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THE SECOND HOARD FROM STRZELCE KRAJEŃSKIE (2014) – PRELIMINARY STUDIES AND METAL ANALYSES OF SELECTED COINS

ABSTRACT

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The second hoard from Strzelce Krajeńskie was discovered in 2014. The assemblage consists of at least 1948 coins. The article presents the interdisciplinary study of 109 of these coins. Apart from all Prague groschen, wittens, hellers and Jagiellonian pennies also 10 Brandenburg and 70 West Pomeranian pennies were loaned for this project by the museum where the assemblage is housed. Care was taken to select the most statistically representative sample possible. Twenty *Vinkenaugen* from the Szczecin mint were selected – as well as ten pennies minted in Gryfino, Koszalin, Słupsk, Stargard and Kołobrzeg. Additionally, 48 coins were subjected to a metallographic analysis – 18 Prague groschen of Wenceslas IV, two pennies of Vladislaus III, two Mecklenburg and three West Pomeranian wittens, four coins identified as Silesian hellers and 19 West Pomeranian pennies.

The results we obtained demonstrate the benefits of collaboration between numismatics and natural sciences. Interdisciplinary research conducted on part of the second hoard from Strzelce Krajeńskie reveals its research potential and value as an archaeological source for the study of monetary history.

Keywords: Strzelce Krajeńskie, hoard, Prague groschen, *Vinkenaugen*, metallographic analyses
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INTRODUCTION

In the history of Polish numismatics there have already been cases of two hoards discovered in the same location, a phenomenon which provokes questions of whether they may be parts of one hoard or two separate finds. Each time, this issue requires careful examination, as there are known cases of pairs of hoards with the same chronology and very similar composition, which are nevertheless clearly separate assemblages. The best-known case from Poland are the hoards from Środa Śląska (Środa Śląska District, Lower Silesia Province). Both hoards are very rich – each comprises over 3,500 coins and the second one also contains a royal crown, brooches and other jewellery. The two hoards have a similar chronology, the *terminus post quem* for the first one has been set at 1340 and for the second one at after 1350. Unfortunately, in spite of more than three decades from their discovery, they have not received a complete monographic publication, but only a large number of shorter or longer, widely scattered, references and a few book entries, which, however, cannot be considered critical source monographs and certainly do not exhaust the subject. The first hoard from Środa Śląska discovered in 1985, consisting solely of 3773 items, mainly Prague groschen of John the Blind (1310-1346) and six Meissen groschen of Frederick II (1323-1349). It has been mentioned in print at least several times, with its description also included in the inventory of medieval finds from the territory of Poland, but has never been properly analysed (Piniński 1990a, 63-65; Idem 1990b, 194-200; Kubiak 1998, 255, no. 760/I). The second Środa Śląska hoard was discovered in 1988. Apart from 3,963 coins (mainly the Prague groschen of John of Luxembourg, amounting to 3,824 specimens and 39 gold coins, among which Hungarian florins predominate) this assemblage also consists of opulent jewellery and a monarch's jewels. The second hoard from Środa Śląska aroused much greater interest among researchers and has been the subject of considerable literature (Kubiak 1998, 255-256, no. 760/(II); Pieńkowski 2002; Żerelik ed. 2006; Borowski and Błażejewski eds 2011; Witecki 2018).

The second similar case are the hoards from Mstów (Częstochowa District, Silesian Province), discovered in September 1961 and May 1963. While there was no supposition that the finds could be two parts of a single hoard, it should be noted that they were discovered relatively close to each other. Both hoards differ in the number of coins, composition and chronology. The first assemblage, discovered in 1961, consisted of more than 650 coins, mainly Jagiellonian pennies and half-groschen and quite a number of Prague groschen of Charles IV and Wenceslas IV. It had been deposited after 1434, and its *terminus post quem* is determined by the crown pennies of Vladislaus III (1434-1444). The second hoard, found in 1963, is a homogeneous find of 109 Prague groschen of John the Blind (1310-1346) and Charles IV. It was buried after 1370 and the youngest coin is a Prague groschen of the Charles VI type Pinta V.b, minted between 1370 and 1375 (Kazanowicz-Milejska and Milejski 2021, 142, 143). Both hoards have been described in detail in the inventory of medieval finds (Kubiak 1998, 190, no. 532/I; Kubiak 1998, 190, no. 532/II),

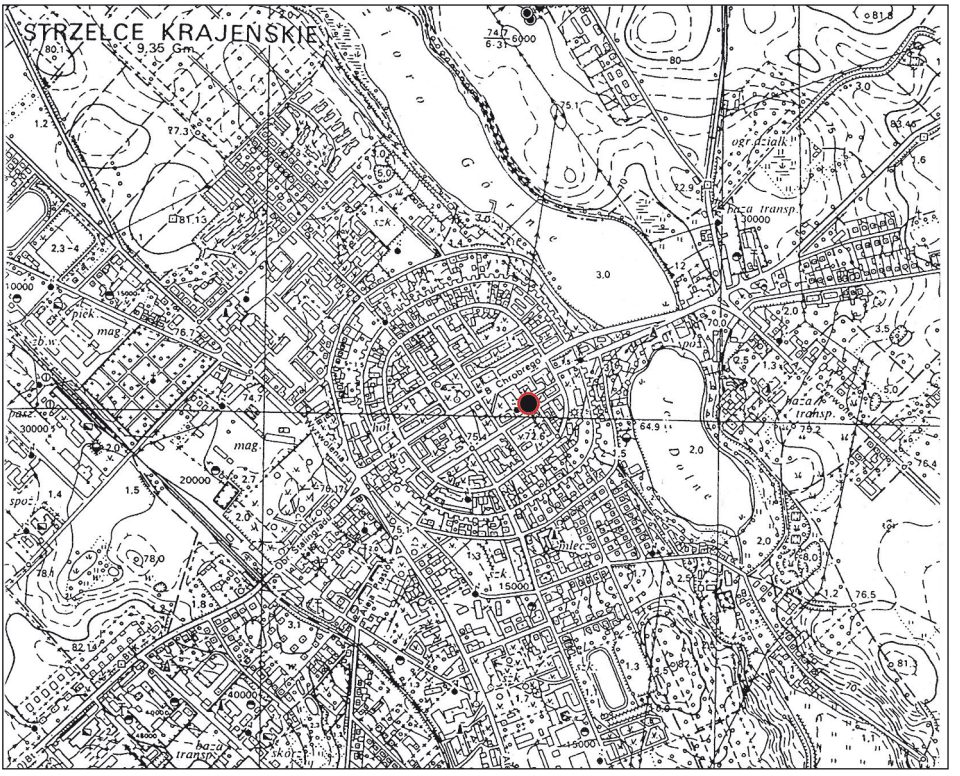

Fig. 1. A map of Strzelce Krajeńskie, the black dot with a red border marks the location of the 2014 hoard discovery (after Kaźmierczak 2016, 119, fig. 1)

and a detailed study of the homogeneous find of the Prague groschen has recently been printed (Kazanowicz-Milejska and Milejski 2021).

The last example of this phenomenon worth mentioning and which will be the main subject of this article, are the hoards from Strzelce Krajeńskie (district of Strzelce-Drezdenko, Lubusz Province).

The first hoard from Strzelce Krajeńskie was discovered in June 1977, within the town walls, in today's Katedralna Street (then Franciszka Jóźwiaka Street). It consisted of 2,783 coins, mainly small Pomeranian pennies (*Vinkenaugen*), two Jagiellonian pennies and eight Prague groschen of Wenceslas IV (Szczurek 2017, 51-94, 100, table 1). Polish numismatics had to wait almost 40 years for a complete study of this find, but the painstaking work of T. Szczurek, whose studies on the first Strzelce Krajeńskie hoard are a valuable basis for further research, should be fully appreciated. The second hoard from Strzelce Krajeńskie was discovered during archaeological research in Ludowa Street, conducted in 2014-2015 (see Fig. 1). The archaeological supervision was carried out by Paweł Kaźmierczak from the Jan Dekert Lubusz Museum in Gorzów Wielkopolski and the most valuable

Fig. 2. Coins from the Strzelce Krajeńskie hoard before conservation, photo by P. Kaźmierczak

outcome of the research was a hoard of late medieval coins (Kaźmierczak 2016, 119-124). With the use of a metal detector and the help of volunteers, it was possible to find 1948 coins in the excavation and on the heaps, which probably make up the main part of the hoard. The exact number of coins that made up the deposit is not known, because not all the coins have been accurately counted and documented. The number of coins discovered there is quoted after Kaźmierczak 2016, 125. All the discovered coins were heavily corroded and patinated, which is reflected in their state of preservation. Many of the coins were stuck together, forming clusters of five to eight, and while separated, part of the surface of one specimen remained stuck to another. This affected the completeness of the preserved coins and their measured weight is often much too low (Fig. 2).

