Metallurgy and Foundry Engineering – Vol. 39, 2013, No. 2, pp. 29–36
http://dx.doi.org/10.7494/mafe.2013.39.2.29

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ARCHAEOLOGICAL REMAINS OF THE COPPER METALLURGY IN LOWER SILESIA

ARCHEOLOGICZNE ŚLADY METALURGII MIEDZI NA DOLNYM ŚLĄSKU

Abstract

Many traces of copper metallurgy, such as slag and other copper melts, can be found in the area of Lower Silesia. The tested material mainly consists of copper slag with different content of copper melts, being a semi product. The copper metallurgy remains, discovered during the research, undergo specialistic analyses, which will help better characterise the findings as well as contribute to documenting metallurgical processes in the historical bloomeries in Lower Silesia, and moreover to prepare further research in this field. The material coming from the area of Miedzianka, being the oldest and the longest working exploitation centre of copper ores and pollymetalic ores, is of special significance for the research. Mining activity in the area of Miedzianka took place as early as the beginning of the 14th century, the first record from 1311 (*Cuprifodina in montubus*) is the oldest information concerning copper mining in Poland.
Keywords: copper metallurgy, archaeometallurgy, mining, smelting

Streszczenie

Dolny Śląsk jest terenem, na którym odnaleziono liczne ślady metalurgii miedzi w postaci żużli i wytopów miedzianych. Badany materiał stanowią głównie żużle miedzi o zróżnicowanej zawartości miedzi i wytopki miedziane, mające charakter półproduktu. Odkryte w czasie badań pozostałości metalurgii miedzi poddawane są specjalistycznym analizom, co pozwala na lepsze scharakteryzowanie znalezisk i przyczyni się do udokumentowania procesów metalurgicznych na terenie historycznie działających hut Dolnego Śląska oraz przygotowania dalszych badań w tym zakresie. Szczególnie istotny dla badań jest materiał metalurgiczny pochodzący z rejonu Miedzianki, będącego najstarszym i najdłużej działającym ośrodkiem eksploatacji rud miedzi i rud polimetalicznych na Dolnym Śląsku. Okręg górniczy w rejonie Miedzianki funkcjonował przynajmniej od początków XIV w., a pierwsza wzmianka na jej temat z 1311 r. (*Cuprifodina in montubus*) jest najstarszą informacją na temat górnictwa miedzi na terenie Polski.
Słowa kluczowe: metalurgia miedzi, archeometalurgia, górnictwo, hutnictwo

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1. Introduction

For several years, the sites connected with the extraction and processing of copper ores have been the subject of archaeological research in the area of Lower Silesia. It has led to a significant increase in the source database as well as the dissemination of knowledge about the discovered relics of mining and smelting works [1–5]. The research carried out in 2012 at the initiative of The Copper Museum in Legnica as part of the research project entitled "Researching the old copper mining and metallurgy sites" (project co-financed by the Ministry of Culture and National Heritage) has revealed six new sites connected with copper smelting and metallurgy in the area of historical districts of exploitation of copper ores in Lower Silesia (locality of Złotoryja, Leszczyna and Kondratów, Chełmiec and Jerzyków, Miedzianka and Ciechanowice). Their chronology, based on archaeological materials and cartographic and written sources, can be dated from the 14–16th to the 19th centuries, however, the majority of them can be dated from 17th to 19th centuries.

Beside the inventory and documentary work, as part of the project specialistic tests were also carried out. They proved the existence of metallurgy processes (slag, copper melt, and pieces of furnaces). The purpose of the analysis carried out by the Faculty of Foundry Engineering at the University of Science and Technology in Krakow was to characterise the findings more accurately. This article presents the results of the analysis of selected kilns, found in the vicinity of Chełmiec and Miedzianka.

