Authentication Report

Japanese Bronze Haniwa Horse

Priceless Past

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Item:

This is a bronze horse figure with removable saddle. Stylistically it has all the traits of a Haniwa horse from the Kofun period (250-600 AD) of ancient Japan. More specifically, it resembles clay figures attributed to Kaminakajo, Saitama Prefecture circa 500 AD.

Haniwa (埴輪) are clay figures which were made for ritual use and buried with the dead as funerary objects. (See “Ancient Japan” by Richard Pearson, The Smithsonian Institution, 1992, pp. 203-208) The major issue with this particular figure is that it is made of bronze and not of clay. We can find no record of any Haniwa or Haniwa type objects crafted from bronze. This particular piece has a removable saddle that has two circular perforations in the top. The body of the horse is hollow to the legs and head, which appear solid. Inside the body cavity is considerable corrosion compared to the rest of the piece which suggests that the cavity may have been filled with something originally.

Inside the body cavity there are also what appear to be iron wires that emerge from the bronze as if they were part of the casting framework. Terminal end of those wires are visible on the bases of all four feet.

The patina on the outer surface of this specimen is a mixture of varying shades of brown and red, likely copper oxides, and light areas of green, likely hydroxides of copper.

There are no signs of repair or restoration.

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Photographs

These photographs show the horse without its saddle. They also show portions of the interior cavity of the horse which has a strikingly different patina than the outside. In the lower photograph there is a brown spot visible inside the cavity toward the upper left. That is corrosion product from the iron wire that runs into the solid bronze leg. It is possible that the wire in the legs was originally joined together inside the cavity but if that was the case, the exposed portions of the wire have corroded away.

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Additional Photographs

These photographs show the figure from additional angles. The differing patina in the internal cavity is obvious in the upper photograph. In the lower photograph, the terminal ends of the iron wires are somewhat visible. They are located roughly in the center of each leg and appear as small, reddish brown circles.

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Additional Photographs

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Additional Photographs

These are photographs of the saddle from different angles.

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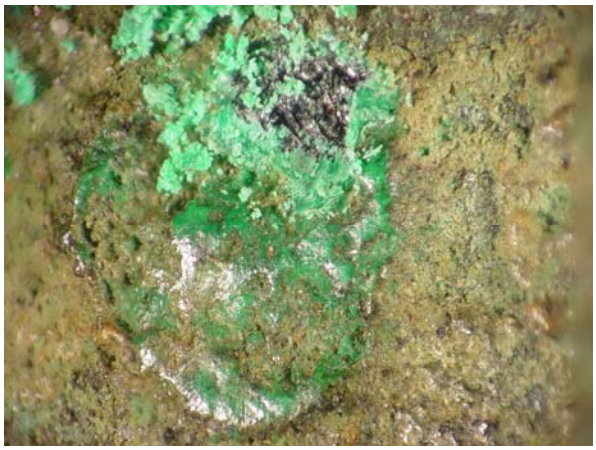
Micrographs



The micrographs above were taken from the right-side, neck area at a magnification of 35X. The left picture shows an apparent malachite ($Cu_2(CO_3)(OH)_2$, Copper Carbonate Hydroxide) formation and the right picture shows the same area after portions of the corrosion were removed. The lower micrographs were taken from the left front leg at a magnification of 45X. Several oxidation phases of the surface metal are apparent including cuprite (Cu2O, Copper Oxide) and malachite. In the right picture, a portion of the surface oxidation was removed.

In both instances, the removal of the corrosion revealed oxidation phases in the base metal that would be consistent with a naturally formed patina.

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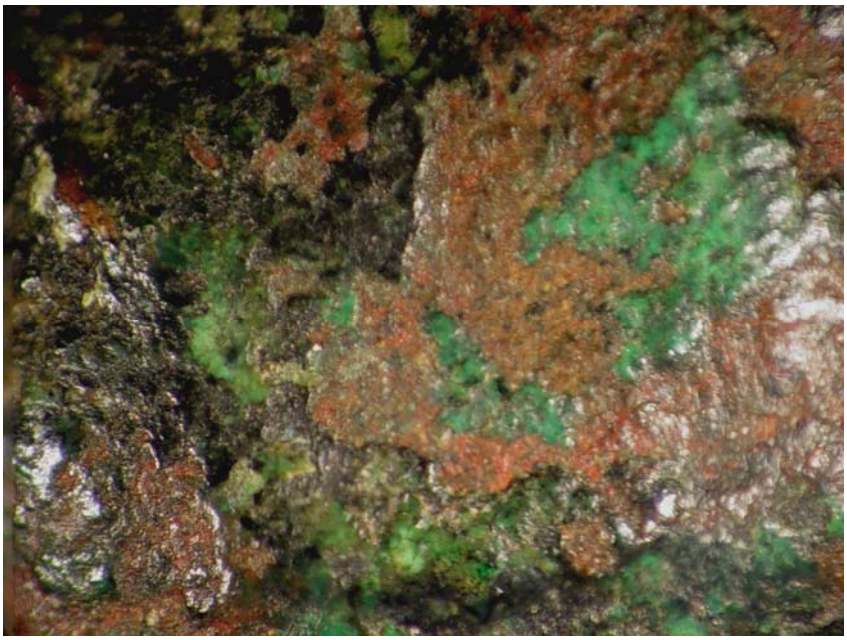
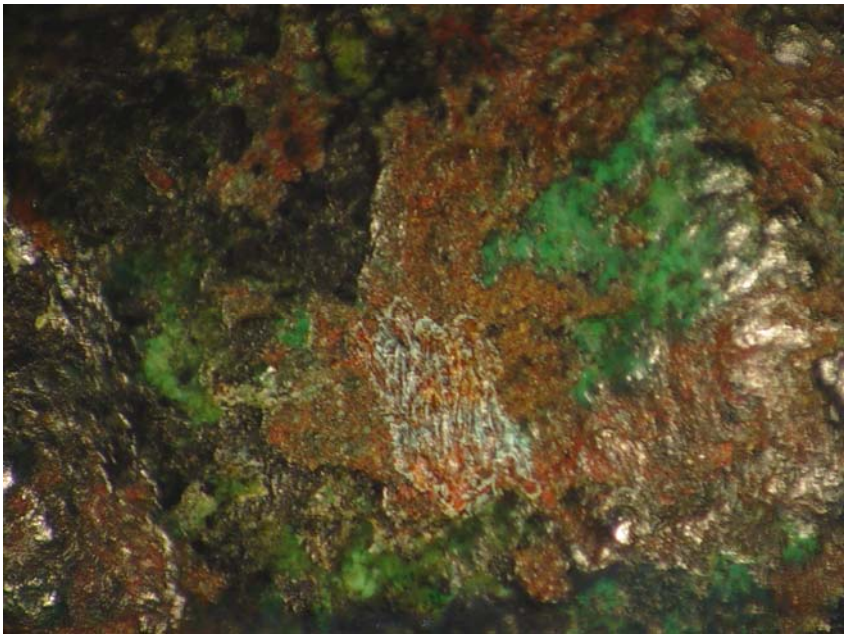
Micrographs





These micrographs were taken from the right side of the horse's head at a magnification of 45X. As with the micrographs on the preceding page, cuprite and malachite seem to be the primary corrosion products. In the lower micrograph, a portion of the patina was scraped away. The corrosion products appear to grow out of the base metal which is again consistent with a naturally formed patina.

