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Metallurgical technology of coins from Samshvilde fortress (South Georgia, Caucasus)

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***Abstract* – Samshvilde represents one of the most representative Georgian archaeological sites thanks to its complex history that began in the Neolithic times and ended in the 18th cent. The area has been always considered an important crossroads for its geographical position, and, for this, rich in different kinds of artefacts from pottery, obsidian objects, bronze coins to other furnishings. This variety testifies to the progress of the different civilizations over time in terms of culture, lifestyle, and technological skills. In the paper, two bronze coins were investigated to determine the main technological process used in the area during the Medieval Age and to increase the knowledge of metallurgical manufacture in the South Caucasus region that is still partly to be discovered.**

I. INTRODUCTION

The studies on the spread of coinage in antiquity are fundamental to reconstruct the social and economic relationships. Also, the selection of the raw materials and the techniques of minting, can suggest information on the historical and political changes in the past. For example, minting is directed by the needs of a political entity for payment or profit; circulation is dictated by the movement of goods within a market economy, and deposition results from a decision to remove currency from circulation for safekeeping or future use (hoarding), or from accidental loss (stray finds), or more for religious purposes. [1].

Analytical techniques commonly used for archaeometric aims for different materials such as Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) [2,3] were also applied with success to the metallurgical investigations to define the manufacturing process of the coins from the choice of the raw materials until to the minting [4-6].

Georgia and more in general Caucasus are, since the ancient times, a fundamental crossroad between the Western and Eastern civilizations with strict contamination of lifestyle, culture, and manufacturing techniques. Samshvilde archaeological site in the south of Georgia is a clear example of this heritage.

Its excavations unearthed traces from Neolithic, to Byzantines, Georgian kingdom, Mongols, Arabian and Turkish ages. The site is rich of artifacts in pottery, obsidian, metal, stone, and other findings that reflect perfectly the numerous historical events that went through the area. It is only last decade, that the site was subject of systematic archaeological campaigns by the University of Georgia. In fact, the previous studies, and results, regarding all the Caucasus area, had little diffusion in the scientific world due to the historical and political issues attributable to the government of the Soviet Union. Even in the case of coins, there are numerous studies and important collections which however remain closed in the museums [7,8].

In this work, two ancient coins of Georgian Kingdom coming from Samshvilde were investigated by SEM-EDS to determine the coinage production techniques typical of that period.

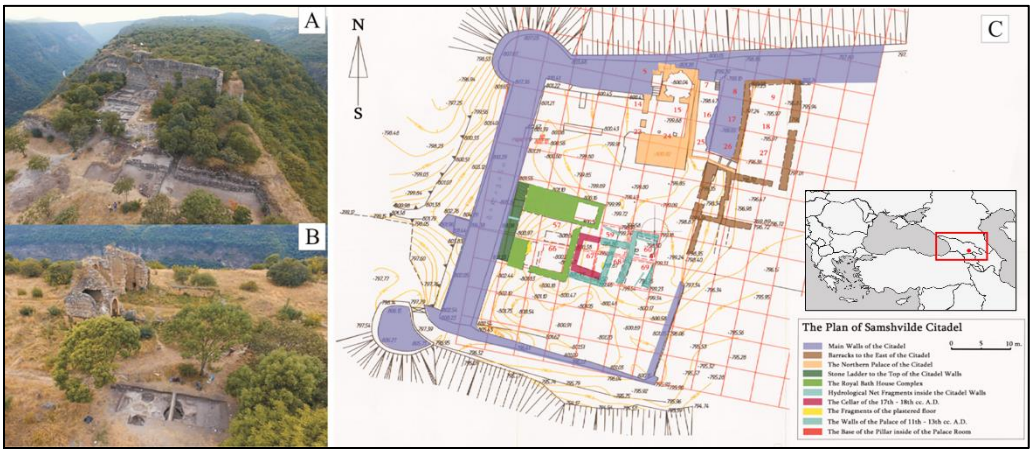

Fig. 1. Samshvilde archaeological site and main ruins of Citadel from the East (A) and the Sioni Cathedral and the excavated area (B); map of Samshvilde citadel showing the main structures in different colours and the numbered trenches (C). Image modified from [9].

II. ARCHAEOLOGICAL SETTING

Samshvilde is one of the most relevant Caucasian archaeological sites, despite the studies available are still few (Fig. 1).

Its strategic position meant that the area was inhabited since the Stone Age until XVIII century. In fact, it is in Kvemo Kartli province (Southern Georgia) on a characteristic basaltic body deeply cut by Khrami and Chivchava belonging to the dense hydrographic basin of Kura River and near to the southern route of the Silk Road. The settlement stretches for 2.5 km in length and 400 metres in width [10,11].

At Medieval times, there was a clear separation between the social classes: on the west side the lower ones, whereas, in the central part the upper ones. Here high structures were enclosed by a 12 m high and 7 m wide fortification wall, forming a citadel. Such heavily fortified well preserved defensive systems are characterized only for most important sites in the southern Caucasus [12].

