A Unique Bimetallic Antiquity from the Early Historic site of Iswal, Rajasthan, India

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Abstract

Heritage of the antiquity is a way to understand the material culture related to man, it gives knowledge about the technology, behaviour, religious and art are followed by generation through generation. This research is to understand the unique bimetallic antiquity heritage from India, especially the Southeast part of Rajasthan. The unique bimetallic antiquity discovered during our excavation at the Early Historic site of Iswal (Tehnsil Girva, Udaipur district, Rajasthan), 20 km north-west of Udaipur city, Rajasthan. Over five seasons of excavation at this site led to the discovery of important evidence on iron smelting, including the remains of six smelting and forging furnaces. This bi-metallic antiquity is rare in the Indian context for this time period and thus raises many questions on aspects of technology and function. The study brings out the technology and scientific analysis of the object and brings out the knowledge of metal technology form Iswal.

Keywords: Bimetallic, Antiquity, Rajistan, Metal Technology, Iswal

Introduction

This note describes an unusual antiquity discovered during our excavation at the Early Historic site of Iswal (Tehnsil Girva, Udaipur district, Rajasthan), 20 m north-west of Udaipur city (Figure 1). Over five seasons of excavation at this site, led to the discovery of important evidence on iron smelting, including the remains of six smelting and forging furnaces. This is currently the earliest evidence of iron smelting in Southern Rajasthan. Structural remains, pottery and antiquities like glass bangles, a few copper and terracotta antiquities were also found. The antiquity discusses here, was excavated from trench number HC, Layer III, at a depth of 9.05 m, during the 2003-04 season. It comprises a flag-like object which has an iron blade on the top with the handle made of copper (Figure 2).

This bi-metallic antiquity is rare in the Indian context for this time period and thus raises many questions on aspects of technology and function. It is 131.05 mm in length and 58.68 mm in breadth with a thickness of 5.8 mm. It is the sole bi-metallic antiquities at this site. The base and handle are made of copper-zinc alloy which was made by the *Lost-Wax* or *Cire Perdue* method; the top of handle is divided into two sections, into which an iron blade was inserted. The handle is highly polished and its base displays artistic work.

Significance of Metallurgical Studies

The scientific result of sample # 33, figure a present an interesting object consisting of an iron blade attached to the cylindrical handle made of a brass alloy. Figure b, an optical micrograph showing the structure observed in the blade, shows cementite precipitated in the form of ribbons along the former austenite grain boundaries. The bright indentation marks in the Figure b correspond to the Vickers hardness of approximately 760, indicating that the phase filling the dark background is martensite. Figure c, a SEM micrograph enlarging the area surrounding the arrow in figure b, reveals a number of tiny cementite particles scattered over the martensitic matrix. This suggests that the specimen was tempered followed by rapid cooling that had induced the martensite phase transformation. The carbon level of this specimen is above the eutectoid, i.e., 0.77% and may be around 1 %. It is important to note that the structure is clean and almost free of any slag inclusions. Figure c, an EDS spectrum taken from the entire area shown in figure c, shows the presence of silicon, the concentration of which, as inferred from the spectrum, is approximately 0.3%. Figure e, an EDS spectrum from the dark spot at arrow 2 in Figure c, shows chemical information frequently observed in a constituent of slag termed fayalite (Fe_2SiO_4). The blade of the object in Figure a is distinctly distinguished from the other objects examined in terms of its high carbon content, the presence of silicon as an alloying element, the structure almost free of non-metallic inclusion and the quench treatment applied for hardening. Figure a present the same object as in Figure a. Figure b, an optical micrograph showing the structure observed in the specimen taken from the handle, consists of the α grain boundaries. This particular structure, occurring in solidification, shows no evidence of mechanical working applied, indication that the object was fabricated exclusively by casting. The phase present at the boundary region are better identified in Figure c, an optical micrograph magnifying themare marked by the arrow in figure b. The small dark areas spread in Figure b and c represent particles of almost pure lead (Pb), which appear as bright spots in figure d, a SEM micrograph covering approximately the same area shown in figure b. figure e and f, SEM micrograph enlarging the area around the arrow in Figure d, demonstrate that there are five different constituents in the structure as marked by arrow 1-5 in Figure f. Figure a present an EDS spectrum from the entire area shown in Figure b and Figure b-14f the spectra from arrow 1-5 in Figure 13f, respectively. The average composition as inferred from Figure 14a is 61.5% Cu-33% Zn-2.0% Pb-1.5% Sn-1.5% As-0.5% Fe. The chemical compositions at arrow 1 and 2 are inferred from Figure b and 8c to be 35.5% Zn-1.0% Sn and 43.0% Zn-2.0% Sn, indicating that the phases at arrow 1 and 2 correspond to the α and β phase of the brass alloys respectively. The chemistry inferred from Figure d and e shows that tin (Sn) is enriched at arrow 3 while the phase at arrow 4 is a special material speiss, i.e, iron arsenide. It is evident that the phase at arrow 3 was precipitated near the end of the solidification reaction when the tin level in the remaining liquid becomes high due to segregation. It is not clear, however, whether the speiss particle at arrow 4 was precipitated during solidification or maintained the solid state after it had been added to the molten alloy. Figure f shows that the bright region at arrow 5 is lead particle (Figure 3, 4 & 5).

