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BOLE HILL, SHELDON : EVIDENCE OF IRONMAKING

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ABSTRACT: A small quantity of material containing 58.4% by mass of iron, and intimately mixed with charcoal, has been found on Bole Hill, Sheldon, Derbyshire. Evidence indicates that it s an iron slag, and that it may date from the iron age period.

INTRODUCTION

In a paper entitled 'Derbyshire Lead Smelting in the Eighteenth and Nineteenth Centuries' (Willies 1990), reference was made to the discovery by the present author, at Bole Hill, Sheldon (SK 182676), of slag apparently derived from an early iron-making process. This paper provides some information about the material and its discovery, and draws a tentative conclusion about its origin.

In Derbyshire, sites known as bole hills are usually places where primitive lead-smelting processes were carried out, from medieval times up to the latter part of the 16th century. Evidence of lead smelting at bole hill sites is usually easy to find. Vegetation is often sparse, or completely absent, due to contamination of soil by lead and other phytotoxic heavy metals. Slag is usually found without difficulty, and is often abundant. Where gritstone has been used in furnace construction, pieces of the rock characteristically reddened and crumbling as a result of exposure to furnace temperatures may be found.

In the course of a preliminary survey of bole hill sites in Derbyshire, the author visited Bole Hill, Sheldon, near Bakewell. The hill stands 356 m above sea level, and a small copse lies just to the west of the highest point. Magpie Mine lies 1.3 km to the north west, and the area contains many disused lead mine shafts. The Ordnance Survey map (1:10000, sheet SKl6 NE) shows the positions of two disused shafts within the copse.

Because of the hill's name and location, it was reasonable to expect evidence of lead smelting activity to be found. However, this was not the case: no samples of slag derived from lead smelting have been found on Bole Hill, despite searches which were both extensive and intensive. The land surrounding the copse is used for grazing, and shows no obvious signs of heavy metal pollution. Entirely within the copse, there is evidence that small-scale open-cast mineral excavation has taken place in recent years, but has now ceased. Low banks of soil surround this area, and the discovery of iron slag was made in a very localised part of the soil bank, on the western slope of the hill, The amount of exposed material was small, and comprised a few irregular lumps, up to about 50 cm in diameter, together with some smaller pieces. The location of the material suggested that it had been buried at a depth of less than 1 m, and uncovered by excavator during the removal of topsoil. Samples were taken for examination and chemical analysis.

EXAMINATION AND CHEMICAL ANALYSIS

The material comprises a highly vesicular, barely competent mass, of reddish brown colour. A black component forms helicitic trails throughout the mass, which is very soft.

Examination of the black component, by low power stereomicroscopy, reveals the presence of occasional small elongated particles possessing a fibrous texture reminiscent of wood grain. Ignition at 800" C in air for 24 hours results in the loss of all of the black component, and it is therefore almost certainly charcoal.

It is interesting to compare the iron contents of the Bole Hill material, and iron age slag dated 24-25 AD, discovered at Maiden Castle, Dorset. (Wheeler 1943). The percentage by mass of iron in the Maiden Castle slag was found to be 57.2, indicating a very low efficiency of iron extraction. The corresponding percentage of iron in the Bole Hill material is 58.4.

Tylecote (1976) quotes chemical analyses for six early iron age slags (various dates from 700 BC to 25 AD). Their iron contents by mass range from 50.2 to 57.5%, with a mean of 53.5%. In contrast, the same author quotes analyses for ten iron age slags from the Roman iron age (various dates from 50 AD to 400 AD). Only four of the ten samples had iron contents greater than 50%, with three samples containing less than 40%. A tentative deduction from these data is that the efficiency of iron extraction may have been greater, on average, during the Roman iron age period. Tylecote (1976) comments on the technological improvements to furnaces, made during this period.

The calcium silicon, magnesium and aluminium contents of the Bole Hill slag were found to be equivalent to 0.22% CaO; 4.4% SiO_2; 0.30% MgO and 0.42% Al_2O_3, by mass. The corresponding data for the Maiden Castle iron slag (dated AD 24-5) are 2.75% CaO; 15.95% SiO_2; 0.45% MgO and 1.47% Al_2O_3.

AVAILABLE SOURCES OF IRON ORE

Limonite (mixtures of hydrated iron oxides and iron hydroxides) may have been present in small quantities on Bole Hill itself. However, it was certainly present in Lathkill Dale, where one source, Gank Hole Vein, is only 1.8 km to the south of Bole Hill.

NOTES ON EARLY IRON PRODUCTION

The melting point of iron, 1539° C, was generally not

the ground, with some means by which air could be blown into them by bellows, and probably having a low dome "shaped structure above". Pieces of ore and charcoal were mixed, or layered, on a hot charcoal fire bed. These furnaces had no slag outlet, and the slag collected at the bottom. The iron was produced as a 'bloom', which also contained slag and unburnt charcoal.

The Roman iron age was marked by a significant increase in scale of production, probably arising from the development of improved furnaces and techniques. On pre-Roman sites, iron slag may be present in amounts rising from a few kilograms to a few hundreds of kilograms. In contrast, at Roman iron-smelting sites, slag heaps amounting to hundreds of tonnes are usual (Tylecote 1976).

DISCUSSION AND CONCLUSIONS

A small quantity of iron slag containing charcoal, has been discovered at Bole Hill, Sheldon. Examination and chemical analysis, in the light of analyses of early iron slags, suggests that the material may date from the iron age (about 500 BC to 400 AD in northwest Europe). The relatively small quantity of material, found in an area contained within a circle of radius 5 m maximum, together with its iron content of 58.4 per cent by mass, may suggest a pre-Roman date, although this is purely speculative.

Since opencast mineral extraction has taken place on Bole Hill in recent times, and iron slags of modern origin have often been imported to such workings to make roadways, the possibility that the material found on Bole Hill might be such a slag must be considered. Evidence which suggests that the slag is not of modern origin, and was not imported to the site, may be summarised as follows :

1. The slag was found only in one very small area of Bole Hill, despite a thorough search, and none was to be found on the roadway.

2. Only a small quantity of material was found. It was in the form of a few lumps, about 30 to 50 cm in diameter, with up to 20 smaller pieces of diameter up to, say, 15 cm, many of which were close to, and could have been broken from, the larger lumps. Material brought in for road-making would, of course, have occurred in much smaller pieces.

3. The slag has a very much higher iron content than would be expected of a modern iron slag: 58.4% by mass, equivalent to 83.5% Fe_20_3. The iron content of a modern slag would be, typically, less than 1 %.

4. The slag has very much lower contents of calcium, silicon, magnesium and aluminium than would be expected of a modern iron slag, formed using limestone. For example, an iron slag produced in a blast furnace might contain, typically, 34% CaO; 34% SiO_2; 7% MgO and 23% Al_2O_3, whilst the corresponding values for the Bole Hill slag are 0.22% CaO; 4.4% SiO_2; 0.30% MgO, and 0.42% Al_2O_3.

5. The slag has unburnt carbon mingled with it, which is visible to the unaided eye. This would not be expected of a modern iron slag. Also, microscopical examination indicates that the carbon is present as charcoal and not coke.

6. The slag is soft, crumbles easily, and would be a poor material for road-making . These characteristics are not typical of iron slags of recent origin.

An accurate radiocarbon date for the charcoal in the slag would provide conclusive evidence for its age. However, it is not yet clear whether sufficient carbon can be extracted from the available slag to enable an accurate date to be obtained.

No evidence for the smelting of lead has been found on Bole Hill, although it cannot of course be claimed that no such process has ever been carried out there. Soil analysis would help to resolve this issue.

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