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ERNEST OBERLÄNDER-TÂRNOVEANU,
BOGDAN CONSTANTINESCU AND KATIUŞA PÂRVAN

**CONCERNING THE MONETARY STANDARDS AND THE METALLIC
SOURCES OF THE RED-RUTHENIAN SILVER COINS
OF CASIMIR III AND LADISLAUS OF OPOLE,
IN THE LIGHT OF RECENT XRF ANALYSES**

The metrology of the silver groats struck for Red-Ruthenia (the Duchy of Halych) by the Polish King Casimir III (1349–1370) and later, by Duke Ladislaus of Opole, as Hungarian governor of the country (1372–1379 and 1383–1387), during the reigns of Louis I and Mary, remains largely a debated question, due to the lack of proper publication of a large amount of data obtained by modern analytical methods. In the old nineteenth-twentieth century numismatic literature, as well as in recent contributions, a set of very contradictory hypotheses and assertions were accepted on this topic. According to Stupnicki and Piekosiński, who wrote in the 1860s and 1870s, the legal standard of the silver coinage struck in Lviv for Casimir III was 14 lots ($875‰ = 21$ carats; 1 lot = $62.5‰$ or $1\frac{1}{2}$ carat; 1 carat = $41.66‰$). These authors asserted that this standard was kept unchanged for the issues of Ruthenian groats, struck in the name of Louis I, King of Hungary and Poland (1370–1382) and Ladislaus of Opole (1372–1378; 1383–1386) (Stupnicki 1865, p. 36; Piekosiński 1878, pp. 142 and 144). In 1962, the well known Ukrainian numismatist Mykola Kotliar considered that, unlike the coinage of the Polish Kingdom, which suffered a severe devaluation during the 1360s, the fineness of the Red-Ruthenian groats of Casimir III never fell below the threshold of $875‰$. But unfortunately, Kotliar did not indicate precisely the highest, lowest or average levels of the silver content measured in these groats (Kotliar 1965a, p. 103). According to the same author, the fineness of the Red-Ruthenian groats struck by Ladislaus of Opole also remained unchanged at the previous level of $875‰$ (Kotliar 1968, pp. 55 and 63).

During the last decade, research on this topic entered a new phase and the traditional common wisdom, largely based on the old nineteenth century chemi-

cal analyses or, more often, touchstone investigations, began to be put under scrutiny. After 2000, substantially new sets of data concerning the evolution of the fineness standards of the Red Ruthenian groats during the second half of the fourteenth century were published. That year, Andrii Kryzhaniv's'kyi, a Ukrainian numismatist, published a short sketch of the metrological developments that occurred in the Red-Ruthenian silver coinage, according to his own, quite debatable, chronological scheme, from 1353 to 1408. In fact, according to recent researches, the chronological span of Casimir III's coinage for Red Ruthenia should be reduced only to the period *c.* 1364–1370 (Paszkievicz 2005, pp. 278–279).

Andrii Kryzhaniv's'kyi stated that the groats of Casimir III were struck from alloy containing 943‰ silver (*i.e.*, *c.* 15 1/10 lots or 22 2/3 carats). According to him, the Ruthenian groats bearing the names of Ladislaus of Opole and Louis I, struck during the period 1372–1386, were issued following variable standards, ranging from 936‰ to 925‰. In parallel, there was also a continuous drop of the average weights of the Ruthenian groats, from 1.35 g under Casimir III (*c.* 1350–1360), to 1.23 g under Ladislaus of Opole's rule (1372–1379), and to 1.07 g for the coinage struck in the name of Louis I (1379–1382) (Kryzhaniv's'kyi 2000, p. 46).

The figures presented by Kryzhaniv's'kyi correspond to *c.* 15 lots and 14 4/5 lots, in the Central European medieval metrology, or 22 1/2 to 22 1/5 carats, in the Byzantine-Mediterranean metrological system. One could remark that the first figure given by Andrii Kryzhaniv's'kyi was equal to the Bohemian groat standard of fineness and the second to that of the so-called 'sterling silver' standard (Spufford 1988, p. 406).

