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ARTEFACTS FROM KRAKOW-NOWA HUTA AS AN ILLUSTRATION OF SELECTED ISSUES OF RESEARCH INTO PREHISTORIC AND MEDIAEVAL CASTING

WYBRANE ZAGADNIENIA BADAŃ NAD ODLEWNICTWEM PREHISTORYCZNYM I ŚREDNIOWIECZNYM NA PRZYKŁADZIE ZABYTKÓW Z KRAKOWA-NOWEJ HUTY

Abstract

An attempt to examine the earliest traces of non-ferrous metal metallurgy and casting in present-day Krakow has been made. The preparatory investigation has centred around a group of finds coming from a small section of the eastern part of the city, the area of Nowa Huta. The paper gives an overall view of objects ranging from the first copper artefacts from the territory of Poland in the 4th millennium BC through Lusatian bronzes and Celtic products to modern slag from Jan Thurzo's copper smelter. The analysis, involving diverse copper or copper alloy artefacts, ornaments and tools – both imports and local products – has been aimed at preliminary identification of Krakow's earliest metal artefacts in terms of their materials and methods of production, and at preparing the ground for further study. This multifaceted research is intended to result in a comparison of materials and techniques used in metallurgy and casting during the timespan of 5000 years.
Keywords: archaeometallurgy, casting of non-ferrous metals, copper, bronze, brass

Streszczenie

Podjęto próbę zbadania najstarszych śladów metalurgii i odlewnictwa metali nieżelaznych na terenie dzisiejszego Krakowa. Do pierwszych badań wybrano znaleziska z niewielkiego obszaru we wschodniej części Krakowa, obejmującego rejon Nowej Huty. Przedstawiono pierwsze zabytki miedziane z ziem polskich z IV tysiąclecia p.n.e., brązy kultury łużyckiej, wyroby celtyckie, aż po nowożytny żużel z huty miedzi Jana Thurzo. Do analizy wybrano zabytki miedziane i wykonane ze stopów miedzi, ozdoby i narzędzia, będące zarówno importami, jak i przedmiotami wykonanymi na miejscu. Celem pracy była wstępna identyfikacja materiałów, z których wykonano najstarsze zabytki metalowe odnalezione na terenie Krakowa, ustalenie technik wytwórczych, dzięki którym powstały, a także przygotowanie dalszych badań w tym zakresie. Rezultatem wielopłaszczyznowych badań będzie porównanie stosowanych surowców i materiałów oraz technik metalurgicznych i odlewniczych na przestrzeni pięciu tysięcy lat.
Słowa kluczowe: archaeometalurgia, odlewnictwo metali nieżelaznych, miedź, brąz, mosiądz

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1. Prehistoric and mediaeval casting

Humans have used metals for over 6000 years, beginning with non-ferrous kinds: gold, silver, copper, tin, lead or their alloys, and then introducing bronze ca. the mid-3rd millennium BC.

This paper presents the preliminary results of a broadly conceived project aimed at a synthetic study of non-ferrous metal artefacts uncovered in Nowa Huta. Metal finds from Nowa Huta have been analysed till now by Prof. J. Piaskowski, among others. Over the area of ca. 100 sq. km in eastern Krakow, researchers have attested intensive settlement continuing since the Early Neolithic Age, ca. 7500 years ago, to our times [1] and reflecting all the significant processes or events of prehistoric and mediaeval Central Europe. This also involves archaeological knowledge of the origins and dating of non-ferrous metal artefacts. The knowledge of technical aspects of prehistoric or mediaeval metal production, however, is still far from adequate. From among the artefacts, the oldest are dated to the mid-4th millennium BC and the youngest to the late 15th century AD. All of them were made of imported raw material [2, 3].

2. The oldest copper

The oldest metal artefacts, recovered from inhumation graves in Wyciąż (Site 5) and Cło (Site 65), were made of copper. They derive from the Danubian cultural traditions. The ornaments and weapons from the mid-4th millennium BC form a small group of prestigious objects. From the archaeological perspective, they should be considered as imported products.

