
(Weight Percent)

	Oak Crag		Park North	
	Mean	S.D.	Mean	S.D.
Na_2O	0.3	0.2	0.3	0.1
MgO	0.4	0.3	0.2	0.1
Al_2O_3	4.8	0.4	6.7	0.7
SiO_2	28.8	1.6	28.3	0.35
P_2O_5	0.4	0.2	0.7	0.2
S	0.1	0.04	0.1	0.04
K_2O	2.0	0.2	1.9	0.3
CaO	2.4	0.1	1.5	0.2
TiO_2	0.5	0.1	0.4	0.1
V_2O_5	0.0	0.0	0.0	0.0
Cr_2O_6	0.0	0.0	0.1	0.1
MnO	4.5	0.3	0.2	0.1
FeO	54.6	1.4	57.7	1.5
CoO	0.2	0.1	0.3	0.2
NiO	0.2	0.1	0.1	0.1

TABLES 9.7.1 - 9.7.4 OUSE GILL DATA

TABLE 9.7.1 SAMPLE OUSE GILL VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60	40	0	20.0	34.6
2	60	40	0	20.0	34.6
3	50	50	0	25.0	43.3
4	60	40	0	20.0	34.6
5	60	40	0	20.0	34.6

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	0				
3	10	10			
4	0	0	10		
5	0	0	10	0	

Mean r-factor = 4 Standard Deviation = 5

TABLE 9.7.2 OUSE GILL BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS	FEOX
Na_2O	0.4	0.2	0.4	0.4	0.4	0.3	0.5	0.2
MgO	4.3	3.3	4.2	4.0	5.1	14.3	0.3	N.D
Al_2O_3	9.2	11.6	9.0	9.1	9.2	0.5	15.6	11.4
SiO_2	30.8	32.0	30.0	30.9	30.6	33.0	31.8	33.1
P_2O_5	1.6	2.1	1.7	2.0	1.7	0.4	2.6	3.9
S	0.2	0.3	0.1	0.3	0.2	N.D	0.5	0.4
K_2O	2.4	3.0	2.2	2.4	2.2	N.D	4.3	5.6
CaO	11.0	13.2	11.3	10.7	10.3	1.7	17.1	21.2
TiO_2	0.7	0.8	0.5	0.5	0.5	0.1	1.1	0.7
V_2O_5	N.D	N.D	0.2	0.1	0.1	N.D	N.D	N.D
Cr_2O_6	0.1	0.1	N.D	N.D	N.D	N.D	N.D	0.1
MnO	1.0	1.1	1.3	1.2	1.2	1.7	0.7	0.5
FeO	37.4	33.4	36.0	36.3	38.0	46.3	24.0	21.8
CoO	0.3	N.D	0.5	0.2	N.D	0.3	0.3	0.1
NiO	0.1	N.D	0.1	N.D	0.1	0.2	N.D	0.2
Total	99.5	101.1	97.5	98.1	99.6	98.8	98.8	99.2

TABLE 9.7.3 SAMPLE OUSE GILL NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
APATITE	3.5	4.6	3.8	4.7	3.6	0.9	6.1	9.2
VIVIANITE								
ULVITE	1.9	2.1	1.3	1.4	1.3	0.3	3.1	2.0
PYRRHOTITE	0.5	0.8	0.3	0.8	0.5		1.4	1.1
KALSILITE	7.6	9.6	7.1	8.1	6.8		14.6	13.6
K-SILICATE								
NEPHELINE	1.7	0.9	1.7	1.8	1.7		2.3	0.9
NA-SILICATE								
ANORTHITE	15.4	21.0	15.6	16.0	15.4		27.9	13.9
HERCYNITE								
MULLITE								
CA-SILICATE	8.2	8.9	8.5	7.5	6.6	1.8	12.6	20.7
FORSTERITE	7.1	5.5	7.0	7.0	8.2	25.4	0.5	
TEPHROITE	1.3	1.5	1.8	1.7	1.6	2.5	1.0	0.7
FAYALITE	48.0	42.4	47.3	49.5	47.7	66.5	29.9	28.2
GEHLENITE	4.7	2.6	5.8	1.3	6.6		0.5	
WUSTITE								
ORTHOCLASE								9.6
ALBITE						2.5		
WOLLASTONITE								
ENSTATITE								
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 9.7.4 SAMPLE OUSE GILL NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	56.4	43.5	0.0	21.75	37.7
2	49.4	50.5	0.0	25.25	43.7
3	56.1	44.1	0.0	22.05	38.2
4	58.2	41.6	0.0	20.8	36.0
5	57.5	42.5	0.0	21.25	36.8

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	6.95				
3	0.6	6.4			
4	1.95	8.9	2.5		
5	1.0	8.0	1.6	0.9	

Mean r-factor = 5.3 Standard Deviation = 4.9

SAMPLE OUSE GILL VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	3.6	10.5	4.1	1.6	2.5
	2	3.6	10.5	4.1	1.6	2.5
	3	6.5	0.5	5:9	8.4	7.5
	4	3.6	10.5	4.1	1.6	2.5
	5	3.6	10.5	4.1	1.6	2.5

Mean r-factor = 4.7 Standard Deviation = 3.2

TABLES 9.8.1 - 9.8.3 TAP SLAG SUMMARY DATA

TABLE 9.8.1 MEAN BULK ANALYSES (Weight Percent)

	FARTH	LEV	AMG714	AMG878	AMG783	BAYS	OAK	PARK	OUSE
Na_2O	0.2	0.1	0.2	0.3	0.2	0.3	0.3	0.3	0.4
MgO	0.2	0.3	0.8	0.5	0.4	4.1	0.4	0.2	4.2
Al_2O_3	8.8	1.0	5.5	3.1	4.7	9.7	4.8	6.7	9.6
SiO_2	43.8	19.8	31.5	17.5	33.2	27.4	28.8	28.3	30.9
P_2O_5	1.7	0.4	1.0	0.8	1.1	2.5	0.4	0.7	1.8
S	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2
K_2O	1.7	0.6	1.4	0.8	1.1	2.2	2.0	1.9	2.4
CaO	0.6	2.8	4.3	1.8	2.4	10.4	2.4	1.5	11.3
TiO_2	0.6	0.3	0.2	0.1	0.2	0.6	0.5	0.4	0.6
V_2O_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Cr_2O_6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0
MnO	0.0	8.3	9.2	7.7	4.9	1.3	4.5	0.2	1.2
FeO	42.3	66.8	47.0	67.5	52.5	41.1	54.6	57.7	36.2
CoO	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.2
NiO	0.0	0.1	0.1	0.2	0.3	0.0	0.2	0.1	0.1
Total	100.3	101.2	101.7	100.9	101.2	100.1	99.3	98.4	99.2

TABLE 9.8.2 TAP SLAG OVERALL MEAN VALUES (Weight Percent)

	MEAN	S.D.
Na_2O	0.3	0.2
MgO	1.4	1.7
Al_2O_3	5.6	3.0
SiO_2	27.3	6.0
P_2O_5	1.1	0.7
S	0.1	0.1
K_2O	1.6	0.7
CaO	4.6	3.8
TiO_2	0.4	0.2
V_2O_5	0.0	0.0
Cr_2O_6	0.0	0.0
MnO	4.5	3.3
FeO	53.1	11.1
CoO	0.2	0.1
NiO	0.1	0.1

TABLE 9.8.3 TAP SLAG MEAN r-FACTOR VALUES

SAMPLE	VOLUMETRIC	TERNARY	VOL/TERN
LEVISHAM	16	19.7	17.7
AMG714	7	8.3	18.4
AMG878	11	3.0	9.0
AMG783	5	1.2	25.1
BAYS	8	7.6	7.7
OAK	6	5.0	11.1
PARK	5	2.6	3.9
OUSE	4	5.3	4.7
MEAN	8	6.6	12.2

TABLES 9.10.1 - 9.10.33 MILLBROOK DATA

TABLE 9.10.1 MILLBROOK SLAG CAKE DIMENSIONS

Sample No.	Weight kg	Major Diameter mm	Minor Diameter mm	Depth mm
A	2.85	170	150	120
C	1.10	170	100	50
D	1.4	200	90	50
E	1.75	160	90	50
F	2.5	200	170	90
	1.6	150	130	75
	1.2	170	110	60
	0.85	150	110	35
	1.4	130	120	50
	0.8	115	110	50
	0.7	150	90	20
	0.5	100	90	45
	5.0	300	250	150

TABLE 9.10.2 WET CHEMICAL AND X.R.F ANALYSES OF SAMPLES A, C, D, and E

	Wet Analyses Sample A	C	X.R.F. Analyses Sample D	E
Na_2O	nd	nd	nd	nd
MgO	nd	nd	1.84	0.17
Al_2O_3	9.1	11.0	5.56	0.78
SiO_2	21.48	28.41	29.8	12.5
P_2O_5	0.21	0.32	0.72	1.55
S	nd	0.16	nd	nd
K_2O	nd	nd	0.93	0.15
CaO	1.30	4.60	9.7	1.24
TiO_2	nd	nd	0.44	0.22
V_2O_5	nd	nd	0.05	0.075
Cr_2O_6	nd	nd	nd	nd
MnO	nd	nd	3.76	1.22
FeO	23.40	30.0	45.2	74.4
Fe_2O_3	34.38	14.06		
CO_2	11.20	1.03		
	101.6	89.63	97.97	92.32

TABLE 9.10.3 NORMATIVE PHASE COMPOSITIONS OF WET CHEMICAL AND X.R..F. ANALYSES

(Weight Percent. 1 used FeO and Fe_2O_3; 2 used Feo only)

	Sample A		Sample C		Sample D	Sample E
	1	2	1	2		
APATITE	0.5	0.5	0.8	0.8	1.6	2.4
VIVIANITE						1.7
ULVITE					1.2	0.7
PYHROTITE			0.6	0.6		
KALSILITE					3.0	0.6
K-SILICATE						
NEPHELINE						
NA-SILICATE						
ANORTHITE	5.7	6.0	23.5	23.9	11.9	
HERCYNITE	13.7	14.2	6.7	6.8		1.1
MULLITE						
CA-SILICATE					9.2	
FORSTERITE					3.1	0.3
TEPHROITE					5.1	1.9
FAYALITE		75.6	12.6	53.8	60.2	42.9
GEHLENITE					4.7	
WUSTITE		3.6				48.5
ORTHOCLASE						
ALBITE						
WOLLASTONITE						
ENSTATITE						
RHODONITE						
FERROSILITE	37.4		39.9	14.1		
QUARTZ	4.4					
HEMATITE	38.3		15.9			

TABLE 9.10.4 SAMPLE MILLBROOK A VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	80	15	5	12.5	13.0
2	70	15	15	22.5	13.0
3	50	20	30	40.0	17.3
4	40	30	30	45.0	26.0
5	70	10	20	25.0	8.7

SAMPLE MILLBROOK A VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	28	18			
4	35	26	10		
5	13	5	17	26	

Mean r-factor = 19 Standard Deviation = 10

TABLE 9.10.5 SAMPLE MILLBROOK A BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	Glass	FEOX	XTAL
Na_2O	N.D	0.6	N.D	0.1	N.D	0.2	1.0	N.D	N.D
MgO	N.D	N.D	N.D	N.D	0.2	0.7	N.D	N.D	N.D
Al_2O_3	8.9	8.7	6.6	8.2	7.0	0.5	11.5	0.3	33.8
SiO_2	30.8	30.3	30.0	32.4	21.2	29.5	33.6	0.7	2.5
P_2O_5	1.0	0.9	0.3	0.9	0.6	N.D	3.9	N.D	N.D
S	0.3	0.4	0.2	0.1	0.2	N.D	3.6	0.1	N.D
K_2O	3.6	3.3	2.4	3.8	3.1	N.D	1.5	N.D	0.1
CaO	4.6	5.7	3.3	3.8	1.6	1.0	20.3	N.D	0.2
TiO_2	0.3	0.4	0.1	0.2	0.3	N.D	0.2	0.2	2.3
V_2O_5	0.1	N.D	N.D	0.2	N.D	N.D	N.D	0.1	0.3
Cr_2O_6	N.D	N.D	N.D	N.D	0.1	N.D	N.D	0.2	0.1
MnO	0.9	1.2	1.0	1.2	0.3	1.5	0.4	0.3	0.1
FeO	43.9	45.1	51.8	50.2	58.5	67.2	23.1	95.2	55.2
CoO	0.1	0.4	0.4	0.3	0.5	0.3	N.D	0.7	0.2
NiO	0.1	0.2	0.2	0.1	0.1	0.4	0.1	0.4	0.1
Total	94.6	97.2	96.3	101.5	93.7	101.3	99.2	98.2	94.9

TABLE 9.10.6 SAMPLE MILLBROOK A NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS	XTAL
APATITE	2.5	2.2	0.7	2.1	1.5		9.3	
VIVIANITE								
ULVITE	0.9	1.1	0.3	0.6	0.9		0.6	6.8
PYHROTITE	0.9	1.1	0.6	0.3	0.6		10.1	
KALSILITE	10.3	11.3	8.4	11.0	11.2			0.3
K-SILICATE								
NEPHELINE		2.9		0.4		0.9		
NA-SILICATE								
ANORTHITE	14.5	11.7	11.4	10.6	4.3		23.1	1.1
HERCYNITE					4.0			60.3
MULLITE								
CA-SILICATE	0.9	3.6	1.1	0.7		1.2	15.8	
FORSTERITE					0.4	1.2		
TEPHROITE	1.4	1.8	1.5	1.7	0.5	2.1	0.6	0.1
FAYALITE	64.3	64.0	75.9	69.7	55.6	92.4	21.4	6.8
GEHLENITE						0.5		
WUSTITE					21.0	1.6		24.4
ORTHOCLASE	4.4	0.4		2.8			9.1	
ALBITE							8.7	
WOLLASTONITE							1.4	
ENSTATITE								
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 9.10.7 SAMPLE MILLBROOK A NORMATIVE PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	65.7	34.3	0.0	17.15	29.7
2	65.8	34.2	0.0	17.1	29.6
3	77.4	22.6	0.0	11.3	19.6
4	71.4	28.6	0.0	14.3	24.8
5	56.5	22.5	21.0	32.25	19.5

SAMPLE MILLBROOK A NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	0.1				
3	11.7	11.6			
4	5.7	5.6	6.0		
5	18.2	18.2	20.95	18.7	

Mean r-factor = 11.7. Standard Deviation = 7.1

SAMPLE MILLBROOK A VOLUMETRIC AND NORMATIVE r-factors

VOLUMETRIC	NORMATIVE B1	B2	B3	B4	B5
1	17.3	17.5	26.0	28.1	22.4
2	17.2	17.5	26.0	28.1	22.4
3	6.7	13.0	28.8	34.3	17.5
4	11.9	14.4	26.8	30.7	19.3
5	20.8	11.7	8.1	14.3	13.0

Mean r-factor = 19.75 Standard Deviation = 7.4

TABLE 9.10.8 'r-factor' COMPARISON BETWEEN WET CHEMICAL AND S.E.M. NORMATIVE TERNARY GROUPINGS FOR SAMPLE A

	NORMATIVE				
	B1	B2	B3	B4	B5
1	33.5	33.5	37.0	34.8	16.2
2	12.2	12.1	3.1	6.9	18.4

1 = CALCULATED USING FeO AND Fe_2O_3

2 = " " FeO ONLY

TABLE 9.10.9 SAMPLE MILLBROOK C AREA A VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	45	30	25	40.0	26.0
2	50	25	25	37.5	21.6
3	70	15	15	22.5	13.0
4	70	30	0	15.0	26.0

SAMPLE MILLBROOK C AREA A VOLUMETRIC 'r-factor' VALUES

	1	2	3	4
1				
2	5			
3	22	17		
4	25	23	15	

Mean r-factor = 18 Standard Deviation = 7

SAMPLE MILLBROOK C AREA B VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	50	30	20	35.0	26.0
2	50	40	10	30.0	34.6
3	40	40	20	40.0	34.6
4	50	25	25	37.5	21.6
5	30	40	30	50.0	34.6

SAMPLE MILLBROOK C AREA B VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	10	10			
4	5	15	13		
5	17	20	10	18	

Mean r-factor = 13 Standard Deviation = 5

TABLE 9.10.10 SAMPLE MILLBROOK C AREA B BULK ANALYSES
(Weight Percent)

	B1	B2	B3	B4
Na_2O	0.2	N.D	0.2	N.D
MgO	1.7	2.0	0.7	1.0
Al_2O_3	4.9	4.0	6.7	3.5
SiO_2	29.1	26.2	25.5	21.3
P_2O_5	1.0	0.8	1.4	0.7
S	0.2	0.2	0.2	N.D
K_2O	0.9	0.3	1.9	0.4
CaO	11.6	8.6	13.5	9.3
TiO_2	0.5	0.4	0.6	0.4
V_2O_5	0.2	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D
MnO	5.6	5.2	4.4	5.3
FeO	45.7	54.6	47.4	58.7
CoO	N.D	0.1	N.D	N.D
NiO	N.D	0.3	N.D	0.3
Total	101.6	102.7	102.5	100.9

TABLE 9.10.11 SAMPLE MILLBROOK C AREA B PHASE ANALYSES
(Weight Percent)

	SIL1	SIL2	GLASS1	GLASS2	FEOX1	FEOX2
Na_2O	0.2	0.3	0.5	0.4	N.D	N.D
MgO	5.1	5.2	N.D	0.2	0.1	N.D
Al_2O_3	0.1	0.3	12.3	13.8	0.6	0.9
SiO_2	29.3	29.9	32.6	32.6	0.7	0.8
P_2O_5	0.4	0.3	2.9	3.3	N.D	N.D
S	0.1	N.D	0.7	0.5	N.D	N.D
K_2O	0.1	N.D	6.1	6.4	0.1	0.1
CaO	6.3	6.0	19.3	18.0	0.3	0.2
TiO_2	0.1	N.D	0.3	0.6	1.1	0.7
V_2O_5	0.1	N.D	N.D	N.D	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D
MnO	9.1	9.5	2.5	1.9	2.3	2.7
FeO	49.5	50.1	20.9	21.8	95.0	94.5
CoO	N.D	N.D	N.D	N.D	N.D	N.D
NiO	0.3	N.D	N.D	N.D	N.D	N.D
Total	100.7	101.6	98.1	99.5	100.2	100.0

TABLE 9.10.12 SAMPLE MILLBROOK C AREA B NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	SIL1	SIL2	GLASS1	GLASS2
APATITE	2.0	1.4	2.3	1.6	0.9	0.7	6.9	7.7
VIVIANITE								
ULVITE	1.2	0.8	1.2	1.1	0.3		0.9	1.7
PYHROTITE	0.5	0.4	0.4		0.3		2.0	1.4
KALSILITE	2.6	0.7	4.6	1.3	0.3		17.8	19.4
K-SILICATE								
NEPHELINE	0.8		0.7				2.4	1.8
NA-SILICATE					0.4	0.2		
ANORTHITE	8.6	7.6	8.5				13.6	17.1
HERCYNITE								
MULLITE								
CA-SILICATE	11.1	6.4	10.3	7.6	8.8	8.5	20.1	15.8
FORSTERITE	2.6	2.6	0.9	1.7	8.9	9.0		0.3
TEPHROITE	6.9	5.6	4.5	7.5	12.9	13.4	3.6	2.7
FAYALITE	54.8	57.2	47.0	44.9	61.7	62.4	27.3	28.0
GEHLENITE	8.8	17.2	19.6	8.2				
WUSTITE				26.0	5.5	5.7		
ORTHOCLASE							5.5	3.9
ALBITE								
WOLLASTONITE								
ENSTATITE								
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 9.10.13 SAMPLE MILLBROOK C AREA B NORMATIVE PHASE PERCENTAGES

Calcium Silicate Apportioned to Silicate and Glass Phases

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	67.9	32.1	0.0	16.05	27.8
2	67.5	32.5	0.0	16.15	28.15
3	55.7	44.3	0.0	22.15	38.4
4	56.6	17.4	26.0	34.7	15.1

Normative Phase 'r-factor' Values

	1	2	3	4
1				
2	0.4			
3	12.2	11.8		
4	22.6	22.6	26.5	

Mean r-factor = 16.0 Standard Deviation = 9.7

Calcium Silicate Apportioned To Glass Phase Only

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	64.3	35.7	0.0	17.85	30.9
2	65.4	34.6	0.0	17.3	30.0
3	52.4	47.6	0.0	23.8	41.2
4	54.1	19.9	26.0	36.0	17.2

Normative Phase 'r-factor' Values

	1	2	3	4
1				
2	1.05			
3	11.9	12.95		
4	22.7	22.7	26.9	

Mean r-factor = 16.4 Standard Deviation = 9.6

Calcium Silicate Apportioned to Silicate Phase Only

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	75.4	24.6	0.0	12.3	21.3
2	71.8	28.2	0.0	14.1	24.4
3	62.7	37.3	0.0	18.65	32.3
4	61.7	12.2	26.0	32.1	10.6

Normative Phase 'r-factor' Values

	1	2	3	4
1				
2	3.6			
3	12.7	9.1		
4	22.5	22.7	25.5	

Mean r-factor = 16.0 Standard Deviation = 8.8

TABLE 9.10.14 SAMPLE MILLBROOK C AREA B VOLUMETRIC AND NORMATIVE 'r-factor' VALUES

14.1 Calcium Silicate Apportioned to Silicate and Glass

VOLUMETRIC	NORMATIVE 1	2	3	4
1	19.0	18.9	17.9	10.9
2	15.5	15.2	8.7	20.1
3	24.9	24.6	18.25	20.2
4	22.3	22.2	22.8	7.1
5	34.6	34.4	28.1	24.8

Mean r-factor = 20.5 Standard Deviation = 7.2

14.2 Calcium Silicate Apportioned to Glass Phase Only

VOLUMETRIC	NORMATIVE 1	2	3	4
1	17.8	18.15	18.95	8.9
2	12.7	13.5	9.1	18.4
3	22.5	23.2	17.5	17.9
4	21.7	21.9	23.9	4.65
5	32.4	33.0	27.0	22.3

Mean r-factor = 19.3 Standard Deviation = 7.3

14.3 Calcium Silicate Apportioned To Silicate Phase Only

VOLUMETRIC	NORMATIVE 1	2	3	4
1	23.2	21.0	17.5	15.7
2	22.1	18.9	11.6	24.1
3	30.7	27.8	21.5	25.3
4	25.2	23.6	21.7	12.25
5	40.0	37.3	31.4	29.9

Mean r-factor = 24.0 Standard Deviation = 7.4

TABLE 9.10.15 SAMPLE MILLBROOK C AREA B COMPARISON BETWEEN WET CHEMICAL AND S.E.M. BULK ANALYSES NORMATIVE TERNARY GROUPINGS

Comparison 'r-factor' Values

	B1	B2	B3	B4	
WC1	21.3	27.9	20.3	19.4	r-mean = 22.2
WC2	8.8	16.8	7.4	24.6	r-mean = 14.4

WC1 = wet chemical analysis including Fe_2O_3 and FeO

WC2 = " " " " FeO only

TABLE 9.10.16 SAMPLE MILLBROOK D VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	70	20	10	20.0	17.3
2	75	20	5	15.0	17.3
3	70	25	5	17.5	21.6
4	90	10	0	5.0	8.7
5	70	25	5	17.5	21.6

Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	5				
3	5	5			
4	17	13	18		
5	5	5	0	18	

Mean r-factor = 9 Standard Deviation = 7

TABLE 9.10.17 SAMPLE MILLBROOK D BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
Na_2O	0.1	0.1	0.4	0.5	N.D	N.D	0.3
MgO	1.0	1.4	1.4	0.7	0.9	3.0	N.D
Al_2O_3	5.3	5.0	5.6	7.9	5.8	N.D	15.6
SiO_2	30.5	30.2	30.6	31.6	30.0	29.6	41.7
P_2O_5	0.9	0.9	0.9	1.3	0.9	N.D	4.3
S	0.2	0.2	0.2	0.4	0.2	0.1	0.3
K_2O	1.4	1.2	1.6	2.2	1.7	0.1	10.3
CaO	12.8	12.1	13.0	16.1	12.7	5.8	15.0
TiO_2	0.5	0.4	0.4	0.9	0.5	0.1	0.3
V_2O_5	N.D	N.D	N.D	N.D	N.D	0.2	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	N.D
MnO	4.7	4.7	4.5	3.6	4.1	7.0	0.8
FeO	42.7	44.5	43.3	37.3	41.9	53.2	10.1
CoO	0.2	0.3	N.D	0.1	0.2	N.D	N.D
NiO	0.1	0.2	N.D	N.D	0.2	0.1	N.D
Total	100.4	101.2	101.9	102.6	99.1	99.2	98.7

TABLE 9.10.18 SAMPLE MILLBROOK D NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
APATITE	2.0	1.9	1.9	2.9	2.0		10.1
VIVIANITE							
ULVITE	1.4	1.0	1.0	2.4	1.4	0.3	0.9
PYHROTITE	0.5	0.5	0.5	1.0	0.5	0.3	0.8
KALSILITE	4.5	3.7	4.9	7.0	5.5		14.5
K-SILICATE						0.2	
NEPHELINE	0.4	0.4	1.7	2.2			1.4
NA-SILICATE							
ANORTHITE	9.5	9.0	8.0	12.2	10.4		11.0
HERCYNITE							
MULLITE							
CA-SILICATE	14.2	12.8	14.1	17.3	13.8	9.0	11.1
FORSTERITE	1.7	2.3	2.2	1.2	1.5	5.3	
TEPHROITE	6.4	6.2	5.8	4.9	5.6	10.1	1.2
FAYALITE	56.5	57.3	54.5	47.0	55.5	72.8	12.8
GEHLENITE	2.7	4.7	5.4	1.8	3.6		
WUSTITE						2.1	
ORTHOCLASE							30.2
ALBITE							
WOLLASTONITE							
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 9.10.19 SAMPLE MILLBROOK D NORMATIVE PHASE PERCENTAGES

19.1 Calcium Silicate Apportioned to Silicate and Glass Phases

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	71.0	29.0	0.0	14.55	25.1
2	71.5	28.5	0.0	14.25	24.7
3	68.8	31.2	0.0	15.6	27.0
4	60.8	39.2	0.0	19.6	33.95
5	68.8	31.2	0.0	15.6	27.0

Normative Phase 'r-factor' Values

	1	2	3	4	5
1					
2	0.5				
3	2.2	2.7			
4	10.2	10.7	8.0		
5	2.2	2.7	0.0	8.0	

Mean r-factor = 4.7 Standard Deviation = 4.1

19.2 Calcium Silicate Apportioned to Glass Phase Only

	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	64.6	35.4	0.0	17.7	30.7
2	65.8	34.2	0.0	17.15	29.6
3	62.5	37.5	0.0	18.75	32.5
4	53.1	46.9	0.0	23.45	40.6
5	62.6	37.4	0.0	18.7	32.4

19.3 Silicate Aportioned to Silicate Phase Only

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	78.8	21.2	0.0	10.65	18.4
2	78.6	21.4	0.0	10.75	18.5
3	76.6	23.4	0.0	11.7	20.3
4	70.4	29.6	0.0	14.8	25.6
5	76.4	23.6	0.0	11.8	20.4

TABLE 9.10.20 SAMPLE MILLBROOK D VOLUMETRIC/NORMATIVE r-factors

20.1 Calcium Silicate Apportioned to Silicate and Glass Phases

VOLUMETRIC \ NORMATIVE	1	2	3	4	5
1	9.5	9.4	10.65	16.65	10.65
2	7.85	7.4	9.7	17.3	9.7
3	4.6	4.5	5.7	12.5	5.7
4	18.95	18.5	21.15	29.2	21.15
5	4.6	4.5	5.7	12.5	5.7

Mean r-factor = 11.3 Standard Deviation = 6.5

20.2 Calcium Silicate Apportioned to Glass Phase Only

VOLUMETRIC \ NORMATIVE	1	2	3	4	5
1	13.6	12.6	15.25	23.55	15.2
2	13.7	12.5	15.7	24.8	15.55
3	9.1	8.0	11.0	19.9	10.9
4	25.4	24.15	27.5	36.85	27.4
5	9.1	8.0	11.0	19.9	10.9

Mean r-factor = 16.9 Standard Deviation = 7.5

20.3 Calcium Silicate Apportioned to Silicate Phase Only

VOLUMETRIC \ NORMATIVE	1	2	3	4	5
1	9.5	9.4	8.8	9.8	8.8
2	4.5	4.5	4.5	8.3	4.5
3	7.6	7.5	5.9	4.8	5.8
4	11.2	11.3	13.4	19.5	13.5
5	7.6	7.5	5.9	4.8	5.8

Mean r-factor = 8.2 Standard Deviation = 3.6

TABLE 9.10.21 SAMPLE MILLBROOK D MEAN S.E.M. AND X.R.F BULK ANALYSES AND NORMATIVE CONSTITUENTS (Weight Percent)

BULK ANALYSES	S.E.M.	X.R.F.	NORMATIVE CONSTITUENTS	S.E.M.	X.R.F
Na_2O	0.2	n.d	APATITE	2.1	
MgO	1.1	1.8	VIVIANITE		
Al_2O_3	5.9	5.56	ULVITE	1.4	1.2
SiO_2	30.6	29.8	PYHROTITE	0.6	
P_2O_5	1.0	n.d	KALSILITE	5.1	3.0
S	0.2	n.d	K-SILICATE		
K_2O	1.6	0.93	NEPHELINE	0.9	
CaO	13.3	9.7	NA-SILICATE		
TiO_2	0.5	0.44	ANORTHITE	9.8	11.7
V_2O_5	0.0	0.05	HERCYNITE		
Cr_2O_6	0.0	n.d	MULLITE		
MnO	4.3	3.76	CA-SILICATE	14.4	10.4
FeO	41.9	45.2	FORSTERITE	1.8	3.0
CoO	0.1	n.d	TEPHROITE	5.8	5.1
NiO	0.1	n.d	FAYALITE	54.2	59.5
Total	100.8	97.28	GEHLENITE	3.6	6.2
			ORTHOCLASE		
			ALBITE		
			WOLLASTONITE		
			ENSTATITE		
			RHODONITE		
			FERROSILITE		
			QUARTZ		

TABLE 9.10.22 SAMPLE MILLBROOK E VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	65	20	15	25.0	17.3
2	65	20	15	25.0	17.3
3	65	25	10	22.5	21.6
4	75	10	15	20	8.7
5	65	25	10	22.5	21.6

Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	0				
3	5	5			
4	10	10	13		
5	5	5	0	13	

Mean r-factor = 7 Standard Deviation = 5

TABLE 9.10.23 SAMPLE MILLBROOK E BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	SIL	GLASS	FEOX
Na_2O	0.2	N.D	0.5	0.5	N.D
MgO	1.9	1.2	2.4	N.D	N.D
Al_2O_3	5.1	4.4	N.D	11.8	0.6
SiO_2	25.5	26.3	29.7	33.1	0.6
P_2O_5	0.9	0.6	0.5	3.2	N.D
S	0.2	N.D	0.1	1.9	N.D
K_2O	1.2	1.2	N.D	6.3	0.1
CaO	11.7	12.4	14.6	17.1	0.3
TiO_2	0.7	0.5	N.D	0.4	1.1
V_2O_5	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	0.1	N.D	0.1	N.D
MnO	5.4	5.8	7.2	2.2	2.2
FeO	47.8	47.9	46.4	24.6	90.1
CoO	0.5	0.4	0.3	0.2	0.5
NiO	N.D	0.2	N.D	0.1	0.2
Total	101.1	101.0	101.7	101.5	95.7

TABLE 9.10.24 SAMPLE MILLBROOK E NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	SIL	GLASS
APATITE	1.6	1.1	1.1	7.4
VIVIANITE				
ULVITE	1.5	1.8		1.1
PYHROTITE	0.4		0.3	5.2
KALSILITE	3.0	3.1		15.4
K-SILICATE				
NEPHELINE	0.7			2.3
NA-SILICATE			1.0	
ANORTHITE	7.1	6.5		11.3
HERCYNITE				
MULLITE				
CA-SILICATE	9.9	11.7	21.1	16.3
FORSTERITE	2.5	1.6	4.1	
TEPHROITE	5.8	6.4	10.1	3.1
FAYALITE	49.1	51.5	56.6	27.8
GEHLENITE	18.5	16.9		
WUSTITE			5.7	
ORTHOCLASE				10.1
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 9.10.25 SAMPLE MILLBROOK E NORMATIVE PHASE PERCENTAGES

25.1 Calcium Silicate Apportioned to Silicate and Glass

BULK	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	63.0	37.0	0.0	18.55	32.0
2	66.1	33.9	0.0	16.95	29.4

r-factor = 3.0

Volumetric/Normative Phase 'r-factor' Values

	VOLUMETRIC 1	2	3	4	5
1	16.1	16.1	11.1	23.35	11.1
2	14.5	14.5	9.6	20.9	9.6

Mean r-factor = 14.7 Standard Deviation = 4.7

25.2 Calcium Silicate Apportioned to Glass Phase

BULK	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	57.4	42.6	0.0	21.35	36.9
2	59.5	40.5	0.0	20.25	35.1

Volumetric/normative Phase 'r-factor' Values

	VOLUMETRIC 1	2	3	4	5
1	19.95	19.95	15.35	28.2	15.35
2	18.4	18.4	13.7	26.4	13.7

Mean r-factor = 18.9 Standard Deviation = 5.0

25.3 Calcium Silicate Apportioned to Silicate Phase

BULK	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	67.3	32.7	0.0	16.35	28.3
2	71.2	28.8	0.0	14.45	24.9

Volumetric/Normative Phase 'r-factor' Values

V O L U M E T R I C

	1	2	3	4	5
1	14.0	14.0	9.1	19.9	9.1
2	13.0	13.0	8.75	17.1	8.75

Mean r-factor = 12.7 Standard Deviation = 3.8

TABLE 9.10.26 SAMPLE MILLBROOK E MEAN X.R.F AND S.E.M. BULK ANALYSES AND NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	XRF	SEM
Na_2O	n.d	0.1
MgO	0.17	1.55
Al_2O_3	0.78	4.75
SiO_2	12.5	25.9
P_2O_5	n.d	0.75
S	n.d	0.1
K_2O	0.15	1.2
CaO	1.24	12.05
TiO_2	0.22	0.6
V_2O_5	0.075	N.D
Cr_2O_6	n.d	0.05
MnO	1.22	5.6
FeO	74.4	47.85
CoO	n.d	0.45
NiO	n.d	0.1
Total	90.755	101.05

	XRF	SEM
APATITE		1.3
VIVIANITE		
ULVITE	0.7	1.6
PYHROTITE		0.2
KALSILITE	0.6	3.0
K-SILICATE		
NEPHELINE		0.3
NA-SILICATE		
ANORTHITE		6.8
HERCYNITE		
MULLITE		
CA-SILICATE	0.9	10.8
FORSTERITE	0.3	2.0
TEPHROITE	1.9	6.1
FAYALITE	41.2	50.3
GEHLENITE	1.8	17.7
ORTHOCLASE		
ALBITE		
WOLLASTONITE		
ENSTATITE		
RHODONITE		
FERROSILITE		
QUARTZ		

TABLE 9.10.27 SAMPLE MILLBROOK XX VOLUMETRIC PHASE PERCENTAGES

SAMPLE XX.1

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	20	20	30.0	17.3
2	60	30	10	25.0	26.0
3	55	40	5	25.0	34.6
4	50	30	20	35.0	26.0
5	60	25	15	27.5	21.6

SAMPLE XX.1 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	10				
3	18	9			
4	10	10	13		
5	5	5	13	9	

Mean r-factor = 10 Standard Deviation = 4

27.2 SAMPLE XX.2 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	75	15	10	17.5	13.0
2	60	15	25	32.5	13.0
3	40	25	35	47.5	21.65
4	70	20	10	20.0	17.3

Volumetric 'r-factor' Values

	1	2	3	4
1				
2	15			
3	31	17		
4	5	13 2	28	

Mean r-factor = 18 Standard Deviation = 10

27.3 SAMPLE XX.3 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	70	20	10	20.0	17.3
2	60	25	15	27.5	21.65
3	65	20	15	25.0	17.3
4	50	35	10	27.5	30.3
5	55	25	20	32.5	21.65

Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	9				
3	5	5			
4	15	9	13		
5	13	5	9	10	

Mean r-factor = 9 Standard Deviation = 4

TABLE 9.10.28 SAMPLE MILLBROOK XX.3 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	N.D	0.1	N.D	N.D	N.D
MgO	0.8	0.6	1.4	1.6	1.9
Al_2O_3	4.2	4.7	3.1	3.0	3.6
SiO_2	24.7	28.4	26.0	26.8	27.8
P_2O_5	0.7	1.1	1.1	0.5	0.9
S	0.3	0.3	0.3	0.1	0.2
K_2O	1.3	1.8	1.4	1.0	1.3
CaO	11.7	13.4	11.2	12.4	10.1
TiO_2	0.5	0.5	0.4	0.3	0.4
V_2O_5	N.D	N.D	0.2	0.2	0.1
Cr_2O_6	N.D	N.D	N.D	0.1	N.D
MnO	4.1	4.0	4.3	4.6	5.0
FeO	50.6	45.3	51.4	50.1	49.4
CoO	0.3	N.D	0.2	N.D	N.D
NiO	0.2	0.2	0.1	N.D	0.1
Total	99.4	100.4	101.1	100.7	101.2

TABLE 9.10.29 MILLBROOK XX.3 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	FEOX1	FEOX2	FEOX3	FEOX4
Na_2O	N.D	N.D	0.2	0.9	N.D	0.1	0.3	0.2
MgO	2.0	1.0	0.5	N.D	0.2	N.D	0.4	0.8
Al_2O_3	0.1	0.2	14.7	12.1	0.3	0.7	0.8	0.6
SiO_2	28.9	28.4	30.0	28.3	0.6	0.7	0.6	0.5
P_2O_5	0.1	0.8	2.6	13.5	N.D	0.1	N.D	0.2
S	N.D	N.D	0.6	0.5	0.1	0.1	N.D	N.D
K_2O	N.D	N.D	3.2	9.1	0.1	0.1	N.D	N.D
CaO	13.8	16.5	17.0	21.2	0.1	0.2	0.5	0.7
TiO_2	N.D	0.1	1.2	0.6	1.0	1.2	1.1	1.1
V_2O_5	0.1	N.D	N.D	N.D	0.1	N.D	0.1	0.1
Cr_2O_6	0.1	0.1	0.1	N.D	N.D	0.1	0.1	0.2
MnO	6.4	5.5	1.4	0.6	1.4	1.0	1.5	1.5
FeO	48.3	48.2	29.7	8.8	94.0	93.3	88.7	92.9
CoO	N.D	N.D	N.D	0.2	0.4	0.4	N.D	N.D
NiO	0.1	N.D	N.D	N.D	0.3	0.5	N.D	N.D
Total	99.9	100.8	101.2	95.8	98.6	98.4	94.1	98.8

TABLE 9.10.30 MILLBROOK XX.3 NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	1.2	2.2	2.5	1.1	1.7
VIVIANITE					
ULVITE	1.1	1.2	1.1	0.8	0.9
PYHROTITE	0.6	0.7	0.8	0.3	0.5
KALSILITE	3.3	5.3	4.7	3.3	3.7
K-SILICATE					
NEPHELINE		0.4			
NA-SILICATE					
ANORTHITE	5.8	6.3			5.0
HERCYNITE					
MULLITE					
CA-SILICATE	10.8	14.3	12.2	14.7	10.0
FORSTERITE	1.1	0.9	2.4	2.8	2.8
TEPHROITE	4.4	5.0	6.1	6.5	6.0
FAYALITE	53.0	54.9	54.4	54.4	58.0
GEHLENITE	18.6	8.6	4.2	5.1	11.4
WUSTITE			11.4	10.8	
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 9.10.31 MILLBROOK XX.3 PHASE NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2
APATITE	0.2	1.8	5.3	32.8
VIVIANITE				
ULVITE		0.3	2.9	1.7
PYHROTITE			1.4	1.4
KALSILITE			9.4	19.1
K-SILICATE				
NEPHELINE			0.8	4.3
NA-SILICATE				
ANORTHITE			26.1	2.2
HERCYNITE				
MULLITE				
CA-SILICATE	20.9	23.2	10.2	4.8
FORSTERITE	3.5	1.7	0.8	0.9
TEPHROITE	9.2	7.8	1.7	9.8
FAYALITE	59.2	57.4	32.5	
GEHLENITE	0.3	0.5	8.8	
WUSTITE	6.8	7.2		
ORTHOCLASE				22.8
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 9.10.32 SAMPLE MILLBROOK XX.3 NORMATIVE PHASE PERCENTAGES

32.1 Calcium Silicate Apportioned to Glass and Silicate Phases

BULK	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	66.6	33.4	0.0	16.7	28.9
2	71.5	28.5	0.0	14.25	24.7
3	72.0	16.6	11.4	19.7	14.4
4	74.7	14.5	10.8	18.05	12.6
5	74.3	25.7	0.0	12.85	22.3

Ternary 'r-factor' Values

	1	2	3	4	5
1					
2	4.9				
3	14.8	11.65			
4	16.4	12.7	2.4		
5	7.6	2.8	10.5	11.0	

Mean r-factor = 9.5 Standard Deviation = 4.5

Volumetric and Ternary 'r-factors'

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	12.1	9.4	2.9	5.1	8.7
	2	13.0	13.6	10.65	13.1	14.7
	3	14.3	13.05	6.0	8.4	13.1
	4	10.9	14.4	17.7	20.1	16.7
	5	17.4	18.5	14.7	17.05	19.7

Mean r-factor = 13.0 Standard Deviation = 4.5

32.2 Calcium Silicate Apportioned To Glass Phase Only

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	58.5	41.5	0.0	20.75	35.9
2	60.8	39.2	0.0	19.6	33.95
3	62.9	25.7	11.4	24.25	22.3
4	63.7	25.5	10.8	23.55	22.1
5	66.8	33.2	0.0	16.6	28.75

Volumetric - Ternary Phase 'r-factor' Values

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	18.6	16.65	6.6	6.0	11.9
2	15.8	14.6	3.3	4.0	13.0
3	19.1	17.5	5.1	5.0	14.2
4	8.8	8.7	8.6	9.1	11.0
5	18.5	17.8	8.3	9.0	17.4

Mean r-factor = 11.5 Standard Deviation = 5.2

32.3 Calcium Silicate Apportioned to Silicate Phase Only

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	69.3	30.7	0.0	15.35	26.6
2	75.1	24.9	0.0	12.45	21.6
3	75.1	13.5	11.4	18.15	11.7
4	78.4	10.8	10.8	16.25	9.35
5	76.8	23.2	0.0	11.6	20.1

Volumetric - Ternary Phase 'r-factor' Values

VOLUMETRIC \ NORMATIVE	1	2	3	4	5
1	10.4	8.7	5.9	8.8	8.85
2	13.1	15.05	13.65	16.7	16.0
3	13.4	13.3	8.85	11.9	13.7
4	12.7	17.4	20.8	23.8	18.9
5	17.85	20.05	17.5	20.4	21.0

Mean r-factor = 14.7 Standard Deviation = 4.7

TABLE 9.10.33 MILLBROOK MEAN BULK ANALYSES (Weight Percent)

	Sample A		Sample C		Sample D		Sample E	
	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
Na_2O	0.1	0.3	0.1	0.2	0.2	0.2	0.1	0.1
MgO	N.D	N.D	1.3	0.6	1.1	0.3	1.5	0.5
Al_2O_3	7.9	1.0	4.8	1.4	5.9	1.1	4.7	0.5
SiO_2	28.9	4.4	25.5	3.2	30.6	0.6	25.9	0.6
P_2O_5	0.7	0.3	1.0	0.3	1.0	0.2	0.7	0.2
S	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1
K_2O	3.2	0.5	0.9	0.7	1.6	0.4	1.2	0.1
CaO	3.8	1.5	10.7	2.2	13.3	1.6	12.0	0.5
TiO_2	0.3	0.1	0.5	0.1	0.5	0.2	0.6	0.1
V_2O_5	0.1	0.1	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
MnO	0.9	0.4	5.1	0.5	4.3	0.5	5.6	0.3
FeO	49.9	5.8	51.6	6.1	41.9	2.8	47.8	0.1
CoO	0.3	0.1	N.D	N.D	0.2	0.1	0.4	0.1
NiO	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1

TABLE 9.10.33 MILLBROOK MEAN BULK ANALYSES (CONTINUED)
(Weight Percent)