The hoard from Strzelce Krajeńskie discovered in 2014 is far less numerous than the first assemblage discovered in this locality. It should be noted, however, that its composition, although strongly similar, is definitely more interesting and more varied than the 1977 hoard. The core of the find is composed mostly of West Pomeranian pennies, the so-called *Vinkenaugen*, of which about 1880 occurred in the recovered material from this hoard. Among numerous municipal and episcopal issues, *Vinkenaugen* minted in Szczecin and Stargard prevailed. Apart from these two centres, municipal coins from Trzebiatów, Goleniów, Gardziec, Uznam, Koszalin, Kołobrzeg and Słupsk were also recorded. The second most numerous group of coins are Brandenburg pennies, very similar to West Pomeranian pennies, minted in Prenzlau in Uckermark, during the reign of Frederick I (1415-1440). About 40 such specimens were discovered. There is also a noticeable group of Prague groschen, which are at the same time the largest denomination recorded in the studied find. There were 18 Bohemian groschen, all with the titles of Wenceslas IV (1378-1419). Apart from the Bohemian coins, the larger denominations were represented by five Hanseatic wittens. A most interesting feature is a small number of imitations of Silesian

hellers, which have tentatively been identified as Silesian coins from an official mint. The smallest part of the hoard consists of two Jagiellonian pennies, undoubtedly dating from the times of Vladislaus III (1434-1444). No ceramic vessel in which the coins may have been hidden was found in the immediate vicinity of the discovery site. There were only fragments of fabric, which in several places were covered with patina identical with that found on the coins. We can therefore conclude that the hoard was wrapped in fabric and only then placed in a container. Perhaps it is possible that the hoard from Strzelce Krajeńskie could have been held in a protective container made of organic materials – for example, a wooden box, like the hoard of Prague groschen from Oleśnica (Milejski 2015, 17-18)- which would explain the lack of any remnants of such protection. It is also possible that was a ceramic vessel or a clay pot that was lined with fabric and filled with coins. We suppose that a find of this size could have been hidden in one large or in two medium-sized ceramic vessels, as in the case of the hoard of 1385 Prague groschen from Boguszów-Gorce (Rodak 2020, 127-133; Miazga and Miazga 2020, 155-166).

MATERIALS AND METHODS

For the time being, the size of the assemblage makes a full study of the second hoard from Strzelce Krajeńskie impossible. Ideally, we would conduct a research project focused on this find alone, which could finance the necessary analyses, photographic documentation of all the coins and physical and chemical studies that would enrich the monographs of the hoard. Taking advantage of favourable circumstances, namely two simultaneous grant projects carried out at the Institute of Archaeology of the University of Wrocław and devoted to similar issues, we were able to select 109 numismatic items from all the coins comprising the second Strzelce Krajeńskie hoard, which were described in detail and photographed, with 48 specimens subjected to metallographic tests. The main aim of the research was to study the structure of the hoard from Strzelce Krajeńskie, and in particular to analyse and describe the mint alloy of the Prague groschen found there. The imitations of Silesian hellers, very uncommon in finds, were also selected for analyses, as their rarity made us particularly interested in their chemical composition. An additional aim was to examine all the smaller components of the hoard – the Mecklenburg and West Pomeranian wittens and the Jagiellonian pennies. It was also important to analyse the core of the entire find, which consisted of West Pomeranian pennies, in order to determine the cities of issue and the quality of the coins, which so far have not been thoroughly studied by Polish researchers.

Unfortunately, only about 1/20th (5%) of the total find has been studied. Among the 109 coins borrowed for this study from the museum housing this material, there were all the Prague groschen, wittens, hellers and Jagiellonian pennies from the Strzelce Krajeńskie hoard. Additionally, 10 Brandenburg and 70 West Pomeranian pennies were studied. Care

was taken to select the most statistically representative sample. Twenty *Vinkenaugen* from the Szczecin mint were selected – ten of each of two different types (DbgP 253 and DbgP 353d) – as well as ten specimens minted respectively in Gryfino, Koszalin, Słupsk, Stargard and Kołobrzeg – the mints of the Kamień Bishopric.

All the coins that constituted smaller groups within the described hoard were selected for metallographic analyses, including: 18 Prague groschen of Wenceslas IV (cat. nos 11-28), two Jagiellonian pennies of Vladislaus III (cat. nos 35-36), two Mecklenburg and three West Pomeranian wittens (cat. nos 29-30; 37-39) and four specimens tentatively identified as Silesian hellers (cat. nos 31-34). The remaining 19 specimens, whose mint alloy was checked, were West Pomeranian pennies – six from the Bishopric of Kamień (cat. nos 42-46, 48), five from Gryfino (cat. nos 52, 56-59) and eight from Szczecin, four of each variety (DbgP 353d, cat. nos 91, 92, 94, 95; DbgP 253, cat. nos 100, 103, 104, 109). Specialised analyses were carried out primarily by energy dispersive X-ray fluorescence spectrometry (ED-XRF), which was used to examine all the selected coins. Analytical studies were performed with Spectro Midex spectrometers, featuring an X-ray tube with a molybdenum anode, which gave an excitation energy from 44 to 50kV and a current of 0.3-0.4mA. The spectrometers had SDD detectors cooled with the Peltier effect. Additional equipment included a 20x magnification CCD camera that allows a precise selection of the examined area. Owing to their variable collimators, XRF spectrometers guarantee spot analysis for micro-areas with a diameter of 0.2-1.0 mm. The instruments were calibrated using certified reference materials and the analytical results were averaged and normalised to determine the content of the main components of the mint alloy.

Some of the coins were additionally examined using a scanning electron microscope coupled with an EDS spectrometer. SEM-EDS analyses were performed with a Hitachi Tabletop TM4000 benchtop scanning microscope with an Oxford Instruments spectrometer (AZtecOne software). Microscopic measurements were performed at the excitation energy of 15kV and in a low vacuum mode with the use of a BSE detector. This examination was designed to verify the previous XRF measurements and determine the amount of surface silver enrichment. The coins were prepared for metallographic examination by grinding and polishing the edge with abrasives containing corundum.

RESULTS AND DISCUSSION

West Pomeranian *Vinkenaugen*

The second hoard from Strzelce Krajeńskie is dominated by small West Pomeranian coins, the so-called *Vinkenaugen*, which were minted in various municipal and episcopal centres from around the mid-14th century. In the analysed hoard, municipal pennies of many West Pomeranian towns were recorded, but only some of them were present in the

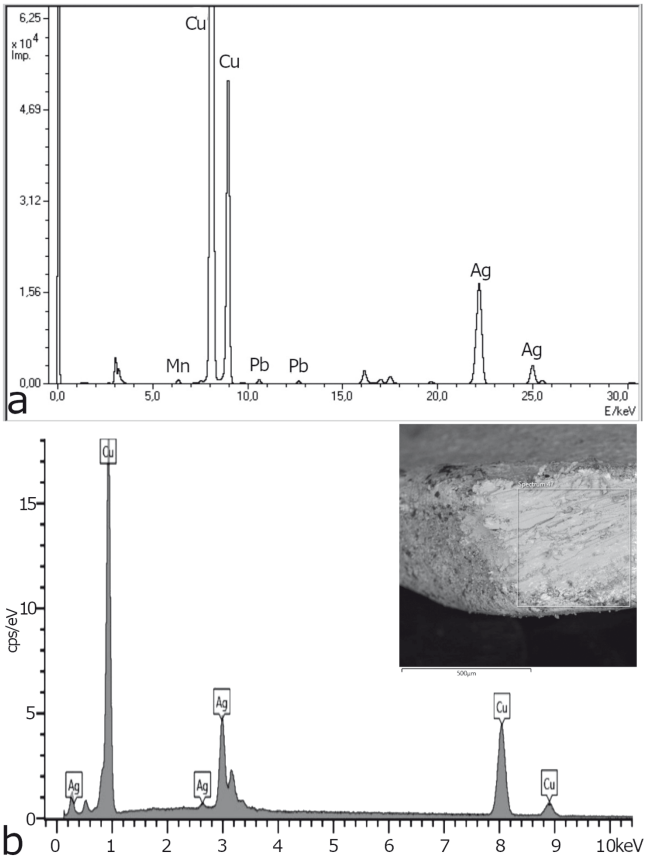

Fig. 3. XRF (a) and EDS (b) energy spectra of a selected Szczecin *Vinkenaugen* (cat. no. 93)

sample examined. A total of 70 West Pomeranian pennies were submitted for examination. These were ten specimens from Gryfino, Koszalin, Słupsk, Stargard and the Bishopric of Kamień and 20 from Szczecin (ten specimens of two separate types). Additionally, 19 of the coins in the sample were metallographically examined.