2. Relicts of smelting activities in the vicinity of Chełmiec and Jerzyków (Kaczawskie Foothills)

The data concerning smelting activity within the mining area in the vicinity of Chełmiec and Jerzyków is extremely poor. During the work carried out there in the 16th century – Jerzyków (St. Georgenberg) obtained the status of a mining town – the exploited ore was probably carried to the smelter operating in Miedzianka, yielding 6750 kilos of pure copper and 4,4 kilos of silver [6] in 1547. At the same time, baron Georg Schweinichen, who was the owner of the local works, received a royal privilege, allowing him, among other things, to build a smelter in Chełmiec. K. Wutke states that in 1558 a couple of cartloads with 'heavy' ore were sent in order to be smelted in Kutna Hora [7]. Mining works in Chełmiec ceased in the 16th century. The smelter was not built here until the second half of the 19th century. It was active until 1867 when production was suspended for economic reasons. The closed smelter was purchased in 1872 by the miners' cooperation, Stilles Glück (Ciche Szczęście), exploiting copper ores in nearby Leszczyna and Prusice. The object was adapted for the smelting of copper matte, desilverisation of lead and producing black and pure copper [8]. In 1876, it consisted of three shaft roaster kilns, two reverberatory roaster kilns, one reverberatory kiln for smelting of copper matte and one refining kiln [6]. The remains of the kilns were found during the field work in 2012. The basis for determining the location was an archival topographic map from the second half of the 19th century of the Chełmiec area (Fig. 1), where the said object was marked as a former copper smelter (ehemalige Kupferhütte). The samples of copper smelting were retrieved from the site – here marked as Chełmiec site 22 (AZP 81-20, site 51).

The material was analysed macro- and microscopically (Figs 2–5), the chemical composition was analysed as well.

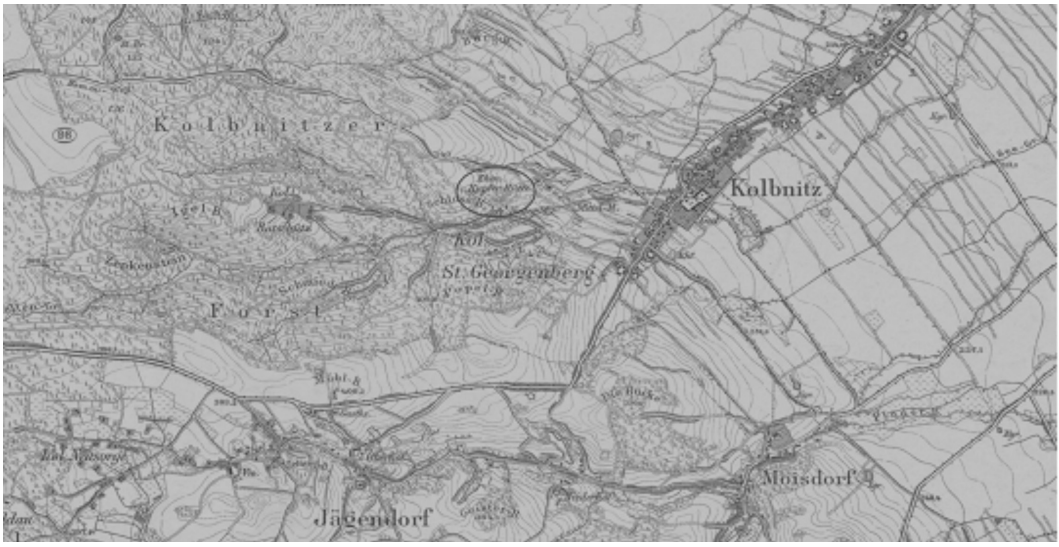

Fig. 1. The fragment of a topographic map in scale 1:25000 in Chełmiec area (no 2886 Kolbnitz ed. of 1888) The collection of Staatsbibliothek zu Berlin

a) b)