	Sample XX		Overall Value	
	mean	S.D.	mean	S.D.
Na_2O	N.D	N.D	0.1	0.2
MgO	1.3	0.5	1.0	0.7
Al_2O_3	3.7	0.7	5.5	1.8
SiO_2	26.7	1.5	27.9	3.1
P_2O_5	0.9	0.3	0.9	0.2
S	0.2	0.1	0.2	0.1
K_2O	1.4	0.3	1.8	1.0
CaO	11.8	1.2	10.1	4.0
TiO_2	0.4	0.1	0.4	0.2
V_2O_5	0.1	0.1	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D
MnO	4.4	0.4	3.8	1.7
FeO	49.4	2.4	48.0	5.3
CoO	0.1	0.1	0.2	0.2
NiO	0.1	0.1	0.1	0.1

TABLES 9.13.1 - 9.13.11 ROMSEY DATA

TABLE 9.13.1 SAMPLE ROM3 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	70	20	10	20.0	17.3
2	55	30	15	30.0	26.0
3	65	20	15	25.0	17.3
4	50	30	20	35.0	26.0
5	65	20	15	25.0	17.3

SAMPLE ROM3 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	13				
3	5	10			
4	17	5	13		
5	5	10	0	13	

Mean r-factor = 9 Standard Deviation = 5

TABLE 9.13.2 SAMPLE ROM3 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.5	0.2	N.D	0.1	0.1
MgO	0.5	0.5	0.4	0.1	0.5
Al_2O_3	5.1	5.7	4.7	6.6	5.2
SiO_2	26.4	26.9	27.3	25.5	27.6
P_2O_5	0.6	0.7	0.3	0.5	0.6
S	0.1	0.1	0.1	0.1	0.2
K_2O	0.7	0.8	0.3	1.8	1.6
CaO	1.1	1.4	0.8	1.6	1.5
TiO_2	0.2	0.3	0.3	0.5	0.3
V_2O_5	N.D	0.3	0.1	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D
MnO	1.6	1.2	1.5	1.1	1.2
FeO	63.1	62.2	60.3	61.8	61.5
CoO	0.4	0.4	0.4	0.7	0.3
NiO	0.2	0.2	0.1	0.2	0.2
Total	100.5	100.9	96.6	100.6	100.9

TABLE 9.13.3 SAMPLE ROM3 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	GLAS3	FEOX1	FEOX2	FEOX3
Na_2O	N.D	N.D	0.7	0.9	1.1	0.1	0.2	N.D
MgO	0.5	1.5	N.D	0.2	0.1	0.3	N.D	0.2
Al_2O_3	0.5	0.6	9.8	10.8	16.7	0.7	0.5	0.9
SiO_2	29.1	30.3	49.1	27.2	37.7	1.0	0.9	1.0
P_2O_5	N.D	N.D	3.2	3.3	4.3	N.D	N.D	0.1
S	N.D	0.1	0.2	0.4	0.7	N.D	N.D	0.1
K_2O	N.D	N.D	1.1	0.4	9.5	0.1	N.D	N.D
CaO	0.2	0.1	3.6	0.4	7.6	0.2	0.1	N.D
TiO_2	N.D	N.D	0.4	0.1	0.6	0.8	0.9	0.9
V_2O_5	N.D	N.D	0.2	0.1	N.D	0.1	0.1	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	0.1	0.2
MnO	1.6	2.1	N.D	0.1	0.3	0.2	0.3	0.3
FeO	67.4	66.3	8.9	30.2	25.1	95.8	95.0	94.7
CoO	0.1	0.4	N.D	N.D	0.1	0.3	0.2	0.6
NiO	0.3	0.2	N.D	N.D	N.D	0.4	0.2	0.2
Total	99.7	101.6	77.2	74.1	103.4	100.0	98.5	99.3

TABLE 9.13.4 SAMPLE ROM3 BULK NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5
APATITE	1.4	1.6	0.7	1.2	1.4
VIVIANITE					
ULVITE	0.5	0.8	0.9	1.4	0.8
PYRRHOTITE	0.3	0.3	0.3	0.3	0.5
KALSILITE	2.4	2.7		6.1	5.4
K-SILICATE					
NEPHELINE	2.3	0.9		0.5	0.5
NA-SILICATE					
ANORTHITE	1.5	2.3	2.1	4.7	3.5
HERCYNITE	5.1	6.2	6.5	4.7	3.4
MULLITE					
CA-SILICATE					
FORSTERITE	0.9	0.9		0.2	0.9
TEPHROITE	2.3	1.7	1.4	1.6	1.7
FAYALITE	77.6	80.1	84.2	69.6	77.7
GEHLENITE					
WUSTITE	5.8	2.4		9.9	4.2
ORTHOCLASE			1.8		
ALBITE					
WOLLASTONITE					
ENSTATITE			1.0		
RHODONITE			1.1		
FERROSILITE					
QUARTZ					

TABLE 9.13.5 SAMPLE ROM3 PHASE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLASS1	GLASS2	GLASS3
APATITE			8.2	1.0	9.7
VIVIANITE			1.5	10.2	
ULVITE			1.5	0.4	1.6
PYRRHOTITE		0.3	0.7	1.5	1.9
KALSILITE					18.7
K-SILICATE					
NEPHELINE					4.9
NA-SILICATE					
ANORTHITE	1.0	0.5			9.3
HERCYNITE	0.2	0.7	16.5	20.5	1.8
MULLITE					
CA-SILICATE					
FORSTERITE	0.9	1.3			0.2
TEPHROITE	2.3	3.0			0.4
FAYALITE	94.4	92.4			29.9
GEHLENITE					
WUSTITE	1.2				
ORTHOCLASE			8.5	3.2	21.7
ALBITE			7.7	10.3	
WOLLASTONITE					
ENSTATITE		1.9		0.7	
RHODONITE				0.2	
FERROSILITE			4.2	45.6	
QUARTZ			51.2	6.4	

TABLE 9.13.6 SAMPLE ROM3 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	80.8	13.5	5.8	12.55	11.7
2	82.7	14.8	2.4	9.8	12.8
3	87.7	12.3	0.0	6.15	10.65
4	71.4	18.9	9.9	19.35	16.4
5	80.3	15.5	4.2	11.95	13.4

SAMPLE ROMSEY3 Normative Phase 'r-factor' Values

	1	2	3	4	5
1					
2	3.0				
3	6.5	4.2			
4	8.3	10.2	14.4		
5	1.8	2.2	6.4	8.0	

Mean r-factor = 6.5 Standard Deviation = 3.9

SAMPLE ROMSEY3 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	9.3	11.15	15.4	1.1	8.9
2	22.6	24.1	28.4	14.3	22.0
3	13.65	15.85	20.0	5.7	13.6
4	26.6	28.45	32.7	18.4	26.3
5	13.65	15.85	20.0	5.7	13.6

Mean r-factor = 17.1 Standard Deviation = 8.0

TABLE 9.13.7 SAMPLE ROM2 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60	20	20	30.0	17.3
2	70	20	10	20.0	17.3
3	70	15	15	22.5	13.0
4	65	20	15	17.3	25.0
5	85	10	5	10.0	8.7

SAMPLE ROM2 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	10				
3	9	5			
4	15	8	13		
5	22	13	13	18	

Mean r-factor = 13 Standard Deviation = 5

TABLE 9.13.8 SAMPLE ROM2 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.2	N.D	N.D	N.D	N.D
MgO	0.9	0.4	0.3	0.8	0.3
Al_2O_3	3.8	4.3	3.9	4.5	5.8
SiO_2	29.0	26.6	27.6	27.4	26.2
P_2O_5	0.3	0.5	0.5	0.9	0.5
S	0.2	N.D	0.1	0.2	0.2
K_2O	0.5	0.2	0.4	0.1	0.1
CaO	0.8	1.1	0.7	0.8	0.8
TiO_2	0.2	0.4	0.3	0.2	0.2
V_2O_5	N.D	N.D	N.D	0.1	0.1
Cr_2O_6	0.1	N.D	N.D	0.1	N.D
MnO	1.6	1.4	1.2	1.4	1.0
FeO	64.4	60.5	62.9	61.1	63.9
CoO	0.3	0.6	0.2	0.3	N.D
NiO	N.D	0.3	0.3	0.2	0.2
Total	102.3	96.3	98.4	98.1	99.3

TABLE 9.13.9 SAMPLE ROM2 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS	FEOX1	FEOX2
Na_2O	N.D	N.D	0.2	0.1	N.D
MgO	1.7	1.8	0.3	N.D	N.D
Al_2O_3	0.3	0.3	14.9	0.5	0.4
SiO_2	30.6	30.2	38.2	1.0	1.0
P_2O_5	N.D	N.D	5.7	0.3	N.D
S	N.D	N.D	1.0	N.D	N.D
K_2O	N.D	N.D	6.9	0.1	N.D
CaO	0.1	0.2	8.6	0.2	N.D
TiO_2	0.1	N.D	0.3	0.8	0.8
V_2O_5	N.D	N.D	N.D	0.1	0.2
Cr_2O_6	N.D	0.1	N.D	0.1	0.1
MnO	2.1	2.1	0.4	0.2	0.3
FeO	66.0	65.8	21.2	93.3	94.4
CoO	0.1	N.D	0.1	0.7	0.1
NiO	0.4	0.2	0.2	0.4	0.4
Total	101.4	100.7	98.0	97.8	97.7

TABLE 9.13.10 SAMPLE ROM2 BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL1	SIL2	GLAS
APATITE	0.7	1.2	1.2	1.4	1.2			13.6
VIVIANITE				0.8				
ULVITE	0.5	1.2	0.9	0.6	0.6	0.3		0.9
PYRRHOTITE	0.5		0.3	0.6	0.6			2.8
KALSILITE	1.6	0.1						
K-SILICATE								
NEPHELINE	0.9							
NA-SILICATE								
ANORTHITE	2.0	2.3	0.2		0.7	0.5	0.8	5.6
HERCYNITE	3.7	5.9	5.9	7.7	9.3	0.2		8.9
MULLITE								
CA-SILICATE								
FORSTERITE	1.6	0.7				1.2	2.9	
TEPHROITE	2.2	2.1	1.7		1.4	3.0	3.0	
FAYALITE	85.8	85.4	86.6	79.5	84.8	92.4	92.9	17.2
GEHLENITE								
WUSTITE	0.5	1.1						
ORTHOCLASE			2.4	0.6	0.6			42.0
ALBITE								1.7
WOLLASTONITE							0.1	
ENSTATITE			0.8	2.1	1.1	2.4	0.3	0.8
RHODONITE			0.1	2.7				0.8
FERROSILITE				4.1				5.8
QUARTZ								

TABLE 9.13.11 SAMPLE ROM2 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	89.6	9.9	0.5	5.45	8.6
2	88.2	10.7	1.1	6.45	9.3
3	89.2	10.9	0.0	5.45	9.4
4	88.4	11.7	0.0	5.85	10.1
5	87.3	13.0	0.0	6.5	11.3

SAMPLE ROM2 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	1.2				
3	0.8	1.0			
4	1.55	1.0	0.8		
5	2.9	2.0	2.2	1.4	

Mean r-factor = 1.5 Standard Deviation = 0.7

SAMPLE ROM2 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	26.05	24.9	25.8	25.2	24.25
2	16.95	15.7	16.6	15.9	14.8
3	17.6	16.5	17.4	16.9	16.1
4	20.2	19.1	19.6	18.8	17.45
5	4.55	3.6	4.6	4.4	4.4

Mean r-factor = 16.3 Standard Deviation = 7.0

TABLE 9.13.12 SAMPLES ROM3 AND ROM2
COMPARISON OF VOLUMETRIC ANALYSES

SAMPLE ROM3

		1	2	3	4	5
SAMPLE ROM2	1	10	9	5	10	5
	2	0	13	5	17	5
	3	5	15	5	18	5
	4	8	13	11	18	11
	5	13	26	17	30	17

Mean r-factor = 12 Standard Deviation = 7

SAMPLE ROM3 AND ROM2 COMPARISON OF NORMATIVE TERNARY GROUPINGS

SAMPLE ROM3

		1	2	3	4	5
SAMPLE ROM2	1	7.75	6.05	2.2	15.9	8.1
	2	6.6	4.8	1.4	14.7	6.9
	3	7.5	5.5	1.4	15.6	7.6
	4	6.9	4.8	0.6	14.9	6.9
	5	6.1	3.6	0.7	13.8	5.8

Mean r-factor = 7.0 Standard Deviation = 4.6

TABLES 9.15.1 - 9.15.5 MUCKING (D.I.S.) DATA

TABLE 9.15.1 SAMPLE MUK5/2 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	75	15	10	17.5	13.0
2	65	20	15	17.3	25.0
3	65	25	10	21.65	22.5
4	75	15	10	17.5	13.0
5	65	20	15	17.3	25.0

SAMPLE MUK5/2 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	12				
3	10	5			
4	0	12	10		
5	12	0	5	12	

Mean r-factor = 8 Standard Deviation = 5

TABLE 9.15.2 SAMPLE MUK5/4 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	80	10	10	15.0	8.7
2	80	10	10	15.0	8.7
3	75	10	15	20.0	8.7
4	85	5	10	12.5	4.3
5	90	5	5	7.5	4.3

SAMPLE MUK5/4 Volumetric 'r-factor' Values

	1	2	3	4	5
1					
2	0				
3	5	5			
4	5	5	9		
5	9	9	13	5	

Mean r-factor = 6.5 Standard Deviation = 4

TABLE 9.15.3 SAMPLE MUK5/2 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS	FEOX1	FEOX2
Na_2O	0.2	0.5	0.1	0.7	0.2	N.D	0.1	N.D	N.D
MgO	N.D	0.3	N.D	0.2	0.1	0.1	N.D	N.D	0.3
Al_2O_3	3.8	2.3	1.4	1.8	2.0	0.1	16.9	1.1	1.0
SiO_2	24.7	23.2	23.2	24.4	22.0	26.9	39.4	0.8	1.0
P_2O_5	1.6	0.8	0.6	1.3	0.7	0.5	6.9	N.D	N.D
S	N.D	N.D	N.D	0.1	N.D	N.D	0.1	N.D	N.D
K_2O	0.7	0.6	0.2	0.7	0.4	N.D	17.4	N.D	0.1
CaO	0.9	0.4	0.4	0.5	0.4	0.2	1.0	N.D	0.1
TiO_2	0.1	0.1	N.D	0.2	0.2	N.D	0.2	0.2	0.8
V_2O_5	N.D	N.D	0.1	N.D	N.D	N.D	0.1	0.1	0.2
Cr_2O_6	N.D	N.D	N.D	N.D	0.2	0.1	N.D	N.D	0.1
MnO	N.D	0.1	N.D	N.D	N.D	N.D	N.D	N.D	N.D
FeO	70.5	70.4	74.8	70.4	70.5	71.1	10.8	99.4	94.9
CoO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
NiO	0.1	0.1	N.D	0.1	N.D	N.D	0.1	0.1	0.1
Total	102.6	98.8	100.8	100.4	96.7	99.0	93.0	101.8	98.6

TABLE 9.15.4 SAMPLE MUK5/2 BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS
APATITE	1.5	0.7	0.7	0.9	0.7	0.4	1.9
VIVIANITE	2.3	1.3	0.7	2.4	1.0	0.9	16.7
ULVITE	0.3	0.3		0.6	0.6		0.6
PYRRHOTITE				0.3			0.3
KALSILITE	2.3	2.0	0.7	2.4	1.4		31.2
K-SILICATE							3.1
NEPHELINE	0.9	2.3	0.5		0.9		
NA-SILICATE				0.1			0.2
ANORTHITE							
HERCYNITE	4.5	1.4	1.7		2.2	0.2	
MULLITE							
CA-SILICATE							
FORSTERITE		0.5		0.4	0.2	0.2	
TEPHROITE		0.2					
FAYALITE	77.5	72.8	76.6	76.9	73.9	92.0	1.4
GEHLENITE							
WUSTITE	10.7	18.4	19.1	16.1	19.0	6.4	
ORTHOCLASE							44.6
ALBITE							
WOLLASTONITE							
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 9.15.5 SAMPLE MUK5/2 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	77.5	11.8	10.7	16.6	10.2
2	73.5	8.0	18.4	22.4	6.9
3	76.6	4.3	19.1	21.25	3.7
4	77.3	6.7	16.1	19.45	5.8
5	74.1	6.8	19.0	22.4	5.9

SAMPLE MUK5/2 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	6.7				
3	8.0	3.4			
4	5.2	3.15	2.8		
5	7.2	1.0	2.5	2.95	

Mean r-factor = 4.3 Standard Deviation = 2.3

SAMPLE MUK5/2 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	2.9	7.8	10.0	7.5	8.6
2	14.8	18.8	21.7	19.3	19.8
3	13.3	15.6	18.8	16.8	16.6
4	2.9	7.8	10.0	7.5	8.6
5	14.8	18.8	21.7	19.3	19.8

Mean r-factor = 13.7 Standard Deviation = 5.9

TABLES 10.5.1 - 10.5.3 CINDER DATA

TABLE 10.5.1 BULK AND PHASE ANLYSES OF WHARRAM PERCY CINDER
(Weight Percent)

	B1	B2	B3	B4	B5	SILICA	GLAS1	GLAS2	GLAS3
Na_2O	0.3	0.4	0.2	0.1	0.3	N.D	0.5	0.2	0.2
MgO	0.4	0.8	0.5	0.6	2.0	N.D	0.5	0.6	0.7
Al_2O_3	3.7	4.9	4.7	5.0	11.1	0.6	4.9	4.7	4.8
SiO_2	75.9	57.2	57.9	55.9	46.7	103.8	68.4	57.5	57.4
P_2O_5	N.D	N.D	0.2	N.D	0.3	N.D	N.D	0.3	0.2
S	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.2	N.D
K_2O	2.6	3.6	3.8	2.8	2.9	N.D	3.5	3.6	3.8
CaO	5.4	9.3	8.1	11.2	6.4	N.D	8.1	8.0	7.7
TiO_2	0.2	0.3	0.2	0.3	0.8	N.D	0.3	0.2	0.4
V_2O_5	0.1	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	0.1	0.1	N.D	N.D	0.1	N.D	0.1	0.1
MnO	N.D	N.D	0.3	0.1	0.1	N.D	N.D	N.D	N.D
FeO	12.0	24.8	24.0	22.2	22.3	0.3	14.6	24.6	23.4
CoO	0.2	0.2	N.D	0.1	0.1	0.1	0.2	N.D	N.D
NiO	0.1	0.2	N.D	N.D	0.1	0.1	N.D	0.1	N.D
Total	101.1	101.9	100.1	98.5	93.3	105.2	101.1	100.1	98.7

TABLE 10.5.2 CINDER BULK NORMATIVE CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5
APATITE			0.5		0.7
VIVIANITE					
ULVITE	0.6	0.8	0.6	0.9	2.4
PYRRHOTITE	0.5	0.3	0.3	0.5	0.6
KALSILITE					
K-SILICATE					
NEPHELINE					
NA-SILICATE					
ANORTHITE	1.0	0.9	0.7	5.0	21.9
HERCYNITE					
MULLITE					
CA-SILICATE					
FORSTERITE					
TEPHROITE					
FAYALITE					
GEHLENITE					
WUSTITE					
ORTHOCLASE	15.3	21.0	22.5	16.9	18.4
ALBITE	2.5	3.3	1.7	0.9	2.7
WOLLASTONITE	10.7	18.6	16.0	21.5	4.2
ENSTATITE	1.0	2.0	1.2	1.5	5.4
RHODONITE			0.6	0.2	0.2
FERROSILITE	20.4	43.6	43.0	39.6	40.3
QUARTZ	47.9	9.5	13.1	13.0	3.1

TABLE 10.5.3 CINDER PHASE NORMATIVE CONSTITUENTS (Weight Percent)

	SILICA	GLAS1	GLAS2	GLAS3
APATITE			0.7	0.5
VIVIANITE				
ULVITE		0.8	0.5	1.1
PYRRHOTITE	0.3	0.3	0.6	
KALSILITE				
K-SILICATE				
NEPHELINE				
NA-SILICATE				
ANORTHITE		0.8	1.3	1.0
HERCYNITE				
MULLITE	0.8			
CA-SILICATE				
FORSTERITE				
TEPHROITE				
FAYALITE				
GEHLENITE				
WUSTITE				
ORTHOCLASE		20.5	21.3	22.8
ALBITE		4.2	1.7	1.7
WOLLASTONITE		16.3	15.2	15.2
ENSTATITE		1.2	1.5	1.8
RHODONITE				
FERROSILITE		25.2	43.8	42.2
QUARTZ	98.8	30.7	13.4	13.7

TABLES 11.1.1 - 11.1.28 BECKFORD DATA

TABLE 11.1.1 BECKFORD HEARTH BOTTOM DIMENSIONS

Diameter 1 mm	Diameter 2 mm	Depth mm	Weight gms
60	60	35	205
60	50	30	75
50	50	30	30
65	60	35	115
55	50	30	30

TABLE 11.1.2 ARCHAEOLOGICAL DETAILS OF THE SAMPLES

Sample Number	Context Number	Period	Feature Type
BEK1	4831	Mid I.A.	Occupation Layer
BEK2	65370	" "	Stone Floor
BEK3	74119	Mid. R.B.	Occupation Layer
BEK4	65726	Late R.B.	Ditch
BEK5	65635	Unstrat.	

TABLE 11.1.3 SAMPLE BEK1 (4831) VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60	10	30	35.0	8.7
2	55	5	40	42.5	4.3
3	40	10	50	55.0	8.7
4	60	10	30	35.0	8.7
5	60	10	30	35.0	8.8

SAMPLE BEK1 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	9				
3	20	13			
4	0	9	20		
5	0	9	20	0	

Mean r-factor = 10 Standard Deviation = 8

TABLE 11.1.4 SAMPLE BEK1 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	SILICATE
Na_2O	N.D	N.D	N.D	0.1	N.D
MgO	0.2	0.2	0.1	0.7	0.3
Al_2O_3	2.8	2.5	1.9	1.8	0.2
SiO_2	21.2	19.9	20.4	18.7	29.1
P_2O_5	N.D	N.D	N.D	N.D	N.D
S	N.D	N.D	N.D	N.D	N.D
K_2O	0.6	0.6	0.6	0.4	N.D
CaO	1.0	0.9	0.9	0.8	0.3
TiO_2	N.D	0.1	0.1	0.2	0.1
V_2O_5	N.D	0.1	N.D	N.D	0.1
Cr_2O_6	0.1	N.D	0.1	N.D	N.D
MnO	N.D	N.D	0.2	0.2	0.3
FeO	74.4	73.7	73.6	75.9	68.4
CoO	N.D	N.D	N.D	N.D	0.6
NiO	0.2	N.D	N.D	N.D	N.D
Total	100.5	98.0	97.9	98.8	99.4

TABLE 11.1.5 SAMPLE BEK1 NORMATIVE MINERAL COMPOSITION
(Weight Percent)

	B1	B2	B3	B4	SILICATE
APATITE					
VIVIANITE					
ULVITE		0.3	0.3	0.6	0.3
PYRRHOTITE					
KALSILITE	2.0	2.0	2.1	1.4	
K-SILICATE					
NEPHELINE				0.5	
NA-SILICATE					
ANORTHITE	5.0	4.6	2.4	2.6	0.6
HERCYNITE	0.6	0.4			
MULLITE					
CA-SILICATE					0.3
FORSTERITE	0.4	0.4	0.2	1.2	0.5
TEPHROITE			0.3	0.3	0.4
FAYALITE	61.4	59.2	63.3	55.4	97.6
GEHLENITE			1.1	0.7	0.3
WUSTITE	30.7	33.2	30.4	37.4	
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.1.6 SAMPLE BEK1[4831] TERNARY PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	61.8	7.6	30.7	34.5	6.5
2	59.6	7.3	33.2	36.8	6.2
3	63.8	5.9	30.4	33.3	5.0
4	56.9	5.7	37.4	40.25	4.9

SAMPLE BEK1 (4831) TERNARY 'r-factor' VALUES

	1	2	3	4
1				
2	2.3			
3	1.9	3.7		
4	6.0	3.7	6.95	

Mean r-factor = 4.1 Standard Deviation = 2.0

SAMPLE BEK1 VOLUMETRIC/TERNARY 'r-factor' VALUES

		NORMATIVE 1	2	3	4
VOLUMETRIC	1	2.3	3.1	4.1	6.5
	2	8.3	6.0	9.2	2.3
	3	20.6	18.4	22.0	15.2
	4	2.3	3.1	4.1	6.5
	5	2.3	3.1	4.1	6.5

Mean r-factor = 7.5 Standard Deviation = 6.4

TABLE 11.1.7 SAMPLE BEK2 [65370] VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	40	0	60	60.0	0.0
2	50	0	50	50.0	0.0
3	60	0	40	40.0	0.0
4	50	0	50	50.0	0.0
5	50	0	50	50.0	0.0

SAMPLE VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	20	10			
4	10	0	10		
5	10	0	10	0	

Mean r-factor = 8 Standard Deviation = 6

TABLE 11.1.8 SAMPLE BEK2 (65370) BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS1	GLASS2
Na_2O	0.1	0.2	0.7	0.3	0.9	0.2	1.0	1.1
MgO	0.3	1.2	0.2	0.2	0.4	1.5	N.D	0.2
Al_2O_3	4.9	5.0	4.9	7.6	5.5	4.0	13.6	13.1
SiO_2	13.8	13.1	13.9	19.0	16.9	29.7	36.2	33.9
P_2O_5	0.6	0.2	0.4	0.5	0.7	0.6	1.5	1.4
S	0.2	0.3	0.1	0.2	N.D	0.2	0.8	0.8
K_2O	1.5	1.3	1.0	1.7	1.1	1.6	6.8	6.2
CaO	2.4	2.4	2.2	3.1	2.4	3.2	14.0	12.6
TiO_2	0.3	0.1	0.2	0.1	0.3	0.1	0.5	0.3
V_2O_5	N.D	N.D	N.D	0.2	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	0.1	N.D	N.D	0.1	N.D	N.D	N.D
MnO	0.1	0.1	N.D	N.D	N.D	N.D	0.1	0.2
FeO	71.4	73.0	73.6	64.5	67.6	58.7	25.0	29.2
CoO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
NiO	0.1	N.D	N.D	0.1	0.1	N.D	N.D	N.D
Total	95.7	97.0	97.2	97.5	96.0	99.8	99.5	99.0

TABLE 11.1.9 SAMPLE BEK2 NORMATIVE CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS1	GLASS2
APATITE	1.4	0.5	1.0	1.2	1.7	1.3	3.5	3.3
VIVIANITE								
ULVITE	0.9	0.3	0.6	0.3	0.9	0.3	1.4	0.8
PYRRHOTITE	0.6	0.9	0.3	0.6		0.5	2.2	2.2
KALSILITE	5.3	4.5	3.5	5.9	3.9	5.2	15.5	17.7
K-SILICATE								
NEPHELINE	0.5	0.9	3.3	1.4	4.3	0.9	4.6	5.1
NA-SILICATE								
ANORTHITE	8.4	7.5	6.5	12.5	7.6	5.1	12.7	12.7
HERCYNITE	0.3			1.4	0.3			
MULLITE								
CA-SILICATE						2.0	14.7	12.8
FORSTERITE	0.6	2.2	0.4	0.4	0.7	2.5		0.4
TEPHROITE	0.2	0.2					0.1	0.3
FAYALITE	28.3	23.2	28.6	37.9	36.5	79.0	31.9	38.6
GEHLENITE		1.7	1.0			3.3		
WUSTITE	53.6	58.2	55.0	38.5	44.2			
ORTHOCLASE							13.4	6.1
ALBITE								
WOLLASTONITE								
ENSTATITE								
RHODONITE								
FERROSILITE								
QUARTZ								

TABLE 11.1.10 SAMPLE BEK2 IRON OXIDE PHASE ANALYSES
(Weight Percent)

	1	2	3	4	5	6
Na_2O	0.1	0.4	0.2	0.2	N.D	N.D
MgO	0.6	0.3	0.4	0.6	0.5	0.7
Al_2O_3	1.4	2.9	1.0	1.1	1.5	0.5
SiO_2	1.1	0.7	1.0	1.2	0.7	1.1
P_2O_5	0.1	N.D	N.D	N.D	N.D	N.D
S	N.D	N.D	N.D	N.D	N.D	N.D
K_2O	0.1	N.D	N.D	0.1	N.D	N.D
CaO	N.D	N.D	0.1	0.2	0.1	N.D
TiO_2	0.2	0.3	0.1	0.2	0.3	N.D
V_2O_5	N.D	N.D	N.D	0.1	N.D	N.D
Cr_2O_6	0.1	0.1	N.D	N.D	0.1	N.D
MnO	N.D	0.1	0.3	0.2	N.D	0.1
FeO	96.1	94.3	96.5	94.5	93.1	96.1
CoO	0.1	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D	N.D	0.3
Total	99.9	99.1	99.6	98.4	96.3	98.7

TABLE 11.1.11 SAMPLE BEK2 NORMATIVE TERNARY GROUPINGS

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	29.1	17.3	53.6	16.3	15.0
2	25.6	16.2	58.2	66.3	14.0
3	29.0	16.0	55.0	63.0	13.9
4	38.3	23.2	38.5	50.1	20.1
5	37.2	18.6	44.2	53.5	16.1

SAMPLE NORMATIVE TERNARY 'r-factor' VALUES

	1	2	3	4	5
1					
2	50.0				
3	46.7	3.3			
4	34.2	17.3	14.3		
5	37.2	13.0	9.75	5.2	

Mean r-factor = 23.1 Standard Deviation = 17.3

SAMPLE VOLUMETRIC/NORMATIVE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	46.2	15.35	14.2	22.4	17.4
	2	36.9	21.5	19.0	20.1	16.5
	3	28.0	29.8	26.9	22.5	21.0
	4	36.9	21.5	19.0	20.1	16.5
	5	36.9	21.5	19.0	20.1	16.5

Mean r-factor = 23.4 Standard Deviation = 8.1

TABLE 11.1.12 SAMPLE BEK3 (74119) VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	40	10	50	55.0	8.7
2	40	20	40	50.0	17.3
3	50	10	40	45.0	8.7
4	30	10	60	65.0	8.7
5	40	10	50	55.0	8.7

SAMPLE BEK3 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	10	10			
4	10	17	20		
5	0	10	10	10	

Mean r-factor = 11 Standard Deviation = 5

TABLE 11.1.13 SAMPLE BEK3 (74119) BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	B6	SIL	FEOX
Na_2O	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
MgO	N.D	N.D	N.D	N.D	N.D	N.D	0.5	0.5
Al_2O_3	1.0	1.3	1.3	1.2	0.5	1.1	0.3	0.4
SiO_2	16.1	12.4	20.0	15.6	12.2	16.2	29.6	0.7
P_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
S	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
K_2O	0.8	0.6	0.7	0.7	0.5	0.8	N.D	N.D
CaO	0.7	0.4	0.8	0.8	0.5	0.7	N.D	0.1
TiO_2	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
V_2O_5	N.D	N.D	N.D	0.1	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	0.1	0.1	N.D	0.1	N.D	N.D
MnO	N.D	N.D	N.D	N.D	0.2	N.D	0.2	N.D
FeO	83.0	86.1	79.1	83.1	84.1	80.6	67.5	92.5
CoO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D	0.3	N.D	0.1	N.D
Total	101.6	100.8	102.0	101.6	98.3	99.5	98.2	94.2

TABLE 11.1.14 SAMPLE BEK3 BULK AND SILICATE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	B6	SIL
APATITE							
VIVIANITE							
ULVITE							
PYRRHOTITE							
KALSILITE	2.6	2.0	2.3	2.3	1.6	2.7	
K-SILICATE					0.1		
NEPHELINE							
NA-SILICATE							
ANORTHITE		1.6					
HERCYNITE							0.5
MULLITE							
CA-SILICATE	0.8		0.3	0.5	0.8	0.7	
FORSTERITE						1.0	
TEPHROITE					0.3		
FAYALITE	49.1	36.7	62.2	47.8	38.9	48.7	95.3
GEHLENITE	0.4	0.2	1.4	1.2		0.6	
WUSTITE	47.1	59.5	33.8	48.3	58.4	46.2	
ORTHOCLASE							
ALBITE							
WOLLASTONITE							
ENSTATITE							1.3
RHODONITE							0.4
FERROSILITE							2.5
QUARTZ							

TABLE 11.1.15 SAMPLE BEK3 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	49.1	3.8	47.1	49.0	3.3
2	36.7	3.8	59.5	61.4	3.3
3	62.2	4.0	33.8	35.8	3.5
4	47.8	3.9	48.3	50.25	3.4
5	39.2	2.4	58.4	59.6	2.1
6	49.7	4.1	46.2	48.25	3.55

SAMPLE BEK3 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5	6
1						
2	12.4					
3	13.2	25.6				
4	1.25	11.15	14.45			
5	10.7	2.2	23.8	9.4		
6	0.8	13.15	12.45	2.0	11.4	

Mean r-factor = 10.9 Standard Deviation = 7.4

SAMPLE BEK3 TERNARY/NORMATIVE PHASE 'r-factor' VALUES

	NORMATIVE 1	2	3	4	5	6
VOLUMETRIC 1	8.1	8.4	19.9	7.1	8.0	8.5
2	14.0	18.05	19.8	13.9	18.0	13.9
3	6.7	17.3	10.6	7.5	16.0	6.1
4	16.9	6.5	29.7	15.7	8.5	17.5
5	8.1	8.4	19.9	7.1	8.0	8.5

Mean r-factor = 12.55 Standard Deviation = 5.8

TABLE 11.1.16 SAMPLE BEK4 (65726) VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	45	20	35	45.0	17.3
2	50	20	30	40.0	17.3
3	60	25	15	27.5	21.7
4	60	30	10	25.0	26.0
5	60	35	5	22.5	30.3

SAMPLE BEK4 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5				
3	18	13			
4	22	17	5		
5	26	22	10	5	

Mean r-factor = 14 Standard Deviation = 8

TABLE 11.1.17 SAMPLE BEK4 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	B6
Na_2O	0.3	0.7	0.2	1.0	0.3	0.6
MgO	0.5	0.2	1.2	N.D	0.6	N.D
Al_2O_3	5.8	6.0	6.1	4.3	4.7	4.6
SiO_2	22.5	24.4	23.4	20.0	20.1	19.5
P_2O_5	0.5	0.6	0.6	0.4	0.4	0.7
S	0.3	0.2	0.3	0.2	0.2	0.3
K_2O	1.7	1.9	1.5	1.2	1.5	1.6
CaO	3.4	4.0	2.7	2.5	2.6	2.8
TiO_2	0.4	0.4	0.1	N.D	0.2	0.3
V_2O_5	N.D	0.1	N.D	0.1	N.D	N.D
Cr_2O_6	N.D	0.2	0.1	N.D	0.1	N.D
MnO	N.D	0.1	N.D	N.D	N.D	N.D
FeO	67.8	61.5	64.7	70.0	70.5	68.0
CoO	N.D	N.D	N.D	N.D	N.D	N.D
NiO	N.D	0.1	0.3	N.D	N.D	N.D
Total	103.2	100.4	101.2	99.7	101.2	98.4

TABLE 11.1.18 SAMPLE BEK4 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2
Na_2O	N.D	0.6	1.3	1.7
MgO	1.9	0.3	N.D	N.D
Al_2O_3	N.D	1.0	11.6	15.8
SiO_2	28.9	21.3	37.0	37.4
P_2O_5	0.2	N.D	1.6	2.5
S	N.D	N.D	0.4	0.8
K_2O	N.D	N.D	7.7	7.9
CaO	0.7	1.3	14.3	13.7
TiO_2	N.D	0.3	0.3	0.6
V_2O_5	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D
MnO	N.D	N.D	N.D	N.D
FeO	68.7	76.7	26.6	17.5
CoO	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D
Total	100.4	101.5	100.8	98.0

TABLE 11.1.19 SAMPLE BEK4 BULK NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	B6
APATITE	1.1	1.4	1.4	0.9	0.9	1.6
VIVIANITE						
ULVITE	1.1	1.1	0.3		0.5	0.9
PYRRHOTITE	0.8	0.5	0.8	0.6	0.5	0.8
KALSILITE	5.6	6.4	5.0	4.1	5.0	5.5
K-SILICATE						
NEPHELINE	1.3	3.2	0.9	4.6	1.4	2.8
NA-SILICATE						
ANORTHITE	5.2		9.4		3.8	1.0
HERCYNITE			1.2			
MULLITE						
CA-SILICATE		0.2		0.8		
FORSTERITE	0.9	0.4	2.1		1.0	
TEPHROITE		0.2				
FAYALITE	53.3	63.5	54.3	52.8	49.7	51.7
GEHLENITE	4.0	7.5		3.7	3.2	4.2
WUSTITE	26.9	15.6	24.6	32.7	33.9	31.5
ORTHOCLASE						
ALBITE						
WOLLASTONITE						
ENSTATITE						
RHODONITE						
FERROSILITE						
QUARTZ						

TABLE 11.1.20 SAMPLE BEK4 PHASE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2
APATITE	0.5		3.7	5.9
VIVIANITE				
ULVITE		0.8	0.8	1.7
PYRRHOTITE			1.1	2.2
KALSILITE			17.1	15.9
K-SILICATE				
NEPHELINE		2.7	5.9	8.0
NA-SILICATE				
ANORTHITE			3.1	12.4
HERCYNITE				
MULLITE				
CA-SILICATE	0.7	1.9	17.7	12.5
FORSTERITE	3.3	0.5		
TEPHROITE				
FAYALITE	92.1	64.2	35.5	21.3
GEHLENITE				
WUSTITE	3.5	29.7		
ORTHOCLASE			15.2	20.0
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 11.1.21 SAMPLE BEK4 IRON OXIDE PHASE ANALYSES (Weight Percent)

	1	2	3	4	5	6
Na_2O	0.1	0.2	N.D	N.D	N.D	0.1
MgO	N.D	0.2	0.3	0.3	0.8	0.6
Al_2O_3	0.4	0.6	0.4	0.8	0.2	1.0
SiO_2	0.6	1.1	0.6	1.0	0.8	1.1
P_2O_5	N.D	N.D	N.D	N.D	N.D	N.D
S	N.D	N.D	0.5	N.D	N.D	N.D
K_2O	0.1	N.D	N.D	N.D	0.1	N.D
CaO	0.2	0.2	0.1	0.1	N.D	0.2
TiO_2	0.4	0.3	0.5	0.4	0.3	0.3
V_2O_5	N.D	0.1	0.2	0.3	N.D	0.2
Cr_2O_6	0.1	N.D	0.1	0.1	0.2	0.1
MnO	N.D	N.D	N.D	N.D	N.D	N.D
FeO	95.2	94.6	94.7	96.6	96.0	97.8
CoO	N.D	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D	N.D	N.D
Total	97.1	97.3	97.4	99.6	98.4	101.4

TABLE 11.1.22 SAMPLE BEK4 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	54.2	18.9	26.9	36.35	16.4
2	64.1	20.3	15.6	25.75	17.6
3	56.4	19.0	24.6	34.1	16.5
4	52.8	14.5	32.7	39.95	12.6
5	50.7	15.4	33.9	41.6	13.3
6	51.7	16.8	31.5	39.9	14.55

SAMPLE BEK4 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5	6
1						
2	10.7					
3	2.25	8.4				
4	5.2	15.05	7.0			
5	6.1	16.4	8.15	1.8		
6	4.0	14.5	6.1	1.95	2.1	

Mean r-factor = 7.3 Standard Deviation = 4.9

SAMPLE BEK4 VOLUMETRIC/TERNARY PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5	6
VOLUMETRIC	1	8.7	19.25	10.9	6.9	5.25	5.8
	2	3.8	14.25	6.0	4.7	4.3	2.75
	3	10.3	4.5	8.4	15.4	16.4	14.3
	4	14.9	8.4	13.2	20.1	20.9	18.8
	5	19.6	13.1	18.0	24.9	25.6	23.5

Mean r-factor = 13.1 Standard Deviation = 6.9

TABLE 11.1.23 SAMPLE BEK5 (65635M) VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	10	30	35.0	8.7
2	50	20	30	40.0	17.3
3	40	20	40	50.0	17.3
4	50	10	40	45.0	8.7
5	50	20	30	40.0	17.3

SAMPLE BEK5 VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	17	10			
4	10	10	10		
5	10	0	10	10	

Mean r-factor = 10 Standard Deviation = 4

TABLE 11.1.24 SAMPLE BEK5 BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL1	SIL2	GLAS1	GLAS2
Na_2O	0.4	0.3	0.4	N.D	N.D	N.D	0.4	0.2	0.9
MgO	0.3	0.5	0.2	0.5	0.8	1.2	1.2	0.1	N.D
Al_2O_3	3.7	1.6	2.9	2.6	2.2	0.1	0.3	12.9	9.7
SiO_2	24.4	14.2	20.6	16.8	17.4	28.9	29.0	38.0	35.8
P_2O_5	1.2	0.6	1.1	0.6	0.6	0.6	0.3	1.0	3.9
S	0.1	N.D	0.1	N.D	0.1	0.1	0.1	N.D	0.2
K_2O	3.0	1.4	2.2	1.8	2.1	N.D	N.D	16.4	9.6
CaO	5.7	3.4	5.4	4.1	4.3	3.0	4.7	2.3	16.2
TiO_2	0.1	0.2	0.1	0.2	N.D	0.1	N.D	0.1	N.D
V_2O_5	N.D	N.D	0.1	N.D	N.D	N.D	N.D	N.D	0.1
Cr_2O_6	N.D	0.1	N.D	0.1	0.2	N.D	N.D	N.D	N.D
MnO	N.D	N.D	N.D	N.D	0.1	0.3	0.2	0.1	0.1
FeO	65.2	78.0	68.6	73.1	72.1	66.9	65.7	27.3	24.1
CoO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
Total	104.1	100.3	101.7	99.8	99.9	101.2	101.9	98.4	100.6

TABLE 11.1.25 SAMPLE BEK5 BULK NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	2.7	1.4	2.5	1.4	1.4
VIVIANITE					
ULVITE	0.3	0.6	0.3	0.6	
PYRRHOTITE	0.3		0.3		0.3
KALSILITE	9.8	4.7	7.4	6.1	6.9
K-SILICATE					0.1
NEPHELINE					
NA-SILICATE	0.2	0.5	0.2		
ANORTHITE					
HERCYNITE					
MULLITE					
CA-SILICATE	6.2	4.0	6.1	4.0	5.4
FORSTERITE	0.5	0.9	0.4	0.9	1.4
TEPHROITE					0.1
FAYALITE	57.7	35.0	50.3	42.0	41.7
GEHLENITE				1.8	
WUSTITE	22.3	53.0	37.7	43.3	42.7
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.1.26 SAMPLE BEK5 PHASE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2
APATITE	1.4	0.7	2.4	9.0
ULVITE	0.3		0.3	
PYRRHOTITE	0.3	0.3		0.6
KALSILITE			30.3	20.5
K-SILICATE			7.5	1.1
NEPHELINE				
NA-SILICATE		0.4	0.4	1.8
ANORTHITE				
HERCYNITE				
MULLITE				
CA-SILICATE	3.2	6.6	1.5	16.9
FORSTERITE	2.1	2.1	0.2	
TEPHROITE	0.4	0.3	0.1	0.1
FAYALITE	89.5	84.5	39.1	33.4
GEHLENITE	0.3			
WUSTITE	2.6	5.3		
ORTHOCLASE			18.3	16.7
ALBITE				
WOLLASTONITE				
ENSTATITE				
RHODONITE				
FERROSILITE				
QUARTZ				

TABLE 11.1.27 SAMPLE BEK5 IRON OXIDE PHASE ANALYSES
(Weight Percent)

	1	2	3	4	5
Na_2O	N.D	0.2	0.1	N.D	N.D
MgO	0.1	N.D	N.D	N.D	0.8
Al_2O_3	0.7	0.5	0.9	0.4	0.4
SiO_2	0.7	0.6	0.9	0.6	2.4
P_2O_5	N.D	N.D	0.1	N.D	N.D
S	N.D	N.D	N.D	0.1	N.D
K_2O	0.2	N.D	N.D	N.D	N.D
CaO	0.2	0.2	0.3	0.2	0.4
TiO_2	0.3	0.3	0.2	0.1	N.D
V_2O_5	0.1	0.1	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	0.2	N.D	0.1
MnO	0.2	0.3	N.D	N.D	0.2
FeO	96.9	97.4	95.3	97.2	95.4
CoO	N.D	N.D	N.D	N.D	N.D
NiO	0.1	N.D	N.D	N.D	N.D
Total	99.5	99.6	98.0	98.6	99.7