The main body of the hoard is made up of Szczecin pennies of two basic types – the first, with a majuscule letter C and a five-pointed star in the centre (DbgP 353d) and the second with a griffin's head looking to right (DbgP 253). The dating of both varieties of the Szczecin pennies is rather problematic, as we are not able to determine their specific chronology and can only propose approximate chronological limits. Both varieties are clearly 15th century ones, as was already pointed out by Hermann Dannenberg (Dannenberg 1893, 100, 127-131). We are able to more precisely determine the beginning of the issue of type DbgP 253, which most probably started after 1408, when the Szczecin mint introduced

Table 1. The content of selected metals in West Pomeranian pennies minted in Szczecin, DbgP 353d determined by XRF testing (%/weight)

Cat. No.	Place of research	Fe	Ni	Cu	Zn	As	Ag	Sb	Au	Pb	Sum
101	core	0.0	0.2	84.6	<LOD	<LOD	14.7	<LOD	<LOD	0.2	100.0
102	core	0.1	0.1	86.2	<LOD	<LOD	13.0	<LOD	<LOD	0.5	100.0
104	core	0.0	0.1	83.7	<LOD	<LOD	15.8	0.1	<LOD	0.2	100.0
105	core	0.1	0.2	84.8	<LOD	<LOD	14.1	0.1	<LOD	0.6	100.0

<LOD (below Limit Of Detection)

Table 2. The content of selected metals in West Pomeranian pennies minted in Szczecin, DbgP 253, determined by XRF testing

Element/Cat. No.	90	93	94	99
Fe	<0.1	<0.1	0.6	0.1
Ni	0.1	0.1	0.5	0.1
Cu	82.3	70.9	86.3	63.5
Zn	<0.01	<0.01	<0.01	<0.1
Ag	16.7	28.2	11.8	35.6
Au	<0.02	<0.02	<0.02	<0.02
Pb	0.8	0.8	0.8	0.7

four-penny coins (firchen, in Low German firken) with representations analogous to those on the pennies (Paszkiewicz 2011, 289, 292; Piniński 1976, 19). On the other hand, we can only date the DbgP 353d variant broadly to around the middle of the 15th century. The dominance of the Szczecin coinage in collective finds composed of *Vinkenaugen* is quite a common pheno-menon and so noticeable that, irrespective of the minting location, an alternative name was formed for the West Pomeranian pennies, which became referred to as Szczecin pennies (Kiersnowski 1962, 12). Eight Szczecin *Vinkenaugen*- four of each variety – were examined metallographically. Pennies of type DgbP 353d are characterised by a strongly similar elemental composition of the mint alloy. The most dominant component is copper, constituting 83.7-86.2% of the alloy, with a small but significant (13.0-15.8%) admixture of silver. Also noticeable is the presence of lead, determined at 0.2-0.6% (Figure 3). As can be seen, Szczecin pennies from the fourth-fifth decade were minted from 130-158/1000 silver, which translates into 2-3 lots (purity of silver was determined in lots (in Polish łuty), 1 lot means 6.25% of pure silver, 16 lots gives 100% pure silver). We expected such a result, as it is commonly believed that West Pomeranian pennies were minted from low quality mint alloy with a predominance of copper. The expected limit for the base silver used for minting these coins should not exceed 3 lots.

We can compare the results obtained from the examination of *Vinkenaugen* DbgP 353d with the analysis of the Szczecin pennies DbgP 253 (see Tables 1 and 2). In the case

of the older of the Szczecin pennies, we can see a greater variation in the quality of the mint alloy in individual specimens. Copper continues to dominate at 63.5-86.3%, with silver ranging between 11.8-35.6%. The coins with cat. nos 90 and 94 represent the poor standard of pennies with the letter C on the obverse. However, the analyses of the pennies with cat. nos 93 and 99 let us assume that the quality of the silver used to mint Szczecin pennies in the early 15th century was better. The sample of the examined coins is relatively small and does not allow for the definite conclusion on the improvement of the minting standard in Szczecin at the beginning of the new century.

The next significant group of coins in the second hoard from Strzelce Krajeńskie are issues of the Kamień Bishopric, which minted its coins in Kołobrzeg. The sample of coins studied here contained two variations of the basic type DbgP 186, with two crossed croziers on both sides of the coin. The first variety, DbgP 186b has pellets around the croziers while on the second variety, DbgP 186c, there is a St. Lazarus cross below the croziers. The right of minting of the Bishopric of Kamień, together with the mints that produced the bishop's pennies, were studied by Ryszard Kiersnowski, who nearly 60 years ago revised the views on the subject (Kiersnowski 1962). Based on his studies, until recently the *Vinkenaugen* of type DbgP 186 were considered municipal coins of Kołobrzeg, issued after the bishop's authority over the Kołobrzeg mint had ceased (Kiersnowski 1962, 21-23). However, a new and more acceptable hypothesis has recently been proposed regarding the attribution and chronology of these coins. Borys Paszkiewicz, while examining an interesting hoard found on the Brandenburg-Pomeranian borderland, in the area of Barlinek and Choszczno, *i.e.* an area very close to Strzelce Krajeńskie, suggested that the coins should be attributed to the Bishopric of Kamień. He made an interesting observation that can influence their chronology. The fact that the coins are absent from the hoards discovered in Cieszyno (Koszalin district, West Pomeranian Province) and Kłodzino (Pyrzyce district, West Pomeranian Province) and appear for the first time only in the hoard from Pyrzyce (district city, West Pomeranian Province), where they very smoothly replace the DbgP 185 pennies, which immediately preceded the analysed pennies with croziers on both sides, makes it possible to date the coins to the first decade of the 15th century (Paszkiewicz 2011, 290, 291).

Six bishopric pennies were submitted for a metallographic examination – three variants of DbgP 186b (cat. nos 42-44) and three DbgP 186c varieties (cat. nos 46-48), whose detailed data is presented Table 3. It may be noted that, irrespective of the variant, the bishopric pennies are characterised by copper concentrations of 72.3-85.8%, with a predominance of coins with 72-79% of the metal. The silver content in these pennies ranges between 19-26%, which means that the coins were minted from 3-4-lot silver (190-260/1000). Studies of the mint alloy of 15 bishopric pennies of the DbgP 186a variety and its variants may serve as comparative material. These coins come from a hoard consisting of 453 *Vinkenaugen* of the bishops of Kamień, discovered in August 1989 in the historical centre of Kołobrzeg (Kubiak 1998, 145, no. 413/I). The pennies from the Kołobrzeg hoard

Table 3. The content of selected metals in West Pomeranian pennies, Bishopric of Kamień, DbgP 186, struck in Kołobrzeg, determined by XRF testing (%/weight)

Cat. No.	Place of research	Fe	Ni	Cu	Zn	As	Ag	Sb	Au	Pb	Sum
42	core	0.0	0.1	73.5	<LOD	<LOD	24.9	0.2	<LOD	1.1	100.0
43	core	0.6	0.1	72.3	0.0	<LOD	25.7	0.1	<LOD	1.1	100.0
44	core	<LOD	0.1	85.8	<LOD	<LOD	12.9	0.1	<LOD	0.8	99.9
45	core	0.1	0.1	74.0	<LOD	<LOD	26.1	0.1	<LOD	1.1	99.7
46	core	0.5	0.1	79.2	<LOD	<LOD	19.1	0.1	<LOD	0.9	100.0
48	core	0.2	0.1	77.7	<LOD	<LOD	20.5	0.1	<LOD	1.1	99.8

Table 4. The content of selected metals in West Pomeranian pennies minted in Gryfino, DbgP 339a determined by XRF testing (%/weight)

Cat. No.	Place of research	Fe	Ni	Cu	Zn	As	Ag	Sb	Au	Pb	Sum
52	core	0.2	0.1	78.6	<LOD	<LOD	20.0	0.1	<LOD	0.9	100.0
56	core	0.2	0.1	79.6	0.0	<LOD	22.6	0.1	<LOD	0.6	100.0
57	core	0.0	0.2	78.7	<LOD	<LOD	19.4	0.8	<LOD	0.6	100.0
58	core	0.1	0.1	79.9	<LOD	<LOD	19.0	0.2	<LOD	0.5	100.0
59	core	0.3	0.1	77.2	<LOD	<LOD	21.4	<LOD	<LOD	0.6	100.0

<LOD (below Limit Of Detection)

have a mint alloy similar to that of the examined coins from the Strzelce find. It should be noted, however, that the coins found in Kołobrzeg show an even higher level of copper, which only in two cases drops below 75%, and in the majority of the specimens ranges between 75-86%. At the same time, we can see a decrease in the silver content, which varies between 12.6% and 22.4%.