Several years later, in 2004, Kryzhaniv's'kyi published more detailed information on the silver content of the Red-Ruthenian groats struck in the names of Casimir III, Ladislaus of Opole and Louis I. On that occasion, the author concluded that in fact the values of the finesses of these issues were a bit different than was previously thought. For example, he asserted that the legal standard of the Ruthenian groats of Casimir III was, in fact, much higher than was previously stated, reaching an average level of 950‰ (15 1/5 lots or 22 4/5 carats) (Kryzhaniv's'kyi 2004a, pp. 13–15). Soon after the publication of the above mentioned contribution, Kryzhaniv's'kyi referred, for the first time, to the results of some unedited investigations of the Ruthenian groats of Casimir III, Louis I and Ladislaus of Opole, held in the public museums of Kyiv, Lviv and Odessa. These analyses were carried-out by the State Inspectorate of Assays during the 1990s, having been ordered by the Ukrainian Ministry of Cultural Affairs. According to him, these series of investigations have revealed that the silver content of most of the 500 analysed coins ranges from 875 to 950‰ (but, in fact, only one coin of Louis I in the Ukrainian National Museum in Kyiv revealed a very low silver content, 875‰, all others having a fineness of 916‰ or more). Kryzhaniv's'kyi supposed that these assays were most likely made using the touchstone method. One should note that objects made from alloys containing a silver proportion

higher than 925‰ usually cannot be correctly measured using such a method, due to the lack of proper assays sets (‘needles’). In normal conditions, institutions which employ touchstone investigations possess sets of ‘needles’ suitable only for testing the modern range of standard alloys of silver, which often are quite distinct from those used during Antiquity or the Middle Ages.

In his second contribution in 2004, Kryzhaniv’skyi refers also to the results of XRF analyses, made by the company SA “Karat”, in Lviv, on a sample consisting of three groats of Casimir III, two of Ladislaus of Opole and two of Louis I. The results of this investigation were:

1. Casimir III: silver — 984.00‰, 983.00‰ and 977.00‰
2. Ladislaus of Opole: silver — 973.00‰ and 965.00‰
3. Louis I: silver — 986.00‰ and 977.00‰.

Kryzhaniv’skyi mentions also the results of some measurements, carried-out with a computer assisted XRF spectrograph, by the Lviv branch of the Ukrainian National Bank, which have given the following values:

1. Casimir III: silver — 985.00‰, 979.00‰, 978.00‰ and 974.00‰
2. Ladislaus of Opole: silver — 967.00‰
3. Louis I: silver — 986.00‰, 982.00‰, 982.00‰, 978.00‰.

Referring to the results of the modern analyses, Kryzhaniv’skyi asserted that the first Red Ruthenian groats of Casimir III (in his classification, variants a-c), struck at Lviv, were issued according to a legal standard from a silver alloy of 950‰ (and an average weight of 1.61 g). Later, the weight standard was slightly reduced to 1.57 g, but the title remains at the same level of 950‰. The last phase of the coinage of Casimir III in Red Ruthenia was struck according to new legal standards. Then the average weight of the groats minted in Lviv dropped to 1.28 g and the fineness was reduced to 927‰–945‰ (c. 15 to 15 1/10 lots).

Based on the same analyses, Kryzhaniv’skyi supposed that the average weight of the groats of Ladislaus of Opole was 1.27 g and that their fineness ranges around 933‰ (c. 15 lots) (Kryzhaniv’skyi 2004b, pp. 86–89).

In his reference work on the Red Ruthenian coinage published in 2007, Andrii Kryzhaniv’skyi presented a set of new data about the silver content of the coinage of Casimir III, borrowed from the acquisition books of the museums in Lviv and Kyiv. According to the analyses carried-out by the State Inspectorate of Assays, the average silver content of the groats of Casimir III belonging to the variants 1 c (r), 1 d and 1 e (following Kryzhaniv’skyi’s classification), kept in the Historical Museum in Lviv, was 943‰, that of the groats with the inscriptions reading **MONTA** — 933‰ and that of the coins belonging to the variants 1 a and 1 b (following the author’s classification) was 950‰.

The existence of some Red Ruthenian coins containing 950‰ silver is also mentioned in the acquisition book of the National History Museum of Ukraine in Kyiv. Other specimens preserved in the same collection have a fineness of 943‰, as well as those from the Archaeological Museum in Odessa (Kryzhaniv’skyi 2007, pp. 59 and 92, footnote 122).