TABLE 11.1.28 SAMPLE BEK5 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	58.2	19.5	22.3	32.05	16.9
2	35.9	11.1	53.0	58.55	9.6
3	50.7	16.6	32.7	41.0	14.4
4	42.9	13.8	43.3	50.2	11.95
5	43.2	14.1	42.7	49.75	12.2

SAMPLE BEK5 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	27.5				
3	9.3	18.2			
4	18.8	8.7	9.5		
5	18.3	9.2	9.0	0.5	

Mean r-factor = 12.9 Standard Deviation = 7.7

SAMPLE BEK5 VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	8.7	23.6	8.3	15.5	15.2
	2	8.0	20.1	3.1	11.5	11.0
	3	17.95	11.5	9.5	5.35	5.1
	4	15.3	13.6	7.0	6.1	5.9
	5	8.0	20.1	3.1	11.5	11.0

Mean r-factor = 11.0 Standard Deviation = 5.5

TABLES 11.2.1 – 11.2.12 WHARRAM PERCY DATA

TABLE 11.2.1 WHARRAM PERCY SLAG CLASSIFICATION (Weight in Kg)

	Site 59	Site 76	Total
Smithing Slag	20.16	54.04	74.20
Hearth Bottoms	2.71	2.42	5.13
Cinder	2.71	0.61	3.32
Tap Slag	0.11	0.00	0.11
Fuel Ash Slag	1.21	0.62	1.83
Hearth Lining	0.81	1.95	2.76
Fired Clay	2.50	0.86	3.36
'Ore'	0.24	0.00	0.24
TOTAL	30.45	60.50	90.95

TABLE 11.2.2 SAMPLE WP1 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	80	20	0	10.0	17.3
2	70	30	0	15.0	26.0
3	75	25	0	12.5	21.6
4	70	30	0	15.0	26.0
5	80	20	0	10.0	17.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	5	5			
4	10	0	5		
5	0	10	5	10	

Mean r-factor = 6 Standard Deviation = 4

TABLE 11.2.3 SAMPLE WP2 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	35	5	22.5	30.3
2	70	25	5	17.5	21.6
3	75	15	10	17.5	13.0
4	60	35	5	22.5	30.3
5	60	35	5	22.5	30.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	18	9			
4	0	10	18		
5	0	10	18		

Mean r-factor = 9 Standard Deviation = 7

COMPARISON BEWTEEN VOLUMETRIC ANALYSES OF SAMPLES WP1 AND WP2

COMPARISON 'r-factor' Values

		W	P	2		
		1	2	3	4	5
	1	18	9	9	18	18
W	2	9	5	13	9	9
P	3	13	5	10	13	13
I	4	9	5	13	9	9
	5	18	9	9	18	18

Mean r-factor = 11 Standard Deviation = 4.5

TABLE 11.2.4 SAMPLE WP1 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.5	0.1	0.1	0.3	N.D
MgO	0.1	0.4	0.2	0.2	0.7
Al_2O_3	5.1	2.6	2.5	3.7	1.8
SiO_2	34.6	30.2	31.1	31.5	29.4
P_2O_5	4.2	0.8	3.2	4.7	2.4
S	0.1	N.D	N.D	N.D	N.D
K_2O	4.1	1.2	1.7	2.5	0.9
CaO	13.5	4.4	5.5	6.4	4.0
TiO_2	0.3	0.1	0.2	0.2	0.1
V_2O_5	N.D	0.1	N.D	N.D	0.1
Cr_2O_6	N.D	0.9	0.2	N.D	N.D
MnO	0.1	0.1	0.2	0.4	0.3
FeO	37.8	59.5	59.4	53.7	62.1
CoO	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	N.D	N.D
Total	100.4	100.4	104.3	103.6	101.8

TABLE 11.2.5 SAMPLE WP1 NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	9.9	1.9	7.1	10.5	5.5
VIVIANITE					
ULVITE	0.8	0.3	0.6	0.6	0.3
PYRRHOTITE	0.3				
KALSILITE	2.5	3.3	2.1	2.1	2.3
K-SILICATE					
NEPHELINE		0.5	0.4	1.3	
NA-SILICATE	0.2				
ANORTHITE		3.1	1.3	1.0	2.2
HERCYNITE				0.2	
MULLITE					
CA-SILICATE	12.4	4.2	1.5		0.6
FORSTERITE	0.2	0.7	0.3	0.3	1.2
TEPHROITE	0.2	0.1	0.3	0.6	0.4
FAYALITE	53.3	84.6	80.4	72.9	86.3
GEHLENITE					
WUSTITE					
ORTHOCLASE	20.3	1.3	6.0	10.6	1.2
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.2.6 SAMPLE WP2 Bulk Analyses (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.1	N.D	0.2	0.5	0.5
MgO	N.D	0.1	0.1	N.D	0.5
Al_2O_3	3.4	3.1	5.6	3.0	2.2
SiO_2	26.5	26.5	30.8	31.4	25.8
P_2O_5	N.D	0.9	1.0	N.D	1.8
S	0.1	N.D	N.D	N.D	N.D
K_2O	3.3	3.1	5.2	2.8	1.6
CaO	2.2	2.2	2.7	2.2	0.9
TiO_2	0.1	0.1	N.D	0.1	N.D
V_2O_5	0.1	0.1	N.D	N.D	0.1
Cr_2O_6	0.4	N.D	N.D	0.2	0.7
MnO	0.1	N.D	N.D	N.D	N.D
FeO	62.5	63.2	58.7	59.8	62.9
CoO	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	0.1	0.1
Total	98.8	99.3	104.3	100.1	97.1

TABLE 11.2.7 SAMPLE WP2 BULK NORMATIVE CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5
APATITE		2.1	2.2		1.6
VIVIANITE					
ULVITE	0.3	0.3		0.3	
PYRRHOTITE	0.3				
KALSILITE	10.7	9.7	16.7	7.7	5.6
K-SILICATE	0.3	0.4		0.1	
NEPHELINE					
NA-SILICATE	0.2		0.4	1.0	0.4
ANORTHITE					
HERCYNITE					
MULLITE					
CA-SILICATE	3.4	1.6	2.0	3.4	
FORSTERITE		0.2	0.2		0.9
TEPHROITE	0.1				
FAYALITE	72.8	75.5	75.4	84.7	80.6
GEHLENITE					
WUSTITE	11.9	10.3	3.1		7.4
ORTHOCLASE				2.9	
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.2.8 SAMPLE WP1 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	53.7	46.4	0.0	23.2	40.2
2	85.4	14.6	0.0	7.3	12.6
3	81.0	19.0	0.0	9.5	16.45
4	73.8	26.3	0.0	13.15	22.8
5	87.9	12.1	0.0	6.05	10.5

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	31.85				
3	27.4	4.4			
4	20.1	11.8	7.3		
5	34.3	2.4	6.9	14.2	

Mean r-factor = 16.1 Standard Deviation = 11.7

SAMPLE WP1 VOLUMETRIC/NORMATIVE 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	NORMATIVE 2	NORMATIVE 3	NORMATIVE 4	NORMATIVE 5
1	26.4	5.4	1.0	6.3	7.9
2	16.4	15.45	11.0	3.7	17.9
3	21.5	10.4	6.0	1.4	12.8
4	16.4	15.45	11.0	3.7	17.9
5	26.4	5.4	1.0	6.3	7.9

Mean r-factor = 11.0 Standard Deviation = 7.4

TABLE 11.2.9 SAMPLE WP2 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	72.9	15.2	11.9	19.5	13.2
2	75.7	14.0	10.3	17.3	12.1
3	75.6	21.3	3.1	13.75	18.45
4	84.7	15.3	0.0	7.65	13.25
5	81.5	11.1	7.4	12.95	9.6

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	2.5				
3	7.8	7.3			
4	11.85	9.7	8.0		
5	7.5	5.0	8.9	6.4	

Mean r-factor = 7.5 Standard Deviation = 2.6

SAMPLE WP2 NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	17.4	18.9	14.7	22.6	22.8
	2	8.6	9.5	4.9	12.9	12.8
	3	2.0	0.9	6.6	9.85	5.7
	4	17.4	18.9	14.7	22.6	22.8
	5	17.4	18.9	14.7	22.6	22.8

Mean r-factor = 14.5 Standard Deviation = 6.9

TABLE 11.2.10 COMPARISON BETWEEN SAMPLES WP1 AND WP2
NORMATIVE TERNARY PHASE PERCENTAGES ('r-factor' Values)

			W	P	2	
		1	2	3	4	5
	1	27.25	28.7	23.7	31.1	32.3
W	2	12.2	10.0	8.7	0.7	6.4
P	3	10.5	8.9	4.7	3.7	7.7
2	4	11.5	11.5	4.4	11.0	13.2
	5	13.7	11.4	11.1	3.2	7.0

Mean r-factor = 12.6 Standard Deviation = 8.9

TABLE 11.2.11 PHASE ANALYSES OF WP1 AND WP2 (Weight Percent)

	SAMPLE WP1			SAMPLE WP2			
	SIL	GLAS1	GLAS2	SIL	FEOX	GLAS1	GLAS2
Na_2O	0.8	1.0	1.4	0.1	0.3	0.5	0.9
MgO	0.5	N.D	N.D	0.1	N.D	N.D	0.1
Al_2O_3	N.D	16.3	7.9	N.D	1.7	8.5	7.5
SiO_2	29.5	46.8	36.1	28.0	1.6	44.6	46.0
P_2O_5	2.1	5.6	9.9	1.8	0.3	2.1	4.1
S	N.D	0.2	N.D	0.1	0.1	0.1	0.2
K_2O	0.1	13.2	5.7	N.D	0.1	9.6	8.1
CaO	2.6	7.7	14.6	1.6	N.D	8.8	2.0
TiO_2	N.D	0.3	0.9	0.1	0.3	0.2	0.1
V_2O_5	N.D	0.1	N.D	0.1	N.D	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	0.6	N.D
MnO	0.1	N.D	N.D	0.1	0.1	N.D	N.D
FeO	66.0	12.5	30.1	67.7	87.9	22.7	26.8
CoO	N.D	N.D	N.D	N.D	N.D	N.D	N.D
NiO	N.D	N.D	N.D	0.1	N.D	0.4	N.D
Total	101.5	103.7	106.6	99.8	92.4	98.1	95.9

TABLE 11.2.12 SAMPLES WP1 AND WP2 PHASE ANALYSES NORMATIVE CONSTITUENTS (Weight Percent)

	Sample WP1			Sample WP2			
	SIL	GLAS1	GLAS2	SIL	FEOX	GLAS1	GLAS1
APATITE	4.5	12.5	22.5	2.8		5.0	3.7
VIVIANITE	0.3			1.5	0.8		6.8
ULVITE		0.8	2.5	0.3	0.9	0.6	0.3
PYRRHOTITE		0.5			0.3	0.3	0.6
KALSILITE		13.9	1.1		0.4		
K-SILICATE	0.2					2.9	2.0
NEPHELINE		4.4			1.5		
NA-SILICATE	1.6		0.7	0.2		1.0	1.9
ANORTHITE		1.0					
HERCYNITE					2.0		
MULLITE							
CA-SILICATE		0.2	2.4			8.2	
FORSTERITE				0.2			
TEPHROITE				0.2	0.2		
FAYALITE	90.7	15.8	39.7	94.3	3.1	32.3	3.1
GEHLENITE							
WUSTITE				0.2	90.8		
ORTHOCLASE		50.8	31.7			47.8	42.8
ALBITE							
WOLLASTONITE						1.9	
ENSTATITE	1.2						0.3
RHODONITE	0.2						
FERROSILITE	1.4						38.6
QUARTZ							

TABLES 11.3.1 - 11.3.9 BIRSAY DATA

TABLE 11.3.1 SAMPLE BIR1395 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	55	40	5	25.0	34.6
2	55	40	5	25.0	34.6
3	40	55	5	32.5	47.6
4	50	45	5	27.5	39.0
5	45	45	10	32.5	39.0

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	0				
3	15	15			
4	5	5	10		
5	9	9	9	5	

Mean r-factor = 8 Standard Deviation = 5

TABLE 11.3.2 SAMPLE BIR1395 BULK AND PHASE ANALYSES
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
Na_2O	1.3	1.4	1.5	1.6	1.7	0.4	2.2
MgO	0.4	0.5	0.6	0.6	0.7	1.9	N.D
Al_2O_3	4.6	4.5	4.4	4.2	5.0	N.D	8.7
SiO_2	36.2	35.2	35.0	34.9	33.8	31.0	38.1
P_2O_5	0.9	0.8	0.7	0.7	1.1	N.D	2.0
S	0.2	0.1	0.2	0.1	0.2	N.D	0.4
K_2O	1.5	1.5	1.4	1.4	1.7	N.D	4.6
CaO	2.6	2.6	2.5	2.6	3.0	0.4	5.0
TiO_2	0.3	0.2	0.3	0.3	0.4	0.1	0.8
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.2	N.D	N.D	N.D	N.D	N.D	N.D
MnO	N.D	0.1	0.1	0.1	0.2	0.1	N.D
FeO	52.6	51.5	51.7	53.9	48.4	66.2	35.4
CoO	0.2	0.2	0.4	0.3	0.2	0.1	N.D
NiO	0.3	0.3	0.1	0.1	0.1	0.2	N.D
Total	101.3	98.9	98.9	100.8	96.5	100.4	97.2

TABLE 11.3.3 SAMPLE BIR1395 BULK AND PHASE NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
APATITE	2.1	1.9	1.7	1.6	2.7		4.8
VIVIANITE							
ULVITE	0.8	0.6	0.8	0.8	1.2	0.3	2.3
PYRRHOTITE	0.6	0.3	0.6	0.3	0.6		1.1
KALSILITE							
K-SILICATE							
NEPHELINE	0.6	2.1	2.4	4.0	5.1		9.1
NA-SILICATE						0.8	
ANORTHITE	2.3	1.6	1.2	0.1	1.0		0.3
HERCYNITE							
MULLITE							
CA-SILICATE	1.5	1.9	2.1	2.5	2.2		3.7
FORSTERITE	0.7	0.9	1.1	1.0	1.3	0.2	
TEPHROITE		0.1	0.2	0.1	0.3	0.1	
FAYALITE	72.8	73.4	73.2	75.1	69.7	93.3	48.3
GEHLENITE							
WUSTITE							
ORTHOCLASE	8.8	9.0	8.4	8.2	10.5		28.0
ALBITE	9.9	8.2	8.5	6.0	5.6		2.3
WOLLASTONITE						0.8	
ENSTATITE						4.4	
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 11.3.4 SAMPLE BIR1395 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	73.5	26.5	0.0	13.25	22.95
2	74.4	25.6	0.0	12.8	22.2
3	74.5	25.5	0.0	12.75	22.1
4	76.2	23.8	0.0	11.9	20.6
5	71.3	28.7	0.0	14.35	24.85

SAMPLE BIR1395 NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	0.9				
3	1.0	0.1			
4	2.7	1.8	1.7		
5	2.2	3.1	3.2	4.9	

Mean r-factor = 2.2 Standard Deviation = 1.4

VOLUMETRIC/NORMATIVE TERNARY 'r-factor' VALUES

VOLUMETRIC	NORMATIVE 1	2	3	4	5
1	16.6	17.4	17.5	19.2	14.4
2	16.6	17.4	17.5	19.2	14.4
3	31.3	32.1	32.2	34.0	29.1
4	21.5	22.3	22.4	24.1	19.3
5	25.1	25.9	26.0	27.6	23.0

Mean r-factor = 22.6 Standard Deviation = 5.9

TABLE 11.3.5 SAMPLE BIR1296 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	50	40	10	30.0	34.6
2	45	40	15	35.0	34.6
3	45	35	20	37.5	30.3
4	35	45	20	42.5	39.0
5	50	40	10	30.0	34.6

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5				
3	9	5			
4	13	9	10		
5	0	5	5	5	

Mean r-factor = 7 Standard Deviation = 4

TABLE 11.3.6 SAMPLE BIR1296 BULK CHEMICAL ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	1.6	1.5	1.6	2.1	1.4
MgO	0.9	0.5	0.5	0.6	0.4
Al_2O_3	4.5	5.2	4.8	5.2	5.2
SiO_2	32.5	32.8	33.2	32.3	33.6
P_2O_5	0.5	0.7	0.3	0.2	0.4
S	0.2	0.2	0.1	0.2	0.1
K_2O	1.2	1.6	1.5	1.7	1.5
CaO	1.9	2.1	2.1	2.1	2.0
TiO_2	0.4	0.1	0.3	0.2	0.2
V_2O_5	0.1	0.1	N.D	0.1	N.D
Cr_2O_6	N.D	0.1	N.D	N.D	N.D
MnO	N.D	0.2	N.D	0.1	N.D
FeO	56.4	53.7	54.6	52.7	54.5
CoO	n.d	0.4	0.1	0.5	0.3
NiO	0.1	0.2	0.1	0.2	0.2
Total	100.3	99.4	99.2	98.2	99.8

TABLE 11.3.7 SAMPLE BIR1296 PHASE ANALYSES (Weight Percent)

	Sil	Glass	FEOX1	FEOX2	FEOX3
Na_2O	0.4	3.7	0.2	0.5	N.D
MgO	0.9	N.D	N.D	0.6	N.D
Al_2O_3	N.D	13.7	0.5	0.9	1.0
SiO_2	27.9	43.5	1.2	0.8	0.9
P_2O_5	0.4	2.1	0.1	0.6	N.D
S	N.D	0.7	N.D	N.D	N.D
K_2O	0.1	5.5	0.1	0.2	0.1
CaO	0.7	8.7	0.2	0.5	N.D
TiO_2	0.1	0.5	0.4	1.7	2.9
V_2O_5	N.D	N.D	N.D	0.2	N.D
Cr_2O_6	N.D	N.D	0.1	N.D	0.1
MnO	0.2	0.2	N.D	0.2	0.1
FeO	69.1	17.4	95.3	89.4	91.2
CoO	N.D	0.2	0.5	N.D	N.D
NiO	0.1	0.1	0.2	0.1	N.D
Total	99.9	96.3	98.8	95.7	96.3

TABLE 11.3.8 SAMPLE BIR1296 BULK AND PHASE NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
APATITE	1.2	1.7	0.7	0.5	0.9	0.9	5.1
VIVIANITE							
ULVITE	1.1	0.3	0.8	0.6	0.6	0.3	1.5
PYRRHOTITE	0.6	0.6	0.3	0.6	0.3		2.0
KALSILITE	0.2	0.5		2.1			
K-SILICATE						0.2	
NEPHELINE	7.3	7.0	7.3		6.0		12.4
NA-SILICATE				0.1		0.8	
ANORTHITE	1.5	2.8	1.5		3.5		4.8
HERCYNITE							
MULLITE							
CA-SILICATE	1.4	1.0	2.2	3.2	1.2	0.3	8.1
FORSTERITE	1.6	0.9	0.9	1.2	0.7	1.6	
TEPHROITE		0.3		0.2		0.3	0.3
FAYALITE	78.3	76.4	77.2	83.7	77.0	90.4	22.1
GEHLENITE							
WUSTITE						5.3	
ORTHOCLASE	6.8	8.7	8.9	7.7	8.9		34.0
ALBITE			0.2		0.8		10.0
WOLLASTONITE							
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 11.3.9 SAMPLE BIR1296 NORMATIVE TERNARY GROUPINGS

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	79.9	20.1	0.0	10.0	17.4
2	77.6	22.6	0.0	11.3	19.6
3	78.1	21.9	0.0	10.9	19.0
4	85.1	14.8	0.0	7.4	12.8
5	77.7	22.2	0.0	11.1	19.2

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	2.6				
3	1.8	0.7			
4	5.3	7.8	7.1		
5	2.1	0.4	0.3	7.4	

Mean r-factor = 3.5 Standard Deviation = 3.0

NORMATIVE PHASE 'r-factor' VALUES

N O R M A T I V E

VOLUMETRIC		1	2	3	4	5
	1	26.4	24.0	24.7	31.4	24.4
	2	30.3	28.0	28.7	35.2	28.4
	3	30.4	28.3	28.9	34.8	28.6
	4	39.0	36.7	37.4	43.8	37.1
	5	26.4	24.0	24.7	31.4	24.4

Mean r-factor = 30.3 Standard Deviation = 5.4

TABLES 11.4.1 - 11.4.17 AMERSHAM (SMITHING SLAG) DATA

TABLE 11.4.1 SAMPLE AM783 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	30	40	30	50.0	34.6
2	30	30	40	55.0	26.0
3	0	10	90	95.0	8.7
4	0	10	90	95.0	8.7
5	0	10	90	95.0	8.7

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	10				
3	52	44			
4	52	44	0		
5	52	44	0	0	

Mean r-factor = 30 Standard Deviation = 24

TABLE 11.4.2 SAMPLE AM783 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.3	N.D	N.D	0.4	0.6
MgO	0.6	0.6	0.3	0.1	0.7
Al_2O_3	3.4	3.5	3.3	0.9	4.1
SiO_2	21.9	21.0	19.5	6.7	27.0
P_2O_5	0.7	0.5	0.5	0.5	0.6
S	N.D	N.D	N.D	0.2	0.1
K_2O	1.4	1.0	1.4	0.1	0.7
CaO	3.8	2.8	3.5	1.3	2.6
TiO_2	0.2	0.1	0.2	0.1	0.4
V_2O_5	N.D	0.1	N.D	N.D	N.D
Cr_2O_6	0.1	0.2	N.D	N.D	0.1
MnO	N.D	0.2	0.2	0.1	0.2
FeO	68.3	64.7	70.3	58.6	57.9
CoO	0.5	0.4	0.3	0.3	0.7
NiO	0.3	0.2	0.2	0.3	0.2
Total	101.5	95.3	99.7	69.6	95.9

TABLE 11.4.3 SAMPLE AM783 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	FEOX1	FEOX2	INCL
Na_2O	0.1	0.3	0.5	1.0	0.2	0.1	0.4
MgO	1.5	1.7	N.D	N.D	0.4	N.D	N.D
Al_2O_3	N.D	N.D	10.7	6.3	0.4	1.6	N.D
SiO_2	30.3	30.3	38.1	36.3	0.9	8.7	102.7
P_2O_5	0.1	0.2	1.8	0.6	N.D	0.1	0.9
S	N.D	0.1	N.D	0.2	N.D	N.D	0.1
K_2O	N.D	N.D	6.8	0.2	N.D	N.D	N.D
CaO	2.0	1.8	14.5	0.7	0.1	0.1	N.D
TiO_2	0.1	0.1	0.1	0.3	0.2	0.6	N.D
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	0.1	N.D	N.D	N.D	0.1	N.D
MnO	0.1	0.1	0.2	N.D	N.D	N.D	N.D
FeO	64.7	65.4	28.6	40.6	91.9	70.5	1.7
CoO	0.4	0.1	N.D	0.2	0.1	0.5	N.D
NiO	0.3	0.3	0.2	0.3	0.2	0.2	N.D
Total	99.5	100.5	101.5	86.7	94.5	82.6	105.8

TABLE 11.4.4 SAMPLE AM783 BULK NORMATIVE MINERAL CONSTITUTION
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	1.6	1.2	1.2	1.7	1.5
VIVIANITE					
ULVITE	0.6	0.3	0.6	0.4	1.2
PYRRHOTITE				0.8	0.3
KALSILITE	4.7	3.6	4.7	0.5	2.5
K-SILICATE					
NEPHELINE	1.4			2.7	2.9
NA-SILICATE					
ANORTHITE		2.7			4.1
HERCYNITE					
MULLITE					
CA-SILICATE	2.1		1.3	1.1	
FORSTERITE	1.0	1.1	0.5	0.3	1.3
TEPHROITE		0.3	0.3	0.2	0.3
FAYALITE	59.2	61.8	54.3	26.3	79.1
GEHLENITE	3.7	4.2	4.9	0.5	2.6
WUSTITE	25.8	24.7	32.2	65.6	4.3
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.4.5 SAMPLE AM783 PHASE NORMATIVE MINERAL COMPOSITION
(Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	INCL
APATITE	0.2	0.5	4.1	1.4	
VIVIANITE				0.2	2.1
ULVITE	0.3	0.3	0.3	1.0	
PYRRHOTITE		0.3		0.6	0.3
KALSILITE			12.4		
K-SILICATE					
NEPHELINE			2.2		
NA-SILICATE	0.2	0.6			0.7
ANORTHITE			6.8		
HERCYNITE				8.8	
MULLITE					
CA-SILICATE		0.3	16.3		
FORSTERITE	0.1	3.0			
TEPHROITE	0.1	0.1	0.3		
FAYALITE	91.6	92.2	39.8	2.6	
GEHLENITE					
WUSTITE					
ORTHOCLASE			17.8	1.4	
ALBITE				9.9	
WOLLASTONITE	3.9	2.8			
ENSTATITE	3.6				
RHODONITE					
FERROSILITE				74.1	0.2
QUARTZ					96.7

TABLE 11.4.6 SAMPLE AM783 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	60.2	14.1	25.8	32.85	12.2
2	63.2	12.0	24.7	30.7	10.4
3	55.1	12.7	32.2	38.55	11.0
4	26.8	7.7	65.6	69.45	6.7
5	80.7	15.1	4.3	11.85	13.1

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	2.8				
3	5.8	7.9			
4	37.0	38.9	31.2		
5	21.0	19.0	26.8	57.95	

Mean r-factor = 24.8 Standard Deviation = 17.2

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE				
		1	2	3	4	5
VOLUMETRIC	1	28.2	30.95	26.2	34.0	43.8
	2	26.1	28.9	22.3	24.1	45.0
	3	62.25	64.3	56.5	25.6	83.3
	4	62.25	64.3	56.5	25.6	83.3
	5	62.25	64.3	56.5	25.6	83.3

Mean r-factor = 47.4 Standard Deviation = 20.7

TABLE 11.4.7 SAMPLE AM661 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	30	30	40	55.0	26.0
2	45	25	30	42.5	21.65
3	60	20	20	30.0	17.3
4	30	25	55	67.5	21.65
5	50	30	20	35.0	26.0

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	13				
3	26	13			
4	13	25	38		
5	20	9	10	33	

Mean r-factor = 20 Standard Deviation = 10

TABLE 11.4.8 SAMPLE AM661 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.4	0.2	0.5	0.7	0.5
MgO	0.5	0.6	0.6	0.5	1.0
Al_2O_3	3.8	3.2	3.7	3.3	2.7
SiO_2	28.2	27.7	28.1	28.5	28.5
P_2O_5	0.7	0.7	0.6	0.4	0.5
S	0.1	0.1	N.D	N.D	N.D
K_2O	1.7	1.7	1.9	2.0	1.4
CaO	4.0	5.2	5.2	5.4	4.1
TiO_2	0.2	0.3	0.3	0.2	0.1
V_2O_5	N.D	0.1	0.1	0.1	N.D
Cr_2O_6	0.1	N.D	N.D	N.D	N.D
MnO	0.2	0.3	0.3	0.5	0.4
FeO	58.3	59.9	59.9	58.8	60.7
CoO	0.3	0.6	0.4	0.3	0.5
NiO	0.3	0.2	0.2	0.2	0.2
Total	98.8	100.8	101.8	100.9	100.6

TABLE 11.4.9 SAMPLE AM661 PHASE ANAYSES (Weight Percent)

	SIL	GLAS1	GLAS2	FEOX1	FEOX2
Na_2O	0.3	1.0	0.6	0.2	N.D
MgO	2.2	N.D	N.D	0.3	N.D
Al_2O_3	N.D	11.3	7.6	0.7	0.6
SiO_2	31.3	61.1	38.6	1.0	0.9
P_2O_5	0.2	1.4	1.6	N.D	N.D
S	N.D	0.1	0.1	N.D	N.D
K_2O	N.D	5.5	6.3	0.1	0.1
CaO	1.6	2.7	10.8	0.1	0.1
TiO_2	N.D	0.1	0.2	0.6	0.8
V_2O_5	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	0.2	0.1	N.D	0.1
MnO	0.6	N.D	0.4	N.D	N.D
FeO	65.1	9.3	35.2	95.9	95.1
CoO	N.D	0.3	N.D	0.6	0.5
NiO	0.2	N.D	N.D	0.1	0.5
Total	101.6	93.0	101.5	99.6	99.1

TABLE 11.4.10 SAMPLE AM661 BULK AND PHASE NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
APATITE	1.5	1.6	1.4	0.9	1.2	0.4	3.5	3.7
VIVIANITE								
ULVITE	0.5	0.9	0.8	0.6	0.3		0.3	0.6
PYRRHOTITE	0.3	0.3					0.3	0.3
KALSILITE	5.4	5.7	6.3	6.9	4.7			
K-SILICATE								
NEPHELINE	1.7	0.9	2.3		2.3			
NA-SILICATE						0.6		0.2
ANORTHITE	3.3						4.6	
HERCYNITE							3.9	
MULLITE								
CA-SILICATE	3.4	4.8	5.3	7.7	4.7			13.5
FORSTERITE	0.8	1.0	1.0	0.9	1.7	1.0		
TEPHROITE	0.3	0.4	0.4	0.7	0.6	0.8		0.6
FAYALITE	76.7	75.7	73.0	74.7	78.1	90.5		49.5
GEHLENITE	6.0	2.8	2.2		1.0			
WUSTITE		5.8	7.2	7.5	5.5			
ORTHOCLASE							35.2	23.9
ALBITE							9.1	
WOLLASTONITE						2.7		
ENSTATITE						3.9		
RHODONITE								
FERROSILITE							14.6	
QUARTZ							28.4	

TABLE 11.4.11 SAMPLE AM661 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	77.8	22.1	0.0	11.05	19.1
2	77.1	17.0	5.8	14.3	14.7
3	74.4	18.3	7.2	16.35	15.85
4	76.3	16.1	7.5	15.55	13.9
5	80.4	14.2	5.5	12.6	12.3

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	5.5				
3	6.2	2.35			
4	6.9	1.5	2.1		
5	7.0	2.9	5.2	3.4	

Mean r-factor = 4.3. Standard Deviation = 2.1

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		N O R M A T I V E				
		1	2	3	4	5
VOLUMETRIC	1	44.5	42.4	40.0	41.3	44.6
	2	31.55	29.0	26.8	28.0	31.3
	3	19.0	15.9	13.7	14.8	18.1
	4	56.5	53.65	51.5	52.5	55.7
	5	24.9	23.6	21.2	22.9	26.3

Mean r-factor = 33.2 Standard Deviation = 13.9

TABLE 11.4.12 SAMPLE AM716 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	80	15	5	12.5	13.0
2	50	30	20	35.0	26.0
3	80	10	10	15.0	9.0
4	70	20	10	20.0	17.3
5	65	20	15	25.0	17.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	26				
3	5	34			
4	9	17	10		
5	13	13	13	5	

Mean r-factor = 15 Standard Deviation = 9

TABLE 11.4.13 SAMPLE AM716 BULK ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5
Na_2O	0.8	1.0	0.5	0.2	0.9
MgO	N.D	0.2	N.D	0.3	N.D
Al_2O_3	5.0	4.5	3.6	2.1	5.7
SiO_2	33.2	32.6	32.4	31.6	33.2
P_2O_5	1.4	1.4	0.9	0.4	1.2
S	0.1	0.1	0.1	0.1	0.2
K_2O	2.4	1.8	2.1	0.7	2.1
CaO	6.7	5.2	5.7	2.8	5.2
TiO_2	0.2	0.3	0.1	0.2	0.3
V_2O_5	N.D	N.D	N.D	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D
MnO	N.D	0.1	0.1	0.2	0.1
FeO	51.7	53.4	55.1	62.3	46.4
CoO	0.2	0.4	0.2	0.5	0.3
NiO	0.2	0.2	0.2	N.D	0.2
Total	101.9	101.2	101.0	101.4	95.9

TABLE 11.4.14 SAMPLE AM716 PHASE ANALYSES (Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	GLAS3	FEOX
Na_2O	0.3	0.4	0.7	1.2	1.1	N.D
MgO	0.3	0.1	N.D	N.D	N.D	N.D
Al_2O_3	0.3	N.D	20.3	8.9	20.8	0.4
SiO_2	30.5	31.7	57.1	30.3	58.5	1.2
P_2O_5	0.3	N.D	0.4	12.7	0.1	N.D
S	N.D	N.D	N.D	0.2	N.D	N.D
K_2O	N.D	N.D	19.4	2.9	19.1	N.D
CaO	2.6	3.4	0.3	24.5	0.3	0.3
TiO_2	0.1	N.D	0.2	0.9	0.2	0.6
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D
MnO	0.3	0.1	N.D	N.D	N.D	N.D
FeO	65.9	66.2	2.3	21.0	2.6	96.2
CoO	0.2	0.2	0.1	0.2	N.D	0.7
NiO	0.2	0.3	N.D	N.D	N.D	0.4
Total	101.0	102.4	100.8	102.8	102.7	99.8

TABLE 11.4.15 SAMPLE AM716 BULK NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5
APATITE	3.2	3.2	2.1	0.9	2.9
VIVIANITE					
ULVITE	0.6	0.8	0.3	0.5	0.9
PYRRHOTITE	0.3	0.3	0.3	0.3	0.6
KALSILITE	3.2	1.3	2.2		
K-SILICATE					
NEPHELINE	3.6	4.6	2.3	0.6	3.4
NA-SILICATE					
ANORTHITE	2.9	2.5	1.4	2.8	5.6
HERCYNITE					
MULLITE					
CA-SILICATE	6.4	4.3	6.6	2.6	4.1
FORSTERITE		0.3		0.5	
TEPHROITE		0.1	0.2	0.3	0.1
FAYALITE	71.4	74.2	76.0	86.8	67.7
GEHLENITE					
WUSTITE					
ORTHOCLASE	8.3	8.3	8.6	4.1	13.0
ALBITE				1.7	1.7
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.4.16 SAMPLE AM716 PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	SIL1	SIL2	GLAS1	GLAS2	GLAS3
APATITE	0.7		0.5	28.7	0.2
VIVIANITE			0.4		
ULVITE	0.3		0.6	2.5	0.5
PYRRHOTITE				0.5	
KALSILITE			21.5		21.6
K-SILICATE			1.0		
NEPHELINE				3.7	
NA-SILICATE	0.2	0.8	1.4		2.0
ANORTHITE				10.1	
HERCYNITE					
MULLITE					
CA-SILICATE	0.4	0.3		8.5	0.2
FORSTERITE	0.5	0.2			
TEPHROITE	0.4	0.1			
FAYALITE	93.4	92.1	2.3	26.2	3.1
GEHLENITE					
WUSTITE					
ORTHOCLASE			72.2	16.7	72.3
ALBITE				3.1	
WOLLASTONITE	4.0	6.5			
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 11.4.17 SAMPLE AM716 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	71.4	28.5	0.0	14.25	24.7
2	74.6	25.3	0.0	12.65	21.9
3	76.2	23.8	0.0	11.9	20.6
4	87.6	12.5	0.0	6.25	10.8
5	67.8	32.2	0.0	16.1	27.9

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	3.2				
3	4.7	1.5			
4	16.0	12.8	11.3		
5	3.7	6.9	8.4	19.7	

Mean r-factor = 8.8 Standard Deviation = 6.0

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

VOLUMETRIC \ NORMATIVE	1	2	3	4	5
1	11.8	8.9	7.6	6.6	15.3
2	20.8	22.7	23.7	32.5	19.0
3	15.7	13.1	12.0	8.9	18.9
4	9.4	8.7	8.75	15.2	11.3
5	13.05	13.2	13.5	19.8	13.8

Mean r-factor = 14.6 Standard Deviation = 6.1

TABLES 11.5.1 - 11.5.12 HEYBRIDGE DATA

TABLE 11.5.1 SAMPLE HEYA8 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	55	30	15	30.0	26.0
2	55	30	15	30.0	26.0
3	55	20	25	35.0	17.3
4	50	25	25	37.5	21.65
5	30	40	30	50.0	34.6

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	0				
3	10	10			
4	9	9	5		
5	22	22	23	18	

Mean r-factor = 13 Standard Deviation = 8

TABLE 11.5.2 Sample HEYA8 Bulk Analyses (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS	FEOX
Na_2O	0.5	0.5	0.1	0.1	N.D	N.D	N.D	N.D
MgO	0.7	0.5	0.4	0.6	0.8	1.7	0.3	N.D
Al_2O_3	2.8	3.0	5.3	2.4	3.4	N.D	0.5	N.D
SiO_2	26.4	29.9	31.8	25.9	22.2	30.0	28.3	0.7
P_2O_5	0.6	1.0	1.9	0.8	0.6	0.4	0.7	N.D
S	N.D	0.1	N.D	N.D	0.1	N.D	N.D	0.1
K_2O	1.8	2.2	4.2	1.8	2.6	N.D	0.1	N.D
CaO	2.6	3.4	8.1	3.6	3.2	1.7	21.1	0.1
TiO_2	0.3	0.1	N.D	0.1	N.D	N.D	0.1	0.2
V_2O_5	N.D	N.D	N.D	N.D	0.1	N.D	N.D	N.D
Cr_2O_6	N.D	0.1	N.D	N.D	N.D	N.D	0.7	N.D
MnO	0.3	0.1	0.1	0.2	0.1	0.3	0.4	0.3
FeO	61.1	58.5	48.8	64.9	63.5	64.9	48.7	96.1
CoO	N.D	0.5	0.1	0.3	N.D	0.4	0.1	N.D
NiO	0.2	N.D	N.D	0.1	0.2	N.D	N.D	N.D
Total	97.3	99.9	100.8	100.8	96.8	99.4	101.0	97.5

TABLE 11.5.3 SAMPLE HEYA8 BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS
APATITE	1.4	2.4	4.4	1.8	1.4	0.9	1.6
VIVIANITE							
ULVITE	0.8	0.3		0.3			0.3
PYRRHOTITE		0.3			0.3		0.3
KALSILITE	6.2	7.0	11.4	6.0	9.1		
K-SILICATE							
NEPHELINE	2.4		0.5	0.4			
NA-SILICATE		0.3					
ANORTHITE			1.6				
HERCYNITE							
MULLITE							
CA-SILICATE	2.8	3.3	8.0	3.4	2.8		30.3
FORSTERITE	1.3	0.9	0.7	1.0	1.5	1.0	0.5
TEPHROITE	0.5	0.1	0.1	0.3	0.1	0.4	0.6
FAYALITE	75.2	84.5	68.7	72.7	59.6	92.4	57.4
GEHLENITE	0.1			0.8	1.6		1.0
WUSTITE	9.4			13.2	23.6		7.9
ORTHOCLASE		1.0	4.6				
ALBITE							
WOLLASTONITE						2.4	
ENSTATITE						2.8	
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 11.5.4 SAMPLE HEYA8 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	77.0	13.7	9.4	16.25	11.9
2	85.5	14.6	0.0	7.3	12.6
3	69.5	30.5	0.0	15.25	26.4
4	74.0	12.7	13.2	19.55	11.0
5	61.2	15.2	23.6	31.2	13.2

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	9.0				
3	14.5	15.9			
4	3.4	12.35	16.0		
5	15.0	23.9	20.7	11.9	

Mean r-factor = 14.3 Standard Deviation = 5.7

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	19.7	26.4	14.8	18.3	28.5
	2	19.7	26.4	14.8	18.3	28.5
	3	19.5	28.1	21.75	16.7	5.6
	4	23.4	31.5	22.75	20.9	10.5
	5	40.7	48.0	35.7	38.5	28.5

Mean r-factor = 24.3 Standard Deviation = 9.6

TABLE 11.5.5 SAMPLE HEY119 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	70	30	0	15.0	26.0
2	65	35	0	17.5	30.3
3	70	25	5	17.5	21.65
4	60	20	20	30.0	17.3
5	75	10	15	20.0	8.7

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5				
3	5	9			
4	17	18	13		
5	18	22	13	13	

Mean r-factor = 13 Standard Deviation = 6

TABLE 11.5.6 SAMPLE HEY119 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
Na_2O	0.1	0.1	N.D	0.3	0.7	N.D	N.D	0.2
MgO	0.8	0.6	1.1	0.8	0.6	2.4	N.D	0.5
Al_2O_3	3.0	2.3	2.8	2.6	8.4	N.D	4.1	6.8
SiO_2	35.6	33.0	33.4	35.2	58.0	28.4	40.3	41.5
P_2O_5	1.9	2.1	2.0	1.7	1.2	0.6	5.2	5.8
S	N.D	N.D	0.1	0.1	N.D	N.D	0.3	0.2
K_2O	2.7	2.3	1.9	1.8	2.4	N.D	2.7	5.3
CaO	8.3	8.6	7.1	7.9	4.2	1.3	22.8	20.4
TiO_2	0.2	0.3	0.2	0.1	0.4	N.D	0.6	0.7
V_2O_5	0.2	0.3	N.D	N.D	N.D	N.D	N.D	0.1
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
MnO	0.6	0.1	0.4	0.3	0.2	0.5	N.D	0.3
FeO	47.8	48.8	52.4	49.6	25.3	66.2	22.8	17.5
CoO	0.1	N.D	N.D	0.3	N.D	N.D	N.D	N.D
NiO	0.1	N.D	N.D	0.2	N.D	N.D	N.D	0.2
Total	101.4	98.5	101.4	100.9	101.4	99.4	98.8	99.5

TABLE 11.5.7 SAMPLE HEY119 BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS1	GLAS2
APATITE	4.4	5.0	4.6	3.9	2.7	1.4	12.2	13.6
VIVIANITE								
ULVITE	0.6	0.9	0.6	0.3	1.1		1.7	2.0
PYRRHOTITE			0.3	0.3			0.8	0.5
KALSILITE								
K-SILICATE		0.3						
NEPHELINE								
NA-SILICATE	0.1	0.2						
ANORTHITE			2.0	0.4	12.5		3.3	2.0
HERCYNITE								
MULLITE								
CA-SILICATE	5.0	6.5	4.9	2.6		0.8		3.3
FORSTERITE	1.4	1.1	1.9	1.4		4.2		0.9
TEPHROITE	0.8	0.1	0.6	0.4		0.7		0.4
FAYALITE	66.8	69.7	72.5	69.5		89.1	18.6	22.6
GEHLENITE								
WUSTITE						3.7		
ORTHOCLASE	15.8	12.8	11.1	10.6	14.0		16.2	31.6
ALBITE				2.5	5.8			1.7
WOLLASTONITE	5.1	3.5	1.7	8.0	0.1		32.1	21.3
ENSTATITE					1.5			
RHODONITE					0.4			
FERROSILITE					44.5		15.1	
QUARTZ					17.3			

TABLE 11.5.8 SAMPLE HEY119 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	69.0	31.0	0.0	15.5	26.85
2	70.9	29.2	0.0	14.6	25.3
3	75.0	25.2	0.0	12.6	21.8
4	71.3	28.6	0.0	14.3	24.8
5	46.4	53.5	0.0	26.75	46.3

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	1.8				
3	5.8	4.0			
4	2.4	0.6	3.45		
5	22.5	24.3	28.3	24.8	

Mean r-factor = 11.8 Standard Deviation = 11.5

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		NORMATIVE 1	2	3	4	5
VOLUMETRIC	1	1.0	0.8	4.8	1.4	23.5
	2	4.0	5.8	9.8	6.4	18.5
	3	5.6	4.7	4.9	4.5	26.3
	4	17.4	17.35	18.0	17.4	29.2
	5	18.7	17.5	15.05	17.1	38.2

Mean r-factor = 13.1 Standard Deviation = 9.8

TABLE 11.5.9 SAMPLE HEY64 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	30	10	25.0	26.0
2	60	25	15	27.5	21.65
3	60	30	10	25.0	26.0
4	60	30	10	25.0	26.0
5	70	20	10	20.0	17.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	5				
3	0	5			
4	0	5	0		
5	10	9	10	10	

Mean r-factor = 5 Standard Deviation = 4

TABLE 11.5.10 SAMPLE HEYA64 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLASS	FEOX
Na_2O	0.4	0.5	0.5	0.2	0.2	N.D	0.8	0.2
MgO	1.0	0.8	0.5	1.1	0.9	1.5	N.D	0.2
Al_2O_3	2.7	2.7	3.3	2.5	2.1	N.D	6.0	0.4
SiO_2	30.1	32.8	30.9	30.2	27.6	31.1	36.8	0.9
P_2O_5	1.5	1.5	1.9	1.3	0.9	0.1	4.0	N.D
S	0.1	0.2	0.1	0.2	N.D	N.D	0.5	N.D
K_2O	2.7	3.1	2.5	2.2	1.9	N.D	7.5	N.D
CaO	7.8	9.0	6.4	7.3	5.9	4.2	8.2	0.2
TiO_2	0.2	0.3	0.3	N.D	0.2	0.2	0.6	0.5
V_2O_5	N.D	N.D	0.1	0.1	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	N.D	N.D	N.D	N.D	N.D	N.D	0.1
MnO	0.2	0.4	0.2	0.3	0.2	0.4	0.1	N.D
FeO	54.0	49.8	48.3	54.5	58.6	63.1	31.6	94.2
CoO	0.1	N.D	0.3	0.4	0.4	N.D	0.2	0.5
NiO	0.2	0.2	0.2	0.1	0.6	N.D	N.D	0.4
Total	101.1	101.3	95.5	100.4	99.5	100.6	96.3	97.6