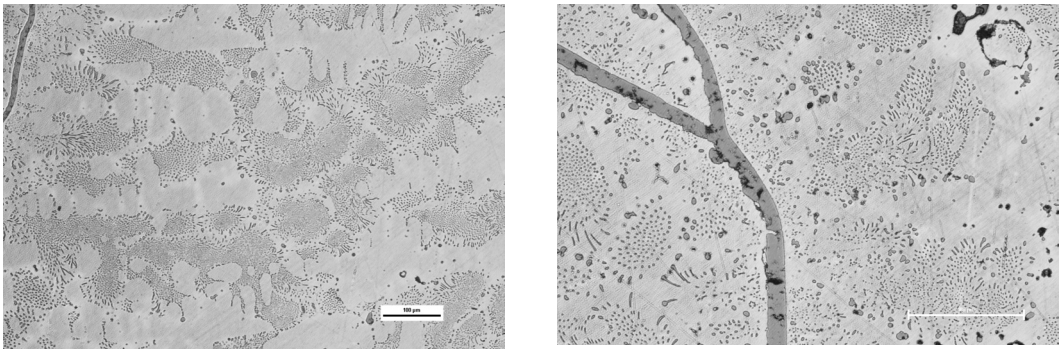

Fig. 2. The microstructures of archaeological material from Chełmiec (site 21) marked CH01a,b. The visible structure of copper with its oxygen eutectic Cu_2O and metallic contamination. Magnification of 100x (a) and 200x (b)

a) b)

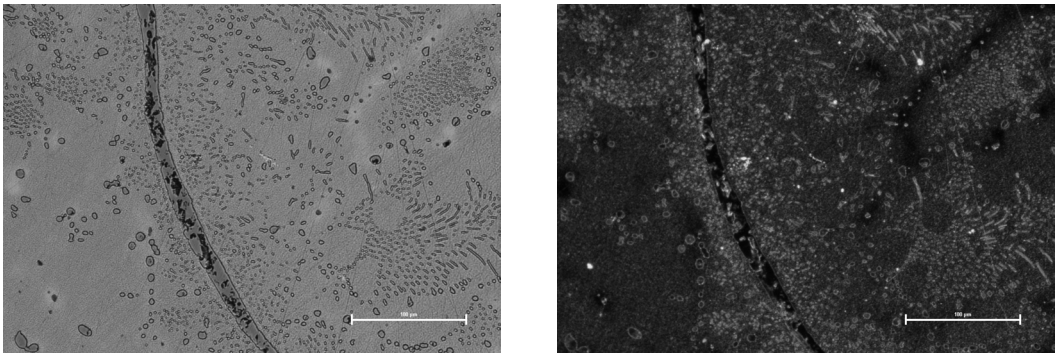

Fig. 3. The microstructures of archaeological material from Chełmiec (site 21) marked CH01a. The visible structure of copper with its oxygen eutectic Cu_2O and metallic contamination. The image in the bright (a) and dark field (b). Magnification of 200x

a) b)

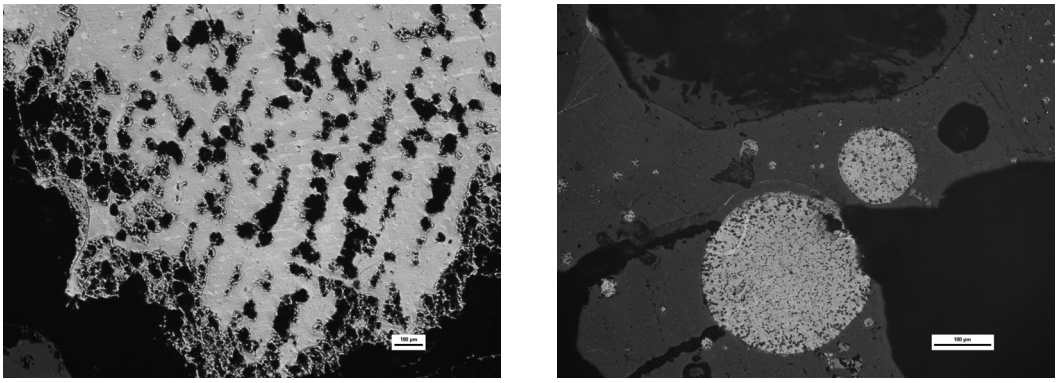

Fig. 4. The microstructures of archaeological material from Chełmiec (site 21) marked CH02a. Visible structure of copper semi product (a) and characteristic copper drops in the area of copper slag (b). Magnification of 50x (a) and 100x (b)

a) b)