The study has included microstructure observation and analysis of chemical composition with X-ray fluorescence (XRF) spectrometry applied to the oldest artefacts in the examined group (from 5500 years ago). Bracelets from Cło and an example of their X-ray spectrums are shown in Figures 1a and 1b; examples of their microstructures are shown in Figures 2a and 2b.

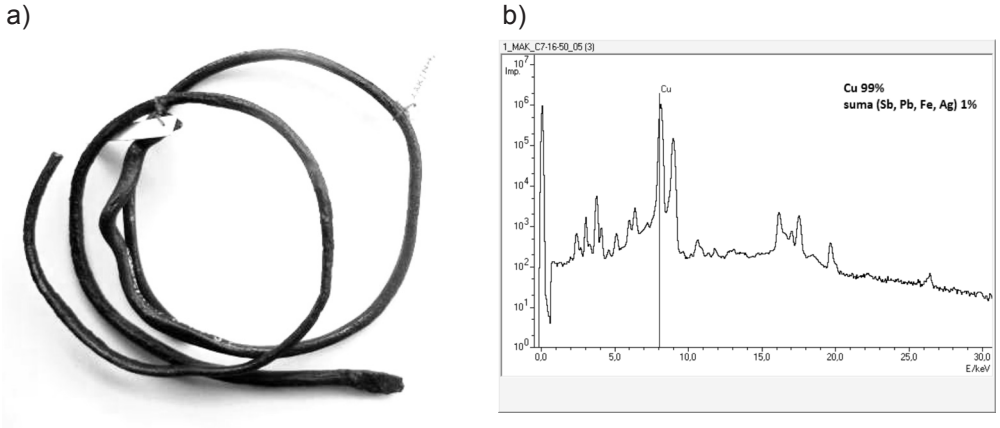

Fig. 1. Copper bracelets, Cło (Site 7), 3500 BC: a) the view, b) the X-ray spectrum with identification lines for copper. Copper content – ca. 99%; sum of metal contaminations – 1%

a) b)

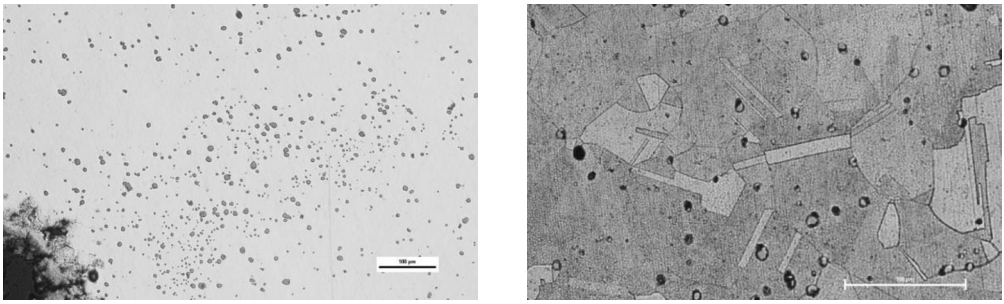

Fig. 2. Copper bracelets, Cło (Site 7), 3500 BC. Microstructure of the copper artefact, with discernible precipitates of Cu_2O oxygen phases against the background of grains of the copper matrix; magnification: 100x (a) and 500x (b)

The oldest artefacts were made of ca. 99% pure copper, contaminated with antimony, iron, lead and silver.

Before copper metallurgy developed, native copper was used, and – since pure copper has low liquidity – copper tools and ornaments were often hammered.

3. The first bronzes

The invention of the first copper-tin alloy triggered technological progress leading to the development of many civilisations. From then on, bronze, having much better mechanical and casting properties than copper, was used to make tools, weapons and ornaments. The first bronze artefacts arrived in western Poland at the turn of the 3rd and 2nd millennia BC; in Krakow's area, however, they were known, as rare imports from the west, no earlier than 1800–1600 BC. After 1600, the character of cultural contacts in western Małopolska changed and local groups established relationships with transCarpathian communities of the advanced Bronze Age [1]. This caused a greater influx of bronze artefacts into the area situated previously outside the distribution of that raw material. As a result, local bronze-working became widespread ca. 1300 BC. Two tools: a chisel and a sickle, found in one feature at the Nowa Huta-Mogiła settlement, Site 55, near the Wanda Mound (Fig. 3a), were probably of local origin. Bronze artefacts within the site have, on average, 88% copper content and 11% tin content; they also contain antimony, arsenic, silver, lead and other admixtures (Fig. 3b) coming from the metallurgic processes.

