Late Roman Glass Furnace in *Heraclea Sintica*

Lyudmil F. VAGALINSKI, Sofia

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A glass kiln found in 2016 in Heraclea Sintica (southwestern corner of Bulgaria) is published. The furnace was used of secondary glass production applying the technique of free-blowing. The furnace dates back to the first half of the fourth century AD.

Key words: *glass, kiln, secondary glass production, Heraclea Sintica, ancient Macedonia*

Introduction

Heraclea Sintica lies in the south-western corner of Bulgaria, near the village of Rupite, Petrich municipality. This ancient city has been systematically researched through archaeological excavations since 2007[1]. The information currently available indicates that was founded by Macedonian colonists in the second half of the 4th century BC. After the Battle of Pydna in BC 168 the city was associated to the Roman state and belonged to the province of Macedonia. Its population was ethnically diverse: ancient Macedonians, Thracians, Hellenes, Celts, Romans, Illyrians (?) and even settlers from distant places like Miletus and Carthage. The city developed successfully despite several enemy attacks. Two powerful consecutive earthquakes caused severe damage. The first happened soon after AD 388. The residents of the city did not restore the agora, but around AD 400 they built an early Christian basilica in the north-eastern corner of the late Roman forum (Fig. 1). The second earthquake hit *Heraclea* shortly after AD 425. It broke the will of the citizens, among whom there are wealthy people, to restore their city. Life in the settlement centre of Middle Struma River's valley in Antiquity faded slowly throughout the second half of the 5th century (*terminus post quem* AD 457).

[1] The author is head of the archaeological research. About *Heraclea Sintica* see: Vagalinski & Nankov 2015; Sharankov 2016; Sharankov 2017; Vagalinski 2018; Vagalinski 2018a as well as www.archaeologia-bulgarica.com

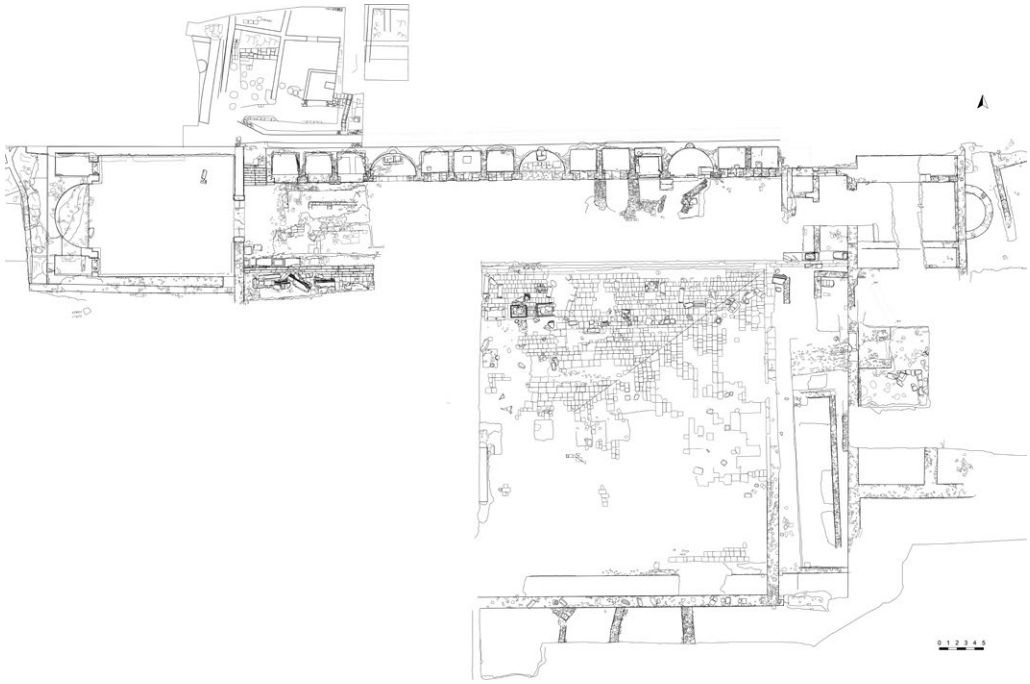

Fig. 1. Plan of the late Roman forum of Heraclea Sintica *(Milena Kamenova).*

Description of the furnace and its use

The furnace was studied in the summer of 2016. It is not published. It is located in the northwest corner of the civic basilica of the city and more precisely in the northeast corner of the northern of its two vaulted rooms (Fig. 2). The basilica itself, with its inscribed apse, occupies the northwest corner of the Late Roman forum (Fig. 1).