Kryzhanivskiy asserts that during Casimir III's reign, the fineness of the Red Ruthenian coinage was affected by several alterations, which followed quite closely the changes underwent in the silver content of the contemporary Bohemian groats, struck by Charles IV. In his opinion, the first Red Ruthenian groats (var. 1a-b) were issued according to a monetary standard of 1.61 g and 950‰ fineness, to fit the standards of the reformed groats of Charles IV (dated to 1356 or 1360). Later, the groats belonging to the variants 1c (r)-d were issued, according to a fineness standard of 927‰ to 945‰. According to Kryzhanivskiy, the last Red Ruthenian issue of groats of Casimir III was the variant 1e **MONTA** — struck from a silver alloy of 933‰ (Kryzhanivskiy 2007, pp. 60–61).

The groats of Ladislaus of Opole belonging to the variants 3a, 3ba and 3v (B) (following the author's classification), contains 943‰ to 935‰ silver and those of the variant 3d — 940‰. On the same occasion, Kryzhanivskiy gave further information on the silver content of some Red Ruthenian coins of Ladislaus of Opole and Louis I, kept in the collections of the National History Museum of Ukraine in Kyiv and in Odessa. The fineness of the groats of Ladislaus of Opole struck during the years 1372–1378 amounted to 940‰ and dropped to 916‰ in 1386. The groats of Louis I from the same collections have 935‰ silver (Kryzhanivskiy 2007, p. 92 and footnote 122).

The problem of the evolution of the metrological standards used for minting the Red Ruthenian coinage is not limited to a local historical question but has a wider regional relevance. For Romanian medieval numismatics it has a particular importance, because since the 1910s the most pre-eminent scholars have asserted that the first Moldavian coinage, during Prince Peter I's reign (c. 1375–1391), was issued following the metrological standards of the Red Ruthenian groats of Ladislaus of Opole (Docan 1907–1908, p. 119; Moisil 1915, p. 18; Țabrea 1944, p. 263–76; Iliescu 1964, p. 85; Iliescu 1970, p. 25; Iliescu 1997, p. 76). During the last ten years or so, hundred of groats of Peter I have been analyzed, but we have needed also more data on the real metrological parameters of the contemporary coinages from neighbouring countries, such as Red Ruthenia, Hungary, Golden Horde, Caffa and Wallachia.

Our investigations of the legal standards of the silver coinage struck in the mint of Lviv during Polish and Hungarian rule are based on the analyses made on the Red Ruthenian coins of the hoard of Siret (1912).

The hoard of Siret (Suceava County) is one of the most remarkable coin finds so far found in the territories of the early Moldavian medieval principality. It was uncovered by chance in 1912, during the time when the small town of Siret was part of the province of Bucovine (*Bukowina*), in the Austro-Hungarian Monarchy. The hoard was unearthed during digging undertaken by the municipal authorities for the municipal water supply system.

According to C. Moisil's first report, the hoard consisted of about 300 silver coins, among them being Bohemian, Polish, Wallachian and Hungarian issues.

Moisil said that the coins were concealed in a ceramic container (Moisil 1913, p. 64, no. 26). Shortly after the discovery, the same author corrected his previous statements, mentioning that, in fact, the hoard did not contain any Polish issues struck during the reign of Ladislaus II Jagello, but only coins struck for Red Ruthenia by the Polish king Casimir III, as well as Red Ruthenian coins struck under the authority of Ladislaus of Opole, the Hungarian governor ('Duke') of the country, during Louis I's last reigning years as Hungarian-Polish King, and under Queen Mary, Louis's successor on the Hungarian throne (Moisil 1915, p. 14).

Several years later, Moisil mentioned that the entire hoard, among which were 35 Wallachian coins struck by Ladislaus I Vlaicu (c. 1365–1377), was bought by the Coin Room of the Romanian Academy. On the same occasion, Moisil asserted that the Siret 1912 hoard was concealed no later than 1378 (Moisil 1924, pp. 119–120 and the separate pamphlet 13–14).

Unfortunately, soon after its discovery the Siret 1912 hoard became unavailable for scholarly investigation for several decades. As part of the collection of the Coin Room of the Romanian Academy, the hoard of Siret was affected by the long lasting consequences of the political and military setbacks suffered during the First World War. During late November 1916, before the occupation of Bucharest by the armies of the Triple Alliance, the government decided to send the most valuable collections of the Romanian Academy, of the museums, churches and monasteries, as well as the gold reserve of the National Bank, the deposits of the Spare Bank, as well as the archives and many other public and private properties to Iași, the city where the Royal court and administration took refuge.