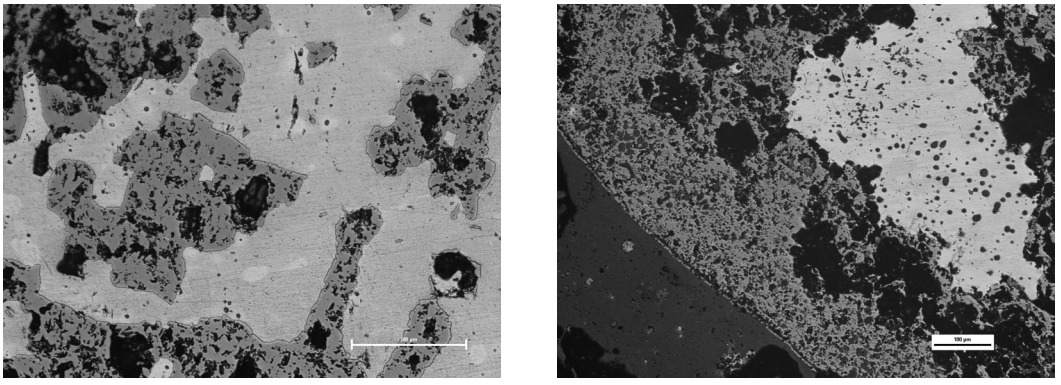

Fig. 5. The microstructures of archaeological material from Chełmiec (site 21) marked CH02a,b. Visible structure of copper semi product and slag phase. Magnification of 200x (a) and 100x (b)

In samples marked CH01 (Figs 2 and 3), the microstructure of copper from Cu-Cu_2O is easily seen. The examples presented in the Figures 2 and 3 indicate the existence of dendritic copper crystallites with oxygen eutectic and local contamination. The samples marked CH02 include slag mixture with copper pieces and precipitates of metallic spherical drops of various size. In the area of metallic copper there is contamination similar to that found in the example of CH01. In the tested structures, micro-precipitates of intermetallic phases and structural defects are visible.

3. Relics of smelting activity in the area of Miedzianka and Ciechanowice (Rudawy Janowickie)

The mining area in the vicinity of Miedzianka operated at least from the beginning of the 14th century. The first documented record about Miedzianka, being at the same time the oldest information about copper mining in Poland, dates to the beginning of the 14th century. At that time, Albert, known also as Bavarus Baier (or Beier) was the owner of Miedzianka at that time. Besides holding the title of the lord of Mniszków, he had

a nickname of de Cuprifodina in montibus [4]. This term was a Latinised form of the German name of the village (Kupferberg). It may be connected with the fact that Miedziana Góra – Kupferberg, was the centre of the Albert's family domain and copper was probably exploited there at that time.

From the 14th to 19th century mining activity in the vicinity of Miedzianka and Ciechanowice was one of the biggest centres of exploiting this metal in Lower Silesia. According to the data cited by T. Dziekoński [9], at the peak of the mining activity in Miedzianka (from the 14th to 16th century) copper production could amount to approximately 1000 tonnes, and till the beginning of the 19th century its total production amounted to a weight of 2300 tonnes.

During works in 2012 in the vicinity of Miedzianka, two sites connected with smelting activities were found (Fig. 2: these are Miedzianka 2 (AZP 84-18, site 22) and Janowice 7 (AZP 85-18, site 13). As far as the latter one is concerned, one can agree with the thesis of T. Dziekoński [9], claiming that a significant accumulation of copper slag in the area of Slag Valley (Polish: Dolina Żużlowa; German: Schlackental) – where slag heaps are accumulated in a stretch of about two kilometres – resulted from the fact that smelters ran there probably in the earliest stages of the mining centre development, but mainly it was a consequence of bringing old slag there in the 16th in order to retrieve vitriolic water from it. Brothers Franz and Hans Hellmann, who were the owners of Miedzianka from about 1545 to 1562, built a leaching plant there, where iron and copper vitriol, and probably also copper were produced [4, 9].

Until the 18th century the sources remain silent about the location of places connected with smelting of copper ores in the area of Miedzianka. T. Dziekoński states [9], not providing the sources, that in the 16th century copper smelting was probably in Miedziany Potok Valley, in the southwest of Miedzianka. From 1720s to 1747 the smelter together with its ore-stamp mill (the place of the processing ore) was located in the east from Miedzianka, in the area of Ciechanowice (Ciechanowice 14; AZP 84-18, site 18).