TABLE 11.5.11 SAMPLE HEYA64 BULK AND PHASE NORMATIVE CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS
APATITE	3.5	3.4	4.7	3.0	2.1	0.2	9.7
VIVIANITE							
ULVITE	0.6	0.8	0.9		0.6	0.5	1.7
PYRRHOTITE	0.3	0.5	0.3	0.6			1.4
KALSILITE	8.2	3.3	2.7	6.7	6.5		0.5
K-SILICATE	0.3	1.0					3.3
NEPHELINE							
NA-SILICATE	0.8	1.0	0.3	0.3	0.3		1.6
ANORTHITE							
HERCYNITE							
MULLITE							
CA-SILICATE	8.9	10.7	6.4	8.6	7.4	2.3	4.7
FORSTERITE	1.7	1.4	0.9	1.9	1.6	2.6	
TEPHROITE	0.3	0.6	0.3	0.4	0.3	0.6	0.2
FAYALITE	75.3	68.5	72.3	77.2	74.7	88.5	43.5
GEHLENITE							
WUSTITE					6.5		
ORTHOCLASE	0.3	8.7	11.0	1.4			33.3
ALBITE							
WOLLASTONITE						5.3	
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 11.5.12 SAMPLE HEYA64 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	80.2	19.9	0.0	9.95	17.2
2	74.0	25.8	0.0	12.9	22.3
3	75.6	24.2	0.0	12.1	21.0
4	82.3	17.7	0.0	8.9	15.3
5	79.0	14.4	6.5	13.7	12.5

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	5.9				
3	4.4	1.5			
4	2.2	8.1	6.5		
5	6.0	9.8	8.65	5.6	

Mean r-factor = 5.9 Standard Deviation = 2.65

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

N O R M A T I V E

		1	2	3	4	5
VOLUMETRIC	1	17.4	12.65	13.8	19.3	17.6
	2	18.1	14.6	15.4	19.65	16.6
	3	17.4	12.65	13.8	19.3	17.6
	4	17.4	12.65	13.8	19.3	17.6
	5	10.05	8.7	8.7	11.3	7.9

Mean r-factor = 14.9 Standard Deviation = 3.6

TABLES 11.6.1 - 11.6.5 WETWANG SLACK DATA

TABLE 11.6.1 SAMPLE WWS501/1 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	65	20	15	17.3	25.0
2	60	20	20	30.0	17.3
3	55	20	25	35.0	17.3
4	50	30	20	35.0	26.0
5	40	30	30	45.0	26.0

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	15				
3	19	5			
4	18	10	9		
5	28	17	13	10	

Mean r-factor = 14   Standard Deviation = 6.5

TABLE 11.6.2 SAMPLE WWS501/2 VOLUMETRIC PHASE PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	Y
1	60	10	30	35.0	8.7
2	70	25	5	17.5	21.65
3	60	20	20	30.0	17.3
4	65	20	15	17.3	25.0
5	40	20	40	50.0	17.3

VOLUMETRIC 'r-factor' VALUES

	1	2	3	4	5
1					
2	22				
3	10	13			
4	24	3	15		
5	17	33	20	34	

Mean r-factor = 19 Standard Deviation = 10

TABLE 11.6.3 SAMPLE WWS501/1 BULK AND PHASE ANALYSES (Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS	FEOX
Na_2O	N.D	N.D	0.1	N.D	N.D	N.D	0.4	0.5
MgO	0.3	0.2	0.5	0.1	0.3	0.2	N.D	0.1
Al_2O_3	6.3	5.9	7.3	7.2	6.0	0.4	14.5	0.6
SiO_2	22.2	20.9	20.4	18.1	18.6	29.1	34.6	0.7
P_2O_5	N.D	N.D	N.D	0.2	N.D	N.D	1.2	N.D
S	0.7	0.8	0.6	0.4	0.3	N.D	0.8	N.D
K_2O	1.2	0.8	0.9	0.2	0.1	N.D	6.6	0.1
CaO	2.6	1.7	1.9	0.6	0.9	1.5	13.0	N.D
TiO_2	0.1	0.2	0.2	0.4	0.4	0.1	0.4	0.3
V_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	0.1	0.1
Cr_2O_6	0.1	N.D	N.D	N.D	N.D	0.1	N.D	N.D
MnO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
FeO	66.7	66.7	64.9	64.9	68.6	67.7	27.6	94.5
CoO	0.4	0.5	0.4	0.2	N.D	0.3	N.D	0.3
NiO	0.1	0.3	0.1	N.D	0.2	0.2	N.D	0.3
Total	100.7	98.0	97.3	92.3	95.4	99.6	99.2	97.5

TABLE 11.6.4 BULK AND PHASE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	B1	B2	B3	B4	B5	SIL	GLAS
APATITE				0.5			2.8
VIVIANITE							
ULVITE	0.3	0.6	0.6	1.2	1.2	0.3	1.1
PYRRHOTITE	1.9	2.3	1.7	1.2	0.9		2.2
KALSILITE	4.0	2.8	3.1	0.7	0.4		18.6
K-SILICATE							
NEPHELINE			0.5				1.9
NA-SILICATE							
ANORTHITE	12.9	8.7	9.8	1.8	4.7	1.1	18.5
HERCYNITE	0.5	3.4	4.8	11.8	7.6		
MULLITE							
CA-SILICATE						1.9	12.0
FORSTERITE	0.5	0.4	0.9	0.2	0.6	0.3	
TEPHROITE							
FAYALITE	50.6	56.3	51.3	62.9	58.2	95.0	36.0
GEHLENITE						1.3	
WUSTITE	29.2	25.5	27.3	19.7	26.5		
ORTHOCLASE							6.7
ALBITE							
WOLLASTONITE							
ENSTATITE							
RHODONITE							
FERROSILITE							
QUARTZ							

TABLE 11.6.5 SAMPLE WWS501/1 NORMATIVE TERNARY PERCENTAGES

AREA	SILICATE %	GLASS %	FEOX %	CO-ORDINATES X	CO-ORDINATES Y
1	51.1	19.6	29.2	39.0	17.0
2	56.7	17.8	25.5	34.4	15.4
3	52.2	20.5	27.3	37.55	17.75
4	63.1	17.2	19.7	28.3	14.9
5	58.8	14.8	26.5	33.9	12.8

NORMATIVE PHASE 'r-factor' VALUES

	1	2	3	4	5
1					
2	4.9				
3	1.6	3.9			
4	10.9	6.1	9.7		
5	6.6	2.65	6.15	6.0	

Mean r-factor = 5.85 Standard Deviation = 2.9

VOLUMETRIC/NORMATIVE PHASE 'r-factor' VALUES

		N O R M A T I V E				
		1	2	3	4	5
VOLUMETRIC	1	23.1	19.6	21.5	14.9	20.6
	2	9.0	4.8	7.5	2.9	5.9
	3	4.0	2.0	2.5	7.1	4.6
	4	9.8	10.6	8.7	13.0	13.2
	5	10.8	15.0	11.2	20.0	17.2

Mean r-factor = 11.2 Standard Deviation = 6.4

TABLES 11.7.1 - 11.7.3 SMITHING SLAG SUMMARY DATA

TABLE 11.7.1 SUMMARY OF SMITHING SLAG SILICATE MINERAL TEXTURES

Sample		Silicate Mineral Texture
Beckford	BEK1	Lath
	BEK2	Massive
	BEK3	Massive
	BEK4	Lath + Massive
	BEK5	Lath + Massive
Wharram Percy	WP1	Lath + (some) Massive
	WP2	Lath + (some) Massive
Birsay	BIR1395	Euhedral
	BIR1296	Lath + Euhedral
Amersham	AMG783	Massive
	AMG661	Lath + Massive
	AMG7116	Lath + Massive
Wetwang Slack	WWS501/1	Lath + Massive
	WWS501/2	Lath + Massive
Heybridge	HEYA64	Lath + Massive
	HEY119	Lath + Massive
	HEYA8	Lath + Massive

TABLE 11.7.2 MEAN SMITHING SLAG BULK ANALYSES (Weight Percent)

	BEK1		BEK2		BEK3		BEK4	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Na_2O	0.0	0.0	0.4	0.3	0.0	0.0	0.5	0.3
MgO	0.3	0.3	0.5	0.4	0.0	0.0	0.4	0.5
Al_2O_3	2.2	0.5	5.6	1.2	1.1	0.3	5.2	0.8
SiO_2	20.0	1.0	15.3	2.5	15.3	3.2	21.6	2.0
P_2O_5	0.0	0.0	0.5	0.2	0.0	0.0	0.5	0.1
S	0.0	0.0	0.2	0.1	0.0	0.0	0.2	0.1
K_2O	0.5	0.1	1.3	0.3	0.7	0.1	1.6	0.2
CaO	0.9	0.1	2.5	0.3	0.6	0.2	3.0	0.6
TiO_2	0.1	0.1	0.2	0.1	0.0	0.0	0.2	0.2
V_2O_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cr_2O_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MnO	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
FeO	74.4	1.1	70.0	3.9	83.1	2.5	67.1	3.4
CoO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NiO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	98.8	1.2	96.7	0.8	100.9	1.5	100.7	1.6

TABLE 11.7.2 (CONT)

	BEK5		WP1		WP2		BIR1395	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Na_2O	0.2	0.2	0.2	0.2	0.3	0.2	1.5	0.2
MgO	0.5	0.2	0.3	0.2	0.1	0.2	0.6	0.1
Al_2O_3	2.6	0.8	3.1	1.3	3.5	1.3	4.5	0.3
SiO_2	18.7	3.9	31.4	2.0	28.2	2.7	35.0	0.8
P_2O_5	0.8	0.3	3.1	1.5	0.7	0.8	0.8	0.2
S	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
K_2O	2.1	0.6	2.1	1.3	3.2	1.3	1.5	0.1
CaO	4.6	0.9	6.8	3.9	2.0	0.7	2.7	0.2
TiO_2	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.1
V_2O_5	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Cr_2O_6	0.0	0.0	0.2	0.4	0.3	0.3	0.0	0.0
MnO	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.1
FeO	71.4	4.8	54.5	9.8	61.4	2.0	51.6	2.0
CoO	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1
NiO	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Total	101.2	1.8	102.8	1.8	99.9	2.7	99.3	1.9

TABLE 11.7.2 (CONT)

	BIR1296		AM783		AM661		AM716	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Na_2O	1.6	0.3	0.3	0.3	0.5	0.2	0.7	0.3
MgO	0.6	0.2	0.5	0.2	0.6	0.2	0.1	0.1
Al_2O_3	5.0	0.3	3.0	1.2	3.3	0.4	4.2	1.4
SiO_2	32.9	0.5	19.2	7.5	28.2	0.3	32.6	0.7
P_2O_5	0.4	0.2	0.6	0.1	0.6	0.1	1.1	0.4
S	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1
K_2O	1.5	0.2	0.9	0.5	1.7	0.2	1.8	0.7
CaO	2.0	0.1	2.8	1.0	4.8	0.7	5.1	1.4
TiO_2	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1
V_2O_5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Cr_2O_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MnO	0.0	0.0	0.1	0.1	0.3	0.1	0.1	0.1
FeO	54.4	1.4	64.0	5.6	59.5	1.0	53.8	5.8
CoO	0.3	0.2	0.4	0.2	0.4	0.1	0.3	0.1
NiO	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1
Total	99.4	0.8	92.4	13.0	100.6	1.1	100.3	2.5

TABLE 11.7.2 (CONT)

	WWS		HEYA64		HEY119		HEYA8	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Na_2O	0.0	0.0	0.4	0.2	0.2	0.3	0.2	0.2
MgO	0.3	0.1	0.9	0.2	0.8	0.2	0.6	0.2
Al_2O_3	6.5	0.7	2.7	0.4	3.8	2.6	3.4	1.1
SiO_2	20.0	1.7	30.3	1.9	39.0	10.7	27.2	3.7
P_2O_5	0.0	0.0	1.4	0.4	1.8	0.4	1.0	0.5
S	0.6	0.2	0.1	0.1	0.0	0.0	0.0	0.0
K_2O	0.6	0.5	2.5	0.5	2.2	0.4	2.5	1.0
CaO	1.5	0.8	7.3	1.2	7.2	1.8	4.2	2.2
TiO_2	0.3	0.1	0.2	0.1	0.2	0.1	0.0	0.0
V_2O_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cr_2O_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MnO	0.0	0.0	0.3	0.1	0.3	0.2	0.2	0.1
FeO	66.4	1.5	53.0	4.1	44.8	11.0	59.4	6.4
CoO	0.3	0.2	0.2	0.2	0.0	0.0	0.2	0.2
NiO	0.2	0.1	0.3	0.2	0.0	0.0	0.0	0.0
Total	96.7	3.1	99.6	2.4	100.7	1.3	99.1	1.9

TABLE 11.7.2 (CONT) OVERALL MEAN VALUES

	OVERALL	
	MEAN	S.D.
Na_2O	0.4	0.5
MgO	0.4	0.3
Al_2O_3	3.7	1.7
SiO_2	25.8	8.0
P_2O_5	0.8	0.9
S	0.0	0.0
K_2O	1.7	0.9
CaO	3.6	2.4
TiO_2	0.0	0.0
V_2O_5	0.0	0.0
Cr_2O_6	0.0	0.0
MnO	0.0	0.0
FeO	61.9	10.8
CoO	0.2	0.2
NiO	0.0	0.0

TABLE 11.7.3 MEAN AND STANDARD DEVIATIONS OF r-VALUES

SAMPLE	VOLUMETRIC		TERNARY		VOLUMETRIC/TERNARY	
	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
BEK1	10	8	4.1	2.0	7.5	6.4
BEK2	8	6	23.1	17.3	23.4	8.1
BEK3	11	5	10.9	7.4	12.5	5.8
BEK4	14	8	7.3	4.9	13.1	6.9
BEK5	10	4	12.9	7.7	11.0	5.5
WP1	6	4	16.1	11.7	13.0	5.1
WP2	9	7	7.5	2.6	16.8	7.8
BIR1395	8	5	2.2	1.7	39.0	6.0
BIR1296	6.5	4	2.7	2.8	38.0	5.1
AM783	30	24	24.8	17.2	47.4	20.7
AM661	20	10	4.3	2.0	33.2	13.9
AM716	14.5	9	8.8	6.0	14.6	6.1
HEYA64	5	4	5.9	2.6	14.9	3.6
HEY119	13	6	11.8	11.5	13.1	9.8
HEYA8	13	8	14.3	5.7	24.3	9.6
WWS	14	6.5	5.8	2.9	11.2	6.4
OVERALL MEAN	12	10	10.3	10.2	19.0	13.4

TABLES 12.2.1 - 12.12.3.2 HAMMER SCALE DATA

TABLE 12.2.1 FLAKE HAMMER SCALE BULK AND PHASE ANALYSES
SAMPLES HS3 AND HS5 (Weight Percent)

	SAMPLE HS3				SAMPLE HS5		
	BULK1	BULK2	SIL	FEOX	BULK1	SIL	FEOX
Na_2O	N.D	N.D	N.D	N.D	0.3	0.2	N.D
MgO	0.1	0.4	0.4	N.D	N.D	1.0	N.D
Al_2O_3	1.5	1.0	0.3	1.0	1.9	0.4	0.2
SiO_2	22.2	16.6	28.7	1.0	11.7	30.0	0.6
P_2O_5	1.4	1.2	0.2	N.D	N.D	N.D	N.D
S	N.D	N.D	N.D	N.D	0.1	N.D	0.1
K_2O	0.4	0.1	0.1	N.D	0.6	N.D	N.D
CaO	0.9	0.6	0.2	0.1	0.7	1.3	0.1
TiO_2	0.1	0.2	N.D	0.4	N.D	N.D	N.D
V_2O_5	0.1	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	0.1	N.D	N.D	N.D	0.1	0.1	N.D
MnO	N.D	N.D	N.D	N.D	0.3	0.2	0.2
FeO	70.5	76.1	68.4	96.3	84.7	67.5	98.4
CoO	0.2	N.D	0.3	0.4	0.1	0.2	0.4
NiO	0.6	0.4	0.2	0.6	0.2	N.D	0.3
Total	98.1	96.6	98.8	99.8	100.7	100.9	100.3

TABLE 12.2.2 FLAKE HAMMERSCALE (SAMPLES HS3 AND HS5)
NORMATIVE CONSTITUENTS (Weight Percent)

	SAMPLE HS3			SAMPLE HS5	
	BULK1	BULK2	SIL	BULK	SIL
APATITE	1.6	1.1	0.3		
VIVIANITE	1.9	1.9	0.1		
ULVITE	0.3	0.6			
PYRRHOTITE				0.3	
KALSILITE	1.4	0.3	0.3	2.0	
K-SILICATE					
NEPHELINE				1.4	0.9
NA-SILICATE					
ANORTHITE				0.6	
HERCYNITE	11.9	1.6	0.3		
MULLITE					
CA-SILICATE					1.9
FORSTERITE	0.2	0.7	0.7		1.7
TEPHROITE				0.4	0.3
FAYALITE	75.5	57.1	97.7	32.6	94.7
GEHLENITE				1.4	0.2
WUSTITE	17.3	36.7	0.5	61.3	0.3
ORTHOCLASE					
ALBITE					
WOLLASTONITE					
ENSTATITE					
RHODONITE					
FERROSILITE					
QUARTZ					

TABLE 12.2.3 FLAKE HAMMERSCALE SAMPLES HS6 AND HS7 BULK AND PHASE ANALYSES (Weight Percent)

	SAMPLE HS6			I	SAMPLE HS7					
	BULK	SIL1	SIL2	SIL3	BULK1	BULK2	BULK3	SIL	FEOX1	FEOX2
Na_2O	N.D	N.D	N.D	0.2	N.D	N.D	0.2	0.1	N.D	0.4
MgO	0.1	0.4	0.	0.4	0.1	0.3	0.2	0.2	0.4	0.4
Al_2O_3	2.0	1.7	0.3	5.4	1.3	1.5	1.3	1.1	0.5	0.2
SiO_2	27.7	29.7	93.4	42.7	12.1	15.0	17.9	19.8	0.8	1.0
P_2O_5	0.3	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
S	0.1	0.1	0.2	0.1	N.D	0.1	N.D	N.D	0.1	N.D
K_2O	0.6	0.4	N.D	1.2	0.3	0.4	0.4	0.3	0.1	0.1
CaO	0.5	0.4	N.D	0.4	0.2	0.2	0.4	0.3	N.D	N.D
TiO_2	0.2	0.2	N.D	0.6	0.1	N.D	0.1	0.1	N.D	0.1
V_2O_5	N.D	0.1	N.D	N.D	N.D	0.1	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	N.D	0.1	N.D	0.1	N.D
MnC	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
FeO	67.2	68.2	0.4	46.7	78.4	73.5	78.0	76.7	95.9	96.0
CoO	0.1	0.2	0.1	N.D	0.4	0.2	0.3	0.1	0.3	0.3
NiO	0.2	0.3	N.D	0.1	0.4	0.6	N.D	0.1	0.1	0.6
Total	99.0	101.7	94.5	97.8	93.3	91.9	98.9	98.8	98.3	99.1

TABLE 12.2.4 FLAKE SCALE SAMPLES HS6 AND HS7 NORMATIVE MINERAL CONSTITUENTS (Weight Percent)

	SAMPLE HS6			SAMPLE HS7			
	BULK	SIL1	SIL3	BULK1	BULK2	BULK3	SIL
APATITE	0.7						
VIVIANITE							
ULVITE	0.6	0.6	1.7	0.3		0.3	0.3
PYRRHOTITE	0.3	0.3	0.3		0.3		
KALSILITE	2.1	1.3		1.1	1.5	1.4	1.0
K-SILICATE							
NEPHELINE						0.9	0.5
NA-SILICATE							
ANORTHITE	0.5	1.9	2.0	1.1	1.1	0.9	1.5
HERCYNITE	2.0	0.9	5.3	1.1	1.3		0.1
MULLITE							
CA-SILICATE							
FORSTERITE	0.2	0.7		0.2	0.6	0.4	0.3
TEPHROITE							
FAYALITE	91.5	94.1	2.4	41.1	51.6	56.2	63.4
GEHLENITE						0.5	
WUSTITE	2.1	0.2		55.1	43.6	39.3	32.8
ORTHOCLASE			7.3				
ALBITE			1.7				
WOLLASTONITE							
ENSTATITE			1.0				
RHODONITE							
FERROSILITE			78.2				
QUARTZ							

TABLE 12.3.1 SPHEROIDAL HAMMER SCALE SAMPLES HS1, HS2 AND HS8
BULK, PHASE AND SPOT ANALYSES (Weight Percent)

	SAMPLE HS1		SAMPLE HS2				SAMPLE HS8		
	RIM1	RIM2	RIM1	RIM2	SIL	FEOX	BULK	SIL	FEOX
Na_2O	N.D	N.D	N.D	N.D	N.D	N.D	0.1	N.D	0.3
MgO	N.D	N.D	N.D	0.1	0.1	0.1	0.5	N.D	0.3
Al_2O_3	0.8	0.7	0.8	0.4	0.4	0.2	1.1	1.8	0.1
SiO_2	20.7	15.8	8.8	8.8	19.5	0.9	11.7	33.1	0.8
P_2O_5	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.1
S	N.D	N.D	N.D	0.1	N.D	N.D	N.D	0.2	N.D
K_2O	N.D	N.D	N.D	N.D	N.D	N.D	0.4	1.1	N.D
CaO	0.1	0.1	0.3	0.3	0.4	N.D	0.6	1.4	N.D
TiO_2	0.1	0.1	N.D	N.D	N.D	N.D	N.D	0.1	N.D
V_2O_5	0.1	N.D	0.1	N.D	N.D	N.D	N.D	N.D	N.D
Cr_2O_6	N.D	N.D	N.D	N.D	N.D	0.1	N.D	N.D	N.D
MnO	N.D	N.D	N.D	N.D	N.D	N.D	N.D	0.1	N.D
FeO	77.8	84.7	87.1	87.1	83.3	98.9	85.1	61.4	96.2
CoO	0.2	0.1	0.2	N.D	0.5	0.4	0.2	N.D	0.3
NiO	0.2	0.5	0.2	0.3	0.4	0.7	0.4	0.3	0.5
Total	100.0	102.0	97.5	97.1	104.6	101.3	100.1	99.5	98.6

TABLE 12.3.2 SPHEROIDAL HAMMER SCALE NORMATIVE MINERAL CONSTITUENTS
(Weight Percent)

	SAMPLE HS1		SAMPLE HS2			SAMPLE HS8	
	RIM1	RIM2	RIM1	RIM2	SIL	BULK	SIL
APATITE							
VIVIANITE							
ULVITE	0.3	0.3					0.3
PYRRHOTITE				1.4			0.6
KALSILITE						1.4	
K-SILICATE							
NEPHELINE						0.5	
NA-SILICATE							
ANORTHITE	0.5	0.5	1.5	0.7	0.2		1.7
HERCYNITE	1.1	0.9	0.4				
MULLITE							
CA-SILICATE							
FORSTERITE				0.2	0.2	0.9	
TEPHROITE							
FAYALITE	69.8	52.1	28.5	29.2	62.6	35.1	81.8
GEHLENITE				0.4	0.9	1.4	
WUSTITE	28.3	46.2	69.5	68.1	36.2	60.8	
ORTHOCLASE							6.6
ALBITE							
WOLLASTONITE							2.2
ENSTATITE							
RHODONITE							0.2
FERROSILITE							6.7
QUARTZ							

Fig 1 THE IRONWORKING PROCESS
'ORE TO ARTEFACT'
(THE SOURCES OF PROCESS DATA
ARE UNDERLINED)

(after C. Saunders, The Iron Firedog from Welwyn, Hertfordshire, Reconsidered, Herts. Archaeology V 1977 13-21)

Fig 2

OCCURRENCE OF IRONWORKING RESIDUES

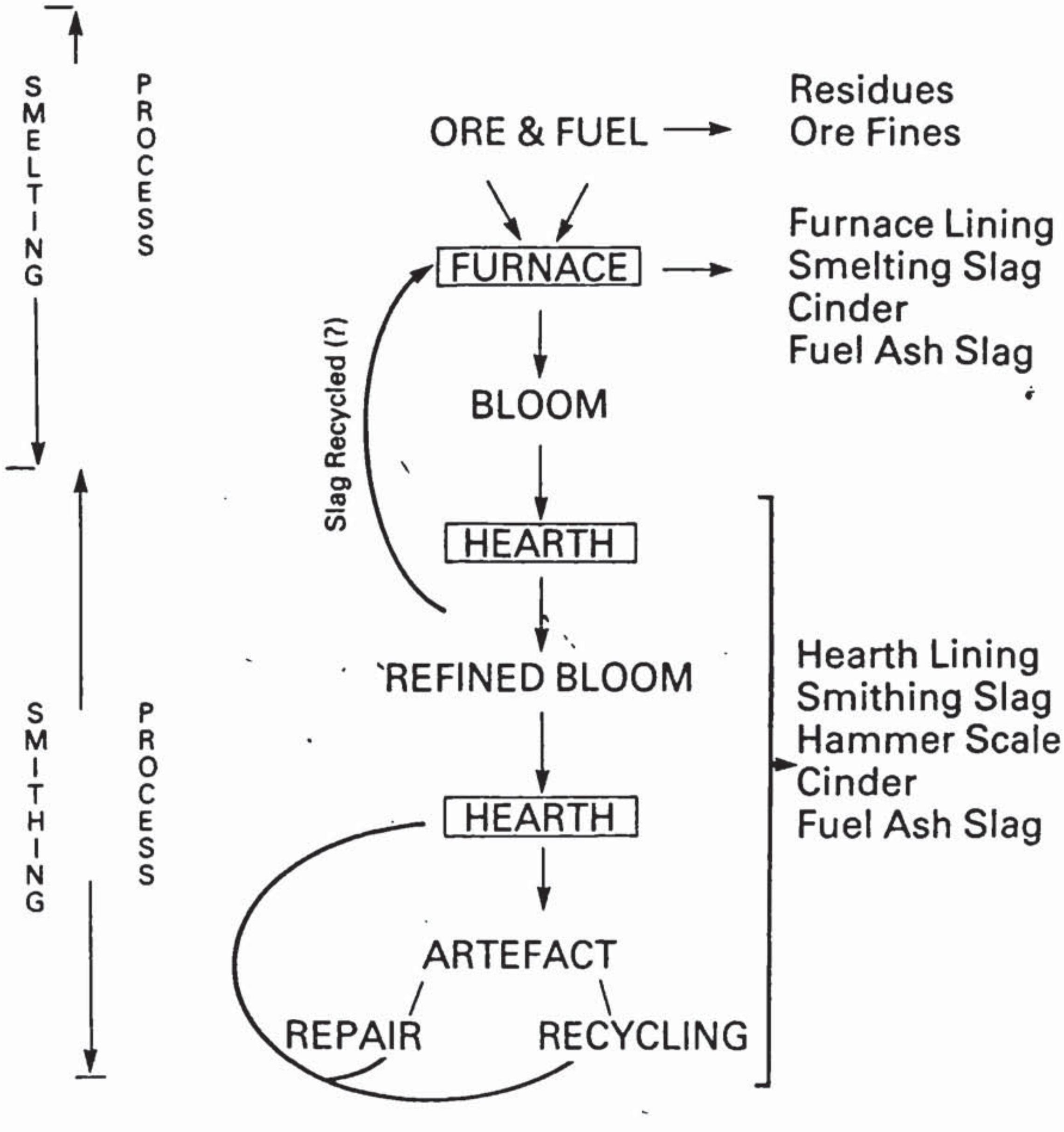
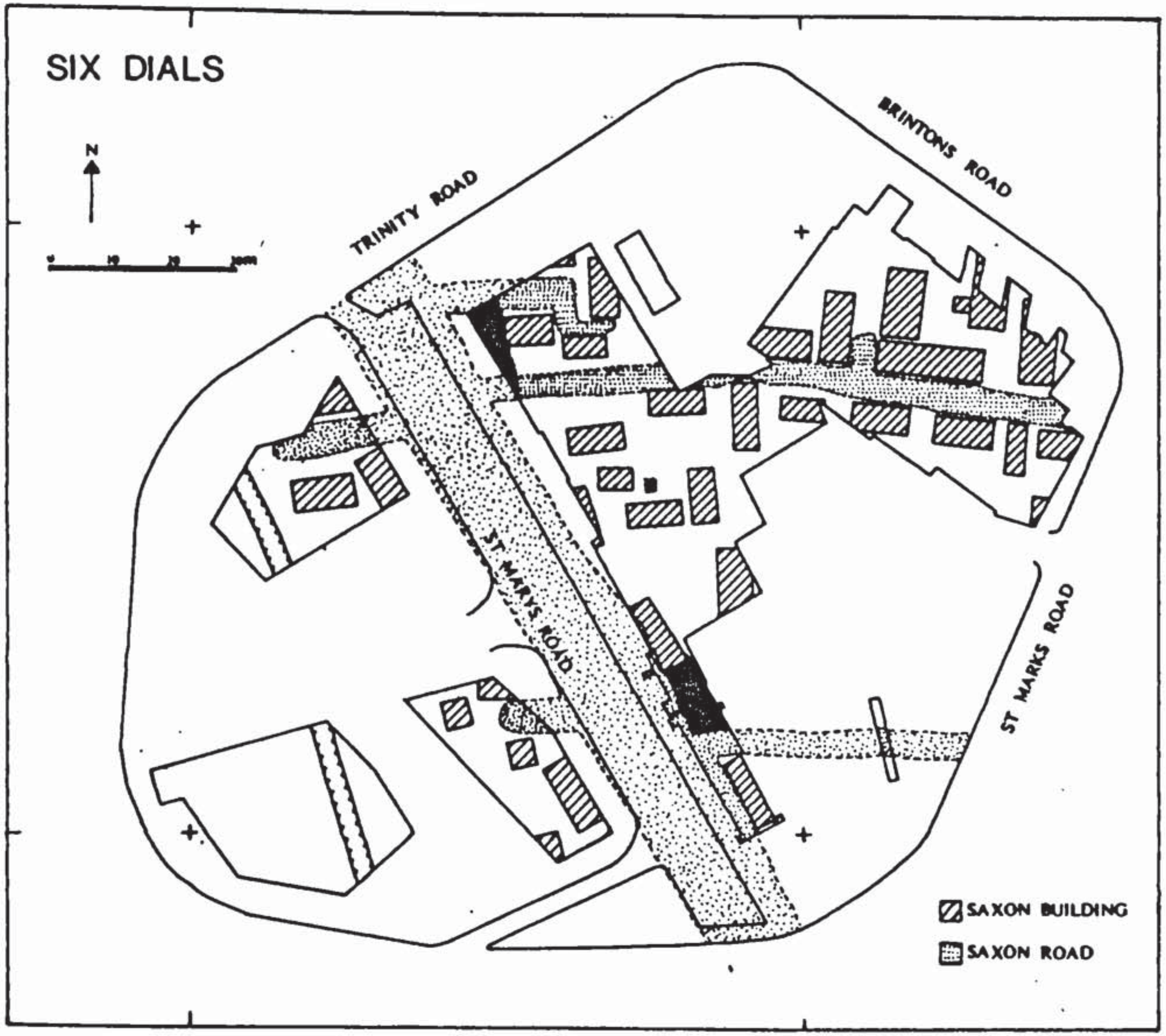


Fig. 3 Slag Distribution At Six Dials, Southampton. [courtesy of Southampton City Museums]

slag concentrations



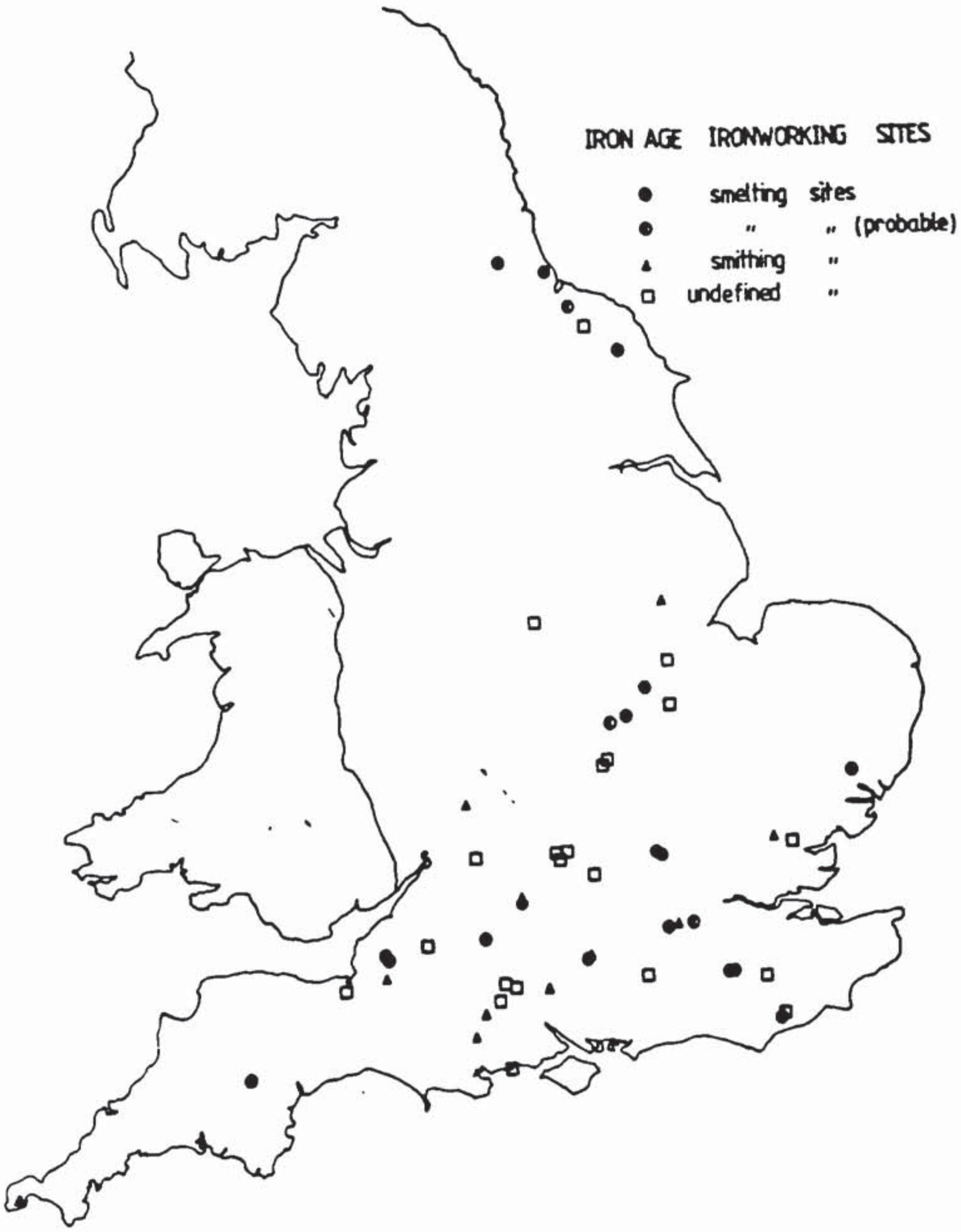


FIGURE 4 Distribution of Iron Age ironworking sites in England

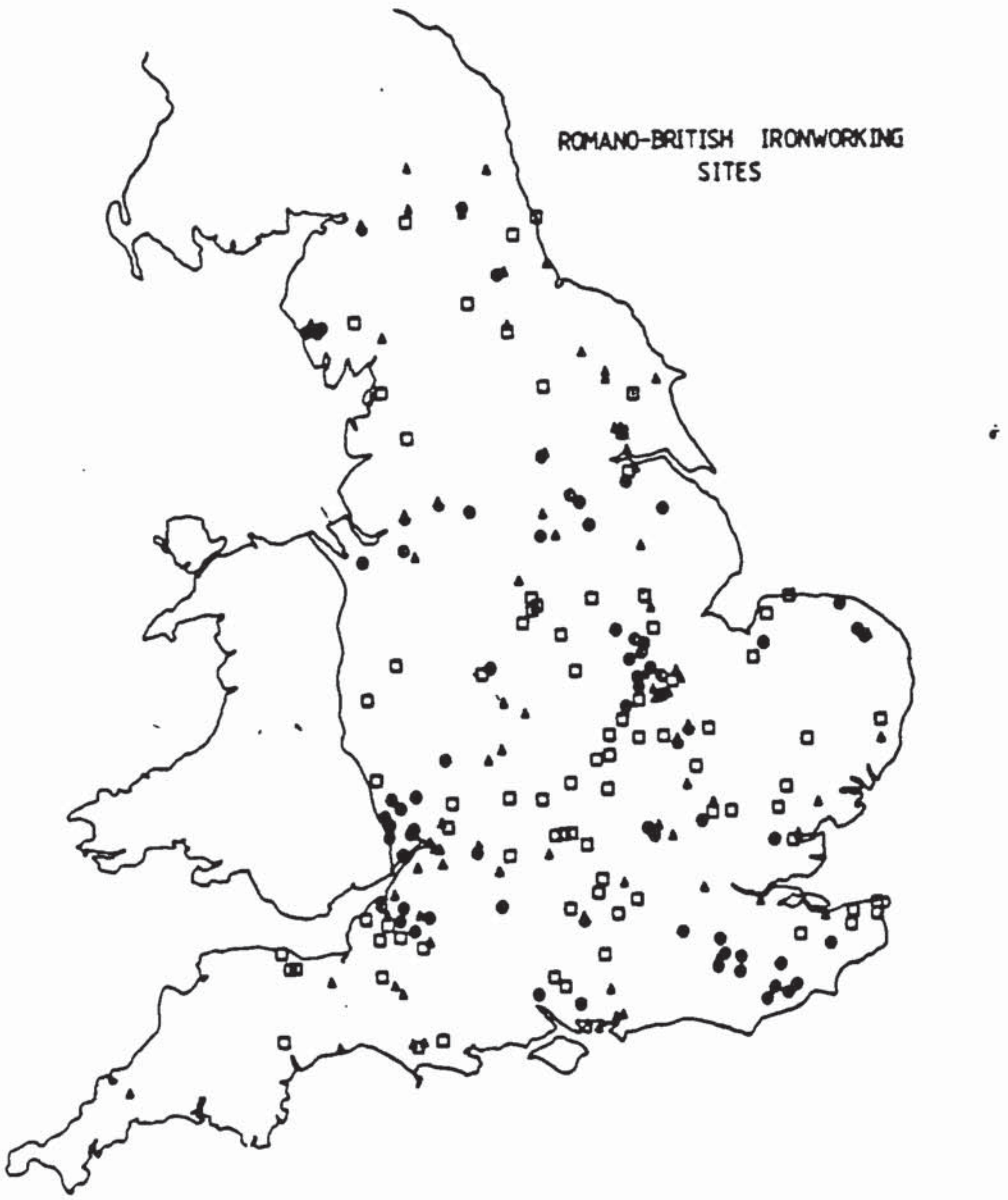


FIGURE 5 Distribution of Romano-British ironworking sites in England. (Symbols as for Figure 4)

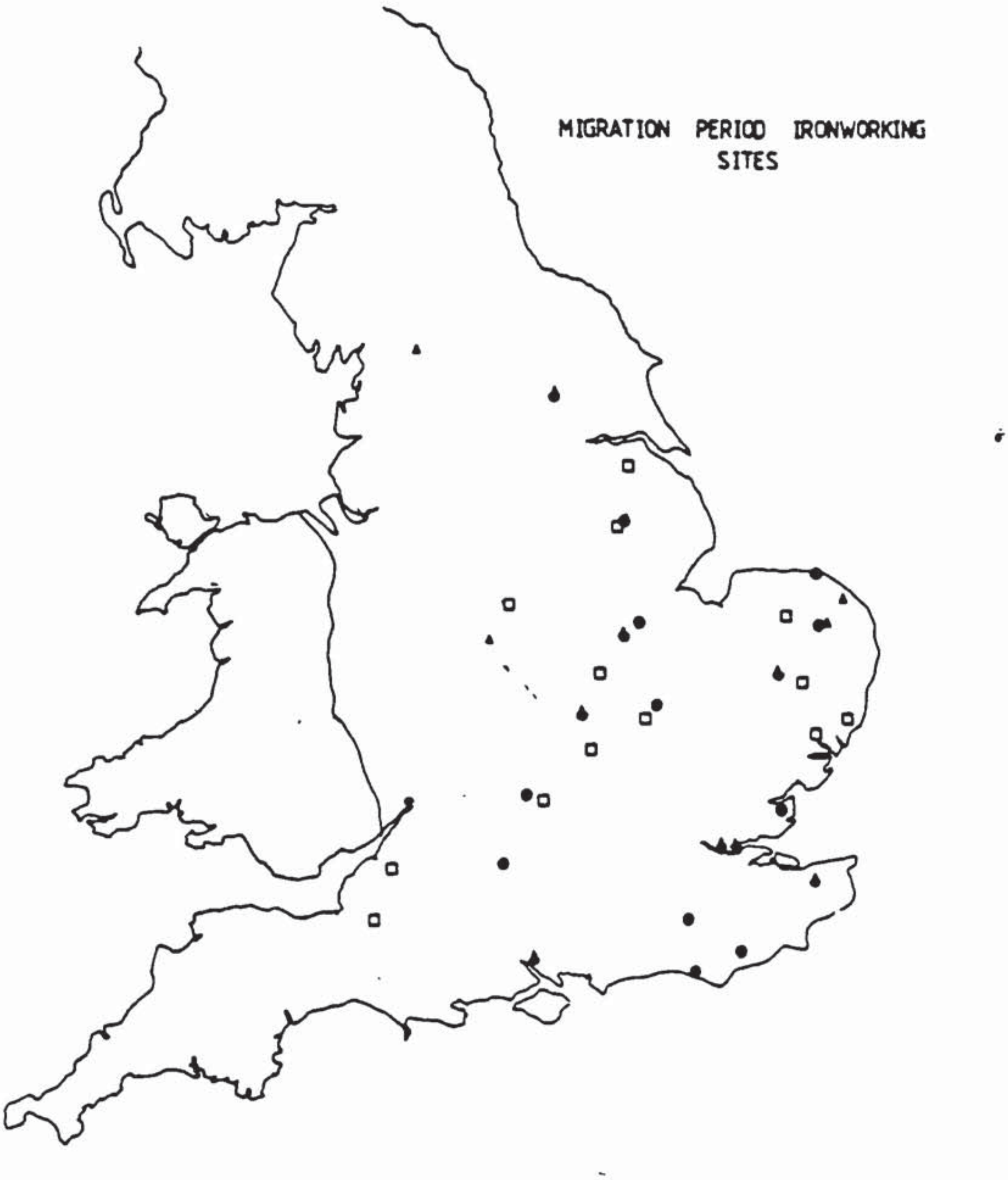


FIGURE 6 Distribution of Migration Period ironworking sites in England. (Symbols as for Figure 4)

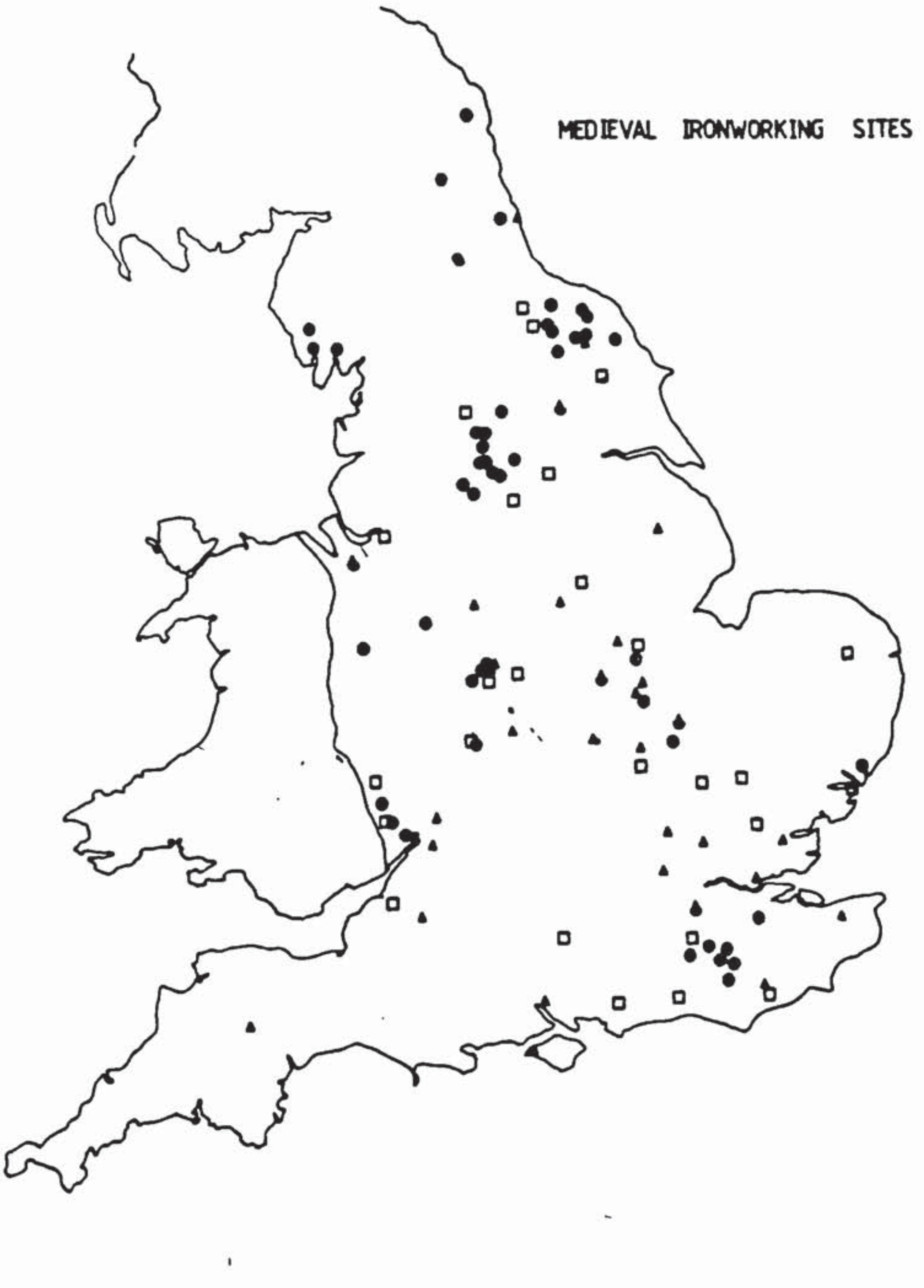


FIGURE 7 Distribution of Medieval Period ironworking sites in England. (Symbols as for Figure 4)

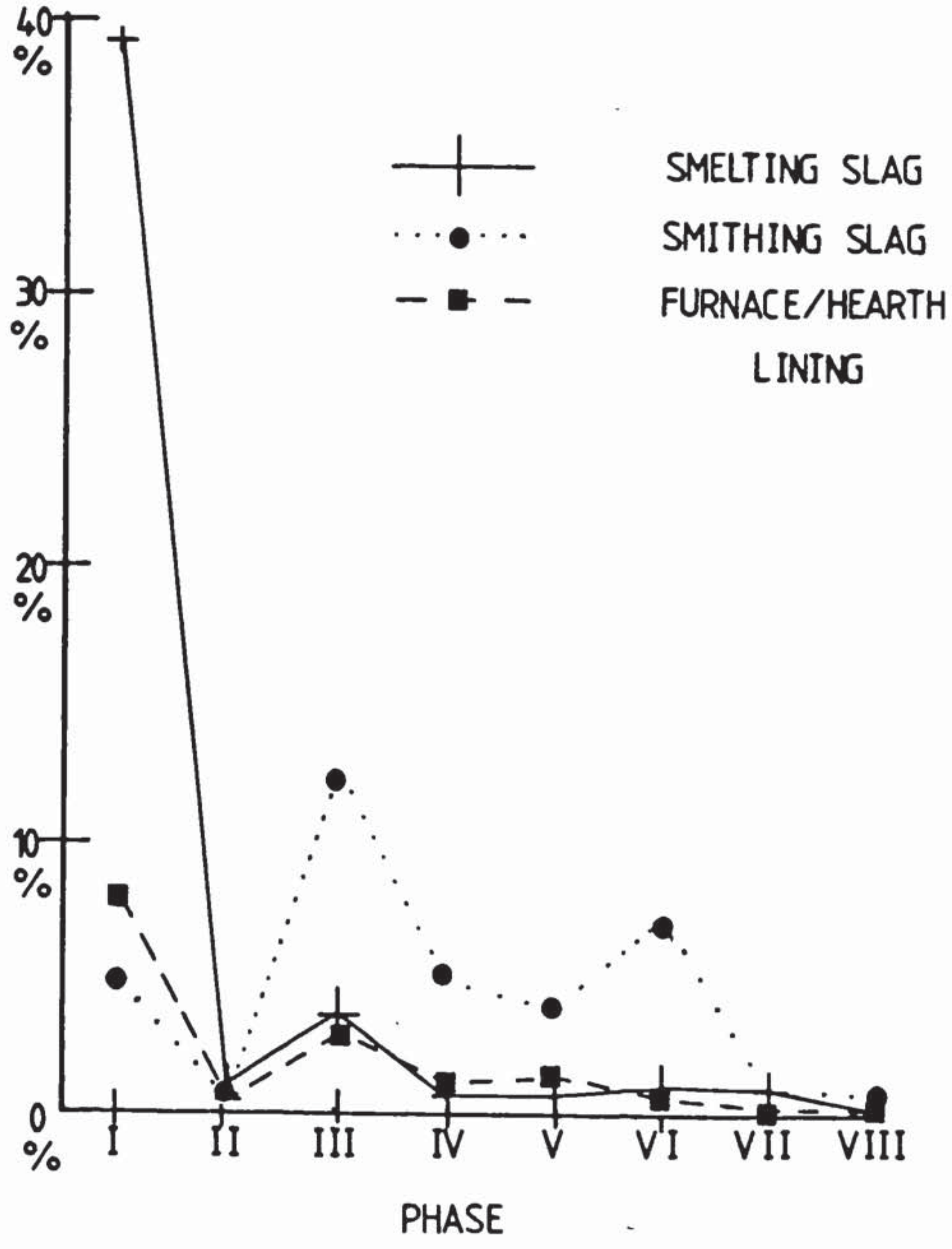


FIGURE 8 Amersham Mantles Green Phase distribution of the ironworking residues plotted as a percentage of the total amount recovered from the site.