The iron blade is distinct from other antiquities in term of its high carbon context, the presence of silicon as an alloy element, the structure being almost free of non-metallic inclusion and use of the quench treatment applied for hardening. The object was fabricated almost exclusively by casting.

Possible Function of the Antiquity

In order to ascertain the use of this object, we surveyed ethnographic literature and looked for analogies in traditional communities. In Rajasthan, similar tools are currently used as goads for camels. Similar object are used in Kerala to goad and control elephant (http://keralaeditor.com/elepants-ill-treated-in-kerala/). In India, the *ankush* or elephant-goad has a long documented history with many varieties being noted, and being depicted in ancient sculpture and painting (James 2002: 42). This has a wooden or metal handle; with a point and a sharp hook. Both the hook and wooden handle are used for poking or hitting the animal respectively. The antiquity described here, differs from these goads, in the sense that it does not end in a hook but with a sharp flat blade. We suggest that it was possibly used as a camel goad, although this is subject to further studies.

At Iswal, other iron antiquities includes arrow-head, spear-head, knives, nail, ring, blade sheet, chisel, double-side chisel, hook, adze, iron-ball, door-handle, musical fragment and clamp fragments. The technology used to make these includes hammering and casting of iron. With above mentioned unique bimetallic antiquity clearly shows that the iron smith at Iswal knew the use of different metals and even tried to combine the same in a skilled manner.

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References

JAMES, G.L. 2002. The Illustrated Encyclopaedia of Hinduism, Volume 1. New York: The Rosen Publishing Group, Inc.

PANDEY, L., V.S.SHINDE, J.S. KHARAKWAL, H. CHAUDHARY, L.C. PATEL & S.C. CHAIN. 2005. A Preliminary Report on Excavation at Iswal 2003-04. Sodh Patrika 56: 58-64.

UDAYAKUMAR, S. 2016. A study of Iron technology of Early Historical and medieval Phase of Iswal and Nathara-Ki-Pal, Southeast Rajasthan. Unpublished PhD dissertation, Deccan College post Graduate Research Institute.