Fearing a major German offensive in 1917, which eventually could have led to the total occupation of the Romanian territory, the Government, advised also by our allies from the Entente, decided to send all these national treasures to Russia. In the event the decision was doubly wrong. During the summer of 1917 the Romanian army managed to make a stand and stop the German and Austro-Hungarian offensives. Thanks to these achievements, the eastern part of the country escaped foreign occupation. On the other hand, Russia proved not to be the safe haven which the Romanian authorities and our Western allies supposed it to be. Soon after the shipping of the Romanian treasures to the Kremlin, in February 1917, Russia was engulfed by the bourgeois-liberal revolution, which plunged the country into anarchy and finally degenerated into major political and social change. In November 1917 the Bolsheviks took power and soon after they decided to sever diplomatic relations with Romania and to confiscate all the Romanian properties within their reach, including the treasures belonging to the national cultural heritage (Romașcanu 1934, passim; Moisiuc, Calafeteanu and Botoran, 1993, passim).

Only after forty years, in 1956, did the Soviet authorities agree to return most of the Romanian cultural heritage, unlawfully confiscated in 1918. Thanks to the

return of the collections of the Romanian Academy from Russia, the Siret hoard became once again accessible for researchers.

During our investigations in the second half of the 1990s, we were able to identify 182 coins, belonging certainly to the Siret 1912 hoard. They were issued, as following:

1. Bohemia — 106 sp.:
 - a) Wenceslas II (1300–1305) — 1 sp.
 - b) John I the Blind (1310–1346) — 25 sp.
 - c) Charles IV (1346–1378) — 78 sp.
 - d) Wenceslas IV (III) (1378–1419) — 2 sp.
2. Red Ruthenia — 38 sp.:
 - a) Casimir III (1353–1370) — 22 sp.
 - b) Ladislaus of Opole (1372–1378) — 16 sp.
3. Wallachia — 37 sp.:
 - a) Vladislav I Vlaicu (c. 1365–1377) — 37 sp.
4. Hungary — 1 sp.
 - a) Louis I — 1 sp.

All the 38 Red Ruthenian coins still existing in the Siret 1912 hoard were submitted to XRF analyses during the ARCHAEOOMET and ROMARCHAEOOMET programmes, supported by the Romanian Ministry for National Education and Research. Twenty-two coins of this sample were struck during the reign of Casimir III (type described by Gumowski 1960, no. 367) and 16 specimens under the rule of Ladislaus of Opole (type described by Gumowski 1960, no. 402).

The results were as follows:

Casimir III

Silver content:

955‰ (2 sp.); 956‰ (1 sp.); 957‰ (1 sp.); 958‰ (2 sp.); 960‰ (1 sp.); 962‰ (2 sp.); 964‰ (2 sp.); 965‰ (1 sp.); 966‰ (2 sp.); 967‰ (2 sp.); 968‰ (2 sp.); 970‰ (2 sp.); 974‰ (1 sp.); 977‰ (1 sp.).

Gold content:

1‰ (1 sp.); 1.50‰ (2 sp.); 2.50‰ (2 sp.); 3.00‰ (1 sp.); 3.50‰ (2 sp.); 3.55‰ (1 sp.); 4‰ (1 sp.); 4.50‰ (3 sp.); 5‰ (4 sp.); 5.50‰ (2 sp.); 6.00‰ (1 sp.); 6.50‰ (2 sp.).

Copper content:

15‰ (1 sp.); 18‰ (1 sp.); 19‰ (5 sp.); 20‰ (2 sp.); 22‰ (1 sp.); 24‰ (2 sp.); 25‰ (2 sp.); 25.50‰ (1 sp.); 28‰ (1 sp.); 29‰ (1 sp.); 29.50‰ (1 sp.); 30‰ (1 sp.); 31‰ (1 sp.); 31.50‰ (1 sp.); 35‰ (1 sp.).