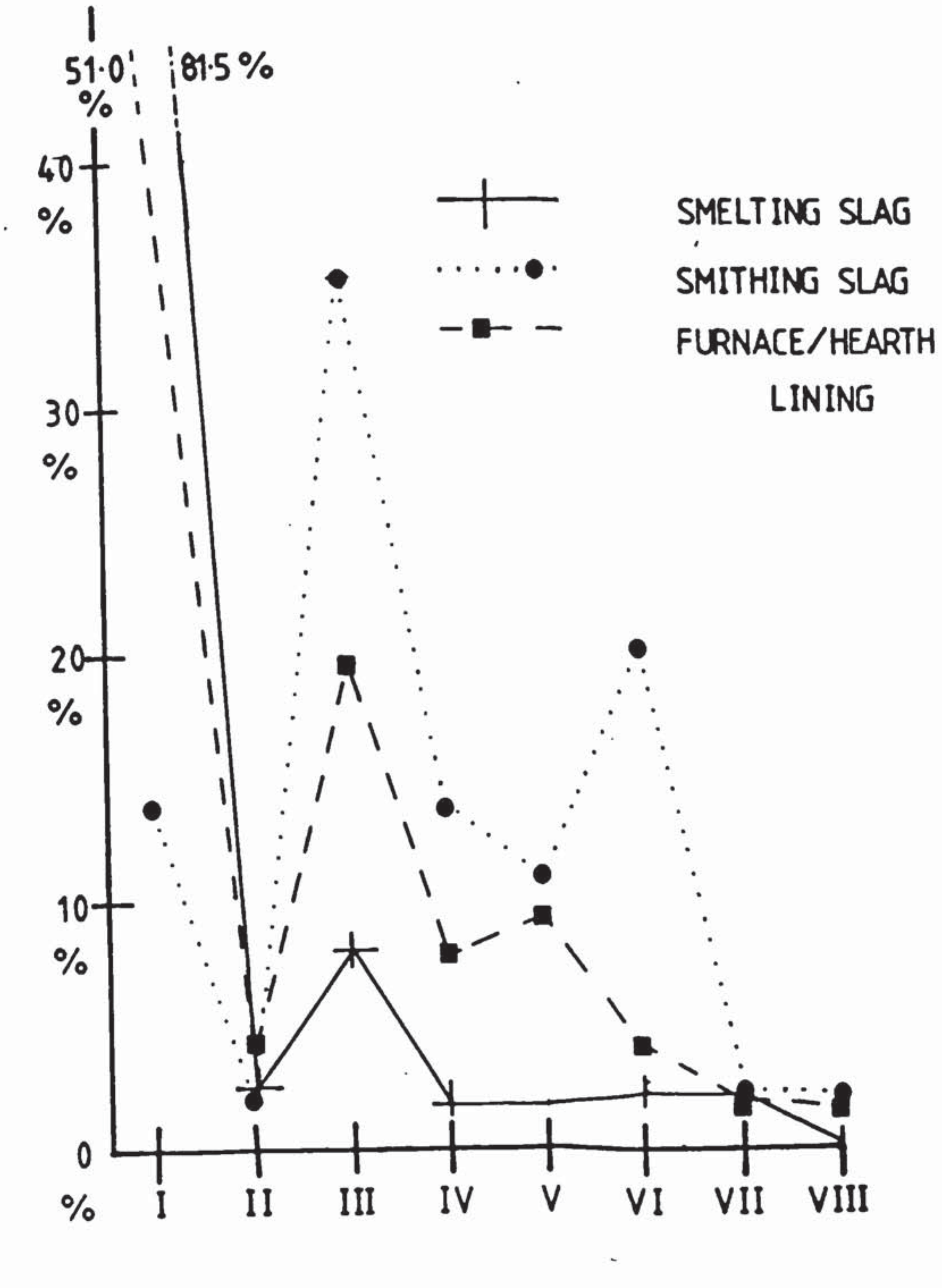


FIGURE 9 Amersham Mantles Green Phase distribution of the ironworking residues plotted as a percentage of each type, i.e. total weight of tap slag=100%.

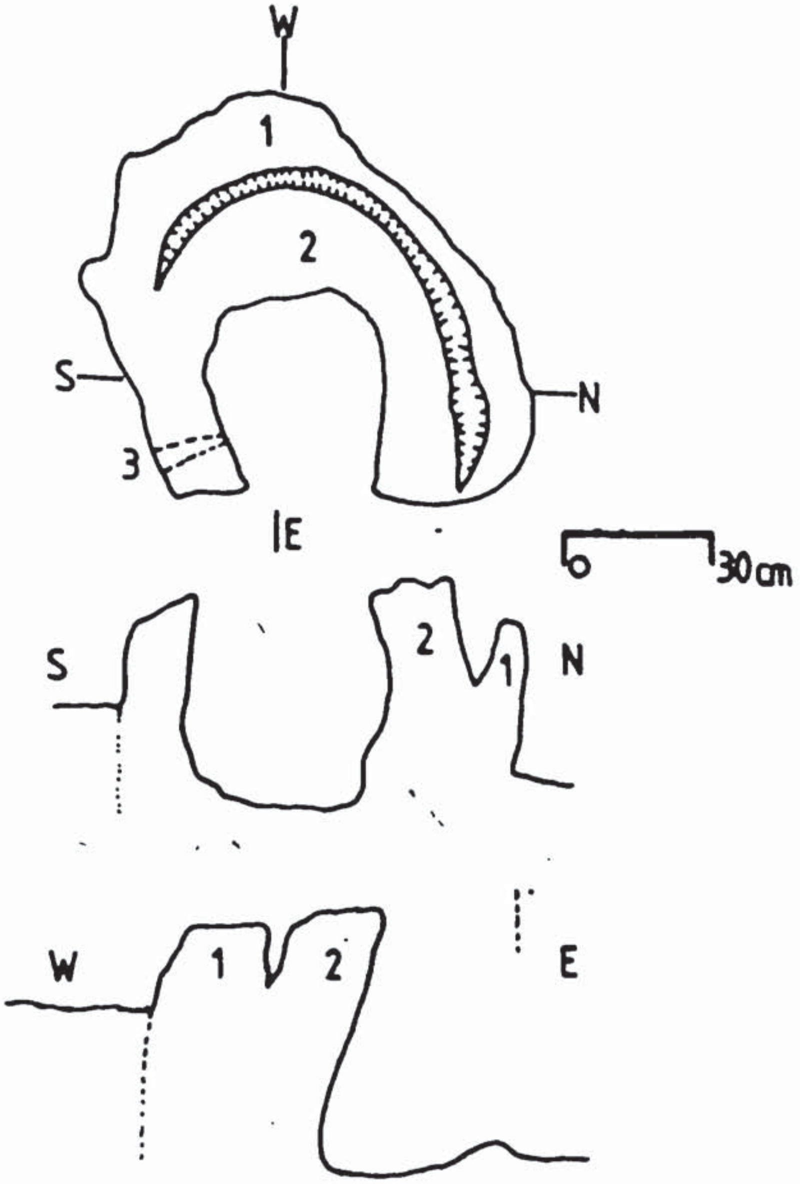
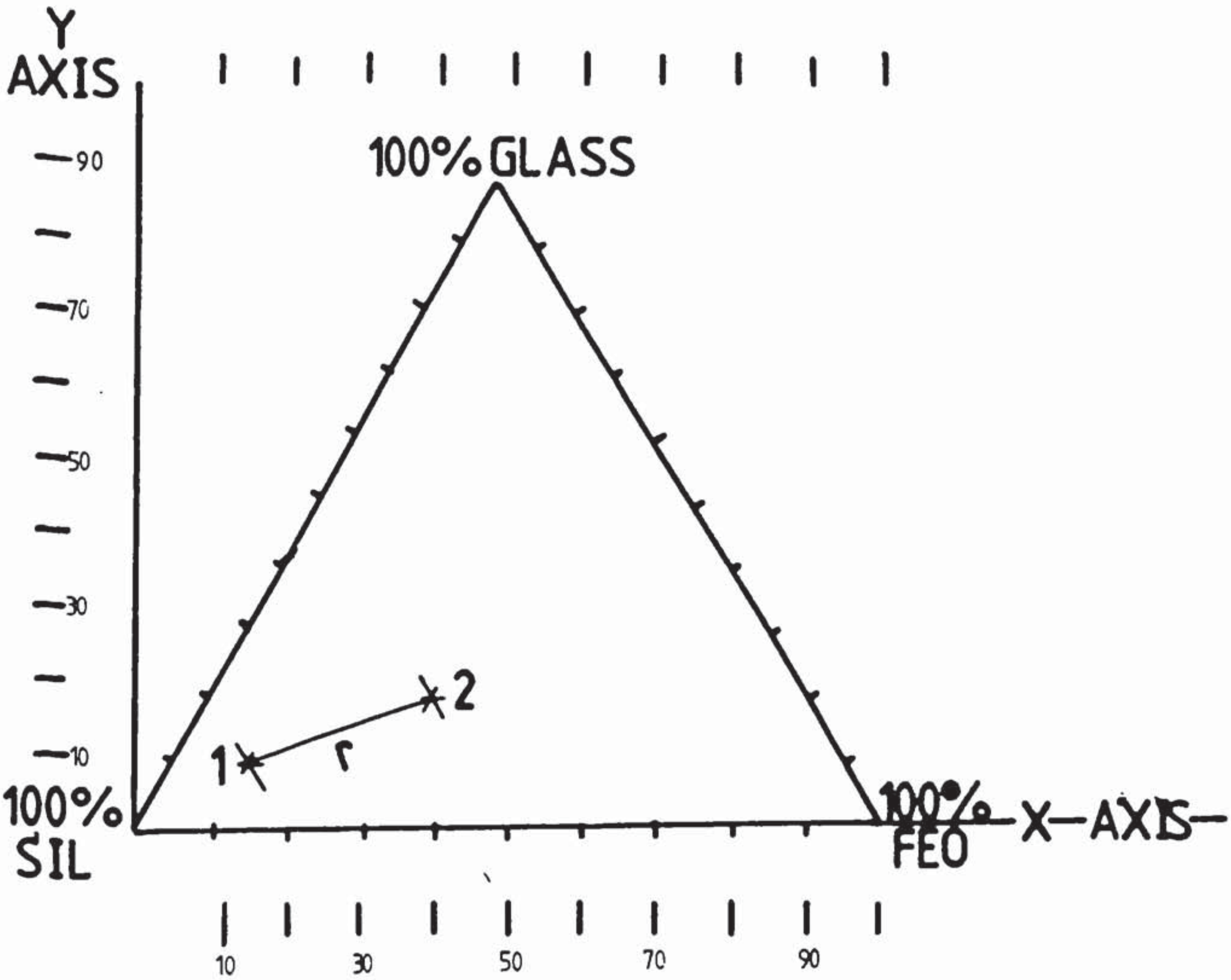


FIGURE 10 Plan and cross-sections of the Levisham Moor Iron Age smelting furnace. Note the under-cutting effect of the slag attack, giving rise to the 'dome' theory of furnace structures.

1 original furnace lining
2 re-lining
3 tuyere



		SIL	GLASS	FEOX
ANALYSIS	1	80	10	10
"	2	50	20	30 %

FIGURE 11 Ternary phase diagram with overlain X,Y axis, and measurement of the distance 'r' between two compositions.

FIGURE 12 Site location map.

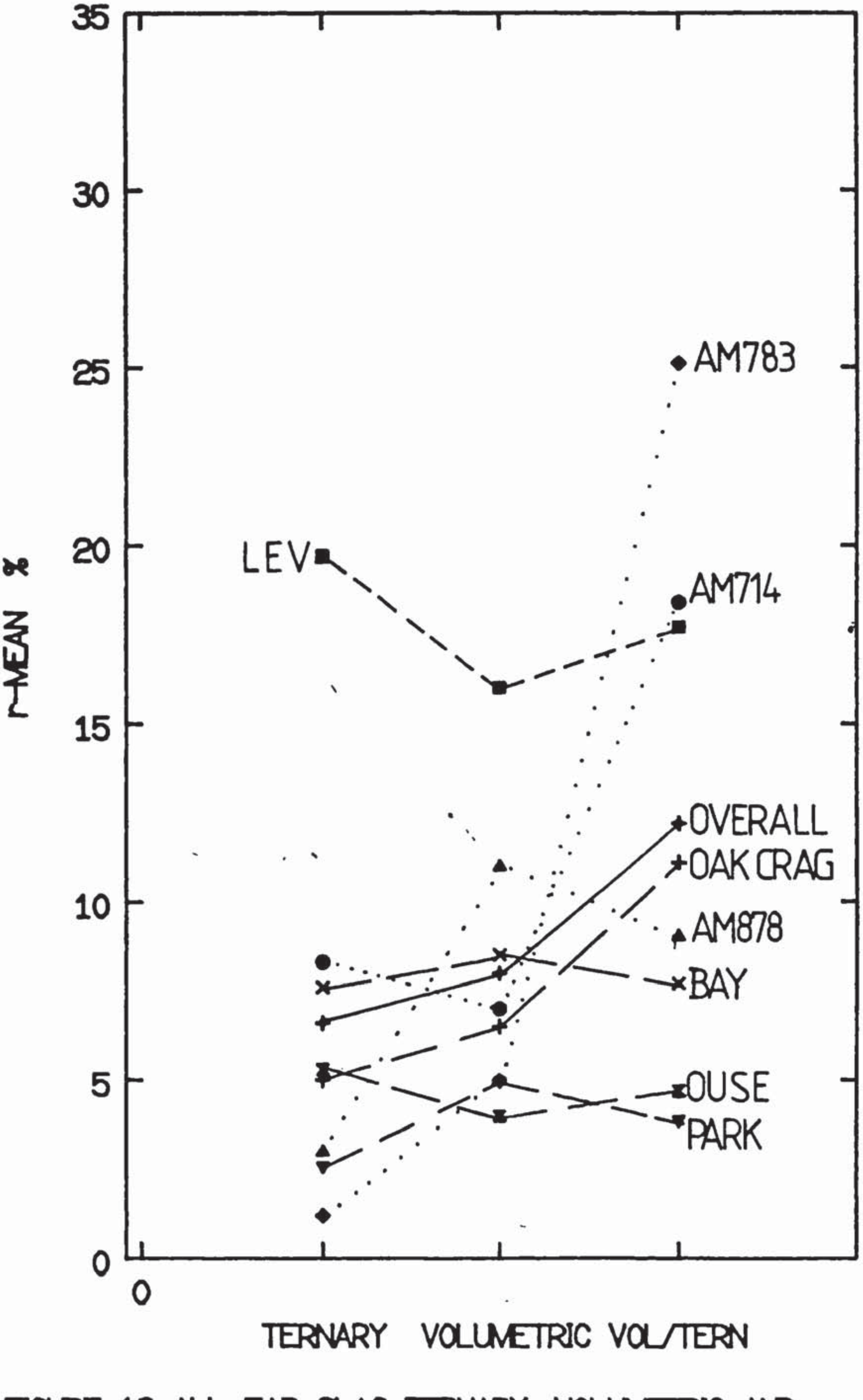


FIGURE 13 ALL TAP SLAG TERNARY, VOLUMETRIC AND VOLUMETRIC/TERNARY r-MEAN VALUES.

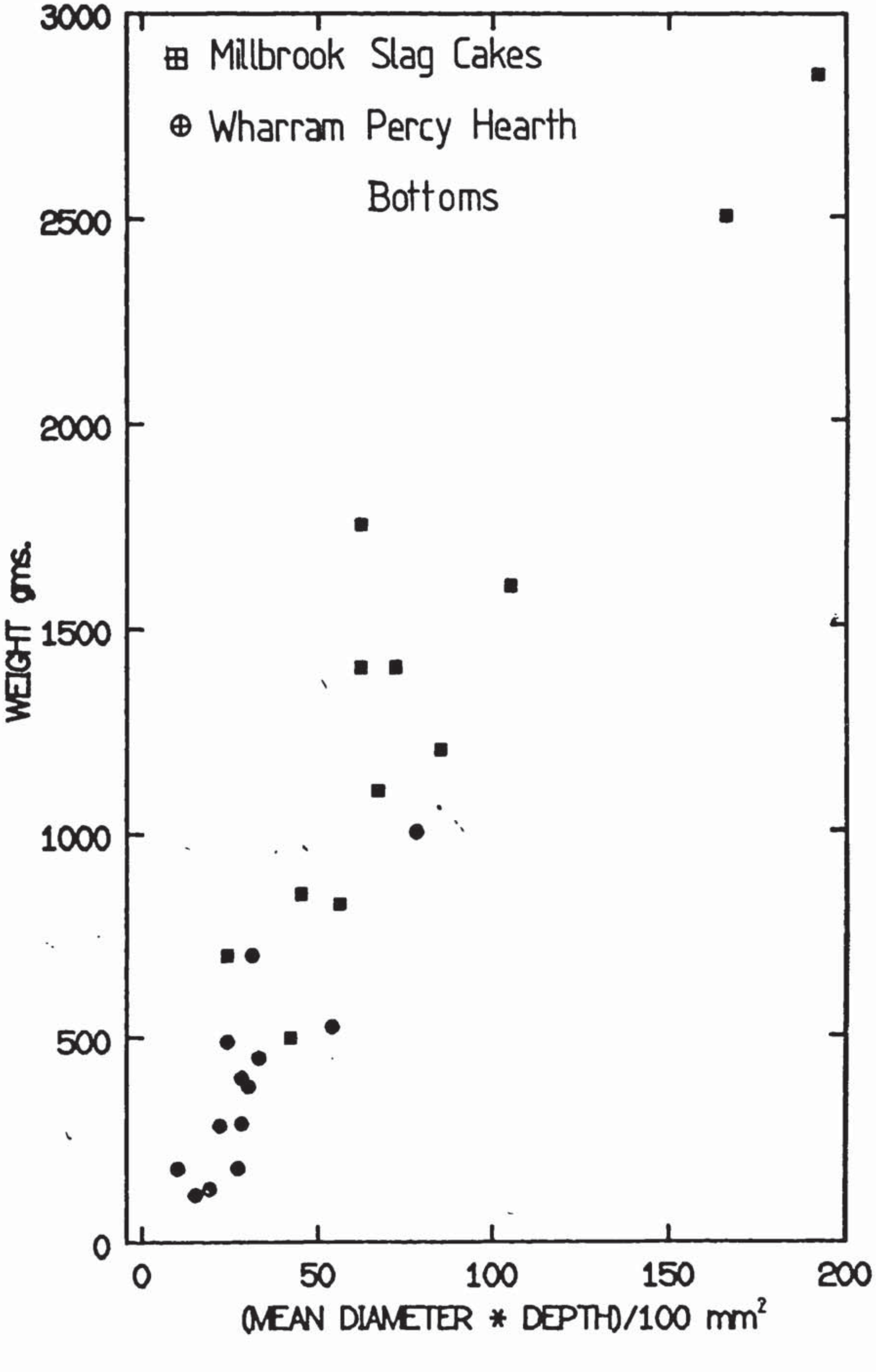


FIGURE 14 PLOT OF HEARTH BOTTOM AND SLAG CAKE PARAMETERS.

FIGURE 15 Birsay, Orkney, location of sites (top). Plan of Site IX, showing location of hearths 0281 and 0282 (in burnt area 0283) within Structure 14. Plan and cross-section of hearth 0282 (right).

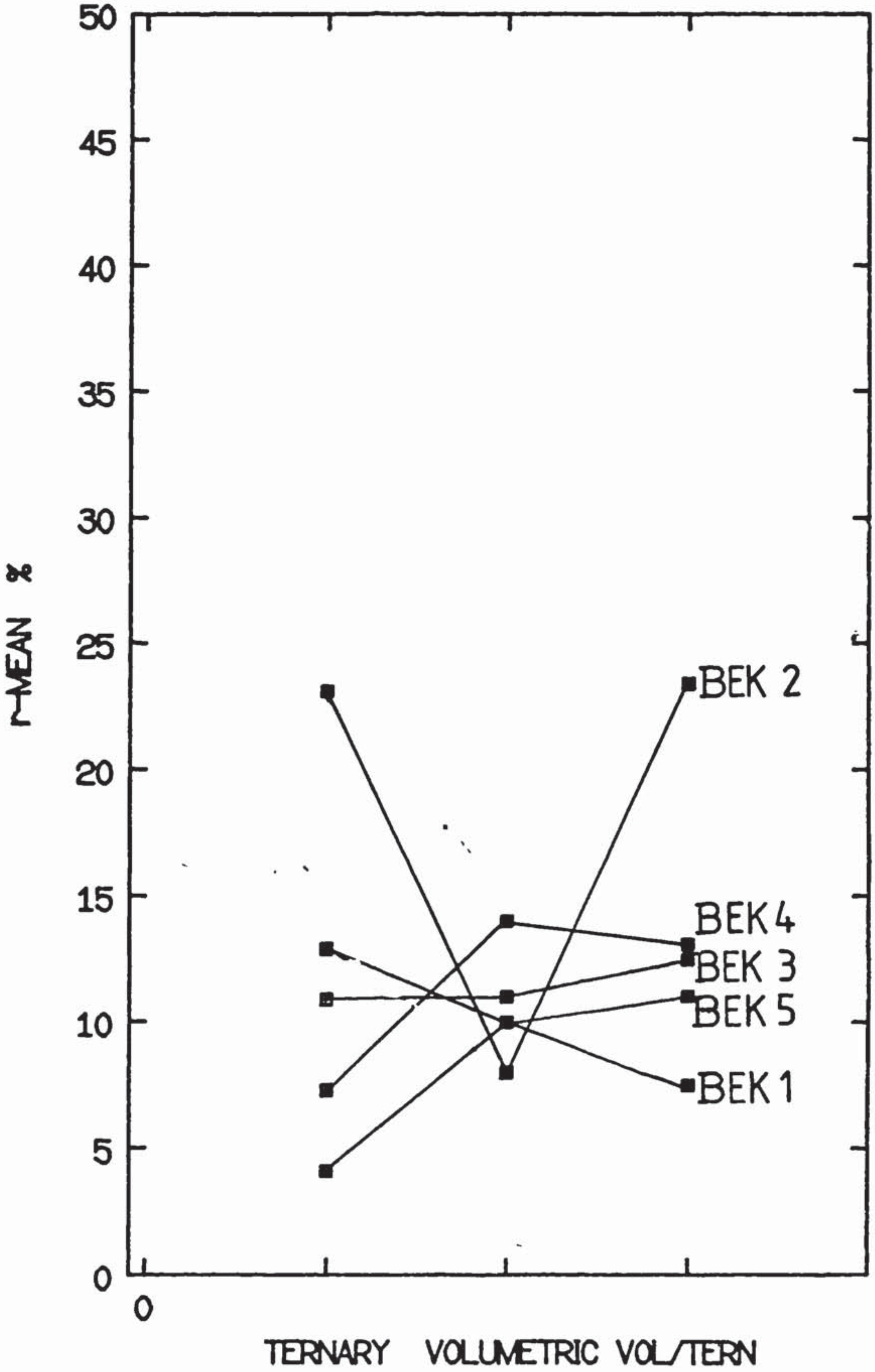


FIGURE 16/a SMITHING SLAG TERNARY, VOLUMETRIC AND VOLUMETRIC/TERNARY r-MEAN VALUES.

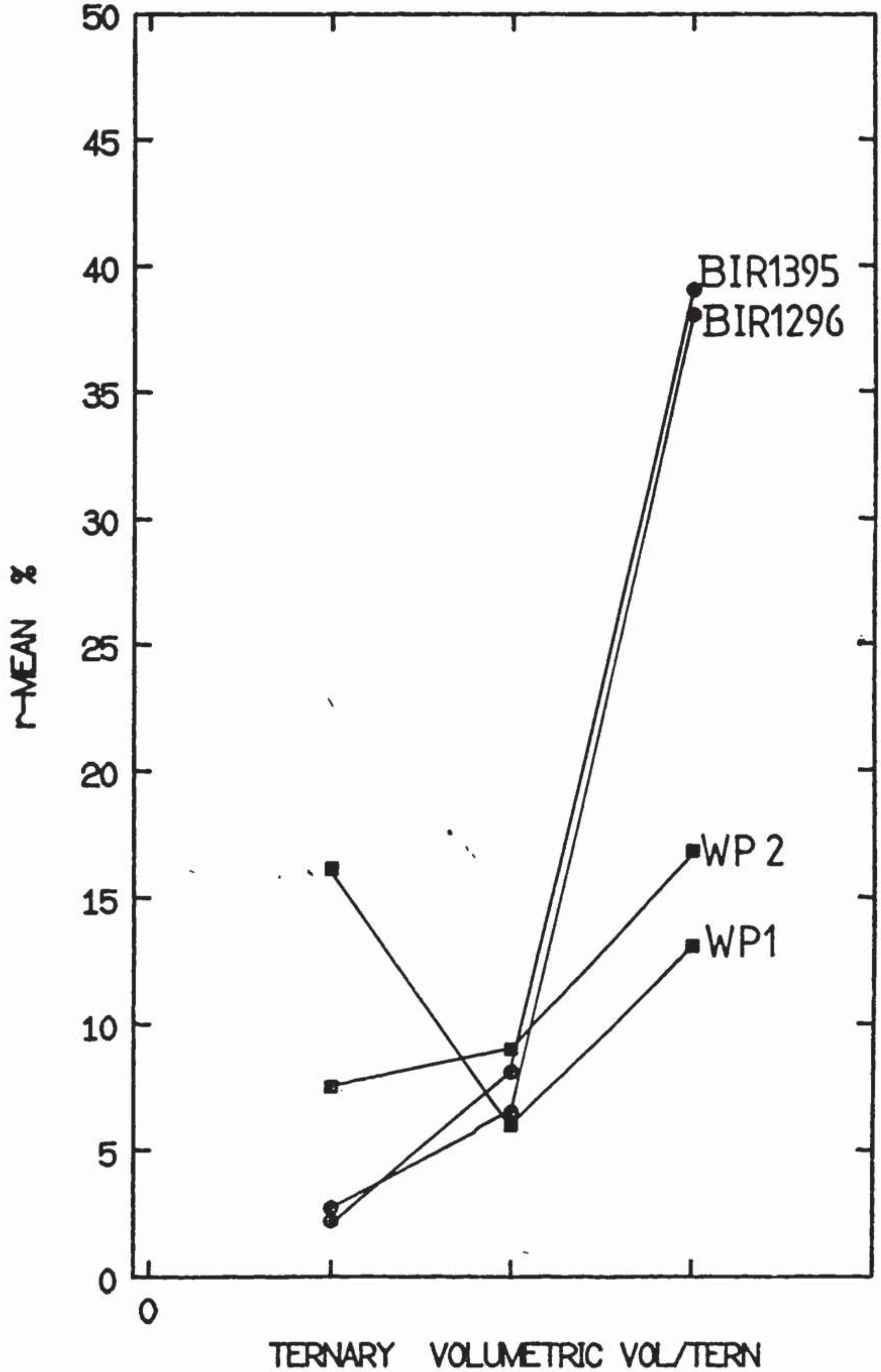


FIGURE 16/b SMITHING SLAG TERNARY,VOLUMETRIC AND VOLUMETRIC/TERNARY r-MEAN VALUES.

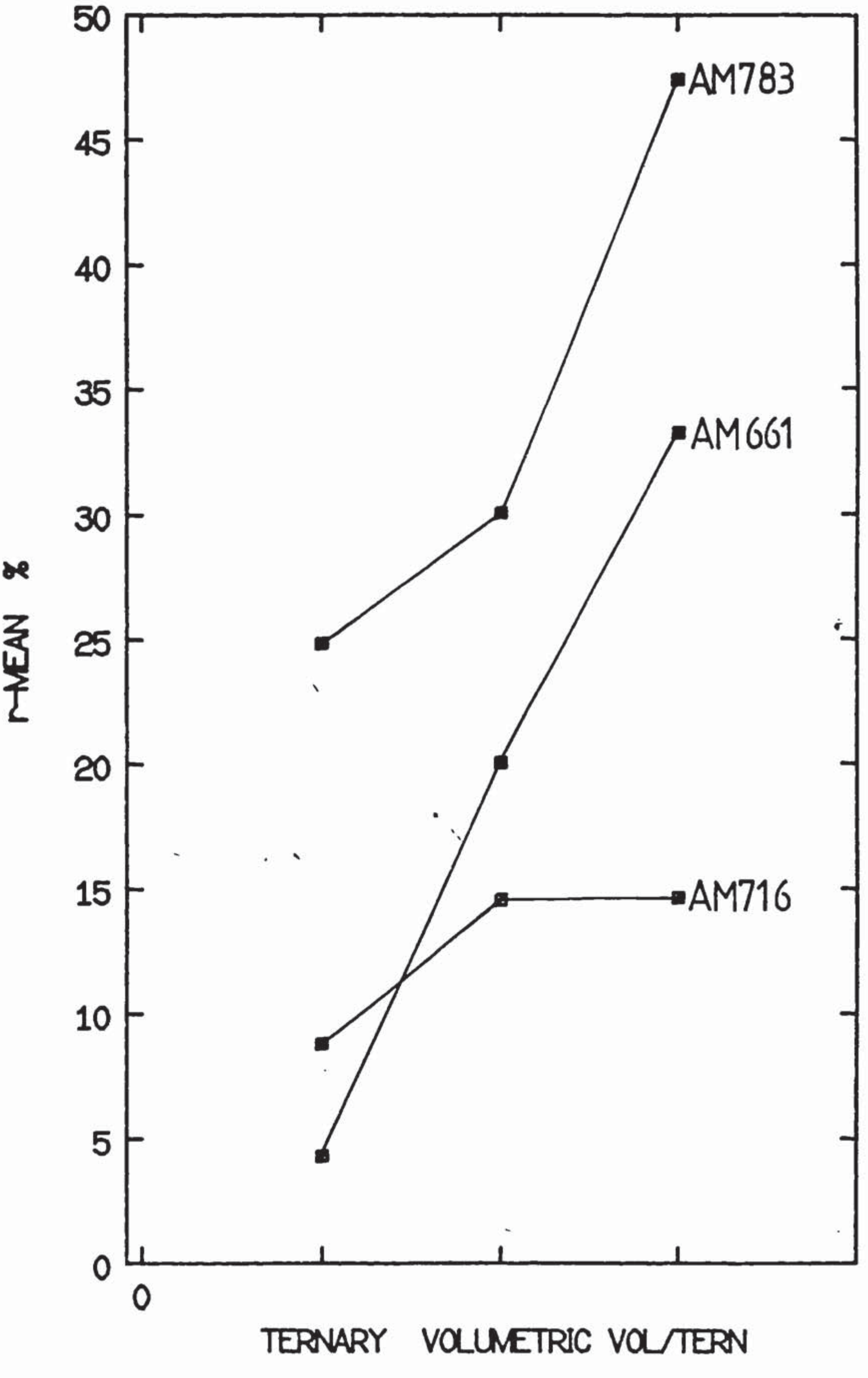


FIGURE 16/c SMITHING SLAG TERNARY, VOLUMETRIC AND VOLUMETRIC/TERNARY r-MEAN VALUES.

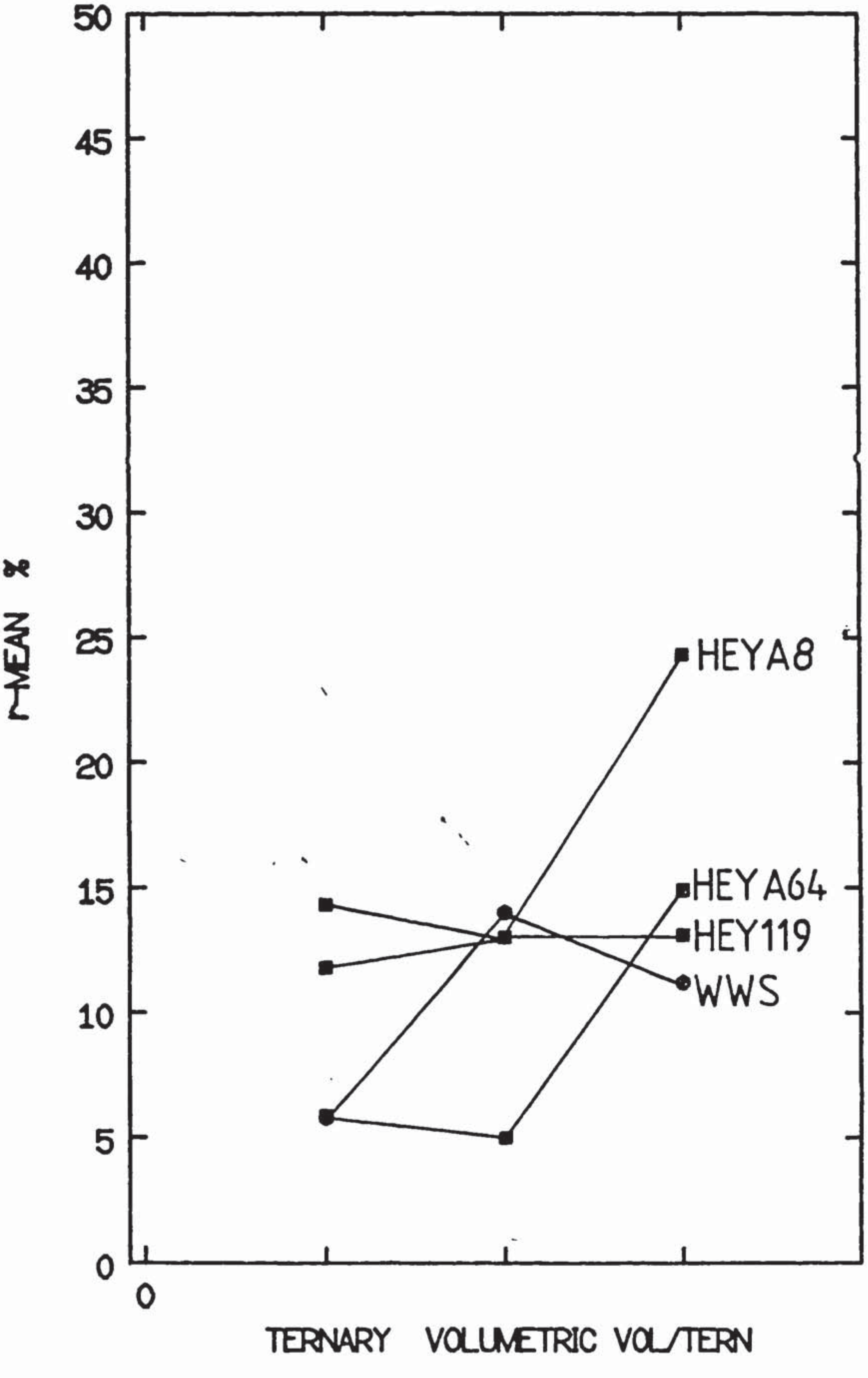
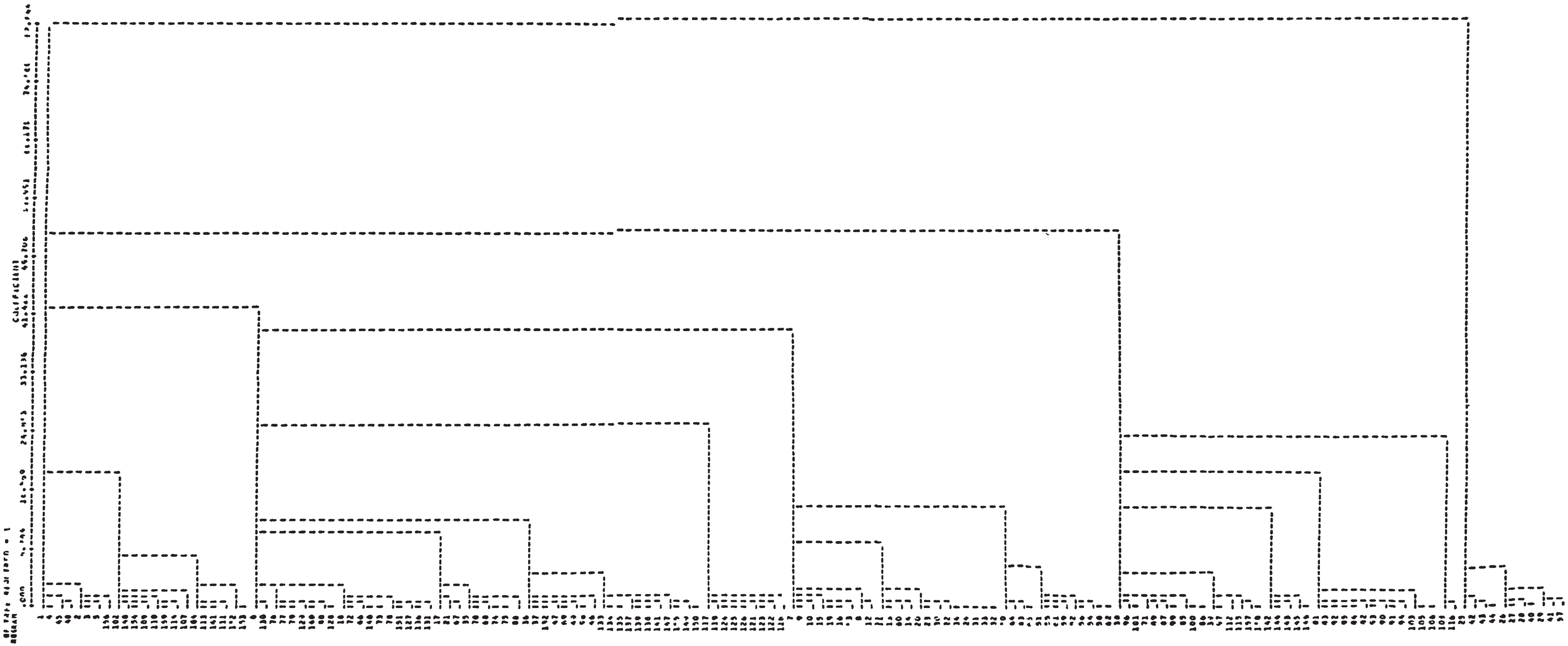


FIGURE 16/d SMITHING SLAG TERNARY, VOLUMETRIC AND VOLUMETRIC/TERNARY r-MEAN VALUES.

FIGURE 17 Clustan endrogram of bulk analyses.