http://keralaeditor.com/elepants-ill-treated-in-kerala/

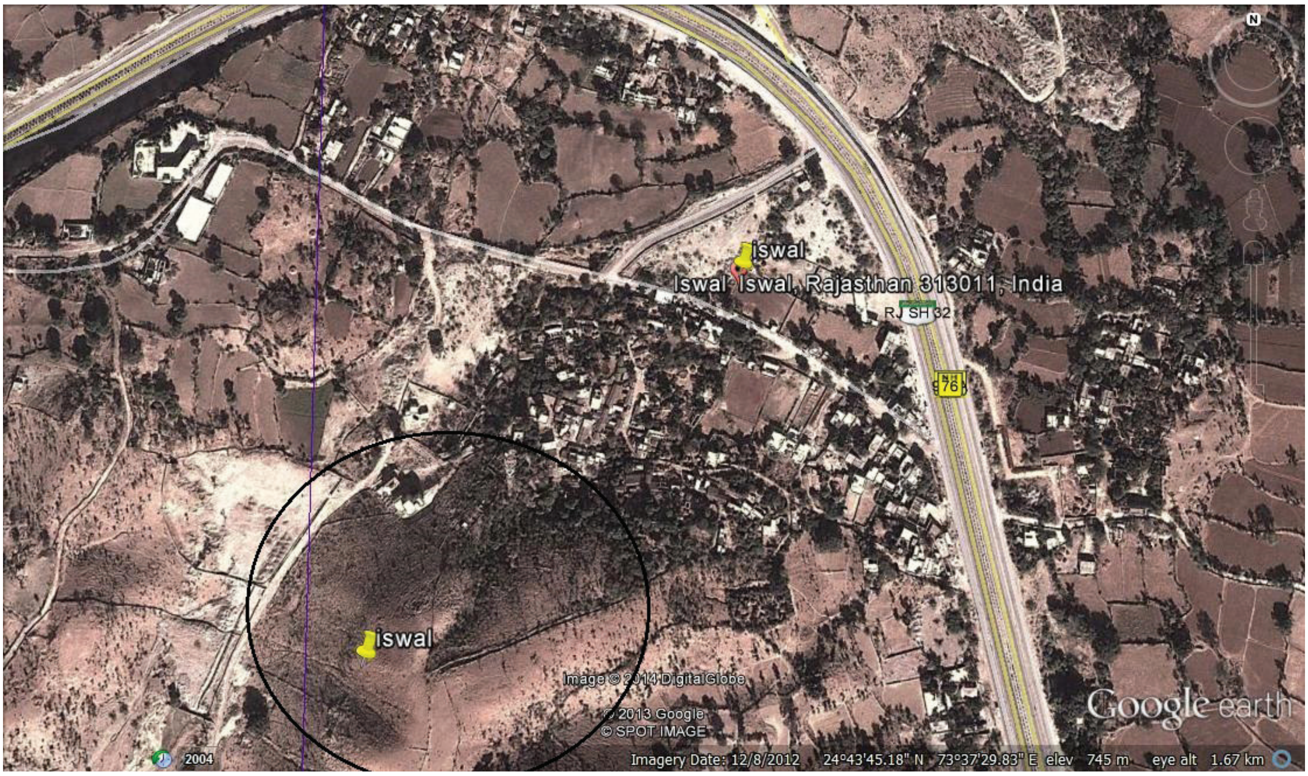

Figure 1. Site Iswal, Udaipur, Rajasthan

Figure 2. Bimetallic Antiquity, Iswal

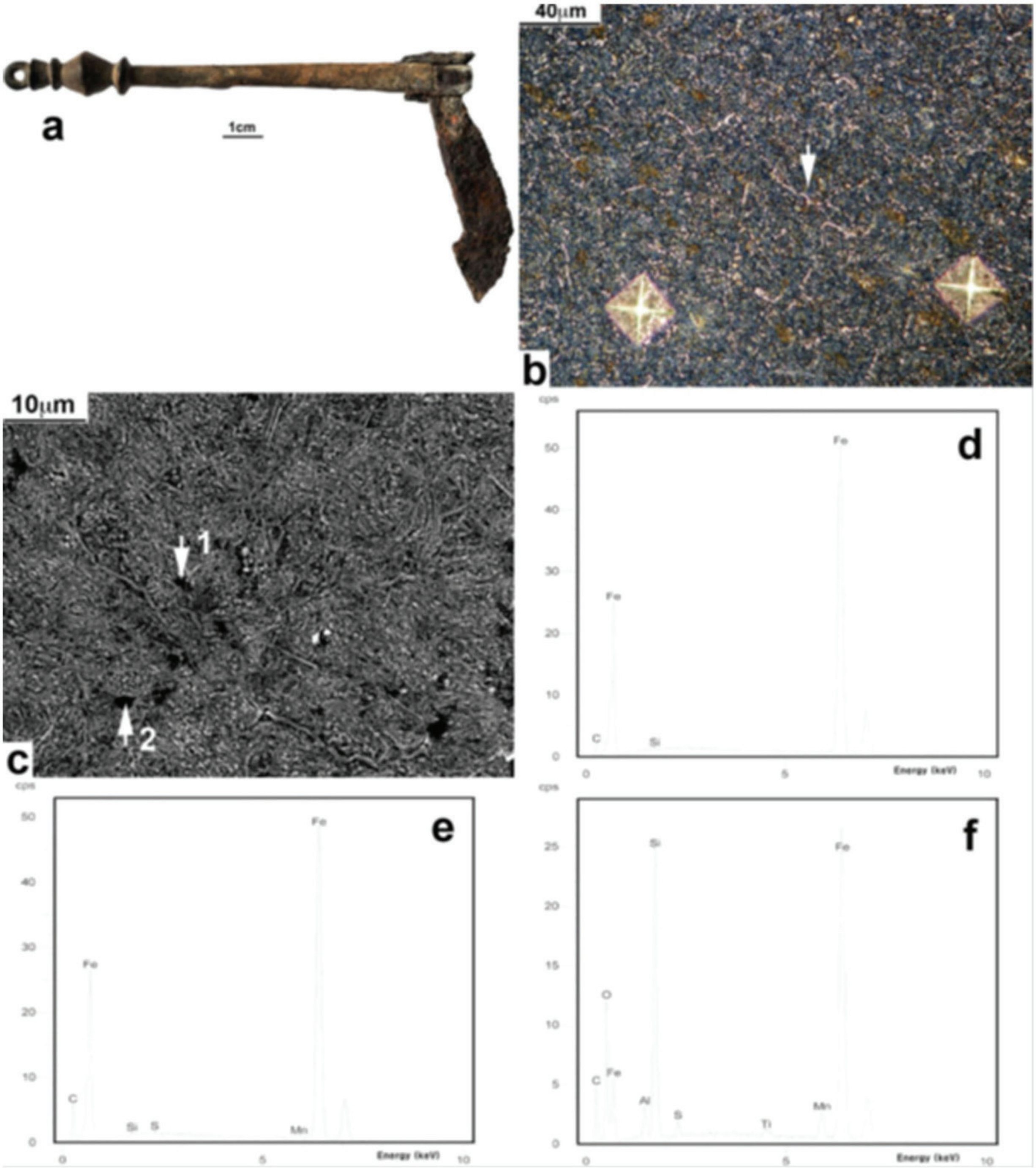

Figure 3. a. Appearance of the object, b. optical micrograph showing the structure of the speciemen from the iron blade in a; c. SEM micrograph magnifying the area near the arrow in b; d. EDS spectrum taken from entire area shown in c; e, f. EDS spectrum taken from arrow 1 and 2 in d, respectively.

