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SLAG ANALYSIS REPORT

Three samples were selected for analysis to determine whether they derived from the smelting or smithing process.

Sample BNB28

Sample BNB28 had a flowed morphology. The mineral texture was silicate in lath and massive form, and rounded iron oxide dendrites in a glassy matrix. The mean volumetric phase percentages of six readings are given in Table 1.

TABLE 1 Mean Volumetric Phase Analyses of Sample BNB28

Silicate	51%
Glass	20%
Iron Oxide	29%

The bulk chemical analyses (Table 2) were typical of fayalitic smithing and smelting slags, but were characterised by high phosphorus pentoxide contents, and low potassium oxide percentages. The manganese oxide content was at the minimum detectable level. The phase analyses (Table 2) show the silicate to have been fayalite with a very low content of other oxides present. The glass phase analysis was a poor result (total = 85.7%), but shows the expected concentration of oxides in the glass phase notably the phosphorus pentoxide. The elemental iron percentage of the iron oxide phase was 74.1%, which indicates

that it was magnetite.

Conclusion

The flowed morphology of the specimen is usually associated with smelting slags, but smithing slags may become 'flowed' if subjected to sufficient heating. The mineral texture is not diagnostic of either smelting or smithing slags. The high phosphorus pentoxide levels present in the analyses, and the low total percentage of oxides other than silica and iron oxide is associated with smithing slags.

The absence of smelting slag characteristics, and the evidence of the analyses indicate that the slag derived from the smithing process.

TABLE 2 Bulk and Phase Analyses of Sample BNB28

(Weight Percent Oxide, Fe as FeO)

	B1	B2	B3	SIL	GLASS	FE0X
Na	0.2	0.2	0.2	0.2	1.2	N.D
Mg	0.2	N.D	0.2	0.1	N.D	0.3
Al	3.6	2.7	2.1	0.1	19.6	0.7
Si	23.0	20.9	23.6	29.0	19.1	0.8
P	2.9	2.4	2.7	0.3	13.8	N.D
S	0.2	0.2	0.2	N.D	0.4	N.D
K	0.4	0.7	0.5	N.D	0.8	0.1
Ca	2.3	2.0	1.9	0.4	7.1	0.2
Ti	N.D	0.1	0.1	0.1	0.1	0.1
V	N.D	N.D	N.D	0.1	0.1	N.D
Cr	N.D	N.D	N.D	N.D	N.D	N.D
Mn	N.D	0.1	0.1	0.1	N.D	N.D
Fe	63.7	69.3	67.3	68.6	23.2	95.3
Co	0.2	0.5	0.4	N.D	0.3	0.5
Ni	0.5	0.2	0.2	0.3	N.D	0.2
Total	97.3	99.3	99.5	99.3	85.7	98.2

SAMPLE BNB30

Sample BNB30 had a similar morphology and mineral texture to Sample BNB28. The volumetric phase analysis showed a higher percentage of silicate present (Table 3).

Table 3 Mean Volumetric Phase Percentage of Sample BNB30

Silicate	80%
Glass	14%
Iron Oxide	6%

The bulk and phase analyses (Table 4) were similar to those from BNB28. They were high in phosphorus pentoxide, but it did not concentrate in the glass analysis shown. The lime, potassium oxide, and manganese oxide contents were slightly higher than those measured in BNB28. The silicate was fayalite with very low percentages of other oxides present. The glass was high in alumina and potassium oxide, but low in lime. The iron oxide was probably magnetite; the elemental iron percentage was 72.5%, and the titania was slightly high, although there was a generally high level of minor oxides present, e.g. silica = 0.9%.

Conclusion

The slag probably derived from the smithing process for the same reasons as BNB28.

TABLE 4 Bulk and Phase Analyses of Sample BNB30

(Weight Percent Oxide, Fe as FeO)

	B1	B2	B3	SIL	GLASS	FE0X
Na	0.8	0.1	0.5	0.3	0.4	N.D
Mg	0.1	N.D	0.2	N.D	N.D	0.2
Al	1.9	2.2	2.5	N.D	14.5	0.4
Si	29.6	29.2	28.2	29.9	41.7	0.9
P	1.5	1.1	1.5	0.3	0.9	0.2
S	N.D	N.D	0.2	N.D	0.2	N.D
K	0.7	1.0	1.0	N.D	11.1	0.1
Ca	2.8	2.5	3.0	0.9	1.7	N.D
Ti	N.D	N.D	0.1	0.1	0.1	0.4
V	N.D	0.1	N.D	N.D	0.1	0.2
Cr	N.D	0.2	N.D	N.D	0.1	0.1
Mn	0.4	0.3	0.3	0.4	N.D	0.2
Fe	61.6	62.4	61.3	68.5	25.7	93.3
Co	0.2	0.1	0.3	0.1	0.1	0.4
Ni	0.1	0.2	0.2	0.2	0.1	0.4
Total	99.7	99.4	99.3	100.7	96.7	96.7

Sample BNB33

Sample BNB33 was a fine grained slag, and had a similar mineral texture to the previous examples; the volumetric phase percentage is shown in Table 5.

Table 5 Mean Volumetric Phase Analysis of Sample BNB33

Silicate	50%
Glass	17%
Iron Oxide	33%

The bulk and phase analyses (Table 6) were generally similar to the previous examples, but showed considerable variation in some of the oxide percentages, e.g. the phosphorus pentoxide content varied between 0.5 - 3.5%. The silicate was fayalite with very low percentage of other oxides present. The iron oxide was probably magnetite (elemental iron = 74.0%), but contained low percentages of other oxides. The glass phase contained a high phosphorus pentoxide content, and equal quantities of lime and potassium oxides.

Conclusion

The slag had a different morphology from the previous examples, but had overall similar bulk and phase analyses. It can therefore be ascribed to the smithing process.

TABLE 6 Bulk and Phase Analyses of Sample BNB33

(Weight Percent Oxide, Fe as FeO)

	B1	B2	B3	SIL	GLASS	FEOX
Na	0.4	0.1	0.4	0.1	0.3	N.D
Mg	N.D	0.2	0.2	0.4	N.D	0.3
Al	1.5	0.9	4.4	N.D	16.4	0.3
Si	25.8	19.3	20.6	29.7	38.2	0.9
P	1.1	0.5	3.5	N.D	8.2	N.D
S	N.D	N.D	0.2	N.D	0.4	N.D
K	0.6	0.2	1.0	N.D	12.7	0.1
Ca	2.6	1.4	4.8	0.9	12.2	0.1
Ti	0.1	N.D	N.D	N.D	0.5	0.1
V	N.D	0.1	N.D	N.D	N.D	0.1
Cr	N.D	0.2	0.1	N.D	N.D	N.D
Mn	0.7	0.3	0.2	0.7	N.D	0.3
Fe	68.3	76.1	67.0	67.5	7.0	95.2
Co	0.3	0.3	N.D	0.5	0.1	0.5
Ni	0.2	0.1	N.D	0.4	N.D	0.4
Total	101.6	99.7	102.4	100.2	96.0	98.2

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