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Micrographs

These micrographs were taken from the saddle and show consistency with those taken from the body of the horse. The upper micrograph shows oxidation characteristics similar to those on the previous pages as do the two lower micrographs. The upper micrograph is a magnification 17X while the two lower micrographs were taken at 45X. The saddle and body appear to be of similar alloys exposed to the same environment during patination.

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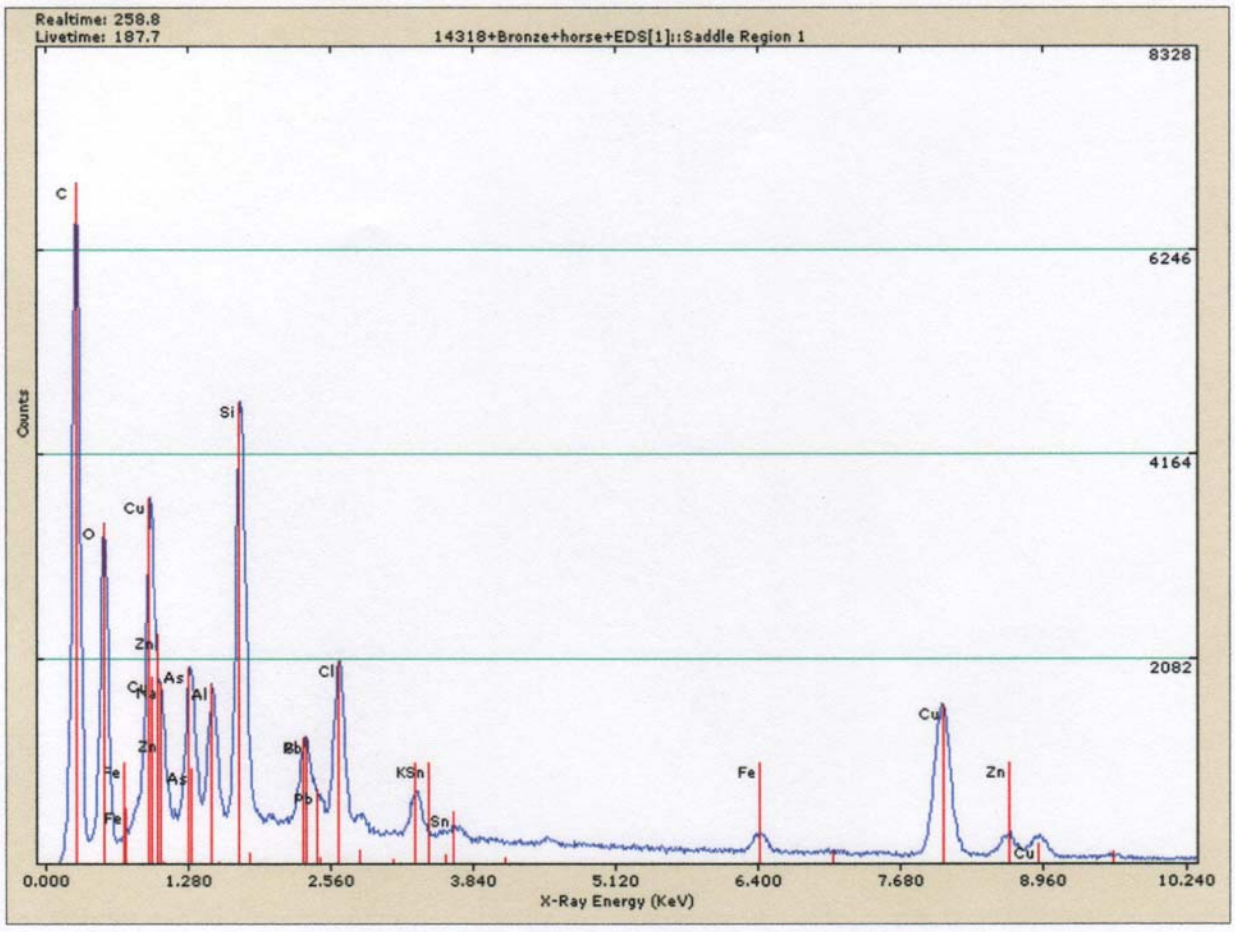
EDS Spectra

On this page and on several to follow are a series of graphs. They represent results of energy dispersive spectrometry (EDS) which is a non-invasive analysis done via the scanning electron microscope (SEM). This analysis allows us to determine the elemental make-up of a given area on the object being examined. Areas are chosen at random for analysis and when possible, several areas on the same pieces are analyzed for consistency. The graph below shows the results from an area of the saddle. Elements appearing in the specimen are Copper (Cu) which is the principle element in bronze, Oxygen (O), Carbon (C), Aluminum (Al) and Lead (Pb) which are not necessarily uncommon in bronze. What was interesting to find was (cont.)



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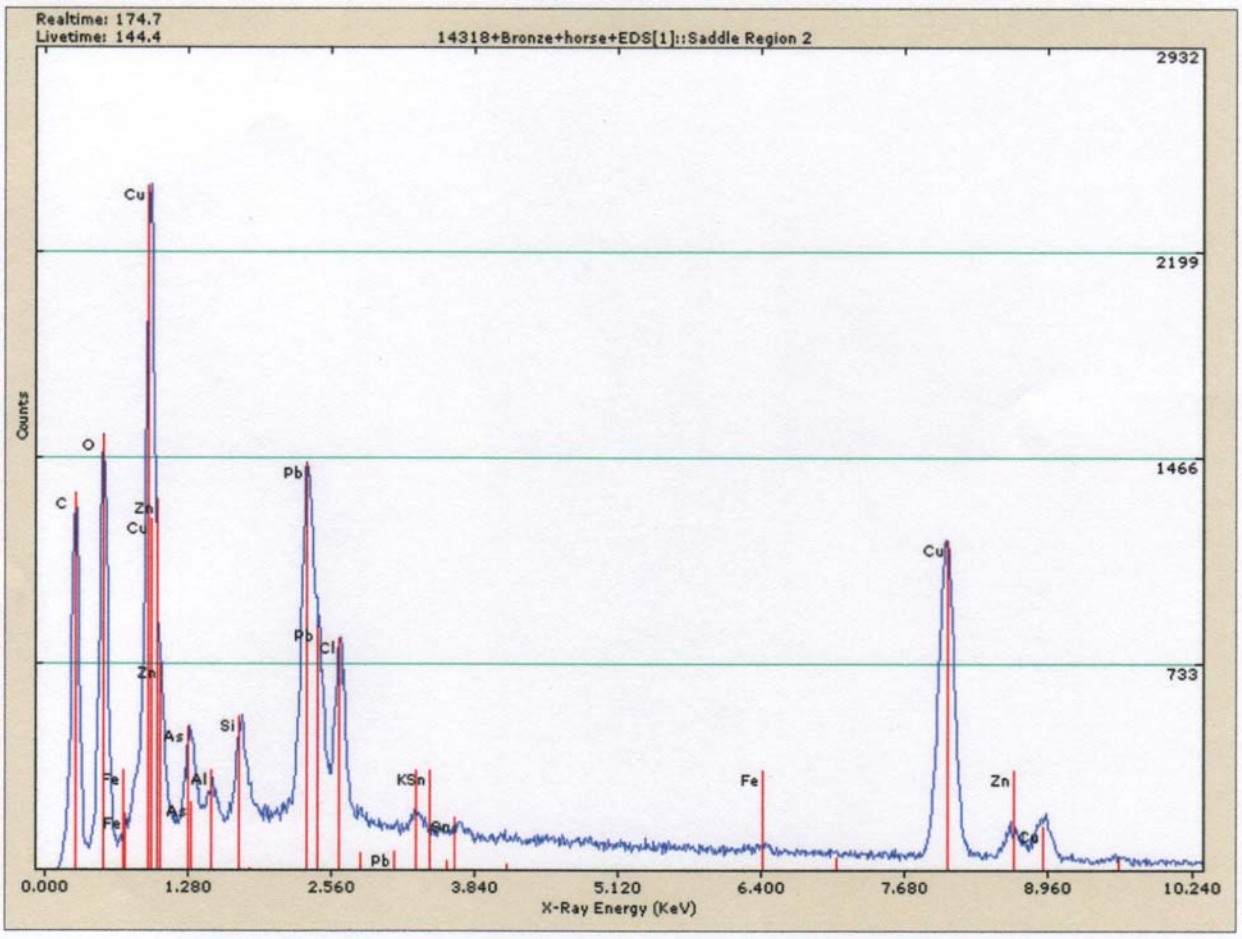
EDS Spectra