a) b)

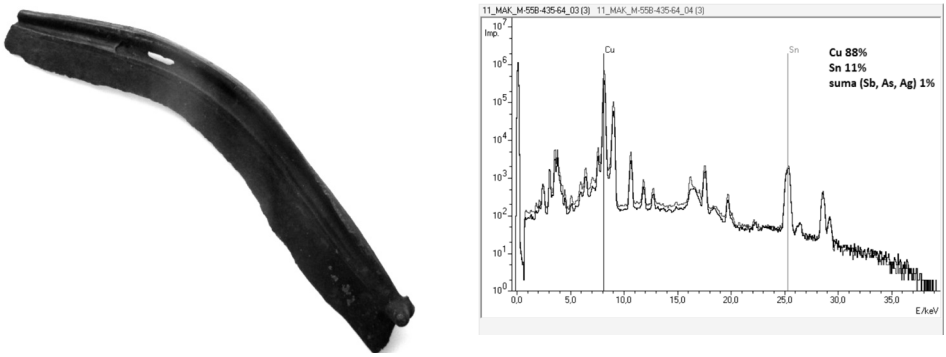

Fig. 3. Bronze sickle, Mogiła (Site 55), 1300 BC: a) the view, b) the X-ray spectrum with identification lines for copper and tin. Concentration of elements: copper – 88%; tin – 11%; sum of admixtures – 1%

Later, bronze was commonly used to make tools and weapons (small axes, sickles, knives) and many ornaments (pins and fibulas, pendants, rings, etc.). Researchers have also found an ornamental knob, imported from Central Germany, made of bronze with ca. 2% tin content.

4. Celtic moulding

The arrival of Celtic settlers in Nowa Huta at the turn of the 4th and 3rd centuries BC was a watershed moment in many fields of production. One consequence was the growing expertise in metal processing; mostly, researchers have found traces of iron smithing. The areas of Celtic settlement have yielded artefacts related closely to copper production, i.e. fragments of clay tuyères used in furnaces for copper melting. Celtic experts also knew metallurgy and casting of non-ferrous metals: bronze, silver and gold, as evidenced by particles found in crucibles and mint moulds for semi-finished coins (Fig. 4).

Artefacts from the Celtic period include miniature tools which may have been used in jewellery making. An analysis of a partly preserved torque (neck ring) has shown that it was cast from leaded tin bronze (Figs 5a and 5b) which differed from earlier bronzes in a considerable (6%) admixture of lead, added purposefully as a technological component. Characteristically, the bronze contained also silver (1.5%), perhaps having prestigious or symbolic functions. Microstructures of the bronze are presented in Figures 6a and 6b.

The images of microstructure show distinct dendritic segregation of tin and lead in the spaces between crystallites of the α solution. The analysis has recorded microprecipitates of phases, containing fusible elements in the interdendritic spaces.

Fig. 4. Fragments of Celtic clay mint moulds; Archaeological Museum in Krakow

a)

b)

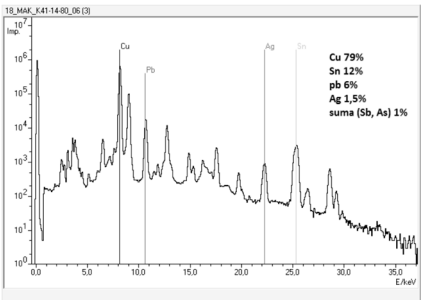

Fig. 5. Bronze torque, Krzesławice (Site 41), 1st century BC: a) the view, b) the X-ray spectrum with identification lines for copper, tin, lead and silver. Concentration of elements: copper – 79%; tin – 12%; lead – 6%; silver – 1.5%, other admixtures – 1%

a) b)