Average values of the three main components are:

Ag = 964.07‰ (c. 15 ½ lots or c. 23 1/10 carats)

Au = 4.09‰ (c. 1/6 lot or c. 1/10 carat)

Cu = 23.98‰ (c. 2/5 lot or c. 2/3 carat)

Median values:

Ag = 964.5‰ (c. 15 ½ lots or c. 23 1/10 carats)

Au = 4.50‰ (c. 1/7 lot or 1/10 carat)

Cu = 24‰ (c. 2/5 lot or 2/3 carat)

Standard deviations:

Ag = 6.098976

Au = 1.592564

Cu = 5.414876

Ladislaus of Opole

Silver content:

930‰ (2 sp.); 937‰ (1 sp.); 940‰ (1 sp.); 945‰ (3 sp.); 953‰ (1 sp.); 954‰ (1 sp.); 955‰ (2 sp.); 956‰ (1 sp.); 963‰ (1 sp.); 965‰ (2 sp.); 968‰ (1 sp.).

Gold content:

1.50‰ (2 sp.); 2.50‰ (4 sp.); 3.00‰ (2 sp.); 3.50‰ (2 sp.); 4‰ (3 sp.); 5‰ (3 sp.).

Copper content:

19‰ (1 sp.); 23‰ (2 sp.); 24.50‰ (1 sp.); 26‰ (1 sp.); 27‰ (2 sp.); 28‰ (1 sp.); 31‰ (1 sp.); 37‰ (1 sp.); 42.50‰ (1 sp.); 43‰ (2 sp.); 45‰ (1 sp.); 47‰ (1 sp.); 50‰ (1 sp.)

Average values:

Ag = 950.44‰ (15 1/5 lots or 22 4/5 carats)

Au = 3.31‰ (1/20 lot or c. 1/8 carat)

Cu = 33.50‰ (c. ½ lot or c. 4/5 carat)

Median values:

Ag = 953.75‰ (15 2/5 lots or 22 9/10 carats)

Au = 3.25‰ (1/20 lot or c. 1/8 carat)

Cu = 29.50‰ (c. ½ lot or 2/3 carat)

Standard deviations:

Ag = 12.15027

Au = 1.138347

Cu = 10.16366

The analyses made during the ARCHAEOOMET and ROMARCHAEOOMET programmes prove that, in spite of a slight reduction that occurred after 1372, the entire silver coinage struck for Red Ruthenia in the names of Casimir III and Ladislaus of Opole was produced from a highly refined silver alloy. It is quite likely that during the late 1360s the local standard used in the mint of Lviv

was about 965‰ (c. 15 ½ lots or 23 1/5 carats). Such a figure shows that it was about 1/2 lot (c. 2/3 carat) higher than the legal standard of the Bohemian silver groat (937‰), established in 1300, when the coinage of the Prague groats began (Castelin 1973, p. 2–3). Later, the same legal standard was adopted in Hungary, during the reign of Charles Robert of Anjou (in 1329, according to Huszár 1979, p. 12), and in Poland, by Casimir III (c. 1365, according to Paszkiewicz 2008, pp. 48–49), for their local groat size coinages.

It is quite likely that the silver standard in use in the Lviv mint during the reign of Casimir III was an improved version of the medieval standard of so-called *argent-le-roi*, or the commercial fine silver, i.e. 958.33‰ fine. In fact, *argent-le-roi* was a highly refined alloy (23/24), containing only about one carat (c. 2/3 lot) of copper and lead and sometimes, gold, zinc or tin. Basically, for a medieval craftsman or merchant such an alloy was just ‘pure silver’.

Such a limited amount of copper and lead was left, not only because any further removal above the threshold of 960‰ of the remaining base metals was technologically very difficult to achieve and too expensive, but also to allow the casting of the melted metal. During the ancient, medieval and early modern times, it was impossible to produce pure silver from lead-silver ores, because the pure silver in liquid state absorbs the oxygen from the air and the bubbles of gas explode during the cooling-down of the cast metal.

Interestingly, the results of the analyses revealed that the silver coinage for Red Ruthenia struck in Lviv continued to be issued according to the ‘groat standard’ even during the 1370s, in the period when such a tender was no longer in use either in Bohemia or in Hungary. One could remark that even the average value of the silver content of the coins struck in the name of Ladislaus of Opole remains, in fact, largely higher than the legal prescriptions for the contemporary Bohemian groats.