a level of Arsenic (As) and Zinc (Zn) which would not be present in ancient bronze. The presence of zinc would suggest that the alloy is brass rather than bronze. Chlorine (Cl) is also present.

The graph below shows a separate region of the saddle with results similar to the first sample area. We were unable to obtain results from the body of the horse due to the excessive out gassing, likely from the corrosion in the body cavity, which prevented the specimen chamber in the SEM from reaching appropriate pressures.



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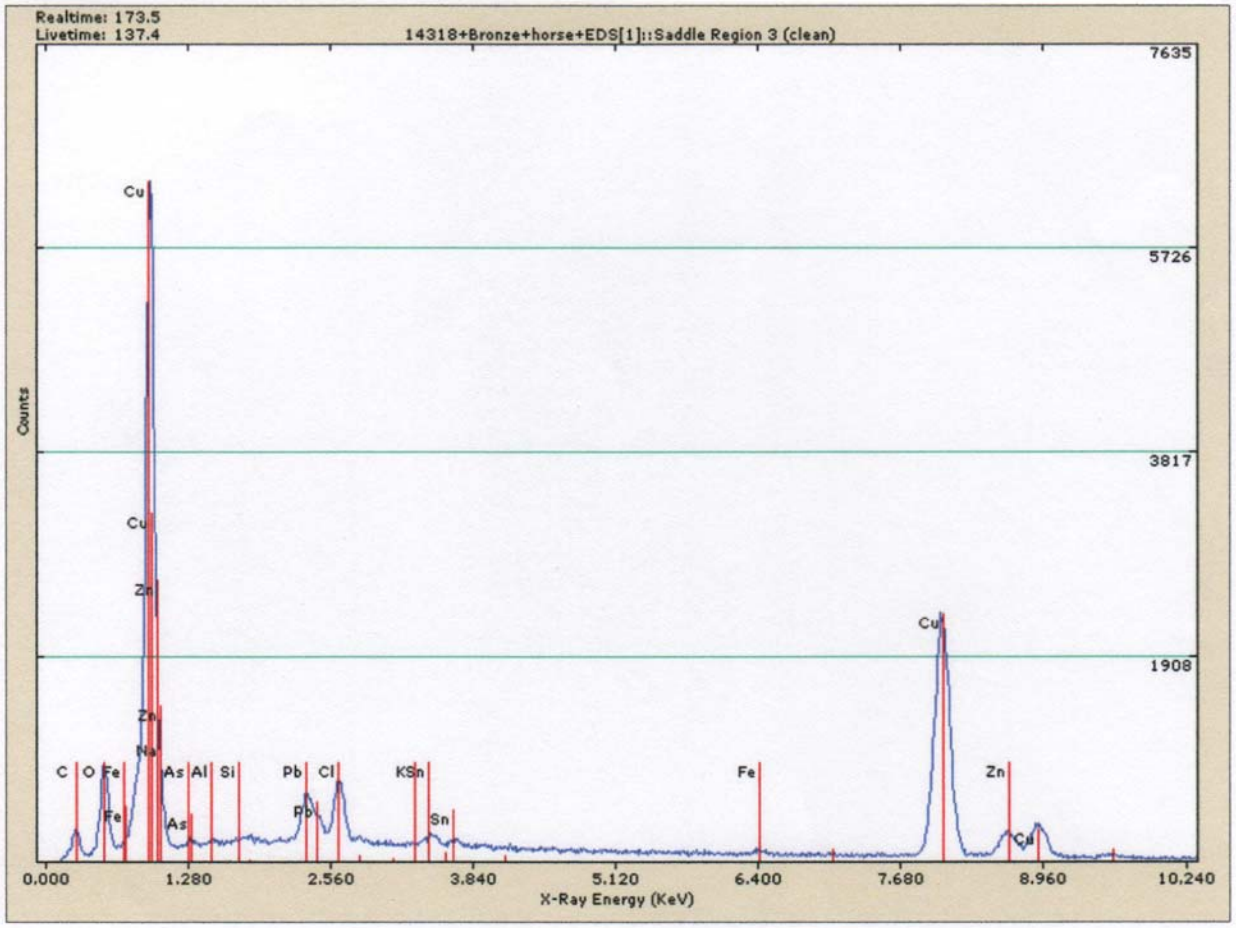
Saddle region three, showing results consistent with the first two regions.