Another town whose pennies were included in the studied part of the hoard is Gryfino. On the obverse of the coins there is an isosceles cross with flared ends, with a large ring and a pellet inside placed in the centre of the cross. The reverse has an image typical of West Pomeranian *Vinkenaugen*, *i.e.* a griffin walking to the left. The type was already known to Dannenberg – DbgP 339 and 339a – who, however, attributed them to bishopric issues (Dannenberg 1893, 118). This view was revised by Ryszard Kiersnowski, who attributed the coins to an unspecified duke or town in Pomerania (Kiersnowski 1962, 9). However, this act of depriving the bishops of Kamień of these coins and attributing them to an unspecified city, did not solve the problem of determining the attribution of the pennies with a cross and a ring inside it. The Gryfino *Vinkenaugen* must have existed and functioned on the monetary market at least in the first third of the 15th century, because after the purchase of the New March, the Teutonic Order decreed to withdraw West Pomeranian

pennies from circulation. In 1439, the *vogt* Hans von Stocheim ordered that local coins should be minted in Arnswalde (Choszczno) and Schivelbein (Świdwin), ordering at the same time the withdrawal of Szczecin, Pyrzyce, Gardziec and Stargard coins. On the other hand, we know about a decree of a new *vogt*, Walter von Kirskorff, issued the following year, which prohibited the acceptance of Pomeranian coins, including also coins from Gryfino and Goleniów (Paszkiewicz 2011, 18). While analysing the occurrence of this type of coins in hoards and single finds from Pomerania and together with the dies used for minting the DbgP 339a pennies, Borys Paszkiewicz proposed a hypothesis, generally accepted, of attributing these coins to Gryfino (Paszkiewicz 2011, 17; Szczurek 2012, 101; Szczurek 2017, 109). We believe that their issue could have started in the last years of the 14th century or in the first years of the 15th century, since the Teutonic Order, included, among others, the Gryfino *Vinkenaugen* in the list of West Pomeranian coins intended to be purged from the New March market.

Five of the ten Gryfino pennies included in this study were subjected to metallographic examination (cat. nos 52 and 56-59). Specimens of this type of coin had never been subjected to specialist analysis before, which is the reason why the results of our examination were so important. The results presented in Table 4 show that the Gryfino *Vinkenaugen* were struck from a mint alloy very similar to that of other West Pomeranian pennies. It is practically two-component in nature – characterised by a high copper content of 77-79.9% and an approximately 20% admixture of silver. Also noticeable is the content of lead, which in some coins reaches around 1%. Other elements are present rather in trace amounts and often do not exceed 0.2%.

Another group of West Pomeranian pennies identified in the Strzelce hoard was struck in Słupsk (DbgP 258, cat. nos 70-79). The Słupsk *Vinkenaugen* are distinguished by three wavy lines on the obverse, which symbolise the Słupia River, while the reverse features a griffin walking to the left. Unfortunately, we have not been able to perform metallographic analysis on this group of pennies, but we know from the literature an individual analysis of their quality, which showed a silver content of 52.9%, a value significantly higher than the results we obtained in the earlier analysed groups of West Pomeranian coins. It should be noted, however, that the examination was carried out on the surface, probably enriched in silver after conservation procedures, or perhaps also after flan blanching, as was indicated by the authors of the research themselves (Miazga and Paszkiewicz 2018, 152, 153, 162). Słupsk coins dating to the first half of the 15th century should have been struck from a 234/1000 alloy and weighed 0.255 g, as announced in the mint agreement of Greifswald, Stralsund, Anklam and Demmin in 1428 (Miazga and Paszkiewicz 2018, 152). The *Vinkenaugen* from Słupsk found in the second Strzelce Krajeńskie hoard are heavier than stipulated in the agreement of the Wendish cities. The heaviest specimen weighs 0.354 g (cat. no. 75), and the weight of the next two is equal to or exceeds 0.300 g. The mean weight of all the Słupsk pennies from the analysed group is 0.269 g, which is significantly higher than the value agreed on in 1428. However, we must remember that

our data come from a selected group of only ten specimens, hence the relationship we observed may not be the rule.

The next town whose pennies were identified in the discussed hoard is Koszalin (DbgP 187, cat. nos 60-69). The obverse of the coins features the head of St. John facing, long haired and bearded, which differs slightly in its form on each specimen. On the reverse there is a majuscule letter Z, with a pellet on each side (this is a town sign of Koszalin, interpreted as a double hook). Hermann Dannenberg, in his work on Pomeranian coinage in the Middle Ages, distinguishes yet other varieties of this type, which differ primarily in the marks placed next to the letter Z on the reverse. Apart from the pellets we recorded, there might have also been annulets, saltires or stars. We also know other variants, featuring an inverted Z with additional symbols placed next to it (Dannenberg 1893, 83). However, only the basic variant of this DbgP 187 coin occurred in the sample of a portion of the hoard studied here. The chronology of these coins is not well determined, we date them to the first quarter of the 15th century (Dannenberg 1893, 82; Kiersnowski 1962, 15, 22-23). Among the analysed part of the Koszalin pennies we have not noticed a newly distinguished variety of these coins, characterised by a differently shaped image of St. John. The Saint's beard is much longer and clearly divided into six strands, the outermost of which are hair extensions. The reverse of the new variety is analogous to those previously recorded (Miłosz 2015, 206-209). It is possible that the analysis of the entire find and a thorough study of the Koszalin part of the Strzelce hoard will bring coins of this variety or specimens of new, so far unrecorded variants.

The last group of West Pomeranian *Vinkenaugen* in the studied portion of the second hoard from Strzelce Krajeńskie was struck in the Stargard mint (DbgP 243b, cat. nos 80-89). The obverse of the Stargard pennies has a broad six-pointed star with pellets between each ray and a centrally placed ring with a pellet inside it. On the reverse, there is the typical griffin walking to the left. We do not know the exact date when the town of Stargard acquired the mint, but on the basis of the existing numismatic material we can assume that it must have been in the 14th century (Paszkiewicz 2011, 285). There is a type of Stargard coins, with great iconographic similarity to the pennies described in this article, which Borys Paszkiewicz dates to the third quarter of the 14th century (Paszkiewicz 2011, 288, 291). This is type DbgP 236, with representations on both sides analogous to type DbgP 243b. The obverse lacks only the ring in the centre of a six-pointed star. We can suppose that the type with the ring, DbgP 243b, may have directly followed type DbgP 236. Therefore, we can propose the dating of the DbgP 243b Stargard pennies to the late 14th and early 15th centuries. This assumption may be supported by the composition of the Barlinek-Choszczno hoard, which contained pennies DgbP 236a, b and c without the DbgP 236 variant (Paszkiewicz 2011, 288). The absence of these coins from the aforementioned hoard suggests that the assemblage might be later, which supports our hypothesis that the chronologies of DbgP236 and DbgP 243b are similar.

Brandenburg pennies of Frederick I (1415-1440)

The largest addition to the West Pomeranian *Vinkenaugen* are Brandenburg pennies minted during the reign of Frederick I, Prince Elector of Brandenburg (1415-1440). Approximately 40 such specimens were recorded in the entire hoard (Kaźmierczak 2016, 125), and the sample studied here included ten of these coins for our analyses (cat. nos 1-10). The pennies are the only local coin found in the second hoard from Strzelce Krajeńskie. The coin was minted in Prenzlau, in the territory of the Uckermark (Paszkiewicz 2013, 17). The obverse of the coins shows an eagle facing to left. On the reverse there is an image of a tournament helmet, the so-called frog-mouth helm, facing to left. It is the representation on the reverse of the Brandenburg pennies that can help us with the dating of this type of coin. The tournament helmet was introduced into the coat of arms of Prenzlau in 1426, so we believe the pennies with this representation must have started to be struck that year at the earliest. In addition, we know the rent settlements from 1430 and 1436 of the mint operating at that time in Prenzlau (Paszkiewicz 2013, 20), which may confirm that coins with an eagle on one side and a tournament helmet on the other were struck from about 1426 to the end of the reign of Frederick I, namely till 1440. Brandenburg pennies are similar in shape and quality to West Pomeranian pennies. Unfortunately, no Brandenburg penny has been examined in terms of its mint alloy. The metrology of the Brandenburg *Vinkenaugen* parallels that of their West Pomeranian counterparts. The weight of the pennies with a tournament helmet on the reverse ranges from 0.160 to 0.312 g. One of the reasons for this relatively large span may be the coins' very poor state of preservation, as they had lost up to 30% of their weight during conservation procedures. The coins were struck from base silver, and we may assume that they were of a quality similar to that of the Pomeranian *Vinkenaugen*, struck from 2-3-lot (120-180/1000) silver. The flans of the Brandenburg pennies are of a rather irregular shape, and their diameters range between 10.1-11.1 mm.

