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Theodosius II's solidus from Prełuki, Sanok County in material and traseological examinations

Abstract: The aim of the analysis of Theodosius' II solid was to determine the chemical compounds of the coin alloy and to conduct a traseological analysis. The results show that the fineness of gold of which the coin was made was very high (obverse: 99,16% which means 23,8 karat gold and reverse of 99,20% which constitutes for the 23,81 karat gold), and the alloy metal was silver (0,65% and 0,62%). Traseological analysis has shown, that the hole in the lower part of the obverse, 2,1 mm in the diameter, was drilled with a very sharp, narrow, conical tool, the marks of which are still visible on the inside of the hole. Also, some traces of work concerning the coin's die have been spotted. The engraving of the die was done gradually. Traces of consequent scratching with a graver are well visible both on the obverse and reverse. The character of places where sharp edges framing letters and some images are preserved serve proof of those being prepared with the use of a narrow, triangular-ended graver. All this suggests, that the maker of the die had a developed set of technical and artistic skills.

Keywords: solidus, Electron microscope, chemical compounds analysis, obverse, reverse, traseological analysis, graver, coin's die

The objective of the examination on the solidus in the name of Theodosius II was to determine the composition of the coin's gold alloy and the performance of traseological research.

The examinations into the composition of the coin's alloy have been carried out by means of non-destructive energy dispersive X-ray fluorescence (ED-XRF) analysis, with the use of the SpectroMidex spectrometer made on the basis of a molybdenum X-ray lamp with an excitation energy of 45kV. This device is fitted with the SDD detector cooled off through the Peltier effect and the CCD camera of a twenty-fold magnification value, while the traseological examinations have been conducted by means of a scanning electron microscope of the Vega Super XM 3 (made by Tescan), with a changeable void (in a range from 0 to 2500 Pa) and

an enhanced depth of the imaging sharpness, with the possibility of a chemical microanalysis of selected areas.

In addition, the study made use of a scanning electron microscope (SEM) equipped with a backscattered electron detector (BSE), optimized to operate in low vacuum conditions (LVSTD), i.e., its construction allowing for limiting the undesired "beamskirt" effect (dispersal of an electron beam in the working gas environment). Besides the imaging in a range from 5x to 1000K, the built-in EDS spectrometer facilitates the execution of qualitative and quantitative analysis (completely standardless or with the use of analytical standards). These analyses have been performed in low vacuum mode with an accelerating voltage of 30kV.

Several measurements for the obverse and the reverse of the coin have been performed using the two instruments described above. The data given in the table 1 reflect the average values of the results obtained in the process of our analysis. The procedure was similar to those employed during some other examinations of this type (cf. e.g. Biborski 2016, 205-208). The results of all the conducted analyses can be found in the table below along with the percentage weight values. According to the results, it can be inferred that the coin was minted with the use of very high-proof gold (obverse 99.16%, i.e.,23.8 carat, while the reverse 99.20%, i.e., 23.81 carat), with a small gold-hardening admixture of silver (0.65% and 0.62%). Also, the presence of some other trace elements such as copper (0.03 - 0.04%) as well as tin (0.03 - 0.04%) has been detected. Very similar results for the obverse and the reverse are indicative of a very homogeneous alloy used for striking this coin.

Table 1. Results of the chemical composition of Theodosius II's solidus

	Au%	Ag%	Cu%	Sn%
Obverse	99.16	0.65	0.04	0.03
Reverse	99.20	0.62	0.03	0.04

Interesting test results can be obtained through traseological examinations with the use of SEM (cf. e.g. Biborski 2017). From the observations conducted it can be seen that the hole in the lower part of the obverse, 2.1mm in diameter (Fig. 1: 1-4), was drilled through with a very sharp and narrow, conically shaped tool (so-called reamer), whose traces can be found in the middle in the centre of the pierced aperture (Fig. 2: 1-2). It seems to be of interest that the aperture was drilled from the reverse side first, and then it was finished up on the obverse side. This is clearly evident from the presence of burrs along the hole's edges (so-called *grad* in Polish), a result of some metal material being pushed out by the reamer.