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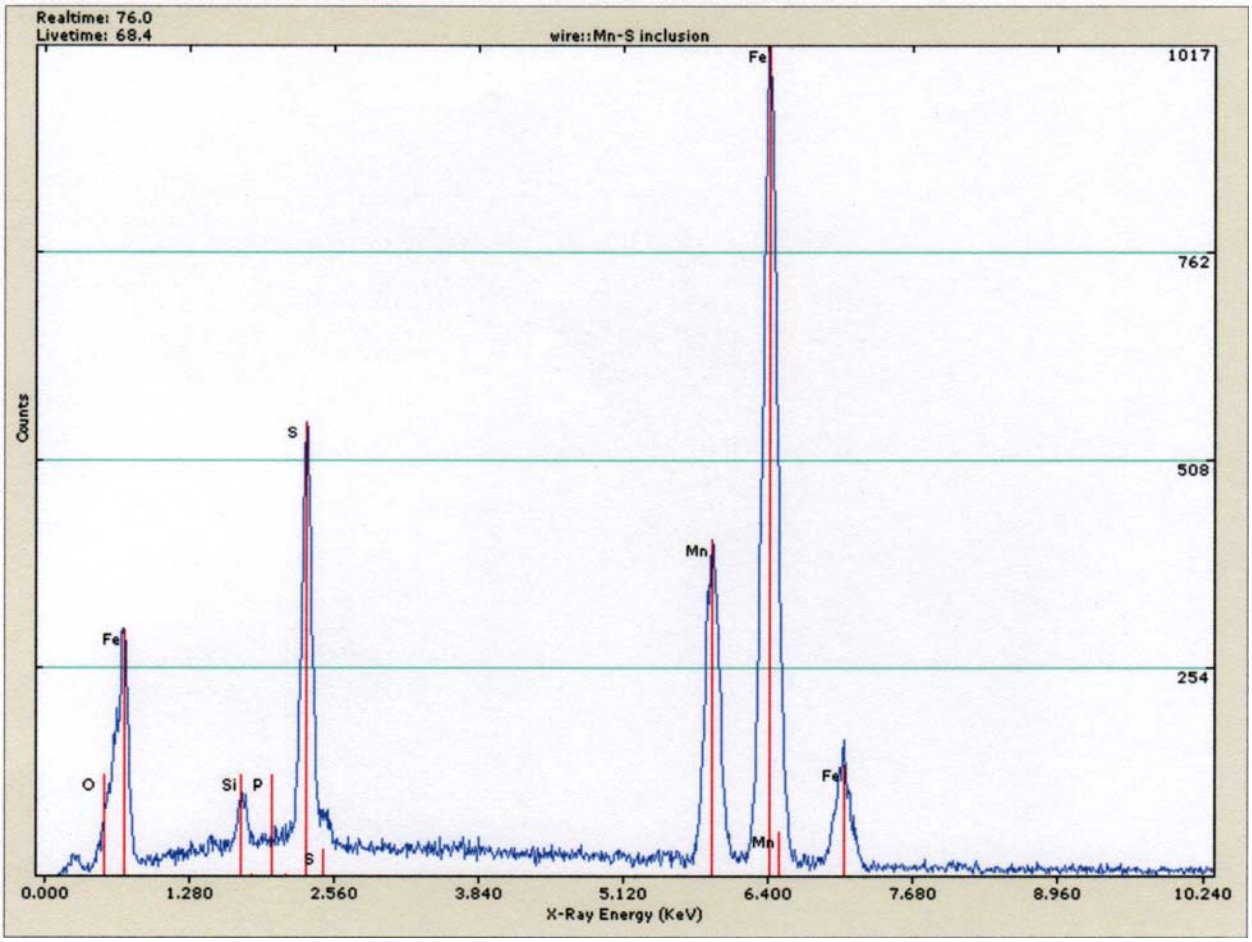
Our next area of interest was a piece of the iron wire frame that was recovered from the internal cavity of the figure. A segment of the wire was mounted and polished for metallographic analysis. Analysis of the mounted sample is represented by the graph below and the graph on the following page. Elements present are Iron (Fe), Oxygen (O), Silicon (si), Phosphorus (P), Sulfur (S) and Manganese (Mn). The wire is steel rather than plain iron. The presence of manganese sulfide inclusions (see metallography pages 17-20) is also very telling.



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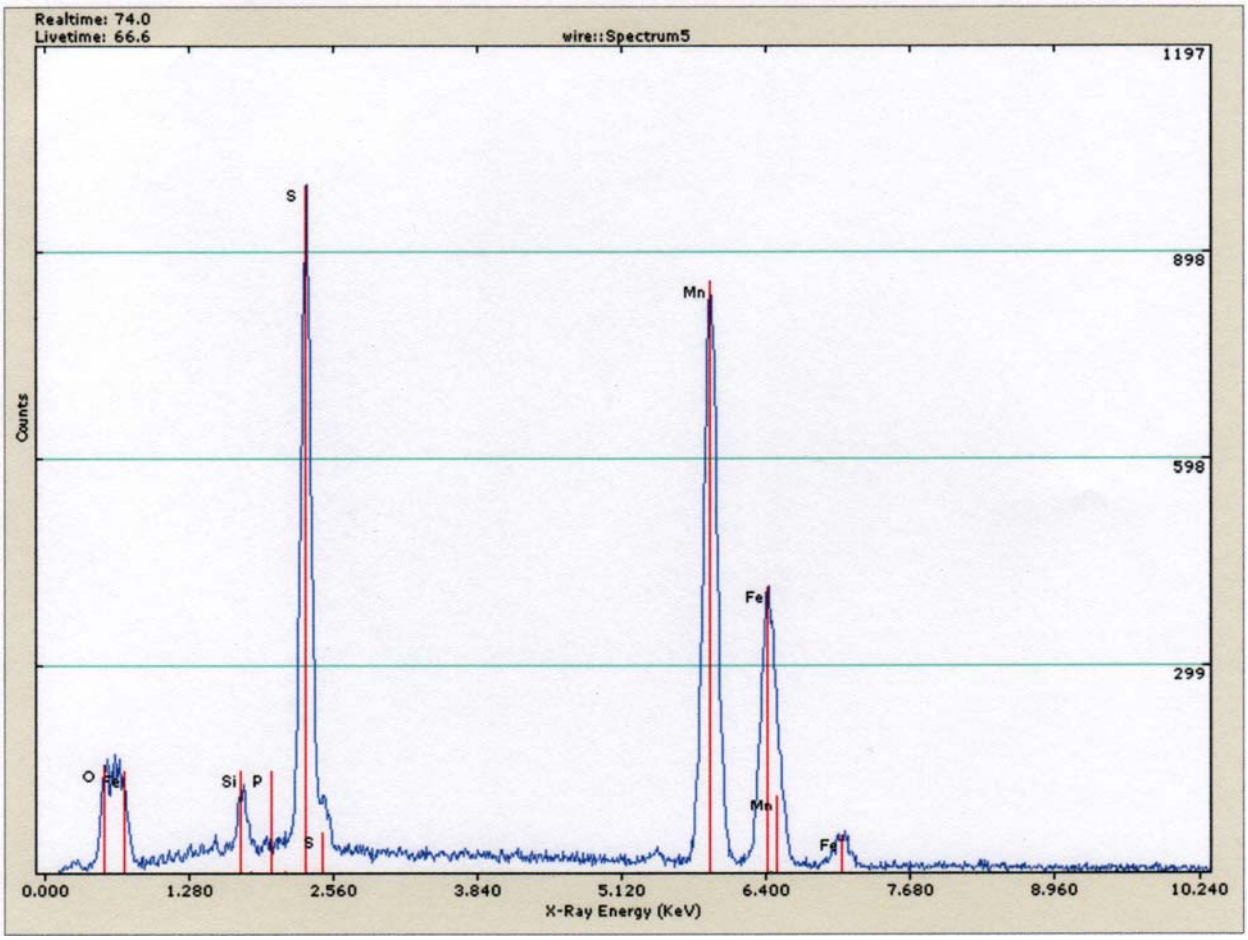
Second analysis of mounted wire sample



