Journal of Archaeological Science: Reports 17 (2018) 617–633

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Firing temperatures of ceramics from Bulgaria determined by rock-magnetic studies

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ARTICLE INFO

Keywords:
Ceramic sherds
Firing temperatures
Magnetic susceptibility
Pottery manufacturing

ABSTRACT

Maximum firing temperatures were determined for a large (198 samples) and variable collection of ceramic sherds from Bulgaria using magnetic susceptibility measurements. The data obtained were combined with the existing archaeological evidences as a first attempt to elucidate the technological development of pottery production in four important Bulgarian archaeological sites – Plovdiv, Pliska, Veliki Preslav and Dragovishtitsa. The results obtained confirm that magnetic susceptibility method is a very effective and precise tool for the determination of ancient firing temperatures, which overall vary from 550 °C to 1010 °C. Regardless of the great variability of the samples studied (according to their archaeological context, technological characteristics and purpose of usage); the results point out that maximum firing temperatures increase with time. Furthermore, in the earlier periods, firing temperatures of cooking and serving wares are distributed in similar ranges. Thus, the purpose of usage of the vessels has not been decisive about their manufacturing. The technological development in later periods obviously leads to the improvement of the quality of the serving vessels first and of the cooking pots after, but the highest firing temperatures are principally related to serving potteries and especially to the glazed ones. The results obtained for Pliska and Veliki Preslav, located relatively close to each other, indicate that during 10–11 c. CE serving vessels have been produced at higher temperatures in Veliki Preslav in comparison to Pliska but there is no such a difference for the cooking pots. This agrees well with the different status of both settlements at that time. Further expansion of the study by analyzing greater number of well-stratified samples of different types and quality, grouped in type-technology sets could allow finding more precise and common characteristics and trends, which could be compared in synchronous archaeological sites.

1. Introduction

Ceramic fragments are the most common artefacts found during archaeological excavations. They are considered as a valuable source of information concerning the culture, tradition, manufacturing tendencies and skills of ancient communities. The traditional study of ceramic typology alone is not able to restore the ancient firing technologies used for pottery production. Many studies (Maniatis and Tite, 1981; Tite and Maniatis, 1975; Bertolino and Fabra, 2003; Matau et al., 2013; Damjanovic et al., 2014; Bayazit et al., 2016; Karacic et al., 2016; Ricci et al., 2016, etc.) show that combination of archaeological evidences and interdisciplinary analytical studies could be very helpful to solve archaeological problems as determination of provenance and characterization of ceramics technologies. Generally, all types of firing procedures applied for pottery production can be described by several thermal characteristics – duration of the firing process, heating/cooling rate, maximum firing temperature, soaking time, and firing atmosphere. However, it should be taken into account that the reconstruction of any firing process is not an easy task because it is a unique event with specific firing conditions affected by different factors (Livingstone Smith, 2001; Carrancho and Villalaín, 2011; Bentsen, 2013). The duration of firing may continue from several hours to several days with regular refuel or without any intervention (Maniatis and Tite, 1981; Livingstone Smith, 2001). The production may be left to cool down in the structure slowly or it can be taken out while it is still hot (Livingstone Smith, 2001). The firing temperature may vary not only within the used structure but also within a single vessel (Gosselain, 1992; Martineau and Pétrequin, 2000; Livingstone Smith, 2001; Spassov et al., 2008; Catanzariti et al., 2008; Maggetti et al., 2010). The atmosphere may be reducing or oxidizing according to the type of fire

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https://doi.org/10.1016/j.jasrep.2017.12.021
Received 14 August 2017; Received in revised form 1 December 2017; Accepted 8 December 2017
2352-409X/

(pit, bonfire, kiln, etc.), the fuel used or the amount of organic matter in the initial clay (Maggetti, 1982; Maritan et al., 2006; Felicissimo et al., 2010). In addition, it can be changed rapidly during the process by some fluctuations in wind and weather (for open firings) or because the ancient potters aimed to produce specifically coloured vessels.

The most common methods (XRD, SEM, DTA, TGA, Mossbayer spectroscopy, etc.) used in archaeometric studies for provenance and firing temperature determinations are indirect, have low level of precision and are applicable only over a limited temperature range (Tite and Maniatis, 1975; Zhu et al., 2014; Karacic et al., 2016). In addition, the results obtained may be influenced by the burial conditions (Keller et al., 2005; Kloužková et al., 2016). In this aspect, methods based on the magnetic properties of ancient ceramics seems to be much more promising and successful (Coey et al., 1979; Beatrice et al., 2008; Rasmussen et al., 2012; Karacic et al., 2016) but they are still rarely applied.

The present study is a first attempt for characterization of a large and variable collection of ceramic sherds from Bulgaria combining archaeological evidences and magnetic susceptibility measurement method for determination of maximum firing temperatures proposed by Rasmussen et al. (2012). The data obtained will allow shedding more light on the technological development and changes in ceramic production in several historical periods, for different ethno-cultural and social communities. An additional task is to demonstrate the possibilities of rock-magnetic analyses and to promote them as an easy, effective and precise tool for determination of maximum firing temperatures of the ancient ceramics.