Prague groschen of Wenceslas IV (1378-1419)

The largest coin discovered in the second hoard from Strzelce Krajeńskie are Prague groschen. A total of 18 specimens of these Bohemian coins were discovered, all struck during the reign of Wenceslas IV. Despite the poor state of preservation, we managed to classify all of them according to their latest typology by J. Hána (Hána 2003). We identified one coin from the 1384-1395 issue, Hána type V. It is the oldest example of Prague groschen in the entire find. Then, there are two coins attributed to Hána type VII, dated to 1395-1400. By far the largest group are 15th century issues, which can be divided into two main groups. The first consists of Hána types VIII, IX and XI, minted between 1400 and 1405. The second contains exclusively type XIV, which is the most abundantly represented in the entire hoard. Eight such coins were identified, the dating of which has recently been

Table 5. Mint alloy of Wenceslas IV's Prague groschen from the second hoard of Strzelce Krajeńskie

Cat. No.	Typ according to Hána	XRF		SEM-EDS		
		%Ag	%Cu	%Ag	%Cu	surface enrichment with Ag (%)
11	V.h/1	70.0	30.0	72.5	27.5	11.4
12	VII.a/1 or VII.d/2	76.0	24.0	66.1	33.9	25.0
13	VII.d/1, 3–4	88.0	12.0	90.9	9.1	10.1
14	VIII.a/3	75.0	25.0	71.7	28.3	24.2
15	VIII.a/3	59.0	41.0	61.1	38.9	32.2
16	VIII.a–e	62.0	38.0	64.4	35.6	35.0
17	VIII.e/1, 3–5	65.5	34.5	68.0	32.0	23.5
18	IX.e/1	68.1	32.9	65.5	35.5	23.5
19	XI.a/1	61.5	38.5	61.1	38.9	24.6
20	XIV.a/1 (variety)	59.0	41.0	60.7	39.3	26.9
21	XIV.b/2	68.9	31.1	58.0	42.0	42.0
22	XIV.h/1	58.7	41.3	62.9	37.1	27.0
23	XIV.h/1 or XIV.i/1	58.6	41.4	55.0	45.0	42.0
24	XIV.i/1	65.0	35.0	66.5	33.5	30.2
25	XIV.i/1–2	76.4	23.6	60.9	39.1	31.1
26	XIV.i/2	63.4	36.6	61.6	38.8	35.3
27	XIV.i/10	56.0	46.0	57.5	42.5	27.6
28	XIV.i/10	34.8	65.2	33.0	67.0	29.9

debated. Until now the chronology of Hána type XIV was determined as the years 1407-1415 (Hána 2003, 111), however Borys Paszkiewicz in his conclusions concerning the study of a large find of Prague groschen from Boguszów-Gorce proposed to modify the dating of the last regular types of groschen distinguished by J. Hána. Having analysed the distribution and composition of Polish, Bohemian, Lithuanian and Ukrainian finds, which included types XIV, XV and Wenceslas IV's groschen minted posthumously, Paszkiewicz suggests classifying type XV to the group of coins minted after Wenceslas IV's death in 1419 (Paszkiewicz 2020, 179-181). Then the dating of Hána type XV would shift from 1415-1419 to 1420 onwards. At the same time, we should assume that type XIV was minted from 1407 to 1419. This hypothesis is quite plausible, but in our opinion it requires additional research and more analyses, especially of the late regular types distinguished by Hána and, above all more posthumous groschen of Wenceslas IV.

All the Bohemian coins from the analysed find were examined metallographically, with both methods used during our study, namely the XRF and SEM-EDS. The detailed results are presented in Table 5, where the last column provides additional information on the surface silver enrichment in all the coins. We can see that those values vary from 11.4% to

as much as 42%, which clearly shows that the examination limited only to the surface of coins can very often yield quite distorted and uncertain data. More reliable results come from the examination of the core, as that method limits the impact of conservation procedures and surface treatment on the obtained results.

When analysing the table presenting the mint alloy composition of Wenceslas IV's groschen, we can notice significant differences between individual coins. The best mint alloy was recorded in the Prague groschen of Hána type VII.d (cat. no. 13), which contains 88% of silver with an admixture of copper of just 12%, which translates into 14 lots (880/1000). During interpreting the silver content results of the groschen, the current state of preservation of the coins and previous conservation work, resulting in the removal of a significant amount of copper from the coin (*i.e.* its enrichment in silver) should be taken into account. This fact made it much more difficult to determine the original composition of the mint alloy. Without the permission to interfere more significantly with the edge of the groschen, the results of most of the coins indicate much overrated silver content. Such groschen are certainly specimens nos 13, 25 and 27. The figures obtained should therefore be approached with caution.

The next four coins are characterised by a silver content of 70-76%. This group consists of groschen of different types – Hána V, VII, VIII and XIV – whose chronological span is quite wide and reaches 20 years. The most similar results were obtained from coins of Hána type XIV. For these groschen, the silver content ranges between 56-68.9%, with two notable exceptions. The first irregularity is a groschencat. no. 25, where the content of silver exceeds 70%, reaching 76.4% of Ag. In the second coin, cat. no. 28, an extremely low silver content of 34.8% was recorded, with a 65.2% copper admixture. It is worth noting that a comparison of groschen cat. nos 27 and 28 – both assigned to the type Hána XIV. i/10- reveals quite significant differences between both coins. The latter is a groschen with the lowest silver content of all the examined groschen, while in the coin no. 27 the silver content was measured at 56%, with a 46% admixture of copper. We suppose that such a large discrepancy may be a result of the coins' very poor state of preservation just after their discovery and the rather aggressive conservation method used. Reportedly, the conservation procedure was carried out with the use of ammonium and sodium tartrate, and corrosion accounted for as much as 30% of the coins' weight, which was determined by comparing the weight of the object before and after conservation (this is verbal message from Dr Grzegorz Bejcar, who was engaged in conservation of coins from the second Strzelce Krajeńskie hoard).

Fortunately, we have a substantial quantity of comparative material for Wenceslas IV's Prague groschen from two Silesian hoards, where 10% of each was subjected to similar mint alloy testing. We are referring to the hoards from Oleśnica (Milejski 2015; Miazga 2015) and Boguszów-Gorce (Miazga 2020, 115-126; Milejski 2020, 81-90). Particularly valuable are the analysis results of Wenceslas IV's Prague groschen from the Boguszów hoard, where more than a hundred coins were selected for mint alloy examination. The

results of the metallographic tests conducted on Prague groschen of Hána type V for all the deposits compared range between 61.2% and 76.9%. Only three coins – all from the Boguszów hoard – showed more than 70% (Miazga 2020, 116). The hoard from Oleśnica produced one examined coin of this type, in which the silver content was measured at 66.99% (Miazga 2015, 212). The data confirm that silver content in type V pennies usually ranges between 62-70%, with a few exceptions where the value exceeds 70%. On the one hand, the Prague groschen of Hána type VII from all three hoards analysed are characterised by a rather stable silver content, ranging between 60.0-65.9% (Milejski 2020, 85), but on the other hand, in each hoard there is at least one coin of this type in which the silver content is surprisingly high and exceeds 80%. The Oleśnica hoard contains one coin with a silver content of 81.6% (Milejski 2015, 54), the Boguszów hoard also contains one coin with 84.4% of silver (Milejski 2020, 85). The analysed find from the second Strzelce Krajeńskie hoard also included one type VII coin with a silver content of as much as 88%. The subsequent types of Prague groschen, Hána type VIII and IX, are characterised by a similar content of silver, determined at 61-70%. In the hoard from Boguszów only one coin of type VIII (cat. no. 959) has a silver content of over 70%, *i.e.* 72.1% (Miazga 2020, 120, 121), whereas in the hoard from Oleśnica no type VIII or IX groschen exceeds this value. Similar results were obtained from Wenceslas's groschen from the Strzelce Krajeńskie hoard; no coin assigned to these two types was struck from a mint alloy in which silver would exceed 70%. More noticeable are the deviations in the opposite direction, with several coins showing a silver content dropping below 60%. The most extreme example from the Boguszów find is a specimen in which the silver content falls to 51.4% (cat. no. 1135). Generally, however, even in the groschen with a reduced content of silver, the metal still reaches between 57.3-59%. The last metallographically examined coins were classified as Hána type XIV. This type of Wenceslas IV's Prague groschen did not appear in the hoard from Oleśnica (*tpq* 1405). However, they are present in large numbers in the hoard from Boguszów-Gorce (*tpq* 1420), where as many as 53 type XIV coins were identified, 12 of which were subjected to metallurgical analysis. The groschen from the Silesian hoard maintain an even silver content that ranges from 54.0% to 62.8%, so with a spread of less than 8% (Miazga 2020, 122, 123). However, in the hoard from Strzelce Krajeńskie these differences are significant, which was probably influenced by the method of conservation. We can see that in most cases the groschen are characterised by a silver content of 56.0-68.9%, with the two exceptions mentioned above.

We can see that the Prague groschen of Hána type V, VII, VIII and IX are of better fineness, with about 65-75% of silver (of course with noticeable deviations both ways). However, we note a steady deterioration of the minting alloy from which the coins were struck in the Kutná Hora mint. Particularly important for us is the mint act of 1407, which stipulated that large coins should be produced from 610/1000 silver and small coins from 400/1000 silver (Castelin 1953, 142-143; Hána 2003, 24, 25; Milejski 2020, 46). The principles must have been applied to Hána type XIV groschen, which – as we have demon-

strated above – were struck from an alloy that complied with the requirements of Wenceslas IV's act, which indicates that the minting law in the Crown of Bohemia at the end of the 14th and the beginning of the 15th century was actually observed and, despite the regular debasement of the Bohemian coin, the groschen were minted in accordance with the acts in force.