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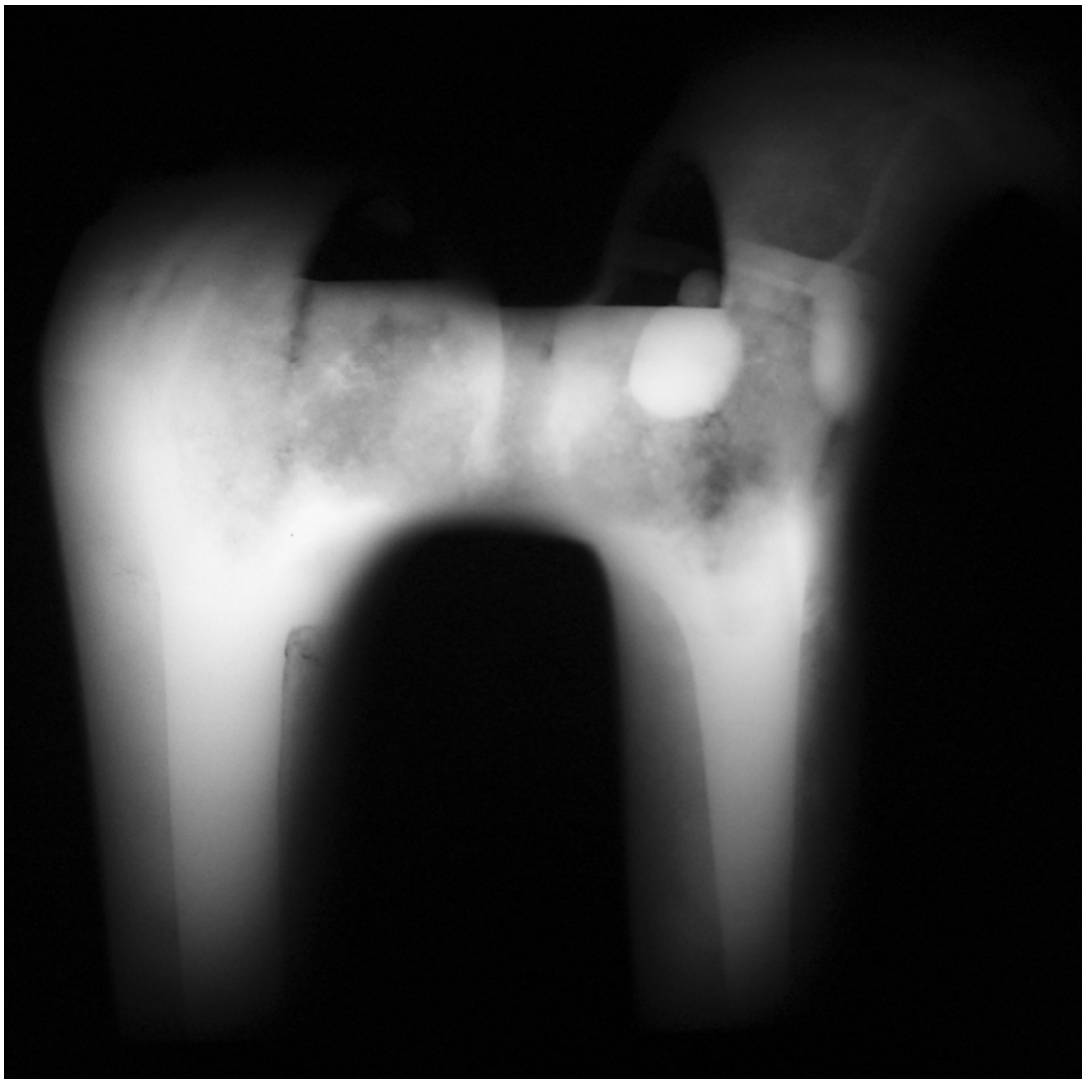
X-Radiograph



Above is an x-ray of the entire figure. The legs appear to be solid metal. The bright white areas represent greater density than the dark areas. Stark lines appear where the legs overlap in the x-ray. Surface decorations appear as light areas. The wire frame is somewhat visible in the head and rear-end areas.

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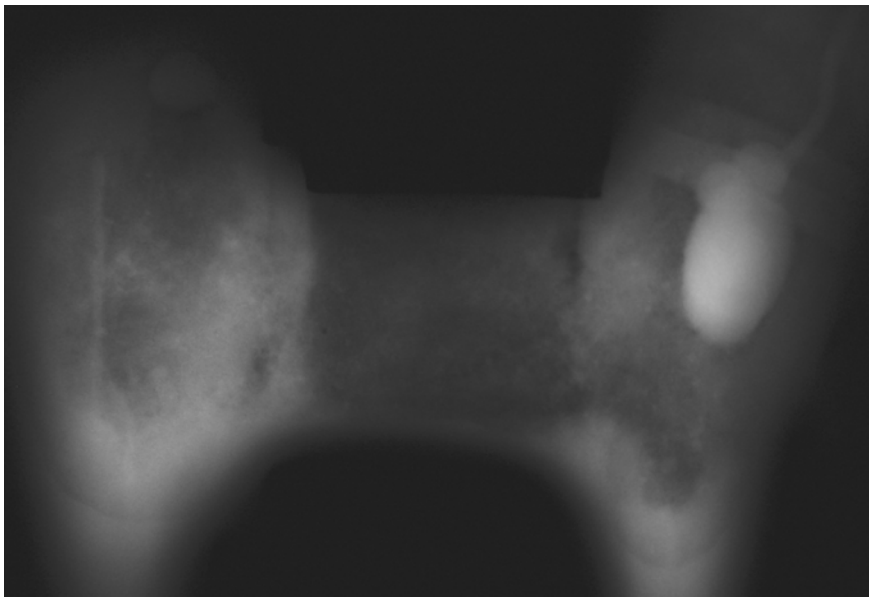
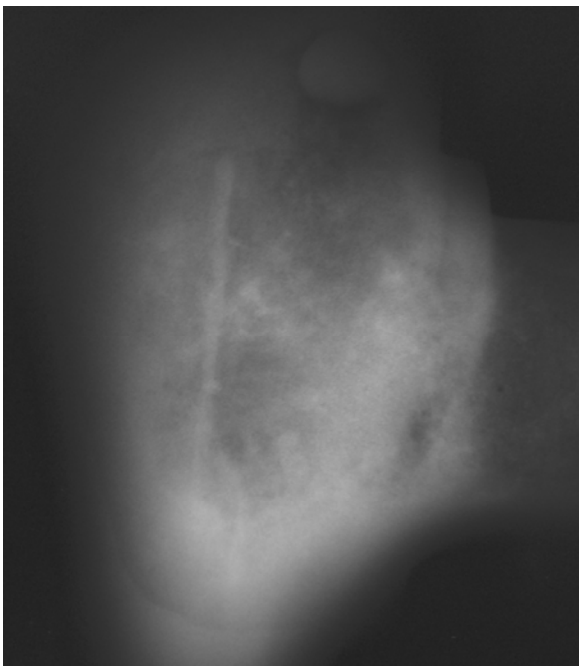
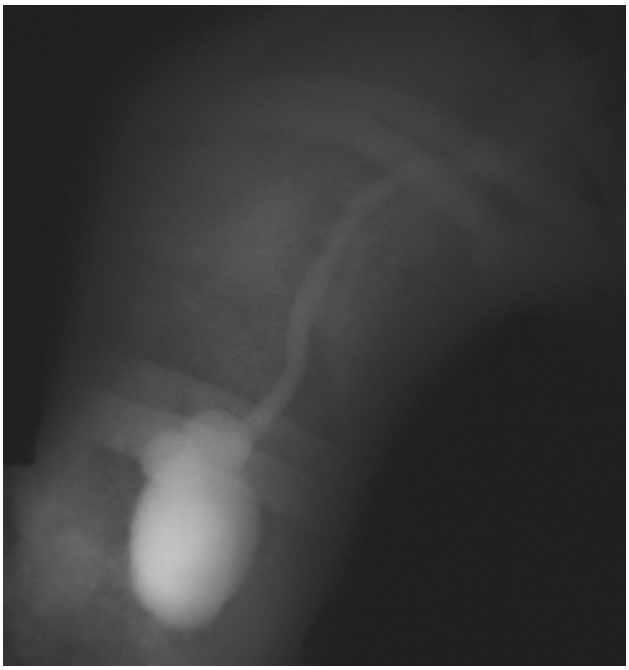
X-Radiographs

In these x-rays, the wire frame is more evident. Also, the metal appears somewhat homogeneous and there is little evidence of corrosion .