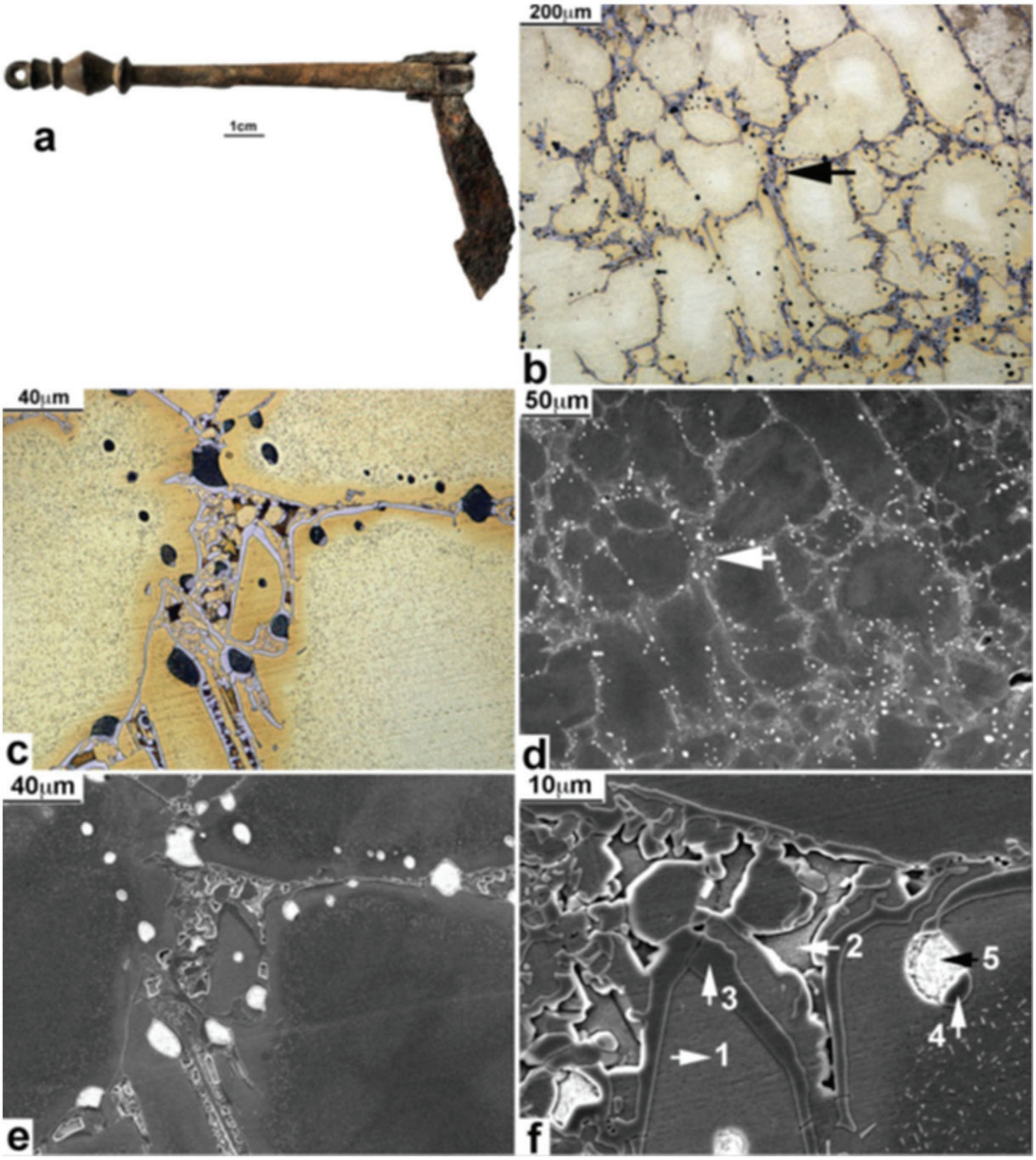

Figure 4. a. Appearance of the object; b. optical micrograph showing the structure of the Specimen from the brass handle in a; c. optical micrograph magnifying the area near the arrow in b; d. SEM micrograph covering approximately the same area shown in b, the arrow in both a and d locating the same spot; e.f-SEM micrograph enlarging the area near arrow in d.