Fig. 2. Late Roman glass furnace in the civil basilica of Heraclea Sintica *(the author).*

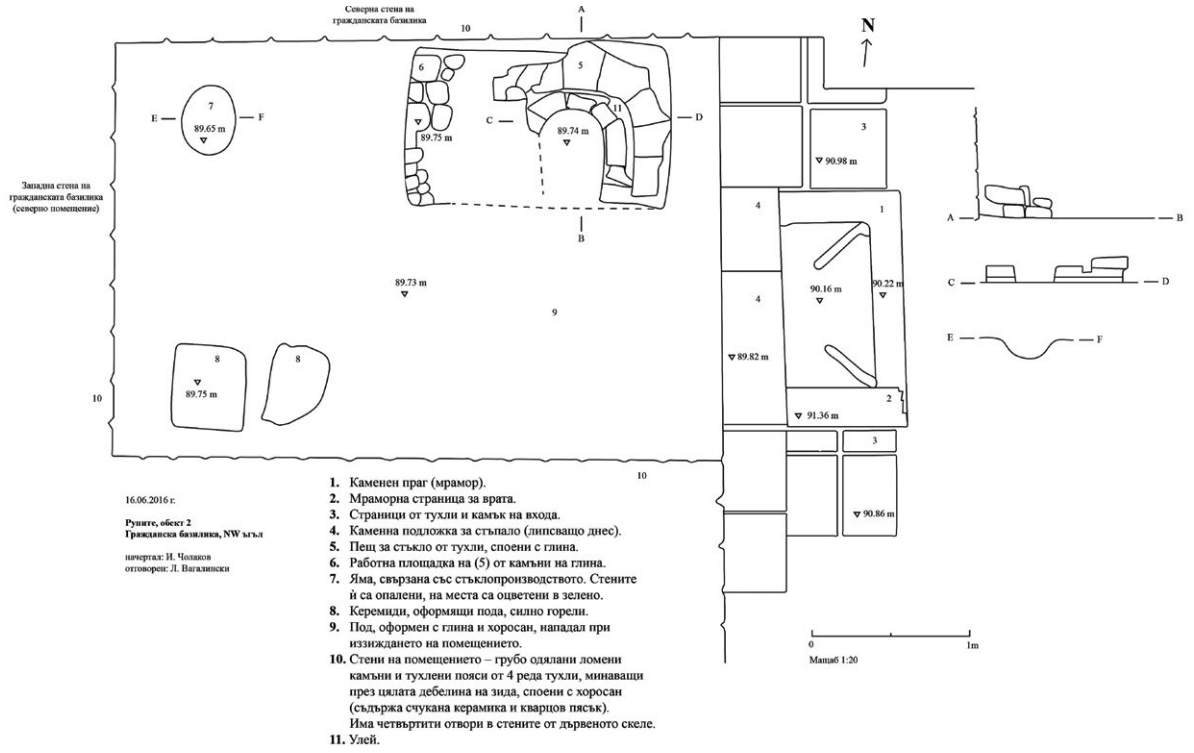

Fig. 3. Plan of the civic basilica's northern vaulted room with glass kiln (Ivo D. Cholakov).

The furnace has a horseshoe shape (Fig. 3). It is built of bricks, bound with clay. The floor is clay, 4 cm thick in total. Only the base is preserved and its southwest part is missing. The clay vault, walls and crucible have not survived. There are two construction phases of the furnace. Because of the very high temperatures developed, glass furnaces had a short life span; they were quickly worn down and constantly required small repairs. It is possible, that they were demolished and rebuilt every year, looking like overlapping rings when excavated (Antonaras 2017: 11).