After Hans Friedrich von Schweinitz started mining activities in the area of Ciechanowice, the miners' cooperation which belonged to Adam Samuel Jagwitz and had been operating in the proximity of Miedzianka since 1728, founded the second smelter. It was located in the valley of Miedziany Potok.

An ore-stamp mill and a washery were also founded in this area (Fig. 6). This object has been currently marked as Miedzianka site 2 (AZP 84-18, site 22), but the remnants of the old smelter objects are, in contrast with the buildings of a smelter in Ciechanowice, poorly recognisable. Currently, what can prove the existences of this complex here, are two large earthen terraces, where the buildings connected with the functioning of the smelter were located.

Fig. 6. A fragment of a map of Miedzianka from 1784 (tracing from 1784) with the area of Jagwitz smelter marked (OBB II 1072). 1 – smelter buildings, 2 – ore-stamp mill buildings, 3 – the course of Miedzianka brook, 4 – pond for smelting, 5 – pond for ore-stamp mill, 6 – an inlet of Neu Glück. Collection of National Archives in Katowice

According to sources, the 18th century smelter was equipped with two so-called curved kilns, a kiln for smelting black copper, and a refining kiln. Bellows provided blast for the smelting devices. The smelting activities were carried out until 1776. In 1785 the old Jagwitz's smelter was purchased by the owner of the Einigkeit mine, Preller, who modernised it building a new ore-stamp mill as well as improving the kilns. The smelter worked until 1806.

During the archaeological work in 2012, besides some measurements being taken (Figs 7a and 7b) and non-destructive testing conducted with a gradiometer and GPR, some archaeological material was collected from the site. There were single pieces of ceramics, slag as well as copper and lead melts. Preparation of further research was based on the sources analysis concerning the history of copper metallurgy technology [9–11].

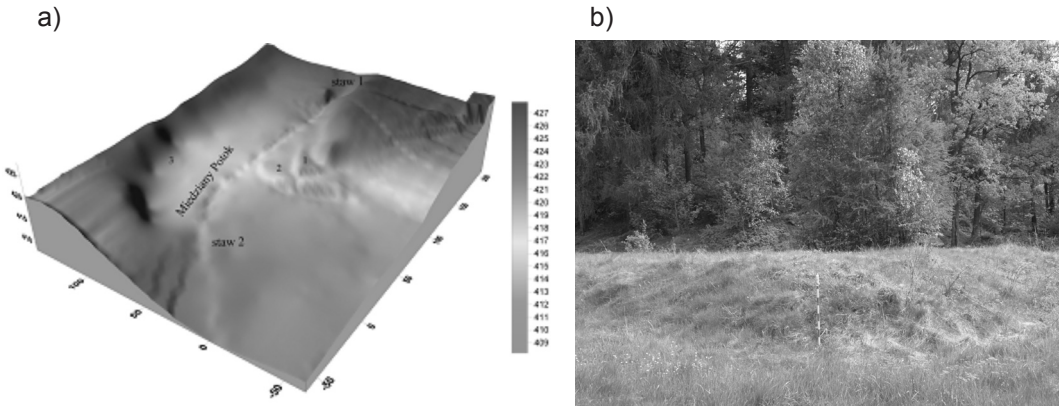

Fig. 7. Miedzianka site 2 (AZP 84-18, site 22): a) Measurement plan made in 2012, 1 – upper terrace, 2 – lower terrace, 3 – entrance of the mine adit Neu Gluck; 4 – pond 1 (smelter's pond); 5 – pond 2 (ore- stamp mill pond; see Fig. 6); b) earthy upper terrace (see Fig. 7a), view from the north side. Results rendering and photo T. Stolarczyk

Selected material was analysed by using thermal methods (TA and DTA), which involved plotting the cooling curve of the analysed samples. The thermal analysis of the materials allows us to determine the characteristic temperatures of phase transformations in the process of the cooling samples. In the samples of Chełmiec (marked CH01 and CH02) the most characteristic points are designated temperatures T_1 and T_2. The occurring thermal effect which can be noticed on the curve dT/dt as the intersection with the zero axis, determines that temperature T_2 is the stable temperature of the crystallising sample, whereas temperature T_1 as the metastable temperature of maximum supercooling. In the case of the sample CH01 the temperature T_3, and CH02 – the temperature T_5 mark the end of solidification.