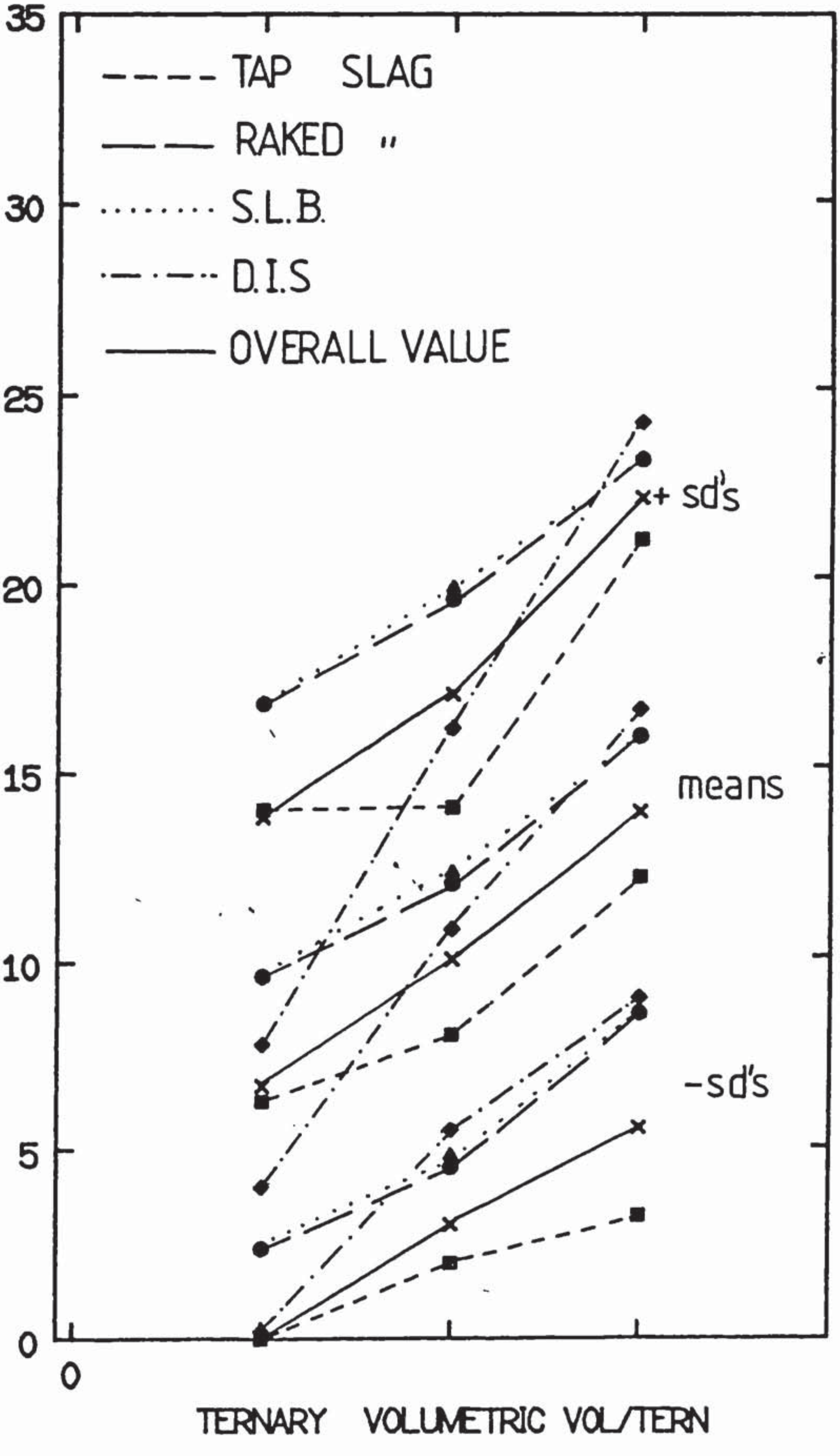


FIGURE 18 SMELTING SLAG r-MEAN VALUES AND STANDARD DEVIATIONS.

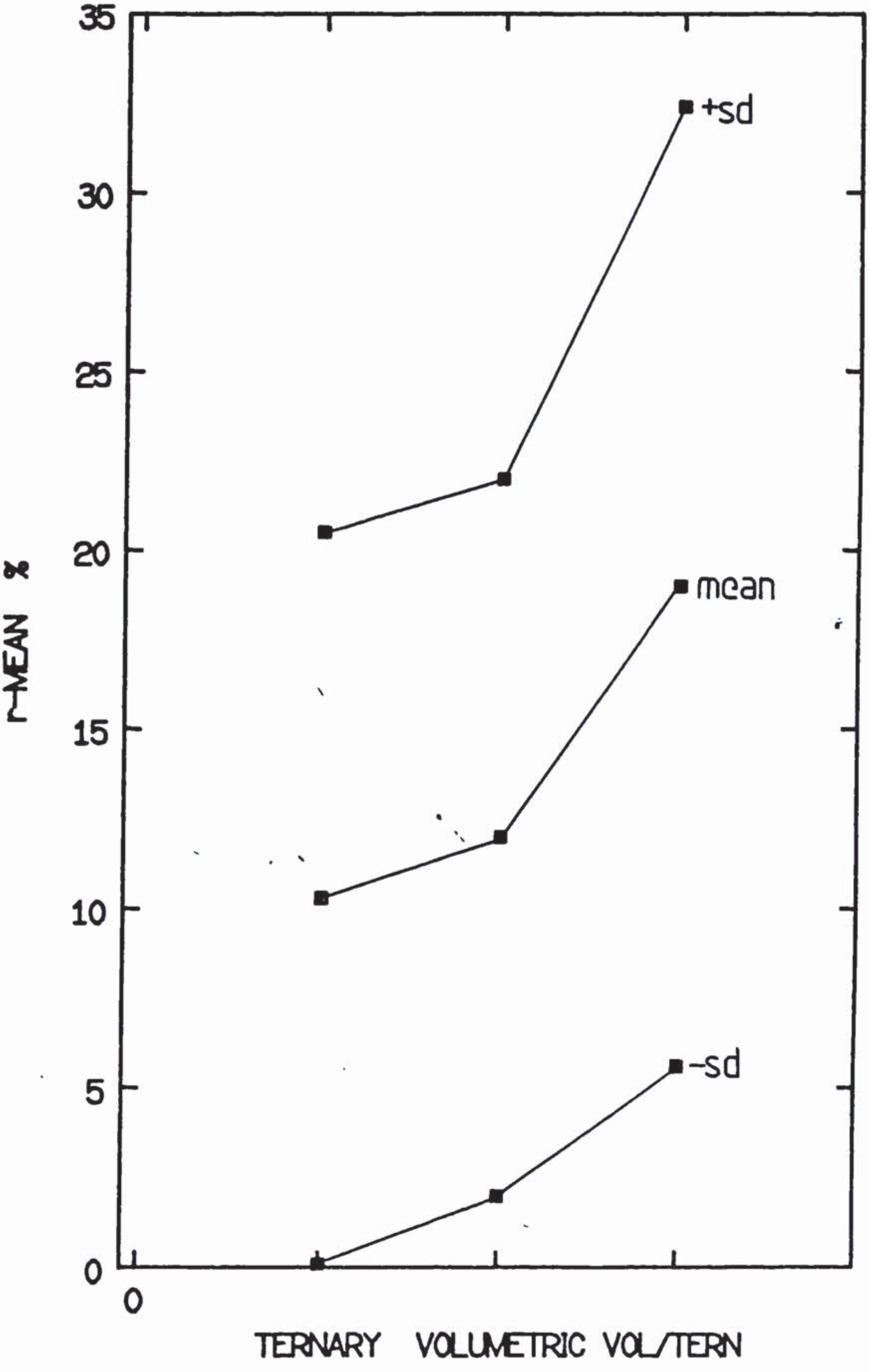


FIGURE 19 OVERALL SMITHING SLAG r-MEAN VALUES AND STANDARD DEVIATIONS.

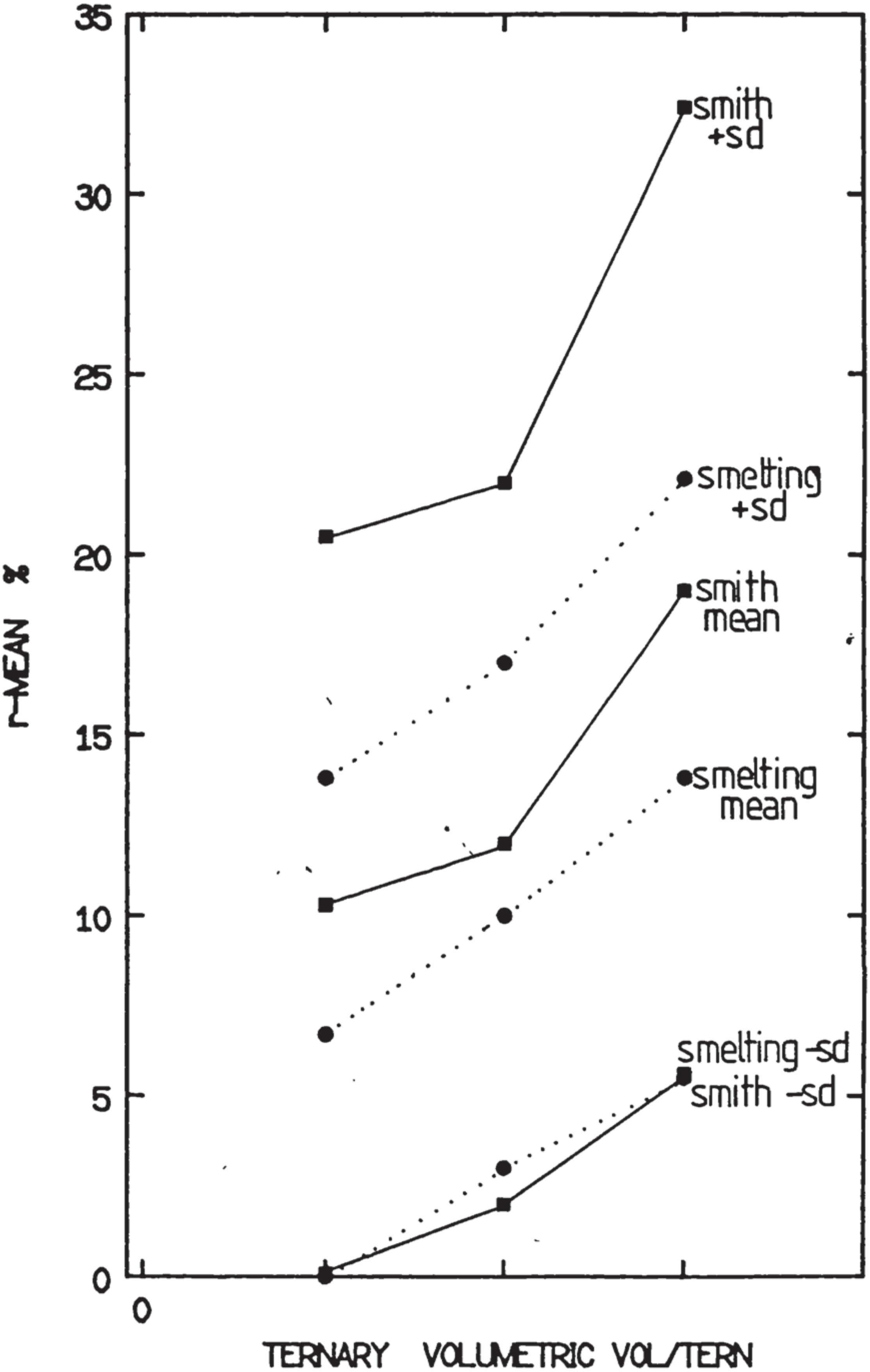


FIGURE 20 OVERALL SMELTING AND SMITHING r-MEAN VALUES AND STANDARD DEVIATIONS.

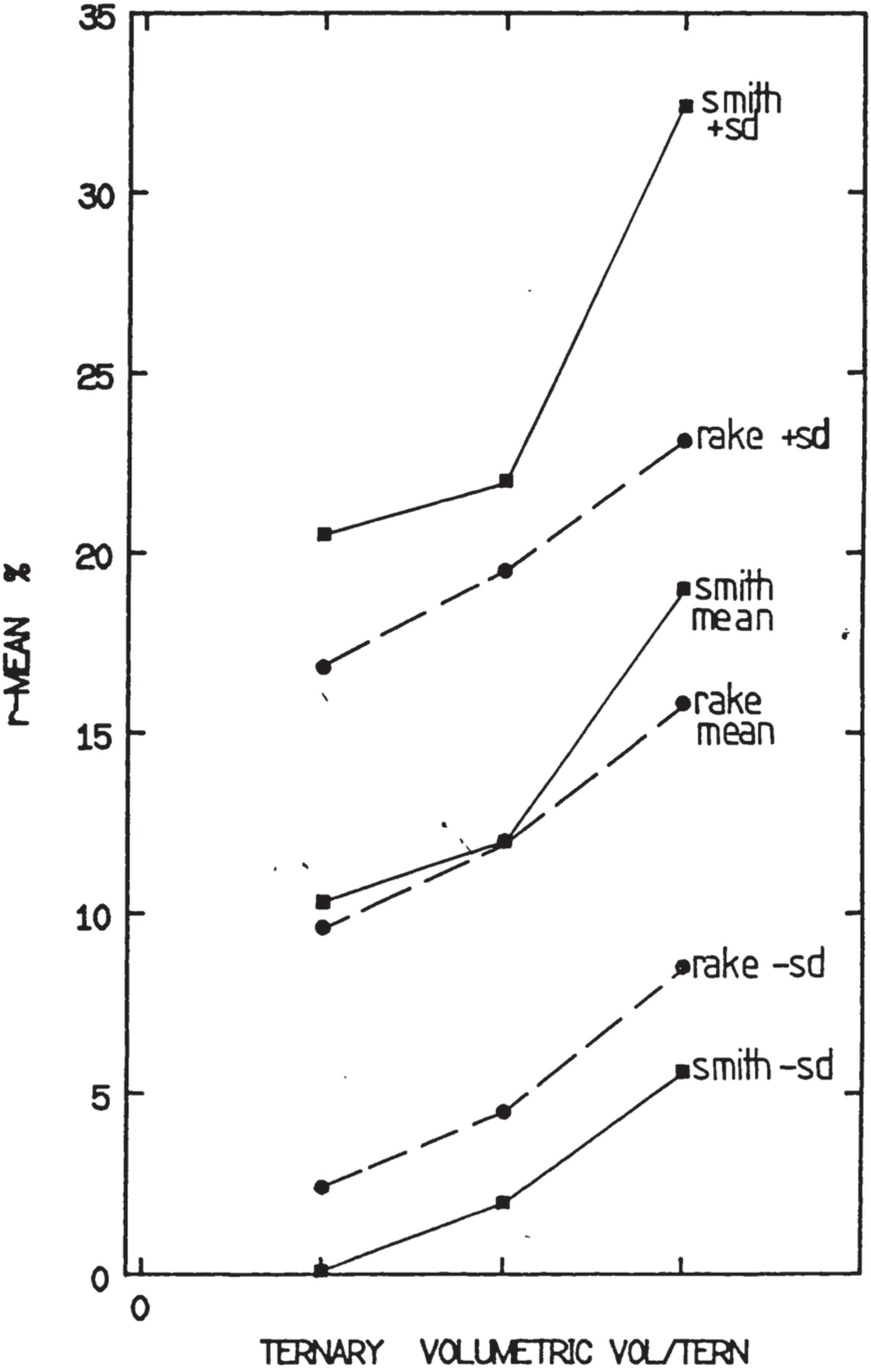


FIGURE 21 OVERALL SMITHING AND RAKED SLAG r-MEAN VALUES AND STANDARD DEVIATIONS.

PLATE 1 Levisham Moor, North Yorkshire, Iron Age shaft smelting furnaces built into a clay bank. The front opening was the tapping arch. (Scale 0.5m).

PLATE 2 Roman shaft furnace at Bulwick (Northamptonshire) built into a clay supporting pad. (Scale 2.0m).

PLATE 3 Reconstructed 17/18th Century smith's hearth at Hutton-le-Hole Folk Museum (North Yorkshire). It is waist high and stone built, but with no substantial foundations.

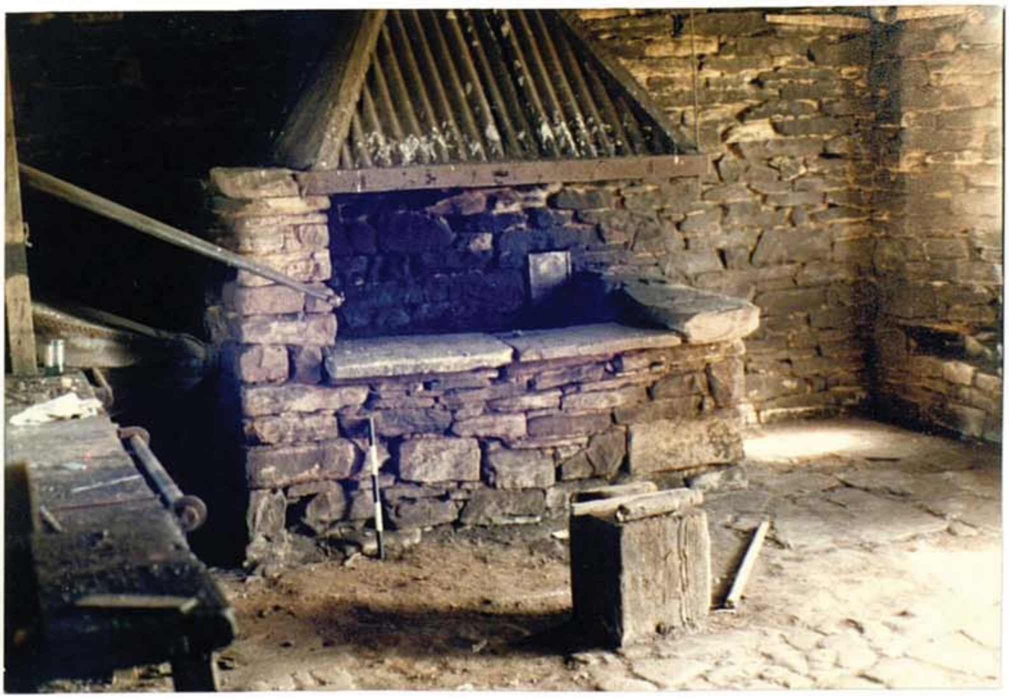


PLATE 4 Disused smith's hearth on Sanday. Orkney. Note similarity to the Hutton-le-Hole example. (Scale 0.5).

PLATE 5 Clay pad (tuyere mouth) protecting the front of the bellows from the direct heat of the fire. The front face may become vitrified. Comparative material has been recovered from the archaeological record.

PLATE 6 Smith's tools from the smithy at Hutton-le-Hole Folk Museum. Comparative tools have been recovered from archaeological contexts.

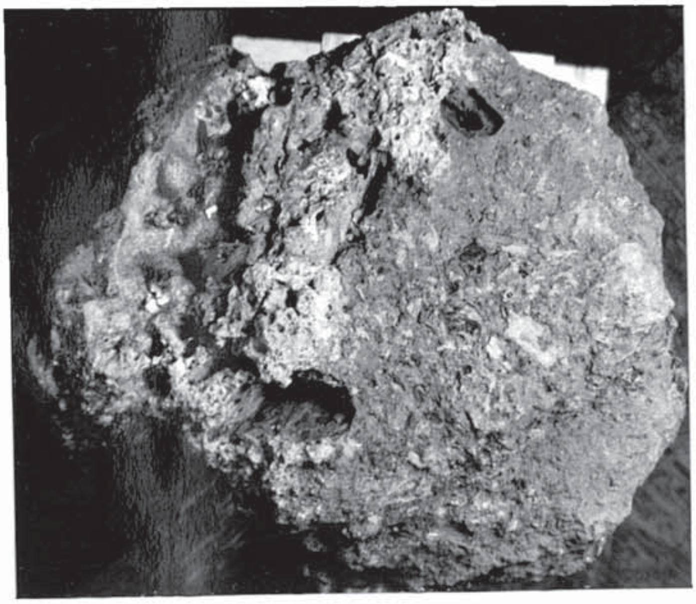
PLATE 7 The furnace lining of the Scole furnace (Norfolk). The internal (hot) face is vitrified and has suffered slag attack. It rapidly degrades to poorly burnt clay.

PLATE 8 Steatite Tuyere, the narrower (hearth/furnace) end has been heat affected. (Photographed with the permission of Tankerness Museum Kirkwall, Orkney).

PLATE 9 Partially cleaned-out smith's hearth. The base is clay, discoloured by the fuel and the effect of heat. but not vitrified. The tuyere emerges several centimetres above the hearth base. (Sanday, Orkney. Scale 0.5m)

HEARTH LINING - REACTION ZONE - SILICATE SLAG

120mm

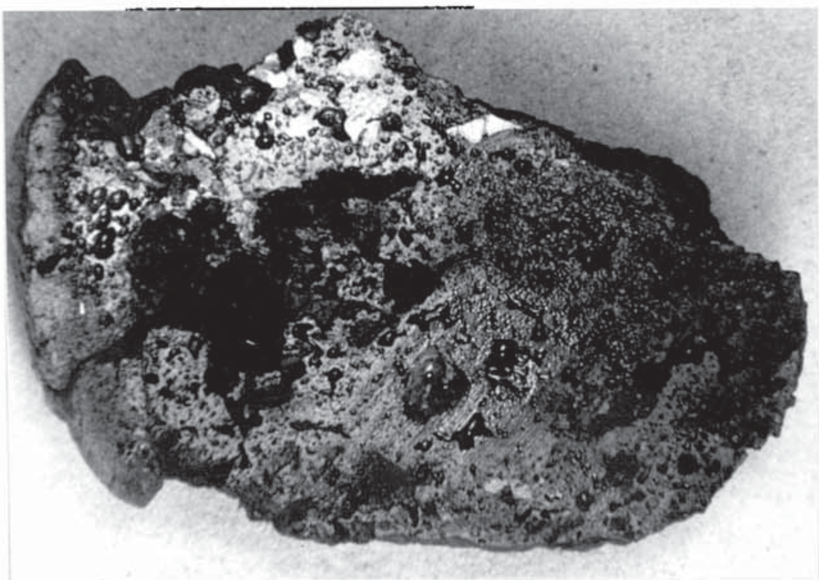


110mm

PLATE 10a Plan photograph of a hearth bottom with attached hearth lining. The lining derived from the side of the hearth, probably the tuyere mouth. There is a reaction zone between the lining and the silicate slag. (Site: Amersham Mantles Green. Date: Roman).

PLATE 10b. Section through the same hearth bottom. The composition changes from vitrified lining - reaction zone - silicate slag. Note the large silica inclusions that would react with the iron oxide to form fayalite, and some may remain unreacted. Part of the charcoal bed adheres to the hearth bottom.

HEARTH LINING SILICA CHARCOAL



80mm

REACTION ZONE SILICATE SLAG

PLATE 11 Fragment of tap slag, note the heavily gassed nature of the upper surface.

PLATE 12 Raked slag cake. Note the feeder 'tail'. (Site: Millbrook. Date: Anglo-Saxon. Size: 13cms diameter).

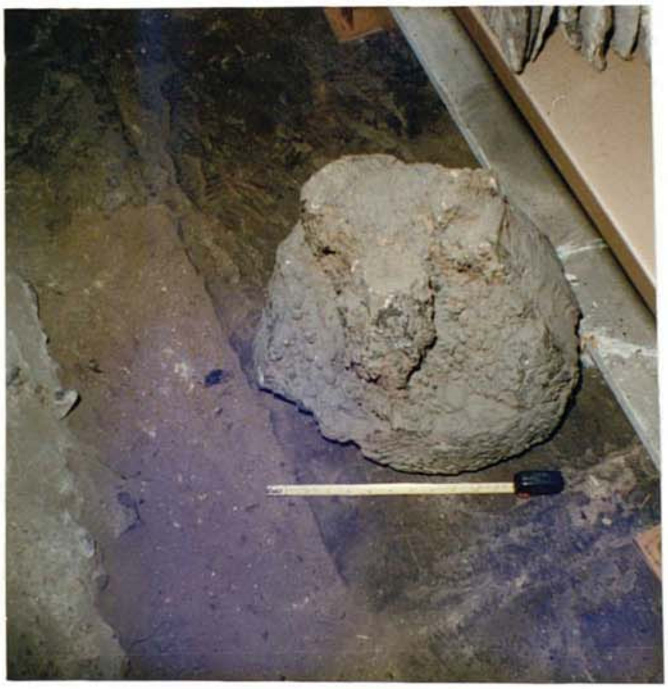


PLATE 13 Slag Block or 'schlakenklotz' from Aylsham, Norfolk. (Photographed with the permission of Norfolk Castle Museum. Scale: 35cms).

PLATE 14 The shaft furnace at Scole, Norfolk. The two slag pits are the burnt/black areas on either side of the front tapping arch. The furnace is built into a clay pad/bank. (Photographed with the Permission of the Norfolk Archaeology Unit. Scale: 25cms)

PLATE 15 Massive tap slag block the result of the accumulation of successive tappings. (Site: Hoveton, Norfolk. Scale 35cms. Photographed with the permission of the Norwich Castle Museum)

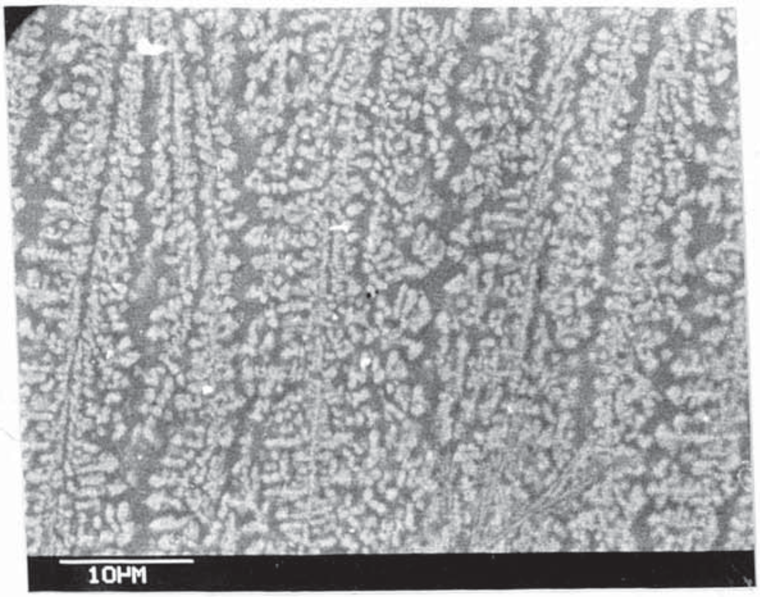


PLATE 16 Farthingstone flowed/tap slag (Section 9.2). S.E.M. micrograph showing the fine dendritic structure.

PLATE 17 Farthingstone S.E.M. micrograph.

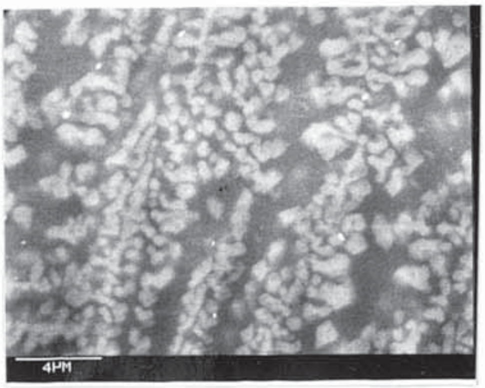
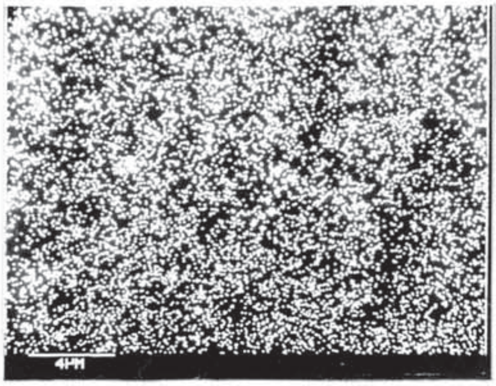


PLATE 18 Farthingstone S.E.M. Fe X-Ray distribution map.



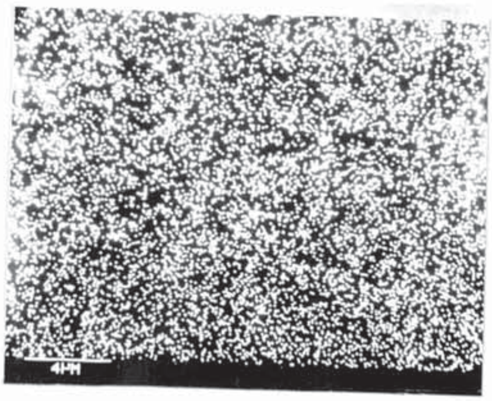


PLATE 19 Farthingstone S.E.M. Si X-Ray distribution map.

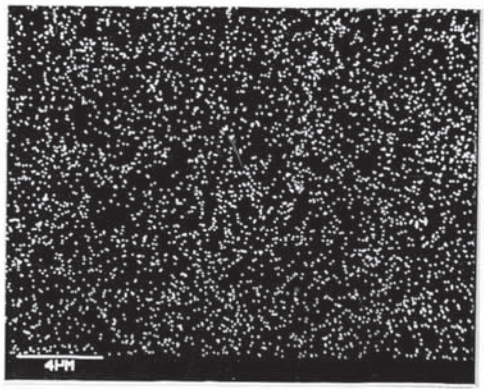


PLATE 20 Farthingstone S.E.M. Al X-Ray distibution map

NOTE: There is no evidence of strong segregation of Fe, Si, or Al oxides bewteen the crstallites and the glass phase.

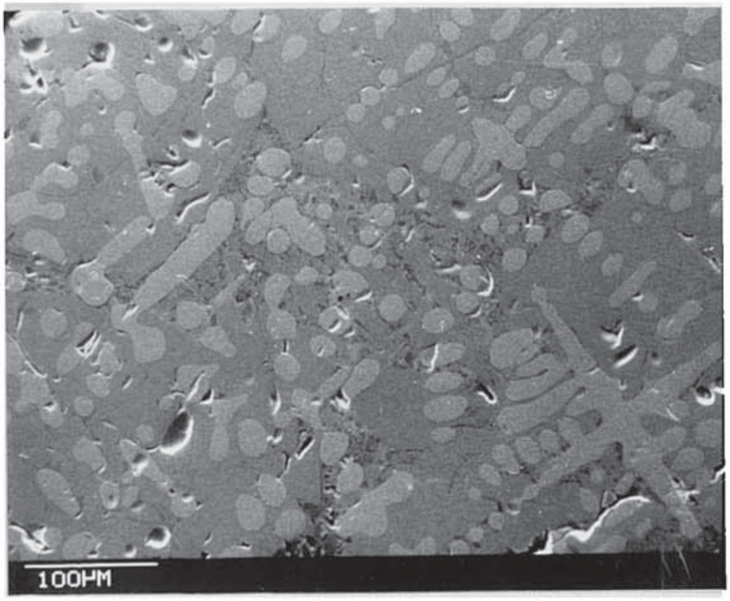


PLATE 21 Tap slag from Levisham Moor, North Yorkshire (Section 9.3). S.E.M. micrograph. Rounded iron oxide dendrites (light grey), massive fayalite (grey), glass (dark grey), holes (black, often with light rims. The presence of holes is not noted on the remaining Plates).

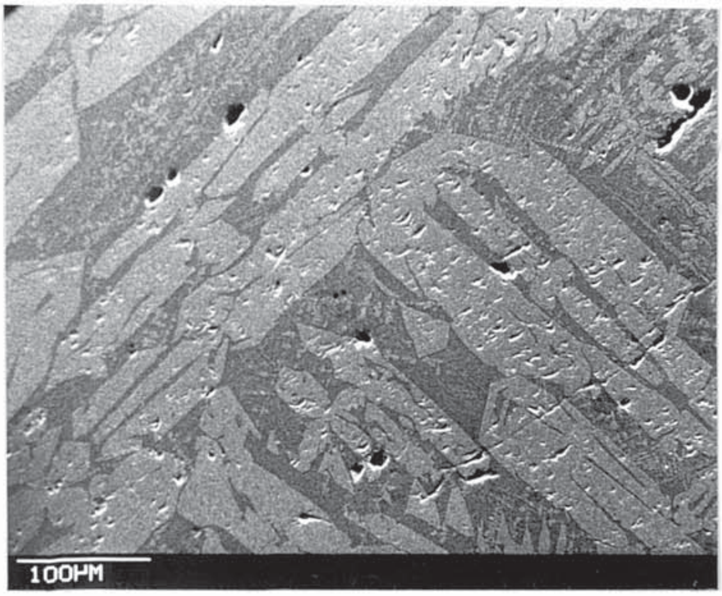


PLATE 22 Amersham Mantles Green, Buckinghamshire. Tap slag Sample AM714 (Section 9.4.1). S.E.M. micrograph. Silicate laths (light grey) in glassy matrix. Crystallites in the glass. free iron oxide absent.

PLATE 23 Amersham Mantles Green, tap slag Sample AM878 (Section 9.4.2). Reflected light micrograph showing cooling surface (iron oxide, white band) and the two different microstructures on each side of the cooling surface. (Magnification X420).

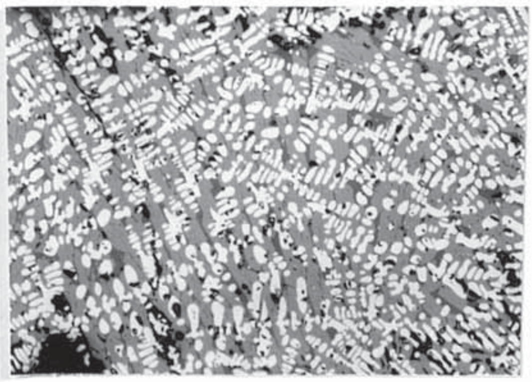


PLATE 24a Micrograph of tap slag Sample AM878 Coarse iron oxide dendritic structure (white), silicate laths (grey), glassy matrix (dark grey). (Magnification X70)

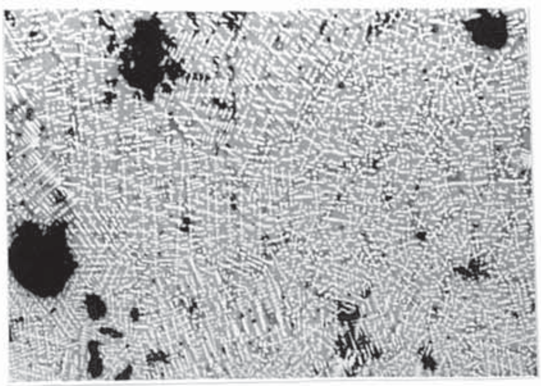


PLATE 24b Micrograph of tap slag Sample AM878 Fine ordered iron oxide dendritic structure compared with 24a. (Magnification X 70)

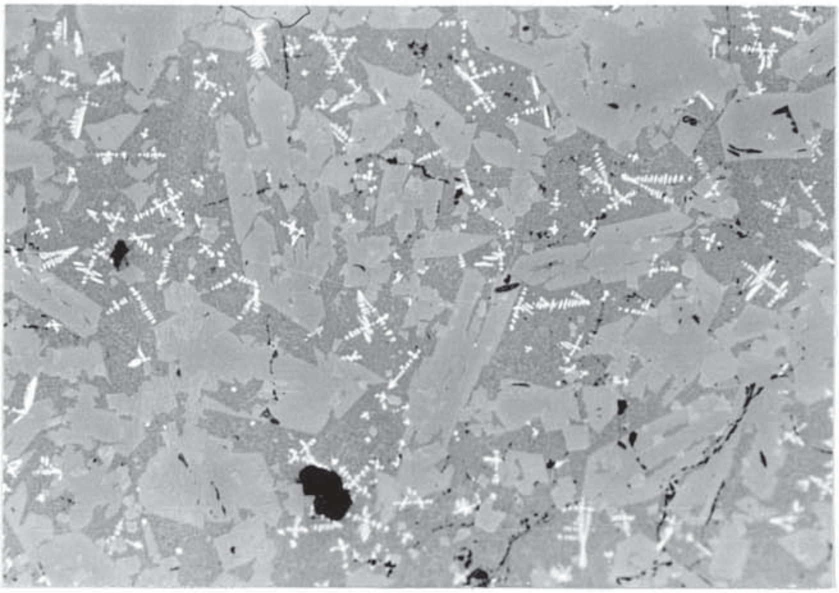


PLATE 25 Micrograph of the tap slag from Baysdale, North Yorkshire (Section 9.5). Euhedral lath silicate and fine oxide dendrites in a glassy matrix. (Magnification X170)

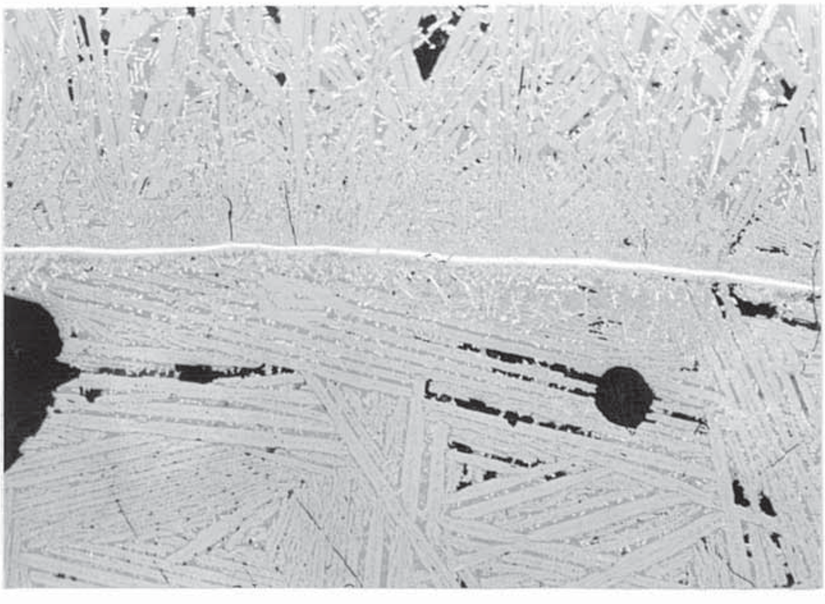


PLATE 26 Micrograph of the sample from Oak Crag, North Yorkshire (Section 9.6.1) showing successive tappings. Note the different structure on either side of the cooling surface. Silicate laths and fine iron oxide dendrites (white) in a glassy matrix. (Magnification X66).

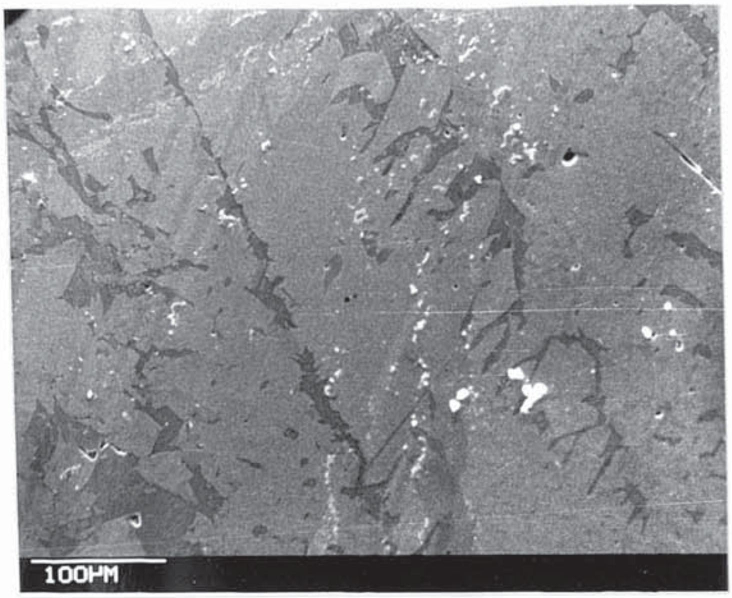


PLATE 27 Tap slag from Park North, North Yorkshire (Section 9.6.2). S.E.M. micrographs showing the silicate laths (two phase?) in a glassy matrix (dark grey). Fine dendrites of metallic iron (white) are present.

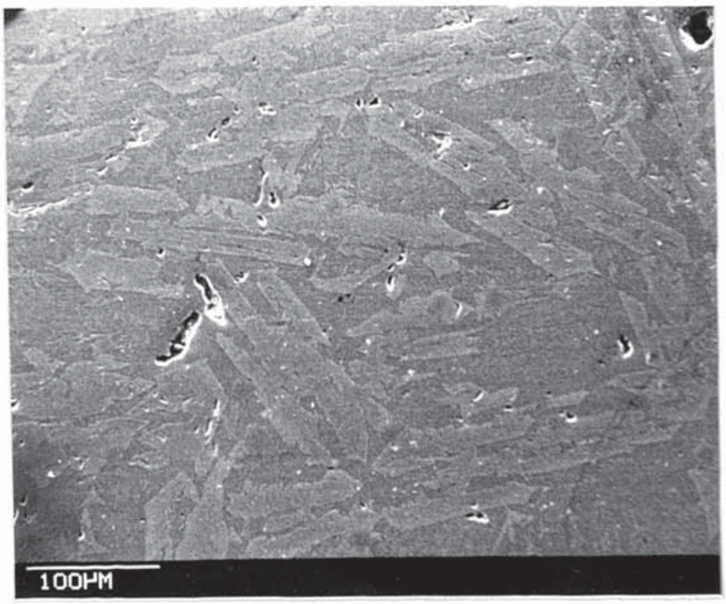


PLATE 28 Tap slag from Ouse Gill, North Yorkshire (Section 9.7). S.E.M. micrograph showing euhedral silicate laths in a glassy matrix. There is no free iron oxide present.

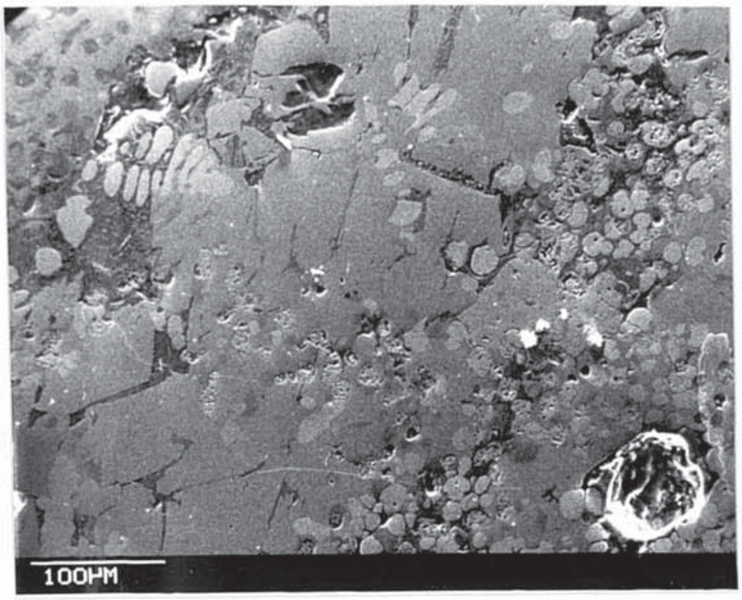


PLATE 29 Raked slag from Millbrook, Sussex. S.E.M. micrograph of Sample A (Section 9.10.2). Euhedral silicate with globular iron oxide in a glassy matrix.

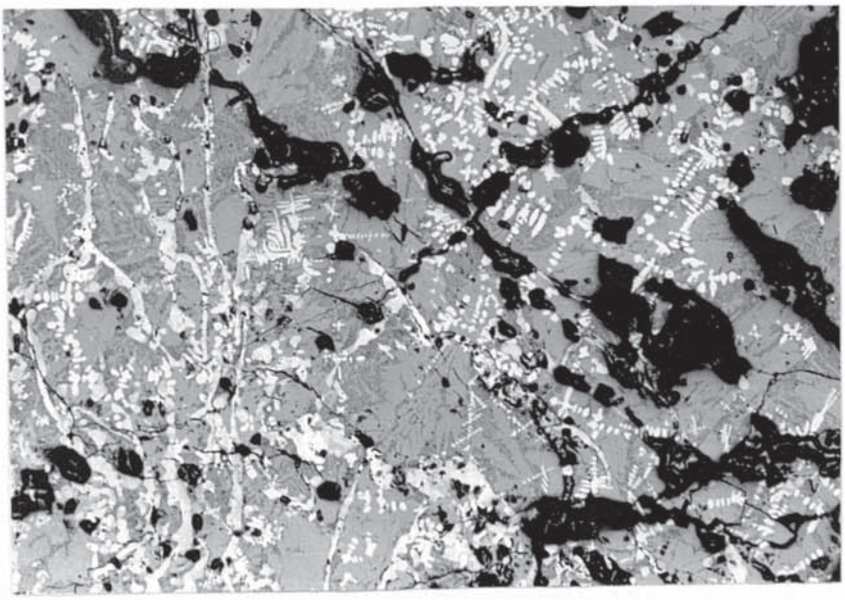


PLATE 30 Raked slag from Millbrook, Sussex. Reflected light micrograph of Sample C (Section 9.10.3). Silicate laths tending to massive form. dendritic and vein iron oxide in a glassy matrix. (Magnification X33).