The first phase is the outer, larger, horseshoe shaped structure (Fig. 3: 5). Its maximum outer width (east-west) is 112 cm. The maximum inner width (east-west) is about 60 cm. The preserved outer length (north-south) is 101 cm. The walls are up to 30 cm thick. They are preserved up to 20 cm in height. The interior of the walls is carefully plastered with clay to withstand the high temperature. The clay floor of the first phase is 1 cm thick.

A smaller horseshoe shaped structure, inscribed into the first one, represents the second phase (Fig. 3). It was built the same way as the first one. The inner width (east-west) of the second phase is about 37–40 cm. There is a distance between the walls of the two phases so that a 2 cm wide groove is formed (Fig. 3: 11). The floor of the second one is 3 cm thick and covers the floor of the older larger furnace.

The uneven rock around the furnace was levelled up with stones, welded with clay (Fig. 3: 6).

230 cm to the west of the furnace and from its centre a pit with oval plan was discovered (Fig. 3: 7); its dimensions are 50 cm (north-south axis) per 40 cm (east-west). Its depth is about 12 cm. The pit was full of ash. It probably served to gradually cool the hot glass vessels. This process, known as annealing, required 18–20 hours (Antonaras 2017: 11).

Approximately 250 cm southeast from the centre of the furnace there were two flat tiles (*tegulae*), carefully placed in horizontal position (Fig. 3: 8). It is difficult to conclude whether this is a ground for rolling the vessel to achieve its final form (Antonaras 2017: 10).

Pieces of glass from the vessel production (testing droplets and deformed masses of glass) as well as small fragments of raw glass were found around the furnace (Fig. 4). The small number of glass fragments found during the excavations confirms that efficient recycling must have been a high priority for ancient glassworkers (Antonaras 2017: 49). There is not enough data to identify the types of glass vessels produced in the furnace.

Fig. 4. Glass fragments by the Late Roman glass furnace in Heraclea Sintica *(the author).*

The kiln was used for secondary glass production applying the technique of free-blowing. It resulted in reduction in the price of glass products. Most residents of the Roman Empire could afford to buy such, even though their price was 10–20 times higher than that of clay pots of similar size. From the 2nd century onwards, most glassware was produced locally. In the eastern part of the Roman Empire, small independent producers prevailed (Antonaras 2017: 9, 15, 17, 48–50). Most likely, such was also the glassmaker from the civic basilica of *Heraclea Sintica*. The social status of craftsmen in the Roman Empire was very low (Antonaras 2016: 89). Glass furnaces, similar as shape and size, are known from other cities in late Antiquity Macedonia (4th – 6th c. AD): Thessaloniki, Edessa and Philippi (Antonaras 2014; Antonaras & Chrysostomou 2015). Typical of the age, they are located in the central parts of these settlements too.

Dating of the furnace

Stratigraphic dating

An enemy attack hit the city soon after AD 276. Its inhabitants quickly recovered and began a massive reconstruction of their forum. The civic basilica was then built. Probably this ambitious building program was also provoked by a decree of Emperor Galerius, which affirmed the urban status of *Heraclea* (Mitrev 2003). A powerful earthquake soon after AD 388 stroke while the construction of the central square was still unfinished. After the quake, the ruins of the furnace were covered by the clay flooring level of the next, fourth, settlement period, during which the basilica was used for husbandry purposes. Thus, the archaeological / stratigraphic date of the furnace stands between AD 276 and AD 388.

Archaeomagnetic dating

This dating is performed by Assist. Prof. Dr. Deyan Lesigyarski and Assoc. Prof. Dr. Maria Kostadinova-Avramova (both from the National Institute for geophysics, geodesy and geography at Bulgarian Academy of Sciences, Sofia). It reveals, that the furnace was ignited for the last time in the interval between AD 303 and AD 354 (Fig. 5).