Currently, just two main structures are visible in area: the Sioni Cathedral and the citadel (Fig. 1a-b).

In the past, many dominations followed in Samshvilde and in Kvemo Kartli region from the Sasanids, Arabs, Byzantines, Armenians, Mongols to the Turks. The city went through many periods of crisis and rebirth over the centuries: from the "golden age" in the XII cent to the decline in the XVIII cent.

George III was the 8th King of Georgia and reigned during the "golden age" from 1156 to 1184. After his death, he was succeeded by his daughter Tamar the Great, the first and the greatest queen of the Georgian History.

Because of all these historical events the area and, especially the citadel is rich in stone, ceramic, glass, and metal findings datable back between V and XVIII centuries. In this regard, the most notable item of the medieval artifacts is the numismatic hoard discovered in 2018 containing more than 280 local and imported copper and bronze coins.

III. MATERIALS AND METHODS

The Samshvilde Archaeological Expedition of the University of Georgia conducted eleven field seasons from 2012 to 2023.

A system of 6 archaeological trenches (5 × 5 m each, no.59, no. 60, no. 66, no. 67, no. 68, no. 69) was realized in the Citadel area (Fig. 1c). The excavations unearthed so far archaeological deposits of 1.3 m depth dated back to the high-late medieval centuries (XI–XIII centuries).

The stratigraphy of the deposits perfectly reflects the chronological order of the historical periods present in the site: The medieval findings overlap Islamic and pre-Islamic archaeological contexts, but they also are overlapped by the deposits of Ottoman periods [9].

The coins #532 and #783 were found, respectively, during the excavation's campaigns in 2017 and 2019 in Samshvilde citadel in the trench no. 60 and squared C-2 e C-3 at 1, 20 m deep.

The artifact #532 is a coin dated back to king George III (1156-1184), instead the coin #783 to king Tamar (1184-1210). The coins were also weighted, and they are respectively 4,03 g and 1,53 g [11].

During the analytical phase, the samples were previously coated with a thin and highly conductive graphite film and then undergone analysis by an ultra-high-resolution SEM (ZEISS CrossBeam 350 equipment), coupled with an EDS – EDAX OCTANE Elite Plus - Silicon drift type detector. type.
SEM-EDS investigated the compositional inhomogeneity of the coins. The morphological analyses were acquired in backscattered electrons (BSE), whereas the compositional data are expressed in elements and their distribution was showed and mapped in RGB model.

Fig. 2. Obverse view of the coins investigated: #532 on the left and #732 on the right side of the image.

IV. RESULTS AND DISCUSSIONS

The SEM microphotographs show the general inhomogeneity of the surface and consequently of the composition (Fig.3).

Table 1 reported results about all elements determined in coins by SEM-EDS. Copper represents the main metal of the alloy exceeding 95% wt. in both coins, whereas lead is about 2% wt. and is visible in clearer domains like random droplets highlighted also in RGB image (Fig.3-4).

Most probably, lead represents impurities of the original deposit; in fact, copper and leads are immiscible metals in each other during the melting process, so the presence of these structures is rather common [13]. Moreover, the presence of lead has the effect of making the alloys of copper easier to cast and it is advantageous during the production of cast objects such as coins, less in swords or daggers blades where a major resistance is necessary [13]. The other elements, especially in #783, are present in minimal amount under the threshold of 1% wt.

They probably come from exogenous materials deposited on the surfaces of the coins during the burial stage in the soil (mostly, Mg, Al, Si) [14,15] or they can also represent the beginning of some deterioration phenomena (essentially, Cl) [14,15]. In this regard, chlorine generally suggests the development of decay processes affecting the copper such as the formation of corrosion patinas made of minerals like nantokite (CuCl). "Bronze disease" is the most serious one in many copper-based alloys, caused by cyclic reactions of nantokite with the internal and external bronzes under the influence of oxygen and water [13]. Generally, the visual effect of bronze disease is the formation of pale green, powdery spots and is also accompanied by the stress cracking of the surface due to the morphology change and subsequent deeper penetration of nantokite into the bronzes [16]. Nevertheless, this process is not still so advanced in the samples investigated.
The composition of the artifacts is perfectly comparable with the compositions of the coins minted in the united Georgian Kingdom (12th–13th c.) when the coins in circulation were mainly the issues of the queen Tamar and her successors. In fact, the Mongol invasion after 1213 destroyed all the main cities and contributed to the creation of a situation of political and economic instability. Thus, all Georgian coins of the epoch were struck in copper, due to the befallen silver crisis [8,17] and perhaps a consequence of the looting of precious treasures by the Mongols and the great availability of copper mines in the region. The production was so large that some pieces of metal were not transformed into blanks but were struck directly [7]. It is worth pointing out that Southern Georgia with the Bolnisi district is from millennials to nowadays one of the most important mining centres of the Country where ores and minerals such as copper, silver, manganese are extracted mainly in open pit mines [18].

Table 1. Summary of all elemental EDS analysis carried out on samples and expressed in weight %.