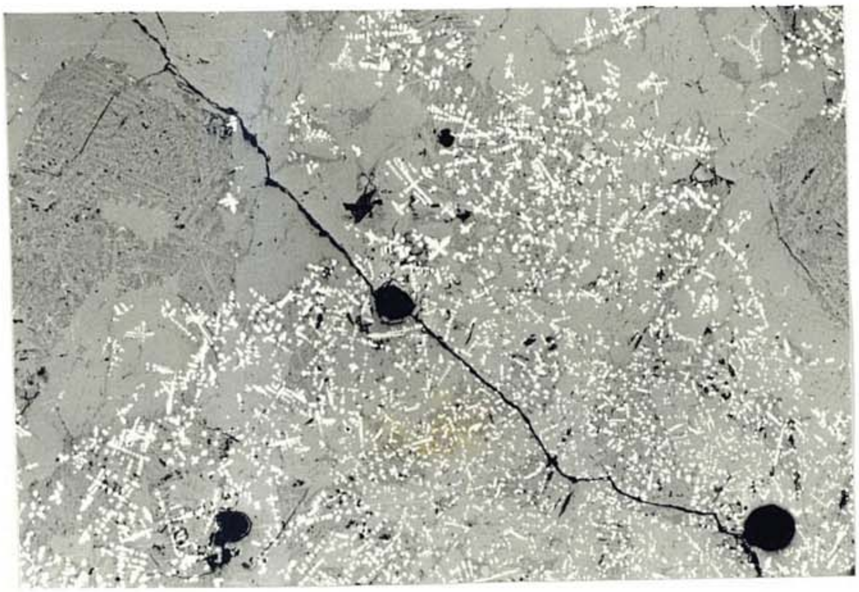


PLATE 31 Raked slag from Millbrook, Sussex. Reflected light micrograph of Sample XX (Section 9.10.6). Varied microstructure, massive silicate with fine iron oxide dendrites. Note crystallisation of the glass phase. (Magnification X33).

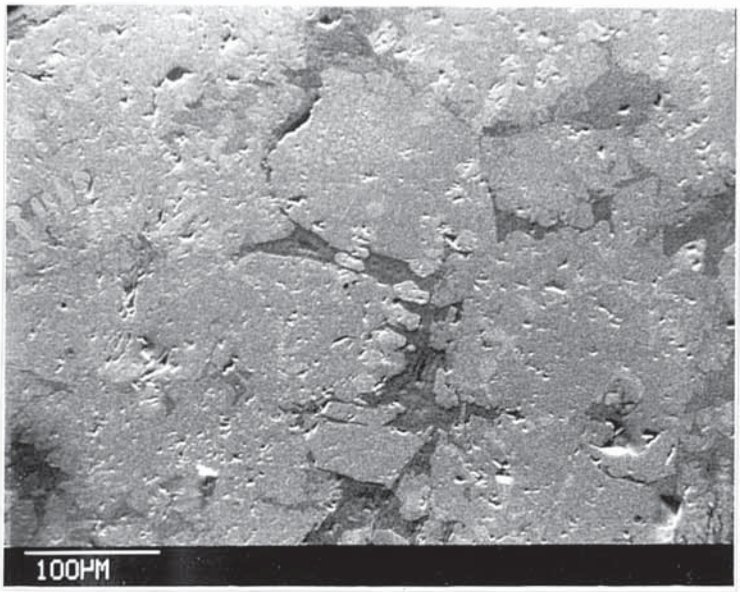


PLATE 32 S.E.M. micrograph of slag block from Romsey, Hampshire, Sample ROM3 (Section 9.13.2). Globular iron oxide with massive silicate in a glassy matrix.

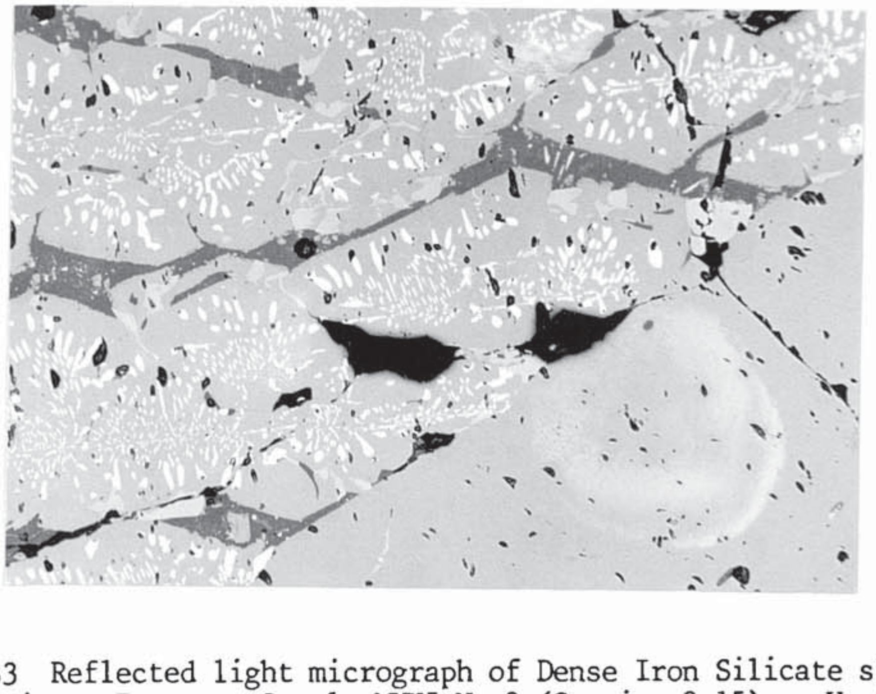


PLATE 33 Reflected light micrograph of Dense Iron Silicate slag from Mucking, Essex. Sample MUK5 No.2 (Section 9.15). Varied structure of massive silicate and broken, euhedral silicate with fine (bleb) iron oxide in a glassy matrix. (Magnification X42).

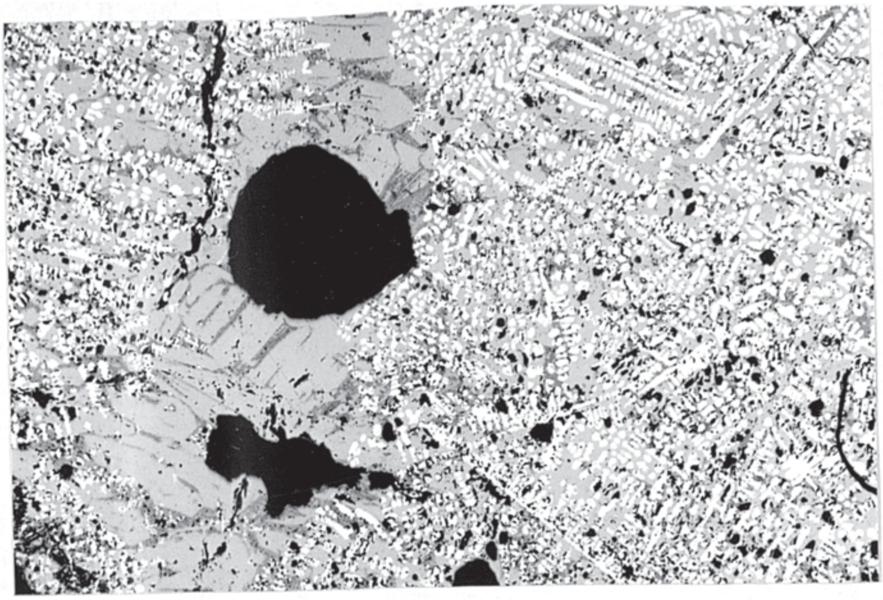


PLATE 34 Reflected light micrograph of a smithing slag from Beckford, Worcestershire, Sample BEK1 (Section 11.1.2). Varied microstructure of lath and massive silicate, globular iron oxide in a glassy matrix. (Magnification X84)

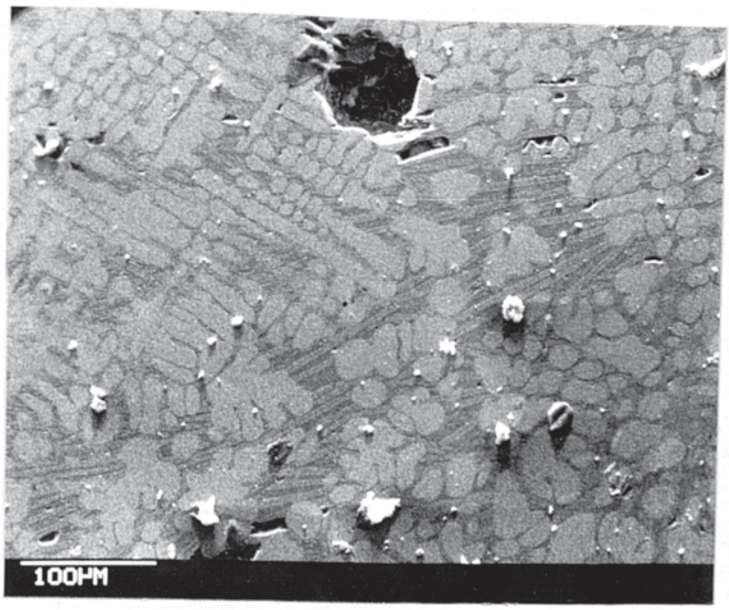


PLATE 35 S.E.M. micrograph of smithing slag BEK2 (Section 11.1.3). The silicate occurs in fine lath form, and there is an above average glass content present.

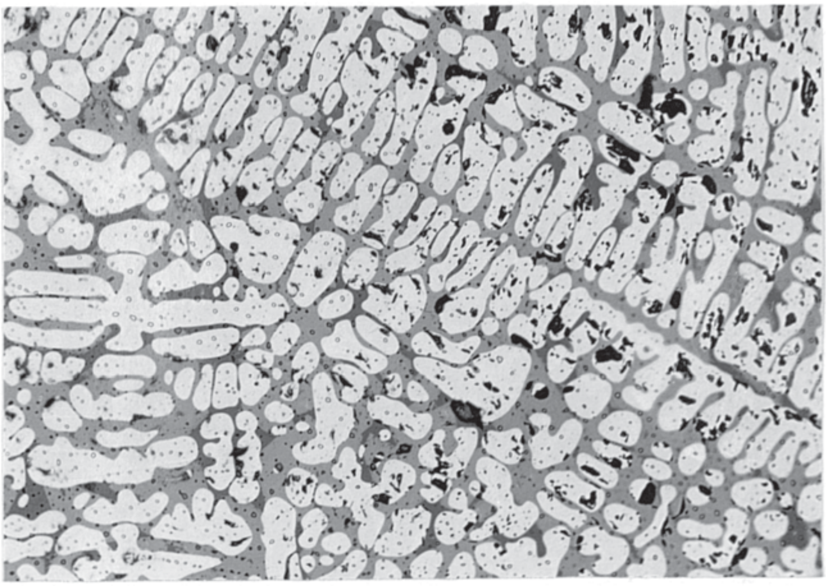


PLATE 36 Reflected light micrograph of smithing slag BEK3 (Section 11.1.4). Massive silicate with globular iron oxide showing orientation. (Magnification X84).

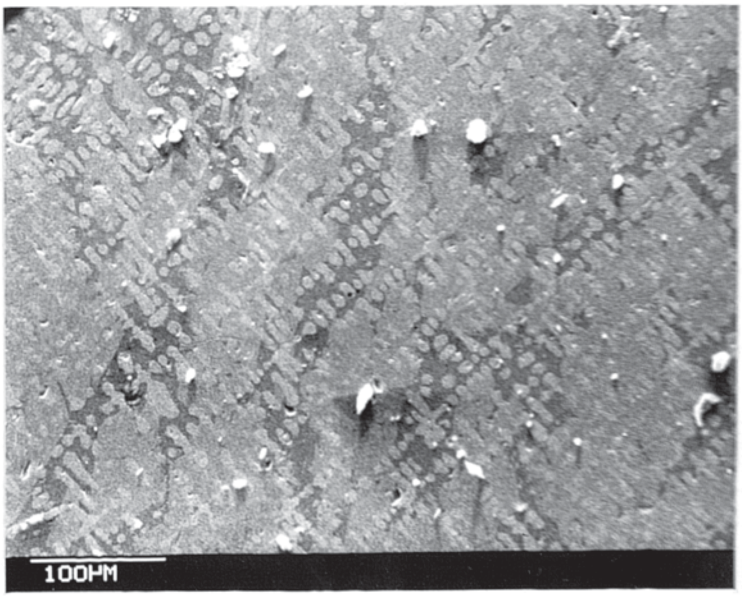


PLATE 37 S.E.M. micrograph of smithing slag sample BEK4. Lath/massive silicate and strongly orientated iron oxide dendrites.

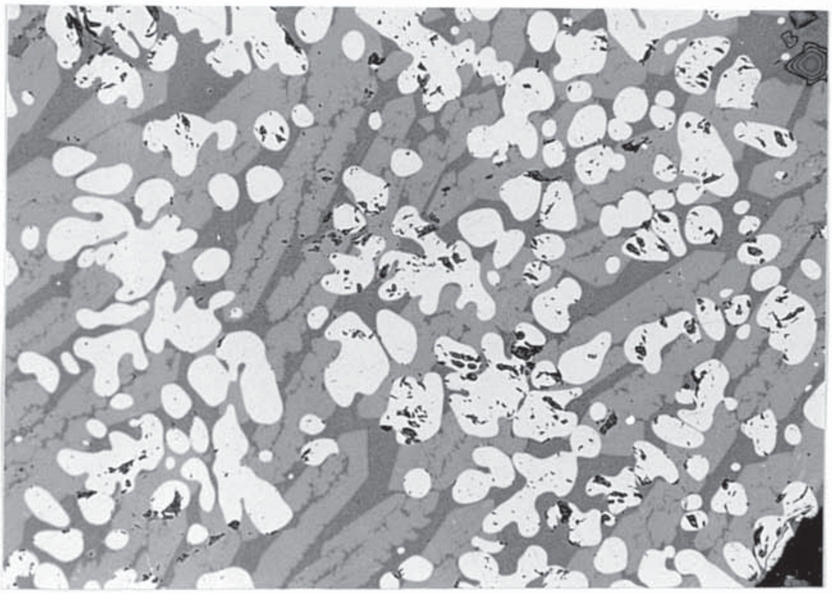


PLATE 38 Reflected light micrograph of smithing slag BEK5 (Section 11.1.6). Broken silicate laths and globular iron oxide dendrites in a glassy matrix. (Magnification X168)

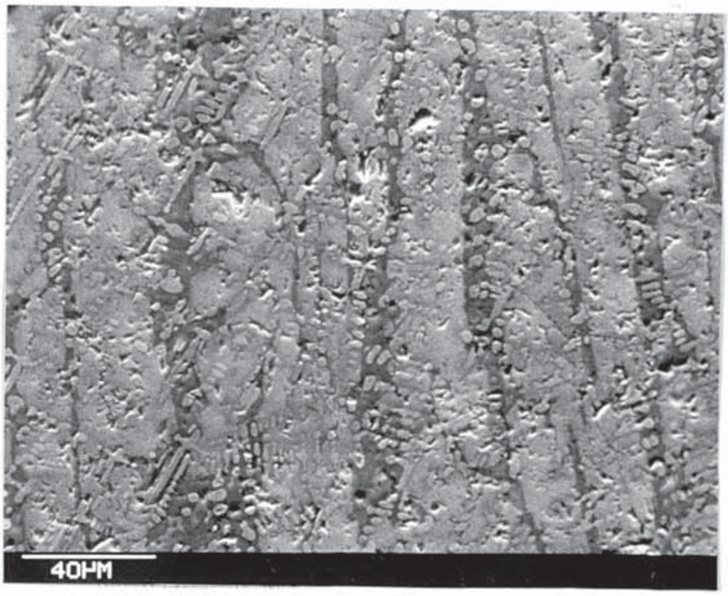


PLATE 39 S.E.M. micrograph of smithing slag sample WP2 from Wharram Percy, North Humberside (Section 11.2). Orientated silicate laths and dedritic iron oxide in a glassy matrix.

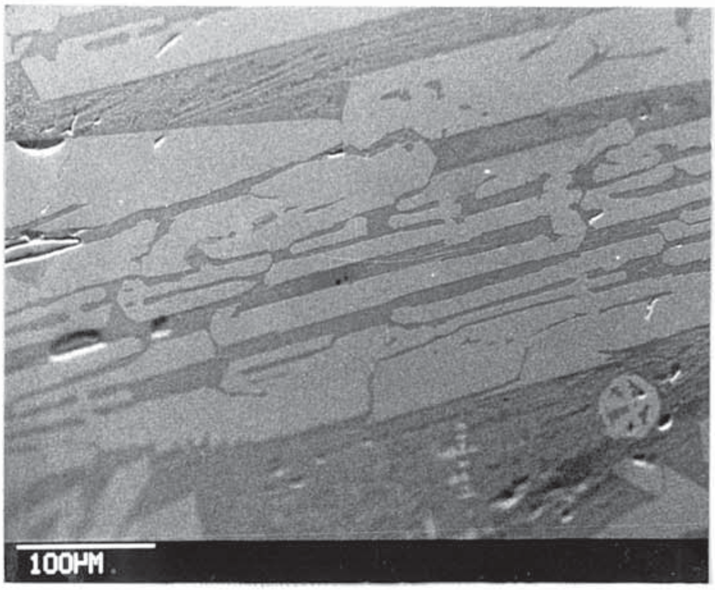


PLATE 40 S.E.M. micrograph of smithing slag BIR1395 from Birsay, Orkney (Section 11.3.2). Broken silicate laths in a glassy matrix with fine dendrites of iron oxide present.

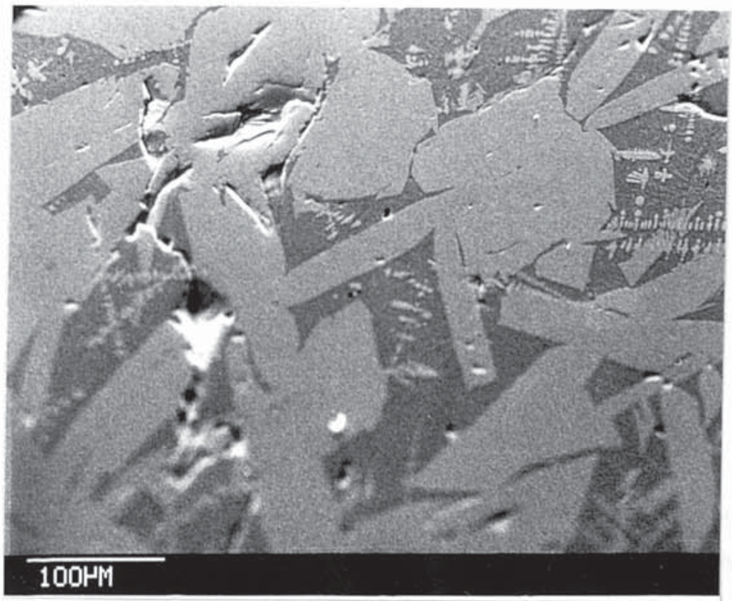


PLATE 41 S.E.M. micrograph of smithing slag BIR1296 from Birsay, Orkney (Section 11.3.3). Broken silicate laths and fine iron oxide dendrites in a glassy matrix.

PLATE 42 S.E.M. micrograph of smithing slag Sample AM783 from Amersham Mantles Green, Buckinghamshire (Section 11.4.2). Globular iron oxide dendrites and broken silicate laths in a glassy matrix.

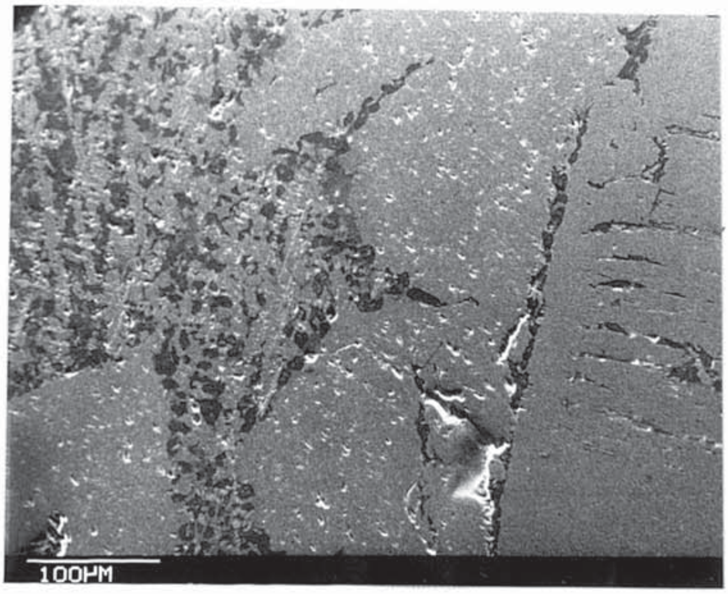


PLATE 43 S.E.M. micrograph of smithing slag Sample AM716 from Amersham (Section 11.4.4). Massive silicate and glass containing crystallites.

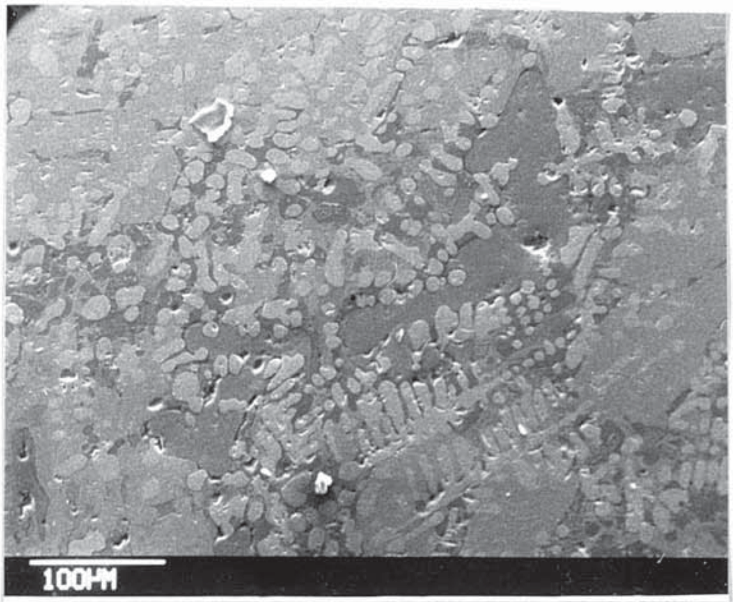


PLATE 44 S.E.M. micrograph of smithing slag Sample HEYA8 from Heybridge, Essex (Section 11.5.2). Massive silicate and globular dendritic iron oxide in a two phase glassy matrix.

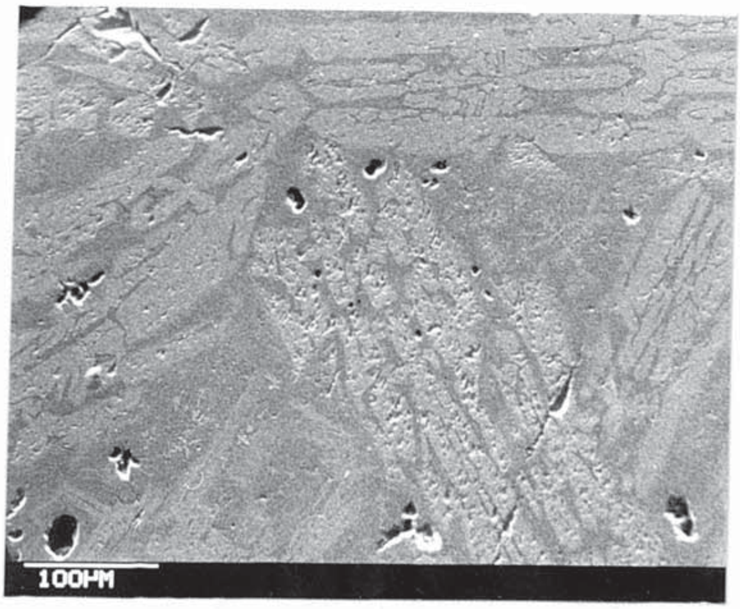


PLATE 45 S.E.M. micrograph of smithing slag Sample HEY119 (Section 11.5.3). Dendritic silicate laths in a glassy matrix. Free iron oxide occurred as very fine skeletal dendrites.

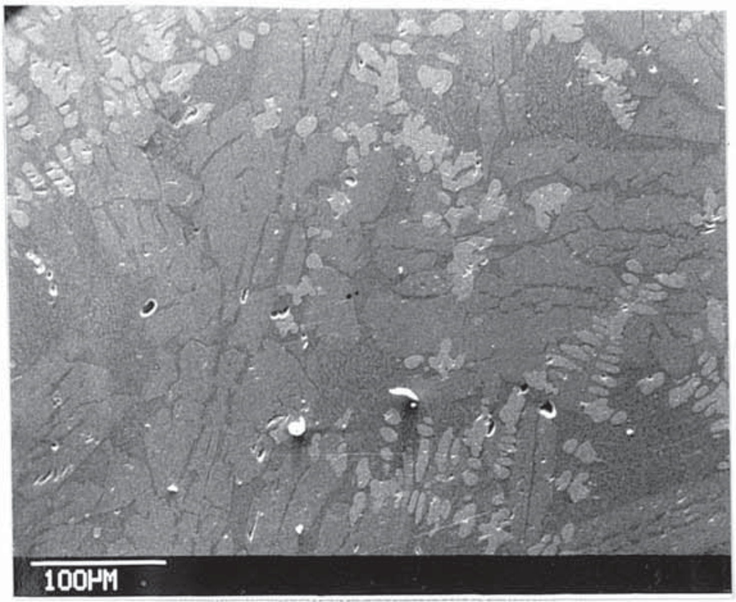


PLATE 46 S.E.M. micrograph of smithing slag sample HEYA64 (Section 11.5.4). Euhedral silicate laths and free iron oxide dendrites in a glassy matrix.

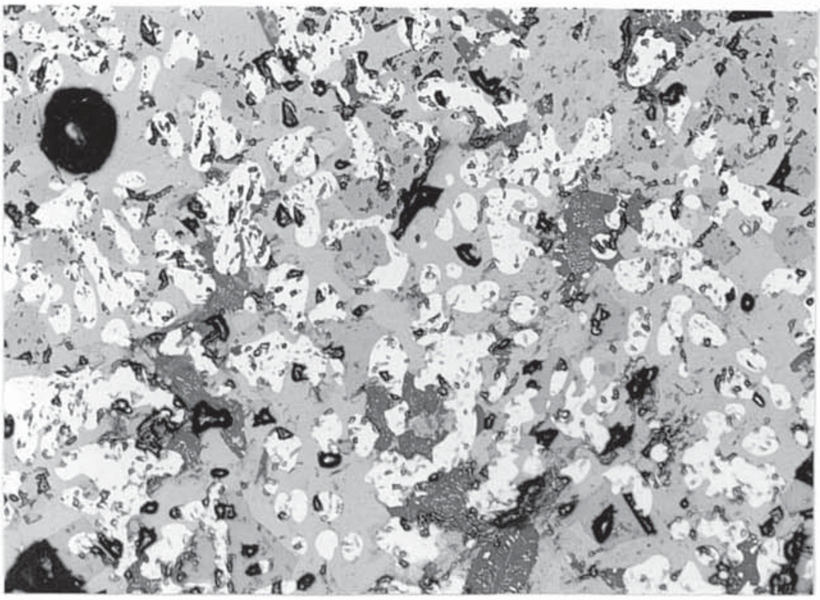


PLATE 47 Reflected light micrograph of smithing slag Sample WWS501/2 from Wetwang Slack, North Humberside (Section 11.6.2). Massive silicate and globular iron oxide in a glassy matrix (dark) that contains crystallites. There is also a second dark grey phase that may be segregation within the silicate, hercynite, or a second glassy phase.

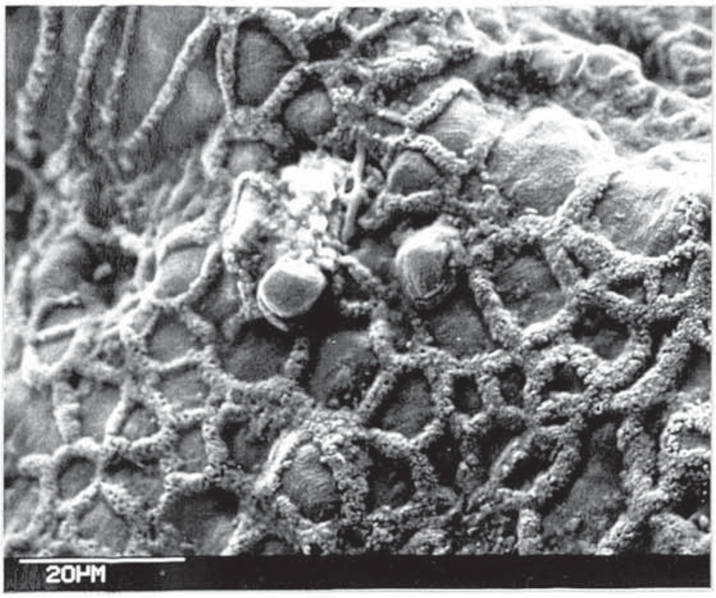


PLATE 48 S.E.M. micrograph of the surface of flake hammer scale (from Wharram Percy) cleaned in dilute HCl. Note the granular pattern.

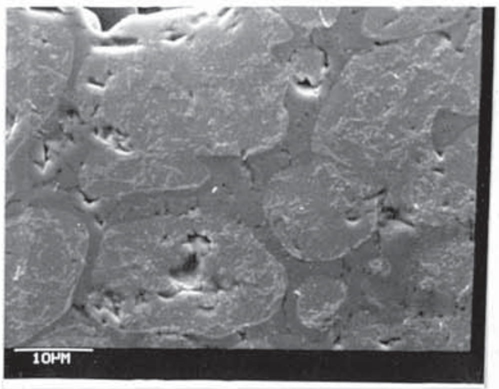


PLATE 49a S.E.M. micrograph of a polished surface of flake hammer scale (from Wharram Percy). Note the granular appearance.

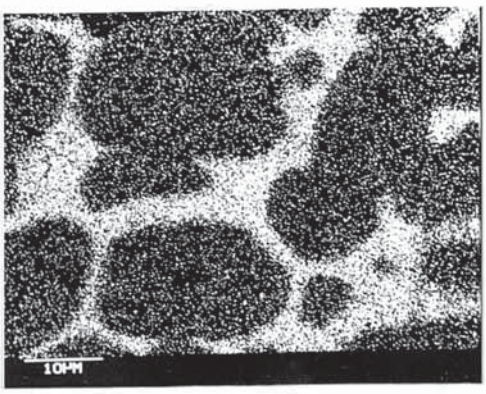


PLATE 49b Si X-Ray map of the structure shown in Plate 49a. Silicate forms the grain boundary around the iron oxide.

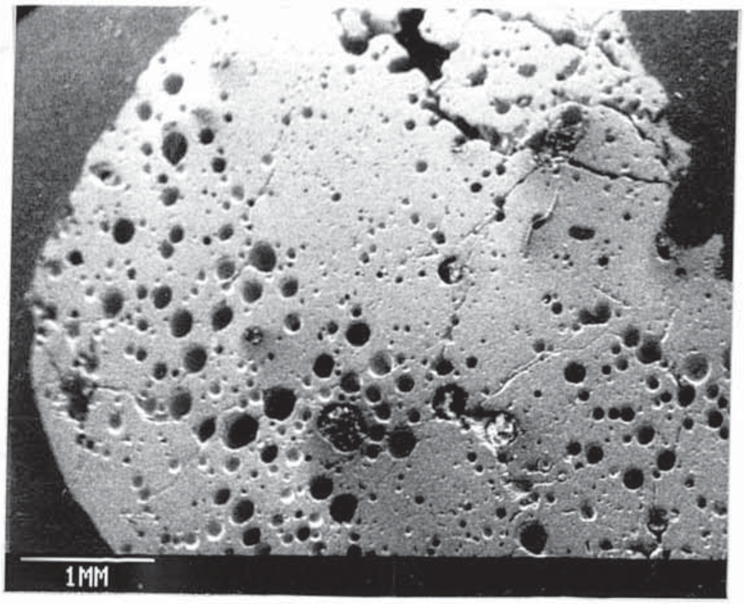


PLATE 50 S.E.M. micrograph of a polished surface of flake hammer scale showing vesicularity.

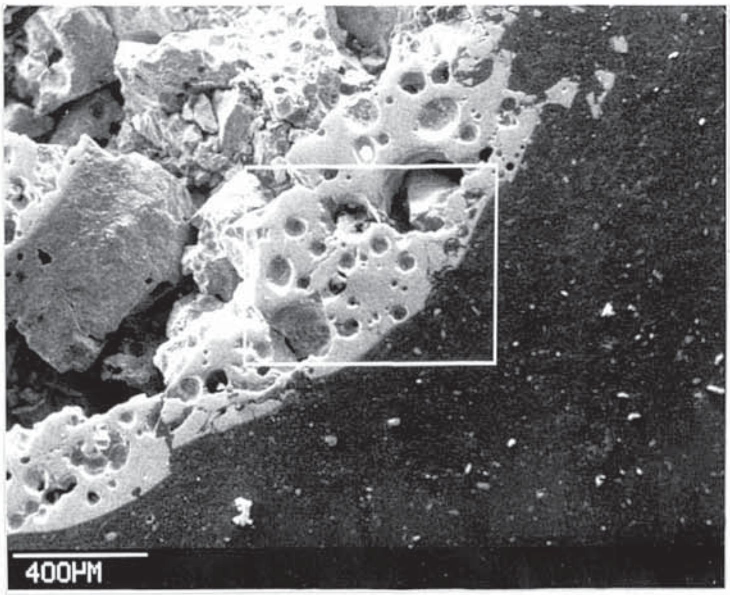


PLATE 51 S.E.M. micrograph showing the vesicularity of the rim of spheroidal hammer scale. (The area of the spot analyses is boxed).

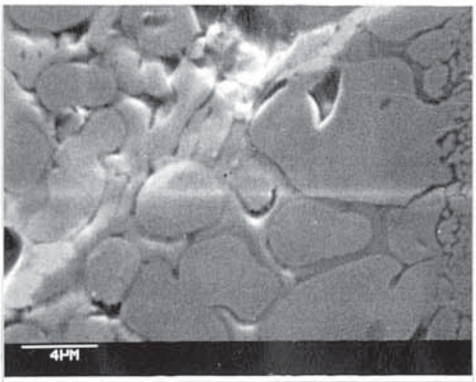


PLATE 52a S.E.M. micrograph of Wharram Percy spheroidal scale, showing granular structure.

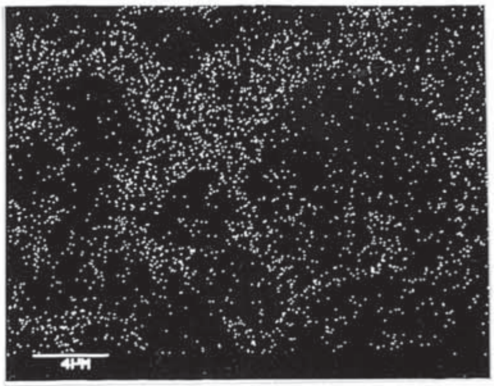


PLATE 52b Si X-Ray map of the granular stucture shown in Plate 52a. Silicates forms the grain boundary.

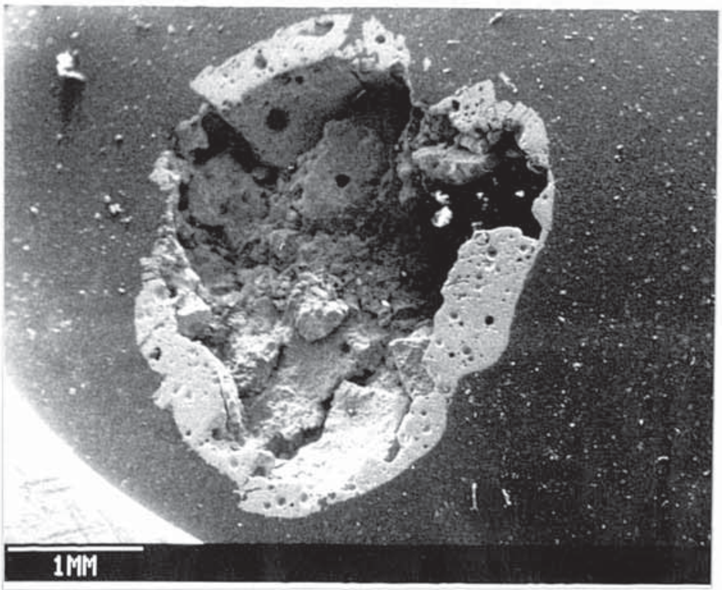


PLATE 53 S.E.M. micrograph of a prepared cross-section of spheroidal hammer scale (from Southampton).

APPENDIX 1

THE CALCULATION OF NORMATIVE MINERAL CONSTITUENTS

The calculation of the theoretical mineral constituents of the bulk and phase analyses used the method published by Kresten[82], with some alterations to the computer programme. The full listing of the programme is given in Appendix 2. In this Appendix a worked example of the calculation on the mean bulk analysis of the smelting slags is given.

The normative procedure relies on the sequence of mineral crystallisation from a melt that cools under equilibrium conditions. The procedure uses all the oxides analysed for, except those of vanadium, chromium, cobalt and nickel. An improvement to the programme to incorporate these oxides correctly into the calculation will be made, but their level is not sufficient to radically alter the amount of the different minerals formed. The chemical analysis is converted into cation numbers, (also termed 'atomic equivalent numbers') by dividing the weight percentages of the oxides by their molecular weight, these are then re-calculated into percentages. The oxides are apportioned to minerals in a strict sequence of fixed relationships, starting with the formation of non-silicate minerals. The formation of the silicate minerals causes the silica to be consumed irrespective of the quantity present until all other oxides are zeroed. This results in either excess silica or in a negative silica amount remaining. These are corrected by either the release of silica to correct a negative silica balance, or the saturation of certain minerals with silica to correct an excess silica balance. In extreme cases, with high silica contents, saturation of all suitable minerals may still result in silica being left over, and this remainder is given as a quartz content.

Calculation Sequence

1 Phosphorus forms apatite (AP): 3 P + 5 Ca = 8 AP

2 Any excess P forms vivianite (VI): 2 P + 3 Fe = 5 VI

3 Titanium forms ulvite (UV): 1 Ti + 2 Fe = 3 UV

4 Sulphur forms pyrrhotite (PO): 1 S +1 Fe = 2 PO

5 Potassium forms kalsilite (KS): 1 K + 1 Al + 1 Si = 3 KS

5 Sodium forms nepheline (NE): 1 Na + 1 Al + 1 Si = 3 NE

6 Aluminium forms anorthite (AN): 2 Al + 1 Ca + 2 Si = 5 AN

7 Calcium forms calcium silicate (CS): 2 Ca + 1 Si = 3 CS

8 Magnesium forms forsterite (FO): 2 Mg + 1 Si = 3 FO

9 Manganese forms tephroite (TP): 2 Mn + 1 Si = 3 TP

10 Iron forms fayalite (FA): 2 Fe + 1 Si = 3 FA

11 Silica Balance Calculation

If a negative silica balance is calculated silica must be released. Firstly by the reaction of anorthite (AN) and calcium silicate (CS) forming gehlenite (GE) and silica.

10 AN + 3 CS = 10 GE + 3 Si

More silica can be released by the conversion of fayalite to wustite + silica

3 FA = 2 WU + 1 Si

If a positive silica balance was calculated silica can be absorbed by the conversion of silicate minerals to silicate saturated minerals.

Formation of orthoclase	(OR):	3 KS + 2 Si = 5 OR
Formation of albite	(AB):	3 NE + 2 Si = 5 AB
Formation of wollastonite	(WO):	3 CS + 1 Si = 4 WO
Formation of enstatite	(EN):	3 FO + 1 Si = 4 EN

Formation of rhodonite (RH): 3 TP + 1 Si = 4 RH

Formation of ferrosilite (FS): 3 FA + 1 Si = 4 FS

Remaining Si is given as quartz (Q).

The resulting molecular norm is converted to weight equivalents by multipling each figure with the molecular weight of the constituent, divided by the number of cations present. The weight equivalents are then re-calculated into weight percents.

Normative Calculation of the mean bulk analyses of the smelting slags.

	Oxide Weight Percentage	gm ions/ 100gm slag ($X10^{-2}$)	Ion Percentage
Na_2O	0.2	0.645	0.42
MgO	1.0	2.48	1.61
Al_2O_3	5.5	10.8	6.99
SiO_2	28.4	47.3	30.63
P_2O_5	1.0	1.41	0.91
S	0.1	0.312	0.20
K_2O	1.5	3.18	2.06
CaO	5.1	9.10	5.89
TiO_2	0.4	0.501	0.32
MnO	3.4	0.479	3.10
FeO	53.1	73.9	47.86

Apportionment of cation percentages to the minerals.

		CALCULATION SEQUENCE NUMBER									
		1	2	3	4	5	6	7	8	9	10
Na_2O	0.42					0.42	(0.00)				
MgO	1.61								1.61(0.00)		
Al_2O_3	6.99				2.06	0.42	4.51	(0.00)			
SiO_2	30.63				2.06	0.42	4.51	1.06	0.80	1.55	23.51(-3.28)
P_2O_5	0.91	0.91(0.00)									
S	0.20			0.20	(0.00)						
K_2O	2.06				2.06	(0.00)					
CaO	5.89	1.52					2.25	2.12	(0.00)		
TiO_2	0.32		0.32	(0.00)							
MnO	3.10									3.10	(0.00)
FeO	47.86		0.64	0.20							47.02(0.00)
Mineral Percentage		2.43 AP	0.96 UV	0.40 PO	6.18 KS	1.26 NE	11.27 AN	3.18 CS	2.41 FO	4.65 TP	70.53 FA

Silica Balance Calculation

More silica has been consumed than was originally present (-3.28 Cation %). Therefore:-

Formation of gehlenite and silica from anorthite and calcium silicate.

10AN + 3CS = 10GE + 3SI -3.28% SI

10.6 AN + 3.18 CS = 10.6 GE + 3.18 SI -0.10% SI

This consumes all the calcium silicate and leaves 0.67% anorthite.

The remaining negative silica balance is corrected by the formation of wustite and silica from fayalite.

3FA = 2WU + 1SI

0.3 FA = 0.2 WU + 0.1 SI 0.0% SI

This leaves 70.23% fayalite and 0.2% wustite.

Conversion of the molecular norms to weight percent.