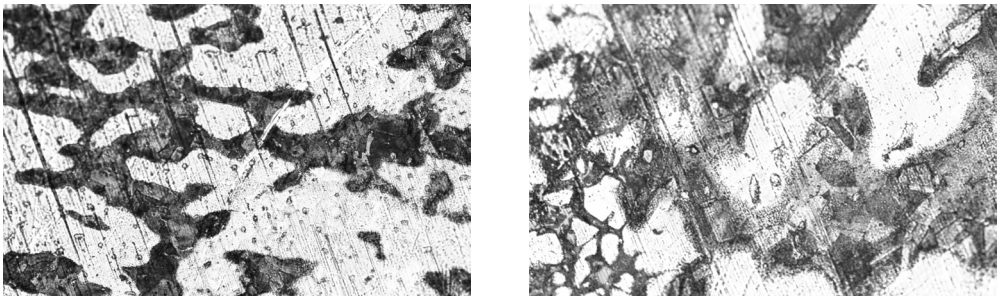

Fig. 6. Bronze torque, Krzesławice (Site 41), 1st century BC. Microstructure of the tin-lead bronze cast, with discernible dendritic segregation of tin and lead in the spaces between crystallites of the α solution; magnification: 200x (a) and 500x (b)

5. The Middle Ages

Early mediaeval cast products from Krakow–Nowa Huta include a bronze buckle (Figs 7a and 7b). The alloy contains copper, tin and lead, but also a considerable concentration (ca. 9%) of zinc.

a) b)

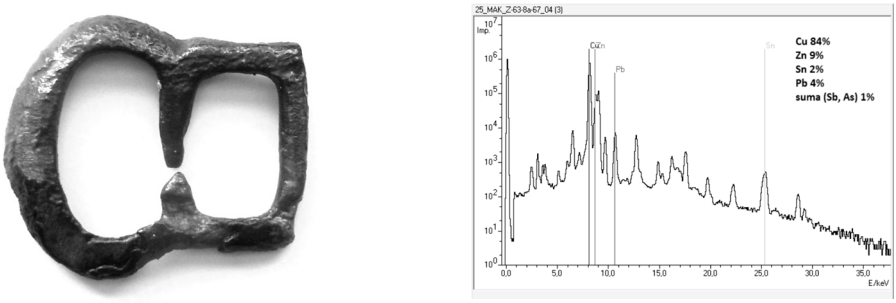

Fig. 7. Bronze buckle, Zesławice (Site 63), 600 AD. a) the view, b) the X-ray spectrum with identification lines for copper, zinc, tin and lead. Concentration of elements: copper – 84%, zinc – 9%; tin – 2%; lead – 4%; other admixtures – 1%

6. Summary

Metals began to be used as early as the Neolithic Age; with time, they became the basic material in the production of tools, weapons, ornaments and many other categories of artefacts. The first metals thus processed were copper, gold and silver in their native states. Later on, copper and silver, but also tin and lead were obtained by smelting ores in crude furnaces. The invention of the first alloy, bronze, was of great significance for the development of culture and technology in the important civilizational period known as the Bronze Age. Alloys were gradually improved with admixtures that increased the scope of their properties and, consequently, their use.

The preserved archaeological finds from present-day Krakow-Nowa Huta, mainly burial goods, illustrate the developing use of metals both in imports and in local production: from the first artefacts made of pure copper with a small amount

of contaminations (bracelets from Cło and Wyciąż) to the first bronzes (sickle from Mogiła). The bronze artefacts themselves signify that technology evolved from two-component Cu-Sn bronze, through three-component Cu-Sn-Pb material in the Celtic period (Krzesławice torque), to Cu-Zn-Sn-Pb bronze in the Early Middle Ages (buckle from Zesławice). As iron gained popularity, the role of bronze gradually diminished, though the alloy was always valued as an excellent material used in the production of ornaments, vessels, artistic everyday items or statues.

The metallurgic and casting traditions in the area of Krakow-Nowa Huta were confirmed when Jan Thurzo founded his copper smelter operating at the back of the Cistercian Abbey in Mogiła in the late 15th century [4, 5].

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