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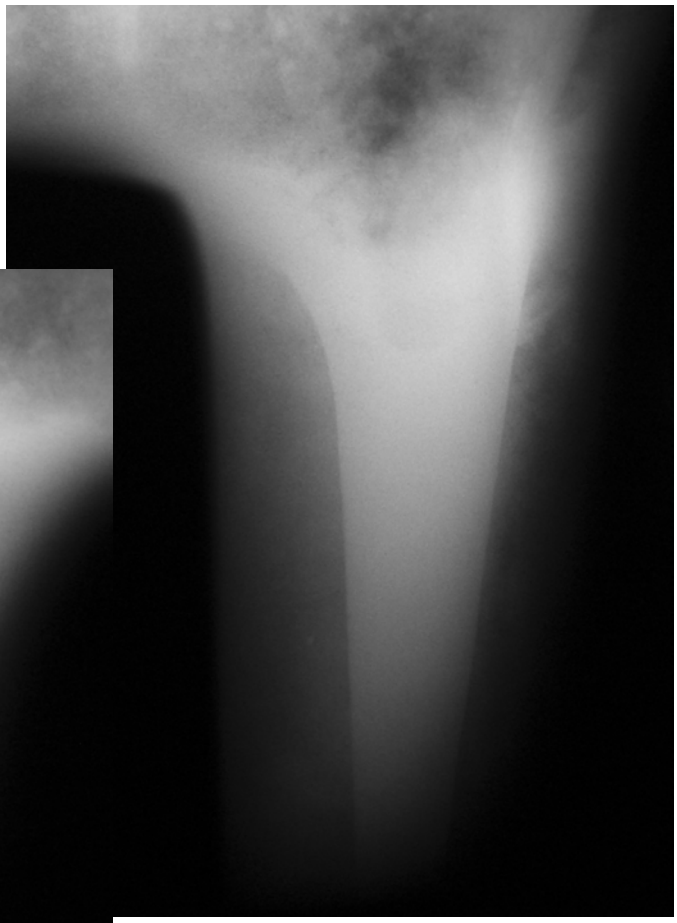
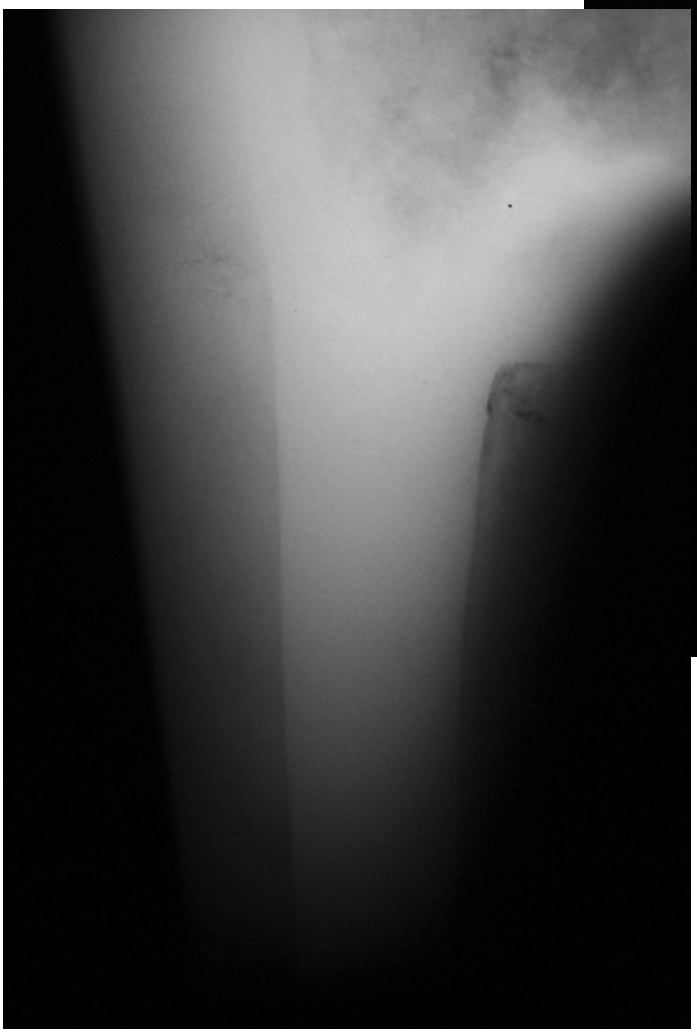
X-Radiographs

These are close-ups of the rear legs (left) and the front legs (right). The density of the metal is too great to be able to see the wire frame. It also appears that the legs are solid.





Metallography

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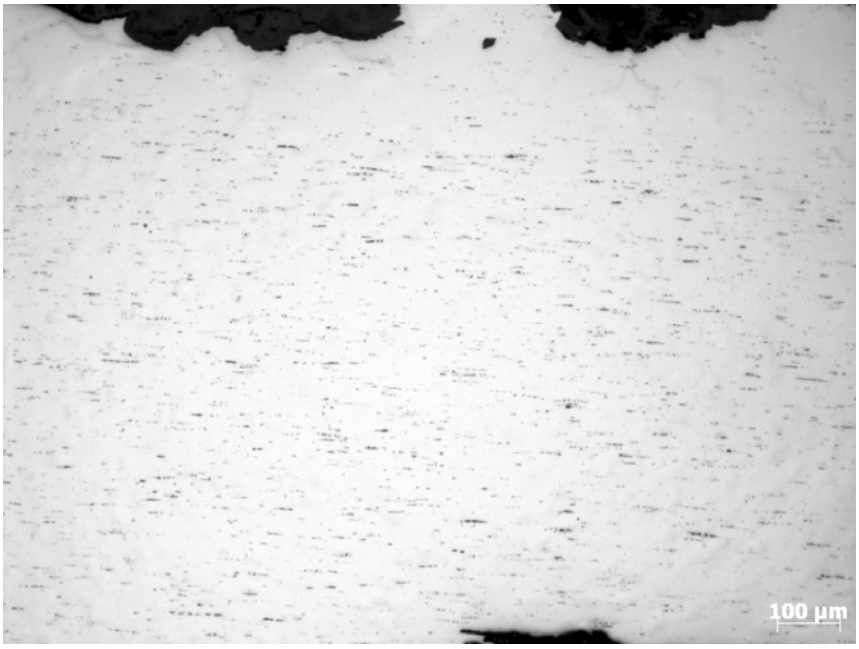
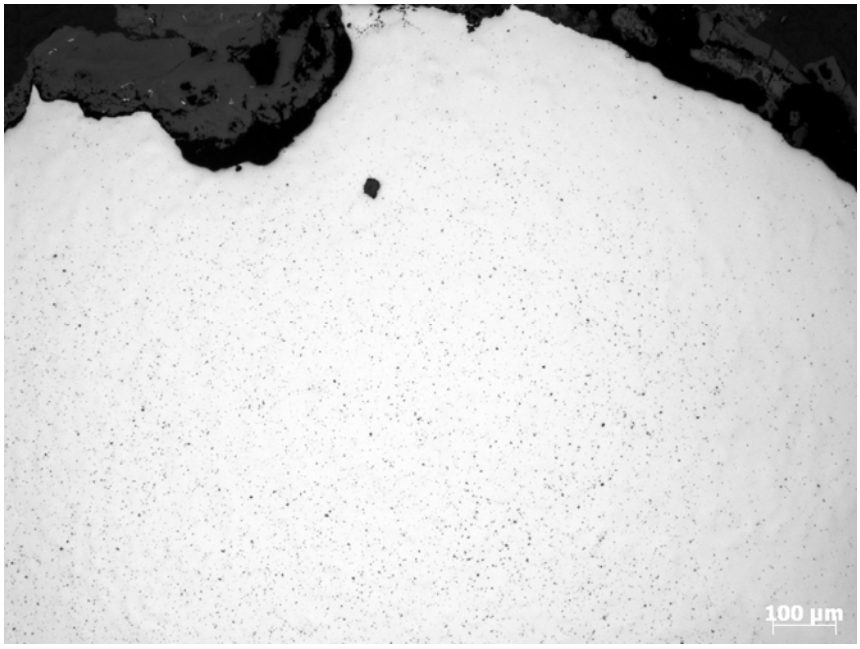


Left:"As-polished" photomicrograph of a longitudinal cross-section of the wire sample . The magnification is 100X. A significant amount of non-metallic inclusions, mostly manganese sulfide type, are visible.