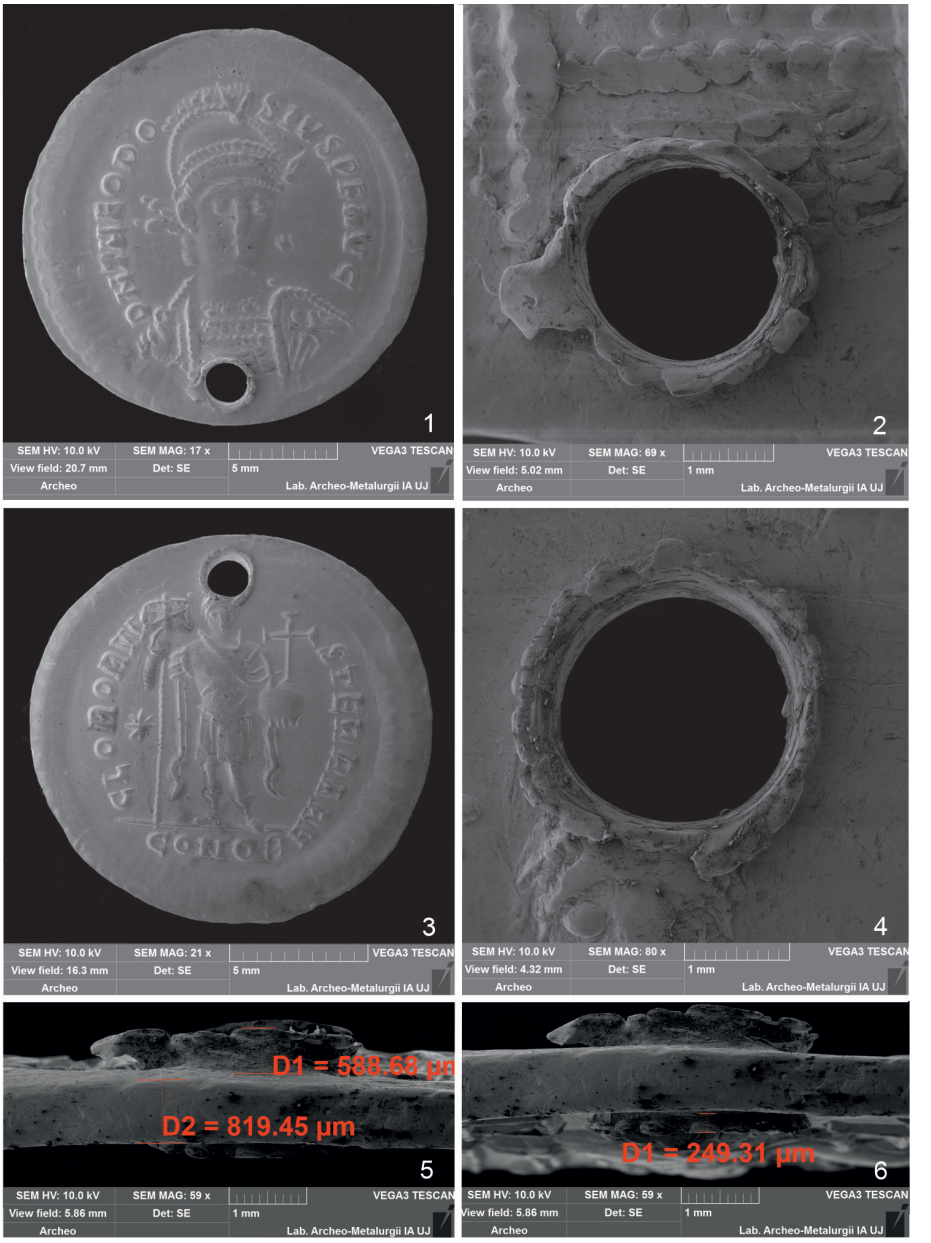

Fig. 1. Prełuki, Sanok County, Theodosius' II solidus. 1: Obverse of the coin; 2: the hole in the coin as seen from the obverse side; 3: reverse; 4: the hole in the coin as seen from the reverse side, 5: view from the profile (in the upper part of the picture: reverse); 6: view from the profile (in the upper part of the picture: obverse)