During Charles IV’s reign the legal weight and fineness of the Bohemian groat suffered several alterations. During his early years, in 1346–1348, their weight was 3.442 g and their title of 854‰ (13 2/3 lots or 20 ½ carats). Soon after, in 1348–1355, the groats of Prague were issued according to a standard of 3.356 g and 875‰ (14 lots or 21 carats). During the period 1356–1358, a new regulation established the legal weight to 3.391 g and the silver content was reduced to 856‰ (c. 13 2/3 lots or c. 20 ½ carats). Before 1370, the legal weight standard was reduced to 3.311 g, meanwhile the fineness was kept at the previous level. A further reductions occurred during the years 1370–1378, when both the legal weight and the silver content of the Bohemian groat dropped severely to 2.97 g and 795‰ (12 ¾ lots or c. 19 1/10 carats). During the last reigning year, in 1378, a new monetary ordinance was issued and the weight and finesses of the Bohemian groat were restored to 3.62 g and 893‰ (14 1/3 lots or c. 21 ½ carats) respectively (Pinta 2005, p. 24). The figures presented by Václav Pinta did not match always to those previously published by Stanislav Veselý and Karel Castelin, during the late 1960s early 1970s (Veselý 1968, pp. 127–131; Castelin 1973, pp. 18 and 22).

During our investigations of the coins from the Siret hoard, we analysed 70 out of the 78 Bohemian groats struck by King Charles IV (1347–1378) from the find. The values of the silver content measured for the Bohemian groats of Charles IV are as follows:

993‰ (1 sp.); 970‰ (2 sp.); 965‰ (1 sp.); 960‰ (3 sp.); 958‰ (4 sp.); 957‰ (2 sp.); 956‰ (2 sp.); 955‰ (2 sp.); 953‰ (3 sp.); 952‰ (5 sp.); 950‰ (4 sp.); 948‰ (2 sp.); 946‰ (6 sp.); 945‰ (5 sp.); 943‰ (4 sp.); 942‰ (1 sp.); 940‰ (2 sp.); 939‰ (3 sp.); 936‰ (2 sp.); 934‰ (2 sp.); 924‰ (2 sp.); 923‰ (1 sp.); 922‰ (2 sp.); 915‰ (1 sp.); 907‰ (1 sp.); 993‰ (1 sp.); 906‰ (2 sp.); 905‰ (1 sp.); 904‰ (1 sp.); 903‰ (1 sp.); 850‰ (1 sp.); 760‰ (1 sp.).

The average value of the silver content of these coins was 939.77‰ (15 lots or *c.* 22 ½ carats), which matches with the legal prescriptions of the early groats of Prague, but one could remark that the finenesses of 17 specimens from our sample (24.28%), were below the legal standard of 937‰ (the median value is 946.00‰, *i.e.* *c.* 15 1/10 lots or *c.* 22 2/3 carats and the standard deviation is 29.82421). However, almost all our measurements, except for two, had shown that the groats of Charles IV had in fact, a far higher fineness than the figures asserted by Pinta or Castelin.

A Hungarian groat of King Louis I, from the same hoard, struck in 1358–1364 (type Huszár 1979, no. 522) contained only: Ag = 905.00‰, Au = 3.30‰, Cu = 70.50‰, *i.e.* 14 ½ lots or 21 ¾ carats.

In fact, due to the constant presence of gold in the monetary alloy used by the mint of Lviv during *c.* 1364–1386, the average ‘silver’ content of the Red Ruthenian groats of Casimir III and Ladislaus of Opole was, in fact, about 3–4‰ higher than the standard figures. One could mention that, an average content of 3–4‰ gold in the Red Ruthenian issues was far above the detection limits of the fourteenth century technologies, so it was considered by contemporary people as being just ‘silver’.

The presence of gold in each Red Ruthenian groat so far analysed could offer some indications for the possible origin of the source of metallic silver used by the mint in Lviv, during the reigns of Casimir III and Ladislaus of Opole. Before undertaking the analyses we supposed that most if not all of the silver used in Lviv mint was produced by melting-down the Bohemian groats, due to the huge popularity enjoyed by this currency on the Red Ruthenian monetary markets, as well as in Poland, Lithuania, Silesia and Moldavia (Nohejlová-Prátova 1956, *passim*; Riabtsevich 1965, *passim*; Kotliar 1975, *passim*; Nudel’man 1976, *passim*; Piniński 1993, pp. 199–202; Kubiak and Paszkiewicz 1998, *passim*; Oberländer-Târnoveanu 2004, *passim*; Paszkiewicz 2005, pp. 280–281), countries which were the main trading partners of Red Ruthenian merchants during the fourteenth century.