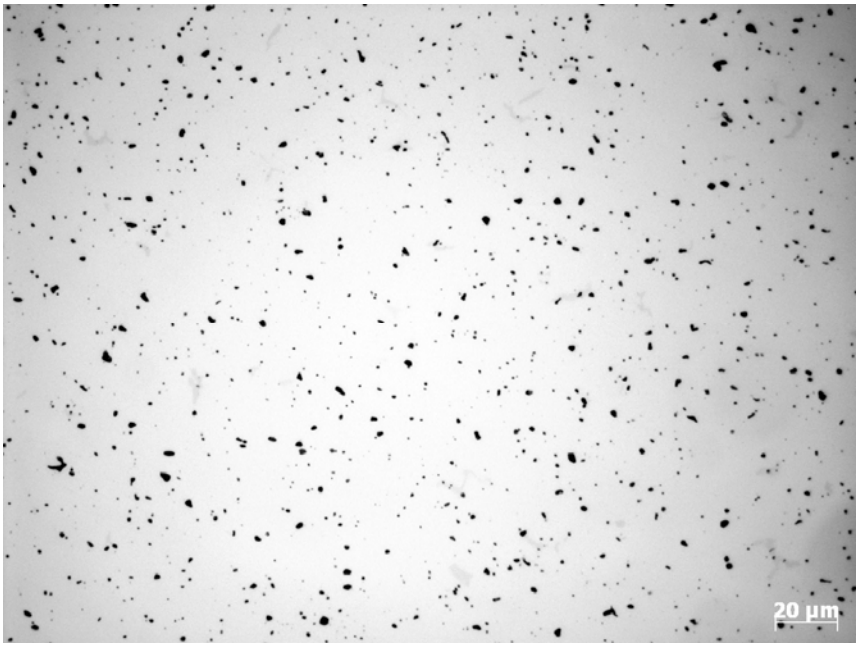
Right: "As-polished" photomicrograph of a longitudinal cross-section of the wire sample. The magnification is 500X. A significant amount of non-metallic inclusions, mostly manganese sulfide type, are visible.

Metallography

Priceless Past



Right: "As-polished" micrograph of a transverse cross-section of the wire sample viewed transversely. The magnification is 100X. The same inclusions seen on the previous page appear as small spots in this view.



Left: "As-polished" micrograph of a transverse cross-section of the wire sample viewed transversely. The magnification is 500X. The same inclusions seen on the previous page appear as small spots in this view.

Metallography

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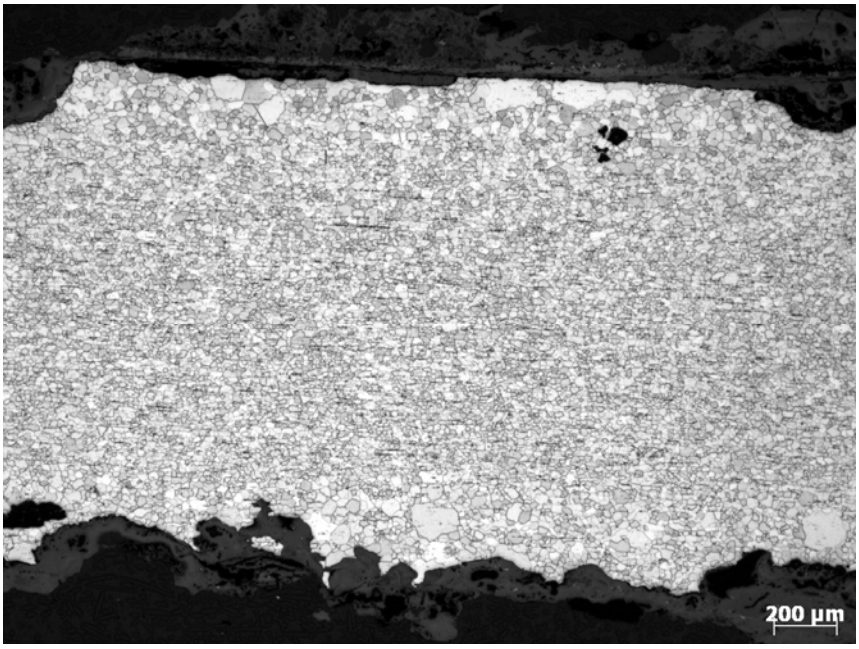
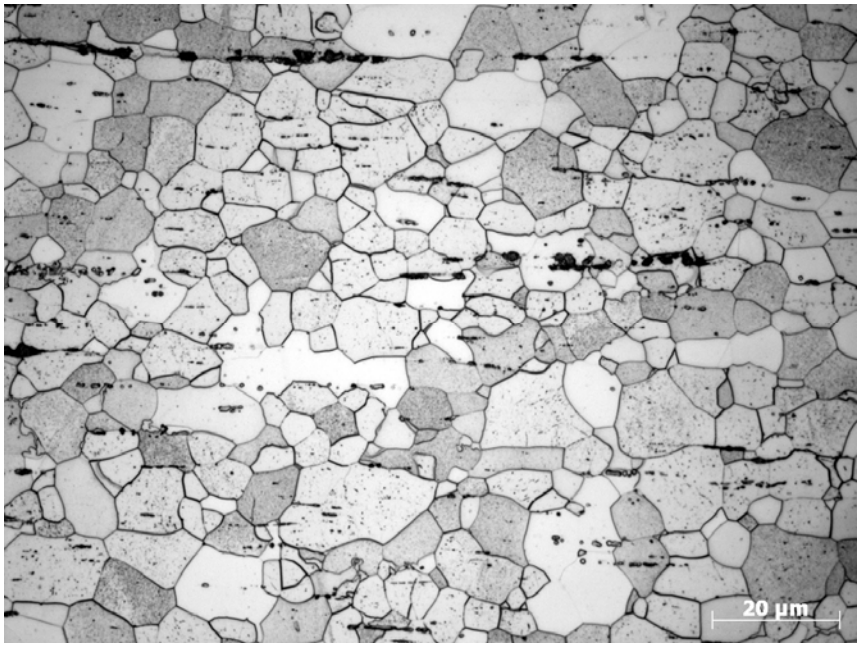


Left: Photomicrograph of a longitudinal cross-section of the wire specimen. The specimen has been etched in a 5% Nital (nitric acid/methanol) solution. Non-metallic inclusions (manganese sulfide stringers) are visible amidst the equiaxed ferrite grains. The large grains at the surface are the result of high temperature exposure. Magnification is 50X.

Right: Micrograph of the same longitudinal cross-section. The manganese sulfide stringers are visible . The elongated nature of the inclusions is likely the result of the metal being drawn into wire. Any other evidence of drawing would likely have been obliterated by the molten metal cast around the wire. Magnification is 500X.



