A Collection of Industrial Waste and Associated Material From Pistiros (Vetren), Bulgaria.

Introduction

This short note describes a collection of industrial waste and associated material from the Emporion Pistiros, Vetren, Bulgaria. The site is believed to have been occupied between the 5th and 3rd centuries BC. and would have represented a major trading settlement on the banks of the modern River Maritsa.

The material discussed in this report is largely unstratified and was initially examined by McDonnell (1992). Where finds have been marked the nature of the context is uncertain. Although this places quite severe limitations upon the conclusions, it is hoped that stratified material from known contexts will be available in future.

Description of the Material

McDonnell (1992) briefly described the main types of material present. Most of the material consists of broken fragments of slag, probably from iron smelting or smithing, many of the fragments were magnetic indicating the presence of metallic iron. Some pieces could be positively identified as *Smithing Hearth Bottoms*, i.e. plano-convex cakes of slag which had accumulated at the base of small bowl hearths of the type commonly associated with the smithing of small iron artefacts (Figure 1). In at least one instance the slag exhibited green corrosion products of copper suggesting that the hearth had been used for two metals (copper and iron). Other fragments exhibited the characteristic fine grained 'ropy' structure of tap slag, possibly derived from a tapping furnace used for iron smelting. However, much of the material consisted of non-diagnostic broken fragments of slag.

Figure 1. Sketch section of a bowl hearth (After Tylecote, 1986)

The material also includes small copper objects, fragments of iron and small strips of lead, few of these could be identified with any degree of confidence, much of the iron work is very heavily corroded .

Examination by Scanning Electron Microscopy

A small sample of the above material has been examined in the National Museums and Galleries on Merseyside, Conservation Centre Scanning Electron Microscope (SEM); an R J Lee PSM-75 with analytical facilities provided by Energy Dispersive Analysis of X-rays (EDAX). Where possible small samples were removed from the object and mounted onto an aluminium stud. In some cases the whole object could be placed inside the chamber of the microscope.

None of the samples were cleaned prior to examination, consequently all of the analyses of metals are of corroded surfaces. The analyses of samples of industrial waste may include contamination with soil particles. All of the samples were conducting and did not require treatment prior to examination

Sample 1

This was a small sample removed from an amorphous fragment of fine grained, slightly vesicular slag. The surface was heavily stained by green corrosion products, freshly broken surfaces were also stained red, characteristic of copper oxide. EDAX analysis (Figure 2) of the surface demonstrated the presence of silicon, calcium, aluminium, tin, copper and iron. The first three probably derive from the soil, the presence of copper and tin confirm that this material derives from the working of tin bronze.

Figure 2. SEM micrograph and EDAX analysis of sample 1.

Sample 2

This was a bent fragment of copper pin, ca. 50mm long, with a square section ca. 4mm across. The surface is covered with a fine green patina. The whole object was examined in the SEM. Artefacts of this type often reflect aspects of the underlying metallography in their corrosion products, this can be used as an aid to understanding the processes used to produce the artefact (Adams, 1994). Unfortunately no such traces could be seen on the surface of this object so the method of manufacture needs to be determined by conventional metallography. EDAX analysis (Figure 2.) of the surface showed the presence of copper, tin and possibly lead. The presence of lead is of particular interest as it was probably added to improve the casting and working properties of the alloy.

Figure 3. SEM micrograph and EDAX analysis of sample 2.

Sample 3

This was a 30mm long strip of lead, 2mm thick and 10mm wide. No elements other than lead were detected.

Sample 4

A small fragment removed from an un-contexted plano-convex hearth bottom was examined. This contained substantial amounts of silicon and iron typical of fayalitic slag.

Conclusions

The samples described above demonstrate that iron smithing and possibly smelting were taking place at Pistiros/Vetren. In addition small copper and bronze objects were also manufactured. The addition of lead to at least some of the tin bronzes demonstrates a significant degree of metallurgical understanding. At present it is impossible state whether these activities were taking place at the same time or in the same place.

Recommendations for Further Work

Although the conclusions discussed above are rather limited, they show a considerable degree of promise for future work.

1. A detailed analysis of the industrial waste by context is required. At the time of writing it is unclear whether or not the iron smelting, smithing, lead and copper working were taking place contemporaneously or at different times. In addition, were different areas of the site used for different metallurgical processes or were they all concentrated in one area of the settlement? The presence of at least one hearth bottom which appears to have been used for copper and iron metallurgy indicates that the same artisans may have produced ferrous and non-ferrous objects. This has major implications for the degree to which these crafts were specialised.

Plots of the type illustrated in Figure 4 can be a very useful tool for interpreting material of this type.

Figure 4. Typical plot of industrial waste distribution by phase.

2. The presence of leaded tin bronze indicates a considerable degree of specialist skill. Further analysis of the copper slags may reveal whether this material was produced on site and shed light on the methods used to produce the alloy. Analysis of the lead wasters may indicate whether it was this material which was added to the bronze, or if the leaded bronzes were imported from elsewhere.

3. Selected residues from wet sieving should scanned for small scale smithing debris (e.g. hammer scale) using a magnet. This may enable areas where iron smithing was taking place to be more closely identified.

4. Samples of slag should be prepared for X-ray diffraction analysis. The mineralogical composition will give an indication of furnace operating temperatures

Bibliography

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