But the results of the investigations of a sample of 98 Bohemian groats, struck by Wenceslas II, John I, Charles IV (I) and Wenceslas IV (III) from the same Siret 1912 hoard, have proved that only 85 of them contained traces of

gold reaching the detectable level of our analytical methods (86.73%). Here they are:

Traces (*i.e.* > 0.01‰) (22 sp.); 1‰ (16 sp.); 1.2‰ (4 sp.); 1.5‰ (20 sp.); 2‰ (14 sp.); 2.5‰ (5 sp.); 3‰ (4 sp.).

The average value of the gold content of these coins was only 1.20‰ and the median reached 1.50‰ (standard deviation = 0.872442). The gold content of the Bohemian groats of Charles IV, which represent the bulk of these issues in Siret hoard (1912) is even lower. The average gold content was only 0.84‰, meanwhile the median value was 1‰ (standard deviation 8.739892). All these figures are far below the similar parameters of the Red Ruthenian coinage of Casimir III and Ladislaus of Opole.

Instead, we found that some of the Bohemian groats analysed by our team contain zinc, as well as traces of bismuth and antimony, which were not found so far in the Red Ruthenian issues.

The presence of tin was detected in eleven specimens struck by Casimir III (50%) (4‰ — 1 sp.; 3‰ — 4 sp.; 2.5‰ — 4 sp.; 1.5‰ — 2 sp.) and six specimens of Ladislaus of Opole (37.5%) (3‰ — 2 sp.; 2‰ — 2 sp.; traces — 2 sp.), but not in the Bohemian groats.

The Red Ruthenian and the Bohemian issues show also different values of the lead content, which is an almost constant component in ancient and medieval silver coinages. The average lead content of the 98 measured specimens of Bohemian groats of Siret hoard is 13.39‰ (the median value is 13‰) (28‰ — 3 sp.; 25‰ — 3 sp.; 24‰ — 3 sp.; 23‰ — 1 sp.; 21‰ — 2 sp.; 20‰ — 2 sp.; 19‰ — 2 sp.; 18‰ — 4 sp.; 17‰ — 7 sp.; 16‰ — 6 sp.; 15‰ — 7 sp.; 14‰ — 2 sp.; 13.5‰ — 3 sp.; 13‰ — 9 sp.; 12‰ — 12 sp.; 11.5‰ — 1 sp.; 11‰ — 4 sp.; 10.5‰ — 7 sp.; 9‰ — 3 sp.; 8‰ — 1 sp.; 7.5‰ — 1 sp.; 7‰ — 2 sp.; 6.5‰ — 1 sp.; 6‰ — 2 sp.; 5‰ — 1 sp.; 4.5‰ — 1 sp.; 3.5‰ — 1 sp.; 3‰ — 2 sp.; 2.7‰ — 1 sp.; 2.5‰ — 1 sp.; 2.3‰ — 1 sp.; 2‰ — 1 sp.; 0.35‰ — 1 sp.; <0.01 — 1 sp.), meanwhile the average lead content of the Red Ruthenian issues amounts to 7.04‰ (the median value is 6‰) (15.5‰ — 1 sp.; 13‰ — 3 sp.; 12‰ — 3 sp.; 11.5‰ — 1 sp.; 10‰ — 3 sp.; 9‰ — 2 sp.; 8‰ — 1 sp.; 7‰ — 2 sp.; 6.5‰ — 2 sp.; 6‰ — 5 sp.; 5.5‰ — 1 sp.; 5‰ — 4 sp.; 4‰ — 2 sp.; 3.5‰ — 1 sp.; 3‰ — 4 sp.; 2‰ — 1 sp.; 1.35‰ — 1 sp.; <0.01‰ — 1 sp.).

So, on the basis of these investigations one could conclude that it is quite likely that at least the coins so far analysed of Casimir III and Ladislaus of Opole were not struck from a silver alloy drawn exclusively from the recycling of the Bohemian currency. Among the contemporary coinages in Central, South-Eastern and Eastern Europe investigated during the ARCHAEMET or ROMARCHAEMET programmes, gold traces (amounting more than about 0.5‰–5‰) were detected in some fourteenth century Hungarian and Moldavian silver coins of Peter I (but not in all of them). The gold was always present in measurable amounts (from about 0.5‰ to 10‰) in Golden Horde issues, as well as in Wallachian, Bulgarian

and Serbian coins. But in the last three cases, the gold is always accompanied by bismuth, which is missing in the analysed Red Ruthenian coinage.