Mecklenburg and West Pomeranian Wittens

The second largest denomination identified in the hoard from Strzelce Krajeńskie are Pomeranian and Mecklenburg wittens. These coins were introduced in 1365 in Lübeck (Berghaus 1973, 89). Their nominal value was set at four pfennigs, but in the Sound currency zone their value was equivalent to six pfennigs. Some Pomeranian towns, *e.g.* Stralsund, joined the Wendish Monetary Union only in 1381, and the decision resulted in these centres issuing a large silver coin – the witten (Stefke 1982, 60, 61).

In the hoard from Strzelce Krajeńskie we have relatively early Mecklenburg wittens, minted after 1387 in Friedland (cat. nos 29, 30). We cannot determine a more precise dating of the Mecklenburg wittens, all we know is that the first large coins in this area were struck in Rostock in 1371 (Oertzen 1904, 51). On the obverse there is a griffin facing left, while the reverse features a Greek cross with a quadrilobe with a pellet in the middle. There are also two pellets in the fourth quarter of the cross. The margin legend on both sides of the coin is the same – MONЄTA ⁘ VRЄDЄL (Friedland = Vredeland). Mecklenburg's Wittens are rarely found in Poland, so it was highly desirable to metallographically examine the coins from the Strzelce hoard. An analysis of Table 6 reveals that Mecklenburg's wittens were minted from 356-378/1000 silver, which corresponds to 6 lots. The predominant component of these coins' mint alloy is copper – 60.1-62.8%. There is also a clear presence of lead, constituting about 1.0% of the alloy in both coins.

Table 6. The content of selected metals in Mecklenburg and West Pomeranian pennies determined with XRF testing (%/weight)

Cat. No.	Place of research	Fe	Ni	Cu	Zn	Ag	Sb	Au	Pb	Sum
Mecklemburgia										
29	core	0.1	0.1	62.8	0.0	35.6	0.1	<LOD	1.0	100.0
30	core	0.2	0.1	60.1	0.0	37.8	0.3	<LOD	1.1	100.0
West Pomerania										
37	core	0.0	0.1	71.2	0.1	27.4	0.1	0.1	0.8	100.0
38	core	0.0	0.1	61.5	0.1	36.7	0.3	<LOD	0.9	100.0
39	core	0.1	0.1	55.6	0.1	42.5	0.1	<LOD	1.1	100.0

<LOD (below Limit Of Detection)

In the hoard there were also three West Pomeranian wittens, all minted in the Wolgast duchy – two in the mint in Barth (cat. nos 37, 38) and one in Wolgast (cat. no. 39). The representations on each of the three coins are practically identical – a griffin to the left on the obverse and a Greek cross with a quadrilobe in the centre on the reverse. The chronology of these coins is also very similar – the Barth wittens were minted after 1415 (Danennberg 1893, 132-134) and taking into account the metrological data of the coin from the mint in Wolgast, we would date it to around 1420-1430 (Leukhardt 2013, 12, 18). Wittens minted in Barth are characterised by an additional symbol placed in the first or second quarter of the cross -a griffin's paw. The coins also underwent specialised physico-chemical analyses (Table 6). We can see that the slightly younger Wolgast coin was struck from a better quality mint alloy. The silver content in this witten is 42.5%, with 55.6% of copper, which means that the coin was struck from 7-lot silver. Older wittens, from the mint in Barth, were struck from a worse mint alloy containing 27.4-36.7% of silver, with over 61-71% of copper. We can therefore see that, despite the small time difference, the quality of the Barth and Wolgast wittens differs quite considerably. It is worth noting that two mints located in the same duchy used minting alloy of unequal quality to mint the same denomination. The mint in Wolgast produced wittens from 450/1000 silver, while the standard of the Barth wittens was only 274-367/1000.

New March or Pomeranian imitations of Silesian hellers

Among the mass of small West Pomeranian pennies, four coins were also distinguished, which were tentatively identified as Silesian hellers, most probably from the Głogów mint (Kaźmierczak 2016, 126; three Silesian hellers are mentioned there, however during a museum search conducted by Paweł Milejski in the Lubusz Museum, it turned out that there were four coins imitating Silesian hellers). After a thorough identification of these coins, it turned out that all of them belong to the so-called northern group of hybrid forgeries of Silesian hellers (this name was first proposed by Borys Paszkiewicz, see Paszkiewicz 2021, 65). There were two main types of the coins – with a bearded head and an eagle and with the letter G and an eagle. These hellers are definitely the most interesting coins in the analysed hoard.

In the second hoard from Strzelce Krajeńskie, three specimens of hellers with a bearded head and an eagle were distinguished, which differ from each other by small details. On the obverse of two coins (cat. nos 32, 33) there is only a bearded head, without any additional symbols (BRP SM 16.15a; FbgCDS 555), and on the obverse of the last coin of the type (cat. no. 34) there are also two slanted, crossing lines, forming a symbol interpreted as St. Andrew's cross (BRP SM 16.15b; FbgCDS 555a). There was no variation with a rim legend in the analysed hoard (BRP SM 16.15c; FbgCDS 555b), which is reconstructed as W C N (Paszkiewicz 2021, 66). Coins of this type are basically a combination of two Silesian hellers – the obverse refers directly to the depiction from Wrocław Rempel's hellers, with

Table 7. The content of selected metals in hellers determined by XRF testing (%/weight)

Cat. No.	Place of research	Fe	Ni	Cu	Zn	As	Ag	Sn	Sb	Au	Hg	Pb	Sum
31	core	0.1	0.1	91.2	1.6	0.2	2.4	1.0	0.2	<LOD	2.8	0.2	100.0
32	core	0.2	0.1	93.0	5.3	0.2	0.3	0.2	0.5	<LOD	0.1	0.0	100.0
33	core	0.3	0.1	80.7	4.3	0.4	5.2	1.8	0.2	<LOD	6.7	0.2	100.0
34	core	0.2	0.1	85.7	12.9	0.2	0.3	<LOD	0.2	<LOD	<LOD	0.2	100.0

a bearded head of St. John (FbgCDS 554), the reverse shows a Silesian eagle with a concave band across its wings and breast, which indirectly refers to the reverse of Legnica hellers (FbgCDS 588-589) (Miazga and Milejski 2019b, 137). This type of coin is very rarely recorded and, despite the fact that they refer to the Silesian hellers, only one specimen is known from Silesia so far, which was discovered at the Romsberg Castle on Gromnik Mountain (Miazga and Milejski 2019a, 344, 345; 2019b). Other finds are recorded primarily in hoards from Nosibądy (Dannenberg 1890, 301-306; Kubiak 1998, 195, no. 546) and Cecenowo (Dannenberg 1885, 398-401; Kubiak 1998, 92, no. 237) and the New March and Pomerania – Choszczno I and II (Dannenberg 1878, 73-91; Kubiak 1998, 180-183, no. 253/I; Kubiak 1998, 97, 98, no. 253/II; Menadier 1887, 194-197). The last recorded find of a heller with the head of St. Andrew comes from Tomice near Stęszew in Greater Poland (Bartkowiak 2017, 26, no. 6, 28). Unfortunately, the attribution and dating of this type of coin is highly uncertain and causes many problems. Ferdinand Friedensburg attributed these coins to Krosno Odrzańskie, where, according to this German numismatist, St Andrew the Apostle was the patron saint of the parish. The heller issue would then be dated to 1422-1430 (Friedensburg 1904, 34). However, as Borys Paszkiewicz has rightly pointed out, such an attribution is inaccurate, since there was no parish of St. Andrew in Krosno, and, more importantly, the eagle on the hellers in question does not feature a cross over the band, which was used by the dukes of the Głogów line (Paszkiewicz 2021, 66). The scholar has also considered several other hypotheses on the possible attribution of the coins with the head of St. Andrew – as possibly originating in Środa Śląska, Legnica, Ujazd in Upper Silesia or interpreting the image in question as St. Blaise's head and attributing the coin to Oława (Paszkiewicz 2021, 66, 67) – although none of the hypotheses is sufficiently supported by the sources to be considered plausible.