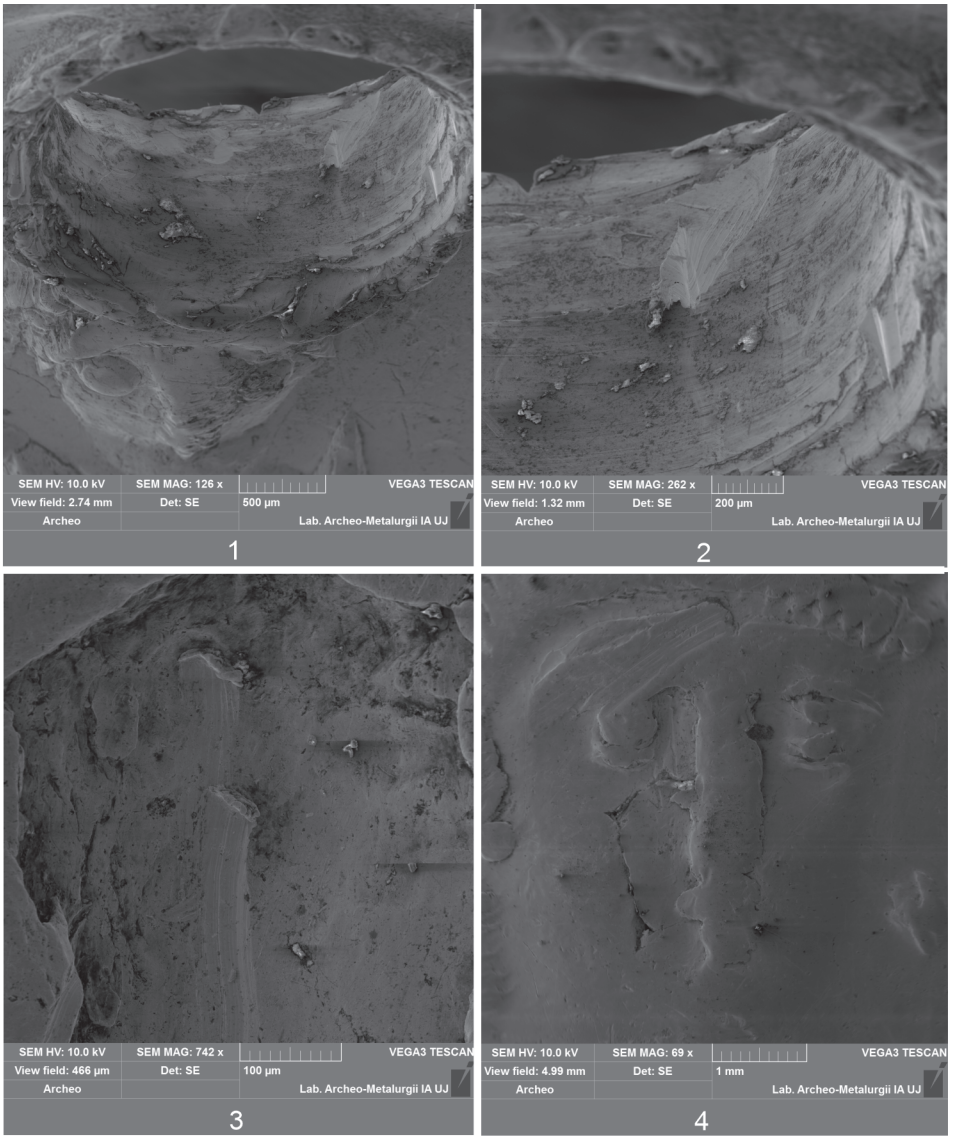

Fig. 2. Prełuki, Sanok County, Theodosius' II solidus. 1: View of the inside of the hole from the side of reverse; 2: view of the inside of the hole from the side of reverse – close up; 3, 4: traces of destruction of the coin surface