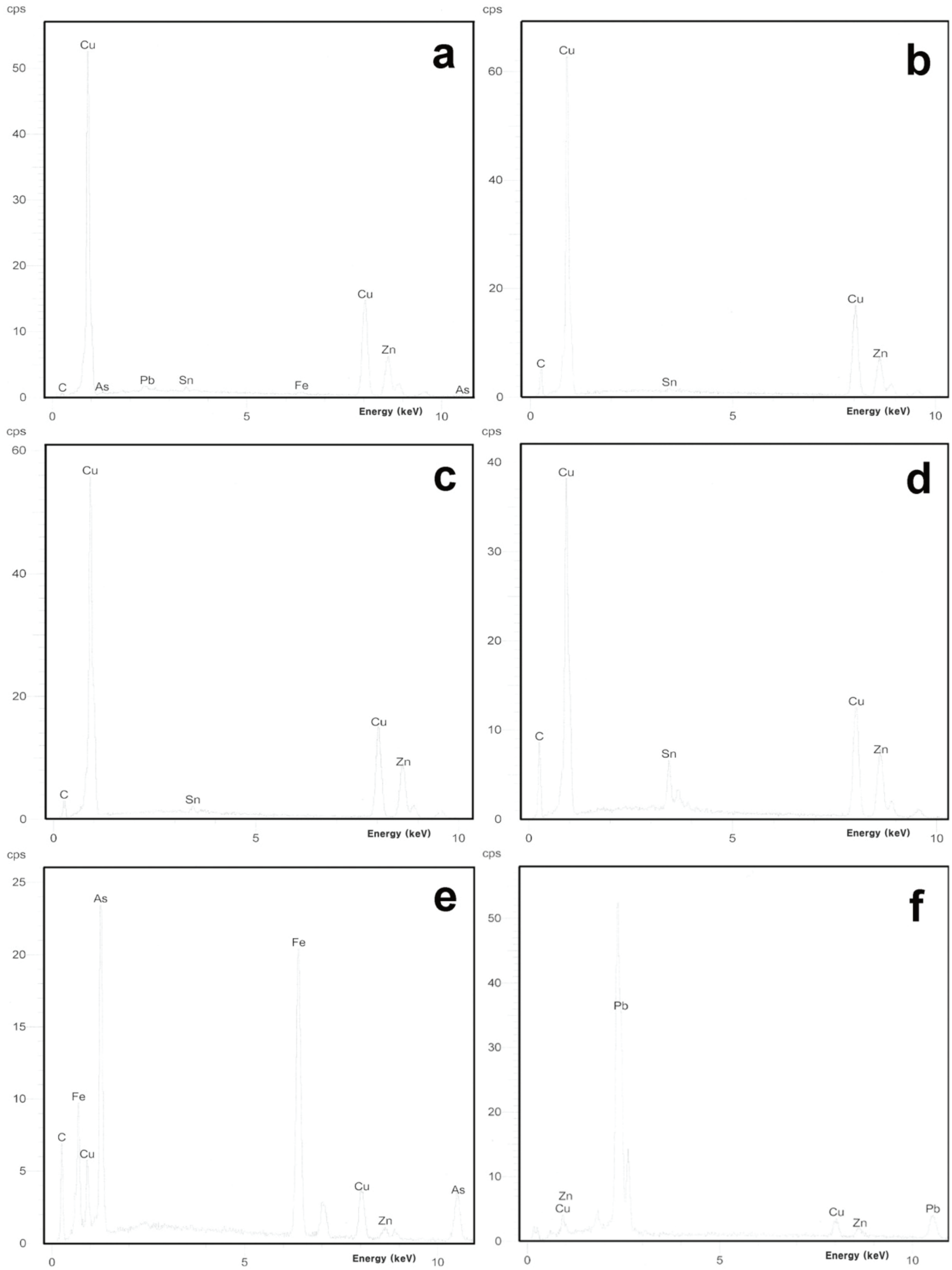

Figure 5. EDS spectra from object #33 a.) EDS spectrum taken from the entire area shown in Figure. 4 d; b) EDS spectra taken from arrow 1-5 in Figure 4 f, respectively.