From the course of the curves for CH01 and CH02 included in the Figures 8a and 8b one can draw a conclusion about the noticeable thermal effects at the temperatures below 1083°C, and the end of the solidification process can be seen at the temperature below 1045°C. In the example of CH02 sample, minor thermal effects are noticeable in the range between 1000–800°C. This data indicates the fact that it is the process of copper solidification with the contamination of the Cu_2O or with other types of metallic contamination.

In the graph ATD, which graphically presents the process of the cooling of the sample from Miedzianka (marked MIE A), only temperatures T_1 and T_2 can be set, which will determine the beginning and the end of cooling of a given sample. The characteristic curve of the thermal analysis dT/dt suggests that the sample is a slag material, solidifying in the temperature range of 1115–980°C.

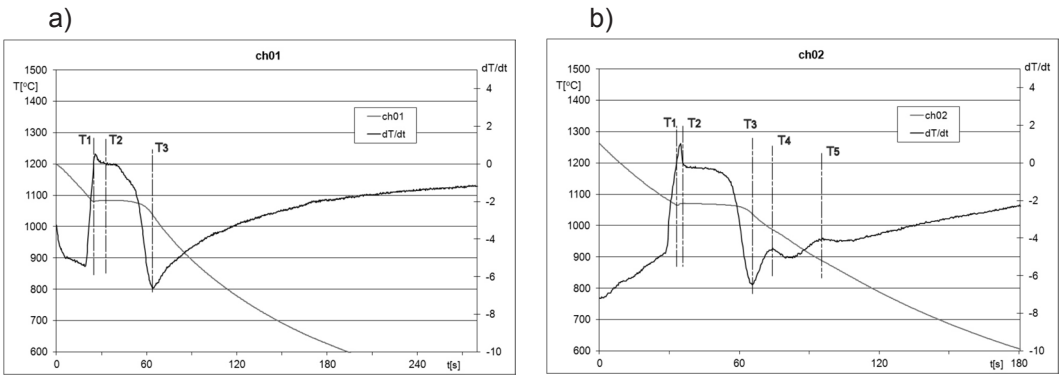

Fig. 8. Cooling curves of archaeological material from Chełmiec (site 21) marked CH01 (a), CH02 (b)

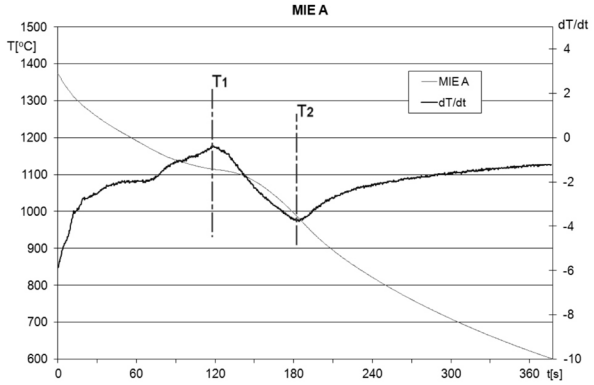

Fig. 9. Cooling curves of archaeological material from Miedzianka (site 2) marked MIE A

4. Conclusion

The tested material mainly consists of copper slag with different content of copper melts being a semi product. In these materials in the slag area, there appear precipitates of metallicspherical droplets with varied dispersion, containing copper and other contaminations, including Cu-Cu_2O. Copper melts are semi-products in character and they were intended for further processing. The remains of copper metallurgy, which were discovered during the research and subject to further specialistic analyses, allow us to presume that smelting processes were carried out in these areas. The material coming from the area of Miedzianka, being the oldest and the longest working exploitation centre of copper and pollymetalic ores in Lower Silesia, is of the greatest significance for the research.

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