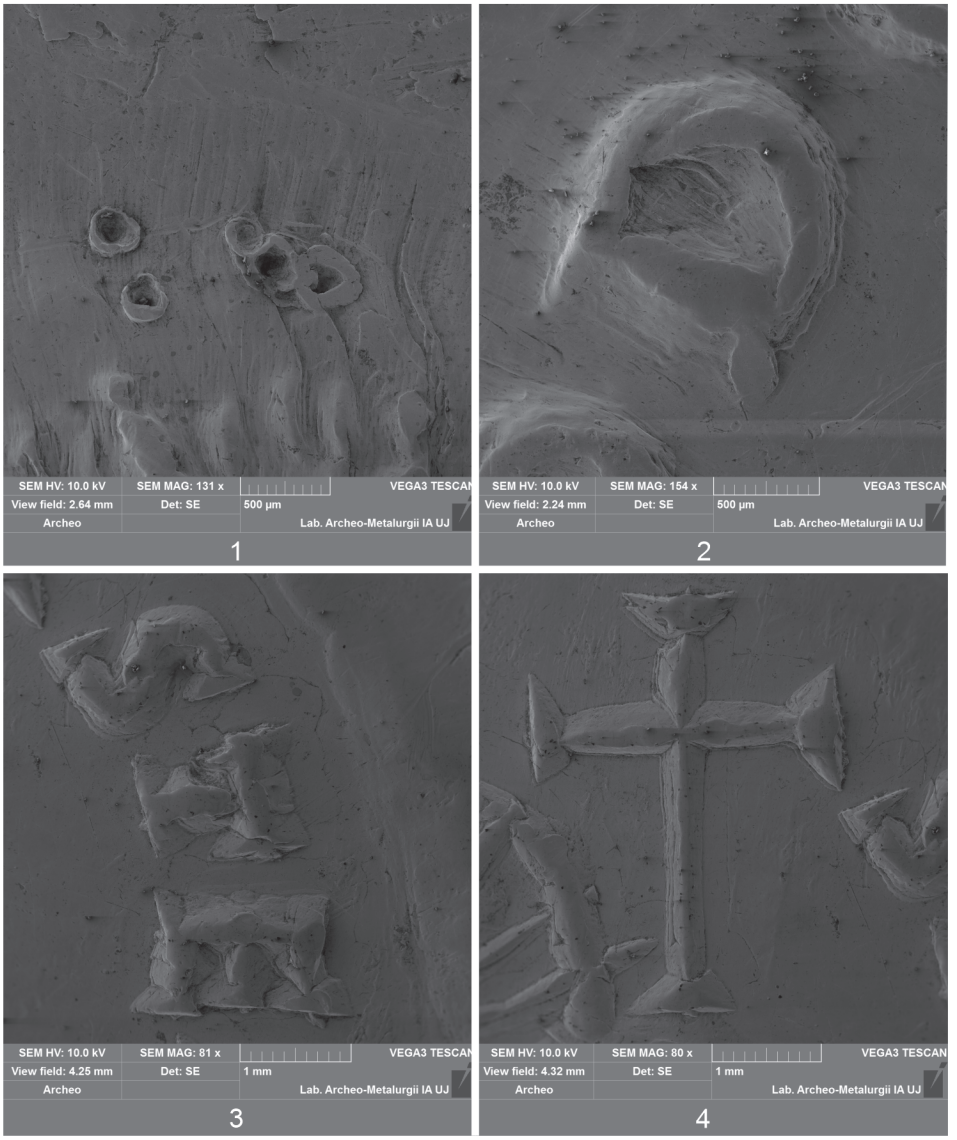

Fig. 3. Prełuki, Sanok County, Theodosius' II solidus. 1: Traces of punching above the head of the emperor (obverse); 2: traces of engraving inside of the letter „D" (obverse); 3: traces of engraving visible at the surface of the obverse of the coin;
4: traces of engraving visible on the cross

Most evidently, the drilling was done in two stages, as indicated by the much larger and higher burrs on the obverse side (588.68 μm) and the lower and smaller ones, most likely resulting from the finishing up of the hole, on the reverse side (249.31μm), (Fig. 1: 5-6). It is somewhat surprising that the inner surface of the hole only shows some early traces caused by the drilling, but there are no (even the slightest) traces of wear and tear (Fig. 2: 1-2).It is worth noting that the gold material is very soft and liable to damage, which is evident in numerous traces of obliteration and other damage all over the coin's surface (Fig. 2: 3-4). For this reason, it would appear that the solidus was not worn as a pendant or was worn for a very short time only.

Under the microscope, we have been able to detect five small dents over the emperor's head on the obverse surface, most likely done with the use of a centre punch (Fig. 1: 1, 3: 1). It is not certain what purpose they might have served, but it is plausible that the initial intention was to make an aperture there and what can be seen are the traces of five attempts to find the right point of puncture. Eventually, however, for reasons unknown, the hole was drilled from the other side of the coin.

We can also notice some individual traces of the work on the coin's die and the fact of the usage of a suitable tool. Upon observation of the legend's lettering and the elements of the emperor Theodosius' representation, it can be ascertained that the etching work on the die was done in stages. The traces of a gradual removal of material by means of a graver can be seen very well, for instance, in the letter D on the obverse (Fig. 3: 2). Clearly visible there are the gradual traces left by the graver, first more shallow, then going deeper and deeper, until the very base of the letter. The identical well-preserved traces can be observed on the obverse, as discernible in the lettering and also e.g. in the depiction of the cross (Fig. 3: 3-4). Places where there are sharp edges cutting off the lettering and some of the images from the base material would indicate that they were made with the use of a triangular graver tool.

Thanks to the presently described examination, it can be determined that the maker of this coin die was technically skilled and experienced, but this person must have also possessed knowledge and a sense of artistic craftsmanship. The tool was employed with much ease and precision.

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