Element	Sample	
	#532	#783
Mg K	-	0,3
Al K	0,2	0,1
Si K	0,6	0,3
Cl K	-	0,3
Cu K	95,8	95,4
Pb M	3,4	3,6
Tot	100,0	100,0

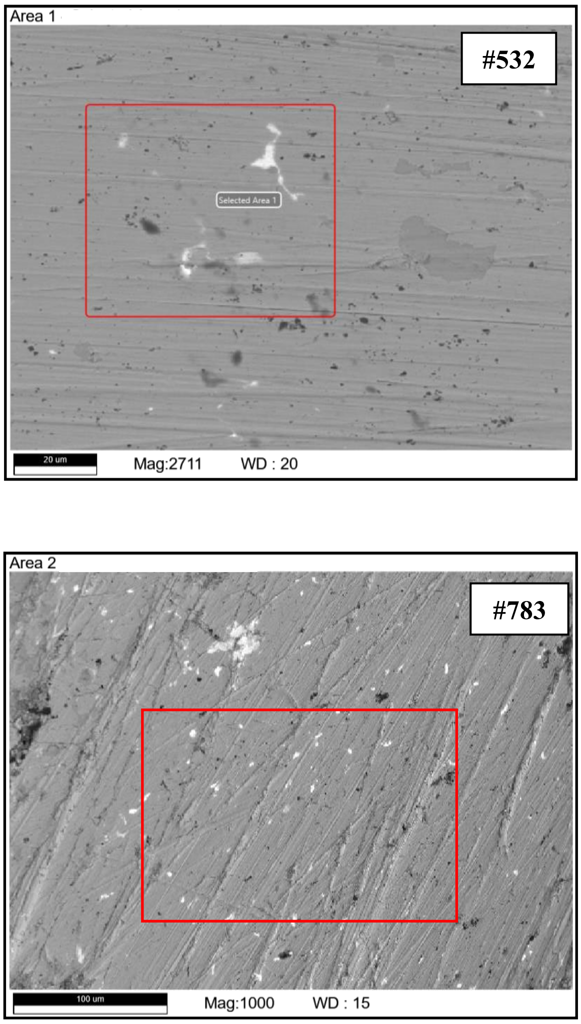

Fig. 3. SEM images in BSE of the micromorphological features of the coins.

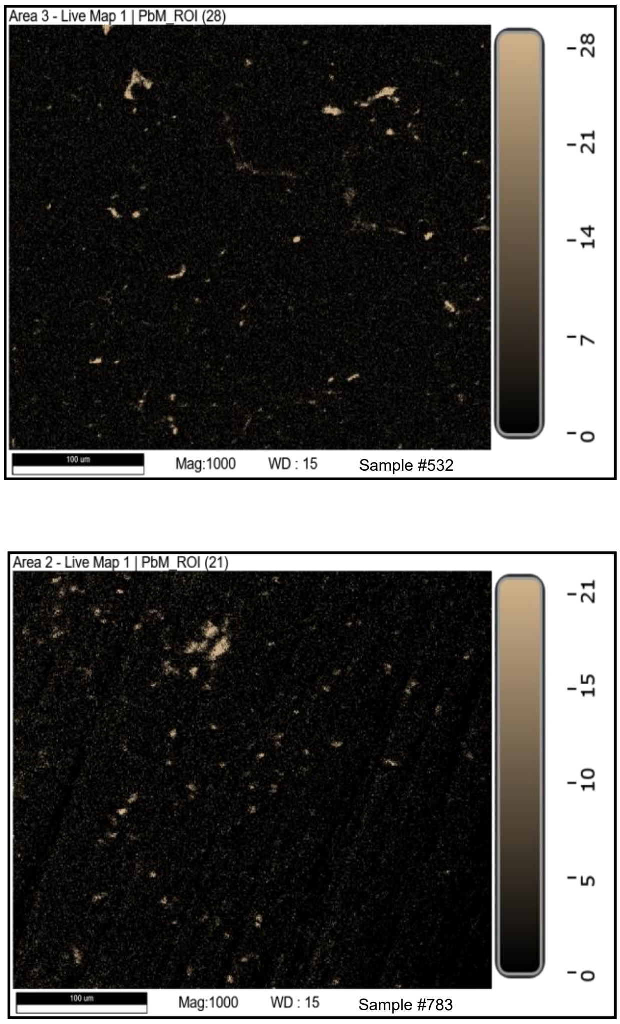

Fig. 4. EDS mapping distribution in RGB model of Pb in coins.

V. CONCLUSIONS

In this work, two ancient Georgian coins coming from Samshvilde archaeological site were investigated by SEM-EDS to define the raw materials and the production processes. The analyses indicated a rather homogenous composition almost exclusively in copper with subordinate lead amounts typical of the United Kingdom of Georgia as reported in historical sources. Moreover, the results obtained demonstrated how Samshvilde was an important centre of economic and commercial exchanges as suggested by the huge number of findings found during the archaeological excavation.

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