The specimen from the Romsberg Castle on Mount Gromnik and three hellers from the hoard found in Strzelce Krajeńskie were examined metallographically (see Table 7) and the results are very interesting. All the analysed coins have a similar elemental composition with the predomination of copper, which in the coin from Gromnik (Miazga and Milejski 2019a, 345) and in one specimen from Strzelce Krajeńskie (cat. no. 32) was determined as 91% and in the two remaining coins ranges between 80.7-85.7%. All the coins are also characterised by a significant admixture of mercury, which reaches 2.8-6.7% as well as a 1.6-12.9% presence

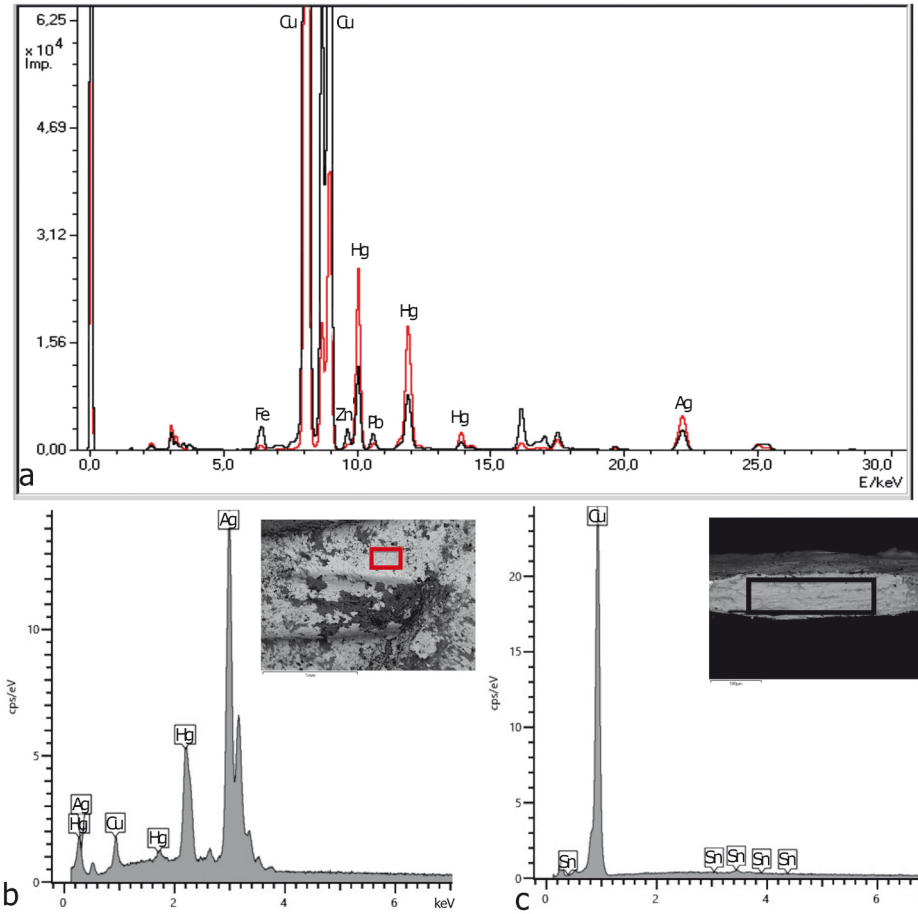

Fig. 4. XRF (a) and EDS (b, c) energy spectra of the heller cat. no. 33, which are indicative of the amalgam technique of coin silvering. The red line shows the surface results, the black line the core of the coin

of zinc. It is worth noting that only in the case of the coin cat. no. 33 the silver content exceeds 1% and reaches 5.2%. Such a composition of the mint alloy of these coins, similar to the coin from Gromnik and the second hoard from Strzelce Krajeńskie, clearly indicates forgery.

In the production of the forged hellers, imitating the issues of the Wrocław mint, the amalgam technique was used, which relies mostly on mercury (Miazga and Milejski 2019b, 139-142). Fig. 4 shows the results of the XRF spot analysis and SEM-EDS micro-area studies, indicating the presence of a significant amount of mercury on the surface of the coin in relation to its concentration inside the specimen. A similar forgery technique was used for coins minted by the lords of Diepholz, which were supposed to imitate Bohemian unilateral coins with the lion of Vladislaus II (1471-1516). As many as seven specimens out

of 11 examined coins of Rudolf VIII (1480-1510) and Conrad XII (1510-1514) were blanched with the use of the amalgam technique (Cihlář *et al.* 2016, 122-129). While analysing the locations of the hellers with the head of St. Andrew and comparing them with the results of specialist research we may assume that the coins were struck in a forgery workshop located most probably in the New March or in (Western) Pomerania. Their chronology is also unclear, but the *tpqs* of their hoards allows us to date the specimens to the 1430s. Borys Paszkiewicz suggests that the area with particularly favourable circumstances for forgery activities in 1433-1435 was the New March (Paszkiewicz 2021, 67). The iconographic references on both sides of the analysed coins, clearly referring to Silesian hellers, allow us to assume that such small coins of the Silesian heller type, three specimens of which were discovered in the second Strzelce Krajeńskie hoard, were produced in the New March or in Pomerania in order to be put into circulation in Silesia. The forgeries would have been difficult to identify in the monetary mass circulating in Silesia in the first and second third of the 15th century. What is puzzling, however, is the fact that – despite their intended purpose – the only place in Silesia the coins have so far been recorded is the Romsberg Castle, which may indicate that the issue of coins with St. Andrew could have been ephemeral. It is also possible that the goal of the issuer of theforgeries may not have been reached, hence such a small overall number of finds (Paszkiewicz 2021, 67).

The last imitation of a Silesian heller recorded in the second hoard from Strzelce Krajeńskie is a coin with a majuscule, Gothic letter G, with a small serif and a decorative trefoil on the obverse and a representation of an eagle without a band on the reverse (cat. no. 31). Similar specimens were recorded in the Choszczno I and II hoards, dated to the 1430s. Coins of this type were quite often identified with very similar coins with analogous representations of BRP SM 4C.1 type, which are known from Silesian hoards dated to the beginning of the 16th century. The discovery of a heller of this type in the hoard from Strzelce Krajeńskie has made it possible to distinguish between the two coins, which was facilitated also by the observation that on the older coins the eagle is depicted without the feet (Paszkiewicz 2021, 67). The specimen is an imitation of Silesian hellers, its obverse clearly corresponds to the Głogów hellers, while the representation on the reverse generally refers to Silesian coins of the second half of the 14th and first half of the 15th century.

The imitation of the Głogów heller was also examined metallographically, and the results of the analyses are consistent with the results of the examination of the alloy used to struck the hellers with the head of St. Andrew. The elemental composition of the heller with the decorative gothic letter G is dominated by copper – 91.2%, with only a 2.4% admixture of silver. Worth noting is the pronounced presence of zinc, at 1.6%, and mercury, measured at 2.8%. These results also point to a forgery produced with the amalgam method, where mercury with a small admixture of silver forms a silvery coat on the coin surface that imitates genuine silver. There is also a high probability that this heller was minted in the same forgery mint as the three hellers with the head of St. Andrew described above. The conclusion is evidenced by study of the mint alloy and the fabric of the coins.

Jagiellonian pennies of Vladislaus III (1434-1444)

The smallest part in the discussed hoard constitutes of two Polish pennies of Vladislaus III. These small coins, minted at the royal mint in Cracow in 1434-1444, have a crown on the obverse, while the reverse features an eagle with outstretched wings, facing to right. Both pennies belong to the same type, Kubiak II: 4, which, according to this researcher, is characterised by joined upper and lower fleurons. In addition, in the lower parts of the crown there are ^ symbols, which divide the lower fields in half (Kubiak 1970, 101, 102).

Vladislaus III's pennies are a very common find, particularly in the territory of the Polish Crown, where they occur in large numbers, but they are also very often recorded outside its borders. They were, however, reluctantly accepted, as the forging of these coins in Silesia, Bohemia and Moravia grew to an unimaginable scale (Paszkiewicz 2008, 150-151), and also because even the original coins were made from only 2-3 lot silver (125-187.5/1000). It is highly probable that one of the forgery mints operated at the Romsberg Castle on Gromnik Mountain, where archaeological excavations have revealed a large number of forged Jagiellonian pennies of Vladislaus III as well as coin blanks, which could have been a semi-finished products used to mint these coins (Miazga and Milejski 2019a, 346-350; Miazga 2008, 156-159; Paszkiewicz 2008, 150-152). The most famous hoard of probably over 100,000 forged Jagiellonian pennies, which, apart from the coins of Vladislaus III, included also pennies of Vladislaus II (1386-1434) and Casimir IV (1447-1492), comes from Kazimierza Wielkiego Street in Wrocław (Butent-Stefaniak and Baran 2003, 217-218). Coins from an official issue should have been struck from 2-3 lot silver (125-187.5/1000) (Kubiak 1970, 103-104), but we sometimes record original coins with a much lower silver content. Taking into account that products of the Cracow mint should contain at least 1-2% of silver, the pennies in which the silver content is lower are considered forgeries.

Both Jagiellonian pennies from the Strzelce hoard were XRF tested and the detailed results of the analyses are given in Table 8. The elemental composition of both coins is very similar – the penny cat. no. 35 has a silver content of 14.2%, with 85.1% copper, while the penny with a cat. no. 36 was struck from an alloy of 14.3% of silver and 84.8% of copper. In comparison, the penny of Vladislaus III discovered in Wrocław, on the site of the Ołbin Abbey, had only 2.6% of silver. The results of metallographic research, together with the correctness of the images on both sides of the coin, allow for the classification of the penny as a product of an official mint (Milejski and Miazga 2016, 249, 250, 257).