2. Description of the samples studied and archaeological background

The collections investigated include 198 pottery fragments from four archaeological sites in Bulgaria (Fig. 1):

1) Plovdiv – 79 samples from №65 “Tsar Boris III” Bld.; №64 “Ivan Karadjov” Str.; and №22 “Graf Ignatiev” Str.;
2) Pliska – 69 samples from sites “Secret burned underground passage”, “SE periphery of the Inner city” and “Palace centre – East”;
3) Veliki Preslav – 35 samples from “Ruler's Church” (Vaklinova et al., 2009);
4) Site №5 near Dragovishtitsa village – 15 samples.

Plovdiv is one of the most ancient cities in Europe. It has a long history spanning more than eight millennia through which it was given various names. The earliest signs of habitation on the Plovdiv territory are related to the 6th millennium BCE. Many different tribes left their traces on the twelve-meter tick cultural layer of the city. In 4 c. BCE the Macedonian king Phillip II named the settlement Philipopolis and he is probably responsible for the building of fortification walls and other facilities, which turned the city in a modern centre for that time. The development of Plovdiv continues through the next epochs. It is especially significant during the Roman period when it became an important administrative centre (metropolis) of the Thrace province. During the Third Crusade (1089), the troops of Emperor Friedrich I Barbarosa stayed in Philipopolis for six months. Obviously, 12 c. CE is another important prosperity period for the city because the literary sources describe it as one of the most beautiful cites in the Byzantine Empire (Robert de Clari, 1924).

Pliska was the oldest capital of the First Bulgarian Empire founded in the end of 7th century. In the 8–9 c. CE, it was the main metropolitan centre of the Bulgarian rulers and with its area of 23 km^2 stands out among the big urban agglomerations in medieval Europe. In the 10–11 c. CE, the city grew also demographically and became one of the most populated cities on the Lower Danube (Grigorov, 2016).

The appearance of Veliki Preslav on the historical scene is related to the first two decades of the 9th century (821–822) and is associated with the large-scale construction program of the Bulgarian khan Omurtag (814–831). The built-in, for the purpose of guarding and

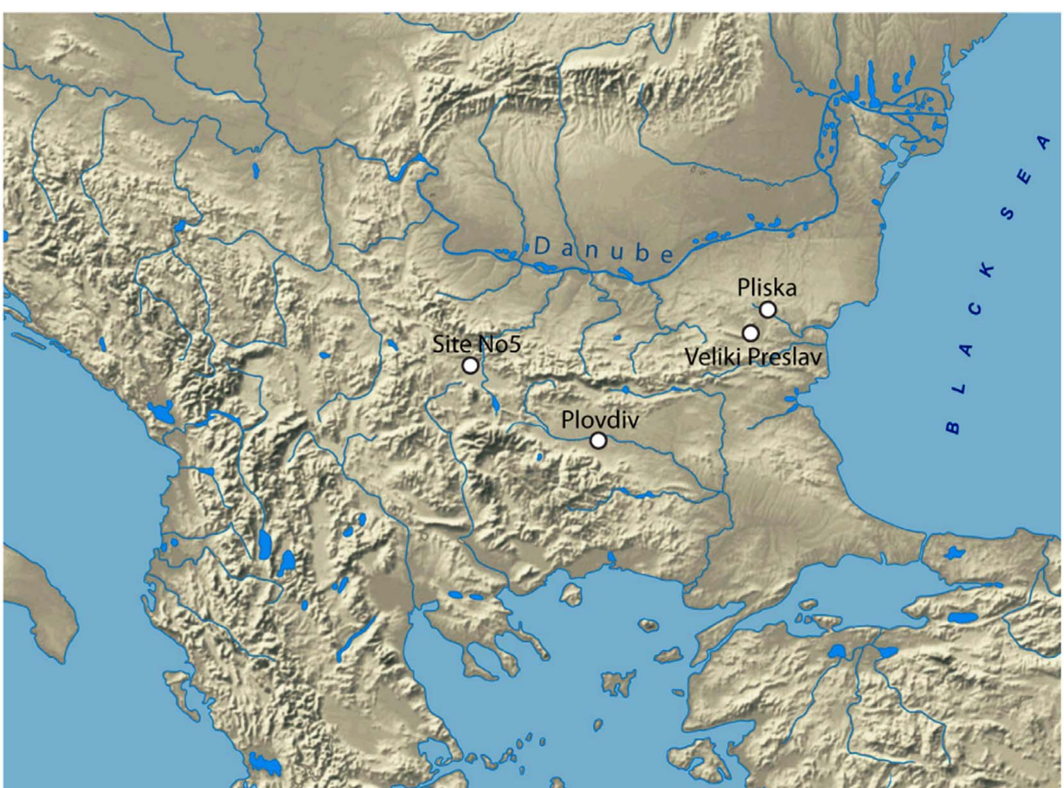

Fig. 1. Locations of the archaeological sites studied.