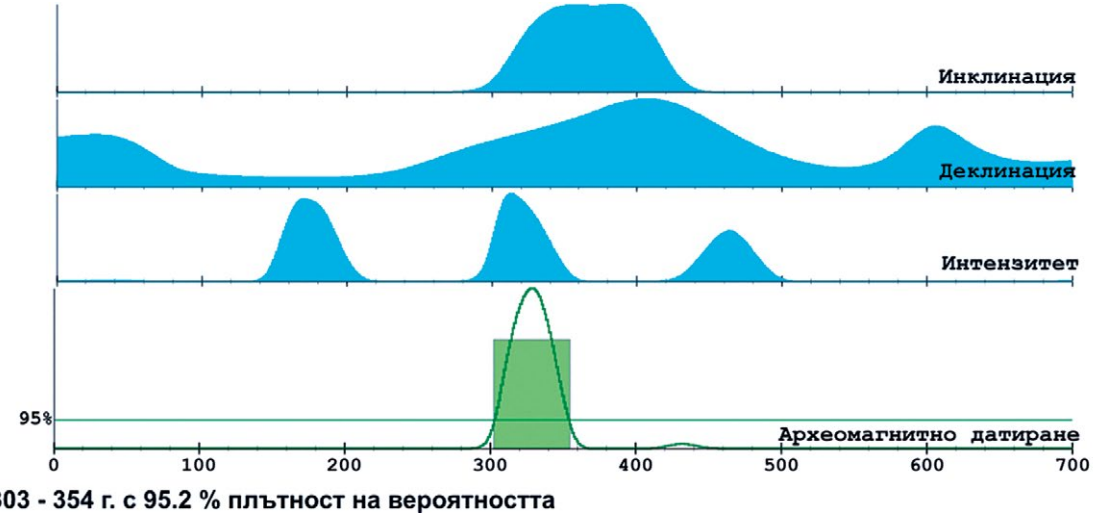

Fig. 5. Archaeomagnetic dating of the Late Roman glass furnace in Heraclea Sintica *(Deyan Lesigyarski & Maria Kostadinova-Avramova).*

It may be assumed that the furnace functioned in the first half of the 4th century.

Chemical analysis of glass fragments found around the furnace

The chemical analysis is performed by Assist. Prof. Dr. Boika Zlateva (Sofia University, Faculty of chemistry and pharmacy, Dept. of Analytical Chemistry) and Assist. Prof. Dr. Deyan Lesigyarski (National Institute for geophysics, geodesy and geography at Bulgarian Academy of Sciences, Sofia). The authors will publish the results of the study separately and in detail. Only the main conclusions will be presented in the present paper.

The analysis of 57 samples is performed through inductively coupled plasma atomic emission spectrometry (ICP-AES 6000, Perkin Elmer) and inductively coupled plasma mass spectrometry (ICP-MS DRC-e, Perkin Elmer). All the analysed samples show a high content of Na_2O, which determines the glass as sodium – typical of the Roman glass found on the territory of modern Bulgaria. Natural soda was used for the production. There are three prescription norms for glass production according to the ratio of the main components – capital-Roman, provincial-Roman and Middle Eastern. The analysed glass fragments belong to the provincial-Roman type. On the other hand, colorants such as MnO_2 and Sb_2O_3, which are typical of the Middle Eastern recipe, are used in the production. Interestingly, in about 10% of the samples, a significant amount of As_2O_3 has been found.

Conclusion

The location and stratigraphic position of the furnace confirm the field results that the rebuilding of *Heraclea Sintica*'s forum in the 4th century lasted for a long time, most probably for financial reasons. The earthquake at the end of the 4th century found the square unfinished. Obviously, the construction of the civic basilica was halted for a while and a glassmaker took advantage to deploy his workshop in its premises.

Until now, we have archaeological data for several manufactures in *Heraclea Sintica*: amphorae[2], terracotta, bone and stone products, fabrics (Cholakov 2015). The present glass furnace enriches our knowledge about crafts in ancient Macedonia[3].

[2] Unpublished results.

[3] My gratitude to Dr. Anastassios Ch. Antonaras (Thessaloniki) for his advices regarding the interpretation of the furnace.

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