	Molecular Norm	Weight	Weight %
APATITE	2.43	149.83	2.3
ULVITE	0.96	71.55	1.1
PYRRHOTITE	0.40	35.17	0.5
KALSILITE	6.18	325.811	5.0
K-SILICATE			
NEPHELINE	1.26	59.65	0.9
NA-SILICATE			
ANORTHITE	0.67	37.27	0.6
HERCYNITE			
MULLITE			
CA-SILICATE			
FORSTERITE	2.41	113.03	1.7
TEPHROITE	4.65	313.04	4.8
FAYALITE	70.23	4770.02	73.8
GEHLENITE	10.6	581.20	9.0
WUSTITE	0.2	14.37	0.2
ORTHOCLASE			
ALBITE			
WOLLASTONITE			
ENSTATITE			
RHODONITE			
FERROSILITE			
QUARTZ			

APPENDIX 2

CALCULATION OF NORMATIVE MINERAL CONSTITUENTS FROM AN OXIDE WEIGHT PERCENT CHEMICAL ANALYSES. COMPUTER PROGRAMME LISTING (OSBORNE BASIC).

```
100 PRINT "************££££££££££££££********************££££££££££££******"
110 PRINT ""
120 PRINT ""
130 PRINT "TO IGNORE     'LPRINT' STATEMENTS TYPE '99' IF NOT TYPE '100'  "
140 PRINT "********************&&&&&&&½½½½½½%%%%%%%$$£@@@@@@@@@@@***********"
150 PRINT ""
160 PRINT "IGNORE 'LPRINT' STATEMENTS ??????";
170 INPUT "IGNORE 'LPRINT' STATEMENTS?";IG$
180 PRINT "******************************!!!!!!!!!!!!!!!!!!!!**************"
190 PRINT ""
200 PRINT "IG$=   "; IG$
210 REM ************************************************************
220 REM SLAGNORM (C) P.KRESTEN & I.SERNING, AMI 1983
230 REM UPDATED BY McDONNELL & NADKHARNI 1985
240 REM SPACE FOR FILE HANDLING ROUTINE
250 REM ************************************************************
260 PRINT "SLAGNORM:":PRINT
270 PRINT: PRINT "Fe3 ANALYSED?";F$: IF F$ ="N" THEN 310 ELSE 280
280 PRINT: PRINT "ALLOCATION OF FERRIC IRON:"
290 INPUT "  Fe3+ AS HEMATITE ONLY                = 1?";X3
300 INPUT "  Fe3+ AS MAGNETITE & HEMATITE         = 2?";X3
310 PRINT "---------------------------------------------------------"
320 REM ************************************************************
330 IF IG$="99" THEN 350
340 LPRINT "SLAGNORM (C) AMI 1983, UPDATE (C) MCD 1985"
350 PRINT "SLAGNORM (C) AMI 1983, UPDATE (C) McD 1985"
360 PRINT "--------------------------------------------------------"
370 IF IG$="99" THEN 390 ELSE
380 LPRINT ""
390 REM ************************************************************
400 REM DIMENSION VARIABLES
410 REM ************************************************************
420 DIM OXIDE$(23), MOLEC(23), MINER$(39), FACT(39)
430 DIM DUM1(23),  OXIDE(23), CATION(23), DUM3(39), DUM4(39)
440 REM ************************************************************
450 REM READ DATA
460 REM ************************************************************
470 FOR I= 1 TO 23 :READ OXIDE$(I): NEXT I
480 FOR I =1 TO 23
490 READ MOLEC(I)
500 NEXT I
510 FOR I= 1 TO 39 :READ MINER$(I): NEXT I
520 FOR I = 1 TO 39
530 READ FACT(I)
540 NEXT I
550 REM ************************************************************
560 REM INPUT DATA
570 REM ************************************************************
580 INPUT "SAMPLE I.D.                                              ";ID$
590 TOTAL1 = 0
600 FOR I= 1 TO 23 : OXIDE(I)=0 : NEXT I
610 PRINT:PRINT "ENTER WEIGHT %                         -         ": PRINT
620 FOR I = 1 TO 12
630 PRINT OXIDE$(I); " =    ";
640 INPUT OXIDE(I)
650 TOTAL1 = TOTAL1 + OXIDE(I)
660 NEXT I
670 PRINT "IF ADDITIONAL DATA PUT 'Y' , IF NOT  'N'";
680 PRINT: PRINT "  INPUT ADDITIONAL DATA             ";Q$
690 INPUT Q$
700 IF Q$ ="Y" THEN 730
```

```
710 IF Q$="N" THEN 790
720 IF ((Q$<>"Y") AND (Q$<> "N")) THEN 680
730 TOTAL2 = 0
740 FOR I = 13 TO 23
750 PRINT OXIDE$(I);  "   =   ";
760 INPUT OXIDE(I)
770 TOTAL2 = TOTAL2 + OXIDE(I)
780 NEXT I
790 IF IG$="99" THEN 860 ELSE
800 LPRINT "SAMPLE I.D.                              ";ID$
810 LPRINT ""
820 LPRINT          "________________________"
830 LPRINT ""
840 LPRINT "ENTER WEIGHT %"
850 LPRINT ""
860 FOR I = 1 TO 23
870 IF OXIDE(I) <= 0 THEN 900
880 IF IG$="99" THEN 900 ELSE
890 LPRINT OXIDE$(I),       "  =      "; OXIDE(I)
900 NEXT I
910 IF IG$ = "99" THEN 990 ELSE
920 LPRINT ""
930 LPRINT ""
940 IF IG$="99" THEN 990 ELSE
950 LPRINT "TOTAL GROUP 1 =";TOTAL1
960 LPRINT "TOTAL GROUP 2 =";TOTAL2
970 LPRINT ""
980 LPRINT ""
990 REM ************************************************************************
1000 REM CALCULATION OF CATION %
1010 REM ***********************************************************************
1020 FOR I = 1 TO 23 : DUM1(I)=OXIDE(I)=CATION(I)=DUM3(I)=DUM4(I)=0 : NEXT I
1030 TOTAL3 = 0
1040 FOR I = 1 TO 23
1050 DUM1(I) = OXIDE(I)/MOLEC(I)
1060 TOTAL3 = TOTAL3+DUM1(I)
1070 NEXT I
1080 X1 = 100/TOTAL3
1090 FOR I= 1 TO 23
1100 CATION(I) =INT(100*DUM1(I)*X1+.5)/100
1110 PRINT "OXIDE$(I)          ";OXIDE$(I);"CATION-%          ";CATION(I)
1120 IF IG$= "99" THEN 1140 ELSE
1130 LPRINT "OXIDE$(I)    ";OXIDE$(I),  "CATION-%    ";CATION(I)
1140 NEXT I
1150 IF IG$ = "99" THEN 1210 ELSE
1160 LPRINT ""
1170 LPRINT ""
1180 LPRINT "      ____________________________         "
1190 LPRINT ""
1200 LPRINT ""
1210 PRINT: PRINT " DO YOU WHISH TO COMBINE ELEMENTS?  'Y' OR 'N'";AN$
1220 INPUT AN$
1230 IF AN$<>"Y" AND AN$ <>"N" THEN 1210
1240 IF AN$ = "N" THEN 1270 ELSE
1250 CATION(3) = CATION(3) + CATION(14): CATION(12) = CATION(12) + CATION(13)
1260 CATION(11)= CATION(11) +CATION(15) + CATION(16)
1270 REM ***********************************************************************
1280 REM PROVISIONAL CALCULATION OF NORMATIVE CONSTITUENTS
1290 REM *******************************************************
1300 IF IG$ = "99" THEN 1340 ELSE
1310 LPRINT "%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%"
1320 LPRINT "  PRINTING OXIDE CATIONS AS NORMS ARE CALCULATED "
1330 LPRINT ""
1340 REM ALLOCATION OF PHOSPHORUS [ OXIDE(5)# TO APATITE AND VIVIANITE
1350 REM *******************************************************
1360 IF CATION(5) = 0 THEN 1520
1370 IF CATION(8) = 0 THEN 1450
1380 IF CATION(5)/3 > CATION(8)/5 THEN 1420
1390 DUM3(1) =INT (266.7 * CATION(5) + .5)/100
1400 CATION(8) = CATION(8) - 1.6667 * CATION(5)
```

```
1410 GOTO 1520
1420 DUM3(1) = INT(160 * CATION(8) + .5)/100
1430 CATION(5) = CATION(5) -.6 * CATION(8)
1440 CATION(8) = 0
1450 IF CATION(5)/2 > CATION(11)/3 THEN 1490
1460 DUM3(2) = INT(250 * CATION(5) + .5)/100
1470 CATION(11) = CATION(11) - 1.5 * CATION(5)
1480 GOTO 1520
1490 DUM3(2) = INT(166.67 * CATION(11) + .5)/100
1500 DUM3(3) = INT ((CATION(5) - .6667 * CATION(11)) * 100 +.5)/100
1510 CATION(5) = 0
1520 PRINT "CATION P= ";CATION(5),"CATION CAO=   ";CATION(8), "CATION FEO=  ";CATION(11)
1530 IF IG$ = "99" THEN 1550 ELSE
1540 LPRINT  "     P =  ";CATION(5), "  CAO =  ";CATION(8), "  FEO =  ";CATION(11)
1550 REM ***********************************************************
1560 REM ALLOCATION OF TI $CATION(9)# TO RUTILE AND ULVITE
1570 IF CATION(9)=0 THEN 1660
1580 IF CATION(9) > CATION(11)/2 THEN 1630
1590 DUM3(4) = INT(300 * CATION(9) + .5)/100
1600 CATION(11) = CATION(11) - 2 * CATION(9)
1610 CATION(9)=0
1620 GOTO 1660
1630 DUM3(4) = INT(150 * CATION(11) + .5)/100
1640 DUM3(5) = INT((CATION(9) - CATION(11)/2)*100 +.5)/100
1650 CATION(11) = 0
1660 PRINT "CATION TI=  ";CATION(9),"CATION FEO=   ";CATION(11)
1670 IF IG$ = "99" THEN 1690 ELSE
1680 LPRINT  "    Ti = ";CATION(9), "  FEO = ";CATION(11)
1690 REM **************************************************************
1700 REM ALLOCATION OF CU [CATION(17)]
1710 IF CATION(17) = 0 THEN 1800
1720 IF CATION(17) > CATION(6) THEN 1770
1730 DUM3(6) = INT(100 * CATION(17) + .5)/100
1740 CATION(6) = CATION(6) - CATION(17)
1750 CATION(17)=0
1760 GOTO 1800
1770 DUM3(6) = INT(100 * CATION(6) + .5)/100
1780 DUM3(7) = INT( (CATION(17) - CATION(6)) * 100 + .5)/100
1790 CATION(6) = 0
1800 PRINT "CATION CU=  ";CATION(17), "CATION S =   ";CATION(6)
1810 IF IG$ = "99" THEN 1830 ELSE
1820 LPRINT  "   Cu = ";CATION(17), "    S = ";CATION(6)
1830 REM **************************************************************
1840 REM ALLOCATION OF ZINC [CATION(18) ]
1850 IF CATION(18) = 0 THEN 1930
1860 IF CATION(18) > CATION(6) THEN 1900
1870 DUM3(8) = INT (100 * CATION(18) + .5 )/100
1880 CATION(6) = CATION(6) - CATION(18)
1890 GOTO 1930
1900 DUM3(8) = INT(100 * CATION(6) + .5)/100
1910 CATION(11) = CATION(11) (CATION(18)-CATION(6) )
1920 CATION(6)=0
1930 PRINT "  CATION ZNO =   ";CATION(18), "CATION S =  ";CATION(6), "CATION FEO=  "; CATION(11)
1940 IF IG$ = "99" THEN 1960 ELSE
1950 LPRINT "  ZnO = ";CATION(18), "    S =  ";CATION(6), "  FeO =  ";CATION(11)
1960 REM **********************************************************
1970  REM ALLOCATION OF SULPHUR  [ CATION(6)  ]
1980 IF CATION(6) = 0 THEN 2060
1990 IF CATION(6) > CATION(11) THEN 2030
2000 DUM3(9) = INT(100 * CATION(6) + .5)/100
2010 CATION(11) = CATION(11) - CATION(6)
2020 GOTO 2060
2030 DUM3(9) = INT( 100 * CATION(11) + .5)/100
2040 DUM3(10) = INT(( CATION(6) - CATION(11)) * 100 +.5)/100
2050 CATION(11) = 0
2060 PRINT "CATION S =  "; CATION(6), "CATION FEO=   ";CATION(11)
2070 IF IG$ = "99" THEN 2090 ELSE
2080 LPRINT "    S =  ";CATION(6), "  FEO = ";CATION(11)
2090 REM **********************************************************
2100 REM ALLOCATION OF SNO  [ CATION(20) ]
```

```
2110 IF CATION(20) = 0 THEN 2140
2120 DUM3(11) = INT(CATION(20) * 100 + .5)/100
2130 CATION(20)=0
2140 PRINT "CATION SNO= ";CATION(20)
2150 IF IG$ = "99" THEN 2170 ELSE
2160 LPRINT " SnO = ";CATION(20)
2170 REM ************************************************************
2180 REM ALLOCATION OF AS [CATION(19) ]
2190 IF CATION(19) = 0 THEN 2270
2200 IF CATION(19) > CATION(11) THEN 2240
2210 DUM3(12) = INT (100 * CATION(19) + .5)/100
2220 CATION(11) = CATION(11) - CATION(19)
2230 GOTO 2270
2240 DUM3(12) = INT(100 * CATION(11) + .5)/100
2250 DUM3(13) = INT((CATION(19) - CATION(11)) * 100 + .5)/100
2260 CATION(11) = 0
2270 PRINT "CATION AS=      ";CATION(19),"CATION FEO= ";CATION(11)
2280 IF IG$ ="99" THEN 2300 ELSE
2290 LPRINT "  AS = ";CATION(19), " FEO = ";CATION(11)
2300 REM ****************************************************************
2310 REM ALLOCATION OF PBO [CATION(23) ]
2320 IF CATION(23) = 0 THEN 2360
2330 DUM3(14) = INT(150 * CATION(23) + .5)/100
2340 CATION(4) = CATION(4) -CATION(23)/2
2350 CATION(23)=0
2360 PRINT "CATION PBO= ";CATION(23), "CATION SIO2 = ";CATION(4)
2370 IF IG$ = "99" THEN 2390 ELSE
2380 LPRINT " PBO = ";CATION(23), " SiO2 = ";CATION(4)
2390 REM ***********************************************************************
2400 REM ALLOCATION OF BAO [ CATION(22) ]
2410 IF CATION(22) = 0 THEN 2460
2420 DUM3(15) = INT(500 * CATION(22) + .5)/100
2430 CATION(3) = CATION(3) - 2 * CATION(22)
2440 CATION(4) = CATION(4) - 2 * CATION(22)
2450 CATION(22)=0
2460 PRINT "CATION AL2O3= ";CATION(3),"CATION SIO2= ";CATION(4), "CATION BAO= ";CATION(22)
2470 IF IG$ = "99" THEN 2490 ELSE
2480 LPRINT "Al2O3 = ";CATION(3), " SiO2 = ";CATION(4), " BaO = ";CATION(22)
2490 REM*********************************************************************
2500 REM ********************************************************************
2510 REM MAJOR MINERALS
2520 REM *********************************************************************
2530 REM ALLOCATION OF K2O $ CATION(7) #
2540 IF CATION(7) = 0 THEN 2650
2550 IF CATION(7) >= CATION(3) THEN 2610
2560 REM K2O FORMS KALSILITE 1K + 1AL + 1SI $CATION(7) + CATION(3) + CATION(4) #
2570 DUM3(16) = 3 * CATION(7)
2580 CATION(4) = CATION(4) - CATION(7) : CATION(3) = CATION(3) - CATION(7)
2590 CATION(7)=0
2600 GOTO 2650
2610 DUM3(16) = 3 * CATION(3)
2620 DUM3(17) = 1.5 * (CATION(7) - DUM3(16)/3)
2630 CATION(4) = CATION(4) - (DUM3(16) + DUM3(17))/3
2640 CATION(3) = 0
2650 PRINT "CATION K2O= ";CATION(7), "CATION AL2O3= ";CATION(3),"CATION SIO2= ";CATION(4)
2660 IF IG$ = "99" THEN 2680 ELSE
2670 LPRINT " K2O = ";CATION(7), "Al2O3 = ";CATION(3), " SiO2 = ";CATION(4)
2680 REM **************************************************
2690 REM ALLOCATION OF NA2O [CATION(1) ]
2700 REM *********************************************************************
2710 IF CATION(1) = 0 THEN 2850
2720 IF CATION(1) > CATION(3) THEN 2780
2730 DUM3(18) = 3 * CATION(1)
2740 CATION(3) = CATION(3) - CATION(1): CATION(4) = CATION(4) - CATION(1)
2750 CATION(1)=0
2760 GOTO 2850
2770 DUM3(18) = 3 * CATION(3)
2780 CATION(1) = CATION(1) - CATION(3): CATION(4) = CATION(4) - CATION(3)
2790 CATION(3) = 0 : IF CATION(1) => CATION(12) THEN 2820
2800 DUM3(19) = 4 * CATION(1) : CATION(12) = CATION(12) - CATION(1)
```

```
2810 CATION(1) = 0 : GOTO 2850
2820 DUM3(19) = 4 * CATION(12) : DUM3(20) = 1.5 * ( CATION(1) - CATION(12))
2830 CATION(4) = CATION(4) - 2 * CATION(12) - DUM3(20)/3
2840 CATION(12) = 0
2850 PRINT "CATION NA2O=  ";CATION(1),"CATION AL2O3=  ";CATION(3),"CATION SIO2=  ";
2851 CATION(4), "CATION FE3O4 =   "CATION(12)
2860 IF IG$ = "99" THEN 2880 ELSE
2870 LPRINT " Na2O = ";CATION(1), "Al2O3 = ";CATION(3), " SiO2 = ";CATION(4), "Fe3O4 = ";CATION(1
2880 REM ************************************************************************
2890 REM FERRIC IRON OPTION  *******************!!!!!!!!!!!!!!!
2900 REM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2910 IF X3 = 1 THEN 2920 : IF X3 = 2 THEN 2950
2920 DUM3(21) = INT(CATION(12)* 100 + .5)/100
2930 CATION(12) = 0
2940 GOTO 3020
2950 IF CATION(12) > CATION(11) THEN 2990
2960 DUM3(22) = INT(150 * CATION(12) + .5)/100
2970 CATION(11) = CATION(11) - CATION(12)/2
2980 CATION(12) = 0 : GOTO 3020
2990 DUM3(22) = INT(300* CATION(11) + .5)/100
3000 DUM3(21) = INT(( CATION(12) - 2* CATION(11)) * 100 + .5)/100
3010 CATION(11) = 0: CATION(12) = 0
3020 PRINT "CATION FE2O3=  ";CATION(12), "CATION FEO=  ";CATION(11)
3030 IF IG$ = "99" THEN 3050 ELSE
3040 LPRINT "Fe2O3 = ";CATION(12), "  FeO= ";CATION(11)
3050 REM ****************************************************************************
3060 REM ALLOCATION OF AL2O3 TO ANORTHITE  [  CATION(3)  ]
3070 REM ***************************************************
3080 IF CATION(3) = 0 THEN 3340
3090 IF CATION(3) > (2*CATION(8))THEN 3130
3100 DUM3(23) = INT(250 * CATION(3) + .5)/100
3110 CATION(8) = CATION(8) -CATION(3)/2: CATION(4) =INT(( CATION(4) - CATION(3) )*100 + .5 )/100
3120 GOTO 3340
3130 DUM3(23) = 5 * CATION(8)
3140 CATION(3) = CATION(3) - 2 * CATION(8) : CATION(4) = CATION(4) - 2 * CATION(8)
3150 CATION(8) = 0
3160 PRINT "CATION AL2O3= ";CATION(3),"CATION SIO2= ";CATION(4),"CATION CAO=  ";CATION(8)
3170 IF IG$ = "99" THEN 3190 ELSE
3180 LPRINT ,"Al2O3 = ";CATION(3), " SiO2= ";CATION(4), "  CaO= ";CATION(8)
3190 REM ******************************************************************************
3200 REM ALLOCATION OF Al2O3 TO HERCYNITE [CATION(3), MINER$(24) ]
3210 REM *********************************************************************
3220 IF CATION(3) > 2 * CATION(11) THEN 3260
3230 DUM3(24) = INT(150 * CATION(3) + .5)/100
3240 CATION(11) = CATION(11) - CATION(3)/2 : CATION(3) = 0
3250 GOTO 3340
3260 DUM3(24) = INT (300 *CATION(11) + .5)/100
3270 CATION(3) = CATION(3) - 2* CATION(11) : CATION(11) = 0
3280 IF CATION(3)/3 > CATION(4) THEN 3330
3290 REM **********************************************************************
3300 REM ALLOCATION OF AL2O3 TO MULLITE  [CATION(4).  MINER$(25)  ]
3310 REM ***********************************************************************
3320 DUM3(25) = INT(133.3 * CATION(3) + .5)/100 : CATION(4) = CATION(4) - CATION(3)/3
3321 CATION(3)=0: GOTO 3340
3330 DUM3(25) = INT(400 * CATION(4) + .5)/100
3331 MINER$(26) = INT((CATION(3)-3*CATION(4))*100+.5)/100
3332 CATION(3)=CATION(4)=0
3340 PRINT "CATION AL2O3=  ";CATION(3),"CATION SIO2= ";CATION(4),"CATION CAO= ";CATION(8),"CATION
3350 IF IG$ = "99" THEN 3370 ELSE
3360 LPRINT "Al2O3 = ";CATION(3), " SiO2 = ";CATION(4), "  CaO = ";CATION(8). "  FeO = ";CATION(1
3370 REM ****************************************************************
3380 REM ALLOCATION OF CaO TO CALCIUM SILICATE  § CATION(8) TO MINER$(27) #
3390 REM **********************************************************************
3400 IF CATION(8) = 0 THEN 3430
3410 DUM3(27) = INT(150 * CATION(8) + .5)/100
3420 CATION(4) = CATION(4) - CATION(8)/2
3430 PRINT "CATION SIO2= ";CATION(4),"CATION CAO= "CATION(8)
3440 IF IG$ = "99" THEN 3460 ELSE
3450 LPRINT " SiO2 = ";CATION(4), "  CaO = ";CATION(8)
3460 REM *****************************************************************
3470 REM ALLOCATION OF MgO TO FORSTERITE, § CATION(2) TO MINER$(28) #
3480 REM ***********************************************************************
3490 IF CATION(2) = 0 THEN 3520
3500 DUM3(28) =INT( 150 * CATION(2) +.5)/100
```

```
3510 CATION(4) = CATION(4) - CATION(2)/2
3520 PRINT "CATION MGO= ";CATION(2),"CATION SIO2= ";CATION(4)
3530 IF IG$ = "99" THEN 3550 ELSE
3540 LPRINT "  MgO = ";CATION(2), " SiO2 = ";CATION(4)
3550 REM ****************************************************
3560 REM ALLOCATION OF MnO TO TEPHROITE , $ CATION(10) TO MINER$(29) #
3570 REM ************************************************************
3580 IF CATION(10) = 0 THEN 3610
3590 DUM3(29) = INT(150 * CATION(10) +.5)/100
3600 CATION(4) = CATION(4) - CATION(10)/2
3610 PRINT "CATION MNO= ";CATION(10),"CATION SIO2= ";CATION(4)
3620 IF IG$ = "99" THEN 3640 ELSE
3630 LPRINT "  MnO= ";CATION(10), " SiO2 = ";CATION(4)
3640 REM ************************************************************
3650 REM ALLOCATION OF FeO TO FAYALITE  $ CATION(110 TO MINER$(30) #
3660 REM *************************************************************
3670 IF CATION(11) = 0 THEN 3700
3680 DUM3(30) = 1.5 * CATION(11)
3690 CATION(4) = CATION(4) - CATION(11)/2
3700 PRINT "CATION FEO= ";CATION(11). "CATION SIO2= ";CATION(4)
3710 IF IG$ = "99" THEN 3770 ELSE
3720 LPRINT "  FeO = ";CATION(11), " SiO2 = ";CATION(4)
3730 FOR I= 1 TO 39
3740 IF DUM3(I)=0 THEN 3760
3750 LPRINT "  ";MINER$(I), "=", "  ";DUM3(I)
3760 NEXT I
3770 REM ************************************************************
3780 REM ************************************************************************
3790 REM SILICA BALANCE CALCULATION
3800 REM *************************************************************
3810 IF CATION(4) => 0 THEN 4110 : REM EXCESS SILICA
3820 CATION(4) = CATION(4) * (-1) : REM SILICA DEFFICIENCY
3830 IF DUM3(27) = 0 THEN 4030
3840 IF DUM3(23) = 0 THEN 4030
3850 IF CATION(4) > DUM3(27) THEN 3940
3860 IF CATION(4) > DUM3(23) THEN 3890
3870 DUM3(31) = CATION(4) * 3.333
3880 GOTO 4700
3890 DUM3(31) = DUM3(23)
3900 DUM3(27) = DUM3(27) - DUM3(23)/3.333
3910 CATION(4) = CATION(4) - DUM3(23)/3.333
3920 DUM3(23) = 0
3930 GOTO 4040
3940 IF DUM3(27) > DUM3(23)/3.333 THEN 3990
3950 DUM3(31) = 3.333*DUM3(27)
3960 DUM3(23) = DUM3(23) - DUM3(31)
3970 CATION(4) = CATION(4) - DUM3(27)
3980 DUM3(27) = 0 : GOTO 4040
3990 DUM3(31) = DUM3(23)
4000 DUM3(27) = DUM3(27) - DUM3(23)/3.333
4010 CATION(4) = CATION(4) -DUM3(23)/3.333
4020 DUM3(23) = 0
4030 IF CATION(4) > DUM3(30)/3 THEN 4070
4040 DUM3(32) = 2*CATION(4)
4050 DUM3(30) = DUM3(30) - 3* CATION(4)
4060 CATION(4) = 0: GOTO 4690
4070 DUM3(29) = DUM3(29) + DUM3(30)
4080 DUM3(32) = 2* CATION(4)
4090 DUM3(29) = DUM3(29) - 3* CATION(4): DUM3(30) = 0: CATION(4)=0
4100 GOTO 4690
4110 REM ***************************************************************
4120 REM EXCESS SILICA ALLOCATION
4130 REM *************************************************************
4140 IF CATION(4) > DUM3(16) * .6667 THEN 4200
4150 REM CONVERT KALSILITE KS  [ DUM3(16) ]  TO ORTHOCLASE OR (OR  )  [DUM3(33)
4160 DUM3(33) = 2.5*CATION(4)
4170 DUM3(16) = DUM3(16)-1.5*CATION(4)
4180 CATION(4) = 0
4190 GOTO 4690
4200 IF CATION(4) > (DUM3(16) + DUM3(18))*.6667 THEN 4310
```

```
4210 REM CONVERT KALSILITE [ DUM3(16) ] AND NEPHELINE [ DUM3(18) ]  TO ORTHOCLASE [ DUM3(33) ]
4211 REM  AND ALBITE  AB [ DUM3(34) ]
4220 DUM3(33) = 1.6667 * DUM3(16)
4230 DUM3(16) = 0
4240 CATION(4) = CATION(4) - DUM3(33) * .4
4250 DUM3(34) =2.5*CATION(4)
4260 DUM3(18) = DUM3(18) - 1.5*CATION(4)
4270 CATION(4) = 0
4280 GOTO 4690
4290 REM CONVERT KALSILITE [ DUM3(16) ] &  NEPHELINE [ DUM3(18) ] & CA-SILICATE [DUM3(27) ]  TO--
4300 REM ORTHOCLASE [ DUM3(33) ] & ALBITE [ DUM3(34) ] & WOLASTONITE [ DUM3(35) ]
4310 IF CATION(4) > ((DUM3(16) + DUM3(18))*.6667 + DUM3(27)/3) THEN 4410
4320 DUM3(33) = 1.6667*DUM3(16)
4330 DUM3(34) = 1.6667* DUM3(18)
4340 DUM3(16) = 0: DUM3(18) = 0
4350 CATION(4) = CATION(4) -(DUM3(33) + DUM3(34))*.4
4360 DUM3(35) = 4* CATION(4)
4370 DUM3(27) =DUM3(27) - 3*CATION(4)
4380 CATION(4)=0: GOTO 4690
4390 REM CONVERT KALSILITE [ DUM3(16) ] & NEPHELINE [ DUM3(18) ] & CA-SILICAT [ DUM3(27) ]
4391 REM & FORSTERITE [ DUM3(28) ] TO
4400 REM ORTHOCLASE [ DUM3(33) ] & ALBITE [ DUM3(34) ] & WOLASTONITE [ DUM3(35) ]
4401 REM & ENSTATITE [ DUM3(36) ]
4410 IF CATION(4) > ((DUM3(16) + DUM3(18))*.6667 + (DUM3(27)+DUM3(28))/3) THEN      4480
4420 DUM3(33) =1.6667*DUM3(16): DUM3(34)=1.6667*DUM3(18)
4430 DUM3(35)=1.3333*DUM3(27): DUM3(16)=0: DUM3(18)=0: DUM3(27)=0
4440 DUM3(36)=4*CATION(4): DUM3(28)=DUM3(28)-3*CATION(4)
4450 CATION(4)=0: GOTO 4690
4460 REM CONVERT KALSILITE [ DUM3(16) ] & NEPHELINE [ DUM3(18) ] & CA-SILICATE [ DUM3(27) ]
4461 REM & FORSTERITE [ DUM3(28) ] & TEPHROITE [ DUM3(29) ] TO
4470 REM ORTHOCLASE [ DUM3(33) ] & ALBITE { DUM3(34) ] & WOLASTONITE [ DUM3(35) ]
4471 REM & ENSTATITE [ DUM3(36) ] & RHODONITE [ DUM3(37) ]
4480 IF CATION(4) > ((DUM3(16)+DUM3(18))*.6667+(DUM3(27)+DUM3(28)+DUM3(29))/3) THEN 4530
4490 DUM3(33)=1.6667*DUM3(16): DUM3(34)=1.6667*DUM3(18): DUM3(16)=0:DUM3(18)=0
4500 DUM3(35)=1.3333*DUM3(27): DUM3(36)=1.3333*DUM3(28): DUM3(27)=0:DUM3(28)=0
4510 CATION(4)=CATION(4)-((DUM3(33)+DUM3(34))*.4+(DUM3(35)+DUM3(36))/4)
4520 DUM3(37)=4*CATION(4):DUM3(29)=DUM3(29)-3*CATION(4):CATION(4)=0:GOTO 4690
4530 IF CATION(4) > ((DUM3(16)+DUM3(18))*.6667+(DUM3(27)+DUM3(28)+DUM3(29)+DUM3(30))/3) THEN 462
4540 REM CONVERT KALSILITE DUM3(16), & NEPHELINE DUM3(18), & CA-SILICATE DUM3(27)
4541 REM & FORSTERITE DUM3(28), & TEPHROITE DUM3(29), & FAYALITE DUM3(30) TO
4550 REM ORTHOCLASE DUM3(33), & ALBITE DUM3(34), & WOLASTONITE DUM3(35),
4551 REM & ENSTAITE (DUM3(36), & RHODONITE DUM3(37), & FORSTERITE DUM3(38)
4560 DUM3(33)=1.6667*DUM3(16): DUM3(34)=1.6667*DUM3(18):DUM3(16)=0:DUM3(18)=0
4570 DUM3(35)=1.3333*DUM3(27):DUM3(36)=1.3333*DUM3(28):DUM3(37)=1.3333*DUM3(29)
4571 DUM3(27)=DUM3(28)=DUM3(29)=0
4580 CATION(4)=CATION(4)-((DUM3(33)+DUM3(34))*.4+(DUM3(35)+DUM3(36)+DUM3(37))/4)
4590 DUM3(38)=4*CATION(4):DUM3(30)=DUM3(30)-3*CATION(4)
4600 CATION(4)=0: GOTO 4690
4610 REM AS 3965 &3966 PLUS EXCESS CATION(4) AS DUM3(39) QUARTZ
4620 DUM3(33)=1.6667*DUM3(16): DUM3(34)=1.6667*DUM3(18): DUM3(16)=0: DUM3(18)=0
4630 DUM3(35)=1.3333*DUM3(27): DUM3(36)=1.3333*DUM3(28): DUM3(27)=0:DUM3(28)=0
4640 DUM3(37)=1.3333*DUM3(29): DUM3(38)=1.3333*DUM3(30):DUM3(29)=0:DUM3(30)=0
4650 CATION(4)=CATION(4)-((DUM3(33)+DUM3(34))*.4+(DUM3(35)+DUM3(36)+DUM3(37)+DUM3(38))/4)
4660 DUM3(39)=CATION(4)
4670 REM ************************************************************************
4680 REM**************************************************************************
4690 REM END OF MOLECULAR NORM    ***************************************
4700 REM CALCULATION OF WEIGHT NORM  ************************************
4710 REM ************************************************************************
4720 TOTAL4=0
4730 TOTAL5=0
4740 FOR I=1 TO 39
4750 DUM4(I)=DUM3(I)*FACT(I)
4760 TOTAL4=TOTAL4+DUM4(I)
4770 TOTAL5=TOTAL5 + DUM3(I)
4780 PRINT "TOTAL MOLECULAR NORM=  ";TOTAL5,  "TOTAL WEIGHT NORM =    ";TOTAL4
4790 NEXT I
4800 Y1=100/(TOTAL4)
4810 PRINT " (TOTAL WEIGHT NORM  =  ";TOTAL4
4820 Y2 = 100/(TOTAL5)
4830 PRINT " (TOTAL MOLEC NORM ) =  ";TOTAL5
4840 IF IG$ = "99" THEN 4900 ELSE
4850 LPRINT ""
4860 LPRINT ""
4870 LPRINT " (TOTAL WEIGHT NORM ) =   ";TOTAL4,   "(TOTAL MOLEC NORM ) =  ";TOTAL5
4880 LPRINT ""
4890 LPRINT ""
4900 REM PRINT MIN NORMS [ DUM3(I) ] & WEIGHT NORMS [ DUM4(I) ]
```

```
4910 FOR I = 1 TO 39
4920 PRINT "  ";MINERS$(I),"=";DUM3(I),"WEIGHT % = ";DUM4(I)
4930 IF IG$ ="99" THEN 4950 ELSE
4940 LPRINT "  ";MINERS$(I), "=";DUM3(I),"WEIGHT % = ";DUM4(I)
4950 NEXT I
4960 REM ***************************************************************
4970 REM PRINTOUT OF NORMS
4980 IF IG$="99" THEN 5100 ELSE
4990 LPRINT "COMPUTED NORMATIVE COMPOSITIONS FOR SAMPLE  ";ID$
5000 LPRINT "SAMPLE ";ID$
5010 LPRINT ""
5020 LPRINT "           MOLE -%", "    WEIGHT-%"
5030 FOR I= 1 TO 39
5040 IF DUM3(I)=0 THEN 5060
5050 LPRINT MINERS$(I);"     ";INT(100*DUM3(I)*Y2+.5)/100, INT(100*DUM4(I)*Y1+.5)/100
5060 NEXT I
5070 LPRINT ""
5080 LPRINT ""
5090 LPRINT ""
5100 REM SCREEN OUTPUT
5110 PRINT "COMPUTED NORMATIVE COMPOSITIONS FOR";
5120 PRINT "SAMPLE ";ID$
5130 PRINT ""
5140 PRINT       "MOLE-%";
5150 PRINT                            "WEIGHT-% "
5160 FOR I = 1 TO 39
5170 IF DUM3(I)=0 THEN 5190
5180 PRINT MINERS$(I);"     ";INT(100*DUM3(I)*Y2+.5)/100, INT(100*DUM4(I)*Y1+.5)/100
5190 NEXT I
5200 REM CONTINUE OR ABORT
5210 PRINT " DO YOU WISH TO CALCULATE MORE NORMS  ?  TYPE 'Y' OR 'NO'    ":INPUT RES$
5220 IF RES$ <> "Y" AND RES$ <> "NO" THEN 5210
5230 IF RES$ = "NO" THEN 5300 ELSE
5240 PRINT " DO YOU WISH TO CHANGE 'LPRINT' AND 'FE3+' CONDITIONS ? TYPE 'Y' OR 'NO' "
5241 INPUT CONS$
5250 IF CONS$ <> "Y" AND CONS$ <> "NO" THEN 5240
5270 ERASE OXIDE$,MOLEC.MINERS$,FACT,DUM1,OXIDE,CATION.DUM3.DUM4 : RESTORE
5280 IF CONS$ = "NO" THEN 390
5290  GOTO 100
5300 END
9000 REM ***************************************************************
9010 REM DATA STATEMENTS
9020 REM ***************************************************************
9030 DATA NaO, MgO,Al2O3,SiO2
9040 DATA P2O5,S,K2O,CaO,TiO2
9050 DATA MnO,FeO,Fe2O3
9060 DATA V2O5,Cr2O3,CoO,NiO,CuO
9070 DATA ZNO,AS,SNO,SBO,BAO,PBO
9080 DATA 30.99,40.32,50.97,60.09
9090 DATA 70.98,32.07,47.10,56.08,79.90
9100 DATA 70.94,71.85,79.85
9110 DATA 74.94,76.02,74.94,74.71,79.54
9120 DATA 81.38,74.92,134.70,121.75,153.36,223.21
9130 DATA APATITE AP,VIVIANITE VI,PHOSPHORUS P,ULVITE UV,RUTILE RU
9140 DATA COVELLITE CV,CUPRITE CU,SPHALERITE SP,PYRHOTITE PO,SULPHUR S
9150 DATA CASSITERITE CA,FE-ARSENIDE IA,ARSENIC AS,PB-SILICATE LS,CELSIANE CS
9160 DATA KALSILITE KS,K-SILICATE PS,NEPHELINE NE.ACMITE AC,NA-SILICATE
9170 DATA HEMATITE HM,MAGNETITE MT,ANORTHITE AN.HERCYNITE HC,MULLITE MU
9180 DATA CORUNDUM CO,CA-SILICATE CS,FORSTERITE FO,TEPHROITE TP.FAYALITE FA
9190 DATA GEHLENITE GE,WUSTITE WU,ORTHOCLASE OR.ALBITE AB,WOLLASTONITE WO
9200 DATA ENSTATITE EN,RHODONITE RH,FERROSILITE FS,QUARTZ Q
9210 DATA 61.66,71.50,30.97,74.53,79.90
9220 DATA 95.61,79.54,97.45,87.92,32.06
9230 DATA 134.70,130.77,74.92,168.84,57.42
9240 DATA 52.72,51.43,47.34,57.74,40.69
9250 DATA 79.84,77.18,55.63,57.93,53.25
9260 DATA 50.97,57.42,46.9,67.32,67.92
9270 DATA 54.83,71.85,55.65,52.43,58.07
9280 DATA 50.19,65.51,65.97,60.09
```

APPENDIX 3

COMPUTER PROGRAMMES FOR THE CONVERSION OF TERNARY CO-ORDINATES TO POLAR CO-ORDINATES AND THE DETERMINATION OF THE DISTANCE 'r'.

3.1 CONVERSION OF TERNARY CO-ORDINATES TO POLAR CO-ORDINATES

```
10 REM PROGRAMME TO CONVERT TERNARY PHASE DIAGRAMS TO POLAR CO-ORDINATES
20 REM USING 3 COMPONENTS A,B,C, (TERNARY), IT CONVERTS TO TWO COMPONENTS
30 REM ie.. X, Y, (POLAR)
40 PRINT ""
50 PRINT ""
60 PRINT "CONVERT TERNARY COORDINATES TO BINARY "
70 INPUT "DO TOU WISH TO CALCULATE ONE (1) OR MORE (2) COMPOSITIONS, TYPE '1' OR'2'.....";ONE$
80 IF ((ONE$<>"1") AND (ONE$<> "2")) THEN 70 ELSE
90 PRINT ""
100 INPUT "TO IGNORE 'LPRINT' STATEMENTS TYPE '99' IF NOT TYPE '100'";IG$
110 PRINT "NORMALLY  COMPONENT A = SiO2"
120 PRINT "                 ''    B = GLASS OR THIRD COMPONENT"
130 PRINT "                 ''    C = FeO"
140 PRINT ""
150 PRINT ""
160 REM ******************************************************************
170 REM INPUT DATA
180 REM ******************************************************************
190 INPUT "SAMPLE I.D.                ";ID$
200 PRINT ""
210 PRINT ""
220 REM TERNARY COMPONENT NAMES
230 INPUT "NAME OF MINERAL COMPONENT A =";A$
240 PRINT ""
250 INPUT "NAME OF MINERAL COMPONENT B =";B$
260 PRINT ""
270 INPUT "NAME OF MINERAL COMPONENT C =";C$
280 PRINT ""
290 PRINT "££££££££££££££££££££££££££££"
300 PRINT "INPUT DATA"
310 PRINT "£££££££££££££££££££££££££££"
320 PRINT ""
330 PRINT "PERCENTAGE OF COMPONENT   ";  A$,"=       ";
340 INPUT A
350 IF IG$="99" THEN 370 ELSE
360 LPRINT "PERCENTAGE OF COMPONENT ";A$."=       ";A
370 PRINT ""
380 PRINT "PERCENTAGE OF COMPONENT   ";  B$."=       ";
390 INPUT B
400 IF IG$ ="99" THEN 420 ELSE
410 LPRINT "PERCENTAGE OF COMPONENT";B$"=             ";B
420 PRINT ""
430 PRINT "PERCENTAGE OF COMPONENT   ";  C$,"=       ";
440 INPUT C
450 PRINT ""
460 PRINT ""
470 REM ***********************************************************
480 REM CALCULATION OF 'Y' CO-ORDINATE FROM B COMPONENT
490 REM ***********************************************************
500 X=Y=0
510 Y=INT(B*86.6025 +.5)/100
520 PRINT "        Y-COORDINATE    =     ";Y
530 IF IG$="99"THEN 570 ELSE
540 LPRINT "Y-COORD = 'B% * COS30'  =     ";Y
550 PRINT ""
560 REM ****************************************************************
570 REM CALCULATION OF X-COORDINATE
580 REM ****************************************************************
590 X=(C+Y/1.73205)
600 X=(INT(100*X+.5))/100
610 PRINT "        X-COORDINATE    =     ";X
620 IF IG$="99" THEN 640 ELSE
630 LPRINT "X-COORD  =    ";X
640 PRINT ""
650 PRINT "*********************************************************"
660 IF ONE$="1" THEN 1000 ELSE
670 PRINT ""
680 REM TO KEEP OR CHANGE COMPONENTS
690 INPUT "DO YOU WISH TO CHANGE COMPONENTS. IE SIO2. GLAS/ANORTHITE ETC.. TYPE 'Y' OR 'N'";CHAN$
700 IF ((CHAN$<>"Y") AND (CHAN$<>"N")) THEN 690 ELSE
710 IF CHAN$="Y" THEN 190 ELSE
720 INPUT "SAMPLE I.D.              ";ID$
730 GOTO 330
1000 PRINT "THANK YOU
1010 END
```

3.2 DETERMINATION OF THE DISTANCE (r) BETWEEN TWO POLAR COORDINATES

```
10 REM DETERMINATION OF 'r' THE DISTANCE BETWEEN TWO POLAR COMPONENTS
20 REM ************************************************************
30 REM INPUT SAMPLE I.D., X, AND Y COORDINATES
40 I=1:J=2
50 REM SAMPLE 1
60 PRINT "INPUT SAMPLE (" I")"
70 INPUT "SAMPLE I.D.  ";IDA$: INPUT "X-COORD  = ";X1:INPUT "Y-COORD = ";Y1
80 REM IMPUT SAMPLE 2
90 PRINT "INPUT SAMPLE ("J")"
100 INPUT "SAMPLE no.2 I.D.  ";IDB$:INPUT "X2-COORD = ";X2: INPUT "Y2-COORD = ";Y2
110 REM DISTANCE r=SQ RT [ (X2-X1)**2 + (Y2-Y1)**2 ]
120 R=SQR((X2-X1)↑2 + (Y2-Y1)↑2)
130 R=(INT(100*R+.5))/100
140 PRINT "r-VALUE FOR SAMPLES   "; IDA$ ; " AND  ";IDB$;"  =  ";R
150 I=I+2 :J=J+2
160 PRINT ""
170 PRINT ""
180 GOTO 60
```

APPENDIX 4

STATISTICAL ANALYTICAL METHODS:

CLUSTAN AND DISCRIMINANT ANALYSIS.

1 Discriminant Analysis

The theoretical and mathematical basis of discriminant analysis is explained in the literature, (e.g. Cooley and Lohnes[103]). It has been applied to many archaeological problems, particularily provenancing, and was used with some success by Fells [9 p150-157] to discriminate ores and slags from different geographical areas.

The method used in this work was the Statistical Package for Social Sciences, (SPSS) as implemented at the Bradford University Computer Centre. All the analysed oxides were entered and the analysis was ascribed to either smelting or smithing. The discriminant analysis was used to examine any difference between the two groups. To test the 'realness' of any differences between the two groups the Wilks' Lambda criterion was used.

The method was also used to determine which oxides had been used to control the clustering in the Clustan Analysis.

2 Clustan Analysis

Clustan Analysis is a means to obtain independant groupings within a set of data (Wishart[102]). The use of discriminant analysis requires the data to be ascribed to a number of groups by the operator before analysis is undertaken. Clustan Analysis removes this requirement. In this study each bulk (or phase) analysis comprised of 15 values, (oxides Na_2O - NiO), the descrepency between the values of the major oxide (e.g. SiO_2, FeO) and the minor oxides (e.g. NiO) was accommodated by implementing the standardisation routine. Clustan can most easily be understood in abstract terms. The method placed each analysis in 15 dimensional space and grouped the closests pairs of data. The grouping procedure continued until two groups remained. Ward's Criteria was used to test the distribution within each group. The difficulty with this method is that once two sets of data (i.e. two 15 dimensional data points) have been paired they remain paired, even though a single member of a paired grouping may be closer to the resultant of a subsequent pair. Therefore the operation 'Relocate" was implemented which enabled intial paired groupings to be broken up and re-asigned.

Cluster analysis was applied to obtain groupings of the slag compositions. To be fully successful the final two groupings would have corresponded to the smelting and smithing groups which were obtained from other data.