Table 8. The content of selected metals in Jagiellonian pennies determined by XRF testing (%/weight)

Cat. No.	Fe	Ni	Cu	Zn	Ag	Au	Pb
35	0.06	0.2	85.1	<0.01	14.2	<0.02	0.4
36	0.1	0.1	84.8	0.1	14.3	<0.02	0.6

CONCLUSIONS

Discovered in late 2014, the second hoard from Strzelce Krajeńskie is one of the more interesting late medieval hoards recently discovered in Poland. The core of the hoard is formed by West Pomeranian pennies that have so far been poorly identified. From around the mid-14th century, such coins were minted in a number of Pomeranian mints, most of which were purchased or leased by municipal authorities. It is necessary to examine the entire hoard, as the sample studied here, consisting of 109 coins, certainly does not allow us to exhaust the subject. The find certainly deserves the attention of historians and numismatists and the formation of a research team to conduct interdisciplinary studies. Owing to external financing, it was possible to analyse 109 coins and examine the mint alloy of almost half of them.

In the process of determining the *terminus post quem* of the discussed hoard, on the basis of our current knowledge and the analysed part of the hoard, we would have to accept several possibilities. The decisive role in the dating of the Strzelce find will rather be played by small Polish, Brandenburg and Silesian coins. The hoard from Strzelce Krajeńskie does not include Prague groschen struck with immobilised dies of Wenceslas IV between 1420 and 1423, hence the Bohemian coin does not close the hoard. Also the West Pomeranian wittens, coined after 1415, do not mark the end date of the hoard. The broad dating of the group of northern imitations of Silesian hellers to the first half of the 15th century also does not allow us to establish the date of the hiding. The Brandenburg pennies of Frederick II were minted between 1426 and 1440, while the Cracow issue of the Jagiellonian pennies of Vladislaus III took place between 1434 and 1444. Without being able to narrow down the chronology, we must assume that it is the Polish small coin of Vladislaus III that determines the hoard's *tpq* as 1434. This date is not insignificant in the history of Strzelce Krajeńskie, as the years 1433-1435 were the period of the Polish-Teutonic war, which did not spare Strzelce Krajeńskie (Rymar 2016, 67-73). The town was in the possession of Brandenburg margraves from about the middle of the 13th century, after the northern part of Lubusz Land was subordinated by Brandenburg in the years 1250-1253 and the German name of Strzelce Krajeńskie – Fredeberg appears as early as in 1286 (Gierke 2016, 56-58). The situation in the New March changed dramatically when it came under the rule of the Teutonic Order (1402-1454). The lack of trust of the local population and the constant conflict with the Kingdom of Poland led to a new war, waged also in the New March between 1433 and 1435. Strzelce Krajeńskie was captured by Polish-Bohemian forces on 5th June 1433, and despite the fact that the enemy troops left the area already on 15 June 1433, foreign knights continued to prowl in the vicinity of the town (Rymar 2016, 71-73). The peace treaty between the Teutonic Knights and the Polish-Bohemian side was concluded only on 31 December 1435. However, the presence of Polish forces in the area of Choszczno and Strzelce is still recorded in 1437. The effects of warfare in Strzelce Krajeńskie must have been quite substantial and harmful, since on 20 April 1437 the Grand Master of the

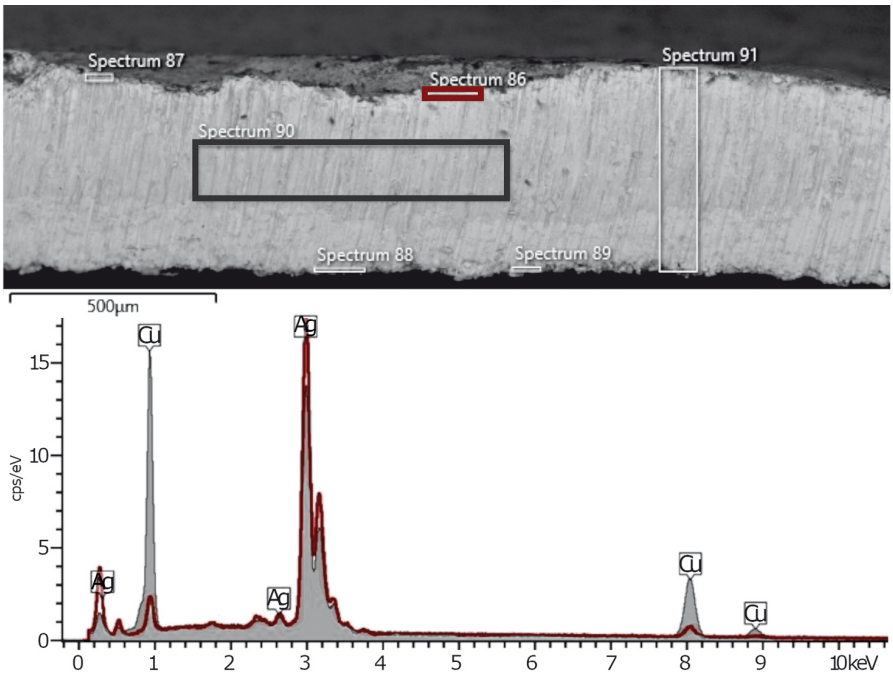

Fig. 5. Energy spectra of the groschen core (grey line) and surface (red line) for the groschen with a cat. no. 21

Teutonic Order Paul von Rusdorf (1422-1441) allowed the town to collect money all around the country to restore the church and its bells. Even as late as in 1450, Strzelce was granted the reduction of half of the real property tax as the place had still not returned to its state from before the Polish-Teutonic conflict (Rymar 2016, 75, 76). We can assume that the owner of the hoard may have hidden it in a safe place during the hostilities or immediately after the conclusion of the peace treaty. Faced with the conflict, or the possibility of the confiscation of his property for the purpose of the reconstruction of the city, the owner decided that it would be better to bury his goods and recover them when the situation improved. The hoard may have also belonged to a trader who had travelled from Western Pomerania southward along one of the trade routes. This would explain the dominance of West Pomeranian coins and the presence of the large Bohemian coin in the discussed find. Perhaps only by studying the find as a whole will it be possible to draw more definite conclusions about the hoard's origin.

Let us consider the relationship of the two hoards discovered in Strzelce Krajeńskie – the first from 1977 and that from 2014, analysed here. The composition of both finds is very similar -they are dominated by small Pomeranian coins accompanied by Prague groschen and Jagiellonian pennies. Having analysed only the contents of the two hoards, we

might get the impression that they are two parts of the same assemblage. However, the fact that they were discovered on plots quite distant from each other clearly indicates that they must be two separate hoards – another example of the so-called "twin hoards" known to Polish numismatics, as we have indicated at the beginning of this text.

The analysed portion of the hoard from Strzelce Krajeńskie has once again confirmed the importance of cooperation between numismatics and science. Interdisciplinary research, enriched by mint alloy analysis, greatly enhances our knowledge. This approach is particularly appropriate when it comes to coins that have not been metallographically examined so far or whose comparative material is very small. This mainly concerns West Pomeranian *Vinkenaugen*, which have not evoked much interest from Polish researchers. The study confirmed the earlier assumptions that West Pomeranian pennies were produced from base silver whose fineness did not exceed 300/1000. The level of silver in the Jagiellonian pennies is clearly lower, but their appearance and physical characteristics enabled these coins to penetrate the monetary mass and circulate unnoticed in the territory of the New March and Western Pomerania. The same is likely to have been true of the circulation of counterfeit hellers, which imitated hellers from Wrocław and Legnica.

Thanks to the microscopic-analytical study, it was also possible to observe the numerical difference in the composition of the mint alloy, analysed on the surface and on a prepared edge, the latter location allowing for reaching the original mint alloy (Figure 5). The analysis of the figures for all the coins examined this way showed significant differences between the silver and copper contents in both batches of coins. The concentration of silver determined during the examination of the surface is much higher than inside the coins. This difference reaches even 40 units for the designated semi-quantitative concentration, a phenomenon known also from studies of other coins (Linke and Schreiner 2000; Beck *et al.* 2004; Beck *et al.* 2008; Borges e*t al.* 2017). Apart from the cooperation between a numismatist and an analyst, it is crucial to stress the importance of proper conservation of coins, especially those from archaeological excavations. The removal of soil contamination and corrosion layers with chemical methods can significantly affect the mint alloy by contributing to a distortion of the measurement of silver and copper concentrations in relation to the original mint alloy. Conservation practice suggests that the best results are obtained by various mechanical cleaning methods or with the use of disodium edetate (Miazga 2020).

The second hoard from Strzelce Krajeńskie relatively quickly entered the academic literature. The contents have been fairly thoroughly identified, at least in terms of its main body and the individual denominations. We cannot, however, exclude the possibility that in the remaining part, consisting of more than 1800 coins, we will find further imitations of Silesian hellers or other very interesting, so far unrecorded numismatic items, which will shed new light on the monetary circulation in the New March and the economic relations in the late Middle Ages in this area. Also desirable would be an accurate comparison of the composition and chronology of the two finds from Strzelce Krajeńskie, but this will

not be possible without the full identification of the hoard discovered in winter 2014. The find from Strzelce Krajeńskie offers many research perspectives and constitutes an invaluable numismatic source for the study of economic relations in the New March in the first and second decade of the 15th century.

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