Metallography

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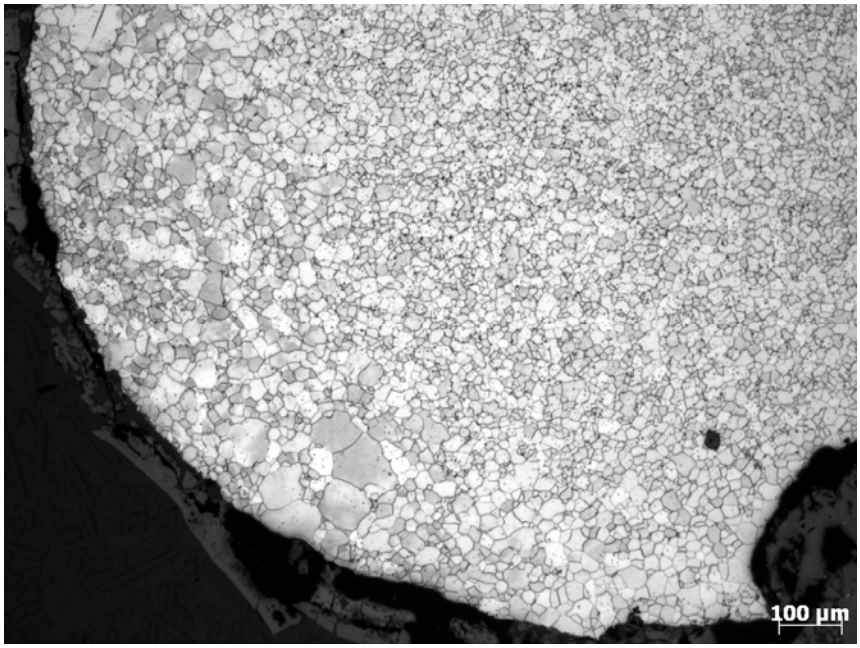
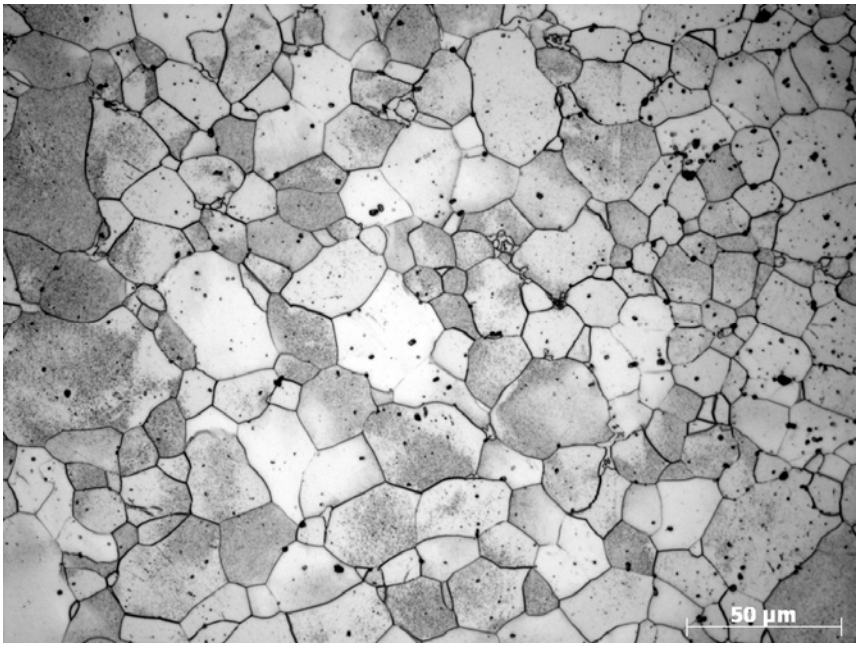
Right: Micrograph of a transverse cross-section of the wire sample . The specimen has been etched in a 5% Nital (nitric acid/methanol) solution. The inclusions that appeared as stringers in the longitudinal cross-section appear as spots in this view. Magnification is 100X.





Left: Micrograph of a transverse cross-section of the wire sample. Magnification is 500X. The specimen has been etched in a 5% Nital (nitric acid/methanol) solution. The inclusions that appeared as stringers in the longitudinal cross-section appear as spots in this view. Magnification is 500X.

Conclusion

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Conclusion:

The dating of metals can prove to be very difficult. Often we rely on the style of the piece and analysis of the patina to determine the probability of authenticity. However, the lack of a strong, naturally occurring age patina neither proves nor disproves an object's authenticity and it is very common to see modern (or "more modern") replicas of genuine ancient pieces. Many authentic ancient bronze pieces have little or no heavy natural patina because of the environment in which they were interred. This particular specimen has a light patina that appears to be natural. This suggests that the piece has some age to it but the exact age is virtually impossible to determine without some additional evidence. All we can say for sure is that the patina was not artificially applied.

Though the indeterminate nature of the patina and the style of the piece itself gave little evidence of the age of this piece, the wire frame, however, was a different story. Analysis of the wire first showed that it was actually steel rather than iron. Iron has been used to fashion items for thousands of years but because of its relatively high melting point, true steel did not emerge until very late in human history. In order to make steel intentionally (not by accident), you first must be able to make iron. In contrast to metals such as gold, silver or copper—metals common to ancient cultures, iron is practically never found as an element but nearly always found as an oxide. In contrast to other metals found as oxides (especially copper and tin oxides needed to make bronze), the temperature of a "normal" fire is not sufficient to melt iron. The melting point of iron is 1535^{o} C, which is far above the 1000-1100^{o} C that ancient cultures were capable of producing.

Most technologies found in early Japan originated in mainland China. While the Chinese were using meteoric iron in weapons as early as 1100 BC, the actual crafting of iron did not arise until the early Han period, roughly 200 BC. By its very nature, iron wire was particularly difficult to create. Early wire was made by cutting small pieces of flat metal which resulted in the wire taking a rec-

Conclusion cont.

tangular shape. Drawn (circular) wire did not appear until around the 14-15th centuries in Europe and did not appear in Asia until roughly the 17th century. Steel wire appeared much later.

With the discovery of coal, furnaces could burn much hotter. With hotter furnaces, steel became much easier to manufacture intentionally. However, new problems arose. The high sulfur content in coal make iron very brittle. Oxygen and phosphorous also make iron very brittle. It wasn't until the middle of the 19th century that an English metallurgist named Robert Mushet discovered that the addition of manganese to the iron would react with the oxygen to form slag and in the process would also neutralize any sulfur in the mix by binding with it, creating manganese-sulfide, Mn-S. The use of manganese in the manufacture of steel did not occur until around 1870.

Because the manganese-sulfide present in the steel wire frame is in such a quantity that it could not be a trace element or an accidental occurrence, it is highly unlikely that the wire was manufactured prior to 1870. The manganese-sulfide stringers also suggest that the wire was drawn, which would support a late date of manufacture as well. The metallography also provides evidence that the brass alloy was cast around the wire, so it is only reasonable to assume that the figure dates to post-1870. The presence of the natural patina on the figure's external surface would be consistent with a dating of late 19th or early 20th century. It is our conclusion that the entire piece dates accordingly and is, therefore, a relatively modern replica of an ancient design.

Authentication Report

Map

No.___-00130-___

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Authorized signature Richard A. Nable owner/operator of Priceless Past Authentications

Date

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