The results of the investigations of the Red Ruthenian coinage of Casimir III and Ladislaus of Opole led to the conclusion that they were struck mainly from a silver source different from the one employed by the old or contemporary Bohemian groats (Kutná Hora — Kutteneberg). One could suppose that most of the silver coined by the Lviv mint during the period c. 1364–1378 came from Eastern, South-Eastern and Hungarian sources. This silver contained enough gold to leave traces even after being blended together with other silver supplies, such as that drawn from remelted Bohemian groats. The slight diminution of the proportion of gold noted in the coinage of Ladislaus of Opole, could be explained not as a consequence of the reduction of the fresh silver supplies of the traditional metallic source containing gold on the Lemberg market during the 1370s, but as the result of the increasing addition of ‘pure’ copper into the monetary alloys.

The results of our investigations confirmed the conclusions of Kryzhaniv’skyi only partially. Our points of view met only on the fact that during the reigns of Casimir III and Ladislaus of Opole the Red Ruthenian groats minted at Lviv were struck from silver of very high fineness. The second common conclusion is that the legal standard of the mint suffered a minute reduction during the rule of Ladislaus of Opole, though it remained considerably higher than the fineness of the monetary alloys used in Poland proper, Bohemia or Hungary. The precise levels of the legal prescriptions regarding the fineness of Red Ruthenian groats under Casimir III and Ladislaus of Opole remain to be established after further investigations, based on larger scale statistical data.

Our researches on the composition of the Red Ruthenian groats struck in Lviv open a new and unexpected perspective on the origin of the silver sources supplying the local monetary market during the sixties-seventies of the fourteenth century. The analyses made by our team have shown that all these coins were struck from a silver source rich enough in gold, which is clearly different from that used by the Bohemian groats. In Lviv, the supplies of this silver rich in gold were very large, and steady enough during more than 15–20 years to maintain a constant and distinctive ‘profile’ for the monetary alloy of the Red Ruthenian groats. Even if one has to expect that some silver obtained from the remelted Bohemian groats was also employed by the mint in Lviv during the sixties-seventies, it was not enough to change the peculiar features of the trace elements in the local monetary alloy. Quite likely, the slight reduction of the gold content shown by the investigations carried out on the Red Ruthenian groats of Ladislaus of Opole seems to be a consequence of the reduction of the fineness by addition of copper, rather than a result of a significant drop of the ‘non-Bohemian’ silver supplies in Lviv.

One could suppose that the distinctive aspect of the structure of the monetary alloys used for issuing Red Ruthenian groats of Casimir III and Ladislaus of Opole was a consequence of a special economic and monetary situation, as

well as of a deliberate decision of the people involved in money handling. This situation was suddenly created during the second half of the fourteenth century in a wider geographical area than Lviv or Red Ruthenia itself. Due to the wide acceptance of the Bohemian groats in large regions in Central and Eastern Europe the merchants of Lviv preferred to keep the Bohemian groats for their transactions in Silesia, Poland, Lithuania, Prussia and Ruthenian countries, in areas where such currency was not only prized by the local populations, but even overvalued. For that reason, they did not often remelt the Bohemian groats, even if they were worn or clipped, because such coins could preserve their full status of legal tender better than any others.

On the other hand, the opening of the new trans-continental commercial road from the Black Sea to the Baltic Sea, on which Lviv enjoyed a strategic position of prime middleman, led to a large influx of silver in the form of ingots or foreign issues of Golden Horde, Hungarian and Balkan origin on the local Red Ruthenian market. These coins and bars, in spite of being struck of very good quality silver, were not always accepted in most of the territories covered by the traditional commercial connexions of the merchants from Lviv. Because of these peculiar new economic and monetary realities, and of commercial behaviour, the non-Bohemian silver became the major source of the monetary metal used by the mint of Lviv during the years *c.* 1364–1378. We hope that the further increase of investigations into the composition of the monetary alloys in Red Ruthenia struck during the second half of the fourteenth century, involving joint research teams from Hungary, Poland, Romania and Ukraine, as well as Western colleagues, will offer new perspectives in trans-European economic and technological exchanges during the Middle Ages.